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IMPACT OF RIVER WATER ON THE GROUND WATER QUALITY IN VARANASI DISTRICT

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ABSTRACT

As the Nation's concerns over water resources and the environment increase, the importance of considering ground water and surface water as a single resource has become increasingly evident. Humans have strongly impacted the global water cycle. Discharge of contaminated aquifers to streams can result in long-term contamination of surface water, which may ultimately contaminate aquifers. Water quality plays an important role in promoting agricultural production and standard of human health. The overexploitation of groundwater has detrimentally affected groundwater in terms of the quality and quantity in Varanasi region. The qualitative analysis of river Varuna water shows the complete deterioration to the extent that for most of its stretches in the Varanasi city, it cannot even be used for irrigation purposes. Higher levels of nitrate and other chemical pollution in the groundwater and surface water in Varanasi environs have been reported by different workers and found nitrate concentration ranging from 66-199 mg/l. The lowering water table, increased hardness and presence of even toxic trace metals indicate degradation of ground water quality of the region. A comprehensive effort including policy makers, administrator, social activists, academicians and common masses should immediately be taken to save this precious commodity both in surface and underground reservoirs.

KEYWORDS : Interaction of Ground & surface water, Ganga & other rivers, Varanasi District, Deteriorating water quality

With increasing nation's concern over quality and quantity of water resources and the environmental issues affecting these, the importance of ground water and surface water bodies as a single resource has become increasingly evident. Issues related to water supply, water quality, and degradation of aquatic environment are receiving the attention of planners. The interaction of ground and surface water has been shown to be of significant concern in many of these issues. Contaminated aquifers that provide input to streams can result in long-term contamination of surface water; similarly, streams can be a major source of contamination to aquifers. Surface water commonly is hydraulically connected to ground water, but the interactions are difficult to observe and measure and commonly have been ignored in water-management considerations and policies. Many natural processes and human activities affect the interactions of ground water and surface water. The ground water quality in the Varanasi district is deteriorating very fast, the reason may be the three most polluted rivers viz. Ganges, Varuna and Gomati passing through the district.

INTERACTION BETWEEN SURFACE AND GROUND WATER

Humans have strongly impacted the global water cycle, water flows and also water quality. The source of 35% of the water withdrawn worldwide (4300 km3/year during 19982002) is groundwater. Groundwater contributes 42%, 36% and 27% of water used for irrigation, households and manufacturing, respectively (Döll et. al. 2012). Each groundwater system in the area has a unique chemistry, acquired as a result of chemical alteration of meteoric water recharging the system. Interactions between groundwater and surface water occur across a transition zone within the beds of lakes, rivers, or seas (Henry, 2002). In the case of a river, a 'hyporheic zone' develops where mixing between groundwater and surface water occurs (Biksey and Gross, 2001). This is an ecological term that refers to an ecotone where both groundwater and surface water are present within a stream bed along with a specific set of biota (Conant, 2000). The flow of river water over variations in

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the surface of the riverbed may cause localized variations in pressure that induce flow through the riverbed, causing groundwater/surface water mixing. The extent of this mixing zone may range from a few cm to hundreds of meters. (Woessner, 2000). The zone is heterogeneous, dynamic and dependent on the surface water and groundwater head distributions, river flow, riverbed hydrogeology and bed-form. Large gradients in concentration and environmental conditions often exist across the transition zone (Boulton et al., 1998). These affect the spatial and temporal distribution of aerobic and anaerobic microbial processes as well as the chemical form and concentration of nutrients, trace metals and contaminants. The hyporheic zone is important ecologically because it may store nutrients (and potential contaminants), transform compounds biologically and chemically, and provide refuge to benthic invertebrates that are the base of the aquatic food web.

Surface water exchange and storage within the hyporheic zone influences downstream nutrient and contaminant transport, and may be associated with enhanced biogeochemical transformation of these compounds in the surface water. Hyporheic flow paths are typically small but if rates of chemical reactions are rapid enough and the volume of exchange great enough then substantial modifications of surface water quality may occur (Choi et al., 2000).

THE IMPACT ON GROUND WATER

The natural background chemistry of groundwater resulting from recharge composition and mineral dissolution can be substantially modified by a wide range of contaminants that may be present as different phases within the subsurface environment Conant (2000) summarized the factors that may help to determine the impact of a contaminant present in the subsurface on a surface water body. They include:

1.Physical and chemical characteristics of the contaminants.

2.Geometry and temporal variations in the contaminant source;

3. Transport mechanisms (advection and dispersion).

4. Reactions (reversible and non-reversible).

The physical and chemical properties of the contaminants determine their mobility and toxic effect. Soluble compounds may be transported readily within the groundwater, and attain high levels of concentration. Less soluble compounds will occur in low concentrations but may provide a long-term source of contamination. Advective transport of dissolved phase contaminants within the groundwater is seen as the primary mechanism by which subsurface contaminants may impact upon surface water systems.

The sources of contaminated groundwater may be spatially restricted point sources such as an industrial spill or waste dump, or more diffused sources such as those arising from the widespread application of agricultural fertilizers and pesticides. Point sources tend to give rise to narrow plumes (Rivett, 2000) which migrate with the groundwater flow and may eventually discharge to the surface water. The surface water quality in a region is largely determined both by the natural processes (precipitation rate, weathering processes, soil erosion) and the anthropogenic influences viz. urban, industrial and agricultural activities and increasing exploitation of water resources. Seasonal variations in precipitation, surface runoff, ground water flow and water interception and abstraction have a strong effect on river discharge and subsequently on the concentration of pollutants in river water (Dixon and Chiswell, 1996).

SCENARIO IN THE REGION

India is endowed with rich water resources. The Ganges, is a trans-boundary river of India and Bangladesh. The 2,525 km long (1,569 mi) river originates in the western Himalayas in the Indian state of Uttarakhand, and flows south and east through the Gangetic Plain of North India into Bangladesh, where it empties into the Bay of Bengal. It is the longest river of India and is the second greatest river in the world by water discharge. Ganga drains a basin of extraordinary variation in altitude, climate, land use and cropping pattern. Ganga has been a cradle of human civilization since time immemorial. It is one of the most sacred rivers in the world and is deeply revered by the people of this country. Rapidly increasing population, rising standards of living and exponential growth of industrialization and urbanisation have exposed the water resources, in general, and rivers, in particular, to various forms of degradation. The Ganges basin is the most heavily populated river basin in the world, with over 400 million people and a population density of about 1,000 inhabitants per square mile (390 /km^2) (Arnold, 2011).. Earlier studies show that urban sewage and industrial effluents to be the main factors responsible for deterioration of Ganga water quality (Singh and Singh 2007).

The Gomati River is a tributary of the Ganges River. The Gomati originates from Gomat Taal which formally known as Fulhaar Jheel, near Madho Tanda, Pilibhit, India. It extends 900 km (560 mi) through Uttar Pradesh and meets the Gangas River near Saidpur, Kaithi in Ghazipur. At the "Sangam" of Gomati and Ganges, the famous Markandey Mahadeo temple is situated. After 240 km from its origin, the Gomati enters Lucknow, through which it meanders for about 12 km. At the entrance point water is lifted from the river for the city's water supply. 25 city drains in the Lucknow area discharge untreated sewage into the Gomati. At the downstream end the Gomati barrage impounds the river converting it into a lake.

Gomati is facing severe problem of pollution due to discharge of sewage and industrial effluent. The characteristic of the river is perennial. The river is characterized by sluggish flow throughout the year, except during the monsoon season, when heavy rainfall causes a manifold increase in the runoff. A combined study of Gomati river and Varuna river is done by Srivastava, et al. (2010) on water characteristics and algal biodiversity in river Varuna and Gomati. The studies have been carried out in relation to diversity and pollution.

The River Varuna is a minor tributary of the Gangas. During its course, Varuna receives huge quantities of untreated sewage, agricultural runoff bringing lot of pesticides, fertilizers etc from catchments areas. In its 15 km long flow through Varanasi City, river Varuna receives sewage from twenty-two municipal drainage located on both sides of the river in addition to agricultural run-off at some selected points (Dwivedi et al. 2006). The washing of large amounts of clothes by villagers, laundry workers, and the continued entry of domestic sewage in some areas are posing serous pollution problems (Bhuvaneswaran, 1996). High bacterial population and BOD values of the river Ganges may be attributed to discharge of untreated effluents in the Varuna at Varanasi. The qualitative analysis of river Varuna water limits shows complete deterioration to the extent that for most of its stretches within the Varanasi city, its water cannot be even used for irrigation purposes.

The impact of surface water on the ground water of surrounding area in the city along its stretches can very well be related to increased contamination level in ground water resources. The chemical alteration of the water coming to surface water bodies (e.g. Ganga, Gomati, Varuna, etc.) depends on several factors such as soil-water interaction, dissolution of mineral species and anthropogenic activities (Umar and Ahmed, 2007). The study of a relatively large number of groundwater samples from a given area, offer clues to various chemical alterations which the meteoric groundwater undergoes, before acquiring distinct chemical characteristics. Most of the inland areas of Indian sub-continent have Ca-Mg-HCO_3 type of groundwater (Datta and Tyagi, 1996). Arsenic and fluoride contamination in both ground and surface water is on the rise (Raju, 2007). The intake of cationic concentration is related to both soil-water interaction and anthropogenic factors (Subba, 2001). Such direct relationship between lithology and the relative abundances of cations is easily discernible in hard rock area. Higher levels of nitrate and other chemical pollutants in the groundwater and surface water in Varanasi environs have been reported by different workers.

CONCLUSION

The discussion so far reveals the pathetic condition of water quality in the Varanasi region which is still continuously deteriorating. Complete elimination of river Assi, near elimination of river Varuna and pathetic condition of Ganga river quality should certainly send an alarm to policy makers and citizens alike. The lowering water table, increased hardness and presence of even toxic trace metals indicate degradation of ground water quality of the region. The carpet cluster of Bhadohi, Varanasi Saree cluster, mushrooming electroplating and other hazaradus industries are contributing to this woe. Stringent measures should certainly be taken by environmental agencies and even by alert citizens so that no untreated discharges should recklessly be made into our holy rivers..

The Indian Government is committed to manage water resources by supporting a thriving economy, healthy environment and growing communities, and the teaching/research community should be committed to future by devising Strategy for 'Strengthening land and water management'. In order to manage our water resources there is a need to understand how effluent and other discharges to surface water impact our ground water resources. A comprehensive effort including policy makers, administrator, social activists, academicians and common masses should immediately be taken to save this precious commodity both in surface and underground reservoirs.

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