IMPACT OF URBANIZATION ON GROUND WATER POLLUTION-AN EMERGING PROBLEM

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ABSTRACT
Over half of the world’s population lives in urban areas and the urban population is increasing by about 2% annually. A rapid population growth in urban areas leads to mushrooming of slums, industries with no proper disposal facilities for their effluents, inadequate sewerage systems and unwanted stress on the natural resources especially increased ground water pollution. Groundwater quality is deteriorated due to the discharge of effluent from septic tanks; soak pits, pit latrines, discharges of domestic wastewater in leaky drains, animal wastes and leachate from solid waste dumpsite. The continuous consumption of contaminated ground water with various forms of nitrates, pathogen, trace metals, inorganic constituents and organic compound which cause of many deadly diseases like cholera, dysentery, diarrhoea, jaundice, tuberculosis etc. to the population. As we know adequate supply of fresh and clean drinking water is a basic need for all human beings on the earth, yet it has been observed that millions of people worldwide are deprived of this. Based on result of groundwater quality, various mitigation measures were suggested to protect the water resources, further groundwater contamination and to improve the health status of the population.

KEYWORDS: Urbanization, Health Hazards, Industries, Groundwater Quality, Drinking Water.

INTRODUCTION
Indian urban population is growing at an average rate of three percentage per annum and has almost doubled from 165 million to 285 million between 1981 to 2991 and is expected to reach 575 million by 2030 (UN, 2002). Rapid and unplanned growth is often associated with poverty, environmental degradation and population demands that outstrip service capacity. Unregulated growth of urban areas, particularly over the last two decades without infrastructural services for proper collection, transportation, treatment and disposal of domestic waste water lead to increased pollution and health hazard. In India, steep growth of urban population has resulted in depletion of the natural resources, increasing number and
size of slum (Muthukumaran and Ambujam, 2003). Ground water has historically been considered as reliable and safe source of water protected from surface contamination by geological filters that remove pollutants from water as it is percolated through the soil. Groundwater plays an important role in providing the main water supply in domestic, private and industrial use in urban area. It is estimated that more than 1 billion urban dwellers in Asia and 150 million in Latin America probably depend directly or indirectly upon well, spring and borehole sources for water (World Bank, 1998). Groundwater consumption may be increase due to higher population growth in city and town resulting in the total withdrawal from groundwater exceeds the natural recharge of ground water. In most of the countries, more and more groundwater withdrawal is taking place because of increase in agricultural irrigation (A.K. Singh, 2004).

**Consumption of ground water in India**

In India about 50% of the total irrigated area is dependent upon ground water (Central water commission, 2000) and 60% of irrigated food production depends on irrigation from groundwater well. Contribution from ground water to India's gross domestic product has been estimated at about 9%. Forty percentages of Indian cities get water through tap water and tube well. About 21% of cities are supplied with only tap water and 12% from tube well water alone (India at 2001 census). Agriculture, industry and domestic sector are main user of groundwater and make the ground water table lower.

**Water quantity needed for humans**

Adequate quantities of water are required for healthy living: for drinking, cooking and washing. The WHO recommends that the minimum daily amount per person is 27 liters per day. Because of the population growth and urbanization the gap between per capita water supply and demand is getting bigger. Population growth also has an effect on demand of food and sewage disposal facilities. This means bigger demand of irrigation water and bigger water resources. The growing urbanization and associated industrialization may result over-pumping of groundwater, this leads to the lower water tables and land subsidence. Groundwater levels decrease, the pumping of water from lower levels is more costly. Groundwater is in many countries used for irrigation. In coastal areas, saltwater intrusion into the aquifers can occur. This process decreases access to water supply by lowering supply and increasing contamination (Kasarda and Parnell 1993, Hillary 1984, Starke 2000).
pollution of groundwater resources is one of the biggest problems in many regions. Groundwater has often proven to be a clean and reliable source of water, but now it is threatened due to a careless disposal of organic and chemical wastes. The groundwater resources are also often taken for granted and not being protected (Somlyódy et al., 2001).

**Deterioration of ground water**

In India groundwater reserves are considered safe for human consumption but now some of the area of ground water reserves are contaminated with naturally occurring minerals such as fluoride, chloride, iron, sulphur, arsenic, calcium etc. Kumar et al (2012) evaluate the suitability of water to irrigation and the results of the study illustrates that the seasonal effect does not change the order of abundance of both cations and anions, but it changes the concentration of various ions present in the groundwater. A large number of studies have been carried out related to ground water contamination by inorganic components such as NO$_3^-$, Cl$^-$, PO$_4^{3-}$ and NH$_4^+$ from sewerage effluents (Sahoo et al., 2002). Concentration of various inorganic, organic and biological contaminants has been going to increase in groundwater and causing adverse effect on human health. Industries, poor sewage discharge system, unprotected septic tanks and dumping of sewage sludge in urban location can directly contaminate the ground water observed by Kadi A.S. et al., (2012). Presence of more than 200 chemical constituents in ground water has been documented including 175 organic and more than 50 inorganic and radionucleotides (Khaiwal and Garg, 2008). USEPA has detected volatile organic compound (VOCs) in 466 randomly selected public ground water supply system. According to World Health Organization reports, about 80% of all the diseases in human beings are caused by water (Kumar et al., 2013). Now, we have been discussing ground water contamination due to heavy metals- arsenic, mercury, fluoride and pesticides which are major concern poses threat to human life and the environment as follows:

**Ground water contamination due to other heavy metals**

Short term exposure to contaminated water can cause vomiting, abdominal cramps, diarrhea, difficulties in breathing, increased or decreased blood pressure, numbness around the face, and muscle weakness. On the other hand large amounts of barium intake can cause, high blood pressure, changes in heart rhythm or paralysis and possibly death (Sabine and Wendy, 2009). Exposure to high lead levels lead can severely damage the brain and and kidneys ultimately cause death. In pregnant women, high levels of exposure to lead may cause
miscarriage. High level exposure in men can damage the organs responsible for sperm production. Rizwan Ullah, Riffat Naseem Malik, and Abdul Qadir, 2009 found the quality of ground water in relation to heavy metal pollution and its implication on human health. The results revealed that the groundwater of the study area cannot be considered of good quality as it is highly turbid (57 of total sites) with high level of Zn, Fe and Pb, which were above WHO and PSQCA permissible limits.

Ground water contamination due to Arsenic
The Arsenic magnitude is considered highest in five Asian countries and the severity is in order of Bangladesh>India>Mangolia>China>Taiwan. The incidence of high fluoride in groundwater of Karbi Anglong and Nagoan district of Assam and its manifestation in the form of fluorosis were already reported by (Singh A.K in 2004). Arsenic contamination has been found in West Bengal and Bangladesh which creating severe illness to the population. The figure 1 given below shows various effects on human due to arsenicosis, with the use of polluted ground water (Miah M.A. and Meer H., 2013).

Figure 1. Some victims of arsenicosis, the worst curse of the upstream water piracy (Miah M.A. and Meer H., 2013).

Ground water contamination due to Mercury
Methyl mercury has the capacity to collect in organisms (bioaccumulate) and to ‘biomagnify’ as the concentrations increase up each level of the food chain, especially in the
aquatic food chain. Methyl mercury and metallic mercury vapors are more harmful than other forms, because more mercury in these forms reaches the brain and the nervous system is very sensitive to all forms of mercury. Exposure to high levels of metallic, inorganic, or organic mercury can permanently damage the brain, kidneys, and developing fetus (Azimi, 2013). Certain places in Haryana, Gujarat, and Andhra Pradesh were also found to have dangerously high levels of mercury. Mercury in the air eventually settles into water or onto land where it can be washed into water.

The EPA has determined that mercuric chloride and methyl mercury are effect the human health and cause many diseases e.g. Exposure to high levels can permanently damage the brain, kidneys, and developing fetuses. Effects on brain functioning nausea, vomiting, diarrhea, increases in blood pressure or heart rate, skin rashes, and eye irritation (Martin and Wendy, 2009) may result in irritability, shyness, tremors, changes in vision or hearing, and memory problems. Short-term exposure to high levels of metallic mercury vapors may cause lung damage.

**Ground water contamination due to trace metals and nitrates**

High values of NH$_4^+$ and NO$_3^-$ ions in some wells of Saudi Arabia have been attributed to contamination by human and animal’s wastes (Alla-eldin et al., 1993). Elevated concentration of NO$_3^-$ in a majority of drinking water sources of Madras has also been observed by Somasundaram et al., (1992). Excess of NO$_3^-$ and SO$_4^{2-}$ were detected in shallow ground water of Nabonne, France and also ground water of the limestone island of Bermuda is contaminated by Cl and NO$_3^-$ as a result of leaching from effluent generated as a result of urbanization (Razack et al., 1988) (Thomson et al., 1986).

Nitrite appeared to cause fetotoxicity in rats at drinking-water concentrations equivalent to 200 and 300 mg of sodium nitrite per kilogram of body weight per day, causing increased maternal metHb levels. However, after similar doses in feed in other studies, no embryotoxic effects were observed in rats. In a reproductive toxicity study in guinea-pigs at dose levels of 0, 50 or 60 mg of sodium nitrite per kilogram of body weight per day given by subcutaneous injection, fetal death followed by abortion occurred at the highest dose level. Teratogenic effects were not observed in reported studies in mice and rats (Speijers et al., 1989; FAO/WHO, 1996). Nitrite was shown to react with nitrosatable compounds in the human stomach to form N-nitroso compounds. Many of these N-nitroso compounds have been found to be carcinogenic in all the animal species.
Nitrate reduction happens in the digestive system of infants and livestock and hence they are at risk at high nitrate levels. The nitrite binds strongly to the haemoglobin in the blood causing the infant to suffer from methaemoglobinaemia which can be fatal. Should the water also be bacterially polluted, as is generally the case with pollution from on-site sanitation, e.g., septic tank overflow. The condition can be recognised by the colouration of the lips and other body parts and hence the term “blue baby syndrome” is widely used. In the case of sub-lethal levels (nitrate-nitrogen < 20 parts per million, i.e. ppm or mg/L), children may show symptoms of “failure to “thrive”, headache, fatigue, shortness of breath, and lack of energy. For mothers ingesting higher nitrate water there is an abortion risk or the chance of stillbirth. The “blue baby syndrome” is often not recognised as such, however in mild cases if it is correctly identified the infant can be treated with methylene blue intravenously, or with ascorbic acid, and can make a full recovery. Alternative treatments include hyperbaric oxygen therapy, while in severe cases exchange blood transfusions are indicated (WRC Report, 2009).

Ground water contamination due to flouride
Anand Kumar Mishra et al., (2011) stated that in India about 150 districts of fifteen states are in confrontation with the problem of fluorosis. High level of fluoride has affected the health of nearly half a million Indian (MOWR, 2000). In coastal area like Gujarat, West Bengal and Tamil Nadu salt water intrusion from excessive groundwater pumping makes the water unsuitable for irrigation as well as for the human consumption. In Madhya Pradesh during recent years, the problem of fluoride has reached an alarming proportion. In the present study ground water samples collected from various sources of eight villages of Narwar Tehsil were subjected to evaluation of pre-monsoon and post-monsoon water quality through parameters like Electrical conductivity, Total alkalinity, Total hardness, Total dissolved solids, Chloride, Silicates with special reference to fluoride concentration. Most of the samples showed high fluoride concentration which was much higher than BIS standard. People were found severely affected by fluoride containing water as they showed mottling of teeth and bony abnormalities.

Ground water contamination due to pesticides
Groundwater pollution due to pesticides is a worldwide problem. According to the USGS, at least 143 different pesticides and 21 transformation products have been found in ground
water, including pesticides from every major chemical class. Over the past two decades, detections have been found in the ground water of more than 43 states (Waskom, 1994). During one survey in India, 58% of drinking water samples drawn from various hand pumps and wells around Bhopal were contaminated with Organo Chlorine pesticides above the EPA standards (Kole and Bagchi, 1995). Once ground water is polluted with toxic chemicals, it may take many years for the contamination to dissipate or be cleaned up. Cleanup may also be very costly and complex, if not impossible (Waskom 1994; O’Neil, 1998; US EPA, 2001).

It was found that worldwide consumption structure of pesticides has undergone significant changes since 1960s. The proportion of herbicides in pesticide consumption increased rapidly and the consumption of insecticides and fungicides/bactericides declined. China has become the largest pesticide producer and exporter in the world (Zhang et al., 2011).

![Groundwater contamination from a waste disposal site](image)

It has been observed that pesticides are not used in an appropriate manner. Much of the portion of chemical pesticides goes to wastage during their use. However, statistics indicates an average annual increase in the quantity of pesticides imported in total imports to the kingdom (Ministry of Agriculture, 2005).

A pesticide is any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest (insects, mites, nematodes, weeds, rats, etc.), including insecticide, herbicide, fungicide, and various other substances used to control pests (EPA, 2009). Worldwide approximately 9,000 species of insects and mites, 50,000 species of plant pathogens, and 8,000 species of weeds damage crops. It is observed that with the rise in concentration of electrical conductivity of groundwater samples, revenue from banana cultivation (in Rs. per acre) has gone down (Sacchidananda Mukherjee et al., 2006). Insect pests cause an estimated 14% of loss; plant pathogen causes a 13% loss, and weeds a 13% loss (Pimentel, 2009). Pesticide is so indispensable in agricultural production. About
one-third of the agricultural products are produced by using pesticides (Liu et al., 2002). Pesticide pollution of air, water bodies and soils, and pesticide-induced deaths in China has been serious in past years. Bio-pesticides should be further developed in the future. Fungicides are used to 80% fruit and vegetable crops in the United States. The economic value of the apple has increased 1,223 million dollars by using fungicides (Guo et al., 2007).

**Worldwide Production and Consumption of Pesticides**

Over 1990s, the global pesticide sale remained relatively constant, between 270 to 300 billion dollars, of which 47% were herbicides, 79% were insecticides, 19% were fungicides/bactericides, and 5% the others. Over the period 2007 to 2008, herbicides ranked the first in three major categories of pesticides (insecticides, fungicides/bactericides, herbicides) and fungicides/bactericides increased rapidly and ranked the second. Europe is now the largest pesticide consumer in the world, seconded by Asia. As for countries, China, the United States, France, Brazil and Japan are the largest pesticide producers, consumers or traders in the world. Most of the pesticides worldwide are used to fruit and vegetable crops. In the developed countries, pesticides, mainly herbicides are mostly used to maize. Since the 1980s hundreds of thousands of pesticides have been developed, including various biopesticides (Zhang et al., 2011).

**Production and usage of pesticides in India**

The production of pesticides started in India in 1952 with the establishment of a plant for the production of BHC near Calcutta, and India is now the second largest manufacturer of pesticides in Asia after China and ranks twelfth globally (Mathur, 1999). There has been a steady growth in the production of technical grade pesticides in India, from 5,000 metric tons in 1958 to 102,240 metric tons in 1998. In 1996–97 the demand for pesticides in terms of value was estimated to be around Rs. 22 billion (USD 0.5 billion), which is about 2% of the total world market. The pattern of pesticide usage in India is different from that for the world in general. As can be seen in Figure 1, in India 76% of the pesticide used is insecticide, as against 44% globally (Mathur, 1999). The use of herbicides and fungicides is correspondingly less heavy. The main use of pesticides in India is for cotton crops (45%), followed by paddy and wheat (Aktar, 2009). Meham in Rohtak district and its nearby villages is a rural area as there is no other source of water like river or Lake Etc. The people around Meham solely depend on ground water for
the drinking purpose. The continuous consumption of contaminated ground water for drinking purpose cause serious health hazards to the local population. The people of that area are not well aware about the problem which is caused by drinking polluted water. Recognizing the enormity and security of the problem ground water quality survey was conducted for the Meham tehsil to identify the suitability ground water quality for drinking purpose (Unpublished data).

Conclusion
Rapid urbanization followed by overexploitation of groundwater and improper waste disposal, has affected the quantity and quality of groundwater. Groundwater quality is as important as the quantity. Poor quality of water adversely affects the plant growth and human health. The lack of sanitation and sewage treatment is the biggest factor regarding water pollution. Local water bodies are used as a dumping ground for untreated water from urban areas or industries. Chemical discharge is also a widespread problem.
In order to study the ground water quality in Meham region about 26 samples were collected from different villages from the various wells and hand pumps and analyzed to find out their suitability for drinking purpose. Interpretation of ground water analysis reveals that ground water in Meham region is hard in nature and slightly alkaline. The pH values of all the samples are within the desirable limit prescribed by the BIS (6.5-8.5). The concentration of the fluoride is also high (>1.5 mg/l) in 8 samples which led to dental and skeletal fluorosis. Chloride values were not exceeding the permissible limit but chloride values were exceeding the desirable limit in 9 samples (Unpublished data).
As ground water of many locations exceeding the permissible limit so it can be used for domestic purpose and not for drinking and cooking. The observed excess concentration of total hardness, fluoride and chloride is found in some water samples. It is suggested that the water for drinking is Pre-treated before consumption at many locations. The emphasis on public awareness about the adverse effects on human health of high fluoride and hardness concentration in drinking water to improve the health status of the population are essential.
While it may be technically possible to treat contaminated groundwater, it can be difficult, expensive and not totally effective. For this reason, prevention is the best way to ensure clean water. Water treatments include distillation, reverse osmosis, ion exchange or blending.
Recommendation /Suggestions

There are numerous suggestions which we should apply to minimize water pollution such as stress on urban waste management, improved sanitation and hygiene interventions including hygiene education. People should encourage tree planting in residential areas, improve facilities in urban areas like janta housing colonies for the poor slum people. Dispose the industrial waste after proper treatment, municipal authorities should manage the sewage water to avoid contamination of ground water. Public should be directed to install deep hand-pumps and consume the water after household treatment. Water obtained from ground water should be tested and analyzed to ensure their suitability for human consumption. Surrounding area should be properly maintained to ensure hygienic condition and the sewage or polluted water should not be allowed to percolate directly to ground water. Proper cement platform should be constructed surrounding the ground water abstraction source, surrounding surface area should be frequently chlorinated by use of bleaching powder, hand pumps, showing suspected water quality should be pointed red to warn the public. In the absence of alternate safe source of water, it should be given specific treatment before human consumption, the mass awareness should be generated about quality of water and a proper system of collection & transportation of domestic waste should be developed.

The most important is defluoridation treatment plant should be set because groundwater is polluted with heavy metal. Now there is urgent need to remove it from groundwater.

References

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