

## Ground water contamination and mitigating strategies

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### ABSTRACT

Water is a precious "gift of nature" on which animals inclusive of man and plant lives are dependent. The whole ecosystem resolves round it. The productivity and development of society is based on it. Unfortunately, surface as well as the ground is being contaminated due to natural and human interference so much so that in certain rural and urban pockets, the underground water is badly contaminated. In this article the authors have dealt with the cause of underground water pollution and its remedial strategies to be taken

**Key Words** - Water, Contamination, Remedial measures.

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### INTRODUCTION

Water is one of the most precious gift of nature given to man, animals and plants and for the maintenance of ecosystem. On earth water is in motion through the hydrogeological cycle and the users use it due to its motion. Groundwater exploitation, in the country has tremendously increased for its use in domestic, industrial and agriculture sectors.

It has been estimated that the number of dug wells increased from 38.6 lakhs (1951) to 94.9 lakhs (1990) and shallow tube wells from 3000 (1951) to 47.5 lakhs (1990) and many more

Yet, in recent years, many of the dug wells have dried because of over exploitation.

The undivided Bihar spreads over 1,74 sq.km & its southern part. (Jharkhand) is having a huge metallic & non-metallic minerals where as its northern part is having Indo-Gangetic Plain which is fertile.

In Chotanagpur plateau ground water occur under unconfined conditions within weathered residue & underlying fractured zones. The thickness of weathered zones ranges between 5 to 20 meters. The deeper fractures (down 200 meters below ground level) have been seen by drilling. The

fracture form potential aquifers. Ground water occurs under semi-confined to confined conditions within these fractured zones - Agarwal & Saha (2002).

Groundwater is found everywhere accepts in certain pockets but its depth varies from place to place, the level changes with season. During rains it increases while in dry season the level decreases.

The groundwater, used to be very clean few years (50-100 years) back but due to heavy industrialization, septic wastes, landfills, farm chemicals and many other factors have resulted into the contamination of groundwater in certain pockets.

These contaminations have been aggravated due to growing population & non-judicious development & exploitation. Groundwater pollution occurs when pollutants are released on the ground. The pollutants percolate down in the ground. This pollution may be natural as well as man-made.

Once the contaminants enter an aquifer, it spreads around wide area due to movement of water in the aquifer, sometimes, these contaminants reach

ground water wells, seeps in springs, lakes as such water supply from these area becomes unsafe for human life as well as the life of animals. This however depends upon the hydrogeology of the area.

### MATERIALS AND METHODS

Several research papers have been consulted & polluting areas photographs have been taken.

#### Main sources of groundwater contamination

Groundwater is available in every area but its depth varies from place to place. The level changes with the season, the level increases during rains compared to dry seasons when its level decreases drastically from place to place.

**Farm Chemicals:** Farmers have been using pesticides, herbicides, fertilizers etc., to boost up their farm produce (Paddy, Wheat, Vegetables). These chemicals are drained by rain and seep through the ground there by contaminating the groundwater.

**Septic Wastes:** The disposal of waste water by homes, offices and many other buildings are connected to a sewer system. The main purpose of the septic system is to slowly drain away human waste underground at a slow rate. The problem increases when an improperly constructed or maintained septic system leaks, bacteria, viruses and household chemicals into the groundwater causing harmful effects.

Majority of the drains constructed in Ranchi are faulty as a result the drains remain clogged, choked. During rain, the drains overflow and reach the groundwater and subsequently seep underground.



Fig-a



Fig-b



Fig-c



Fig-d



Fig-e



Fig-f

Fig. a-f. DRAINAGE SYSTEM AT HATMA, KANKE ROAD

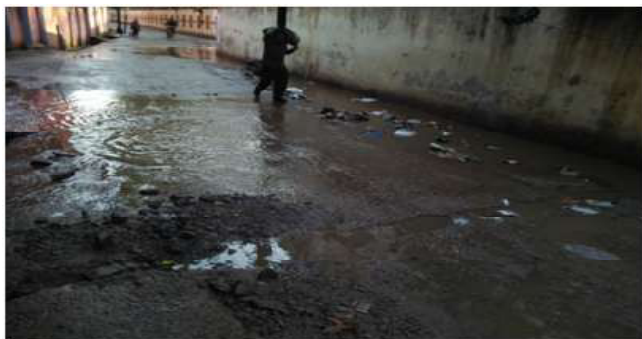


Fig-g



Fig-h



Fig-i



Fig-j

Fig. g-j. LANDFILL AREA IN BARIATU, RANCHI

**Landfills:-** With increasing population the garbage production has also increased tremendously. The garbage is collected and taken to a particular location called 'Landfill area', where the garbage is either dumped or buried. The landfill area needs a protective layer of uncontaminated soil to stop the seepage of liquid and spread of other materials by street dogs. Unfortunately the landfill area lack this protective layer as a result the chemicals (oils, medical products and non- biodegradable products) penetrate the ground and reach the deeper layer contaminating the groundwater.

**Storage tank:-** The harmful chemicals, minerals, oil and other products stored in tanks above and below the ground are very harmful for both surface as well as groundwater.

**Underground pipes:-** Underground pipes are used to transport different products such as oil, cooking gas as well as drinking water. Unfortunately, many a times these underground pipes burst and release the content into the ground, which percolates deep into the ground and contaminate the groundwater.

**Hazardous waste sites:-** Hazardous waste includes radioactive wastes, war chemicals, electronic wastes etc. Improper maintenance and in improper sites for their disposal sometimes lead to leakage of dangerous substances into the ground, reaching ultimately into the groundwater during rains.

**Industrialisation:-** Urbanization and heavy industrialisation is a major causative factor in polluting the groundwater by trace elements and heavy metals. Heavy metals reaching the underground water if consumed leads to serious health hazards (cardiovascular, neurological disorders). Nitrates, Fluorides, Arsenic, Cadmium, and Lead are the real culprits.

**Faecal Coliform Bacteria:-** Faecal Coliform Bacteria originating in the intestinal tract of warm-blooded animals and humans is E.coli which percolates into the ground and reach the groundwater and contaminate it.

**Organic Compounds:-** Organic compound is due to careless industrial practices. These organic compounds are volatile and include:

**a) Aromatic hydrocarbons** (Benzene, Toluene, Ethylbenzene, Xylenes and Chlorinated solvents, tetrachloroethylen, trichloro ethylene and vinyl chloride). The above unrestricted chemicals are important components of gasoline. Tetrachloro ethylene and Trichloroethylene are industrial solvents used in dry cleaning.

**b) Polycyclic Aromatic Hydrocarbons (PAH):-** Are polycyclic aromatic hydrocarbons example- Naphthalene, Benzopyrene (toxic). These are produced due to incomplete combustion of organic matter.

**c) Metals:** Trace metals enters the groundwater due to weathering process in rocks, mining, metallurgy solid waste disposal, paints, enamel works etc. which leads to elevate metal like lead, cadmium and chromium.

**Pharmaceuticals:-** Enter an aquifer and contaminate the groundwater. These include antibiotics, anti-inflammatories, antidepressants, decongestants, tranquilisers which enters the water.

**Others :-** It includes Organ halides, Petroleum Hydrocarbons, Cosmetics products etc.

**Chart 1. Polluted water results into several consequences in man and animals. The annexed chart explains the pathogenic effects.**

METALS	Pathogenic effect on man /animals
Arsenic	Disturbed peripheral circulation, mental disturbances, liver cirrhosis, lung cancer, ulcer in intestine.
Barium	Excessive salivation, vomiting, Diarrhoea, colic pain etc.
Cadmium	Bone deformation, atrophy of testis, anemia, hypertension.
Cobalt	Diarrhoea, low blood pressure, deformation of bones, paralysis.
Copper	Hypertension, uremia, coma and sporadic fever.
Hexavalent Chromium	Nephritis, ulceration in the intestinal tract, diseases of central nervous system.
Mercury (from power plants Labs., hospitals)	Minamata disease, abdominal pain, headache, diarrhoea, chest pain
Selenium	Blindness and death, low blood pressure.
Zinc	Vomiting, cramps, cell damage.

**Chart 2. Polluted water- Sources and contaminants**

SOURCES	CONTAMINANTS
Oil & Natural Gas Productions	Na, Ca, Cl, SO <sub>4</sub> , hydrocarbons
Mining Activities	Cd, Cr, SO <sub>4</sub> , Fe, acidity, Pb, Zn and Cu
Agricultural (animal wastes etc.)	Nitrates
Fertilisers, Pesticides, Herbicides, Fumigants	Phosphates, Nitrates, Potash, Aldrin, Gammexane, etc.
Municipal	TDS, NO <sub>3</sub> Cl, Organic and Bacterial, Protozoans.
Pulp & Paper Industry	Phenol, Sulphite, Heavy Metals, Nitrogen, TDS, Phosphorus.
Plastic Synthetics	Phosphorus, Nitrate, Chlorinated Benzenoids, Polynuclear aromatic Cyanide, Zinc mercaptans etc.
Petroleum	Cl, Cu, cyanide, Iron, Lead, Zinc, Nitrogen, Sulphate, Refineries Phosphorus.
Steel Cyanide	Phenol, Iron, Tin, Chromium. Industries
Fertilizer Industries	SO <sub>4</sub> , Nitrogen, Zinc, Cadmium, Ca, COD, Iron, Mercury, Phosphorus, Sodium, aluminium, Arsenic, Uranium, fluoride.

**Remedial measures and mitigating strategies:-** Protection and conservation of groundwater is important because of its utility in all spheres of life. As such following strategies can be planned.

**Part A-**

- I. Proper storage and disposal of potential pollutants and proper land use management.
- II. Protective measures around well heads & sinkhole.
- III. Educating people of the hazards of contamination - i.e., Awareness program to be initiated in urban as well as rural pockets.
- IV. Educating people of the simplest method of curing the underground water and how to make it drinkable after boiling.
- V. In houses, which does not have proper filtering mechanism (Apparatus) should be asked to use 3 earthen pot filtering technique used in olden times. In the top earthen pot water from different sources should be kept, in the pot below sand

(properly washed) and in the third pot charcoal (wood coal) be kept. In the centre of the pot a hole is made plugged with a "bati" is inserted through which the water trickles below. After the water passes through 3<sup>rd</sup> pot, be treated with basil seeds if available else be boiled, cooled then is made drinkable.

**Part B:-** There are several methods known to remove the pollutants in the groundwater. Some of them are:-

- I. **Pump and Treat method:** Pump and Treat method involves pumping out contaminated groundwater with the help of submersible or vacuum pump and allow the extracted groundwater to be treated through a series of vessels containing absorbing materials for contaminants, preferably an activated carbon. Suitable for industrial polluted water - water being pumped out then treated to safer limits followed by replenishment of aquifer with fresh water.
- II. **Bioventing and Biosparging:** This is a method in which microorganisms are injected into the contaminated underground water to biodegrade organic constituents. Bioventing enhances the activity of indigenous bacteria and stimulates the natural in situ biodegradation of hydrocarbons by including air or oxygen flow into the unsaturated zone. During Bioventing, oxygen supply through direct injecting has been suggested.
- III. **Phytoremediation:** Certain plants are well known where root go deep in the soil underground. The roots absorb contaminants from the underground water, but this takes time.

Such plant are:

- a) Chinese ladder fern *Pteris vittata*-accumulates arsenic.
- b) Genetically altered Cottonwood Tree - absorbs mercury.
- c) Trans-genic Indian Mustard Plant - absorbs selenium.

**IV. Chemical Oxidation:** In this method oxidants are delivered in the subsurface to destroy the organic molecules. This may be in the form of gases or liquids. The oxidants are air, ozone, hydrogen peroxide, permanganate and persulfate. The generation of ozone at the site can be done with the air and electricity.

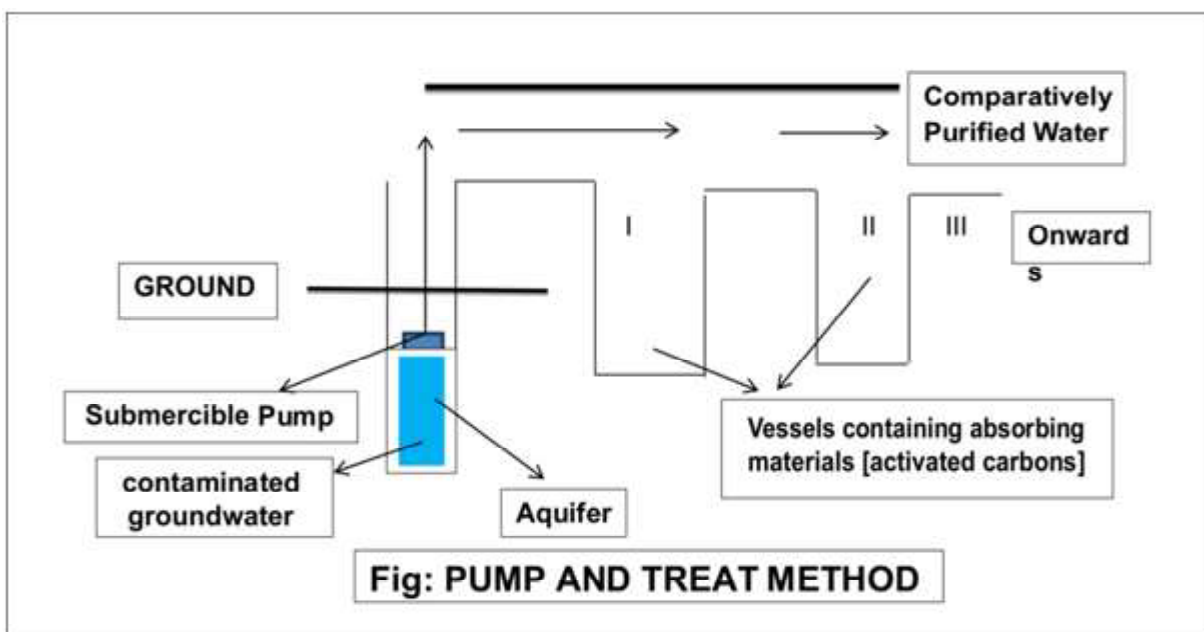
Sewage is a major threat to water pollution and is thrown wherever thrower wishes to throw and dump. NEERI has suggested methods which could be safely adopted. One of which is the preparation of oxidation ponds (ditches) where mechanical aeration is brought about.

These methods enhance aerobic degeneration or potentially oxidize.

U.S National Aeronautics and Space administration NASA at Space Laboratory (NSTL) at Mississippi used water hyacinth (*Eichhornia crassipes*) and duck weeds (*Spirodela*) species, *Lemna* species and *Wolffia* species to upgrade waste water treatment lagoons and treat chemicals waste waters. It is suggested that water hyacinth with waste stabilisation ponds increases the BOD (Biological Oxygen Demand) capacity of the systems but also reduce the high total suspended solids normally associated with sewage lagoons.

Removal of water hyacinth crushed further yields materials rich in Nitrogen, Phosphorus, Potassium, Sulphur, Calcium.

There are several methods known but the best method is to make people aware of the groundwater contamination and its health hazards. Why to pollute the groundwater, save it before it percolates.



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