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Sources of Groundwater Pollution

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Perspective

Groundwater pollution caused or generated by human activities has been a problem since the early Holocene, some 10,000 years ago, when humans became sedentary and began to inhabit towns and farm the land. As a result, significant amounts of nitrogen were released into groundwater as a result of farming activities, and microbiological diseases and bacteria were also dispersed in the aquifers as a result of hygienic home waste disposal. Agriculture and urbanisation have expanded and intensified throughout time as a result of population development, as has the attendant groundwater pollution. Another relevant human activity that degrades groundwater quality is industry. In this sense, ancient civilizations responsible for mining for gemstones, gold, silver, copper, and lead released essentially inorganic substances into groundwater bodies. Wastes reaching groundwater after the industrial revolution included organic molecules such as tars, phenols, oils, and complex combinations of synthetic organic chemicals.

Groundwater pollution has increased dramatically over the last 50 years as a result of intensive and extensive exploitation of this water resource for human consumption (drinking and sanitation) and diverse economic uses (tourism, landscaping, agriculture, energy production, and other industrial purposes), as well as radical changes in land use. Over-abstraction of groundwater reduces the level of the groundwater table. This could lead to decreased surface water natural discharge flows, land subsidence, and possibly groundwater quality degradation. Changes in groundwater flow patterns can displace saline fluids, move the seawater–groundwater contact inland, and enhance surface water infiltration. Furthermore, different quality waters may mix in wells and boreholes, affecting even deep aquifer water quality. Land-use activities affect groundwater resources by raising groundwater demand (for example, land irrigation for agriculture or irrigation of golf courses in dry and semi-arid areas) and affecting recharges patterns. The rate of recharge is lowered in sloping ground deforested or reforested areas with non-deciduous species.

However, it is significantly higher in areas dedicated to irrigated crops. Land usage influences not just the rate of recharging but also the quality of the recharge. Indeed, pollutants discovered in a groundwater body are typically linked to activity on the terrestrial surface. Nitrogen compounds, synthetic organic pollutants, and pathogens, for example, are likely to leak into groundwater in metropolitan regions. Crop intensification, on the other hand, will be accountable for the discharge of agro-chemicals (i.e., pesticides and fertilisers) into the aquifer. Furthermore, when reclaimed water is used for irrigation in the case of irrigated cropping, an additional hazard occurs because persistent wastewater-derived organic pollutants may eventually contaminate the ground water.

Pollutants detected in groundwater can be divided into two major categories: biological and chemical, with the latter further subdivided into two subcategories: inorganic and organic. Bacteria, viruses, and parasites are biological contaminants that cause watery diseases such as typhoid fever, cholera, dysentery, polio, hepatitis, and schistosomiasis. The presence of Coliform bacteria indicates that there has been recent faecal contamination. Human and animal waste is solely to blame for this form of contamination. Cations and anions are examples of inorganic pollutants that exist naturally in soils, sediments, and rocks. Heavy metals such as cadmium (Cd), chromium (Cr VI), lead (Pb), manganese (Mn), mercury (Hg), and nickel are examples of cations (Ni). These very toxic substances may enter groundwater as a result of mineral dissolution with acidic waters (from mining or industrial activity) or as a result of industrial emissions. High nitrate/nitrite concentrations in groundwater are caused by anthropogenic activities and naturally occurring nitrification processes, whereas seawater intrusion and rock weathering raise Sulphate and Chloride ion levels.

Natural arsenic contaminated streams have been discovered in Argentina, Chile, Mexico, China, Hungary, India, Bangladesh, and Vietnam, and they are a public health issue in the Bengal Basin (India), affecting over 40 million people. This arsenic-rich groundwater is limited to poorly flushed aquifers located inland or in confined basins in dry or semi-arid environments, or to decreasing aquifers formed by alluvium. Organic pollutants are substances with carbon as a molecular backbone. Volatile organic compounds soluble in water, such as trihalomethanes, solvents gasoline components and gasoline oxygenates compounds, such as medium to highly polar insecticides, and pharmaceuticals and personal care items, are among the chemicals that most frequently leach into groundwater. In addition to parent compounds, several transformation by-products produced by natural breakdown or bio transformation events may be present in groundwater. These metabolites are sometimes more harmful than the original substances.

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