IMPACT OF WASTEWATER ON SOIL, WATER AND CROP-AGROECOSYSTEMS

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Introduction:

Wastewater, defined as water used in various applications and processes (including freshwater, raw water, drinking water, and saline water), comprises substances like human waste, food scraps, oils, soaps, and chemicals.In households, this encompasses water from sinks, showers, bathtubs, toilets, washing machines, and dishwashers.India generates an estimated 26.4 km^3 of wastewater annually from urban areas, of which only 28% is treated (Minhas*et al.*, 2022). This untreated wastewater presents both a challenge and an opportunity. While it could potentially irrigate approximately 2.1 million hectares of agricultural land, contributing 4 million metric tons of plant nutrients, generating 2.8 million person-days of employment, and reducing greenhouse gas emissions by 73.7 million metric tons of CO_2 equivalent, its current state poses significant risks. Peri-urban farmers often rely on raw or partially treated wastewater for irrigating high-value crops like vegetables, fodder, and fruits, creating a potential pathway for contamination.Both controlled and uncontrolled wastewater disposal lead to the progressive and irreversible pollution of soils, surface water, and groundwater with pathogens, heavy metals, and organic micro-contaminants.This contamination can then transfer through the food chain (sewage-soil-vegetation-animal-humans), posing health risks

Reports of using treated sewage for agricultural purposes

Wastewater treatment that neglects nutrient removal can still contribute to meeting the increasing global water demand, aligning with sustainable development goals and the principles of a circular economy (Ricart, Rico, and Ribas 2019). Globally, approximately 15 million cubic meters of reclaimed water are used daily for agricultural irrigation (Elgallal 2017). In India, wastewater irrigation supports approximately 73,000 hectares of land (Singh *et al*. 2022). A study by Surinaidu*et al*. (2023) found that roughly 40,000 acres of farmland near Hyderabad are irrigated using a combination of treated effluent and fresh water from the Musi River.

Impact of wastewater irrigation on soil

The practice of using wastewater, whether treated or untreated, for agricultural irrigation can have both beneficial and detrimental effects on soil health and farming systems. The specific impacts are largely determined by the wastewater's quality, how it's applied, and the types of crops cultivated.Wastewater

irrigation can positively and negatively influence soil in several ways:

Positive impacts

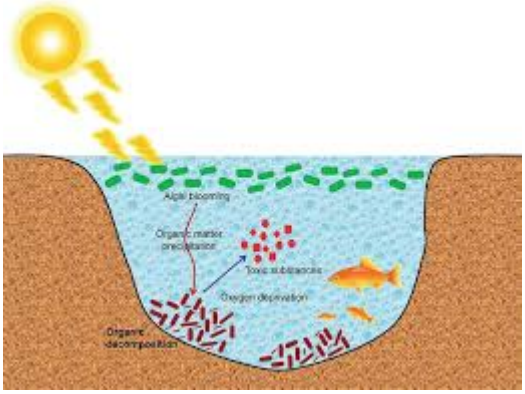
1. **Nutrient Enhancement:** Wastewater frequently contains valuable plant nutrients like nitrogen, phosphorus, and potassium. When managed effectively, this irrigation method can provide these essential elements, potentially boosting crop production and improving soil fertility.
2. **Enhanced Soil Moisture:** Especially in dry or semi-dry regions, irrigating with wastewater can increase soil moisture levels. This can lengthen the growing season and lessen the chance of crops suffering from drought.
3. **Decreased Freshwater Consumption:** Utilizing wastewater for irrigation can lessen the reliance on freshwater sources, a significant advantage in areas where water is scarce.

However, wastewater irrigation also carries potential risks:

- **Contaminant Buildup**: Wastewater can contain a range of pollutants, including heavy metals, pathogens, and organic compounds. Repeated and poorly managed wastewater irrigation can cause these contaminants to accumulate in the soil, potentially harming human health and the environment.
- **Salinity and Sodicity**: High salt concentrations in wastewater can lead to soil salinization and sodicity over time, reducing soil productivity and harming crops.
- **Soil Clogging**: Suspended solids in wastewater can block soil pores, reducing water infiltration and potentially creating waterlogged, poorly aerated conditions that negatively impact plant roots.
- **Health Hazards**: Untreated wastewater may contain pathogens that can contaminate crops, posing health risks to consumers if produce isn't thoroughly washed or cooked.
- **Residue Accumulation**: Persistent organic pollutants in wastewater, like pharmaceuticals and pesticides, can accumulate in the soil, potentially affecting long-term soil health and the safety of agricultural products.

Impact of wastewater discharge on water bodies

The discharge of wastewater, whether from industrial, municipal, or agricultural sources, can have significant impacts on water quality and the overall aquatic ecosystem. These impacts can be harmful to both the environment and human health.The presence of high levels of nutrients, such as nitrogen and phosphorus, in wastewater can cause nutrient pollution in nearby water bodies. This can trigger excessive algal growth (eutrophication), leading to oxygen depletion and the development of "dead zones" where aquatic organisms cannot survive. Furthermore, wastewater frequently contains a mix of pollutants and contaminants, including heavy metals, pathogens, pharmaceuticals, and industrial chemicals. These contaminants can pollute water sources, posing risks to both aquatic ecosystems and human health.



Bacteria in wastewater consume oxygen as they break down organic

matter. When large quantities of wastewater are discharged into water bodies, it can deplete dissolved oxygen levels, leading to hypoxia or anoxia, which can harm aquatic organisms like fish and other wildlife.The pH of wastewater can vary, and its discharge can alter the pH of receiving waters. Drastic changes in pH can be harmful to aquatic organisms, as many species have specific pH requirements for survival and reproduction.The physical flow of wastewater into aquatic ecosystems can disrupt natural habitats, destroy vegetation, and harm aquatic organisms. The increased sedimentation from wastewater can also smother streambeds and disrupt aquatic habitats.

Impact of wastewater on crop-agroecosystem

Wastewater, when not properly managed or treated, can have significant negative impacts on crop-agroecosystems. These impacts can affect both the environment and human health Wastewater often contains various contaminants, including heavy metals, pathogens, organic matter, and chemicals. When wastewater is used for irrigation or when it contaminates nearby water bodies, it can introduce these pollutants into the soil and water.Contaminants in wastewater can accumulate in the soil over time, making it less suitable for crop cultivation. Heavy metals, for example, can become toxic to plants and reduce crop yields.The excessive use of wastewater for irrigation can lead to soil erosion and compaction due to increased water application and runoff. This can degrade soil quality and decrease its ability to support healthy crop growth. When crops are irrigated with untreated or inadequately treated wastewater, pathogens such as bacteria and viruses may contaminate the crops. Consumption of these contaminated crops can lead to food borne illnesses in humans.Wastewater often has high levels of salts and nutrients, which can accumulate in the soil over time. This can result in soil salinity and nutrient imbalances, leading to reduced crop productivity and quality.

Conclusion

Wastewater's impact on soil, water, and crop-agroecosystems is complex and far-reaching. While treated wastewater can be a valuable resource, untreated or inadequately treated wastewater poses significant risks. It can degrade soil quality, contaminate water sources, and negatively affect crop health and yield, ultimately impacting food security and human health. Sustainable wastewater management strategies are crucial to mitigate these risks and harness the potential benefits of wastewater reuse.

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