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A Review Based On the Health Effects and General Environment with Wastewater Treatment, Disposal and Reuse.

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Abstract: *In this paper, we present a comprehensive review of scientific literature from the year 2018, focusing on the health risks associated with human and environmental exposure to wastewater reuse, treatment, and disposal. The literature review is divided into several sections, each addressing specific aspects of wastewater management. One of the key sections explores the management of wastewater, covering various strategies and approaches to handle and treat wastewater effectively. Another section delves into the topic of wastewater reuse, with a particular emphasis on microbial hazards and potential risks to human health and the environment. In addition, the review highlights the importance of addressing chemical hazards in wastewater and the implications for human and environmental well-being. Recent research pertaining to wastewater treatment plants, as well as the disposal of wastewater, sludge, and biosolids management, is also included in the review. By examining these critical issues, we aim to shed light on the challenges and potential solutions related to wastewater management, ultimately contributing to the promotion of sustainable and safe practices in this vital domain*

Keywords: *environmental health; public health; risk assessment; sewage; toxicity; wastewater; water reuse*

I. Introduction:

In a unique study researchers focused on the management of domestic wastewater in Greece and conducted an estimation of greenhouse gas emissions originating from wastewater treatment plants. To achieve this, they employed a comprehensive steady state model. The findings of their research revealed that the average daily production of wastewater per capita in Greece was approximately 210 liters. Moreover, the total amount of greenhouse gases emitted from the treatment plants reached a staggering 892,454 tCO_{2e} per year. Based on their study, the authors emphasized the need for Greece to ensure the efficient operation of smaller-scale treatment plants while simultaneously implementing measures to reduce greenhouse gas emissions. They also advocated for the promotion of wastewater reuse as an important step towards achieving more sustainable wastewater management practices in the country [1].

A Smart Sewer Asset Information Model with Industry Foundation Class version 4, using distributed smart sensors for real-time monitoring and predicting sewer flooding [2].Researcher have simulated and compared the cost of cluster-type decentralized wastewater management (DWWM) with centralized wastewater management (CWWM) in a case study in India [3]. Using a three-step model, the authors simulated a wide range of potential DWWM configurations with varying numbers and layouts of cluster subsystems. The results indicated that cluster-type DWWM, incorporating simplified sewer and decentralized wastewater treatment systems, could be a cost-competitive and viable alternative to CWWM, considering the lower cost involved in its configuration. In another study, a comprehensive review focused on the recovery of ammonium during the wastewater treatment process. The authors highlighted the potential benefits of ammonium recovery, as it can be utilized in other applications, making it a valuable resource. The review encompassed various technologies and their mechanisms for ammonium recovery in wastewater treatment. Additionally, the economic feasibility of these processes was assessed, and the review offered insights into possible future directions for ammonium recovery from wastewater treatment [4].

Chemical Hazards

Nanoparticles

The synthesis, characterization, and photodegradation of synthetic wastewater using immobilized cerium doped ZnO nanoparticles. The experiments involved examining various parameters, such as doping percentage, pH, nanoparticle density, initial density of the wastewater sample, and exposure time to ultraviolet light. The results demonstrated higher efficiency under acidic conditions, and the immobilized ceriumdoped zinc oxide nanoparticles exhibited excellent crystallinity and even dispersion [5].A unique study conducted to investigate the impact of wastewater effluent (WE) containing aged nanoparticles (NPs) used in agriculture. The

research involved a soil microecosystem, including a microbiome, 4 Arabidopsis thaliana plants, and 3 Eisenia fetida earthworms, for a duration of three months. The results revealed higher concentrations of extractable titanium (Ti) and Zn in WE-irrigated soil compared to soil irrigated with deionized water. However, there were no significant differences in the extractable silver (Ag) concentrations between the WE-irrigated soil and the soil irrigated with deionized water [6].

Heavy Metals

A investigation on heavy metals in the acid soluble reducible, oxidizable, and residual fractions of soils collected from greenhouses and agricultural fields in Baiyin City. These areas were using treated industrial and municipal wastewater for crop cultivation. The analysis indicated that greenhouse soils had higher concentrations of metals in bioaccessible fractions compared to field soils. Furthermore, the wastewater irrigated from industrial sources showed higher concentrations of heavy metals compared to treated municipal wastewater [7].Researchers have studied water samples collected along the Taizihe River in China, which was receiving wastewater from neighboring industrial activities. The research aimed to link the possible health risks associated with heavy metal presence using principal component analyses. The findings identified Cd and Cr as the main health risk pollutants in the Taizihe River. The average concentration of heavy metals followed the order Pb > Cr > Cu > Zn and Cd. The authors recommended the implementation of suitable measures to control wastewater discharge into the river system [8].

Pharmaceuticals and personal care products

The effects of exposure to selected pharmaceuticals and personal care products (PPCPs) on Burkholderia cepacia in drinking water distribution systems. Their results indicated that the selected PPCPs had no significant effects on swimming motility, biofilm production, and susceptibility to trimethoprim and sulfamethoxazole. The study concluded that the presence of PPCPs in wastewater could influence the behavior of bacteria and decrease their efficiency [9].The occurrence and fate of PPCPs in urbanized areas of North Italy, analyzing samples of wastewater, surface, and groundwater. The analysis detected various PPCPs in all wastewater treatment plants (WWTPs), including phenylbenimidazole sulfonic acid, benzophenone 3, benzophenone 4, 4-methyl benzilidine camphor, triclosan, and triclocarban. The authors emphasized that these results serve as indicators to develop pollution control strategies in the area [10].

Genotoxicity and cytotoxicity

A study evaluated the toxicity impact of cumulative disinfectant concentration over time (Ct) values. In addition, authors used different methods to achieve identical Ct values by ozonation and chlorination of wastewaters from four agricultural sources on the cells of mammals. Based on the experiment results, two sources of wastewater for ozonation and chlorination higher Ct values enhanced cytotoxicity. The study suggested using lower disinfectant doses to tackle the increase in cytotoxicity [11].

For the treatment of effluents containing cytotoxic compounds, the efficiency of microalgae evaluated through bioremediation. Biosorption of the anticancer drug such as flutamide was used on living and dead biomass of Chlorella vulgaris. Results showed that living microalga performed better in the drug removal considering the amount of biomass, pH, and time of adsorption. Overall, this study showed use of microalga could be a promising technology for the removal of cytotoxic compounds in the wastewater treatment [12].

Ecotoxicity

The acute and chronic ecotoxicity of cyclophosphamide (CP) and ifosfamide (IF) investigated, which are commonly found in hospital wastewater. The study used aquatic organisms, including the green alga Pseudokirchneriella subcapitata, the rotifer Brachionus calyciflorus, and the crustaceans Thamnocephalus platyurus and Ceriodaphnia dubia, for the experiments. The results indicated that IF was more toxic than CP, and the effects on aquatic organisms might be attributed to interactions between the parent compounds and their metabolites [13].In another study, Pantazopoulou and Zouboulis (2018) investigated the stabilization of tannery sludge produced during the physicochemical treatment of tannery wastewaters. They added ladle furnace slag to the sludge to assess its ecotoxicity. The study found that the leachate of raw tannery sludge exceeded the standards set by the European Union for disposal into nonhazardous and hazardous waste landfills, particularly with regards to chromium and dissolved organic carbon. However, the stabilized leachate showed reduced ecotoxicity compared to the untreated leachate [14].

Microbial Hazards

Viruses

Researchers have assessed the potential infection risks resulting from nonpotable exposures to distributed graywater and domestic wastewater. These waters were treated using an aerobic membrane

bioreactor (MBR), followed by chlorination. Microbial risk assessment was performed using norovirus, rotavirus, Campylobacter jejuni, and cryptosporidium as reference pathogens. The study results indicated that MBR technology has the potential to reduce health risks associated with the nonpotable reuse of wastewater [15].The reasons for differences in human norovirus (hNoV) resistance to free chlorine and assessed the persistence of hNoV GI and GII during the disinfection of municipal wastewater effluent. The study revealed that the choice of hNoV purification technique prior to seeding the viruses in the water matrix played a crucial role in disinfection outcomes. The authors concluded that wastewater treatment plants using disinfection with free chlorine are effective in protecting public health from viral contamination [16].

Bacteria

The impact of various modifications in sewage treatments on antibiotic-resistant bacteria and antibiotic-resistant genes in sewage investigated from treatment plants using activated sludge technology. The results showed no significant differences in the presence of antibiotic-resistant bacteria and genes regardless of the time of sampling and type of treatment. However, the study observed a higher reduction in these elements in wastewater treatment plants with a mechanical-biological system, particularly with elevated removal of nutrients [17]. In another Study,A case study was conducted in China to characterize airborne bacteria in a municipal wastewater treatment plant. The study included two sampling sites, one indoor and one outdoor, within the treatment plant. The results revealed that the concentration of culturable airborne bacteria indoors was more than ten times higher compared to the outdoor aeration tank site. Additionally, the particle size of indoor airborne bacteria was about twice as large. Authors emphasized the need for protective measures indoors to safeguard health from airborne bacteria [18].

Wastewater Reuse

Agricultural reuse

A study conducted using the DESERT prototype technology, which combines filtration and solar-based renewable energy to reclaim treated water for agricultural purposes. The treated water was used to cultivate baby romaine lettuces in a greenhouse using drip and sprinkler irrigation. The results demonstrated that the DESERT prototype technology is suitable for safe water reclamation for agricultural crop production [19]. Furthermore, this technology could be beneficial for irrigation and ensuring safe water use.Researchers have studied The water quality evaluation of MBR treated wastewater for its reuse in irrigation. The results showed that MBR effluent was not suitable for irrigation due to its high salinity content. However, the addition of reverse osmosis (RO) to MBR effluent improved its suitability for irrigation, as indicated by the values of SAR EC. The study concluded that the addition of RO treatment reduced the harmful effects of salinity [20].

Wastewater treatment plants

A study conducted on an assessment of the effects of municipal wastewater treatment plant effluents on the energetics and stress response of rainbow darter. Samples of male and female rainbow darter were collected from both upstream and downstream locations of the Waterloo WWTP in Canada. The results of this study revealed that sex differences played a significant role in determining various metabolic changes in response to physiological stress, providing a new avenue for further exploration and consideration [21].A study was conducted to provide insights for improving local wastewater management by examining wastewater treatment plants in a Finnish community. The authors considered two different technological setups to enhance the wastewater treatment process. The study demonstrated that integrating a wastewater treatment plant with a combined heat and power (CHP) plant can be economically viable in a wide range of likely price scenarios for alternative wastewater purification systems, thereby improving the efficiency of solid waste and wastewater management [22].

Wastewater disposal

A group of researchers have applied life cycle assessment (LCA) to compare the environmental performance of various scenarios for wastewater and sludge disposal in Southern Italy. The results of the scenarios indicated that the most impacted categories were freshwater eutrophication potential (FEP) and human toxicity potential (HTP), which were reduced by approximately 53%. The authors also discussed other potential options to be explored in future studies to assess their potential to support the performance of wastewater treatment (WWT) plants [23].Since et al. (2018) conducted an investigation into the occurrence of radium in sediment streams at centralized waste treatment facilities (CWTs) in Pennsylvania, United States. These CWTs were used for treating both conventional and unconventional oil and gas wastewater. Despite strict environmental discharge regulations, the study revealed higher concentrations of radium in downstream sediments of CWTs, indicating greater availability for dissolution and desorption compared to radium in upstream sediments [24].

Industrial wastewater

A investigation on wastewater effluents from factories located at an industrial park in Toluca State of Mexico. Galvanic (GT), galvanic Fenton (GF), and hydrogen peroxide treatments were used to remove organic matter in the wastewater. The GF treatment showed promising results by eliminating anthropogenic organic matter associated with aromatic groups and proteins, improving effluent biodegradability, and not increasing toxicity or sublethal effects observed for lettuce radicles [25].The efficiency of ballasted electro- flocculation (BEF) technology explored with aluminum electrodes in removing cadmium and zinc from industrial mining wastewater. Results indicated that the flow rate and density significantly affected the quality of the settled water. The study concluded that the BEF process technology was a cost- effective solution for treating wastewater when compared to Actiflo TM and electrocoagulation technologies [26].

Hospital effluent

A study Presented on the removal of a wide range of pharmaceuticals from real hospital wastewaters using a gas-phase pulsed corona discharge oxidation. The nonselective oxidation of the observed pharmaceuticals was found to be effective in reducing the pharmaceuticals from raw sewage. Good removal was achieved with 1 kWh/m3 from the raw sewage for biologically treated wastewater. The proposed treatment was concluded to be capable of reducing the pollution risk for aquatic life [27].A study Conducted to treat Kete-Krachi District Hospital effluent using packed granular (GAC) and smooth activated carbon (SAC) treatment systems. The results of this study showed that the SAC treatment was effective in reducing the pollutant concentrations of the hospital effluent. The authors suggested that this treatment could effectively treat the effluent and control depletion of oxygen, eutrophication, algal bloom, and ecosystem disturbance in the area [28].

Sludge and biosolids

The impact of soil amendment evaluated with tannin-coagulated dairy industry sludge on fertility chemical attributes and the release of selected pollutants. The study was conducted using soil column leaching tests and soil incubation experiments with the application of different doses. The results showed that the effects on parameters were more perceptible for thermally dried sludge due to lime addition in the drying process. Treatment of soil with the amendment had no significant effect on organic matter. The authors concluded that the application of the studied residues in agriculture was a feasible option for treating biosolids [29].A researchers grouphave examined infrequently monitored antibiotics in biosolids of archived American sewage sludges collected as a part of the National survey by the Environmental Protection Agency of the USA. The analysis indicated the presence of six antibiotics with average concentrations (ng/g dry weight) as follows: amoxicillin (1.0), nalidixic acid (19.1), oxolinic acid (2.7), erythromycin (0.6), oxytetracycline (4.5), and ampicillin (14.8). Overall, this study provided new data on the persistence of these antibiotics during long-term frozen storage [30].

Future of the Topic

Wastewater treatment and reuse have been well-established practices for a considerable time, and significant improvements in treatment technologies have been developed over the years. The reclamation of both untreated and treated wastewater has become increasingly widespread, serving various purposes in urban areas and beyond. Particularly, diverting human waste outside of urban areas has gained importance, aiming to utilize it effectively. Continuous efforts have led to a better understanding of treatment processes and technologies, which has resulted in the development of international and national standards to control pollution worldwide. These activities play a crucial role in pollution control and in minimizing adverse health effects.

Recognizing the significance of both public health and economic factors, research on wastewater treatment and reuse will undoubtedly continue in the future. Future studies and reviews will likely focus on various aspects, including policy and regulations related to wastewater management, microbial and chemical hazards associated with wastewater, advancements in wastewater reuse, wastewater treatment plant technologies, sustainable wastewater disposal methods, and the management of sludge and biosolids.

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