

HUMAN HEALTH RISKS OF LAND APPLICATION OF SEWAGE SLUDGE - REVIEW

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Abstract: The treatment of sludge is not usually effective in reducing number of pathogens because the infections dose for some of these pathogens may be as low as one particle (virus). This leads to public health risk concern that need appropriate measures. In line with this, when sludge is applied to land for agricultural use and landfill, pathogens can survive from days to years based on environmental conditions. Due to their long survival shallow aquifers can become contaminated and depending on aquifer orientation pathogens may travel significant distance from the sludge disposal site. So that communities which use ground water for domestic consumption can be exposed to these pathogens, leading to potential disease outbreaks. On the other hand, land disposal method of sewage sludge is one of the most preferable ways to recycle plant nutrient in sewage sludge. Nutrient present in sewage sludge are also useful to the soil microbial biomass. This paper focuses on possible exposer and human health risk of land application of sewage sludge.

Index Terms - sewage sludge, health risk, sewage disposal, land application.

I. INTRODUCTION

Waste water treatment in the industrial cities and urban areas has become very important because of the negative consequence posed by the improper disposal of waste water from domestic, industrial and municipal sources [1]. If not treated well, the waste water from these sources will end up in the various spheres of the environment with their pollutant. It is for this reason; the treatment facilities have been recommended and established. The main function of these facilities is to treat and reduce the level of harmful content of waste water before discharging into the environment.

Sewage sludge is therefore one of the by-products of waste water treatment. It is a composite mixture of organic and inorganic compounds of biological and mineral origin that is extracted from waste water. Noticeable numbers of microorganisms which include viral, bacterial, protozoan, fungal, protean, and helminthes pathogens present in the sludge [2].

Sewage sludge should be treated and disposed according to the various standards and regulations set by both the various environmental protection bodies in countries or the Municipal and City Authorities. The essence of these is to ensure that sewage sludge is not just disposed into the environment without taking necessary precautions of their environmental and human health risk.

To reduce human health risk and for safe disposal of sewage sludge both the short as well as long term health risks costs and benefits should be evaluated during the selection of possible alternative of sewage sludge disposal [3]. When applying sludge to land, management practices must consider concentrations of organic and inorganic chemicals in the sludge which are potentially pathogenic, maximum allowable accumulation levels in soils, rate of accumulation, local soil conditions (PH, soil organic matter content and cat ion exchange capacity), climatic conditions, and topography.

Treated sewage sludge should be spread in a manner that meets the needs of the plants and in a manner that does not deprive the quality of soil, ground and surface water. Sludge utilization should be supported by effective industrial effluent control practices and policies [4]. This article therefore revises pathogenic microorganism that could cause disease, possible exposure pathway to health risk sewage sludge and recommends human health risk reduction and safe sewage disposal management in case of land application as sewage disposal alternative through controlled chemical and microbiological quality.

II. SOURCE OF SEWAGE SLUDGE

The source of sewage sludge is domestic and industrial waste water that is collected and treated in municipal sewage treatment plants. The production of sewage sludge in municipal sewage sludge is highly increasing with population increase, urbanization, economic development and industrialization. The pushing factor for collection and treatment of municipal waste water is environmental and human fate posed by pathogenic as well as hazardous contaminant of waste water.

III. BIOCHEMICAL COMPOSITION OF SEWAGE SLUDGE

In general biochemical composition of sewage sludge can varies based on different factors. The major factors on which the composition of sewage sludge depends on includes source of sewage, sewage treatment methods, and detention time and storage condition. Sewage sludge composition is complex of biochemical constituents which may mainly include:-

- A. **Microorganisms:** sewage sludge may contain wide variety of microorganism which is potentially pathogenic to life. The major pathogenic microbes include bacteria, viruses, protozoa, helminthes and fungi.
- B. **Organic micro pollutants:** mainly depending on source of sewage organic micro pollutants may include hydrocarbons, solvents, detergents, cosmetics, natural as well as synthetic hormones, pharmaceutical products and endocrine disruptors, and radioactive elements.
- C. **Macro and micro nutrients:** in this sense nutrients can be substances in sewage sludge which are essential for living things growth and development. Depending on the need nutrients can be classified in to macro nutrients which are relatively required in large amounts and micro nutrients which are relatively required in small amounts. Macro nutrients mainly include potassium, magnesium, calcium, nitrogen, fat, proteins and carbohydrates. Micro nutrients include iron, chlorine, zinc, copper, boron, vitamins and minerals.

D. Organic compound: sewage sludge organic compound constituent may include polychlorinated biphenyls (PCBs), chlorinated pesticides such as DDT, chlordanes, dieldrin, aldrin, heptachlore, mirex; chlorinated compounds such as dioxins and polynuclear aromatic hydrocarbons [3].

E. Non-essential trace metals: sewage sludge may also contain potentially health risk non-essential trace metals such as cadmium (Cd), lead (Pb), uranium (U), arsenic (Ar), and others [5].

IV. TREATMENT AND DISPOSAL METHODS OF SLUDGE

Generally sewage sludge resulting from municipal sewerage treatment plant need to be further treated to remove offensive odors from the incomplete decomposition of organic matter, to reduce organic matter, water content and to reduce the concentration of pathogens. Basically aerobic sludge digestion, anaerobic digestion (mesophilic or thermophilic), composting and lime stabilization are common methods of sludge treatment. The efficiencies of treatment vary method to method. In light of desired pathogen reduction, treatment facilities may use a combination of one or two of the known methods.

Even though the methods and approaches used to dispose sewage sludge differ from country to country; agricultural land application, landfill and incineration are the most common sewage sludge disposal methods. Modern day sewage water treatment plants have either sludge treatment facility attached to them or sludge is sent to specific treatment facilities meant for sludge treatment. The advantages of this method of treatment is that there are no investment costs needed for the treatment units and fees charged by the remote sludge treatment facility and transportation costs are the only operating costs. Sludge land application has also proven to be a better substitute for inorganic fertilizer, if provided pathogenic control is applied.

V. ADVANTAGES AND DISADVANTAGES OF LAND APPLICATION OF SEWAGE SLUDGE

In general it has been proved that the application of sludge to arable land improves the production and productivity of crop plants. The major advantages of land application of treated sewage sludge specifically biosolid includes [6]:

- The possibility of recycling valuable components such as organic matter, N, P and others plant nutrients that may replace the requirement of inorganic fertilizers in crop land. [7]
- Organic matter added to soil as sewage sludge may improve the soil properties, including bulk density, porosity and capacity of water holding. [8]
- Sewage sludge application may increase the soil microbial activity, soil respiration and soil enzymes activities. [9]
- The nutrient content of the sludge is use as a substitute for the commercial fertilizers.
- The organic matter in the sludge enhances the soil quality. [10]

However unwise sludge application may disturb the soil properties especially when it bears high concentrations of heavy metals associated with sewage capacity, organic matter, and mobility and specification of metals [11].

VI. HUMAN HEALTH RISK SEWAGE DISPOSAL

In general various contaminants that exist in treated sewage sludge may adversely affect our environment as well as human healthy through several ways of exposure and can have both acute and chronic effects based on the type of exposure. Furthermore, the different interaction among different contaminants may increase their pathogenicity [12].

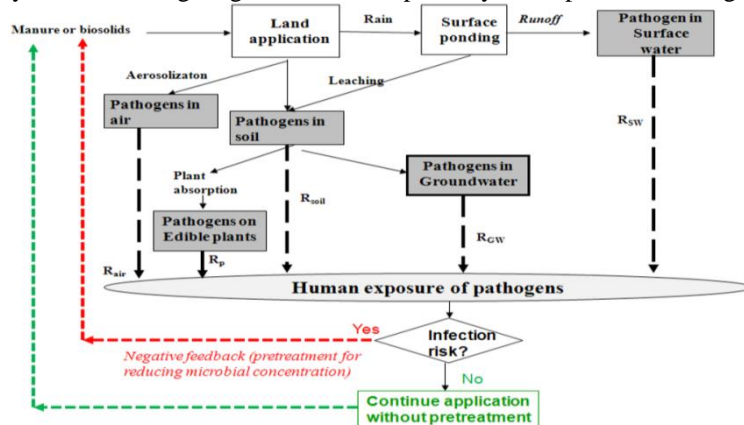
A literature review of different articles suggests that in the case of human health risk, significant concentrations of human pathogens might be exist in treated sewage sludge which are potentially fatal to human being. There are four major kinds of human pathogens that exist in biosolids [11].

No	kinds of human pathogens	Specific pathogens	Related Diseases	Exposer
1	Bacteria	Enterohaemorrhagic E.coli (O157:H7)	<ul style="list-style-type: none"> • Gastroenteritis • Enterocolitis 	<ul style="list-style-type: none"> • Contaminated drinking water; • Contaminated recreational water;
		Helicobacter pylori	<ul style="list-style-type: none"> • Hemolytic uremic syndrome • Peptic ulcer disease 	
2	Protozoa	Cryptosporidium and Giardia	<ul style="list-style-type: none"> • Cryptosporidiosis 	<ul style="list-style-type: none"> • Contaminated food; and • Exposure to animal and human wastes
			<ul style="list-style-type: none"> • Giardiasis 	
3	Viruses	Hepatitis E virus	<ul style="list-style-type: none"> • Hepatitis 	
		Astroviruses and Rotaviruses	<ul style="list-style-type: none"> • Gastroenteritis 	
4	Helminthes	Ascaris lumbricoides, Trichuris trichiura, Taenia saginata and Hymenolepsisnane	<ul style="list-style-type: none"> • Ascariasis 	
			<ul style="list-style-type: none"> • Trichuriasis 	
			<ul style="list-style-type: none"> • Taeniasis 	

VII. EXPOSURE PATHWAYS

Exposure pathways are the various channels by which the pathogens microorganisms in the sewage sludge can come into contact with humans and cause various types of diseases. These channels could be through direct and indirect contact [9]. The two major forms of contaminations of sludge could be the sewage sludge itself or through aerosols. Contact with the sewage sludge is a direct contact that can results in disease infections whilst the indirect contacts can be gotten through aerosols. Aerosols are mostly transported by strong blowing winds on fields that sewage sludge has been applied. Microorganisms may be carried by winds and deposited on surface water. Many enteric microorganisms can efficiently be transmitted by aerosols. It is during the process of

spraying sewage sludge on the fields, microorganisms in the sludge; find their way into the aerosols generated. Such aerosols with contaminated microorganism can be inhaled directly by human beings or through the direct contact with the contaminated surface. In addition to this, if wind velocity is high at a given site, suspension sludge particles could. Dried sludge may be very light and, therefore, easily suspended. However, most sludge would not be easily re-suspended because of their moisture content and tendency to mat as they dry. The following diagram shows the pathways of exposure to sewage sludge related health risks.



VIII. CONCLUSION AND RECOMMENDATION:

In conclusion, as we look the advantages of sewage sludge as coming to solve some problems in the field of agriculture, especially with the excessive and misapplication of chemical fertilizers, we should as well be very careful to have proper research into the hidden dangers of sewage sludge as this could have hidden health effects on human being. Finally, to reduce human health risks, my recommendation summarized in to the following major points:-

- I. Chemical quality should be controlled in such a way that the receiving soil does not become contaminated so as to cause crops to be hazardous to eat or reduction of their yields.
- II. Microbiological quality must be taken into account so that the spread of human, animal and plant diseases are prevented.
- III. Aesthetic considerations must be taken into consideration and the operation must not cause nuisance or offence.
- IV. The product and service should be acceptable to users.

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