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Groundwater Problems Caused By Irrigation with Sewage Effluent

Dr. Osama Asanousi Lamma
Department of Soil & Water, Faculty of Agricultural, Bani Waleed University, LIBYA

Corresponding Author: osamalamma@bwu.edu.ly

ABSTRACT

Sewage effluent water is consistently used for the agricultural irrigation in rural and urban region farms. The spread of the potential infectious diseases is the major concern for farm workers and also for city inhabitant when they get exposed to these effluents. They also will affect those people consuming crops developed using effluent water irrigation system, particularly when the farm produce is consumed raw by people or otherwise, the farm yield is brought in that raw condition into the kitchen. Only way of preventing is by making adequate measures to disinfect the effluent. Moreover, the effluent water must meet all the conditions of usual irrigation water parameter needs such as trace elements, sodium adsorption ratio, salt content, and so on. Regrettably, no proper interest taken and awareness paid to curtail sewage irrigation long-term effects on principal groundwater.

The irrigation water is mostly applied during the dry climatic conditions that evaporates quickly. Whereas, the non-biodegradable chemical concentration of the drained water and deep-percolated water goes down to join the groundwater, which may remain at a higher level than the effluent water itself. There are various chemicals included in such effluent water, comprising of various salts, potential pesticide residues, nitrates, and they are usually expected in the farming and irrigated farming. However, the chemicals in the sewage, such as pharmaceuticals, organic, synthetic compounds, by-products of disinfection, and pharmaceutical active endocrine disruptor, chemicals, Fumic acids are mainly known to be the main disinfection precursor by-products. They are formed as soon as the drainage water joins the drinking-water, which gets chlorinated subsequently. Therefore, the groundwater right under the sewage-irrigated regions finally can become completely unfit for human consumption and drinking. The is the main issue that is raising questions of its accountability and burden, when the sewage water irrigated, joins the groundwater.

Keywords- Wastewater, contaminants, groundwater, treatment, chemicals, irrigation, sewage, effluent, rivers, lakes.

I. BACKGROUND

Due to an extensive growth of the population, most of the cities in the developing countries, turn into mega-cities and they require mega-clean water needs. Simultaneously, there are bound to be mega-sewage stream surge, creating mega-problems to plan, design and structure the entire city configuration. People living in countries having a high living standard, are likely to grow gradually, besides the United States, who is facing the basic immigration problem. When the population growth continues, there is an increase in demands to obtain more water, generating tremendous competition. The water resource management has to integrate all their activities, considering every aspect of the water problem, by applying a holistic approach to gain the best strategies to find solutions. For the knowledge sake, the of management water distributors must involve a demand management system to determine whether the problems related to better solutions of water shortage can be achieved economically by more efficient method of use, and effective conservation strategy, to get high economic returns, and other identical benefits, reuse, recycling, water pricing, and such measures (Oppel et al., 2004).

Integrating all the water management programs and systems can also include the management of water quality, efficient pollution control, public health, economics, ecological aspects, environmental aspects, sociocultural aspects, long-term water storage and banking, conjunctive application of groundwater, surface water, bringing involvement of people and community, with public conflict resolution, and flexible application of climatic changes (Naeem Khan, 2018). This also includes water supply changes with regional approaches, application of sustainability, the virtual water concept, and so on. This review paper tries to explore the reuse of water through irrigation, and how groundwater problems are caused by uses of sewage effluent water for irrigation purpose.

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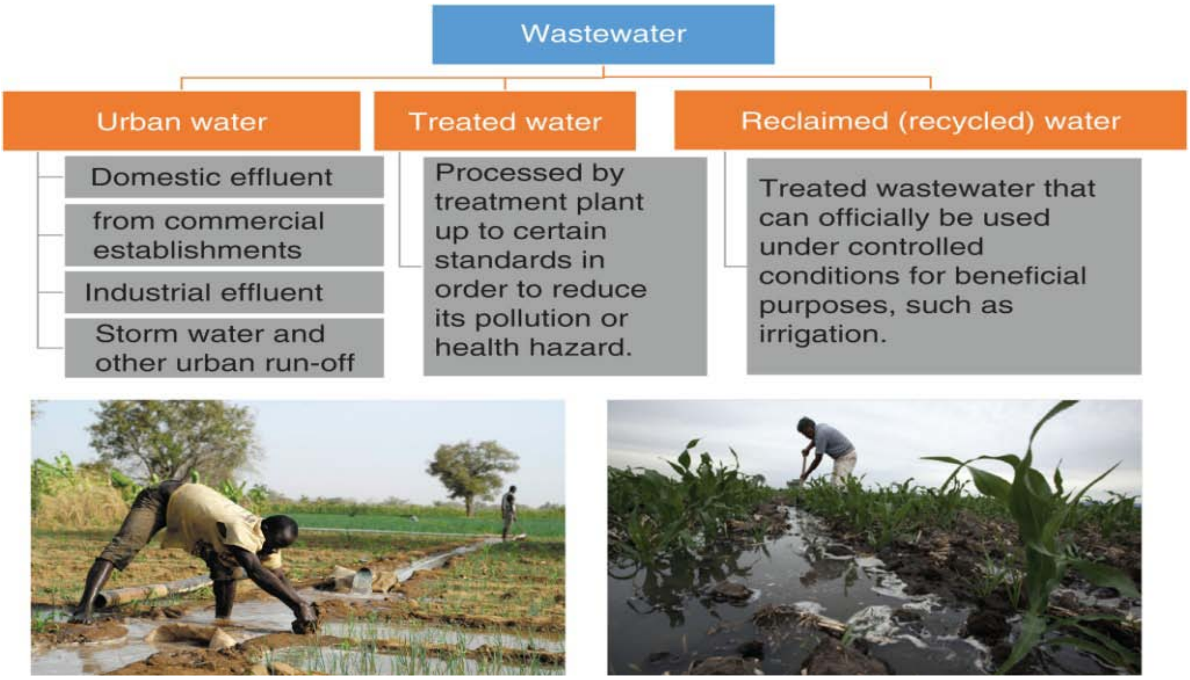
Figure1: The existing status & challenges due to wastewater irrigation & groundwater polluted with dirty water (Parvin Zolfaghary, Zakerinia & Kazemi, 2021).

II. INTRODUCTION

There are short-time benefits related to use of effluent water for irrigation, as they provide enough nutrients for development and growth of plant, for the soil improvement structure, and also for the increase in the yield of the crop (Jolly, Islam & Mustafa, 2012). The main effluent irrigation risk can be the likely propagation of infectious diseases in grazing animals near sewage-irrigated fields and also to people, who get exposed to the effluents, directly or indirectly. Lately, the authorities started investigating the long-term potential harm connected with the effluent water irrigation system, primarily the irreversible aspects of groundwater quality deterioration effects (Patil, Sawant & Deshmukh, 2012).



The raised anthropogenic contaminant concentration like heavy metals, organic chemicals, pharmaceuticals, effluent-based hormones, soil-generated organic pollutants, are well-known at effluent-irrigated groundwater sites. (Mahajan Saroj, 2014).

Due to various chemicals and salts in the irrigation source of water, they get leached out from the main root zone with much less water than the irrigation water applied, the salt content in the original water zone and it is leached out in the drainage water more than in that of irrigation water. The presence of chemicals in agricultural matters get percolated deeply in water arriving from the irrigated fields, and that degrades the water quality and characteristics of the primary groundwater (Satone et al., 2011). Another supplementary recharge system can be acquired urbanization process, when a large portion of land involving driveway, streets, roofs, and several impermeable areas, where the rate of water evaporation is higher than natural surfaces, leaving unwanted particles on the surface.

Hence, Thus, the concentration of various chemicals and salts are not absorbed by the bio-degraded plants, but moved into the soil surface four times more than the Leachate, the contaminants arriving from soil leaching, than from the irrigated water. This drainage water and deep percolation Leachate move down towards the groundwater, causing serious quality damage by degradation (Ladwani et al., 2012).

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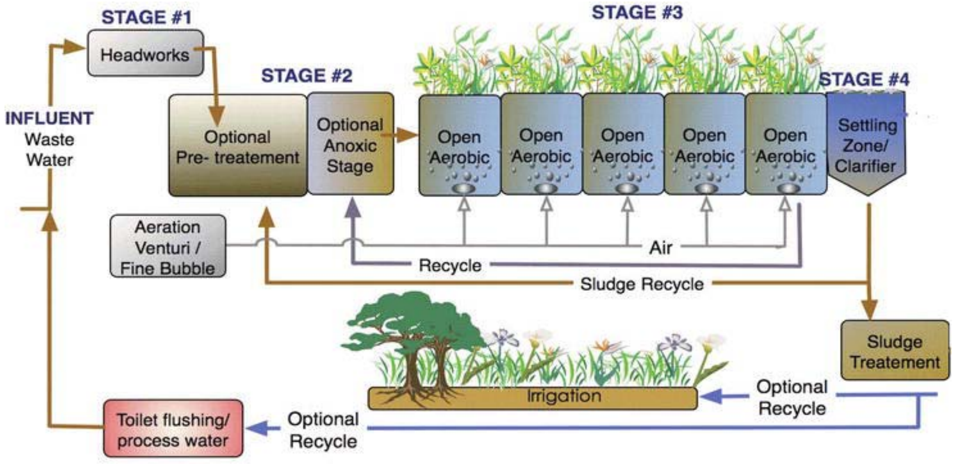

Figure2: Irrigation stages (Attila Bai, & Gabnai, 2021).

Into the bargain, to freshwater resource depletion, surface with groundwater pollution resources intimidates animal and human life long with other biota. Either surface pollution or groundwater can easily impact the water quality and thereafter, the irrigated soil with such waters. For example, the contaminated surface movement of water along the soil layers at the deeper level can influence the quality of groundwater (Fazila Younas, et al., 2021).

III. MUNICIPAL WASTEWATER TREATMENT REQUIREMENTS FOR IRRIGATION

If for irrigation, use of municipal wastewater is made, for road plantings, urban irrigation, agricultural irrigation, golf courses, parks, residential areas, sports fields, and so on, several chemicals from the wastewater can prove to be a real threat to harm the groundwater quality. This is an acute concern for dry climates, efficient irrigation, where the drainage water, chemical concentrations or its deep-percolation effect can increase in the wastewater also, depending on irrigation efficiency and rainfall. The concerned chemicals of include pesticide residues, various salts, mostly nitrogen as drainage water, nitrate, by-products of disinfection, active pharmaceutical chemicals, disinfection by-products, and many dissolved organic elements to form a new disinfection suite of by-products, no sooner the groundwater is sent up for chlorination or for drinking (Attila Bai, & Gabnai, 2021)

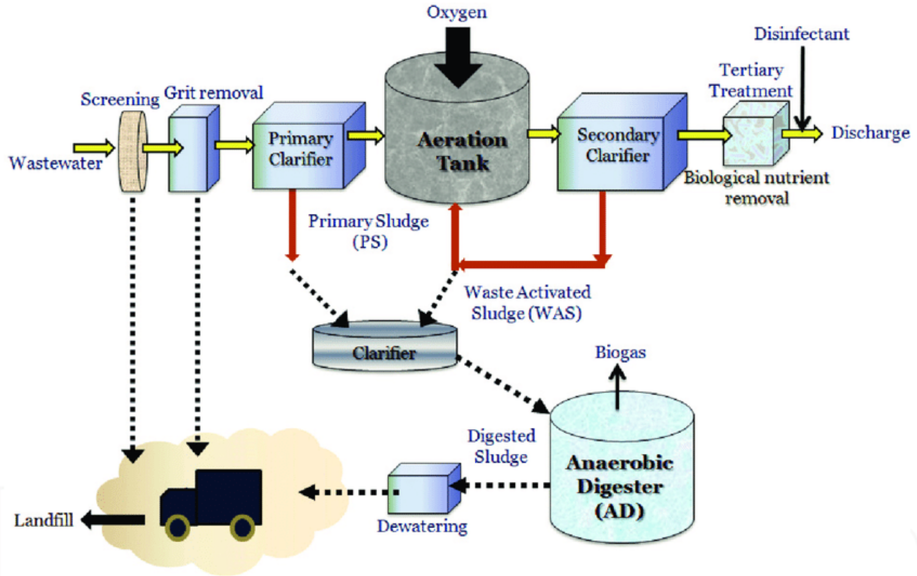

Figure3: Typical treatment process of municipal wastewater (Attila Bai, & Gabnai, 2021).

The effluent irrigation, quality standard major criteria are the usual chemical needs for crop irrigation supplied with irrigation water measured as salt contents, the ratio of sodium adsorption, chloride, sodium,

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nitrogen, trace elements, bicarbonate and so on. Almost all domestic effluent waters meet them, while the industrial discharges are concluded in the sewer system to cause larger heavy metal concentration with other elements. The major effluent irrigation concerns are the health effects of farm workers who are in constant touch and exposed to such water and those people who use the agricultural products in irrigated areas.

IV. GROUNDWATER EFFECTS

Regrettably, the requirement of basic microorganism and chemicals for the purpose of municipal wastewater irrigation, do not include by-products of disinfection, pharmaceuticals, active chemicals, and various probable contaminants. The by-products of disinfection are already included involved in the wastewater and that enters the water plant treatment because of the drinking water chlorination process. The By-products are formed in this process of effluent treatment in the treatment plant wastewater, specifically when a long contract, large chlorine doses are used for the tertiary treatment. The ultraviolet irradiation of disinfection with filtration granular media can decrease disinfection levels of by-product in the region of tertiary effluent. Certain by-products of disinfection, like Haloacetic acids, Trihalomethanes were observed in biodegradable aquifers near the recovery and storage wells (Singer et al., 1993).

Also, by-products of disinfection are the major organic compounds of Halogenated products and their real identity is to-be-found and discovered, because they decide the fates of underground water and environment. The Trihalomethanes involves Bromodichloromethane and chloroform. The can create problems due to the harm to pregnant women. Concerning the dissolved salts, the by-products of nonvolatile disinfection and refractory concentration in the multi-layer drainage water percolation can also involve more than 500% higher than effluents used for the purpose of irrigation, even when the irrigation 80% efficiency is maintained. Due to its likely carcinogenicity, and toxicity, the by-product disinfection level in drinking water gets consistently analyzed, to find the optimum level of contaminants, to reduce that level in the future. The Environmental Protection U.S. Agency has reduced the MCL level 20 micrograms, per liter from 100 to 80 levels of drinking water to identify Tri-Halomethanes. This cannot by used as potable groundwater purpose because it involves deep- water percolation coming from effluent-irrigated regions. Hence, it is a challenging task to get the balanced disinfection by-product drinking-water formation, because of microbial control, and for reuse of water issues. They observed an acute illness like diarrhea, stomach ache and worse, initiated pathogens involvement possibility, and there can be immediate many more serious problems attracting diseases like malignancy and cancer scourged by chemicals due to many years of water ingestion (Ansari, et al., 2019).

The high level of organic-carbon and nutrients in effluent water can also be expected to increase the Bioactivity and plant growth in the soil. The plant parts, decaying roots and other related biomass can also generate Fulvic and Humic acids as a secure end product. They are non-biodegradable elements, they are considered as by-product disinfection precursors in the groundwater, which is further chlorinated. Therefore, when effluent-irrigated groundwater from the lower areas is sent for chlorination for potable application and pumped for the purpose, a new disinfection byproduct suite can be generated.

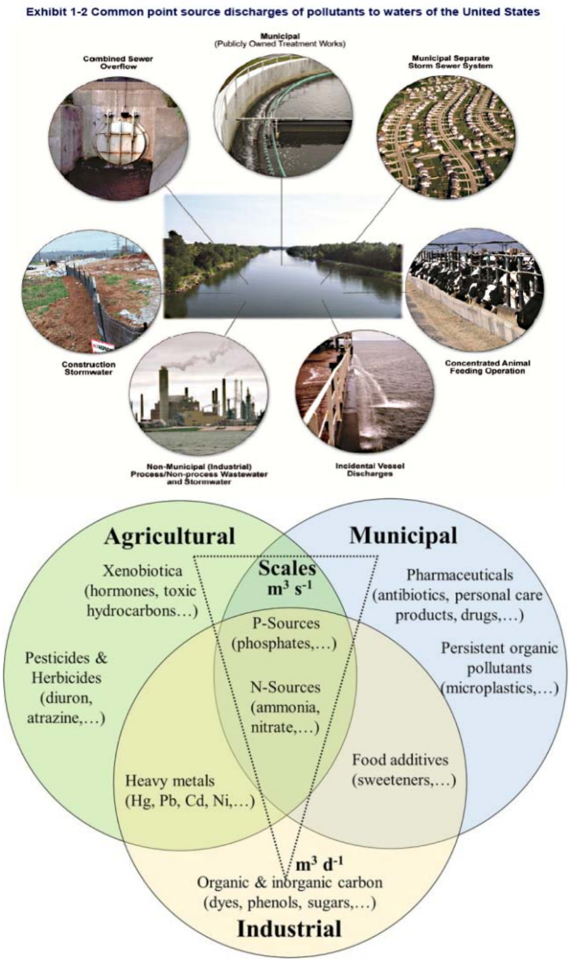

Figure 4: Municipal Wastewater pollutant (Sousa, et al., 2018).

There is a major concern regarding the increase in active pharmaceutical chemicals that enters the waste discharge sewers including hospital, domestic, pharmaceutical, and industrial outlets of water (Menció, et al., 2016). The pharmaceutical effective chemicals in the wastewater can be treated and they normally are not adsorbed effectively in the soil particles. Hence, they can be intractable in the environment underground water sources. When such chemicals are not always toxic, they

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are likely to produce an unpleasant health outcomes by disturbing the hormone system and immunity of human beings and animals, because they can behave like endocrine disruptors. Minimum 45 chemicals were identified having likely endocrine disrupting ability as contaminants, and that included industrial and commercial place contaminants identified as PCB, dioxins, Carbaryl and DDT kind of insecticides, herbicides similar to Atrazine, 2,4-D. Further research is required to identify the occurrence and involvement of active pharmaceutical chemicals in the below ground water, streams, and environment and regarding their synergistic effects while the entire pharmaceutical spectrum of active chemicals along with other dangerous contaminants are present (Subash Chandra Bose, et al., 2013).

Moreover, the drainage water includes all types of organic chemicals. They enter effluent water irrigated fields. They always contain excessive nitrates and salt levels, together with the agricultural pesticide residues from farming practices.

To evaluate the downward movement of drainage water inclusive of various chemicals from the root zones, it can be obtained the average flux amount dividing with the volumetric contents of the water. For instance, the irrigation water of 100 centimeters, is provided every year and the water consumptive use, that is, evaporation + transpiration, per year, is 80 cm, the descending flux will be 20 cm per year, (100 – 80), if insignificant rainfall is assumed. In the unsaturated zone, when the volumetric content of water is 15%, the downward velocity pore of the molecules of water will be 20 divided by 0.15, which means, 133 cm every year.

This would also be possible id we consider the conservative or nonreactive downward velocity, or dissolved chemicals. Chemical adsorption to soil particles decreases the chemical movement rate, while preferential water flow augments it. As soon as the water from drainage comes in contact with the groundwater and also when there exists no different discharge or recharge from the aquifer, the groundwater level increase is considered as the downstream flux to be dividing with the unsaturated fillable porosity or the saturation deficit or the d zone, which is the difference of the entire porosity and volumetric content of water. Considering the earlier illustration, wherein the entire porosity remains at 32%, the related fillable porosity will be 32% - 15% = 17%. Hence, the 20 cm per year downward flux can cause an increase in the level of groundwater of 20 divided by 0.17, which is equal to 118 cm per year. These results were identified when there is an increase in the level of groundwater in the irrigated areas. When the irrigation process is inevitable, and seasonal, identical measures of calculations are processed to bring them in a less time periods. When rainfall is maximized, this also should be considered and taken into explanation (Madeira, et al., 2017).

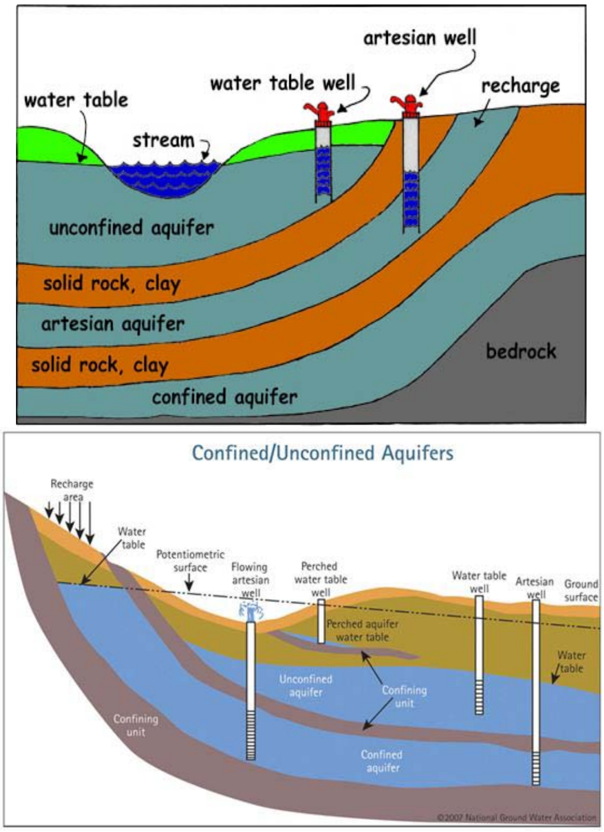

Figure 5: Water Table Aquifers, (NGWA, 2021).

When joined the aquifer, it will cause the ground water level to increase. At that stage, the drainage water is likely to remain in upper aquifer level, at the top portion, according to the principles of vertical-stacking. Hence, the shallow wells obtain their level filled with water from the top portion of the aquifer, which will initially demonstrate the groundwater contamination evidence. The groundwater is pumped from the deep wells coming from the aquifer deeper portion or from basic confined aquifers and they will indicate the contamination level some other time (Subash Chandra Bose, et al., 2013).

V. AIM AND OBJECTIVE

The major aim of this review is to conduct an elaborate survey to assess the damage to groundwater and the environment caused due to use of sewage effluent water for irrigation purposes.

Objectives

1. To investigate the type and amount of sewage effluent reaching the irrigation applications;
2. To explore the inadequate waste water, its analysis, management procedures, and the related environmental and groundwater impact due to the problems caused by the use of sewage effluent for irrigation and the adverse health outcomes.

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3. To explore the indirect and the indirect effects on groundwater caused by irrigation with sewage effluent water.
4. To explore whether these water pollution effects can be reversed.

VI. REVIEW OF LITERATURE

Singh et al., (2013) surveyed the waste, untreated water arriving from the nearby industries and from the human settlement near the industries and found out that it was the prime deterioration cause of Ludhiana water quality.

Divya & Belagali, (2012) observed that, water analysis of Budha Nullah surface water revealed a large amount of dissolved solids to the level of 1672 mg/L, Chemical Oxygen values of 438 mg/L, Chloride level 412 mg/L, Demand of Biochemical Oxygen varied from 52 to 195 mg/L.

Jitendra Giri et al., (2014) found out that in effluents, the TS- total solid values, TSS- total suspended solids, and TDS- total dissolved solids were very high, when compared to the tube well water. It also reduced with increase in industry distance.

K. Brindha, et al., (2014) surveyed the water of 45 mg/l, as stipulated by the BIS standards and that was the optimum permissible limit. Also, groundwater sample of 18%, did not comply with these standards, therefore making this water unfit for domestic use and drinking use.

VII. WASTEWATER TREATMENT, PROBLEM STATEMENT

Problems related to water, sanitation starts with the development of urban migration and discharging practice of untreated wastewater. The non stop population growth in urban regions has ended the expansion and planning of sewage system and water extremely expensive and difficult to accomplish. Additionally, more people move towards the city for better incomes, and that make the situation problematic for the upgrade of any water system (Jitendra, Giri et al., 2014).

In several developing countries, the urban population of more than 315 million residents is staying without proper sanitation access. This is mainly due to the urban dwellers of low-income groups, affected due to lack of proper sanitation facilities and without useful infrastructure. Around 65% of the developing world population has no proper hygienic measures of excreta disposing and also the highest number lack satisfactory means to dispose of the entire wastewater (Singh et al., 2013).

They follow a usual practice to release untreated sewage straight into water bodies that is directed onto agricultural farms. This causes considerable health issues and economic dangers. Several householders having access to proper drinking water, have increased by almost 85% in the Caribbean and Latin America, while the link to the Urban area sewage systems is meager 5%.

VIII. CONCLUSION

WWT- Wastewater treatment has become a global problem. By applying any single technique or science, and due to a large scale of various contaminants in groundwater and Wastewater coming from wastewater, the conditions does not permit to purify the groundwater. Due to this in the industrialized nations, the water quality has touched an agonizing state (Shahid Malik, et al., 2020).

Waters at various locations contain a range of chemicals and pesticides, including an excessive intensity of NO 3, arsenic (As), boron (B), selenium (Se), along with metal traces like Lebron and Suarez. If such sewage municipal effluent is applied for the purpose of irrigation, without any proper treatment, the entire pollutant new spectrum gets included in the soil, that further joins groundwater, and thereon, joins the food chain of human beings and animals.

There are WWT conventional methods to get rid of suspended solids, by mainly mechanical means, and further to reduce demand of biological oxygen by activating sludge process (Wang, et al., 2017). It involves inorganic and organic constituents and molecules breakdown of nitrogen and phosphorous compounds, to prevent the downstream water Eutrophication to join lake and river waters. The capacity of degradation uses standard, but limited technologies, related to heavy metals, having a large nutrient base of Xenobiotics, and that lead to the addition of such elements in groundwater (Wang, et al., 2017).

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