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Feasibility Study of Constructed Wetlands for Treatment of Domestic Wastewater in Rural Areas of Pakistan

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Abstract

Constructed wetlands system removes the nutrients and organic matter from wastewater through the combination of physical, biological and chemical mechanism. Pakistan is a developing country; constructed wetlands are very useful and effective treatment system for the domestic wastewater. Hence these wetlands set-up involve simple technology and low operational costs and contain diverse variety of other plants such as Pistiastratiotes L., Eichhorniacrassipes(Mart.) Solms, Menthaspicata L., Nasturtiumofficinale R. Br., Phylanodiflora(L.) Greene, with diverse properties in removing pollutants from wastewater usually require normal garden care i.e., encouragement of new flowers and pruning for appearance it help in enhance removal of nutrient and organic matter. Constructed Wetlands are the best system for the treatment of domestic wastewater due to seasonal variation, availability of space, diverse variety of plant in nearby areas of Punjab, and the last most important is the suitability of physiochemical proprieties of soil..

Keywords: ***Feasibility study; Domestic wastewater; Wet lands***

Introduction

Wetlands are engineered based and natural systems which are used for treatment of domestic and industrial wastewater. Through a combination of physical, biological and chemical mechanism, these systems remove the nutrients and organic matter from the wastewater [1,2]. Usually wastewaters from petite communities are settling down into water bodies. The adverse effects of organic matter, phosphorus and nitrogen on ecosystem could be reduced by removing above constituents from wastewater before the final discharge in to the natural receiving water bodies. The solution of the problem in small communities, an efficient and cost effective constructed wetlands technology has to improve the domestic water quality standards [2]. The lower maintenance, operational and control costs linked to constructed wetlands as compared to traditional wastewater treatment plants.

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Though, the wetland operation as well as bacterial activity and nutrient assimilation are affecting due to temperature fluctuations. Among other crucial removal mechanisms in constructed wetlands, the efficiency of pollutant removal is adversely affected with decrease in temperature [3,4].

As a part of demonstrative research, globally wetland ecosystems are the most biologically productive and diverse natural ecosystem. Constructed wetlands make sense that help to improve the water quality and support wildlife habitat [5,6]. Constructed wetlands are cost effective, low operating cost and maintenance, technically feasible approach in treating wastewater to make it available for use. These wetlands are less expensive in construction than traditional wastewater treatment plant. These wetlands are generally developing for secondary and sometime tertiary treatment of wastewater. In areas where landscape is limited, high water table content and poor soil condition which inhabit the adsorption of soil in fields, researcher are experimenting with unconventional system for treatment of domestic wastewater. Generally, their low maintenance cost and investment, many small communities and individual homeowners are interested with its good performance in purifying wastewater [7].

Treatment of domestic wastewater and agriculture wastewater are mainly take place in constructed wetlands [8,9]. In Europe as well as in USA, many wetlands are operated with horizontal flow system [10]. In Germany and USA, there are approximately 50,000 and 8000 establish wetlands facilities for domestic wastewater treatment [10]. In Europe, currently these are the subject of many researches in order to improve their basic design limitations [11]. These constructed wetlands are very effective in the removal mechanism of not only BOD and TSS but in cold climate also effective for nitrification even at high loading rate [12-15]. Because in VFCW which are often drainage or flooded allowing the oxygen to refill in pores of substrate and in this way improving the transfer of oxygen from atmosphere to the bed [15].

In developing countries, constructed wetlands are very useful and effective treatment system of wastewater. Hence these wetlands set-up involve simple technology and low operational costs. Sometimes, the wetlands can be constructed with local and available resources which significantly lower the construction cost. Moreover, these manmade artificial treatment systems are good at removing pathogens and nutrients like nitrogen and phosphorus but also useful in removal of toxic metals and organic pollutants [16]. The warmer climate and richness in biodiversity allow the use of non-conventional species of plants such as ornamental plants, emerged plants and commercially valuable plants and animals. These attractive plants species in addition of improving the condition of landscape for treatment, can also important for economic benefits for the community through production of commercially important flowers [17].

It is essential to adopt those technologies for treatment of wastewater which can sufficiently treat the wastewater in extended time period i.e. sustainable technologies. Constructed wetlands have shown good efficiency and successfully control to remove organic material, pathogens and nutrients. Greenway explore that technology of constructed wetlands is a workable option that not only partially eliminate nutrients but it also performs well in disinfection function [18]. Treated wastewater is a source of irrigation for crops, watering of gardens, play grounds or golf courses. Globally in both developing and developed countries, constructed wetlands are the attainable, well-organized and low cost alternative for wastewater treatment.

Objectives

1. To study the possibility of constructed wetlands for treatment of domestic wastewater.
2. To selection of the ornamental plants in treating domestic wastewater.

Discussions and Results

Plants

Wetland plants usually require normal garden care i.e., encouragement of new flowers and pruning for appearance. Sometimes, pruning is essential as it enhance nitrogen intake modestly. Pruning can be used outside the system for mulch and can be added to compost piles.

The above mentioned 20 species are named as *Pistiastratiotes L., Eichhorniacrassipes(Mart.) Solms, Menthaspicata L., Nasturtiumofficinale R. Br., Phyla nodiflora(L.) Greene, Persicariaglabra(Wild.) M. Gomes, Cyperusalopecuroides Rottb, Cyperusnutans Vahl, Enum.,Cyperusglomeratus L., Cyperusdigitatus Roxb.,Saccharumspontaneum L. Polypogonfugax Nees ex Steud., Arundodonax L.,Typhalatifolia L. Juncus articulates L, Nymphaeanouchali Burm.f, Veronica-anagallis- aquatic L. Ranunculus scleratus L., Lemna minor L.*

All these plants are distributed in different regions of Pakistan like Sialkot, Gujranwala, Gujrat, Baluchistan, Sindh, Islamabad, Rawalpindi, Chakawal, Abbottabad, Sargodha, Mansehra, Multan etc. *Pistiastratiotes L, Eichhorniacrassipes (Mart.) Solms, Nasturtium officinale R. Br, Cyperusalopecuroides Rottb, Nymphaeanouchali Burm. f, Ranunculus scleratus L.* are used as precious ornamental plants while the other plays important roles as a pollutant absorbent, as a good source of fodder for livestock, as a useful weed, as efficient soil binder, used to increase the fertility of soil and for many other purposes. *Phragmitesaustralis* is one of the main wetland plant species used for phytoremediation water treatment.

In Pakistan, Punjab province and its cities like gujrat, ponds exist naturally, which is a type of wetland. Because of this reason, this soil is best suitable for wetlands. Seasonal differences were evident significantly, with much better vegetation performance especially polyculture systems during warmer seasons of the year while the unplanted systems perform their best during winter months of the year. Polyculture systems give the better and consistent treatment features for all of the wastewater parameters and is being least susceptible to the climatic variations. The latency of diverse species may provide more emphatic rooting biomass distribution as well as more diverse habitat for microbial population as compared to monoculture systems [7].

Depending on the type of plants being used and with the passage of time, hydraulic conductivity increase because old channels of rhizome remain open up after the rhizomes decayed thus creating a chain of pores through bed. These can be developed after 3-5 years in a significant quantity. The size of the constructed wetland depends on the kind/type of treatment that is black or fecal water only, grey water or mixed water, in warm weather, for sewage treatment of household, (+/-) 1-4 m^2 per person. In cold climates, double size (+/-) (Wastewater Gardens International 2000).

Conclusion

Constructed wetland systems showed a potential for the removal of fecal bacteria, Biological Oxygen Demand as well as Total Suspended Solids from domestic wastewater. Significant seasonal changes were observed, with the vegetation showing best performance especially polyculture during warmer days of the year. Possibly in vegetated cells, falling residues and roots of plants while increasing the food sources and attachment surface for microbial populations gives more sufficient medium for filtration than gravel alone.

Recommendations

- Location: No shade, no rain-gathering areas.
- Ensuring proper primary treatment.

- Ornamental plants and energy crops should be used with deep root structure.
- Materials used: gravel or broken recycled concrete (washed and screened)

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