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Integrated Management of Wastewater through Sewage Fed Aquaculture for Resource Recovery and Reuse of Treated Effluent: A Case Study

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Abstract

India has 18% of the world's population, 1.15 billion people, but access to only 4% of world's fresh water resources. In the recent past, the dependency of Indian agriculture on ground water resources has increased upto an enormous extent due to several factors including increased demand of food, erratic behavior of monsoon, developmental pressure of various allied sectors *etc*. Currently, the available 70% of water resources in India being used to fulfill the water demand for agriculture and the 80% of domestic water supplies come from groundwater which led to rapidly declining groundwater tables in most of the states in India and has found no longer sustainable. Present study has primarily highlights the need of the Indian conditions for treatment and reuse of wastewater which happens to be the main cause for pollution of water resources in India. In this study efforts were made for assessment the potential of model sewage fed aquaculture system of capacity 8 MLD in Karnal, India for wastewater treatment, reuse and resource recovery during the treatment process. The in-depth evaluation study were conducted for integrated assessment of STP in association with health, environment, society, and institutions aspects as well as quality of treated effluent subjected for reuse in irrigation. The Economic analysis of the model sewage-fed aquaculture system shows that there was an annual profit of INR 8-10 lakhs through selling of fish in local market as well as ample amount of revenue generated through selling of treated effluent to the farmers. Also, the irrigation with treated wastewater able to save the fertilizer upto 50kg of Urea and 50kg of diammonium phosphate during cultivation of one acre of crop annually. The system was found good for removal of physic-chemical pollutants and also found very effective in removal of bacteriological pollutants. The reported removals for total coliform, fecal coliform and fecal streptococci were found 99.988, 99.965 and 99.9567, respectively.

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1. Introduction

A large volume of wastewater continues to be discharged into natural watercourses leading to pollution of the coastal zones and drinking water reservoirs in India [1]. Disposal of partially treated and mostly untreated effluents into rivers and lakes and runoff from urban and agricultural areas are the two main reasons responsible for deterioration of drinking water resources [4]. In addition, the excessive withdrawal of water for agricultural and municipal utilities as well as use of rivers and lakes for religious and social practices, and perpetual droughts limits the capacity of river for dilution of wastes [2, 5]. On one hand the available water resources are rapidly depleted due to increased domestic water demands whereas the available water is getting deteriorated due to disposal of domestic and industrial effluents, on other hand. Although, the number of sewage treatment plants (STPs) have increased over the years in urban India, this increase is not adequate to keep pace with escalating generation of wastewater which results in a large volume of untreated or partially treated wastewater continues to be discharged into natural watercourses leading to pollution of the coastal zones and drinking water reservoirs in India [1, 3].

The conventional mechanised wastewater treatment systems turn out to be rather expensive in terms of both, the installation as well as O&M costs and hardly gave any resource out of the treatment process, whereas the NTSs provide opportunity to produce useful byproducts during the course of treatment. It is argued here that the newer solutions should be such that the peri-urban and small communities should be able to own and operate their wastewater treatment systems [4]. Interestingly, in the recent past, communities seem to accept the natural treatment systems (NTSs) that are capable of providing adequate treatment to wastewaters in conjunction with supplementing fish and nutrition to the food baskets of the fishing communities engaged in managing the systems as well as generating adequate water for irrigation of farms and agro-forests [3]. Also, the engineered NTSs blend well with the agricultural, peri-urban, and rural ecosystems.

There are different types of NTSs practiced in India and the most experienced include, Waste Stabilization Ponds (WSP), Sewage fed Aquaculture, Constructed Wetlands, Polishing Ponds, Duckweed Ponds, and Karnal Technolgy [5]. Sewage Fed Aquaculture system in conjunction with pisciculture is one such technology which has the potential of offering effective wastewater treatment besides providing economic returns as well as generating employment opportunities in the rural areas. The traditional practices of recycling effluent through agriculture, horticulture and aquaculture have been in used in several developed and developing countries in the world [6, 9]. The practices of using waste as a resource for the sustainable rural and urban development is not only help in treating the wastewater but also make the system long-lasting. Moreover, the practices of using wastewater for resources recovery not only reduces the pollution load into the natural water bodies but also make a continuous system of food production irrespective of any environmental disparity such as rainfall or drought.

In the present study efforts have been made for in-depth evaluation of selected sewage fed aquaculture plant of capacity 8 MLD operated in Karnal, India. During in-depth evaluation study the integrated assessment of STP Karnal, India was carried out in association with health, environment, society, and institutions aspects as well as quality of treated effluent subjected for reuse in irrigation.

2. Materials and Methods

To treat the wastewater of Karnal city, the WSP of capacity 8 MLD was established in year 1999 under