Economies Of Wastewater Reuse

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Abstract: The rapidly increasing population, the technological and industrial booms have brought enormous problems and degradation of the environment. Water pollution and water scarcity is an emerging problem in Pakistan. Pakistan has no effective collection and treatment of domestic and Industrial Wastewater. Due to the shortage of water in Pakistan, we should go for new water resources. Wastewater reuse after treatment is a reliable water resource for irrigation. In case study of Faisalabad, wastewater of the city is treated by using waste stabilization ponds and evaluated the effluent quality as a function of cost. The results shows that by increasing the number of ponds the ultimate cost of the project will increase and area requirement will be more, six (6) parallel series of anaerobic, facultative than that will be high in coliform, but if one maturation pond is added then coliform reduces but not in the range to WHO guideline for unrestricted crops, by adding four ponds the values will be in range but adding more maturation ponds will increase cost of the project.

Introduction:

Use of highly treated wastewater effluent, discharged to the environment from municipal wastewater treatment plant is important to save the natural water bodies. In many part of the world, water reuse is receiving more attention as a reliable water resource. While water reuse is viable option water conservation, efficient use of existing water supplies and new water resources development and management are other alternatives that must be evaluated. The feasibility of reuse will depend on local circumstances, which will affect the balance of costs and benefits. The major benefit in most cases is likely to be the value of the fresh water exchanged for high-value urban or industrial use. This would lessen the cost for municipal authorities of seeking their supplies through more expensive means. In addition, reuse prevents untreated wastewater discharge to coastal and groundwater systems with ecosystem and tourism benefits. Depending on the local situation, there could also be benefits to farmers if they can avoid some of the costs of pumping groundwater, while the nutrient present in the wastewater could save some of the expense of fertilizer. There could also be benefits to the local environment from reduced flows of untreated wastewater – though the interruption in the downstream water cycle could have other, less beneficial, effects. The costs of the reuse option would depend upon the type of reuse. Where climatic and geographical features are suitable, low-cost treatment of wastewater may be an option through the use of stabilization ponds, constructed wetlands, etc. The net cost of treatment may also be reduced through the reuse of biogas for energy and power in the intensive treatment processes, or potentially through the sale of carbon offsets. The economic appraisal of the project should be from a regional basin viewpoint, comparing its economic costs and benefits. Judging by the evidence of our case studies, it is unlikely that schemes could be economically justified with reference only to agriculture.

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Although farmers may be net beneficiaries from using treated wastewater, compared with their previous or alternative sources of water, this depends very much on local circumstances, and in any event their net benefits are unlikely to offset the full costs of the scheme. On the other hand, the benefits to urban and industrial users could be relatively sizeable, and in most cases would be the principal justification for the project. The net impact of the project on the local and downstream environment will also be very site-specific, and there are likely to be both benefits and costs.

Statistics of Pakistan

In Pakistan, a major fraction of untreated wastewater is used to irrigate crops, some of which, (salad crops) are eaten uncooked. Consequently 50% of crops are contaminated with pathogens. About 2,000 acres of land are being irrigated in the city of Lahore, 5,000 acres of land in Hyderabad and 6,000 acres of land in Faisalabad [7]. Moreover, in all over the country, especially in small towns, use of raw sewage effluents is a very common practice. Direct reuse without any restrictions on the types of crops poses potential health hazards and adverse environmental impacts. Use of sewage for irrigation has also affected the ground water quality. Studies conducted at Faisalabad and Lahore has indicated increased microbial count in ground water [8]. Therefore, although the use of reclaimed water offers the potential for exploiting a new resource, which can be substituted for existing sources, it must be approached with care, i.e. health risks must be considered. A study near the town of Haroonabad in the Southern Punjab region has been conducted by 'IWMI' by taking into consideration the current wastewater practices and the related irrigation, health and environmental issues. This study reveals that an accumulation of heavy metals in the wastewater-irrigated soils, will make the land unprofitable unless it is properly managed, using reclamation and other measures. This study confirms that wastewater irrigation offers benefits that can help many rural water-short areas increasing their agricultural productivity and profitability. But in each location the negative impacts and sustainability issues must be carefully evaluated. IWMI's wastewater research in Pakistan is being strengthened with the launch of a new project, funded by the German Ministry for Economic and Development Cooperation. This new project will look at practices and impacts of the reuse of wastewater in semi-urban areas.

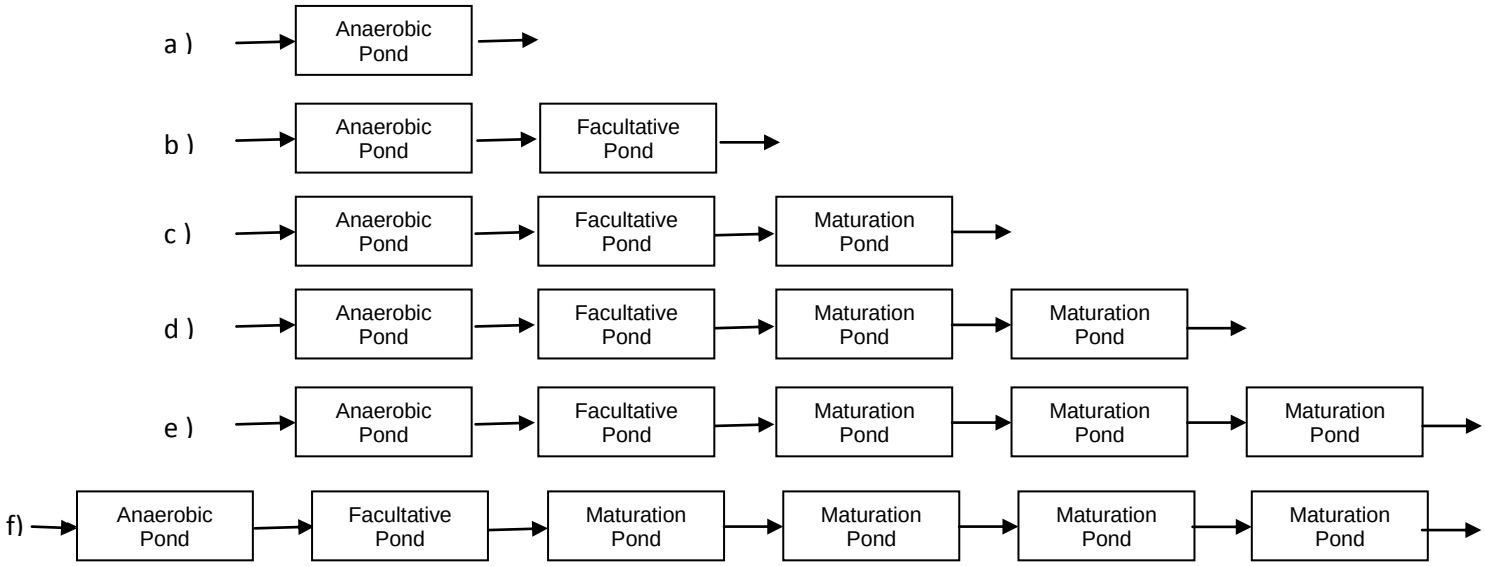

Figure 1: different alternative of waste stabilization ponds used for treatment of wastewater

Study Area:

The Temperatures in Faisalabad ranged from a minimum of 38°C in January to a maximum of 47°C in May, while the mean daily temperature during the coldest month (January) was 13.5°C. Total annual pan evaporation (1992 mm/y) was found to be 10 times higher than the annual precipitation (190 mm/y), with pan evaporation being especially high (9.9 and 10.8 mm/d) in May and June. The domestic wastewater flow of Faisalabad for design of waste stabilization ponds is 90 000 m^3/day with an average biochemical oxygen demand (BOD) of 380 mg/l.

Treatment Methodology:

Design:

To design waste stabilization ponds, six (6) parallel arrangements are made, each series with the combination anaerobic, facultative and maturation ponds. There are different alternatives used as shown in figure 1.

Cost Estimation:

The cost of cutting and filling is based on the prices of Pakistan Institute of cost and contract. The cost for cutting is Rs 110.7, and the cost for filling the excavated material is Rs 290.38. The graphs below show the relationship between cost and effluent quality in terms of BOD and Coliform reduction.

Comparison of Cost with removal efficiency:

The figure below shows the relationship between cost and removal efficiency, in figure 2. The relationship of removal efficiency in terms of BOD removal with cost is shown.

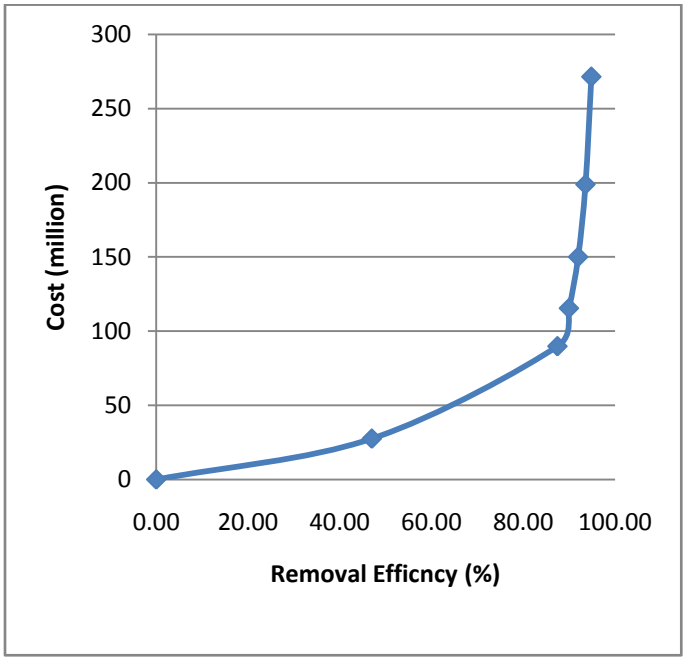

Figure 2. Relationship between cost and removal efficiency in terms of BOD removal

The figure shows that as the cost increses the removal efficency will also increase. If only anarobic ponds are provided than the cost will be minimum at the same time only 47% reduction in BOD will achive, but if we provide a fucaltative pond to increase the removal efficiency up to 87.47%, the cost will increase, the increase in cost shows exponetial behaviour as we provide fucaltative and then maturation ponds, as the maturation ponds do not remove significantly remove BOD, but these are provided to treat the pathogens. In figure 3 the relationship of removal efficiency in terms of coliform reduction with cost is shown.

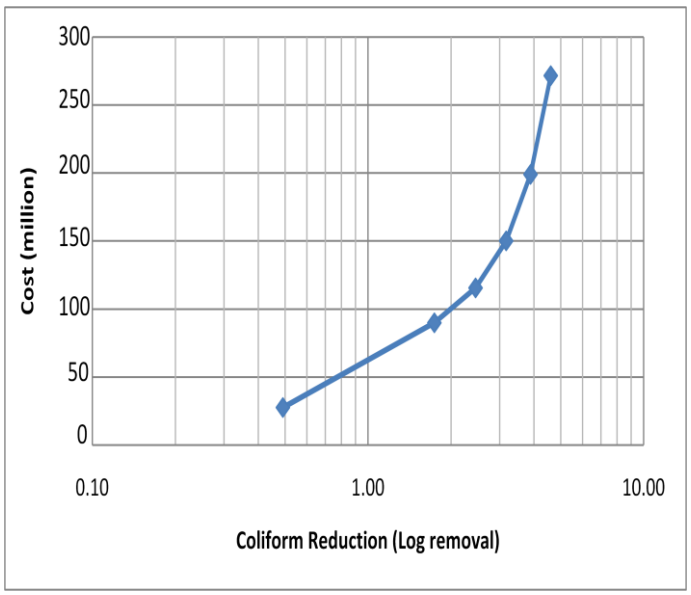

Figure 3. Relationship between cost and Coliform reduction, in terms of Log reduction

The figure shows that as the cost increses the removal efficency will also increase. If only anaerobic ponds are provided than the cost will be minimum at the same time only 0.49Log reduction in Coliform will achive, but if we provide a fucaltative pond to increase the removal to 1.74Log , the cost will increase, the increase in cost is more than double, if we want to achive the WHO guidelines that is <1000MPN/100mL (4Log reduction), we have to provide four maturation ponds, the cost will increase exponetially and we get the coliform reduction upto 4.6Log.

Summary & Conclusion

Faisalabad city has been selected for the purpose of this study. Wastewater of the city is treated by using waste stabilization ponds and evaluated the effluent quality as a function of cost. A number of alternatives consisting of anaerobic pond in series with facultative pond, anaerobic pond in series with facultative pond and a combination of number of maturation ponds have been evaluated. The following conclusions are drawn from the study.

- When anaerobic ponds are used for the treatment of domestic water, all the factors that is BOD, Coliform and Helminth in effluent are high and that water is not suitable for irrigation.
- When anaerobic and facultative ponds are used, the coliforms are high in effluent and adding facultative pond with anaerobic pond, cost of the project will increase more than twice, and land requirement will increased from 10 hector to 176 hectors. Effluent water can be used for restricted corps.
- When anaerobic, facultative and maturation ponds are used, the coliforms are high in effluent and adding maturation pond, cost of the project will increase, and land requirement will also increase. Effluent water can be used for restricted corps.
- When anaerobic, facultative and four maturation ponds are used in series, the coliforms are less than WHO guideline for unrestricted irrigation in effluent and adding more maturation pond, cost of the project will increase exponentially , and land requirement will also increase. Effluent water can be used for unrestricted corps.

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