Sustainable management of recycled wastewater – A case study

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Abstract

Waste water reuse is considered as a best solution to climate change adaptation, lack of water service and sanitation in rural areas in particular. The proposed method was the implementation of a real case which describes the benefits of application of treated waste water in Guru Nanak Institution of Technology, Hyderabad for ground water recharge and miscellaneous purposes. The waste water was analyzed for physical and chemical parameters before and after treatment and were compared with WHO, Indian standards and FAO irrigation standards. DO and BOD, Total hardness, Calcium, Magnesium, chlorides and sulphates were found in high concentration as compared to standard values. Hence, infiltration basins filled with filter media were designed and constructed in the campus to recharge ground water. Therefore treated waste water was passed through infiltration beds consisting of Coarse River sand, wood charcoal, 3/4th inch gravel, 3/4 inch Granite stones and river boulders. Final analysis was done after filtration. BOD of the filtered water was reduced Ca^{2+} , Mg^{2+} , T.H, Cl and So_4^{2-} were reduced. The research suggests that the waste water after treatment and filtration could be used for ground water recharge. This study provides an exploratory investigation into advantages of managing recycled waste. The paper also provides evidence that an Integrated planning and approach is necessary for the waste water management in a water stressed basin. This work is a challenge for the present and also for the future.

Introduction:

About 71% of earth's surface is covered with water globally, among which 99.7% is locked up in oceans, polar ice caps and only 0.3% is available as usable water. India holds 4% of global precipitation with 16% of its population and ranks 133rd in the world in terms of availability of water per person per annum. India experiences an average precipitation of 1,170 milli liters /year. As per ministry of housing and urban affairs, 135 liters per person per day has been suggested. Water cycle represents the evaporation of water into vapor and its condensation to form clouds and precipitation back to the surface of the earth. According to CPCB, waste water generation in India is estimated to be 62 billion liters/day.

Water reuse or re-cycling is the process of treating municipal wastewater, return flows, grey water, and tail water, brackish water, Kitchen wastes, produced water and others, for specific uses, like the irrigation of crops, before it re-enters the natural water cycle. The quantity of water which is available for human consumption is only one hundredth, among 3% of fresh water. If this water is untreated, it may pollute various water bodies. Water recycling has been considered as a viable solution for utilization of water resources more efficiently.

Study Area:

Telangana constitutes the state of South Central India nearly 720 kilometers along the Arabian Sea. The State is surrounded by Maharashtra to the North, Odisha and Chhattisgarh to the northeast, Andhra Pradesh to the south east, and Karnataka to the south. The state has a geographical area of 112,077 km

College of Engineering and Technology, Guru Nanak Institutions comes under Baramulla Education Society. It is one of the independent university in Telangana region It provides Technical education. The college is located in Khanapur village, Manchaal mandal of Telangana district, Hyderabad with total area of 10 acres. The total quantity of water discharged from hostels is around 8000-9000 liters per day.

Objective:

The objective of the present study was to evaluate the scope of waste water management challenges in India. The objectives were

- To estimates of waste water generation in the Guru Nanak Institute of Technology campus.
- To design a method for ground water recharge with acceptable levels of pollutants
- To reduce water scarcity for the most effective water resource management practice in the campus.

Methodology:

The total waste water generated in the campus is 200 KLD. Water coming from washrooms outlet was collected and with respect to the reuse of waste water, Important parameters like Colour, odour, Ph, temperature, turbidity, TDS, BOD and major ions (Na^+ K^+ , Ca^{2+} , Mg^{2+} , SO_4 , Cl) were estimated by standard methods. Each test was conducted in triplicates and the mean value was taken. The analysis was repeated after treatment was done from SWWTP and results were compared. It was found that D.O, B.O.D, Total hardness, Calcium, Magnesium, chlorides and sulphates exceeded the standards as prescribed by Indian standards. This work is in consistent with the work done by Popa et al., in 2012. According to these authors, domestic waste water was high in B.O.D and C.O.D. compared to industrial waste water. Akhil Gurijala and SS.Asadi [1.2] worked on estimation of Hazardous compounds in waste water and found that unless they are treated to standard limits, they can prove toxic to plants. The toxicity of higher constituents of bicarbonates, chlorides on human health were worked out by Dr.M.Venkateswarulu and M.Narsireddy [3] .Therefore, the treated waste water was not fit for gardening, ground water recharge and other miscellaneous purposes. For sustainable reuse of water, following type of treatment was finalized.

Construction of Infiltration basins:

Infiltration basins were constructed at the backyard of the campus. Total quantity of wastewater generated in the campus is 200 KLD and the water generating from SWWTP was estimated to be 150 to 180 KLD. Keeping this point in view, for recharging ground water, number and dimensions of Infiltration basins were calculated.19 number of infiltration basins were constructed in ground in a row-wise manner. The dimensions of each basin are as follows:

Dimensions of infiltration basins	
Length	7foot
width	7foot
depth	9foot

The basins were filled with Coarse River sand, wood charcoal, 3/4th inch gravel, ¾ inch Granite stones and river boulders as filter media. Distance between each basin was kept as 10 feet. Thickness of the filter media was decided as per the standard guidelines for slow sand filter. The total thickness of filter bed provided was 1.5m. in which depth of each filter media is as follows: sand (0.1m), wood charcoal layer (0.1m), Gravel (0.3m), granite stones (0.3m), and river boulders (0.1m). The filter media containing 5 layers were packed in an infiltration basin and the treated water coming from Water treatment plant was introduced into it. Each basin was filled with water in a step-wise manner.

S.No	Filter media	Size	Depth
1	sand	1-3.6mm	0.1 m
2	Wood charcoal	2–3 mm	0.1 m
3	¾ inch gravel	3/4th inch	0.3 m
4	¾ inch granite stones	3/4th inch	0.3 m
5	River boulders	5-10mm	0.1 m

Result And Discussion:

In the present study a detailed characterization of water collected from educational institute was performed to check its reusability for ground water recharge and gardening purpose. The water was characterized in 3 stages. In first stage, waste water directly coming from washrooms and kitchen, in the second stage, treated waste water coming from SWWTP and finally in the third stage, water coming through infiltration basin outlet. The characterized data were then compared with the prescribed limit of Food and Agriculture Organization (FAO [1994](#)), Indian standards and WHO standards.

It was found that there was a decrease in Biochemical Oxygen Demand (Graph.1) and increase in Dissolved Oxygen (Graph.2)

According to FAO ([1994](#)), irrigation water with excess ionic concentrations can cause plant toxicity. All trace elements are not lethal, but in small concentration, many trace elements are essential for plant

growth (FAO,1994). Potassium plays an essential role in photosynthesis and metabolism of plants. Calcium and magnesium are important component of hardness.(Graph-4 and Graph-5) Extremely hard water consumption for long term might lead to increased probability of cardiovascular disorders. Its value was found within permissible limits .The range of total hardness in filtered water sample varies from 300 to 600 mg/L with an average value of4002 mg/L(Graph:3). Sulfate is also an important anion that causes its concentration was obtained from 1000 to 125 mg/L with a mean value of 1100 mg/L which is close to those FAO standards (960 mg/L)(Graph-6). Chloride value varies from 350 to 500 mg/L with an average value of 400 mg/L and is found within the acceptable limit (1062 mg/L) of FAO (1994) guideline.

Table: 1 Summary of water sample analysis and comparison with Indian standards

No	Parameter	Water sample Analyzed sewage water	Water sample analyzed after treatment	Water sample analyzed Infiltration basin water	Indian standards
1	Color Hazen units	Dark brown	7	Colorless	Colorless
2	Odour pt-co units	stinky	Foul smelling	unobjectionable	unobjectionable
3	pH	5.6	6.8	6.9	6.5-8.5
4	Temperature Celsius	28.7	27.6	28.5	-
5	Turbidity NTU	Highly turbid	0.9	0.5	-
6	TDS	350	320	267	-
7	Total Hardness mg/lit	760	500	400	600
8	D.O.mg/lit	3	8	25	-
9	B,O,D mg/lit	260	100	4	-
10	Potassium mg/lit	10	6.77	5.2	-
11	Calcium mg/lit	1145	780	234	200
12	Magnesium mg/lit	134	120	52	100
13	Chlorides mg/lit	1200	990	400	1000
14	Bicarbonates mg/lit	1100	730	700	-
15	Sulphates mg/lit	1600	1246	1100	400

Conclusion:

Waste water coming from Hostels and kitchen of GNIT campus was analyzed for its re-use in the Campus. After analyzing the water coming from SWWTP, it was found that the water was high in DO, B.O.D₅, total hardness, calcium, magnesium, chlorides and sulphates, which proved that the water was not safe for its re-use in terms of ground water recharge gardening purposes. Hence, a new treatment method was suggested which could further reduce the amount of degradable organic matter and thereby complying with standards. That was the construction of infiltration basins filled with filter media which proved to be more efficient practically in reducing the organic load on waste water. Presently, this method is being followed in the Campus and thereby facilitating for the use of reused waste water for all miscellaneous purposes throughout the campus. This would be a sustainable management as well as recycling of water. The main disadvantage associated with the construction of basins is the requirement of large space but as the college campuses are very big and lot of space is available, this disadvantage can also be ignored. Currently, water from infiltration basins are recharged directly into the ground and also watered for plants throughout the campus. The quantity of water required is 10,000 to 15,000 liters per day to maintain green campus and 5000 liters per day for miscellaneous purposes. This study proved that the major demand which was on the ground water recharge and gardening side could be satisfied with the treated waste water generated in the campus. On a large scale, this would prove as a cost effective technique.

Declaration:

Availability of data and materials: All data generated during this study and work done are taken from Guru Nanak Institute of Technology .The Principal, Guru Nanak Institute of Technology permitted us to carry out the above work. Mobile no.8096609821

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Author's contribution:

Dr.P.Sudha Rani Compiled and prepared the script .Mr.Nalla Naresh carried out Physico-chemical analysis .Mr.Akhil gurijala helped in filling of infiltration basins using filter media, taking photographs and collecting water throughout the campus. All authors read and approved the final manuscript.

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Figures

Figure 1

Step by step procedure.

Figure 2

Construction of Infiltration basins

Figure 3

Constructed Infiltration basin

Figure 4

Infiltration basin with water

Figure 5

shows DO levels stage to stage wise.

Figure 6

shows BOD levels stage to stage wise.

Figure 7

shows Total hardness levels stage to stage wise.

Figure 8

shows Calcium levels stage to stage wise.

Figure 9

shows Magnesium levels stage to stage wise.

Figure 10

shows Sulphates levels stage to stage wise.

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