February 28, 2021

[AgroScience Today]

Popular Article

e-ISSN: 2583-0147

Volume 2 Issue 2
Page: 0066 - 0072

Bharani Alagiriswamy
Associate Professor (Env. Sciences)
Department of Soil and Water Conservation Engineering
Agricultural Engineering College & Research Institute
Tamil Nadu Agricultural University
Kumulur – 621 712
India

Corresponding Author
Bharani Alagiriswamy
bharania2004@rediffmail.com

Grey Water Recycling and Utilization

In the developing countries like India, waste water management remains the most important cause for many pollution and disease spread due to poor sanitation. Grey water is the domestic waste water excluding toilet waste water gains attention in the present scenario for recycling and reuse. Application of this grey water after proper treatment can be put to many uses in urban areas thereby reducing the demand for fresh clean water. Treated grey water is well advocated in agriculture for crop cultivation. Of the total grey water generated in the country, 10% is contributed through kitchen waste water that accrues from households. Since this waste water is low in contamination, treatment through any methods is possible and feasible for reuse. Regarding the chemical composition, grey water is very less in nitrogen levels than sewage water. Unlike rainwater harvesting, grey water is not dependent on unpredictable cycles of monsoon and variability of rainfall and is therefore a reliable water resource. Further, the high nitrogen and phosphorus content that is harmful to aquatic life, when used in irrigation can make a good nutrient or fertilizer source.

INTRODUCTION

Climate change, population growth and increasing water demand necessitate that we look beyond using water from natural sources, restrict use of freshwater in activities that do not require high levels of water quality and recycle and reuse the waste water that is generated in both commercial and non-commercial activities. For this, grey water recycling and reuse has emerged as a viable alternative and can be used for irrigation and agriculture, in bathrooms and kitchens. It is therefore pertinent to examine what constitutes grey water, the methods of treating grey water and the ways in which countries across the world have adopted grey water reuse and recycling for efficient water management. Necessity has arisen to effectively utilize the water resources due to an increase in the consumption of the same because of population growth and declining availability of water as a whole. Prioritization on the water conservation methods for easy

availability to public is concerned the most so as to reduce costs on environmental and financial aspects thereby overcoming the shortage.

WATER CONSUMPTION IN HOUSEHOLDS

Regarding total freshwater consumption of the country, approximately 37% is for domestic and 45% is utilized by public sectors. Out of the quantity of water utilized by households, 65% contributes for grey water. This is typical pattern followed in the consumption of water in developing countries. An estimate reports that about 35% is being used or consumed for each function viz., bathing, toilet flushing etc. Thus by utilizing the grey water for flushing will save about 35% of water consumption, an additional savings of 5% of drinking water can be attained by using grey water for lawn maintenance.

WHAT IS GREYWATER?

Grey water can be defined as the percentage of waste water obtained from domestic use that does not include flush water. It is generally classified as light and dark grey water. Light grey water is the water coming from bathing area and the water from sinks that are used for hand washing that contains very low concentration of pollutants. Dark grey water is the water released from washing machines and kitchen outlets that have high concentration of pollutants. Pollutant load in grey water contributes between one third to half of the total contamination of sewage water causing damage both to the environment and health besides polluting the water resources.

COMPOSITION OF GREY WATER

Based on the levels of cleanliness in waste water, it can be categorized as

- Grey water, which is specifically wash water – waste water being discharged from a house including water from showers, bathtubs, sinks, kitchen, dishwashers and washing machines.
- Black water, which is highly polluted by biological contaminants such as faecal waste and chemicals (Oron et al., 2014).

The type of activity decides the chemical composition of the grey water. It might be either due to chemical use or kitchen waste water; hence, there is no uniformity in the composition. For example, there is a huge difference in the kitchen waste water from the bathroom sinks that comes from showers. Grey water from bathing rooms, showers and hand wash basins is considered to be the least polluted source (FBR, 2012). Grey water from kitchen outlets contains high concentrations of degradable components and residues from detergents and soaps. Presence of pathogens will be seen only in fractions of grey water that is mixed with faeces. The grey water serves a favourable environment for bacteria to multiply faster wherein it needs proper treatment before being disposed. In addition, the untreated grey water turns anaerobic very easily creating a foul odour. Of the total grey water generated in a household only 10% contribute for kitchen wastewater. Kitchen grey water contributes to about 10 per cent of total grey water volume accruing from households (Pachkor and Parbat, 2017). Since water from kitchen use is rich in organic and inorganic wastes that enhance the population of pathogens, warrants the reuse of kitchen water in all kinds of grey water systems. The water generated during washing of clothes contributes to 25 – 35% grey water and its quality depends on the number of times the clothes are rinsed in the water. On the other hand, water used in bathrooms generates about 50 to 60 per cent of total grey water while being the least contaminated. Common contaminants in grey water include use of soap, shampoo, and toothpaste (Lambe and Chougule, 2009) by the members of any household. Thus, a major portion of grey water generated in households, about 60 per cent, can be recycled and reused.

NUTRIENTS CONTENT IN GREYWATER

Any grey water is very low in nutrient content compared to other waste waters. Nutrients like nitrogen and phosphorus though are important in fertilizing plants, have a negative impact on the water ecosystem. High phosphorus content in grey water sometimes may enhance profuse algal growth in the receiving waters. Generally, nitrogen level in grey water though low, the main source being urine, besides kitchen waste water contributing as major source in any domestic grey water. Del Porto & Steinfeld (2000) reported that ammonia containing cleansing products and protein containing shampoos are few other sources. In Hanoi province of Vietnam, main water supply itself is one of the major sources of nitrogen where NH4 –N concentration was found to be as high as 25 mg/l. The reason for high value is due to the mineralization process of peat, an abundant organic material that was mixed in the groundwater aquifers (Hong Anh et al., 2003).

Household grey water sometimes had nitrogen levels at a range of 5–50 mg/l with an extreme value of 76 mg/l (Siegrist et al., 1976). In few cases high phosphorus concentrations were observed but nitrogen was always found to be low. The high phosphorus levels have to be reduced to normal range for it to be reused through advanced treatments.

OTHER POLLUTANTS

Concentration of heavy metals and organic pollutants may increase if any hazardous material gets mixed with the grey water. Such type if influence might result due to corrosion of metal pipe system, cutlery and use of shampoos in the household. At every household we use shampoos, adhesives, preservatives and cleaners that contain one or other pollutant. In such a situation, people can greatly influence the greywater composition, hence, application of environmentally friendly chemicals can be used and avoid pouring hazardous chemicals into the drains.

SOURCE CONTROL

Treating grey water which involves cost may be prevented instead the pollution level can be controlled and the amount water usage also can be controlled. Therefore, proper usage of all grey water systems and their information about environment-friendly household chemicals and water-conserving techniques must be clearly defined. By levying fees for water consumption and providing incentives for water saving technologies, the grey water generated from households can be reduced. While planning for any urban sanitation activity, the primary aim must be to produce less quantity of grey water from each and every person.

GREYWATER TREATMENT METHODS

Grey water is comparatively harmless to other waste waters. Any problems if encountered in its management are much easier to be resolved using environmental friendly technologies that do not cause any odour problem. Any treatment process followed reduces the pollutant level in general. To be specific pathogen population in the incoming waters also is reduced. For removal of pathogens, biofilms are employed for complete degradation since aerobic situation is created inside the grey water systems. Utilization of trickling filters and bioreactors are best examples.

1. APPLICATION AS IRRIGATION SOURCE

Grey water application as irrigation source helps in slow release of the waste water such that the soil ecosystem is able to convert the grey water into usable water to crops and help in production. At the same time, huge quantities of grey water should not be applied as the crops may suffer due to saturation. On the other hand too little water will bring in stress conditions in the plants and make them sensitive. The quantity of grey water application depends on the evapotranspiration rate which must be between 2-15 litres per m^2 per day. Another alternative method is application through mulch beds.

2. SOIL FILTER SYSTEMS – VERTICAL FLOW

Construction Wetlands to treat industrial waste waters has become common in the recent times. The vertical flow soil filter system is designed in such a way that the pollutant removal efficiency of 90 – 99 % is achieved, besides, removing pathogens like bacteria and viruses at 95 – 99.9%. Depending on the soil property, depth of unsaturated zone and load of waste water, phosphorus removal is accounted between 30 and 95%. Denitrification and nitrification process removes nitrogen up to 30%. Soil used for filtering must not be too coarsely or too finely textured. Too fine particle decides its suitability for filtration and there are chances of clogging in the soil. A sand filter with a drainage layer at the bottom is provided when the natural soil is unsuitable. The grey water let through the inlets must be spread evenly on the surface of the filter. If spread unevenly, deep clogging of the zones might take place and no further treatment is possible. During worst situations, the water might flow directly into the groundwater through deep pores which can be overcome by using a controlled clogging in gravity system. In this case water is applied in a narrow trench for the bottom to be clogged with a biofilm. Hence, water will impound and spread horizontally and infiltration takes place easily through the walls of trench. The bacteria present in between the water and soil help in decomposing organic pollutants.

OTHER DISTRIBUTION OPTIONS FOR SOIL FILTERS INCLUDE:

Surface flooding - Application of large quantity of grey water for a short span of 5 minutes to achieve uniform infiltration.

Perforated horizontal pipes - Plastic pipes with holes is fitted in soils for the water to trickle in small quantities.

Drip irrigation - Installing drip irrigation system to some extent works well unless clogging in the lateral is encountered. Because of this problem drip irrigation system is not opted for using grey water.

Spraying techniques – Grey waters are used in trickling filter beds.

3. TRICKLING FILTERS AND BIOROTORS

Trickling filters are constructed using a filter media with large surface area use having large pores for the water to trickle down the media. Though the system is compact, removal efficiency cannot be compared to soil filters as they creates more of sludge.

End use of grey water: Treated grey water is used for irrigation onto the soil surfaces.

Discharge into surface waters: One of the easiest and natural way of disposal of grey waters into the environment. Most of the times, it is discharged into the open ditches.

Percolation to groundwater: Treated grey water is allowed to percolate into the ground to reach the unsaturated zone of one metre depth.

Grey water subjected to groundwater should be treated properly for draining. The water should then percolate through the ground in an unsaturated zone of one metre or more. A layer of sand forms the subsoil. Safety zones around water extraction wells need to be established. As a thumb rule, retention period of one month is allowed in saturation zones for secured water extraction. Grey water irrigation is recommended on the ground and sub-surface level than through sprinkling. Irrigation to crops where leaves or stems are not consumed directly is most suitable for grey water application. Crops that are consumed raw must be irrigated with grey water before one month of harvest.

NEED TO RECYCLE AND REUSE

It is important that grey water is put through an adequate treatment process and not discharged straight in to the environment since both organic and inorganic constituents in the grey water can often cause irreparable damage causing removal of natural oxygen and development of aseptic conditions. The inorganic constituents – mainly phosphorus and nitrogen, when discharged into the aquatic environment, can lead to the growth of excessive algae, deplete the dissolved oxygen content in water and cause the death of organisms vital to maintaining an ecological balance in water bodies (Schneider, 2009). Through the recycling of grey water, it is possible to both prevent potential harm to the environment and reduce the demand for freshwater by substituting it with recycled grey water where high quality is not required. Unlike rainwater harvesting, climatic conditions and monsoon, variability in rainfall are not influenced and therefore reliability in the water source is highly achieved. Further, the high nitrogen and phosphorus content harmful to aquatic life, when used in irrigation can make a good nutrient or fertilizer source (FBR, 2012). It can also be used for toilet flushing and even bathing when adequately treated (Pachkor and Parbat, 2017).

WORKING OF GREYWATER RECYCLING

In a household, whatever water used is only potable water which is collected in a single pipe and released through outlets as sewage. If the recycling facility is established, two pipes are used. The first pipe is used for removing black water and dark grey water respectively. The waste waters from these two pipes are then sent directly to the sewers. The

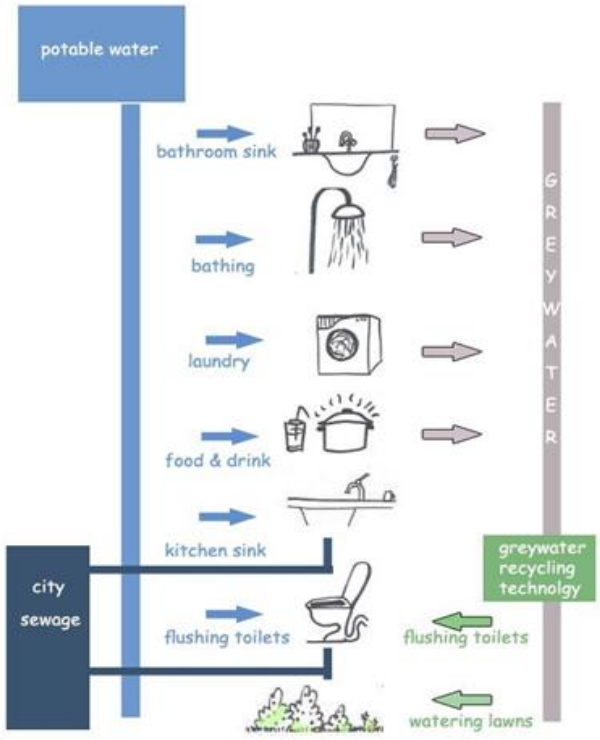

Figure 1. Grey water recycling system

second one removes light grey water and let into tanks for recycling. The waste waters thus recycled will be returned to the house for reuse. Such waters can be put to use to flush toilets and for lawns. Treatment of grey water is easier comparatively and may be recycled than black waters as the contaminant level is very low. Untreated black water is not safe for disposal into the environment. Hence, black water may be collected in a separate system so that contamination of grey water can be avoided. Household grey water can be recycled within the house and reused and not advised for drinking purpose. In that case, the water has to follow many steps of microbial digestion. Clean grey water is directly applied to gardens and other uses since soil and plants itself act as cleaning agents.

APPLICATION OF GREYWATER CROP PRODUCTION AS IRRIGATION SOURCE

Grey water degrades faster than that black water and is low in nitrogen and phosphorus content besides various species of pathogens. With regard to application, direct soil application is recommended instead of spray. Not much research is being done in grey water, if at all is used it was found to have negative impact on productivity. If grey water is used for soil application, then it must be checked for the detergent or soap powders that may affect the soil fertility during drought seasons.

DOMESTIC USE

Grey water recycled may be put to use in flushing the toilets whereby it saves great amounts of water. Untreated water is not advisable for recycling since it might emit foul smell and change the colour of the flush toilet mixtures if left unattended for a day or two. In such a situation, the biological oxygen demand (BOD) should be either low or nil. It means that it should not be treated to a standard of treating potable water. Nowadays, grey water recycling is not done up to the standard or is ecofriendly.

BENEFITS OF GREYWATER RECYCLING

• By applying grey water as irrigation use would reduce the freshwater requirements and save money in agricultural lands.

• There is a proper delineation of indoor and outdoor water usage

• Excluding the water from toilets, all others can be diverted outdoors so that usage of nature's water can be minimized.

• Applying lot of strain in septic tanks can be reduced, thereby extending the septic tank life and capacity.

• Considering the municipal treatment facility, reduction in the grey water flow into the sewers will ensure efficient treatment processes.

• Purification becomes efficient.

• Purifying the grey water will become spectacular and achieve a better biologically active region of soil protecting the quality of ground waters.

SITE UNSUITABLE FOR A SEPTIC TANK

A grey water system can be partial or a complete substitute in cases of sites of low soil percolation. Grey water application in large quantities helps in recharging the groundwater. By applying grey water, usage of freshwater and wastewater becomes reduced. Thereby the energy consumption is also reduced. Grey water application to landscape helps in supporting the plant growth and also reclaims the wasted nutrients. Thus grey water applied to soil maintains the soil fertility and encourages a wise crop husbandry.

HOW TO SELECT THE RIGHT SYSTEM?

In the present scenario, there is no such technical solution that is used for greywater management. Most of the household systems perform well. Whatever system is chosen, it has to function well for better results. The most appropriate management system must be selected for better management and evaluation including discharge quality standards. Other criteria namely environmental risks, health aspects, reuse, financial and economic considerations, energy demand, social acceptance etc., are also taken into considerations. Selection of any system should be household centred one since it involves cost for long term maintenance. People show less interest in environmental sanitation. A report by WHO (2005) says that willingness of the households to implement a system and invest on the same are based on their comfort, convenience, reuse opportunities and so on. The overall costs incurred by implementing the system operation by either a household or group of households exceeds the perceived costs then steps must be taken to go for less expensive measures.

REGULATION LOCALLY AND GLOBALLY

In countries like United States, Australia, Japan, Germany, Cyprus, Saudi Arabia, Oman and Jordan,

recycling of grey water is governed by law. In Australia, the CSIRO (Commonwealth Scientific and Industrial Research Organization) is one of the main organizations involved in emphasizing standardization of grey water recycling. The Environmental Protection Agency is sole body responsible for monitoring its standards for operation worldwide. Application of grey water with approval from authorities providing financial allowances for private consumers is done for quantity of upto 950-1500 liter per day. Legislation is responsible for method of organization, system definition, installation technicalities, recycled waters quality, health hazard prevention, aquifer protection methods, public health etc.

POLICIES ON GREY WATER – INDIA AND OTHERS

So far, India does not have a focused policy framework for management and usage of grey water in urban and rural areas. However, some guidelines for treatment of wastewater do exist. For example, The Central Public Health and Environmental Engineering Organisation (CPHEEO) has specified permitted discharge standards for treated water; use of treated wastewater in agriculture and horticulture (MoHUA, 2012). The Central Ground Water Board (CGWB, 2000) directed that treated wastewater can be used as a source of artificial ground water recharge once it meets the standards and is compatible with existing groundwater. Further, India has been using treated sewage for farm forestry, horticulture, toilet flushing, industrial use and fish culture (ibid). However, drainage systems in traditional Indian villages lack a lateral line as result of which, only half of the population uses it efficiently. Black water goes into septic tanks of individual houses while grey water is discharged directly in to the open. The discharged water runs in to lakes and rivers resulting in pollution. It is important that policy coupled with technological interventions is adopted in India so that the existing usage and generation of grey water can be regulated, recycled and reused. Since grey water is conducive to the growth of pathogens, it is imperative that safe disposal is mandated through law. Comparisons with countries that have already taken a step forward can be helpful.

CONCLUSION

In the present global scenario, the demand-supply ratio of fresh water and potable water often tends to be skewed. It is imperative that we look at alternatives and adopt methods for reuse and recycling so that unnecessary wastage of fresh water can be curtailed. Although India attempts to keep a check on the ways in which sewage is disposed and treated water is used, it is a far cry from what needs to be done. For efficient waste management a policy framework that specifically deals with grey water needs to be put in place.

REFERENCES

British Broadcasting Corporation (BBC). (2018). The 11 cities most likely to run out of drinking water – like Cape Town. Accessed on June 18, 2018

Central Ground Water Board (CGWB). (2000). Guide on artificial recharge to ground water, Ministry of Water Resources, Available at: https://bit.ly/2Jsn1v3

Del Porto, D. & Steinfeld, C., (2000). What about Graywater, The composting toilet system book. Massachusetts the Center for Ecological Pollution Prevention (CEPP), Concord, Massachusetts, pp. 167-193.

Fachvereinigung Betriebs - und Regenwassernutzung E.V. (FBR), (2012). Greywater Recycling and Reuse, Available at: https://bit.ly/2JwSRCS

Ferguson D. (2014). Grey water systems: can they really reduce your bills? The Guardian, July 21.

Hong Anh, D. et al. (2003). Trihalomethane formation by chlorination of ammonium- and bromide-containing groundwater in water supplies of Hanoi, Vietnam. *Water Research, 37*, 3242–3252.

Indian Express. 2018. Shimla water crisis: Govt. schools to remain closed for a week, The Indian Express, June 3.

Journal of the Environmental Engineering Division-Asce, 102(3): 533-548.

Lambe J & Chougule R. (2009). Grey water – Treatment and Reuse, Second International

Conference on Emerging Trends in Engineering, Available at: https://bit.ly/2y0FSbl

Ministry of Housing and Urban Affairs (MoHUA). 2012. Recycling and reuse of sewage, Available at: https://bit.ly/2sTQunB

Oron G., Adel M., Agmon V., Friedler E., Halperin R., Leshem E. & Weinberg D. (2014). Greywater use in Israel and worldwide - Standards and Prospects. *Water Research, 58*, 92-10.

Pachkor R. & Parbat D. (2017). A Literature Review on Integrated Approach for Greywater Treatment. International *Journal for Research in Applied Science & Engineering Technology, 5*, (4).

Press Trust of India (PTI). (2015). India to become water scarce by 2025, The Hindu, July 31.

Ridderstolpe, P. (2004). Introduction to Grey water Management. EcoSanRes Publication Series. Report 2004-4. Stockholm Environment Institute; Stockholm, Sweden. Available from www.ecosanres.org

Safi, M. 2018. Tourists told to stay away from Indian city of Shimla due to water crisis. The Guardian, May 31.

Schneider L., 2009. Greywater reuse in Washington State, Washington State Department of Health, Available at: https://bit.ly/2MkmCse

Shegokar V., Ramteke D. & Meshram P. (2015). Design and Treatability Studies of Low Cost Grey water Treatment with Respect to Recycle and Reuse in Rural Areas. *International Journal of Current Microbiology and Applied Sciences, 4* (8): 113-124.

Siegrist, R., Witt, M. & Boyle, W.C. (1976). Characteristics of Rural Household Wastewater.

Swedish International Development Cooperation Agency (Sida) EcoSanRes Factsheet 8 May 2008

WHO. (2005). Guidelines for the safe use of wastewater and excreta in agriculture and aquaculture. (Draft)

www.ecosanres.org Stockholm Environment Institute Kräftriket 2B, 10691 Stockholm, Sweden Tel +46 8 674 7070 Fax +46 8 674 7020 www.sei.se EcoSanRes.