Wastewater Reuse at Home

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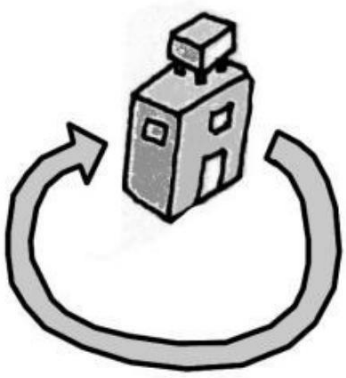


Executive Summary

Domestic water use represents a growing proportion of global water use. Water use optimisation means resistance to chronic and short-term water scarcity and cost and energy savings for water supply and wastewater treatment as less water is required and less polluted water produced. Besides installing water saving appliances, source separation and reuse of different types of wastewater is a way to optimise water use at home. Depending on the type, quality and quantity of water, wastewater can either be reused directly, or treated and reused (recycled). This factsheet summarises the variety of technical options for wastewater treatment, reuse, as well as reuse possibilities for organic waste at the household level.

Advantages

- Reduces household water consumption and increases resilience to water scarcity
- Reduces costs and energy spent for water supply as less is required. Reduces volume of wastewater and thus infrastructure, money and energy required for treatment
- Can produce livelihood (e.g. urban farming) and increase food security
- Increases water availability for other uses
- Reduces pressure on local water resources

Disadvantages

- May need to treat wastewater before reuse
- May be legal barriers preventing wastewater reuse
- May need to refit household plumbing system to collect greywater

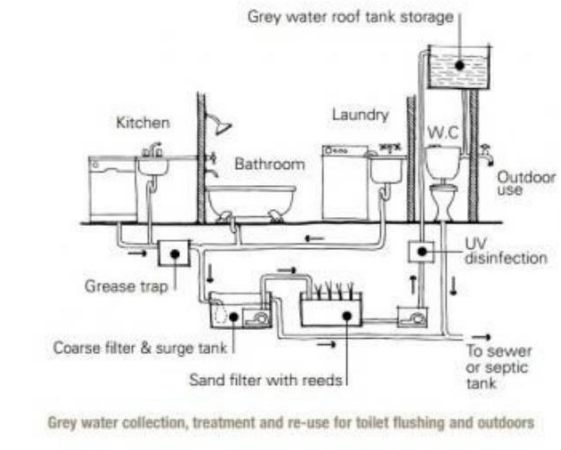
Introduction

Domestic water consumption makes up 8% of total global water use (UNWATER 2012). Particularly in developed countries, domestic water use is often many times larger than the WHO minimum recommended per capita consumption. Thus,

household water consumption has a large potential to be reduced. Benefits of reducing domestic water consumption include lower water bills or less time spent collecting water, reduced pressure on local water resources, and increased availability of potable water available for appropriate purposes such as drinking, cooking, and hygiene.

One effective way of reducing water consumption is to reuse the wastewater produced at the household level. The reuse of wastewater presents an opportunity to not only save water and financial resources by reducing water consumption, but to simultaneously increase food production or create livelihood. In developing countries, optimising wastewater reuse can therefore be a significant window for development.

A critical aspect for wastewater reuse is that the quality of wastewater must be appropriate for its reuse. There are several different types of wastewater produced at the household level that have very different levels of contaminants (i.e. nutrients, pathogens) and reuse potential, including rainwater, greywater (all household wastewater except toilet flushing water), urine, blackwater, and faeces. Separating these streams of wastewater reduces the amount of wastewater contaminated by pathogens (i.e. blackwater, faeces, urine) by preventing it from coming into contact with less contaminated water (i.e. greywater, rainwater), thereby allowing greywater and rainwater to be used for a wider range of purposes.



Example of a household greywater reuse system. Source: COMMONWEALTH OF AUSTRALIA (2005)

By separating these waste streams at the source, it is possible to retain high volumes of relatively safe water (i.e. greywater, rainwater) that can be directly reused, whilst reducing the volume of wastewater (i.e. blackwater) that must be treated before reuse. Particularly in developing countries where water and wastewater systems are non-existent or incomplete, implementing source separation is key in developing sustainable systems that will benefit users over the long term.Depending on the contaminants present in wastewater and its future reuse, wastewater can either be directly reused, or treated and reused (recycled). Similarly, organic waste (such as kitchen waste or toilet waste) can also be reused at the household level to reduce the quantity of waste produced and to gain the benefits of nutrients or energy.

How Does it Work?

Direct Reuse

Water that is of a relatively high quality with few contaminants, such as rainwater or greywater, can be directly reused. Numerous technologies exist for household precipitation harvesting, while greywater can be collected by refitting pipes to divert wastewater from appliances like showers, washing machines, and sinks.

- Even though water for direct reuse may be relatively free of contaminants, the future reuse of rainwater and greywater must be appropriate for the level of contaminants present. Appropriate purposes for direct reuse can include:
- Washing (cars, etc.)
- Flushing toilets (see toilet systems to learn more about different types of toilets and flushing systems)
- Gardening and food production can be done with greywater towers, vertical gardens, fertigation, drip-irrigation, and subsurface drip irrigation

Treat and Reuse Wastewater (Recycling)

If wastewater is not suitable for direct reuse, household wastewater treatment options may be employed to reduce the level of contaminants to a level that is safe for reuse. Some possibilities for household wastewater treatment systems include:

- Constructed wetlands (see free-surface, horizontal, vertical, and hybrid constructed wetlands)
- Biogas settlers
- Anaerobic baffled reactors
- Septic tanks
- Leach fields
- Evapo-transpiration beds
- Surface or subsurface groundwater recharge

Once treated sufficiently, wastewater can be used similar as rainwater or greywater, for purposes such as gardening and urban farming, toilet flushing, etc. (see "Direct reuse" above).

Treat and Reuse Organic Waste (Recycling)

Organic waste, such as kitchen waste and toilet waste, can be reused for energy production (biogas) or for compost or soil amendments.

There are numerous technologies that use anaerobic digestion processes to produce biogas, including small scale anerobic digestion, biogas settlers, and anaerobic baffled reactors. Biogas may either be used directly (see direct use of biogas) or to produce electricity (see biogas electricity).

Organic waste can also be reused as fertiliser for growing plants. However, because faeces and excreta contain pathogens that can transmit diseases, treatment must take place before reuse. Composting renders both kitchen waste and toilet waste safe for application to soil, and can be produced in numerous ways. **invalid link** may be used for kitchen waste as well as faeces and excreta. There are also toilet systems designed to produce on-site useable compost from faeces and excreta, such as composting toilets, fossa alterna, arborloos, or UDDTs and subsequent storage and drying of faeces. An alternative to the conventional composting process is terra preta sanitation which produces high quality compost without odour or gas production (also see terra preta toilets).

Urine may also be used as fertiliser without a composting step if they are properly handled. For this, urine must be diverted from faeces (see UDDT and urine diverting flush toilets) and stored (see urine storage) before being applied to soil (see small scale urine fertilisation).

How to Optimise?

It is essential that the quality of waste (wastewater or organic waste) is adequate for its reuse purpose. Source separation of wastewater is a way to maximise the potential for wastewater reuse, as different types of wastewater (i.e. rainwater, greywater, urine, blackwater, and faeces) have differing contamination levels of pathogens and contaminants but also nutrients and salts, and are therefore appropriate for different purposes. By separating these waste streams at the source, it is possible to retain high volumes of relatively safe water (i.e. greywater, rainwater) that can be directly reused, whilst reducing the volume of wastewater (i.e. blackwater) that must be treated before reuse.

If the quality of wastewater is not high enough for direct reuse, it must be treated beforehand, or not reused at all. To ensure that the quality of wastewater or greywater is appropriate for reuse, the water quality should be tested for nutrient concentrations, pathogens, and other contaminants.

Legal Aspects

While the reuse of greywater and wastewater may be encouraged in areas experiencing water scarcity, there are often strict regulations determining the levels of contaminants allowable for reuse, and laws governing what are permissible uses for wastewater and greywater. Many countries (such as the U.S., Switzerland, and Australia) have regulations for wastewater disposal that make reuse prohibitively complicated. Regulations regarding the use of wastewater, greywater and excreta can

be found in WHO guidelines for policy and regulatory aspects of safe wastewater reuse.

Health Aspects

- Disease-carrying mosquito populations may increase if home treatment involves stagnant water (such as in free-surface, horizontal, vertical, and hybrid constructed wetlands).
- Crossing plumbing lines when refitting pipes can lead to contaminated drinking water, and may be illegal.
- Diseases can be transmitted when using greywater or treated wastewater to produce fruits or vegetables that are eaten raw. To avoid contamination risk when reusing greywater or treated wastewater for food production, refer to WHO guidelines on reuse of wastewater in agriculture and WHO guidelines of reuse of excreta and greywater in agriculture.
- Quality of water might be too risky for reuse if toxic cleansers or sick people are present. For example, many pharmaceuticals (antibiotics, hormones, etc.) are not degraded by wastewater treatment and may therefore be present in high concentrations in urine. Separation of urine from other wastewater streams can reduce exposure to these pharmaceuticals.

Cost Considerations

- Wastewater (including greywater, blackwater, urine, etc.) is free: reusing it means paying less for potable water.
- Refitting systems to collect greywater can range from zero to hundreds of dollars, depending on the modifications that are necessary.
- Using urine, faeces, and organic waste for plant fertilisation reduces the cost of purchased fertiliser and increases plant productivity.

Case Study: The Eco-Home

One example of a household system that has incorporated many technologies for reuse of wastewater is the Eco-Home in Kathmandu, Nepal. See: The Eco-Home. By employing a number of water and nutrient recycling systems, the home has managed to establish nearly closed-loop water and nutrient cycles. The home is not connected to water distribution or wastewater collection systems, and supplies all its needed water with rainwater harvesting that is purified with a biosand filter and disinfected with SODIS. Wastewater and greywater are treated with a vertical flow constructed wetland, and reused for rooftop gardening. Nutrients from urine and faeces are recovered with a composting toilet (SHRESTHA 2010).

Applicability

Measures can be taken for optimising (reducing, reusing) wastewater or organic waste in almost any household. It may be more difficult to reuse greywater if significant changes must be made to wastewater collection, such as in areas where greywater collection must be modified, or if reusing wastewater is illegal. However, if it is permitted, reusing wastewater can greatly reduce the amount of potable water that is needed for a household. Particularly in areas where water delivery and wastewater collection is done manually, water reuse reduces the amount of drinking water that must be collected, reduces the time and effort spent collecting water, and increases the availability of potable water for appropriate purposes such as drinking, cooking, and personal hygiene.

Library References

Wastewater Re-Use

This website from the Australian government provides information regarding greywater reuse systems, reuse possibilities, and treatment systems at the household level.

COMMONWEALTH OF AUSTRALIA (2005): Wastewater Re-Use. Canberra Act: Department of Climate Change and Energy Efficiency URL [Accessed: 27.08.2012]

Eco Home for Sustainable Water Management- A Case Study in Kathmandu

This paper describes a case study of a house in Kathmandu where rainwater is used for all purposes including drinking, greywater is recycled for non drinkable purposes and human excreta is utilized as a fertilizer by adopting ecological sanitation technique.

SHRESTHA, R.R. (2010): Eco Home for Sustainable Water Management- A Case Study in Kathmandu. Kathmandu: United Nation Development Program (UNDP) URL [Accessed: 05.01.2011]

Statistics. Water Use

UNWATER (2012): Statistics. Water Use. New York: United Nations URL [Accessed: 27.08.2012]

Further Readings

Water Conservation Techniques and Graywater Reuse at the Single Household Level

This paper explains how to use greywater at household level in order to counteract the water scarcity.

ALKHATIB R. Y. EDGERLY J. (2006): Water Conservation Techniques and Graywater Reuse at the Single Household Level. Fort Collins: Colorado State University URL

Overview of Greywater Reuse. The Potential of Greywater Systems to Aid Sustainable Water Management

This document describes technologies, legal considerations, and challenges and opportunities for greywater reuse all around the world, with a focus on the Middle East.

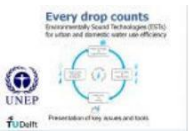
ALLEN, A. CHRISTIAN-SMITH, J. PALANIAPPAN, M. (2010): Overview of Greywater Reuse. The Potential of Greywater Systems to Aid Sustainable Water Management. Oakland, CA: The Pacific Institute URL [Accessed: 01.10.2012]

Greywater for Domestic Users: An Information Guide

This guide published by the British Environmental Agency provides information for all aspects of greywater reuse at the household level. While some information is specific to the U.K., much of the guide can be useful in any location.

ENVIRONMENT AGENCY (2011): Greywater for Domestic Users: An Information Guide. Bristol, U.K.: Environment Agency URL [Accessed: 01.10.2012]

Every Drop Counts



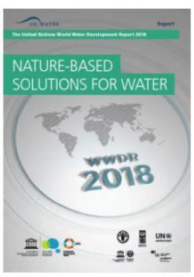
Presentation with 60 slides on key issues in water saving at household level, containing backgrounds of decision making (policies and criteria) and a number of environmentally sound technologies storage, supply, use, reuse & recycling.

UNEP ; TU DELFT (2008): Every Drop Counts. PowerPoint Presentation. Osaka & Delft: UNEP and TU DELFT URL [Accessed: 09.08.2010]

Recycle And Reuse Of Domestic Wastewater

VIGNESWARAN, S. SUNDARAVADIVEL, M. (2004): Recycle And Reuse Of Domestic Wastewater. In: VIGNESWARAN, S. ; (2004): Wastewater Recycle, Reuse, and Reclamation. Sydney: . URL [Accessed: 31.07.2012]

The United Nations World Water Development Report 2018



The 2018 edition of the World Water Development Report (WWDR 2018) seeks to inform policy and decision-makers, inside and outside the water community, about the potential of nature-based solutions (NBS) to address contemporary water management challenges across all sectors, and particularly regarding water for agriculture, sustainable cities, disaster risk reduction and improving water quality.

(2018): The United Nations World Water Development Report 2018. United Nations Educational, Scientific and Cultural Organization (UNESCO) URL PDF

Case Studies

Eco Home for Sustainable Water Management- A Case Study in Kathmandu

This paper describes a case study of a house in Kathmandu where rainwater is used for all purposes including drinking, greywater is recycled for non drinkable purposes and human excreta is utilized as a fertilizer by adopting ecological sanitation technique.

SHRESTHA, R.R. (2010): Eco Home for Sustainable Water Management- A Case Study in Kathmandu. Kathmandu: United Nation Development Program (UNDP) URL [Accessed: 05.01.2011]

Important Weblinks

http://www.unwater.org/

http://www.unwater.org/statistics_use.html [Accessed: 27.08.2012]

http://greywateraction.org/

http://greywateraction.org/ [Accessed: 27.08.2012]
Greywater Action is an organisation based in the U.S. that promotes greywater reuse at the household level, offering information on technologies available as well as workshops and events related to greywater reuse.

http://www.yourhome.gov.au/

http://www.yourhome.gov.au/technical/fs74.html [Accessed: 27.08.2012]
This website from the Australian government provides information regarding greywater reuse systems, reuse possibilities, and treatment systems at the household level.

http://www.thinkwater.act.gov.au/

http://www.thinkwater.act.gov.au/water_savingtips/water_saving_tips.shtml [Accessed: 07.05.2010]
This website explains how to save water at household level and describes how to reuse greywater.