



Yellow-black-grey makes many things possible

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No tiger duck and no football club - the formula "yellow-black-grey" refers to the separation of wastewater streams at their source, i.e. at the toilet, washbasin or shower. This opens up new possibilities and saves resources. On the occasion of World Toilet Day on 19 November, a series of Eawag fact sheets shows how this can be done.

Greywater is wastewater with low levels of contamination, for example from the shower. It can be used as a source of heat and - treated on site - also as service water, for example for irrigation or flushing toilets. Urine, the yellow water, on the other hand, contains many nutrients, especially phosphorus. The world's phosphorus reserves will not last forever and its extraction leads to environmental damage in the deposits and elsewhere. So what could be more obvious than to rescue the valuable substances from the "pee" and produce fertiliser from it? And finally, black water: this is toilet flush water with faeces, which most people prefer to make disappear very quickly. In our country, it is therefore diluted with a lot of clean water and washed underground. Elsewhere, it is sunk into pits or dumped into the nearest river. Yet the faeces contain a lot of energy; our ancestors knew that when they used cow dung for heating. So why not modernise the age-old process and produce hygienic fuel pellets from the unloved faecal sludge?



Urine source separation

Wastewater contains valuable resources. However, because existing wastewater management systems have been designed primarily for pollution control and hygiene, the recovery of resources from wastewater is cumbersome. Source separation is an alternative system which can facilitate resource recovery [13]. The waste stream urine, faeces and greywater are collected separately and treated according to their properties.

Most of the nutrients in wastewater are excreted in urine: 85–90% of nitrogen, 50–60% of phosphorus and 80–90% of potassium [14]. These three nutrients are also the main components of fertilisers. Urine additionally contains many other nutrients important for plant growth, such as sulphur. However, urine accounts for less than 1% of total wastewater volume [15]. Recycling of nutrients from urine to agriculture is therefore an obvious goal of source separation.

To prevent dilution with flushing water, alternatives to conventional toilets and sewers are required for transport, or urine needs to be treated directly onsite. Source separation could be implemented particularly in cities and regions where sewers do not exist or are not appropriate due to low water availability. This is the case for most large urban cities in low and middle-income countries.

Applications of urine source separation
Onsite treatment of urine offers many advantages, for example:
• Urine is a sustainable source of nutrients. Producing a fertiliser from urine helps to close the nutrient cycle between sanitation and agriculture [16].

Nitrogen	85%–90% from urine	High
Phosphorus	50%–60% from urine	Medium
Potassium	80%–90% from urine	Medium
Volume	<1% of total wastewater	Low

Proportion of nitrogen, phosphorus and potassium contained in urine and urine as a proportion of total wastewater volume

- In many regions of the world, urine source separation is used in dry-on-site sanitation systems to facilitate the drying of faeces [17]. Faeces contain organic substances, which can be used for energy production.
- In high-income countries, urine separation has been proposed as a way of increasing the efficiency of centralised wastewater treatment plants [18]. Nitrogen removal is an energy-intensive and space-consuming process. With source separation, less nitrogen would have to be removed in wastewater treatment plants.

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Greywater

Greywater is relatively clean wastewater – from showers, baths, bathroom and kitchen sinks, washing machines or dishwashers – which (unlike blackwater) has not been in direct contact with faeces. It accounts for almost 70% of all wastewater produced by Swiss households. After appropriate treatment, greywater can be safely reused for toilet flushing or irrigation. With advanced treatment processes, the quality and thus the potential for reuse of greywater can be further increased.

Breakdown of household water consumption

142 l

In Swiss households, per capita water consumption is around 142 litres per day. The bar chart shows what proportion of wastewater also has the same source in that 142 l is described as greywater (blue bars).



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Blackwater

Blackwater is the wastewater that comes from toilets, and consists of excreta (urine and faeces), flushwater and cleansing materials. Blackwater is a risk to public and environmental health, if not effectively treated. On the other hand, it contains nutrients, energy and water, which makes it valuable for resource recovery. Management and resource recovery options for blackwater rely on multiple scales of infrastructure, which are appropriate based on local drivers. Off-grid solutions entail treatment at the source, decentralised and semi-centralised onsite containment with transport to treatment, and centralised transport via a sewer to treatment.

Using a measuring off-grid, decentralised and centralised approaches for treatment and resource recovery of wastewater streams, in order to increase the sustainability of globally relevant solutions. In the future, resource-oriented based approaches for citywide inclusive sanitation (CWIS) will include a combination of greater solutions, based on off-grid, decentralised, and centralised solutions.

Expensive centralised solutions

Centralised solutions that prevail in high-income economies are well established based on their effectiveness in protecting public health. However, centralised solutions are expensive, and resource and energy intensive, based on construction of required infrastructure, reliance on large volumes of water, and energy for transporting and treating the wastewater. Sludge is commonly used as an efficient way to transport excreta for treatment, but is not ideal as it results in the contamination of large volumes of drinking quality water. Off-grid and decentralised solutions reduce the volume of water that needs to be treated, as excreta is not mixed with greywater.

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Blackwater often ends up untreated
In many low and middle-income economies countries, decentralised and semi-centralised treatment of blackwater presents a challenge. For example, with centralised sewerage systems, blackwater is often not treated. These solutions have the potential to provide adequate sanitation if the entire service

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To mark [World Toilet Day](#) on 19 November 2022, Eawag has completed a series of three practical fact sheets: one on each of the three topics "[urine source separation](#)", "[grey water](#)" and "[black water](#)". They show what speaks for separate collection and treatment of grey, yellow and black, but also where the challenges lie in order not to create new problems.

Available in D, E and F at Publications for practitioners and via the project website for the [Waterhub](#) in the Nest experimental building.

Cover picture: In the Water Hub in Empa and Eawag's research and innovation building NEST, a distinction is made not only between yellow and black, but also between light and dark grey. (Photo: Eawag)

Related Links

Focus page "Decentralised resource recovery from wastewater"



SF1 - Einstein (in German only) «Kann die Forschung unser Wasser retten?»
with a visit to the Eawag/Empa Water Hub.

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