

'Water is Life' - but what is wastewater?

Abstract

Water is our most precious food item. This article deals with water-related perceptions among residents and professionals and with the role of wastewater to mitigate supply of nutrients and water. The topic covers different times and different geographical areas with a focus on urban areas. Examples from European and Asian cities guide the text. The purpose is to enhance our understanding of why our cities are or aspire to become pipe-bound, despite that this leads to resource problems.

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Introduction

It is often said that the more water we use the better is our wellbeing. This holds true in a community where water is very scarce. But, why is the general idea still so strong among professionals and organisations in 2018 – despite the fact that technical development of water-saving appliances and devices allow us to use a fraction of what is normally being used? Why do water professionals and decision-makers continue to propose business as usual with high per capita water allocations? Other sectors may display more innovation-based approaches. Landbased telephone cables and television networks shifted to wireless systems in a generation. Even electric power lines are rapidly complemented by solar panel-generated power, and cars run on batteries. The original energy technologies were developed only a century and a half ago, which may facilitate a change without too strong perceptual barriers. Water's mythological past, on the other hand, may partly explain the inertia in the water sector. The urban supply of water was local: initially drawn from wells, rivers and lakes and carried to the home. As urban areas got more congested, pipes were introduced to bring water into the homes, thus making the chore to fetch water outdoors obsolete. And later, also used water was disposed of in an indoor pipe. These technical shifts were appreciated by those who earlier had to carry buckets – in particular smelling wastewater buckets.

The introduction of water pipes and sewers was seen as important progress. In addition, piped systems contributed to improved public health. Towns were seen as unhealthy places in the mid-nineteenth century, and statistics prove that urban morbidity and mortality was significantly higher than in rural areas.^{1,2} However, improved access to piped water did not necessarily reduce morbidity. Improved public health in Swedish towns came only later and was more a consequence of improved sanitation practices in households.³

Wastewater replaced direct nutrient recovery – for good?

Agriculture and sanitation were closely linked in the period of early urbanization,^{4,5} since farmers wanted all nutrients they could get to replenish their fields – including animal manure, organic waste, and human excreta (Figure 1). An oft-cited example is the millennia-old Chinese and Japanese practice to applying human excreta from cities on farmland. As towns grew to cities and, in the second half of the 20th century into mega cities, the link between agriculture and

sanitation weakened. Water was used for all cleaning purposes and to flush toilets. Water from toilets was rarely treated, but went as raw sewage to water bodies. When treated, the sludge quality had already deteriorated since city-dwellers began using non-biodegradable chemical products in their households instead of the hitherto used biodegradable soap for all purposes.

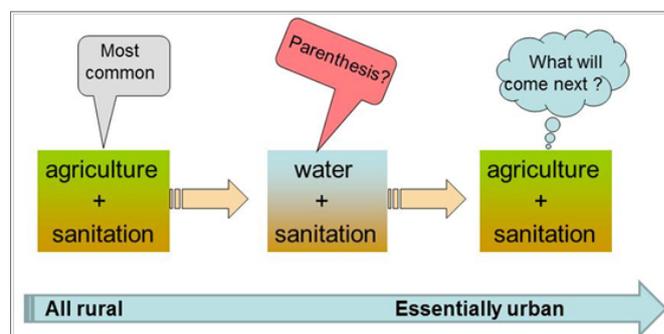


Figure 1 The links between the sanitation, agriculture and water sectors over time.

Recirculation of nutrients disappeared (except for unlawful sewage irrigation and application of contaminated sludge) while chemical fertilisers substituted the missing soil nutrients. A strong link between water and sanitation emerged (Figure 1). As easily accessed global resources of phosphorus and sulphur are dwindling, a solution would be to reconnect the sanitation and agricultural sectors. Cofie et al. (2003) estimated that 800 million people were involved worldwide in urban agriculture, and 150 million fully employed, while they contributed an estimated 15% of food production in 1993. Cities such as Lusaka, Dar es Salaam, Moscow produced almost half of their consumed food within the city limits.⁶ But this link (Figure 1) has become problematic due to the presence of chemicals in the sludge.^{7,8} The future will show whether the scarcity of nutrient resources facilitates a renewed urban planning to recycle water and nutrient flows. Change agents are manifold, and rarely is it possible to rely on one only. There are indications that city planners are 'thinking green' which initially meant more green areas such as parks and trees, but increasingly green means food production on roofs and more gardening. For example, New York city has an estimated 52,000 acres of backyard space that collectively could provide vegetables for 700,000 people.⁹ A recent interview survey about features of cities in Sweden by 2050 shows that 58% of the respondents want roof

gardens, 38% want plants and flowers on house facades, and they expect parking spaces to be converted to green areas when private cars are replaced by other means of transport.¹⁰

Recent material flow research indicate a promising potential to recover and recycle nutrients from urban sanitation to agricultural use.^{11,12} As for phosphorus (P) a conservative potential is to replace 60% to 75% of the mined P in chemical fertiliser by P made available through less use of P in various products (detergents and food and feed additives), reduced food waste, reuse of urine, and recycling of faecal matter show in Figure 2. Human excreta make up most of the plant nutrients leaving the household. Yet, recovery and reuse of urine and faecal matter are not regulated by the European Union.⁸ This exclusion of human excreta is likely to be a cultural construction rather than a scientific distinction.

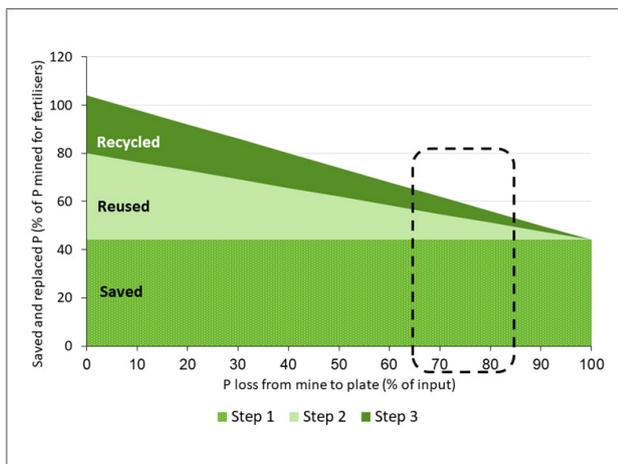


Figure 2 The steps in the figure refers to the 'solid waste hierarchy': reduce, reuse and recycle. The dashed box indicates the area of common losses of P from mine to plate which varies between countries, diets and agricultural efficiency.¹²

Effectiveness and efficiency in the use of water

There is a growing consensus that water should not be wasted but be used wisely. Up to now, the dominant cultural idea is that a person needs 150 liters of water daily, and some countries have design criteria stipulating three times as much.¹³ This is a reminiscence of supply-management thinking. Escalating costs for providing more water, however, forced utilities to embark on demand-management measures to curb demand. Introducing a progressive tariff allows to punish big users, given that flats have individual metering of water usage. The water saving may reach one-third, but most estate owners do not invest in meters.

Other kinds of demand-managing measures are to promote residents' awareness about their use of water and to instal water-saving equipment. Manufacturers have developed many such products over the last few decades. For instance, a low flush urine-diverting toilet requires 3-4 liters per big flush, and only 0.3 liters for the urine flush.¹⁴ Since a person on average visits the toilet 6-8 times a day, of which one to two is for defecation, such toilets will reduce the water for flushing by some 30 liters every day – or 20% of the total use. A modern washing machines uses only 50 liters per 6 kg of clothes, and dishwashers use less water than washing dishes by hand. There are adjustable nozzles for faucets that reduce the water flow by 85 % without loss of comfort.¹⁵ Such demand-reducing measures may

lower the daily water use from 150 liters to less than 60 liters per person – without any loss of comfort for the residents. The emerging option to recycle used water can reduce the need for virgin water even further. A sewage treatment plant in the basement of a housing estate can achieve an effluent quality good enough to flush toilets, water plants, fill washing machines, and be used for car wash. Such use of recycled water may reduce the required water by another 15–30 liters per day. Recycling wastewater becomes easier when hazardous compounds are not added to the water while using it. In an expanding chemical society, this requirement is more and more demanding, at least since the Second World War. At that time most cleaning of the body, clothes and dishes was done by using biodegradable soap, leaving a wastewater of relatively good quality. Today, the wastewater treatment plants are ideally supposed to remove not only nutrients, but 100 000 human-made chemical substances released from the use of various household products.¹⁶ This is not possible, but the utilities could become watchdogs for chemical control agencies. Remedies to toxic wastewater are found 'upstreams' where manufacturers should be restricted to using non-toxic compounds in their products.¹⁷

In line with local production of solar energy and wireless communication, part of the water supply may also come from locally harvested rainwater. Due to seasonality of rains and limited storage capacity, rainwater supply needs to be complemented with groundwater recharge and tank/pond storage of excess water during rainy season. Thereby, the demand for water from virgin sources are reduced further.¹⁸

Investment and running costs

Cities have a unique opportunity to embark on the above measures to secure supply of water for urban areas and nutrients for agriculture. The urban world population will increase from 3 billion to an estimated 8.5 billion this century.¹⁹ This means that three times more dwellings and offices than what existed the year 2000 are to be erected during this century. If these new buildings are built to catch and store rain, recycle used water, and are fitted with water-saving appliances and faucets, at least three-quarter of the buildings are water-efficient at the end of this century without any costs for retrofitting. Since the already existing houses will be retrofitted anyway during this century also these can be made water-efficient without extra investment. The result is that the urban population will have access to enough water in the foreseeable future and farmers will have sufficient plant fertilisers. This is achieved without high investment costs or retrofitting.²⁰

Conclusion

The growth of world population results in pressure on water and nutrient resources globally, while consumption is concentrated to urban areas. Therefore, the management of wastewater plays a major role in avoiding this squeeze, and also 'wastewater is life'. The strong link between the sanitation and agricultural sectors more than a century ago shifted to a strong link between the sanitation and water sectors. Today, there are indications that this phase is only a detour or parenthesis in human history, and the world is again strengthening the link between sanitation and agriculture. This development is partly driven by global resources constraints, especially for water and nutrients. There is rarely an unavoidable water shortage in urban areas or nutrient shortage in agriculture, but often such limited supply is due to poor planning and management of the available water and nutrient resources in urban areas. Zero input of imported water and imported nutrients is the only limit.

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Conflict of interest

There is no conflict of interest.

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