The road not taken - how traditional excreta and greywater management may point the way to a sustainable future

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ABSTRACT

This paper argues that modern, end-of-pipe sanitation systems are not the pinnacle of centuries of wastewater technology development, and may actually prove to be a technological dead-end - expensive to build, operate and maintain, and out of step with traditional wastewater management philosophy. A brief examination of a series of excreta and wastewater management systems from around the world and throughout history clearly shows that viewing faeces, urine and grey water as a worthless waste to be disposed of is only a modern concept, which ignores the realities of limited resource availability, and the obvious benefits to be had from closed-loop systems – as was clearly recognised in the past. While currently, expensive, technically complicated end-of-pipe sanitation systems dominate, several modern systems have been developed specifically to ensure an efficient resource recovery and reuse. Reconsidering and researching historical approaches to wastewater management and applying modern technologies to improve their functionality may contribute to the solution of many of today's sanitary and environmental problems.

KEYWORDS

Sanitation philosophy, excreta and greywater reuse, agriculture, wastewater management systems

INTRODUCTION

The advent of agriculture around 10 000 B.C.E. enabled larger human populations to settle in a fixed location for longer periods than had been previously possible among hunter-gatherers. With this settlement, people were faced for the first time with the problem of what to do with the large volumes of excreta and used water that accumulated as a result of a sedentary lifestyle. Many old, traditional agricultural societies approached this in a logical and pragmatic manner that recognised the nutrient and organic value of excreta by practising the recovery and use of "night-soil" (faeces and excreta). This enabled them to live for centuries in closed loop systems, where nutrients and organic matter from liquid and solid household wastes were returned to the soil from whence they came. In China, where this is still widely practised, they have been able to maintain soil fertility over millennia, despite the high population density. This knowledge however was not based on scientific research, but was rather culturally codified and traditional practical knowledge. In general, historical descriptions on this theme are sparse.

Over the last century or so traditional reuse practices have been abandoned, and replaced by "end-of-pipe" wastewater disposal systems. Today, in view of the construction and operation and maintenance costs of these systems, the degrading quality and fertility of our soils, the limited availability of mineral phosphorous reserves, the high energy consumption of fertiliser production, and the need to protect our freshwater reserves, the resource value of excreta and greywater needs once more to be recognised and systematically implemented, using modern technological and operational solutions, and ensuring maximum health protection.

To be able to apply such closed loop approaches in a modern and hygienically safe manner historical research is needed, as is an improved cooperation between scientific disciplines. The motivation for this paper was therefore to look to the past to provide a direction for the future.

A BRIEF HISTORY OF EXCRETA AND GREYWATER USE

In a very broad sense the recovery and use of urine and faeces has been practiced over millennia by almost all cultures. The uses to which they were put were not limited to agricultural production (although for modern application this is of course of most relevance), and indeed covered a wide variety of practices.

The Celts had many uses for urine, one of particularly practical importance being its use in dyeing and washing cloth, although they also used it in personal hygiene and had various ritual uses. In India, ancient Sanskrit texts outlined the medicinal use of urine through *shivambu* (auto-urine therapy), which was practiced throughout India and Asia, and still has a popular following today.

Like the Celts, the Romans were well aware of the cleaning power of urine and also used it for washing clothing, developing in some towns and cities the logistics to collect larger volumes of urine. Fullers, who worked in laundries, would install amphoras in streets and alleys of towns to serve as public urinals, and would pass regularly to collect the urine, transporting it back to the laundry for washing. Of course, for those involved, washing with urine was a rather smelly business, but also an extremely lucrative one, which led to Vespasians famous quote “pecunia non olet”. Throughout Europe fullers continued to work in this way right through to the Middle Ages, using urine to remove the fat from raw wool and to soften it.

From these few examples it is clear that throughout history attitudes to excreta have not always been as negative as they are today, and that excreta was seen as a resource. However, this can most clearly be seen when one considers the use to which both excreta and greywater have been put in agriculture throughout the ages.

The most widely renowned example of the diligent collection and use of human excreta in agriculture is of course that of China. It is reported that the Chinese were aware of the benefits of using excreta in crop production before the 500 B.C.E., enabling them to sustain “more people at a higher density than any other system of agriculture” (Brown, 2003). The value of “nightsoil” as a fertiliser was clearly recognised with well developed systems in place to enable the collection of excreta from cities and its transportation to fields. Like the work of the fuller, this was a lucrative enterprise. Contractors first had to pay for a license before collecting the excreta and selling it on to farmers, and larger towns were often zoned so that those living nearer the fields paid less for their collection than those living in the centre. In Scott (1952) the annual market price of the excreta output of the entire population was estimated at “between 50 and 80 million pounds sterling at 1924 market prices.”

The Japanese too practiced a disciplined use of excreta in agriculture, being applied at rates of up to 4 t/ha on fields in an environment that was considerably more urbanised than that of China. King in 1911 reported seeing nightsoil transported out of Yokohama and Tokyo “carried on the shoulders of men and on the backs of animals, but most commonly on strong carts drawn by men bearing six to ten tightly covered wooden containers holding forty, sixty or more pounds each” (Brown, 2003). Statistics from the Japanese Bureau of Agriculture for 1908 state that 23 950 295 tons of excreta had been used on around 13.5 million hectares of arable land (King, 1926). Like the Romans, the Japanese provided public toilets with the express aim of collecting excreta for use. The Japanese regarded urine as a particularly useful fertiliser and this would be collected separately for direct use (Matsui, 1997).

The reuse of excreta was however not only limited to China and Japan, and was and continues to be practiced right across Asia.

Apart from collecting urine separately for laundry purposes, the ancient Romans also practiced the use of excreta in agriculture, a practise which they may have adopted from the ancient Greeks. Texts exist from both ancient Roman and Greek authors praising the virtues of its use in agriculture. The Romans also practiced the consequent reuse of greywater – huge volumes of which were produced as a result of the Roman bath culture. Daily per capita water consumption has been estimated at up to 600 l for the upper classes, whereas slaves and soldiers may have used around 200 l/cap/day (Guhl, 2004, unpublished). As the use of excreta for agriculture was the rule in Roman times, the wastewater from most settlements was in the main greywater only. This was often lead outside of the settlement and used to irrigate agricultural areas, as for example was the case at Barbegal in Provence, France. Here, greywater coming from the settlement which had an estimated population of around 500, was mixed with the water passing through the largest grain mills in the Roman Empire and used to irrigate an agricultural area of around 22 ha.

Ancient Arab cultures also incorporated the collection and use of excreta into their agricultural systems, a practice that continued for very many centuries. In the 12th and 13th Century, Ibn al-Awam, an Arab living in southern Spain wrote of composting techniques incorporating human excreta, and of its benefits in curing illnesses in plants such as bananas, apple trees, peach trees, citrus trees, figs, grapes, palms, cedars and wheat. Elaborate systems were developed in the urban centres of Yemen that enabled the separation of urine and excreta even in multi-storey buildings. Faeces were collected from toilets via vertical drop shafts, while urine did not enter the shaft but passed instead along a channel leading through the wall to the outside where it evaporated. Here, the faeces were not used in agriculture but were dried and burnt as fuel. This was common practice for many centuries resulting in a sanitation system, which required very little water. In modern times this traditional sanitation system has been changed with the introduction of water-flush toilets, which appeared to offer a more convenient and "modern" solution. However this has lead to water shortages and a dramatically falling water table in the area of the Yemeni capital city of Sana'a, and to structural damages of the existing multi-storey clay-buildings (Winblad and Simpson-Hébert, 2004).

In Mexico and Peru, both the great Aztec and Inca cultures collected human excreta for agricultural use. In Peru, the Incas had a high regard for excreta as a fertiliser and would store it, dried and pulverised to be used when planting maize.

After the fall of the Roman Empire, many of the centralised structures and systems put in place during that period began to dissolve. However not all of their knowledge was lost. Indeed the collection and reuse of excreta continued. Monasteries, which served as repositories for information and learning throughout Europe at this time continued to apply the recovery of nutrients from excreta and greywater. For example near Milan, the Cistercians introduced the use of city refuse and sewer water on their land in around 1150 C.E. (History of Technology, Vol. II, 1956). The Cistercians had also developed sophisticated washing systems, and used the greywater from wash houses to either directly irrigate gardens or, as at their monastery at Silvacane, near Marseille, mixed it with wastewater from buildings and fresh water to feed fish ponds (Guhl, 2004, unpublished).

In the Middle Ages, the use of excreta and greywater was well established. European cities were rapidly urbanising and sanitation was becoming an increasingly serious problem, whilst at the same time the cities themselves were becoming an increasingly more important source of agricultural nutrients. In Flanders, for example, the sale of excreta and animal dung was a booming business. By the sixteenth century up to 60% of farmers expenditure was on fertiliser (excreta and dung). By then near Antwerp farm rents were soaring, with farmers able to ensure a high enough production to pay them thanks to their relatively easy access to the cities nutrients (Brown, 2003).

In Freiburg, Germany, meadows were irrigated with nutrient rich wastewater coming from the town, with this practice first officially recorded in 1220 C.E.. The meadows were mostly located in areas with permeable soils along rivers. The installation of agriculture on these meadows ensured plant growth in dry periods and extended the vegetation period by washing away the snow in spring or winter. The irrigation also served to reduce the incidence of plant pests (a phenomena reported from other areas where either excreta or greywater was used), and contributed to ensuring a stable nutrient balance in the meadows. The water used for irrigation had passed through settlements and had been used several times, and was therefore enriched with nutrients and suspended matter. Thus the nutrient loss caused by the removal of crops from the meadow was compensated. Irrigation of the meadows reached its heyday in the early 19th century, although the practice itself only stopped in the 1960s.

The practice of using the nutrients in excreta for agriculture therefore clearly continued in Europe into the middle of the 19th Century, and the marketing of fertiliser derived from excreta and organic waste continued to be a thriving business. There were "great stores of manure on the Schelde between St Amand and Baasrode…whence the excrement from Dutch towns was transported by barge" (Brown, 2003). Farmers were eager to get these fertilisers to increase their yields, the value of excreta was clearly recognised, and urban sanitation benefited. There are countless similar examples from these times of the use and potential of the excreta coming from urban areas. In Paris for example, in 1850 urban agriculture was practised on 15% of the city area and Paris was exporting vegetables, compost and fertiliser from pits to the surrounding regions (Illich 1987, Lange 2002).

As the industrial revolution progressed it was becoming increasingly possible to develop more complex approaches to collect excreta for reuse. In 1865, Prince Heinrich der Niederlande had asked T. Charles Lienur to remove the sewage from Castle Luxembourg without polluting the River Elz and without using wagons. (The introduction of sewer systems in the second half of the 19th century - see below - provoked hefty discussions on their pros and cons, as treatment plants were non-existent and they were causing serious pollution of surface water bodies.)

Lienur's system consisted of two pipes. One carried rainwater, greywater, and industrial water, while the other was what could be considered the predecessor of modern vacuum sanitation systems (as found on planes and high speed trains), and was used to transport blackwater and water from stables and slaughter houses. The vacuum toilets required very little flushing water and the blackwater collected was used to produce "poudrette" (a dried natural fertiliser). At that time the industrial production of mineral fertiliser had not yet started (the first factories were built in 1870) and the price for fertiliser was high enough to allow the production and successful marketing of "poudrette".

In developing areas of Amsterdam in 1906 more than 4 500 vacuum toilets where connected to a Lienur-system. Soon however the production of poudrette was seen as being too costly as prices for industrial mineral fertiliser decreased.

Although some information on Lienurs system is available, a thorough investigation of why the system could not compete with central sewer systems in urban areas, particularly under the specific and very difficult conditions in a city like Amsterdam, has not been carried out (Lange and Otterpohl 2000, Lange 2002).

WHY DID THIS ALL CHANGE?

However, whilst the recovery of nutrients and organic matter from excreta and greywater was addressing the sanitation problems of settlements and contributing to securing and increasing agricultural productivity – one Spanish author in the 18th Century describing yields from excreta fertilised crops as being "monstrously large" – the practice was not destined to become the dominant approach to sanitation in the 20th Century. There were four main driving factors that lead to the demise in the recovery and use of excreta and greywater from cities.

Firstly, urban settlements have continued to grow dramatically in size over the centuries. The cities attracted people eager to try their luck there, with each new arrival producing excreta and wastewater. However, the logistical challenge of removing the faeces of a booming population from densely packed city centres to bring to agricultural areas many miles away proved too great. The sanitary conditions in major European cities degraded rapidly. In nineteenth century Britain an average of 26% of children died before the age of 5, whereas in the cities the average was double that at around 50% (Brown, 2003), and cholera was the scourge of the country. In addition to this the collection, handling and use of partially or untreated waste was having extreme impacts on public health – particularly as there lacked any knowledge of modes of transmission of faeco-oral diseases. Considering once more the example of China, a study looking at agriculture and health there in the 1930s revealed alarming statistics (Scott, 1952). Life expectancy at birth was 34 years, compared to 60 years in Britain at that time, with 42% of all deaths occurring amongst children under 10. In Tinghsien, south-west of Beijing, 18.5% of all deaths were from gastro-intestinal illnesses.

Secondly, up until the end of the nineteenth century the dominant theory on the spread of illness was the miasma theory. This long established theory, which had its roots in classical times, basically held that illness was caused by volatile substances that were inhaled. As bad smells were thought more likely to contain illness, everything that smelled had to be gotten rid of. To some degree the miasma theory contributed to containing some disease, but did not allow for a suitable approach to safe excreta reuse to be adopted. Excreta smelled bad and was therefore to be gotten rid of.

Thirdly, the arrival of piped domestic water supplies in the nineteenth century made water flushed sewerage system finally possible. The water flushed system, often using existing stormwater drains, was the answer to many people's prayers at the time. Governments had attempted to legislate to improve sanitation but this was proving difficult to implement, and physician and hygienists were caught in a losing battle. Water flushed systems dramatically transformed this situation, with sewage being flushed away from homes and the hearts of cities into nearby rivers. Water flushing of course greatly increased the volume of sewage, whilst at the same time diluted the nutrients in it, making it virtually impossible for nutrient to be recovered and reused as they we previously.

And fourthly, as was seen in the case of Lienur's poudrette, the nutrient demand of farmers was eventually met by cheap chemical fertilisers, making any efforts to recover and reuse the nutrients and organic material from the large volumes of sewage completely obsolete.

The evidence was clear. Sewered cities became cleaner, healthier places to live, city pollution became river pollution, downstream communities suffered and the concept of the water-borne sewer system became the standard approach to solve the sanitation problems in urban areas of industrialised countries during the second half of the 19th century and into the 20th (van Zon 1986, Lange and Otterpohl 2000, Lange 2002).

THE END OF THE PIPE AT THE END OF THE LINE?

Of course for 19th Century engineers there was already a precedent for water flushed systems systems, from the times of the mighty Roman Empire. The Roman Cloaca Maxima, built by Tarquinius Priscus (616 – 578 BC), was originally a system of channels draining rainwater from Rome, particularly the area around the Forum. It later became the main Roman sewerage canal carrying wastewater and storm water out of the city, and discharging it downstream into the Tiber, thus protecting at least to a small degree the water quality of the Tiber within the city catchment. However, despite this water quality "protection measure", the Tiber was still unsuitable to be used as a water source, requiring fresh drinking water to be brought to the city via aqueducts. Today for many it remains a mystery as to why the achievements of this forerunner of modern centralised wastewater systems, and this form of wastewater "disposal" was completely forgotten until the 19th Century. What however is less often recognised is that the Cloaca Maxima was practically an emergency "solution" to deal with the vast quantities of wastewater generated in the capitol that could not be dealt with in any other way. It is by no means proven that the Cloaca Maxima served to transport excreta out of the city. Indeed this would have been surprising as recovery and reuse of excreta was common place in the time of the emperors.

In many ways, the sewage systems of the 19th Century were a similar emergency solution to a social health crisis, and for 150 years engineers have continued to try and perfect this emergency solution. Instead of fixing the hole in the dyke, we have continued to ensure that the boy's fingers just about fill the crack. In order to improve the abysmal sanitary state of cities it was initially considered acceptable to discharge effluent (raw sewage) to surface water bodies, spending large sums of money to install vast sewerage networks throughout cities to do so. Later, when the effects of the severe river pollution this caused became obvious, mechanical treatment of wastewater was introduced (the first German treatment plant being built in 1887 in Frankfurt-Niederrad), followed in time by biological treatment for the degradation of organic substances, and tertiary treatment for the removal of nutrients and reduction of eutrophication of the receiving water bodies. These three steps now represent the present state-of-the-art in wastewater treatment.

Although these conventional sewer systems have improved the public health situation in towns, cities and countries that can afford the massive installation, operation and maintenance cost, they have also drained economies, polluted and squandered fresh water resources, broken nutrient cycles and impoverished soils. For almost half of the world's population, the estimated 2.6 billion people who do not have access to adequate sanitation today (WHO/UNICEF JMP, 2005), "end-of-pipe" systems remain both unaffordable and inappropriate. The centralised end-of-pipe paradigm has let billions of people down. As millions are spent perfecting these expensively wasteful systems, an estimated 2.2 million people, most of them children under the age of five, die every year as a result of illnesses caused by contaminated drinking water and poor sanitation and hygiene in developing countries. 80 % of all diseases and 25 % of all deaths in developing countries are caused by polluted water (UN 1992). At the same time soils are impoverished and nutrients lost to water bodies as the "end-of-pipe" paradigm discourages recovery and reuse. In Africa, 85% of arable land is losing an average of 30kg of nutrients per hectare per year (Morin 2006).

However it is not only in the developing world that end-of-pipe systems are at the end of the line. In wealthy Europe for example, of 540 major cities, only 79 have advanced tertiary sewage treatment, 223 have secondary treatment, 72 have incomplete primary treatment and 168 cities have no or an unknown form of treatment of their wastewater. (EcoSanRes, 2002).

The conventional sewer system was developed at a time, in regions, and under environmental conditions where the priority was mainly to remove liquid wastes and dilute excreta from cities. Today with increased population pressure, changes in consumer habits and increasing pressure on freshwater and other resources, this human waste disposal system is no longer able to meet the pressing global needs. In the light of dwindling natural resources there is a need to reassess the functioning of conventional sewage collection and treatment stems. The motivation and inspiration behind end-of-pipe systems needs to be reassessed from a historical perspective and in the light of technological advances.

Around the globe the reflections have begun and a range of systems have been developed, based on the recycling principals of the past and using modern technological and systems approaches.

CLOSING THE LOOP ONCE MORE

In Sweden, near a nature reserve in a suburb of Stockholm, the Gebers collective housing project can be found, initiated by a network of friends and neighbours, who converted a deserted and vandalized building complex into 32 apartments with a total of 80 inhabitants. With the installation of a closed-loop system for toilet and organic waste, the project contributes to the environmental protection of the reserve. (GTZ -project data sheets, 2006)

Toilets designed to separately collect faeces and urine were installed, with each fraction being treated before reuse. The urine is flushed with water and piped to polypropylene collection tanks whilst the faeces are collected without flushing water, falling straight into individual plastic bins, with both the tanks and the bins located in the cellar of the complex. The plastic bins are housed in a special compartment which is constantly under negative pressure through ventilation, improving dehydration of the faeces and preventing odours from entering the homes. The urine tanks are emptied about twice a year by a tanker truck and the treated urine is used as fertiliser in agriculture. The faeces are composted together with other organic household wastes. The resulting compost has a soil-like appearance, and will be used as a soil conditioner in agriculture to produce horse feed.

On the other side of the globe, Erdos is a cluster of cities in a coal mining belt of Inner Mongolia, where a new town is being developed in a suburban area a few kilometres from the city centre of Dong Sheng. Housing for 7.000 people in the town is being equipped with modern porcelain dry toilets which enable urine to be collected separately. The toilets and related equipment and fixtures are being developed and manufactured in China. (Zhu 2006)

Similar to Gebers, the faeces will be collected in dry form in containers in the cellar, which will be regularly emptied. The faeces will then be composted together with household organic wastes and used as a soil conditioner. Urine will be collected on-site in tanks and used in local agriculture. Greywater will be collected and treated on site in small aeration and filtration treatment facilities. Organic and other solid wastes will be sorted and collected in eco-stations. Storm water will be collected separately using drains. The project will undergo a period of development and testing prior to its full-scale implementation. Once in operation the model town will be the object of further performance studies by water and sanitation specialists, urban planners, urban agriculturalists and others.

The village of Haran Al-Awamied is located south east of Damascus, Syria. The villagers are poor in this village, with farming the main source of income. Untreated wastewater from the existing gravity sewers was, until recently, commonly used for irrigation, resulting in a high incidence of disease. A new combined public sewer system was therefore recently installed to collect and transport rain and wastewater to a new wastewater treatment plant. The plant consists of bar screens and a sedimentation tank as a pre-treatment, two reed beds to treat the wastewater, and one reed bed for the soilification of the sludge. The treated water is collected in a tank for storage, and is pumped from the collection tank to irrigate the fields near the plant when needed, with the distribution being organised by the farmers.

The improved availability of irrigation water with a high nutrient content has reduced the farmer's expenditure on commercial mineral fertilisers. It has contributed to higher yields in crop production, and increased the number of harvests from one to several per year. The reed plants of the constructed wetland are used for wicker and roofing materials and the treated sludge is used as a soil conditioner. As the farmers clearly benefit from the constructed wetland, they have provided a great deal of support to ensure its correct functioning. (GTZ -project data sheets, 2006)

A further example of how closed-lop systems are being implemented can be seen at the headquarters of the German Technical Cooperation (GTZ) in Eschborn, near Frankfurt. During the renovation of the main office building, a modern, ecologically sustainable concept for the management of the wastewater from the toilets has been installed. The main building is equipped with waterless urinals and water flushed urine diversion toilets. Through the separate, undiluted collection of urine, the water demand for flushing toilets is expected to be significantly reduced. With this concept, the GTZ will not only saves 900 m³ of water per year, but also significantly reduce the load of nutrients and other substances from the urine on the water treatment facilities. (GTZ -project data sheets, 2006)

After treatment the urine will be used in agricultural tests carried out as part of a research project. The information collected from the project aims to improve agricultural production with urine based fertiliser. When finished, the system will serve as a model for similar facilities, also in countries where water is scarce and fertiliser is needed in local agriculture. As the building receives thousands of overseas visitors per year from developing countries, a large public relations impact is expected.

For the treatment and reuse of the brownwater (i.e. faeces and flush water originating from the toilets) an additional research component is foreseen. Treatment with an activated sludge reactor, followed by membrane filtration, is currently being discussed as one possible technological option.

CONCLUSION: THE PAST MAY CONTAIN THE PATH TO A SUSTAINABLE FUTURE

A brief examination of excreta and wastewater management systems from around the world and throughout history clearly shows that viewing faeces, urine and grey water as a worthless waste to be disposed of is only a modern concept, which ignores the realities of limited resource availability, and the obvious benefits to be had from closed-loop systems – as was clearly recognised in the past. 150 years ago this changed dramatically and unsustainable, end-of-pipe, wastewater disposal systems were developed as a way out of a sanitation crisis in wealthy, water rich cities, where they successfully contributed to improving the hygienic situation there. With a century and a half of research and development behind them end-of-pipe systems have become the state of the art in waste water management.

The unreflected export of this end-of-pipe philosophy, even to water scarce, poor regions of the South, has however also contributed to the alarming sanitation statistics there, with 4 000 children under 5 dying daily from the effects of contaminated water. Historical research is therefore needed to help clearly establish how we have arrived at this situation and to highlight alternatives to the current dominant approach.

In attempting to understand the road that has been taken in sanitation it is important to understand the context of the time. Clearly this includes the technological, economic and environmental context, but the cultural context in which sanitation developments have taken place is also of rime importance. For example the influence of the ultimately erroneous Miasma Theory on the development of cultural attitudes to excreta in Europe can help explain to a degree the “faecophobic” thinking behind end-of-pipe systems. Socio-cultural considerations are also important for new developments in sanitation. Research on history and traditions of sanitation-related socio-cultural aspects can therefore greatly contribute to the socio-cultural sustainability of sanitation systems.

Historical research on the urbanisation of 19th Century Europe has already shed some light on the driving forces behind sewered, water-borne sanitation, and end-of-pipe treatment systems in Europe. The historical research of Lange (2002) and some earlier work of van Zon (1986) are useful to help us understand the alternatives that have been discussed and tested, and to gain some preliminary insight as to why these were ultimately rejected or accepted in their day.

In order to effectively address the current global sanitation crisis, and to lobby for a paradigm change towards closed-loop, socially, economically and environmentally sustainable systems it is important to have a clear understanding of the history of sanitation. This field has to date not been given sufficient attention, and the future of sanitation would clearly benefit from an examination of the past.

Historical research questions could include:

- Which sanitation systems were developed in different periods and cultures?
- How were these systems culturally, economically, technically and environmentally embedded in the given social context?
- Why has the end-of-pipe sewer system become so dominant today?
- How can previous, historical experience and philosophy of sanitation be collected and made useful and relevant in a modern context?
- What traditionally codified social knowledge, values and habits may prove to be of use when introducing innovative sanitation systems? Which taboos, reservations and social boundary conditions need to be considered?

Historical research is therefore being called upon to examine the route we have taken in addressing our sanitation problems and in so doing to provide inspiration fort he road we may take into the future.

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