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Peri-Urban Sanitation and Water Service Provision

Challenges and opportunities for developing countries

Jennifer McConville and Hans Bertil Wittgren (eds)

SanWatPUA

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FOREWORD

Rapid urbanization in many parts of the developing world is putting increasing strain on the ability of municipalities to deliver critical services, such as water and sanitation. Peri-urban areas surrounding cities in the developing world are often at the fringes of urban planning, both physically and politically, making service provision an even greater challenge. In addition, these areas face a variety of challenges related to poverty, environmental degradation, shifting cultures and unclear social boundaries.

Water plays a fundamental role in people's lives. Access to safe water is a basic human need and a key factor in the development and sustainability of human societies. Access to facilities and services for safe disposal of human waste, i.e. basic sanitation, is considered to be equally important, because a lack of sanitation results in contaminated water resources and exposure to disease. At the societal level, sanitation is also required to ensure human dignity and personal safety.

SanWatPUA (Sanitation and Water Supply in Peri-Urban Areas) is a Swedish network of experts established in 2010, that has focused on the synthesis and communication of scientific knowledge about the provision of sanitation and water to peri-urban areas in developing countries. The network aims to support innovation in peri-urban areas through knowledge dissemination on key areas for change. SanWatPUA has applied methods and tools to synthesize knowledge that is instrumental for practitioners in the planning and problem-solving of real-life situations.

This report is written by members of the SanWatPUA network. The different chapters highlight challenges and opportunities concerning sanitation and water supply in peri-urban areas of developing countries. Chapter 1 describes the particular features of peri-urban areas and highlights different challenges for improving sanitation and water supply. The following five chapters (2-6) deal primarily with opportunities for improvement concerning crucial aspects of sanitation and water supply in peri-urban areas. Finally, chapter 7 introduces gaming as an arena for learning and discussion about different solutions. In gaming, as well as in real planning and negotiations, the other chapters can be used for inspiration and as sources of information.

Contributors to the SanWatPUA network include: Chalmers – Architecture; Chalmers – Water Environment Technology; KTH – Environmental Geochemistry and Eco-technology; KTH – Industrial Ecology; Linköping University – Water and Environmental Studies; Linköping University – Biology; Lund University – Water Resources Engineering; Stockholm Environment Institute; Swedish University of Agricultural Sciences – Energy and Technology; Swedish Institute for Infectious Disease Control; and Urban Water Management Sweden, AB.

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Stockholm, January, 2014

Jennifer McConville and Hans Bertil Wittgren, editors

CHAPTER 1: THE PERI-URBAN CONTEXT

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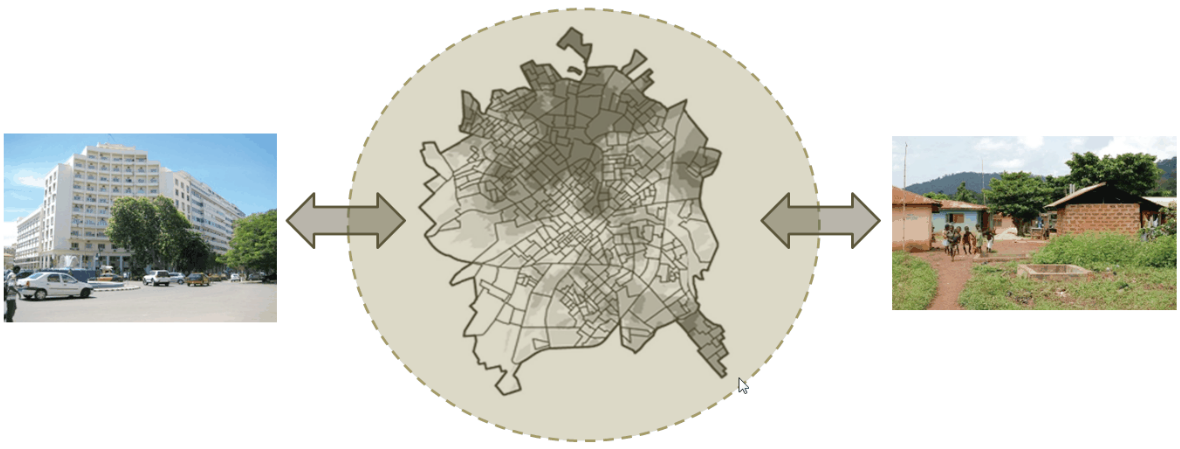
The world is being shaped by urbanization. Cities in the developing world are expanding at an enormous rate, and Africa in particular is predicted to urbanize the fastest. UN-HABITAT predicts that 50% of the continent's population will live in urban areas by 2050, which equates to a total of 1.2 billion people (UN-HABITAT, 2008). Formal procedures and mechanisms for urban services and infrastructure development cannot keep pace with this unprecedented growth, and the result is a fast growing number of transition areas at the periphery of cities – so-called peri-urban areas (PUAs).

WHAT IS PERI-URBAN?

It is a challenge to define the term peri-urban because of the shifting nature of such areas. There is no standard classification of peri-urban, and the term is applied to a diverse mix of informal and formal settlements, which can contain a wide variety of housing types and range from densely built slums to spacious suburban estates. In general, however, the term refers to the geographical edge of the city, more specifically the urban fringe outside the formal city-limits (Dupont, 2005). In addition to this geographical definition peri-urban also describes the interface between rural and urban activities, and embodies a transition from rural to urban norms, legislation and institutional settings, in which social structures, commercial activities and even the built environment are in flux. However, there are also examples of shrinking cities, where the peri-urban contains a transition in the opposite direction, from urban to rural.

Spatially, PUAs are growing more rapidly than formal urban districts. In many cities peri-urban sections are already bigger than the formal areas (Hogrewe et al., 1993), and in most developing countries are characterized by rapid population growth, a mixture of planned and un-planned settlements, inadequate service infrastructures, insecure land tenure, social tension, and environmental and health problems. In addition, PUAs often fall into a gap between the responsibilities of rural and urban authorities, leaving such areas in a grey zone of unclear legality, regulation and administration, which leads to a lack of regulatory control, poor policy design and implementation, and corresponding ineffective and unjust delivery of basic services (Iaquinta & Drescher, 2000).

At the same time, PUAs are often economically dynamic and offer many opportunities for residents. They are strongly influenced by easy access to urban markets, services, resources and a ready supply of labour. They are also , the proximity of rural agricultural zones makes the peri-urban interface a critical area for the management (or mis-management) of natural resources.



Photos: Jennifer McConville

Figure 1: Conceptualizing the peri-urban area: The geographical fringe surrounding the formal city-limits where urban and rural influences strongly interact

CONTEXTUAL CHALLENGES

There are a number of challenges that are common to most PUAs. In general, these relate to unclear institutional responsibilities, infrastructure provision, and heterogeneous populations.

Institutional responsibilities

Because PUAs are usually positioned on the fringe of existing urban jurisdictions and spatial boundaries, they often face a number of complex institutional challenges that reduce the capacity of local authorities to provide basic services to the populations (Norström et al., 2009; Parnell et al., 2009). For example, PUAs can be regulated under several different (and sometimes contradictory) legal bodies, or under none, and this lack of a clearly defined institutional structure often means that no responsibility is taken for urban planning, development or service provision.

Even where administrative control is defined, the responsible bodies are often dealing with a lack of resources, fragile technical networks, inadequate financial frameworks, and weak staff competence and capacity for dealing with booming peri-urban neighbourhoods (Norström et al., 2009). The rate of change is so fast in many of these areas that it is difficult to establish internal routines, policies and norms that could guide their governance.

As a result, enforcement of regulations can be weak, leading to vandalism, unauthorized building and dumping of waste, and other illegal activities and security problems. Inhabitants of PUAs often have low expectations of public services and can abuse those services that are provided. In general, PUAs are characterized by a low awareness of and respect for the responsibilities of citizenship.

Infrastructure and housing

Peri-urban areas are faced with a number of issues related to public infrastructure and housing. In general, infrastructure development cannot keep pace with population growth, leading to a backlog of unserved populations and unmaintained infrastructure. Sanitation and water supply are commonly affected, but other infrastructure such as roads, schools, and electricity networks are also often in poor condition.

Another issue that impacts on infrastructure in PUAs is the legal status of land and associated unregulated patterns of land-use. Land ownership is often unclear, leading to tenure issues and problems for authorities wishing to plan and zone the area. When people settle on marginal plots without land rights, permission or security of tenure, they are unwilling to invest in improving them, and local authorities tend to be unwilling to invest in infrastructure, since it is difficult to enforce payment for use of services. Housing structures in PUAs are often temporary, unimproved and can easily be dismantled in case of future eviction or voluntary displacement. However, formalization of tenure in informal settlements may result in higher rental costs, pushing disenfranchised families further away from access to urban livelihoods.

In addition to tenure issues, the unregulated construction in these areas leads to poor quality buildings and non-compliance with building regulations. These housing structures are usually not connected to basic public services, such as water provision and waste disposal. This creates major health and safety issues for the population as well as environmental degradation.

Heterogeneous populations

Another challenge is the variable population found in PUAs. Globally, these areas are home to millions of people, many of whom originate from rural areas and are unfamiliar with urban conditions and ways of life. The economic opportunities offered by cities are strong drivers for rural-urban migration, but many of these rural migrants remain poor and find it difficult to find housing in more consolidated urban areas and therefore settle on the fringes, often seeing this as a temporary solution. In addition, there can be large fluxes in internal settlement patterns as people move in search of jobs, or due to political interventions. The result is a regular flux of people in and out of these areas, especially in peri-urban slums.

The varying backgrounds of peri-urban dwellers can also lead to social tensions and lack of community cohesion. There can be large disparities in income between the poor, who settle here due to lack of options, and upper- and middle-class populations seeking a suburban lifestyle and space. This of course creates equity and power issues when it comes to controlling limited local resources.

Inhabitants of peri-urban areas can also represent a diversity of origins, ethnic backgrounds, cultures, religions, social norms, and hygiene behaviours and preferences. In many PUAs people still defecate openly or practice unhygienic waste disposal methods, while others aspire to more affluent lifestyles. Varying levels of education and expectations for public services creates further challenges for designing acceptable service levels and for taking community-based action.

WHAT DOES THIS MEAN FOR SANITATION AND WATER SUPPLY?

The contextual challenges of peri-urban areas impact in a variety of ways on sanitation and water supply, particularly on the availability of these services and on the potential to develop them further, which of course have predictable health and environmental consequences.

In many peri-urban areas, the availability of water and sanitation is not so much a problem of scarcity as it is a problem of access and control of resources (Marshall et al. 2009). As mentioned above, the lack of clear administrative and governance structures can have huge implications for the availability and upkeep of infrastructure. Provision of water and sanitation is no exception. Generally, no one has a clear mandate to provide these services and there is a lack of financial and human capital for construction and maintenance. A key reason for this lack of investment is that sanitation is often given a low priority. Furthermore, the unregulated nature of peri-urban areas and their position on the edge of urban zones also increases the tension between agricultural, urban and industrial demands for water resources. Of course, the poor are hardest hit by the resulting reductions in access and higher prices for water and sanitation.

The high densities and unplanned nature of these urban fringes also create problems for implementing sanitation and water supply services, particularly in slums. The haphazard placement of houses makes laying pipe networks difficult, and it can be impossible to gain access by road to empty on-site sanitation facilities.

The heterogeneous and fluctuating population makes planning and service provision very complex, not only for providing permanent sanitation infrastructure, but also for training local people and maintenance workers in its proper use and hygiene practices. Training and awareness-raising efforts need to be continuous in order to reach new community members.

Because many residents of PUAs lack public services, they often resort to their own means of obtaining water and disposing of waste. Private solutions fill a critical service gap and can be appropriate when they are well managed. However, when unregulated or poorly maintained, these systems can carry a high price for society: water quality can be uncertain, and the cost of water from vendors and private wells can be significantly higher than the municipal water services accessible to more affluent populations. When without sanitation services, residents resort to open defecation, hand-dug pit latrines, unregulated septic systems and informal dumping. The result is unsanitary environmental conditions and high rates of exposure to excreta, chemical contaminants and waterborne disease.

There can also be security problems related to sanitation practices in PUAs. There is a risk that users, of public facilities and open defecators – particularly women and young girls – may be molested when they leave their homes at night.

Anna Norström

TRANSITIONS MEAN OPPORTUNITIES

The challenges facing peri-urban areas may seem daunting, especially because many of them are interlinked and subject to frequent change, which brings greater complexity. However, when problems are interconnected, there can also be opportunities for synergetic and cross-cutting solutions, and rapid change creates space for effective innovation.

Thus, despite the challenges, peri-urban areas can also offer rich opportunities. Decentralization of institutional arrangements has had the effect of slowly increasing the mandates and capacity of local government in PUAs, and there is growing recognition of the role that informal and community-based sectors play in urban economics and development. The lack of services in PUAs can present market opportunities for new actors, while weak regulations and competition for resources can stimulate innovation.

PUAs can provide openings to change existing, often ineffective, approaches to service delivery. There is room to develop new regulatory procedures, approaches to planning, financing schemes and innovative governance. Many peri-urban residents are already resorting to alternative approaches to service provision, which can be improved and up-scaled to meet demands. There are also opportunities to make the most of the urban-rural divide. For example, resource-oriented sanitation can return urban organic waste to agricultural areas in need of fertilizers.

Improvements in peri-urban sanitation and water supply will need to involve a mix of stakeholders and the implementation of new planning and decision-making strategies that include representatives from the diverse inhabitants of these areas: there are roles for public and private sectors, community actors, experts and entrepreneurs. Future solutions will have to combine new methods of service delivery with resource efficient technology that can meet the needs of all.

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CHAPTER 2: IMPROVED NUTRIENT MANAGEMENT FOR FOOD SECURITY

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Today, one rural dweller provides food for two persons. If the urbanisation trends continue, within a lifetime, the same rural dweller will have to feed 6-7 people. Efficiency of food production has to improve manifold, and there is also a scope for urban food production by using recycled nutrients. Peri-urban areas at the cross-roads of rural and urban are a logical starting point for this transition.

TOWARDS FOOD SECURITY

The OECD (2013) estimates that at the end of this century 1.5 billion people will reside in rural areas, providing food for the 8.5 billion living in cities. Urbanization implies that a shrinking rural population will need to feed a rapidly growing urban population. How can we understand and prepare for food security during this process?

At the same time as cities and infrastructure encroach on prime farmland and acreage for fuel production increases, the nutrient-rich organic wastes from cities is wasted and not recovered and recycled as fertiliser. The on-going shift towards more meat in diets around the world puts further pressure on food production, because more land, nutrients and water are required per kilogram of meat protein than per kilogram of vegetable protein (Prud'homme 2011).

A business as usual scenario shows that current trajectories of food production and consumption are not sustainable, and this chapter outlines ways to enhance nutrient management for food security.

Wasteful linear food chains

The food chain begins with plants taking up nutrients from the soil. Domestic animals feed on these plants, and humans prepare and eat food from plants and animals. In most societies, this flow is linear and discharged wastes are not returned to fields. Instead, mineral fertilisers have to be added to the soils. For example, phosphorus (P) is an essential nutrient for plant growth, and around 80% of it is lost in the process of bringing food to the plate (Cordell et al. 2009). The remaining 20% is usually wasted through sanitation systems.

Hans Bertil Wittgren

The current linear system is very different from circular systems characterized by nutrient loops, which were common in the past, and in which nutrients are recovered and returned to agricultural fields. By reversing linear systems to circular ones, virgin inputs to food production can be saved and add to soil fertility.

Over-fertilization of fields with phosphorus (P) was rampant in rich countries in the recent past, but has been reduced. However, P is now being added to animal feed despite no positive effects on animal health. Also, Winger et al. (2012) cite several studies suggesting that 50% of the daily human P intake in the West is from food additives. One of the studies found that foods with additives contained 70% more P than similar foods without additives.

In the last half-century, P has also been added to washing powders and detergents, the amount of which equals almost 10% of the total mined phosphate rock (OCP, 2010). By reducing P in feed and food additives and replacing P in detergents, demand for mined P would go down by some 15–20%.

Significant quantities of nutrients can also be saved by reducing food waste: Gustavsson et al. (2011) conclude that much more food is wasted in the industrialized world than in developing countries, and estimate that consumers in Europe and North America waste 95–115 kg per year, while this figure in sub-Saharan Africa and South and Southeast Asia is only 6–11 kg per year. Most losses in high-income countries occur at markets and in households, while low-income country losses occur mainly at farm level, and during transport to marketplaces because of inadequate infrastructure.

Bending the linear flows

Cities are fast becoming "nutrient hotspots" in two senses – first as centres of demand for Nitrogen (N), Phosphorous and Potassium (K) in the form of food to be consumed, and second as location of large amounts of these nutrients in excreta and food waste. For example, urine is the largest single source of N, P and K emerging from cities (Jönsson, 2004). However, most nutrients in urban waste and wastewater are not recovered and reused (EC, 2008). For the most part, solid organic waste is collected and transported to landfill sites, where the nutrients will often remain for years, unless they leach into groundwater or are emitted into the atmosphere. Toilet waste (excreta) from urban households, in the best of cases, ends up as sludge in a wastewater treatment plant. However, sludge is also often sent to landfills and in some cases incinerated due to its perceived or real toxicity. The more linear the flow of nutrients is from mine and industry to toilets and onward to air and water bodies, the greater our dependence on mineral nutrients will be and the faster virgin resources will be depleted. Recycling urban nutrients such as urine back to agriculture therefore presents an under explored opportunity for the future.

Systems perspectives

Figure 1 is a theoretical representation of a common situation with little nutrient recovery in today's urban areas. It shows how the total output from households of nitrogen (N) and phosphorus (P) is distributed in the system. Nutrients are largely discharged to water bodies (red arrow in Fig. 1). Organic matter in sewers causes eutrophication and algal blooms in receiving water bodies. This may result in less aquatic flora and even dead zones on lake floors and reduced living space for fish.

The term "bio-waste" refers to such items as food waste, paper, and garden waste. It is usually easier to manage solid organic waste than liquid organic waste, which gets caught in sludge that remains after wastewater treatment. If food remains and fat and grease from plates, pans and cutlery are swept into the organic waste bin, it makes it possible to use it for biogas production and/or to use the compost as fertiliser in agriculture. Also, when fat, oil and grease are washed away with water, they can clog sewer pipes, and costly repair is often necessary.

Worldwide, the nutrient-rich excreta are commonly flushed to a septic tank for partial treatment, but much of the nutrients remain in the effluent, while part of the sludge is collected and ideally brought to a compost facility. However, illegal dumping is commonplace in developing cities. Co-composted sludge and solid organic waste is available for use in agriculture, although most of the nitrogen content gets lost to the atmosphere. The theoretical flows in Figure 1 indicate a modest one-fifth of the P that households discharge is being gainfully used, and only 5% of the N.

Modified sanitation systems can considerably improve the capacity to reuse and recycle (see Figure 2). Here, a hypothetical scenario for a typical city in the developing world has taken some steps to make its sanitation system more sustainable. Residents separate household solid organic waste, and the waste company composts it, and this added value reduces illegal dumping. Also, urine-diverting toilets have been installed, which collect urine separately, while dewatered faecal matter is stored in line with World Health Organisation recommendations (WHO 2006) before being applied to soil. The wastewater treatment plant has been improved to remove 90% of the P, but, the same effect could have been achieved by prohibiting phosphate-based detergents, as the European Union did in 2013.

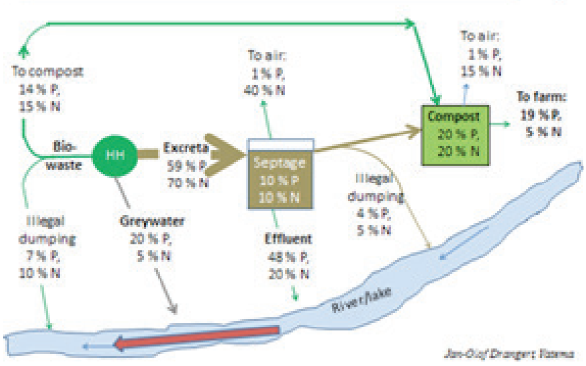

Figure 1: Average nutrient flows from households (HH) today

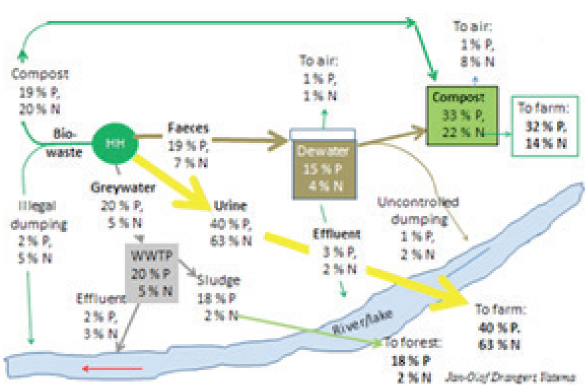

Figure 2: 2030 scenario for nutrient flows from households

The nitrogen-deficient greywater sludge contains polluting substances that may accumulate in soil. Therefore this sludge is only applied on trees, after a treatment that removes the available organics to avoid clogging of soil pores. The urine can safely be applied on agricultural soil (WHO, 2006), and it represents the least polluted fertiliser available on the market, and has a well-balanced nutrient composition (Jönsson et al. 2004). The nutrient loss from well-managed urine is insignificant (Vinnerås et al. 2006). Likewise, the organic compost is likely to be of good quality and possible to apply on soil for food production. The short nutrient loop when using urine and composted organic matter in the garden is sustainable, whereas sludge from treated mixed wastewater is more risky and difficult to monitor. With these changes in the system, productive use of the P originating from households increases from 19% to 90%, while N increases from 6% to 79%. This drastic reduction in wastage also means that water bodies are saved from nutrient pollution and eutrophication. It is equally important to note that these recycled nutrients can replace a significant part of the purchased chemical fertilisers, as indicated below.

Jönsson et al. (2012) calculated the theoretical economic value of four nutrients in two systems for Sweden: for all toilet water (black water) and for all municipal mixed wastewater sludge (Figure 3). The annual values are expressed as the value of the chemical fertilisers that could be replaced by recycled nutrients. Somewhat more P could be extracted from sludge than from toilet water, given a removal rate of 100% in the wastewater treatment plant. This is because wastewater contains not only the toilet water but also detergents and food scraps that contain P. However, the P in the toilet water is more accessible for plants than the P in sewage sludge.

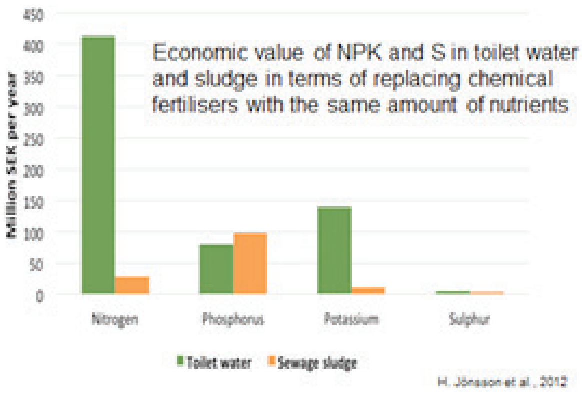

Figure 3: Economic value of plant nutrients in toilet water and sewage sludge from Swedish households

A striking feature in Figure 3 is that the economic value of potassium (K), and more so of nitrogen, is very high in toilet water compared to sludge. This reflects the fact that nitrogen disappears to air on its way from the toilet to sludge in the treatment plant. This loss of nitrogen has to be replaced by the very energy-intensive production of nitrogen from ammonia and hydrogen. Also, dissolved K is not captured in the treatment plant and is therefore not found in the sludge. The total amount of N, P, and K from toilets is equivalent to 20%, 50%, and 55%, respectively, of the amounts of these nutrients in chemical fertilisers sold in Sweden in the broken financial year 2009/2010.

In addition to the economic benefit from recycling, CO_2 emissions would be reduced in Sweden if chemical fertilisers were replaced by recycled nutrients from toilet water and sewage sludge. Jönsson et al. (2012) estimate the reduction to 203,500 and 17,000 tons per year of CO_2 equivalents for toilet water and sludge respectively. Again, the nitrogen in the toilet water dominates with 196,500 tons.

Food security in urban areas

Over the past century, food production has shifted from cities to rural areas. The idea that food should not be produced in towns has long been a feature of urban identity. However, it has often been challenged during periods of societal stress, such as war and economic depression. Data gathered in the 1980s revealed the surprising fact that urban agriculture was strong in many capitals of the world (Smit et al. 1996). Lusaka, Dar es Salaam, Moscow, and other cities produced almost half of its their consumed food within the city limits. 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.

Still, a good deal of urban agriculture is practised in low-income countries for both personal consumption and for sale. Reuse and recycling of urban organic waste can be beneficial for local food production by both newly arrived urbanites and established land-owning farmers keeping some of their peri-urban holding for urban agriculture. Komakech et al. (2013) showed that in some cities like Kampala in Uganda, animal husbandry is also common in peri-urban areas. City dwellers that farm want to strengthen the family economy as well as ensure availability of food. Urban agriculture by definition occurs close to the home or market, and thus decreases the risk of losses during transport and handling of the food. Often, low-income farmers cannot afford to add mineral fertilisers, leading to a further decline in yields. Using urine from neighbours could be a cheap alternative, as it has been shown to be in West Africa (Dagerskog et al., 2008).

An example of urban agriculture is Europe's allotment movement, which started around the turn of the twentieth century, and has had a turbulent development since. Initially, it was introduced to complement workers' income by producing food, and to improve their well-being. But, between the First and Second World Wars interest in the movement faded, only to pick up again in the 1970s. And the renaissance in urban agriculture in the West is on-going. Today, urban agriculture occurs in high-income cities, for example in roof gardens and through the use of hydroponic technology. For instance, at the NYC Food and Climate Summit in 2009, an estimate was presented that New York City has 52,000 acres of backyard space that collectively could provide vegetables for 700,000 people (Stringer, 2010). Today, there are also claims that urban agriculture can produce better quality food. Home-grown vegetables, berries and fruits have a higher quality than when irrigated with often untreated wastewater downstream of the city (Drechsel et al. 2011).

A novel method to make meat production more independent of fertilizers and available land is to let earthworms or fly larvae process manure and organic waste into protein-rich animal feed (Lalander et al., 2013). This is in line with FAOs aim to increase insect-based food production in order to feed the growing global population (van Huis et al., 2013). By so doing, the land area required for waste management would also be reduced.

This chapter shows that food security is within reach, if urban areas are designed for reuse and recycling of nutrients in organic waste. Such a system creates a win-win situation by also reducing health risks for humans, and minimising polluting emissions to water bodies and greenhouse gases to the atmosphere.

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CHAPTER 3: WATER-ENERGY EFFICIENCY: A SYSTEMS PERSPECTIVE

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Using water and energy efficiently plays a vital role in water supplies and sanitation services in middle- and low-income peri-urban areas. On the one hand, provision of water and sanitation services depends on a reliable water supply of an acceptable quality, either based on centralized or decentralized systems. On the other hand, energy is required for water and sanitation services, for instance for treatment and delivery.

A systems perspective

In order to develop water- and energy-efficient water supply and sanitation systems, it is first of all necessary to better understand various links between water and energy from a broader systems perspective. Figure 1 is a simple representation of water and energy flows through water supply and sanitation systems, including factors that may lead to societal responses to identified problems of water supply and sanitation.

In this respect, it is crucial to use a systems perspective to develop water- and energy-efficient water supply and sanitation systems, and to take into account the core system under investigation as well as its upstream and downstream systems. It is also worth emphasizing that water is an important input factor for energy production (including for biomass energy), and vice versa. In water scarce regions, energy is particularly important for maintaining a secure water supply, for example in terms of water withdrawals and energy-intensive treatment technologies (such as desalination).

In particular, this section focuses on: 1) using a systems approach to assess the water-energy efficiency of different types of water provision and sanitation options, and 2) paying attention to links between water and in planning and decision-making processes. These two aspects could contribute to improved water supply and sanitation service provision

Energy use in water supply and sanitation systems

The biggest impact on the development of reliable water supply and sanitation systems in peri-urban areas (besides water availability in the ambient environment) is the requirement for energy. Electricity accounts for roughly 80% of municipal water processing and distribution costs (EPRI, 2000). In the United States, for example, annual electricity consumption for water supply and wastewater treatment totalled about 30 billion kWh and 7 billion kWh, respectively, at a cost of about USD 3 billion (ICF International, 2008).

In order to develop energy-efficient water supply and sanitation systems, it is necessary to know how much energy is consumed in different steps of various water and sewage treatment processes. Figure 2

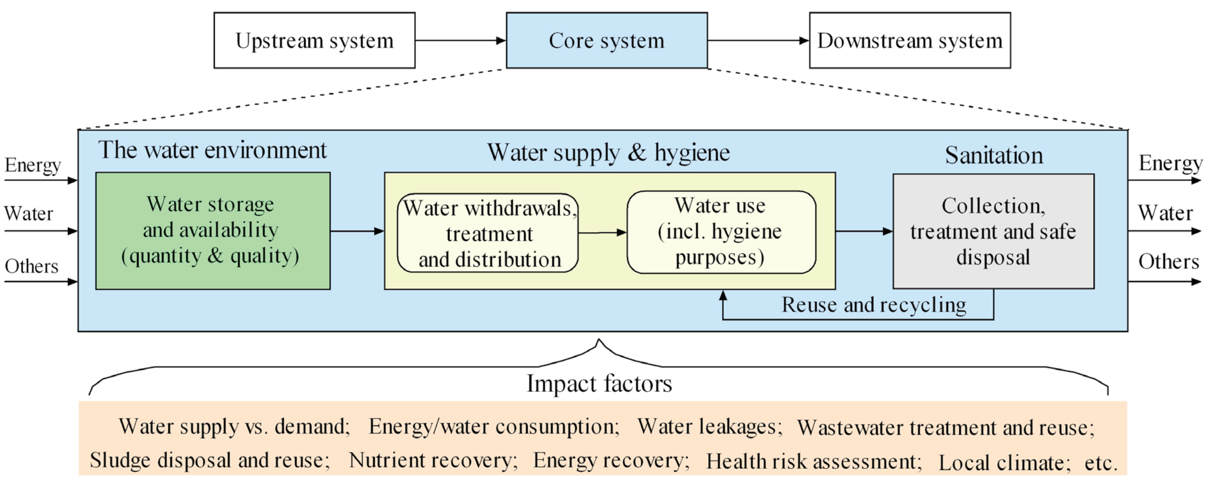

Figure 1. A simplified picture showing water & energy flows in water service and sanitation systems.

illustrates energy use in the provision of water and wastewater services.

In a typical wastewater treatment plant with the activated-sludge process, around 50–60% of total plant energy is used for aerobic treatment (Tchobanoglous et al. 2003). This is also the main reason why urine separation (which reduces the need for nitrification and de-nitrification) has been touted as a means to lower the energy demand for aerobic degradation of organic matter (Larsen and Gujer, 1996).

One way to reduce the net energy consumption per service unit is to recovery energy from different sources. Besides energy production from organic matter and recovery of embedded energy, a recent idea on energy recovery in wastewater treatment is to produce fuel (microalgae) from wastewater nutrients (Rittmann, 2013).

Water-energy efficiency and conservation

In the provision of water and sanitation services water-energy efficiency deserves proper attention from relevant technicians and managers at all levels. In order to develop more sustainable water supply and sanitation services, both supply-side and demand-side energy and water management are crucial.

At present, there are a range of innovative technologies that could contribute to improved water supply and sanitation systems. Examples of such technologies include: membrane technologies (promoting decentralized and small-scale treatment systems), source separation (improving grey water reuse at the source and nutrient recovery), anaerobic fermentation (producing biogas and recovering energy from wastewater), and natural treatment systems (minimizing energy use and promoting water reuse).

Nowadays opportunities exist for using renewable energy (like solar energy, biomass energy and wind energy) in the provision of water and sanitation services. For example, the Global Water Partnership (2012) emphasizes that membrane systems can be combined with photovoltaic systems (with a solar driven power source) and an oxidation process, which would drop the cost of membrane systems dramatically.

However, it is important to systematically assess the amount of water used to produce different forms of energy. Regarding primary energy production today, almost 90% of freshwater is used to produce biomass, which accounts for only about 10% of total energy production (World Energy Council, 2010). As for hydropower production, evaporation losses on average are around 17,000 litres per MWh (US DOE, 2006).

The water-energy nexus

In recent years there has been increasing agreement that water and energy issues are tightly linked at all levels, but these links are poorly understood and rarely used in water and energy policy-making (Waughray 2011). For practitioners involved in water and sanitation planning and decision making, one key issue is therefore to

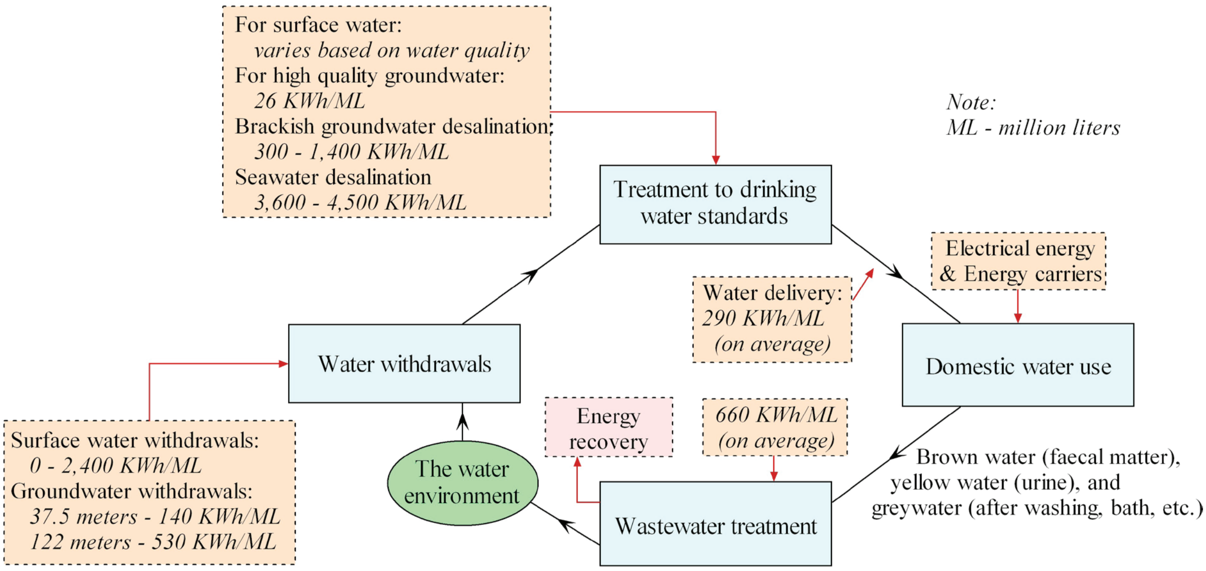

Figure 2: Demonstration of energy use in the provision of water and wastewater services (after Waughray, 2011).

develop more sustainable solutions (often location-specific) to address various problems of water supply and sanitation, taking both the direct and indirect water and energy use into account.

In order to better use scarce resources in planning and decision-making on water supply and sanitation in peri-urban areas, it is important to have a more holistic understanding of how water and energy systems interrelate in the provision of these services. Besides investigating the consumption of water and energy in water supply and sanitation technologies, both water for energy production (including hydropower and biofuels) and energy for water production have to be considered in each specific peri-urban area. Having a good understanding of various water and energy linkages could also aid in resolving peri-urban conflicts and in building multi-stakeholder platforms for effective dialogue on the provision of water and sanitation services.

Centralized versus decentralized

Currently, there is much debate on the pros and cons of centralized, semi-centralized and decentralized water supply and sanitation systems. On the one hand, decentralized (often simplified) or semi-centralized water and sewage systems with lower net water and energy consumption are regarded as a viable alternative. The traditional centralized water and sanitation systems in high-income countries, characterized as "chemical-, energy- and operational-intensive, based on heavy infrastructure systems, and requiring considerable capital and maintenance" (Institute of Medicine, 2009), may not be suitable for middle- and low-income peri-urban settings. On the other hand, Rittmann (2013) pointed out that decentralized systems actually require the same kind of investment as do large systems.

Take, for example, the case of semi-centralized water supply and treatment systems. Such systems, introduced by Bieker et al. (2010), are intended as integrated infrastructure solutions for fast growing urban areas. As demonstrated in a case study of the city of Qingdao, China, Bieker et al. (2010) concluded that the aforementioned systems have freshwater saving potentials of up to 80%, because they minimize the energy demand for water transport and energy recovery (like biogas production from brown water).

Adaptation to local conditions

It is essential to better address the interdependence of water and energy in the water-food-energy-climate nexus. In practice, it is of highest importance to realize that i) promoting water conservation and efficiency can contribute to decreasing energy consumption, and ii) that facilitating energy savings and recovery could help to alleviate water crises.

When addressing the interdependence between water and energy, the location-specific ecological, socio-cultural, economic, climatic and hydrological context has to be taken into account. There is no "one-size-fits-all" water supply and sanitation system. Although there are emerging innovative technologies, it is the local socio-economic and environmental conditions that determine the suitability of different water supply and sanitation options.

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CHAPTER 4: PROMOTING HYGIENIC BEHAVIOUR

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Hygiene is a complex issue that is linked to medical questions, like preventing the spread of contagious diseases, as well as a range of social considerations. The concept of hygiene varies from society to society; what is customary in one society could be unacceptable in another.

Learning from history

A very basic aspect of personal hygiene is hand-washing, which is very efficient in restricting the spread of germs and parasites. The Hungarian physician Ignaz Semmelweis showed in practice a radical decrease in mortality in delivery wards by introducing hand washing. His findings were rejected by the medical community and some doctors even felt offended by the idea that they should wash hands before taking on a delivery. It was only after Louis Pasteur confirmed the presence of germs as a cause of disease that Semmelweis's findings were accepted.

Globally, there are still big problems with hygiene in hospitals, and more so in daily life. In developing countries this is further accentuated by a lack of water and sanitation, which makes it impossible to adopt appropriate hygienic practices, but also by ignorance. Thus, a twofold approach is required to tackle hygiene problems – there is a need to both improve infrastructure and to confront ignorance and spread knowledge about hygiene. Good hygiene would also counteract the current overuse of antibiotics, especially common in developing countries (Blomberg 2009; Bloomfield and Scott 2013), which causes widespread resistance in bacteria leaving us with fewer tools to combat really serious infections.

An example of peri-urban hygienic conditions

Jacks (1997) documented a case from the city of Rosso in southern Mauritania, which is a model illustration of how parasitic infestations are caused by an absence of water supply and sanitation. The Senegal river that forms the border between Senegal and Mauritania is regulated by two major dams, one upstream in Mali and one close to the exit of Senegal river into the Atlantic, downstream of Rosso. The variations in water level caused by the construction of the dam caused the spread of snails that host the parasites that cause schistosomiasis (also called snail fever or bilharzia). Jacks' study showed that the parasites were far more prevalent in children from a peri-urban area without water supply or sanitation facilities compared with two other urban areas (Fig. 1). The slum dwellers had to use a bay of the River Senegal for a range of purposes, including water supply, washing and bathing (Fig. 2). It was common for people to defecate and urinate close to the shore, which closed the cycle of the parasites from humans to the snail.

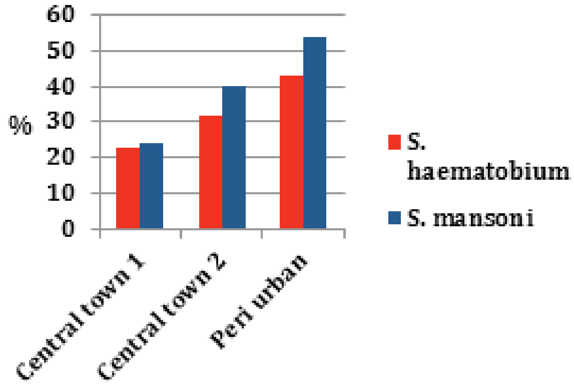

Figure 1: Prevalence of shistosomiasis in schoolchildren from central Rosso and a peri-urban area (Jacks 1997)

Figure 2: Bay of the River Senegal. The peri-urban population in Rosso, Mauritania, lacked a safe water supply, and used the bay to collect water, wash clothes, and bathe

Efficiency of hygiene improvement

There are many published assessments of how efficient different interventions are at decreasing the rate of infections in developing countries. Curtis and Cairncross (2003) reviewed 18 studies on hand washing. One measure of the efficiency

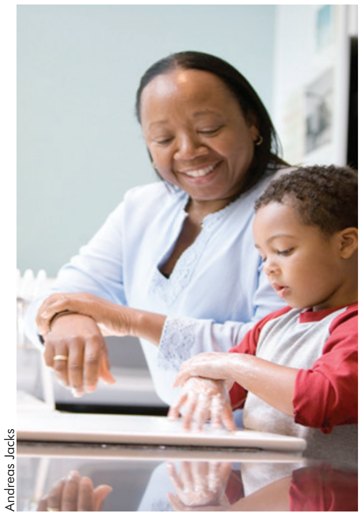

Figure 3: Teaching hand washing with soap

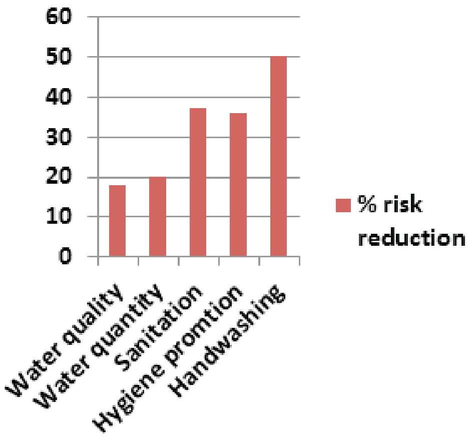

Figure 4: Reduction of risk of diarrhea under different healthcare interventions (Curtis 2003)

of interventions is the degree to which they reduce diarrhea. Another is how much it costs to save the life of a child (Larsen 2003). As Fig. 4 and Table 1 show, changes to personal hygiene practice can provide more cost effective risk reductions than solely the provision of water and sanitation.

The teaching methods used for introducing better hygiene in homes should be based on a risk assessment (Bloomfield and Scott 2013). Such assessments require in depth knowledge of the actual home environments in question. The conditions can vary in terms of the quality of water supply and sanitation, but also in terms of other environmental factors that also must be taken into account, such as the presence of standing water with its attendant risk of mosquito breeding.

An intervention aimed at introducing hand washing is often long lasting. For example, a follow up to an intervention in Pakistan showed a large difference between a reference group and a group that had been motivated to practice hand washing five years earlier (Bowen et al. 2013). Once the custom of hand washing is established it appears to become more or less automatic behaviour. A study in India (Cairncross et al. 2005) showed a clear effect even nine years after the hygiene intervention. One problem in this connection is the cost of soap, which is a considerable expense for poorer sections of the peri-urban population.

In rural India hand washing practices have been taught in schools so effectively that the children have been able to teach their parents about the importance of hygienic behaviour. Notably, an investigation in Kerala shows that information taught in health-classes on hygiene is more effective than information aimed at individual households (Cairncross et al. 2005). The same study found that the motivation for hand washing in men was channeled via women.

The marginal cost for teaching hand washing is small and the gains are remarkable. Only when good personal hygiene, in connection with, for example, food preparation and visits to the latrine, are introduced will investments in water and sanitation become fully effective.

Table 1: Cost in USD of saving the life of a child under different healthcare interventions (Larsen 2003)

	India	Sub-Saharan Africa
Provision of safe water supply	8000	1000
Provision of safe sanitation	5000	3000
Child immunization	1000	300
Female literacy	5000	3000
Hygiene improvement (high mortality case)	400	300
Hygiene improvement (low mortality case)	700	500

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CHAPTER 5: UNDERSTANDING SOCIO-ECONOMIC DRIVERS

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Providing sanitation and water supply is not just a question of building infrastructure. There are a number of social, cultural, and economic issues that impact on service delivery and the quality of people's lives, particularly in peri-urban areas.

Socio-economic aspects of water and sanitation

The socio-economic condition of households often defines the type of infrastructures available for water and sanitation and therefore, determines exposure to waterborne diseases and pathogens in human faeces (Figure 1). For example, coverage of piped water and sanitation networks is generally low in poor areas. To meet their need the poor must resort to alternatives such as water vendors and open defecation.

While water and sanitation experts promote health improvements from infrastructure interventions, the social and economic benefits are often more important drivers for many households. Social benefits of home access to clean water and sanitation include higher social status, convenience and privacy. Improved access to water can results in reduced water costs. It is estimated that poor people living in informal settlements often pay 5-10 times more per litre of water than people living in formal settlements in the same city. Other economic benefits for households include reduced health costs, fewer work days lost as a result of illnesses and time saving by direct access to facilities (Mara et al., 2010). The loss of income can be substantial and inadequate access to water and sanitation therefore contributes to poverty.

In addition, inadequate access to water and sanitation has long-term implications for national economies through higher costs for public health and improved workforce. Environmental degradation resulting from the lack of sanitation affects food supply and resources, e.g. in areas where fish is an important staple.

Gender issues

In many countries, women are responsible for providing water to the households. They also take care of sick children and relatives. The countless hours spent for these tasks represent a loss of income for households and lock women into poverty. Women also suffer from inadequate sanitation. In many countries women are not able to relieve themselves during daytime and have to wait nightfall in order to have adequate privacy. The need to go to the bush or to public latrines at night increases the risks for attacks and rape, making women more vulnerable. Providing access to water and sanitation is often seen as a means of empowering women (www.Water.org).

Impacts on children and education

Health effects associated with inadequate access to clean water and adequate sanitation touch particularly children. Diarrhoea is the second cause of mortality for children under five with around 1.5 million deaths per year. An additional 850,000 die of malnutrition related to water, sanitation and hygiene (Water.org).

Lack of access to clean water and sanitation is generally associated with low school attendance and reduced time for education. Diarrhoea and other

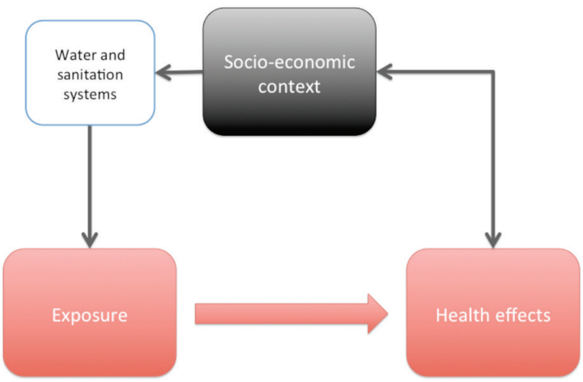

Figure 1. Representation of the links between context, exposure and health effects.

A. DiPasquale

Figure 2. Women collecting water in Mali

illnesses resulting from the lack of sanitation keep many children away from school. In addition, when children are old enough, they often spend much time supporting their family's efforts to get water.

Girls are more affected than boys by the lack of privacy at schools without toilets. Lack of sanitation prevents girls to attend school during menstruation and may cause girls to drop out when they reach puberty (WHO, 2009). Globally, about half of the girls attend schools without toilets (Water.org).

Socio-economic barriers

The importance of socio-economic factors also means that there are socio-economic barriers to the successful implementation of water and sanitation systems. The barriers are in most cases more significant for sanitation than for water.

Local establishments and traditions

Socio-economic establishments and traditions can be an important barrier to system change and can therefore affect the improvement of water and sanitation systems. In India, for instance, the handling of human excreta is the task of a caste of scavengers with an extremely low social status. This caste is based on a long hereditary tradition that enables households to get rid of their excrements, which are disposed without treatment. The task itself is considering degrading and affects the health of the scavengers. This tradition is well established in Indian society, making it difficult to improve sanitation while improving the lives of the scavengers.

Lack of investments

Sanitation is given a relatively low priority at the international and national level, resulting in relatively low investments. For households, sanitation is likely to have a low priority compared with water, food and shelter. Those willing to invest in water or sanitation often lack the funds (Paterson et al., 2007).

Lack of tenure and informality

Poor peri-urban settlements are often informal and therefore not recognised by municipalities (see Chapter 1), partially explaining the lack of investment. Lack of tenure also discourages household to invest in permanent facilities for water and sanitation.

Perception of low cost technologies

Low cost technologies are often seen as being of lower standard, making them less attractive to poor household who aspire to have a higher social status (Paterson et al., 2007).

Lock-in effects of poverty

Many of the socio-economic causes and consequences of the lack of access to clean water and sanitation are interconnected, making improvements in the conditions of poor households particularly difficult. Poor households often do not have the possibility to improve their water and sanitation conditions owing to the loss of income and time, reduced opportunities to get education, etc. caused by the lack of access to water and sanitation. Women are further locked into poverty owing to their role in water supply and the associated loss of income.

Integrated solutions address socio-economic issues

Alternative systems have been put in place to supply peri-urban areas with water, including water vendors and water trucks. However, the households often pay a relatively high price for water of dubious quality. As an alternative, small-scale, decentralised treatment facilities havte been implemented in many places, offering the advantage of requiring smaller investments, simpler to install and maintain, and in some case portable. For water supply, examples of small-scale systems include sand filters, ceramic filters and solar disinfection. Small-scale systems for sanitations include sceptic tanks, wetlands or more advanced treatment facilities.

Socio-economic drivers

The spreading of water and sanitation facilities requires the identification of relevant drivers in peri-urban contexts. Until now, the construction of water and sanitation infrastructures has mostly been motivated by health reasons, but socio-economic benefits have been identified as key drivers for households (Mara et al., 2010). Investment in clean water and sanitation contributes to economic growth with an estimated $3-34 return for each $1 invested, depending on the place and the technology (WHO, 2004). In Salvador, Brazil, the demand for sanitation has been found to be driven by health protection, accessibility, privacy and house modernisation (Santos et al., 2011).

As key drivers are identified, it is essential to support demand creation through innovative schemes to complement centralized sanitation approaches. New business models are especially needed; people-centred demand creation coupled with service providers could transform sanitation by addressing the problem of affordability, while creating new business opportunities (Mara et al., 2010). Micro-financing could provide initial funds for households to invest in sanitation (Paterson et al., 2007).

Focus on women and children

Women and children are most vulnerable to the risks associated with inadequate water supply and sanitation. Focusing on women and children can provide greater benefits. Installing toilets at school can for instance support education leading to better hygiene practices, while providing the privacy required for girls to continue going to school after puberty.

Important considerations in water and sanitation projects

Projects aimed at implementing water and sanitation systems in developing countries have in many cases been unsuccessful because facilities are not used or maintained adequately. The following points are important considerations in projects aimed at providing water and sanitation in peri-urban areas:

- Affordable technologies should be used in order to reach poor people; maintenance and running costs should be low.
- Selected technologies should be socially and culturally acceptable in the local context.
- Education should describe use and maintenance of the facilities, as well as the wider benefits of clean water and sanitation.
- Community involvement in projects can ensure acceptance and education, as well as provide a sense of ownership, thereby ensuring proper use and maintenance.

Examples of integrated projects

Access to clean water and sanitation has successfully been provided through a wide range of approaches in various contexts. The following projects provide examples of successful implementation in peri-urban areas.

A sewerage system and a decentralized wastewater treatment plant were built in Lomas del Pagador, a peri-urban area in Cochabamba, Bolivia (AguaTuya, 2012). The implementation resulted in an improvement of the quality of life for all in the target group and was particularly positive for women owing to improved safety and privacy, as well as better possibilities to manage their time.

In India, Sulahb International has enabled the implementation of two-pit, pour-flush toilets in 1.2 million households, as well as 800 public toilets with the aim of improving the lives of scavengers (Sulabh International). The implementation is based on a new model for sanitation based on the combination of technology and social idealism. The pour-flush toilets do not require excrement collection by manual scavenging; scavengers are provided with vocational training, while children in scavenger communities are provided with education. This combined effort is leading to the employment of scavengers in other activities areas and social elevation.

Sebastien Rauch

Figure 3. Decentralized wastewater treatment plant at Lomas del Pagador, Bolivia

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CHAPTER 6: INNOVATIVE PLANNING APPROACHES

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Solutions to the complex problems facing peri-urban areas require a structured planning approach that is adapted to the heterogeneous nature of these areas and the diverse needs of the inhabitants. Achieving this means using innovative planning approaches that are more inclusive, participatory, open-ended and multi-disciplinary.

WHY PLANNING?

Peri-urban areas are faced with a number of complex and interconnected development problems which make delivery of sanitation and water services very difficult (see Chapter 1). Specifically, unclear regulations, mixed settlements and rapidly changing populations make it difficult to define visions and service standards that will meet current and future needs. To overcome these challenges, the careful planning of water and sanitation provision becomes a key activity to ensure efficient and equitable implementation and delivery of services.

Planning is essentially the process of answering the following questions:

1. Where are we now?
2. Where do we want to be?
3. How do we get from here to there?

Historically, water and sanitation planning has focused on the second question and ignored the other two. The results have been wide-spread project failure and inappropriate services delivery. Improved planning processes that focus on all three questions and follow appropriate planning principles like those suggested below are more likely to be informed decisions and lead to improved service delivery.

THE PLANNING PROCESS

Planning is a structured process of evaluating the existing situation and making informed decisions for the future. Such planning includes:

- Involving and engaging relevant stakeholders
- Identifying problems and service objectives

Planning Principles

- Plans should deal with services rather than facilities. Consider the entire service chain, including activities of organizations and individuals.
- Take a wide and integrated view of water and sanitation services. Explore options for synergies with other sectors and win-win scenarios, recognizing that different options may be appropriate in different areas.
- Engage with local stakeholders in appropriate ways to ensure that outcomes are demand-driven, widely owned and based on sound knowledge about local conditions.
- Build on what exists and improve services step by step through 'securable' intermediate objectives.
- Assess services based on their impact upon conditions both locally and across the whole town.
- Ensure that services are affordable and financially viable. Consider resources needs (both human & financial) for construction, operation & maintenance.
- Ensure that the roles and responsibilities of all stakeholders within the system are clearly defined, as well as understood and committed to by all.
- Establish effective feedback loops within the planning process to assure that all of these planning principles are being met.

Adapted from (Tayler et al. 2003; IWA 2006; McConville 2008)

- Developing appropriate solutions based on reliable knowledge
- Ensuring that adequate resources are available and that these are used efficiently
- Securing effective implementation of selected solutions

HOW TO PLAN?

Beyond applying the basic principles listed above, planners will need to recognize the challenges posed by the mixture of rural and urban characteristics within peri-urban areas. While the lack of clear institutional mandates and the transitory nature of peri-urban areas often obstruct traditional (often top-down and expert-driven) planning approaches, it does not mean that planning is impossible. On-going decentralization processes are increasing governance capacity and mandates in these areas and there is growing recognition of the role of the informal sector in urban development (Tannerfeldt & Ljung 2006). However, planning processes in peri-urban areas need to be more flexible than traditional Master Planning approaches. In many ways, the lack of rules in these areas even gives planners opportunities to try innovative planning and management techniques. Accordingly, there is a growing number of planning tools and techniques available that are designed to work in peri-urban areas (see example in Box 1). Three approaches with particular potential for peri-urban areas are community participation, equity planning, and reuse-oriented planning.

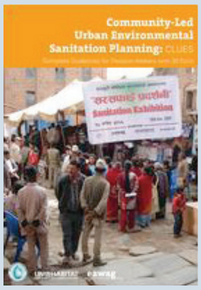
Community participation

In the water and sanitation sector, participation is often promoted as a tool for overcoming some of the major challenges linked to improved access to services, such as low demand, poor hygiene habits, weak institutional structures and low capacity for the operation and maintenance of built systems.

Planners are encouraged to use community participation as a means of gathering input to answer the first planning question: Where are we now? There is increasing evidence that community input should also be part of answering the second question regarding desired service levels: Where do we want to be? Here there can be differences between what experts and community members desire. It is important to have an open and transparent planning process that recognizes the needs of all stakeholders and clearly communicates how these needs are being addressed.

Community-Led Urban Environmental Sanitation Planning (CLUES)

These guidelines offer tools for planning for the urban poor and in un-planned urban areas. CLUES is based on a multi-sector and multi-actor framework which balances the needs of people with



those of the environment to support human dignity and a healthy life. It emphasizes the participation of all stakeholders from an early stage in the planning process and an open approach that considers a range of technology solutions. (Lüthi et al. 2011)

However, studies have found that not all forms of participation are equally influential in delivering successful urban water and sanitation services (Nance and Ortolano, 2007). There is a tendency for low participation and high degrees of expert control, especially when designing and selecting technologies (McConville, 2010). Community members and residents are rarely given true decision-making power. This may be due to a number of institutional and social factors that create inertia around planning practices, and hence hinder the up-take of new planning modes. Therefore, it is important that the purpose and extent of community engagement is clearly communicated at the beginning of the planning process to avoid power-struggles, miscommunications and undue expectations.

Equity planning

Another way to engage with communities is to specifically tailor the planning process for citizen empowerment. Equity planning sees the planning process as an opportunity to combat poverty and inequity by proposing new and better opportunities for citizens and organizations that have not been represented in traditional planning approaches (Fainstein, 2000). Diverse groups are invited to cooperate and collaborate in a negotiation process that aims to eventually satisfy all participants. While this planning style opens possibilities for improved democracy, it also upgrades the planning process by bringing in a diversity of opinions, information and ideas that can lead to better and more resilient solutions.

Resource-oriented planning

Globally, there is increasing need and interest for improving resource management. Linking resource issues to water and sanitation planning has the potential to increase stakeholder interest and increase demand for services (see Chapters 2 and 3). Innovative approaches to improved services can also be linked to creation of work opportunities. For example, producing fertilizer products from peri-urban sanitation systems can create jobs and stimulate markets through their proximity to both urban centers and agricultural areas in need of fertilizing waste.

The initial focus of resource-oriented planning must be on determining the desired end-products (fertilizers, energy, water recovery, etc.). Developing solutions then works backwards to assure that the desired outputs are achieved. This means working closely with the users of end-products but also with other related stakeholders. This approach also opens up opportunities for new management models as different actors become involved in the planning process. A focus on resources within processes of multi-stakeholder planning can generate opportunities for win-win solutions.

Jennifer McConville

CHOOSING SUSTAINABLE SOLUTIONS

The aim of the planning process is of course to find appropriate and sustainable solutions. A good planning process is helpful for structuring the decision-making process so that sound decisions are made. However, it is also helpful to have some guidelines for choosing between potential solutions.

Much work has been done on the development of 'sustainability criteria' as a means of comparing alternative sanitation and water supply systems. It is generally recognized that these criteria must cover a broad range of aspects, even beyond technical performance. A sustainable system has to be not only economically viable, socially acceptable, and technically and institutionally appropriate, it should also protect the environment and the natural resources (SuSanA, 2008).

When using criteria in evaluation it is important to remember that each technology is part of the larger sanitation and water supply system. Choices in one part of the system will affect the results of the rest of

Summary of sustainability criteria related to sanitation and water supply (McConville, 2010)

Health
Risk of infection from pathogens
Risk of exposure to hazardous substances
Environment
Environmental releases to water, air, soil
Resource consumption and conservation
Impact on biodiversity & natural systems
Economics
Affordability
Marketing
Financial Management
Technical
System robustness
Local competence for construction and O&M
Adaptability to user needs and local environment
Socio-cultural
Acceptability in current local cultural context
Institutional requirements
Laws and policy
Convenience (comfort, smell, attractiveness)
Awareness-raising
Capacity development (O&M resources/knowledge)
Process
Participation
Planning
Monitoring and Evaluation

the system. For example, installing flush toilets will affect water consumption and hence have impacts on the feasibility of different water supply systems. Therefore, a systems approach (see Chapter 3) which understands the whole chain and its interconnections is highly recommended.

Although it is useful to have a checklist of criteria for use in evaluation of options, it is important to remember that creating sustainable solutions is a process. In a study about sustainability in West Africa, local actors simply defined sustainable systems as "ones that will endure and continue to provide benefits after the initial stimulus, support, and funding have ended" (McConville et al. 2010). Local practitioners stressed the need to reinforce behavior change, develop local capacities, establish long-term financing mechanisms, and monitor results. These activities of course need to be blended with more technical evaluations of system robustness and functionality (protection of health & environment). All of these aspects can be integrated into a carefully designed and adaptable planning process.

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CHAPTER 7: STIMULATING CHANGE THROUGH GAMING

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New solutions are needed to meet the sanitation and water supply needs of peri-urban areas. Creating these solutions will mean taking a more dynamic and creative approach to planning, designing and communicating information. The SanWatPUA Network has been working with gaming as a tool.

Why a game?

Gaming is an increasingly popular way to improve decision-making and raise awareness. Games have been designed to support scientific exploration, scenario management and city planning, among other tasks. Using the format of a game helps to create an open and creative learning environment, which can stimulate problem-solving and sharing.

Learning through play

The SanWatPUA network has developed a role-playing game to support communication and problem solving in the area of sanitation and water supply in peri-urban areas. It is intended to help users to understand the complex relationships between, for example, service provision and resource use, users and organizations.

The game uses visualization and role-playing techniques. Actors "play" their way through a series of decisions and critical issues related to water and waste management in a given peri-urban area. In the process they can come to appreciate the complexity of stakeholder interactions and organizational needs. The game aims to inspire innovative institutional and technical solutions.

The game was launched at the final Sida-financed meeting of the SanWatPUA Network. Members of the network spent the afternoon playing.

The game is initially aimed at university students, but with some adaptation it could also be used in professional training of consultants, municipal officers and other practitioners.

The plan is to further develop the game as a planning tool for peri-urban areas, which can strengthen multi-stakeholder cooperation and support the exploration of innovative solutions.

Jennifer McConville

SanWatPUA

SanWatPUA is a Swedish network of experts working with Sanitation and Water Supply in Peri-Urban Areas. The network was established in 2010 and has focused on the synthesis and the communication of scientific knowledge about the provision of sanitation and water to peri-urban areas in developing countries. The network aims to support innovation in peri-urban areas through knowledge dissemination on key areas for change. SanWatPUA has applied methods and tools to synthesize knowledge that is instrumental for practitioners in the planning and problem-solving of real-life situations.

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This report is written by members of the SanWatPUA network. The different chapters highlight challenges and opportunities concerning sanitation and water supply in peri-urban areas of developing countries.

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