Sanitation: Controlling Problems at Source

Water, Sanitation and Health Theme Article

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Prepared for Water, Sanitation and Health. Written by Dr. Rosalind Stanwell Smith and reviewed by the Water and Sanitation Programme, World Bank and the Water, Sanitation and Health Unit (WSH), World Health Organization (WHO).

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Summary

- Across the world, billions of people still lack basic sanitation.

- Unless it is controlled and safely disposed of, human excreta poses a major threat to health, particularly through infectious diseases.

- Basic sanitation, such as good latrines, can protect health.

- Poorly controlled waste is also a threat to other species and the environment.

- Waste can also be a useful resource. Human excreta and wastewater are used and recycled in many countries, for example in agriculture and aquaculture, and this can be done safely.

- Careful management at source can avoid the spread of infection or a build up of pollution in rivers and other waters.
Controlling waste at source is one of the major challenges of the 21st century.

Introduction

Wherever humans gather, their waste also accumulates. Progress in sanitation and improved hygiene has greatly improved health, but many people still have no adequate means of disposing of their waste. This is a growing nuisance for heavily populated areas, carrying the risk of infectious disease, particularly to vulnerable groups such as the very young, the elderly and people suffering from diseases that lower their resistance. Poorly controlled waste also means daily exposure to an unpleasant environment. The build up of faecal contamination in rivers and other waters is not just a human risk: other species are affected, threatening the ecological balance of the environment.

The discharge of untreated wastewater and excreta into the environment affects human health by several routes:

- by polluting drinking water;
- entry into the food chain, for example via fruits, vegetables or fish and shellfish;
- bathing, recreational and other contact with contaminated waters;
- by providing breeding sites for flies and insects that spread diseases;
- poor nutrition from loss of important fish protein sources due to environmental pollution.

Used carefully, wastewater and excreta are valuable resources and increasingly important for agriculture and aquaculture, particularly in countries with insufficient water resources. Climate change, threatening water supplies in both water rich and water poor countries, has raised the issues of wastewater use worldwide. This fact sheet focuses on:

1. People and waste: the size of the problem
2. Wastewater and excreta: hazards or resources? including diseases linked to waste
3. How sanitation prevents disease
4. Sanitation Options
5. Using human waste, overcoming barriers

1. People and waste: the size of the problem

Worldwide 2.4 billion people do not have access to basic sanitation: they lack safe means of disposal of excreta and waste water (Figure 1.).
Despite continued efforts to promote sanitation, 40% of the world’s population is still without basic sanitation. This number does not tell the whole story; sanitation coverage is often much lower in rural areas than in urban areas. For example, in Africa 84% of urban but only 45% of rural residents have access to basic sanitation. The numbers are similar in Asia where 78% of urban and 31% of rural residents have access to basic sanitation (WHO, 2000). In many cases, improving sanitation can be as simple as installing a well-designed ventilated improved pit latrine (VIP) or composting latrine. However, in other cases, improving sanitation will be more challenging, particularly in rapidly growing urban slums. Moreover, while building improved sanitation facilities is a crucial health intervention, the full health benefits will not be realized without proper use and maintenance of the facilities and good personal and domestic hygiene (Carr and Strauss, 2001).

Sanitation facilities interrupt the transmission of faecal-oral disease at its most important source by preventing human faecal contamination of water and soil. Poor waste disposal practices are responsible for a significant proportion of the world’s infectious disease burden. Diseases due to poor water supply, sanitation, and personal and domestic hygiene cause 4.0% of all deaths and 5.7% of all disability or ill health in the world. This burden is not distributed equally; waterborne illnesses predominantly affect the poor and the young. However, when basic water, sanitation, and hygiene
interventions are applied, waterborne illnesses can be effectively reduced. Low cost
interventions such as composting latrines can be used to reduce the transmission of
many diseases.

Municipal sewage is a mixture of human excreta and household wastewater that is
transported via pipes to a treatment or disposal point. In many areas, municipal
sewage is often mixed with industrial waste. Sewerage systems are common in
industrialised countries and often occur in urban areas of less-industrialised countries.
In some regions very little wastewater receives treatment before it is discharged into
the environment. In Africa, virtually no wastewater receives treatment before it is
discharged. In other regions, rates of treatment are not much better, for example, in
the Latin America and Caribbean Region only 14% of wastewater is treated, while in
Asia approximately 35% of wastewater is treated before it is disposed of in the
environment (WHO 2000b). Problems in waste disposal are not confined to less-
industrialised countries. Industrialized countries also need to improve their sewage,
excreta, and sludge management practices. In North America 10% and in Europe 34%
of wastewater is not treated before it is discharged into the environment (WHO,
2000b). In the United States of America, the number of detected waterborne disease
outbreaks and the number of affected individuals per outbreak has increased since
1940 (Hunter, 1997). Similarly, water quality monitoring of major European rivers
indicates that average coliform levels - the organism present in human, animal and
bird excreta - have been steadily increasing for decades (Meybeck et al. 1990).

Currently, water-borne sanitation systems typically use 50 to 100 litres of water to
remove 1-1.5 litres of human excreta per person per day (Jönsson, 1997; Van der
Ryn, 1995). Moreover, most of this water is used to remove urine (urine makes up
90% of the volume of excreta) which poses little threat to human health (Esrey,
2000). In this type of system, a small amount of faeces then contaminates a large
amount of water and nutrients that could be useful locally are washed away into other
areas (or removed at great expense in a treatment system) where they concentrate.
High levels of nutrients cause environmental damage and exacerbate the growth of
potentially toxin-producing algae. Clearly, sustainable sanitation alternatives are
needed.

**Toilets and latrines: a basic right and an essential way of controlling
sanitation problems at source**

In examining the larger issues of waste disposal, we should not forget the role played
by the humble latrine. Far more people lack access to a properly managed toilet or
latrine, than to water (figure 1). In a recent survey in Uganda, only a third of schools
had adequate sanitation and separate toilets for girls (Box 1). In another study in
Ecuador, latrines designed for use by 30 to 40 pupils, in reality served as many as 180
(WHO, 1994). A lack of separate sanitation facilities for girls has been cited as a prime
cause of girls leaving school before finishing their studies (WHO, 1997b).

**Box 1: Sharing toilets in Uganda**

A recent survey by the Ministry of Health in Uganda suggested that there is only one
toilet for every 700 Ugandan pupils, compared to one for every 328 pupils in 1995. Out
of 8000 schools surveyed, only 33% of the 8000 schools sampled have separate
latrines for girls. The deterioration in sanitary conditions was attributed to increased
enrolment in schools. UNICEF surveyed 90 primary schools in crisis-affected districts of north and west Uganda: only 2% had adequate latrine facilities (IRIN, 1999).

2. Wastewater and Excreta: Hazards or Resources?

Wastewater and excreta consist of water, micro-organisms (including human pathogens), and organic and inorganic substances including nutrients. The microbial pathogens (bacteria, helminths, protozoa, and viruses), heavy metals (in municipal and industrial wastewater), nutrients, and organic compounds contained in wastewater and excreta pose a potential threat to human health and the environment.

Wastewater and excreta also contain valuable nutrients that can be used to fertilize crops and fish ponds. Most of the nutrients a person consumes end up in the excreta. Therefore, the excreta from one person over the course of a year will contain nearly enough nutrients to grow the amount of grain (250 kg) required by that person to meet their nutritional needs (Drangert, 2000). Moreover, most of the nutrients (88% of the nitrogen, 67% of the phosphorus, and 71% of the potassium) in excreta are found in the urine. Urine, generally, poses much less health risk than faecal material because it rarely contains pathogens and thus can be used as a fertilizer after minimal treatment. Faecal material can also be safely used as a fertilizer after it has been composted or stored suitably to kill intestinal worm eggs and other pathogens that might be present.

Wastewater contains large amounts of water that can be used for irrigation. It is likely that wastewater use will increase in the future due to the scarcity of fresh water in many areas. Some estimates suggest 35% of the world’s population will live in areas with chronic water shortages by 2025 (Hinrichsen et al., 1998). Because irrigation is the single largest use of freshwater worldwide (Abramovitz, 1996), using treated wastewater for irrigation may allow high quality freshwater resources to be reserved exclusively for supplying drinking water. In this era of growing water scarcity, sanitation technologies will not only be required to protect public health but they will also need to promote water conservation and reuse. Using these resources in a controlled fashion also helps to reduce the environmental degradation that occurs as a result of inappropriate waste management practices.

People and waste: the infection burden

Human excreta have been implicated in the transmission of many infectious diseases including cholera, typhoid, infectious hepatitis, polio, cryptosporidiosis, and ascariasis. WHO estimates that 2.1 million people die annually from diarrhoeal diseases and that 10% of the population of the less-industrialised world suffer from parasitic worm infections related to improper waste and excreta management (WHO, 2001; WHO, 2000; WHO, 2000b). Nearly two million of these deaths are in children of less-industrialised countries (WHO, 1999). (Box 2).

Poor sanitation, hygiene and inadequate water supply are also related to the spread of other diseases, including tropical diseases such as schistosomiasis. Among human parasitic diseases, schistosomiasis (sometimes called bilharziasis) ranks second behind malaria in terms of socio-economic and public health importance in tropical and subtropical areas. The disease is endemic in 74 developing countries, infecting more
than 200 million people. Of these, 20 million suffer severe consequences from the disease.

Trematode infections are caused by parasitic flatworms (also known as flukes) that infect humans and animals. Infected individuals transmit trematode larvae in their faeces. In many areas of Asia where trematode infections are endemic, untreated or partially treated excreta and nightsoil are directly added to ponds, rivers, or lakes. The trematodes complete their lifecycles in intermediate hosts and subsequently infect fish, shellfish, or encyst on aquatic plants. Humans become infected when they consume the fish, shellfish, or plants raw or partially cooked. WHO estimates that more than 40 million people throughout the world are infected with trematodes and that over 10% of the global population is at risk of trematode infection (WHO, 1995).

Box 2: Sanitation and diarrhoeal disease

Gwatkin and Guillot (1999) have claimed that diarrhoea accounts for 11% of all deaths in the poorest 20% of all countries. This toll could be reduced by key measures: better sanitation to reduce the cause of water linked diarrhoea; and more widespread use of oral rehydration therapy (ORT) to treat its effects. Improving water supplies, sanitation facilities and hygiene practices reduces diarrhoea incidence by 26%. Even more impressive, deaths due to diarrhoea are reduced by 65% with these same improvements (Esrey et al., 1991). Of the 2.2 million people that die from diarrhoea each year, many of those deaths are caused by one bacteria - Shigella. Simple hand washing with soap and water reduces Shigella and other diarrhoea transmission by 35% (Kotloff et al., 1999; Khan, 1982). ORT is effective in reducing deaths due to diarrhoea but does not prevent it.

Poor sanitation gives many infections the ideal opportunity to spread: plenty of waste and excreta for the flies to breed on, and unsafe water to drink, wash with or swim in.

The role of poor sanitation in trachoma

Infection with trachoma is the leading global cause of preventable blindness: trachoma is closely linked to poor sanitation and is one of the best examples of an infection readily preventable through basic hygiene.

Six million people worldwide are permanently blind due to Trachoma, another 146 million people with the disease are threatened by blindness.

Trachoma is spread by a combination of:

• poor sanitation, allowing the flies that spread the infection to breed;

• poor hygiene associated with water scarcity and poor water quality;

• lack of education and understanding of how easily the infection can spread in the home and between people.

A review of the evidence from several studies (Prüss & Mariotti 2000) suggests that improving personal, domestic and community hygiene would provide a sustainable
reduction in the spread of trachoma. Antibiotic treatment of active cases would also reduce the risk of person-to-person spread. The WHO Global Alliance for the Elimination of Trachoma by 2020 has adopted a strategy called ‘SAFE’ (Surgery, Antibiotics, Facial cleanliness and Environmental changes). Addressing water scarcity, hygiene practices and poor sanitation are essential parts in this strategy for the sustainable reduction and elimination of this disease.

People and waste: the toxic burden

Infectious agents are not the only health concerns associated with wastewater and excreta. Heavy metals, toxic organic and inorganic substances also can pose serious threats to human health and the environment - particularly when industrial wastes are added to the waste stream. For example, in some parts of China, irrigation for many years with wastewater heavily contaminated with industrial waste, is reported to have produced health damage, including enlargement of the liver, cancers and raised rates of congenital malformation rates, compared to areas where wastewater was not used for irrigation (Yuan, 1993).

Nitrates from waste water can build up to high concentrations in water sources underground. This is associated with methaemoglobinaemia (blue baby syndrome) when contaminated water is used to prepare infant feeds. Nutrients may also cause eutrophication - undesirable excess in nutrients - in water sources. This can result in overgrowth of algae and harmful cyanobacteria. The toxins produced by some toxic cyanobacteria cause a range of health effects, from skin irritation to liver damage.

3. How does sanitation prevent disease?

For a sanitation system to provide the greatest health protection to the individual, the community, and society at large it must:

• Isolate the user from their own excreta;

• Prevent nuisance animals (e.g. flies) from contacting the excreta and subsequently transmitting disease to humans; and

• Inactivate the pathogens before they enter the environment or prevent the excreta from entering the environment.

It is important to understand that sanitation can act at different levels, protecting the household, the community and 'society'. In the case of latrines it is easy to see that this sanitation system acts at a household level. However, poor design or inappropriate location may lead to migration of waste matter and contamination of local water supplies putting the community at risk. In terms of waterborne sewage the containment may be effective for the individual and possibly also the community, but health effects and environmental damage may be seen far downstream of the original source, hence affecting 'society' (Carr and Strauss, 2001).

4. What are the options for control of excreta?

For practical purposes sanitation can be divided into on-site and off-site technologies. On-site systems (e.g. latrines), store and/or treat excreta at the point of generation.
In off-site systems (e.g. sewerage) excreta is transported to another location for treatment, disposal or use. Some on-site systems, particularly in densely populated regions or with permanent structures, will have off-site treatment components as well.

**On-site disposal**

In many places, particularly in areas with low population densities, it is common to store and treat wastes where they are produced - on-site. There are a number of technical options for on-site waste management which if designed, constructed, operated and maintained correctly will provide adequate service and health benefits when combined with good hygiene. On-site systems include: ventilated improved pit (VIP) latrines, double vault composting latrines, pour-flush toilets, and septic tanks. Dry sanitation or eco-sanitation is an onsite disposal method that requires the separation of urine and faeces (box 3). Building and operating these systems is often much less expensive than off-site alternatives. Some on-site systems (e.g. septic tanks or latrines in densely packed urban areas) require sludge to be pumped out and treated off-site. Composting latrines allow waste to be used as a fertilizer after it has been stored under suitable conditions to kill worm eggs and other pathogens.

**Box 3: Eco-sanitation**

Dry sanitation or ecosanitation as it is called, can provide viable alternatives to water-borne sewerage in some areas. Dry sanitation approaches usually require the separation of urine and faeces. Urine which generally poses little threat to human health, also contains most of the nutrients (88% of the nitrogen, 67% of the phosphorus, and 71% of the potassium) (Wolfgang, 1993; Swedish Environmental Protection Agency, 1995). Separation of urine allows it to be used safely as a fertiliser after minimal treatment. Similarly, faeces which contains most of the pathogens, also can be safely used as a fertiliser after storage at ambient temperatures for two years or composting at high-temperatures for six months (WHO, 1996; Mara and Cairncross, 1989). Several types of dry-sanitation systems have been used in China, central America, Sweden and elsewhere.

**Off-site disposal**

In more densely packed areas sewerage systems are frequently used to transport wastes off-site where they can be treated and disposed. Conventional centralized sewerage systems require an elaborate infrastructure and large amounts of water to carry the wastes away. This type of approach may work well in some circumstances but is impractical for many other locations. The cost of a sewerage system (which can be as much as 70 times more expensive than on-site alternatives (Carr and Strauss, 2001)) and its requirement of a piped water supply preclude its adoption in the many communities in less-industrialised countries that lack adequate sanitation (Franceys, Pickford, & Reed, 1992). In specific circumstances, cost-effective alternatives to conventional sewerage systems have been developed including small diameter gravity sewers, vacuum and pressure sewers. Simplified sewer systems have been successfully used in Brazil, Ghana and other countries.

**Wastewater and Excreta Treatment**
Waste needs to be treated to remove or inactivate pathogens before it can be safely reused or disposed of safely. Many on-site waste disposal methods treat excreta by storing it for enough time to kill the pathogens. Most off-site strategies (and some on-site systems) require wastes to be treated at a facility before it can be safely used or released into the environment. In industrialised countries, one approach has been to use mechanical and biological processes (primary and secondary treatment) to remove suspended solids, biological oxygen demanding substances (BOD) and other pollutants. Pathogens and nutrients are typically only minimally removed in these processes. The problem is that these conventional or mechanical processes are expensive to operate: they require energy, skilled labour, infrastructure, and maintenance. To further reduce the pathogens and nutrients requires additional processes, which pushes up the cost still further. In efforts to reduce the cost and complexity of waste treatment, experiments have been conducted with smaller decentralised treatment units. For example in Durban, South Africa local sewerage networks have been connected to small treatment plants (baffled aerobic reactors) to cost-effectively treat more waste. In other areas where offsite treatment is required, and land is available at low cost, waste stabilization ponds have proven to be cost effective methods for treating wastewater (Box 4).

**Box 4: Waste stabilization ponds**

In warm climates where land is available at low cost, waste stabilization ponds (WSP) are an excellent method for treating wastewater. When designed properly, WSP are more effective at removing pathogens - particularly intestinal worm eggs, than most conventional secondary treatments. Moreover, WSP remove pathogens without the addition of chemicals such as chlorine, are simple to operate and maintain, and promote the use of the water and nutrient resources in the wastewater.

The pathogen removal ability of WSP has been well documented. For example, the use of inadequately treated wastewater in irrigation is especially associated with elevated prevalence of intestinal worm infection. In one area studied in Mexico, irrigation with untreated or partially treated wastewater was responsible for 80% of all intestinal worm infections and 30% of diarrhoeal disease in farm workers and their families. However, when wastewater was retained longer in a series of retention ponds there was minimal risk of either intestinal worm infection or diarrhoeal disease (Cifuentes et al., 2000).

**5. What are the barriers to control at source?**

Why does 40% of the world’s population still have no basic sanitation? Many people do not realize the health benefits to the individual, the community and to society from improving sanitation. The high cost of improving sanitation is often cited as a barrier to implementing sanitation projects. However, to decrease the proportion of people lacking basic sanitation and water supply by 50% worldwide by the year 2015, it is estimated that US$ 23 billion per year would be needed - about US$ 7 billion a year more than is currently spent (WHO, 2000; WHO, 2001b). On a global basis this is truly a small sum of money. Improving sanitation is often low on the list of priorities. There are so many other pressing needs for the attention of governments: food supply, education, medical treatment and dealing with war and conflict. Most people are aware that poor sanitation has a health impact, but there is a lack of awareness of the extent of ill-health that it causes.
Empowering people

There needs to be a political will for - and in investment in - sanitation, and those in need of such services need to exert sufficient pressure to bring about change. WHO’s strategy for improving access to sanitation focuses on targeting the highest risk communities. Success depends on:

• identification of the communities at highest risk from diseases related to insanitary conditions;

• giving higher priority to sanitation in national planning for health and investment in infrastructure;

• community involvement in planning, implementing and maintaining the services;

• the development of sanitation technologies suitable for difficult geographical and residential conditions;

• taking into account cultural beliefs and habits;

• sanitation should be integrated with other aspects of development, e.g., hygiene promotion, child survival, maternal and child health, essential drugs, and agricultural development;

• allowing for long-term ecological and financial sustainability.

The question of who pays for improvements often arises. The set up costs have to be considered: but public investment would lead to substantial returns in the form of better health for these communities, and the associated economic benefits for the community and nation as a whole. To offset costs and ensure greater sustainability of sanitation systems, considerable community involvement and self-help are needed (WHO, 1997).

The cultural factor: throwaway societies versus ‘waste-not-want-not’ societies

People have evolved different ways of thinking and behaving about waste: this affects behavior and also affects the way messages about health effects or sensible re-use will be received. Human society has developed very different sociocultural responses to the use of untreated excreta. This ranges from deep disgust to practical preference. While determined partly by survival economics, these cultural differences apply to many water poor countries, as well as to water rich areas of the north. For example, in Africa, the Americas and Europe, excreta use is generally regarded as culturally unacceptable, or at best with indifference. This results from the strongly held view that human excreta, especially faeces, are repugnant substances best kept away from the senses of sight and smell. Products fertilized with raw excreta are regarded as tainted or defiled in some way. These views are less rigid in the case of using excreta in compost and sludge for agriculture, but still pose a barrier to use of waste.

In contrast, both human and animal wastes have been used as fertilizers in agriculture and aquaculture in, for example, China, Japan, and Indonesia for thousands of years.
Some countries such as China, India and Japan have used wastewater and excreta for irrigation for over 100 years. In China over 1.3 million hectares are irrigated with wastewater. This practice reflects the high social importance of frugality: a waste not, want not approach. It also relates to a deep ecological, as well as economic, appreciation of the way soil fertility and enrichment with waste are related. In such societies intensive cultivation practices have evolved in response to the need to feed a large number of people with only limited land available. All resources have to be carefully conserved, included excreta. This does not mean that the excreta are always used safely. There can be strong cultural barriers in changing practices to make them safer. For example, excreta are safer if stored long enough for worm (helminth) eggs to be inactivated. Introducing the use of stored rather than fresh excreta is likely to be culturally acceptable: but persuading people not to eat raw fish from contaminated waters is much more difficult. In some cultures, consumption of raw fish is a major element of the diet and it may be hard to persuade them that raw fish pose an increasing hazard, because of rising pollution of marine and freshwaters (Mara and Cairncross, 1989).

Waste as a resource

Reducing the adverse health effects associated with inadequate management of wastewater, sludge and excreta is possible but takes sustained effort at the individual, community and national levels. Additionally more emphasis must be placed on finding sustainable approaches for reducing health hazards associated with wastewater, sludge and excreta, and at the same time, closing the nutrient cycle from waste to agriculture and aquaculture and protecting limited fresh water sources and the environment.

If waste is to be used safely then:

• Wastewater and excreta need to be treated in such a way as to reduce pathogen concentrations and facilitate the use of nutrients;

• Application of wastes should be done safely;

• Exposed workers should wear protective clothing;

• Wastewater and excreta application to crops should be restricted based on the degree of treatment it receives and the type of crop to be grown (e.g., food eaten raw, food normally cooked or industrial crops);

• Industrial wastes need to be treated separately to avoid contamination of drinking water sources and the environment by toxic chemicals.

Wastewater - and human excreta - is used in many countries and in some places this dates back thousands of years, for example in the cultivation of fish. In urban communities, use of wastewater may supplement an otherwise insufficient water supply (Table 1).

Table 1 Uses of wastewater

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<th>Type of use</th>
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Wastewater - and human excreta - is used in many countries and in some places this dates back thousands of years, for example in the cultivation of fish. In urban communities, use of wastewater may supplement an otherwise insufficient water supply (Table 1).
Coastal/river banks | Aquaculture (fish cultivation), aquifer recharge to prevent saline intrusion.
Rural communities | Irrigation, Aquaculture.
Urban | Car washes, toilet flushing, irrigation of recreational areas, and street cleaning

**Use of wastewater and excreta**

The goal of safe wastewater and excreta use is to ensure that wastewater, sludge, and excreta are managed, treated and used so that the adverse health effects are controlled and the water and nutrients can be reclaimed for beneficial use.

Treated municipal sludge has long been used by individuals and communities as a fertiliser and soil amendment. In the United States of America, some wastewater treatment facilities sell treated sludge to farmers and home owners for use as a fertiliser. This activity helps defer some of the cost of wastewater treatment. However, it is important that sludge is treated to a high degree before it is used in this manner. Most of the pathogens and toxic chemicals are concentrated in the sludge. Therefore, sludge is often composted or dried at high temperatures to kill pathogens that might be present. Care also must be taken to reduce the amount of toxic substances that might initially appear in the wastewater. This can often be accomplished by treating industrial wastewater separately from municipal wastewater.

Aquaculture, the cultivation of fish, shellfish, and aquatic plants, has been practiced for thousands of years in many different regions. Fish and plants grown in wastewater and excreta fed ponds still account for a large percentage of the world’s aquaculture production. In Calcutta India, for example, 10 - 20% of the region’s fish is supplied by a network of wastewater fed fish ponds to the east of the city. In many areas, untreated wastewater and excreta are directly used for pond fertilisation. However, this practice can have adverse human health effects. The use of untreated wastewater or excreta to fertilize fish ponds has been associated with the transmission of many diseases - particularly those caused by trematodes or flukes. Wastewater and excreta should be properly treated before they are used in aquaculture and products grown in this manner should be thoroughly cooked before they are eaten.

In many areas of the world, particularly in water scarce regions, treated wastewater has been used for numerous activities in urban settings including: irrigation of golf courses and public parks, creation of recreational lakes, street cleaning, environmental restoration, car/train washing, fire protection, and for toilet flushing. In many urban areas non-potable uses require larger amounts of water than potable uses. Using properly treated wastewater for these purposes is one way of extending water supplies. This could allow communities to protect high quality water sources, reserving them exclusively as drinking water sources.

Aquifers that supply drinking water may be used faster than they recharge. Moreover, in coastal areas saline intrusion of aquifers occurs as water is withdrawn faster than it can be naturally replaced. Increasing salinity makes water unfit for drinking and other purposes such as irrigation. In several countries where arid conditions exist and advanced wastewater treatment techniques are available, treated wastewater is used to augment ground water, creating a barrier to saline intrusion.
When treated wastewater is used to replenish ground water sources that serve as drinking water sources, important safe guards must be put in place. For example, after conventional secondary treatment, chemicals may be added to the water to help remove particles, the water may be filtered through several different types of filters, it may be processed through a membrane, and may be disinfected at several different stages of the process. Additionally, it is important to monitor the health of the exposed population through epidemiological studies to ensure that no adverse health effects occur because of this wastewater reuse practice. Highly treated wastewater has been safely used to supplement drinking water supplies in Windhoek, Namibia since 1968 (Box 5). The State of California, USA also has safely used highly treated wastewater to augment water supplies in aquifers for nearly 30 years.

Box 5: Use of treated wastewater for drinking water in Namibia

Windhoek, Namibia is located in an arid region characterized by chronic freshwater shortages. In the late 1960’s, all available freshwater sources were being used at the maximum rate to supply the city with drinking water. During prolonged droughts, the only alternative water supply the city could turn to was treated wastewater. In 1968, Windhoek became the first city in the world to directly augment its drinking water supplies with treated wastewater.

To ensure the safety of the water supply Windhoek has developed a comprehensive treatment process that relies on primary, secondary and tertiary treatments. It also includes extensive chemical, bacteriological, virological and epidemiological monitoring. Potentially toxic industrial wastewater is prevented from entering the municipal waste stream and is treated separately (Haarhoff and van der Merwe, 1995).

Since 1973, epidemiological studies of Windhoek residents have shown no adverse health effects associated with drinking reclaimed wastewater (National Research Council, 1998).

The Role of WHO

The use of waste and wastewater has to be carefully controlled to prevent risks to health. In 1989, following extensive collaborative activity with the World Bank and others, WHO with UNEP published Guidelines for the Safe Use of Wastewater and Excreta in Agriculture and Aquaculture. These guidelines outline the health basis for guideline derivation and describe the practices necessary to protect public health. Other WHO reports relevant to sanitation include the Technical Report Control of Foodborne Trematode Infections (1995) and the Technical Report Food Safety Issues Associated with Products from Aquaculture published in conjunction with the Food and Agriculture Organization of the United Nations and the Network of Aquaculture Centres in Asia - Pacific. WHO is supporting UNEPs “Global Plan of Action” for the protection of the marine environment against land-based sources of pollution through the coordination of the “Sanitation Connection” web-based resource (Box 6) as a mechanism to increase access to information on sanitation in general and sewage in particular. The WHO has also made prevention of trachoma a priority, through its worldwide campaign to eliminate the causes of preventable blindness.

Box 6: Sanitation Connection
Sanitation Connection is an internet-based resource intended to facilitate access to information on sanitation. The site brings together a number of ongoing initiatives in sanitation information management, to ensure that the best information is widely available, and brings together important institutions working in sanitation into a single wide-reaching information initiative. Sanitation Connection functions as a virtual partnership with a range of sector players taking responsibility for the provision and maintenance of state-of-the-art information on selected issues. Sanitation Connection is administered by a core group of partners and coordinated by WHO.

The core Sanitation Connection Partners include, the Water and Sanitation Program for South Asia (World Bank), the International Water Association, the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA) of the United Nations Environment Programme, the Water Supply and Sanitation Collaborative Council, and the World Health Organization.

For more information please visit Sanitation Connection at [http://www.sanicon.net](http://www.sanicon.net)

**For more information please refer to:**

For further information on WHO’s Water, Sanitation and Health Program:

http://www.who.int/water_sanitation_health

**Cyanobacteria:**


All WHO Press Releases, Fact Sheets, and Features as well as other information on this subject can be obtained on the Internet at [http://www.who.int](http://www.who.int).

**Ecosystems and sanitation:**


Swedish Environmental Protection Agency (SEPA), 1995. *Vad innehaller avlopp fran hushall?* (Content of wastewater from households). Report 4425, Stockholm, Swedish Environmental Protection Agency


**Toilets/latrines:**


**Trachoma:**


**Wastewater re-use:**


**World population and sustainable development:**


WHO reports and collaborative reports (see also under specific topics)


