Title	**Breaking the sanitation barriers; WHO Guidelines for excreta use as a baseline for environmental health.**
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Short CV for Introduction Purposes (100 words max)	**Thor Axel Stenström** is the Head of Water and Environmental Microbiology at the Swedish Institute for Infectious Disease Control, Stockholm Sweden. He is also a part-time Professor at Linköping University and a guest Professor at the Agricultural University of Norway. He has actively been involved in environmental health and risk assessment in international sanitation, is a member of the Swedish EcoSanRes group and have been involved in the drafting of “WHO Guidelines for the safe use of Excreta and Greywater”.
Photograph attached (jpg)	

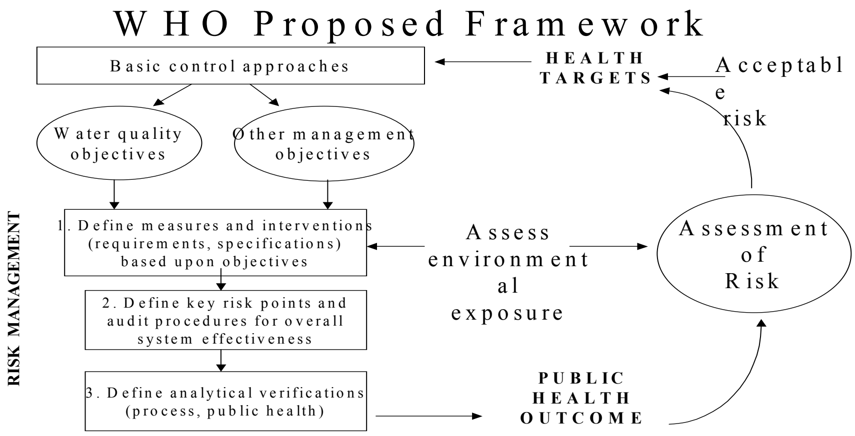
Sanitation and Health.

With the title "Hurry up in the Toilet: 2.6 Billion are Waiting" WHO introduce the perspective and anticipations for the future (WHO 2004a). In front of us, we have a massive challenge. To be able to reach the Millenium Development Goals (MDGs) within 10 years " to half the number of people without access to sustainable sanitation" would in crude figures mean to give new sanitation access to 360 000 people every day year around. One of the driving factors is the foreseeable health benefit. Diseases related to unsafe water, poor sanitation and lack of hygiene are among the most common causes of illness and death especially among the poor in developing countries. WHO estimates that 1.6 million people every year dies due to these health determinants (WHO. *Water, sanitation and health*. (online). http://www.who.int/water_sanitation_health/diseases/en/ (accessed April 2005). This equals about 4400 people per day out of which 3900 are estimated to be children. In addition many more becomes ill. According to the estimation made by Prüss et al (2002) the total impact on health amounts to nearly 68 000 000 DALY (Disability Adjusted Life Years) per year. This also largely impacts the burden on the health system as well as costs. More than half the hospital beds in the world are occupied by people with diseases related to inadequate water supply and sanitation (Bartram et al, 2005). Furthermore, based on cost-benefit analysis, if the goal for water and sanitation were met, equals saved costs of US Dollars 7.3 billion per year. The improvement in sanitation, hygiene and water thus, in addition to gained health benefits, generate savings both on the household level and the national budgets.

The Stockholm Framework – A base for Guidelines.

Following a major expert meeting in Stockholm Sweden, WHO published the book *Water Quality: Guidelines, Standards for Health; Assessment of Risk and Risk Management for Water-related Infectious Disease* (Fewtrell and Bartram, 2001). This created a harmonized framework for the development of health-based guidelines and standards in terms of water- and sanition related microbiological hazards. The Stockholm Framework involves the assessment of health risks prior to the setting of health targets and the development of guideline values, defining basic control approaches, and evaluating the impact of these combined approaches on public health (Figure 1). The framework allows countries to adjust guidelines to local social, cultural, economic and environmental circumstances and compare the associated health risks with risks that may result from microbial exposures through excreta and wastewater use, drinking water and recreational/occupational water contact. This approach requires that diseases be managed from an integrated health perspective and not in isolation. WHO water- and sanitation related guidelines are now developed in accordance with the principles of the Stockholm Framework.

Within the framework an "acceptable risk level" is defined and combined with health targets. These targets are partly generic and partly adaptable to the local conditions. The health targets in turn relates to "basic control approaches" defined in relation to quality criteria and management objectives. The "quality criteria" in turn is linked with the product to be used and in relation to the reuse of excreta, greywater (or wastewater) links to the "barrier function" of different treatment steps and potential exposure which in turn is linked with the assessment of risk. By this, and as part of a "Management Procedure" the linkages is also to control procedures, that does not necessarily needs to be based on Guideline or control values, but rather in the assessment of functionality and capacity to minimise exposure. This in turn will define the risk for the population "The Public Health Outcome", which in turn can be assessed and related to health targets. WHO is now in the progress of finalising the drafting of a set of three Guideline volumes related to the safe use of wastewater, excreta and greywater in different settings. These currently have the working titles "WHO Guidelines for the Safe Use of Wastewater in Agriculture; WHO Guidelines for the Safe Use of Excreta and



Greywater and WHO Guidelines for the Safe Use of Excreta and Wastewater in Aqualculture. As for the already published WHO Guidelines for recreational water (WHO, 2003) and Drinking water (WHO, 2004b) the concept of risk assessment, is an integrated part of the forthcoming Guidelines.

Exposure and barrier functions.

Untreated wastewater from piped supplies is currently released in water bodies to a high extent. Currently the median percentage of wastewater produced that is considered treated, range from close to zero on the African continent (regional differences) to between 70-90 % in the European and North American regions. Asia and Latin America are in between. Wastewater is also in certain regions extensively used for irrigation of food crops. In a compilation by PAHO (M Pardon pers comm.) more than 900 000 ha of arable land in Colombia are estimated to be irrigated with untreated wastewater. Both treated and untreated wastewater is used extensively on arable land (the focus of the WHO Guidelines for the safe use of wastewater in agriculture). Untreated wastewater as well as untreated excreta poses a direct treat to human health. Ottoson (2005) summarized the occurrence of some pathogens found in ´mainly European wastewaters (Tab 1).

Table 1. Reported number of pathogens in wastewater [L^{-1}]

Pathogen	Range	Country
Bacteria		
Salmonella spp.	930 – 110,000	Finland
	8,900 – 290,000*	Germany
Campylobacter spp.	500 – $4.4 \cdot 10^6$	Germany
	16,300	Italy
Enteric viruses		
Enteroviruses	100 – 10,000	Italy
Rotavirus	< 1 – 10,000	Netherlands
Norovirus	< 1,000 – $1,6 \cdot 10^6$	Germany
Adenovirus	250 – 250,000	Spain
Protozoa		
Giardia cysts	1,100 – 52,000	Scotland
	100 – 9,200	Canada
Cryptosporidium oocysts	< 20 - 400	Scotland
	1 – 560	Canada

- Slaughterhouse wastewater

The levels and ranges of pathogens are generally higher in developing countries. Their occurrence is a function of the disease prevalence in the connected population. A re-concentration occurs in the sludge. In surface water a dilution will occur, but many organisms have the ability to survive for extended periods. Their persistence can be expressed as a decimal (one log) reduction in days. An example of their survival in surface water is given in Table 2 (from Westrell, 2004).

Table 2. Die-off of pathogens in fresh water expressed as days for 90% reduction, T_{90}.

Organism	T_{90}
EHEC	7-19
Salmonella	same as for EHEC
Rotavirus	5-16
Adenovirus	21-29
Giardia	23-30
Cryptosporidium	40-100

Based on these examples it is clear that treatment is needed to safeguard human health. If we assume that 1 billion more people will use waterborne flush systems, around 30 - 50 million m^3 water will be needed per year, just for flushing. A further expansion of water use especially in water scare areas will hardly be sustainable. Secondary wastewater treatment will, when functioning, reduce different pathogen groups with about 2 logs, sometimes less for viruses. The pathogens are partly re-concentrated in the sludge, which is necessary to treat. The current sludge treatment methods in use will most often reduce the pathogen content between 0.5 – 4 logs. In the primary treatment of excreta in dry latrines a better reduction (between 4-6 logs) where achieved (Schönning and Stenström, 2004). A rapid die-off normally occurred in collected urine, with the potential exception of viruses. In greywater the current indicators of faecal pollution, the *E coli*, overestimated the risks with around 2 logs. These systems therefore have a potential to give a similar or higher health protection than conventional systems. Caution should however be given to parasitic helminths, like Ascaris. The current information suggests a substantial reduction of these as well, if the systems are managed in accordance with guidelines.

Targets for health in WHO Guidelines for Excreta.

The targets may be referred to from different perspectives, where health outcome targets based on epidemiological evidences may need more resources and a more developed institutional system to verify than performance targets. Hence, the later is more valid for small-scale applications. In relation to performance targets, this should not be based on a singe organism or group of indicators, like the coliforms, for its assessment but rather a range of “conservative pathogens” in relation to their persistence under adverse treatment or environmental conditions. The later ensure that the performance assessment also account for other, more vulnerable microbial groups, and should, at best cover different performance conditions. These conditions relates to the well-known variability and shorter periods of decreased efficiency in many processes. The targets should also account for background rates of disease during the normal operation. Performance assessments can be based on experimental evaluations carried out internationally and does thus not need to be extensively repeated under all local conditions. However, it will be valuable to link the treatment performance with competent national or regional competence authorities or institutions. Different types of targets as also defined in other WHO Guidelines, are briefly summarized in Table 3. The targets for the safe use of excreta and greywater are mainly based on performance as well as the further application in which exposure assessment is addressed. Application guidelines will further add to the safety of the reuse of the products.

Table 3. Nature, application and assessment of health related targets.

Type of targets	Nature of targets	Application	Assessment
Health outcome; epidemiology based	Reduction in disease incidence/prevalence	Microbial with high measurable disease burden.Direct impact or food associated	Health surveillance; An. epidemiology
Risk assessment based	Tolerable level of risk Relationsship to other local exposure or sanitation facilities	Microbial hazards. Disease burden indirect assessed	Quantitative microbial risk assessment
Quality targets	Guideline values (Ensure validity of measurement parameters.)	Measurements *less applicable* in: -Small application For urine - rapid die-off of indicators For greywater-growth overestimate risk	Measurements - assessment of technical performance. Applied as for the assessment of wastewater.
Performance targets	Generic performance-removal of organisms Customized targets. Guideline values less applicable	Microbial contaminants	Compliance through system assessment Health authorities. Checklists
Specified technology	Authorities specify specific processes to address constituents handling practises or behaviours in relation to health effects	Health effects in small scale settings	Compliance assessment Operation and handling

No Guidelines can be seen in isolation. Due to that efforts have been put on additional factors, like behavioural and social factors, institutional and legal aspects and the implementation and handling. Within the guidelines different technical approaches are exemplified in relation to treatment. Furthermore scale issues have been addressed as well as the handling chain - from producer to the field. Since one of the main issues is to, in a sustainable way, without compromising health issues, reuse the plant nutrients the additional positive health impact by enhanced nutrition is also addressed.

These Guidelines, when issued, is not the end. It should be seen as a starting point. The implementation, shortcomings and positive impact needs to be addressed. The risk assessment framework needs to be tested and implemented in different regional and institutional settings. The approach, which is partly household centered needs to be related to the Bellagio principles and revisions and updating are probably, needed as the collective knowledge in the area grow. Furthermore, comparative risk assessment is needed between excreta, wastewater and manure based fertilization systems. Furthermore, the principles needs to be integrated in educational programmes and laid down in institutional settings.

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