Ecological Sanitation and Health Aspects

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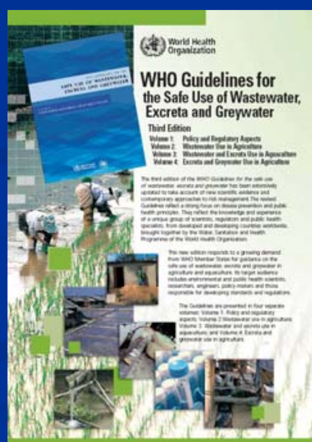
Prof Thor Axel Stenström
Senior Research Fellow, Health and Hygiene Expert
Stockholm Environment Institute (SEI), Sweden
Thor.axel.stenstrom@sei.se

WHO Guidelines for the Safe Use of Wastewater, Excreta and Greywater



Current Guidelines – Presentation

Four volumes to better reach different target audiences:

Volume 1 Policy and regulatory aspects (March 2007)

Volume 2 Wastewater use in agriculture (Sept 2006)

Volume 3 Wastewater and excreta use in aquaculture (Sept 2006)

Volume 4 Excreta and greywater use in agriculture (Sept 2006)

A 5th Volume: Sampling and laboratory aspects discussed but currently not in production

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Finding the Guidelines

http://www.who.int/water_sanitation_health/

CD-ROM 'electronic library' (from 5th edition)

Hard copy from WHO, bookshops

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WHO Guidelines on water

- Protection of human health
- Advisory to national standard setting – flexible to account local social, cultural, economic & environmental context
- Risk-benefit - adaptation to local priorities for health gain
- Best available evidence - science and practice
- Scientific consensus
- Use global information and experience

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Wastewater, Excreta and Grey Water Use - Background

Wastewater use is extensive worldwide

•10% of world's population thought to consume wastewater irrigated foods

•20 million hectares in 50 countries are irrigated with raw or partially treated wastewater

•The use of excreta (faeces, urine) is important worldwide for its fertiliser value

•The use of greywater is growing in both developed and less-developed countries – culturally more acceptable in some societies

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Wastewater, Excreta and Grey Water Use - Health Concerns

Current practises regarding discharge of excreta and wastewater unsatisfactory from a health view point

Direct Health Effects

- Disease outbreaks (developing and developed countries)
- Contribution to background disease (e.g., helminths, + others?)

Indirect Health Effects

- Impacts on the safety of drinking water, food and recreational water
- Positive impacts on household food security and nutrition

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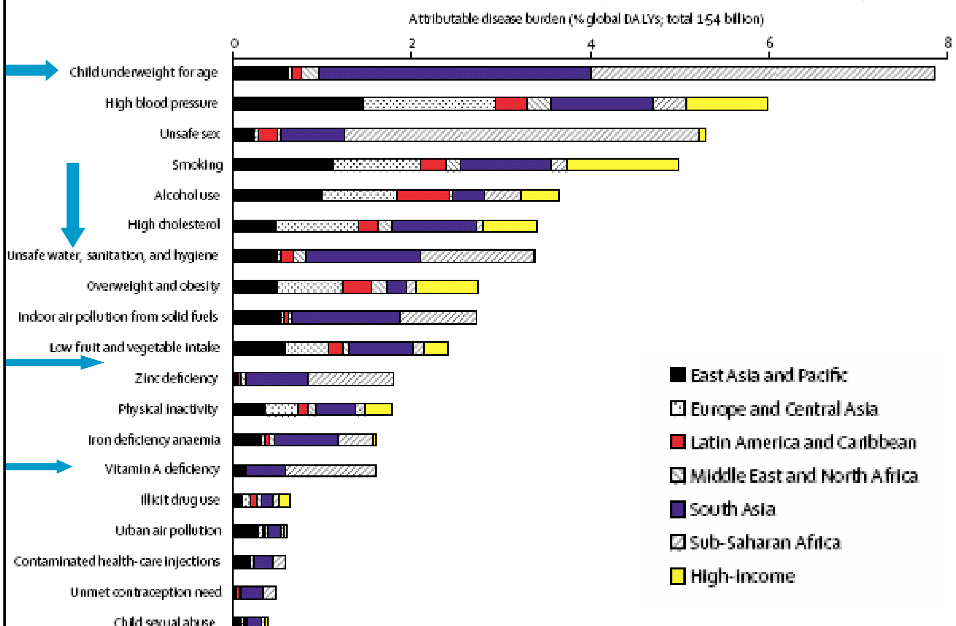
Global burden of disease (% of DALYs)



Lopez et al. 2006. Global and regional burden of disease and risk factors

Wastewater, Excreta and Grey Water Use – Lessons Learned

Overly strict standards borrowed from other countries often fail

Guidelines are not just numbers
= good practice + microbial water quality standards

Low-cost effective treatment technologies needed

Risk reduction strategies necessary (and possible) where wastes receive no or inadequate treatment

2006 WHO Guidelines for Safe Wastewater, Excreta and Grey Water Use

Objective:

Maximize the protection of human health and the beneficial use of important resources

Target Audience:

Policy makers, people who develop standards and regulations, environmental and public health scientists, educators, researchers and sanitary engineers

2006 WHO Guidelines on Wastewater, Excreta and Grey Water Use?

Guidelines provide an *integrated preventive management framework* for maximizing public health and environmental benefits of wastewater, greywater and excreta use.

Health components:

•Defines a level of health protection expressed as a health-based target;
•Identifies health protection measures **which used collectively** can achieve the specified health-based target.

Implementation components:

•Establishes monitoring and system assessment procedures;
•Defines institutional and oversight responsibilities;

Requires:

•System documentation; and
•Confirmation by independent surveillance.

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Current Guidelines – General Information

Scope:

Covers intentional use but may be relevant to unintentional uses e.g., irrigation with sewage contaminated surface waters;

Covers municipal or domestic wastes without substantial industrial inputs;

Covers faecal sludges derived from on-site sanitation facilities (traditional as well as source-separating) but does not cover sludge produced from the treatment of wastewater;

Provide detailed information only on matters related to health protection

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WHO Guidelines for the Safe Use of Wastewater, Excreta and Greywater
In Agriculture and Aquaculture – Vol I Policy and Regulatory Aspects

National policy perspectives

- poverty reduction
- food security
- protection of public health
- protection of the environment
- consumer protection
- integrated water resources management
- energy reliance

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WHO Guidelines for the Safe Use of Wastewater, Excreta and Greywater.

Key issue:

Exposure assessment
in the handling chain

Handling strategy:
Risk management;
Health targets and
Acceptable risk

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Assess the situation and exposure routes and make priorities based on health situation/incidence of disease.

How am I exposed?

A central part of a preventive assessment is the exposure and
To minimize it!

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Approaches – Evidence based or Predictive –
Based on WHO Stockholm Framework

WHO Guidelines for the Safe Use of Wastewater, Excreta and Greywater
In Agriculture and Aquaculture – Vol I Policy and Regulatory Aspects

Institutional Arrangements

How to create institutional arrangements

- map out which sectors are of relevance
- make an inventory of successful existing institutional arrangements
- assess current and potential roles of sectors in safe use of wastewater, excreta and/or greywater
- organize a national event to start the national dialogue
- prepare an intersectoral action plan with a realistic budget

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Assessments

- Assess the exposure in the full handling chain.
- Assess the human environment in light of danger to human health.
- Account for other factors that as well that may impact – not just ”one-eyed” on water or sanitation.

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Establish an evaluation system

- Which are the critical points of exposure?
- What are the barriers that may reduce the risks?
- What other operational or behaviourws may affect the risk?

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Pathogen reductions (log units) achieved by health-protection control measures

Control measure	Pathogen reduction (log units)	Notes
Excreta & urine Treatment (on-site and/or as post-treatment)	2–6	The required pathogen removal depends on the combination of the treatment and selected health-protection control measures
Crop selection and means of application	2-4	Higher risk: Root crops and crops that grow just above (lettuce) and in partial contact with the soil. Lower risk: Crops with the harvested parts not in contact with the soil.
Pathogen die-off	2-4	Die-off on crop surfaces that occurs between application and consumption. The log unit reduction achieved depends on climate (temperature, sunlight intensity), crop type, etc. With-holding time essential in risk reduction
Produce washing with water	1	Washing salad crops, vegetables and fruit with clean water.
Produce peeling	2	Fruit, root crops.
Produce cooking	5–6	Immersion in boiling or close-to-boiling water until the food is cooked ensures pathogen destruction.

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Treatment option or process	Helminth egg log reduction	Duration months
Low-cost		
Faecal sludge settling ponds	3	4
Faecal sludge reed drying beds (constructed wetlands)	1.5	12
Drying beds for dewatering (pretreatment)	0.5	0.3–0.6
Drying beds for drying	2.0–3.0	1
Composting (windrow thermophilic)	1.5–2.0	3
pH elevation >9	3	6
Anaerobic (mesophilic)	0.5	0.5–1.0
High-cost		
pH elevation >12	3	
Thermophilic, in-vessel (aerobic/anaerobic)	3	1–5 days

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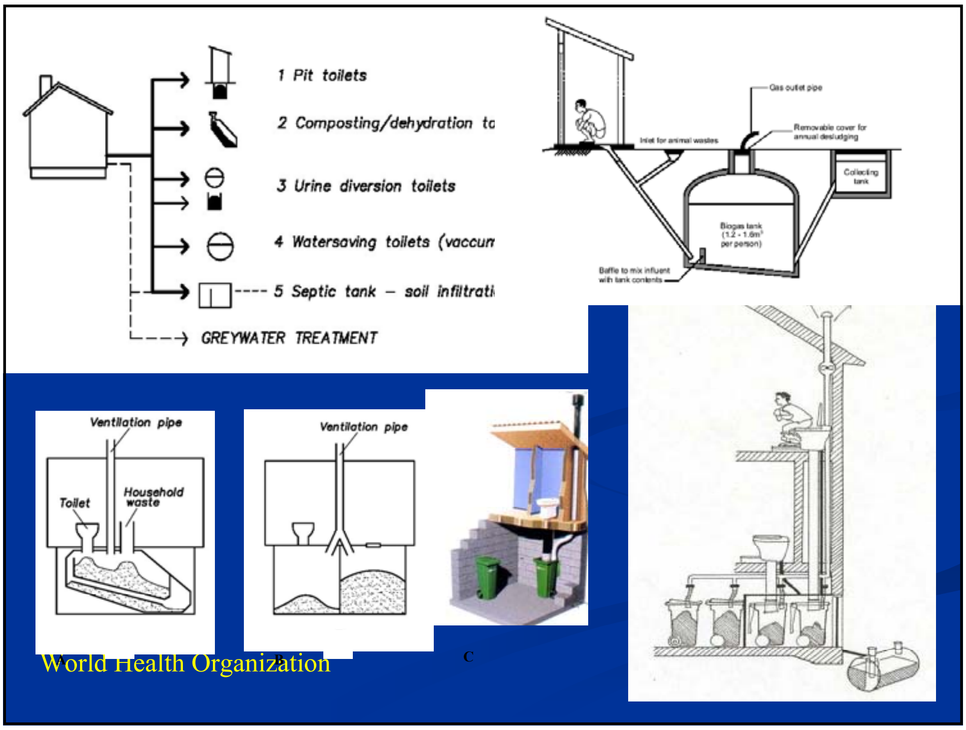

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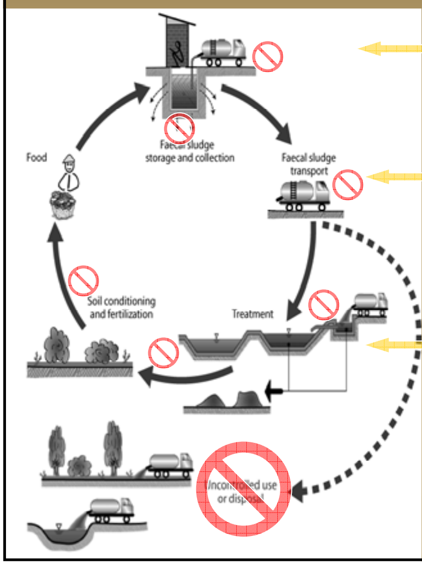
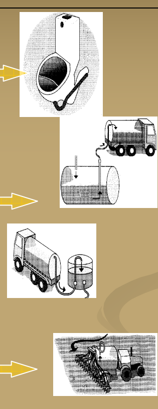
Example of Excreta Systems

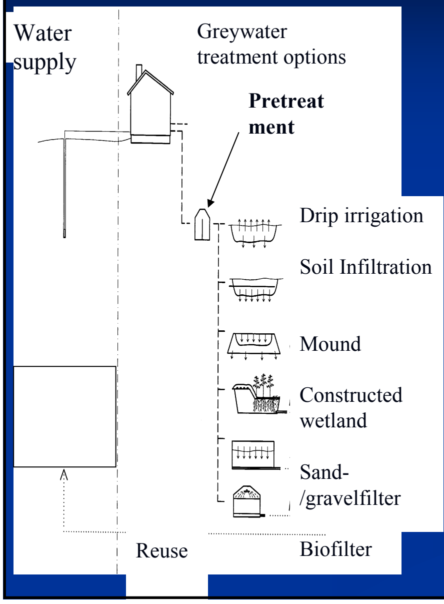




Exposure	Risk
Cleaning of blocked pipes	Ingestion of pathogens
Accidental ingestion when handling unstored urine	Ingestion of pathogens
Accidental ingestion when handling stored urine	Ingestion of pathogens
Inhalation of aerosols created when applying urine	Inhalation of pathogens
Consumption of crops fertilised with urine	Ingestion of pathogens

Greywater – same principals

Faecal input crucial to assess risk!!



Treatment as a barrier – reduction efficiency.

Reduction in dry latrines, storage time 6 months, pH value around 9 or more.Based on added organisms, at time 0. Reduction given as log_{10} values.

Parameters	Reduction efficiency	Remark
Bacteria (coliforms)	> 6 log	Chinese exp
Bacteria (fecal enterococci)	4-6 log	Extrapolations/Mexico
Bacteriophages (index virus)	5->6 log	Chinese exp Vietnamese exp Mexican extrapol
Ascaris ova (index parasite)	100% reduction of viability	Vietnamese exp Chinese exp

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The first thing is to assemble a suitable team for an assessment

- How do you select and which ones is the essential player?
- Which is the institutional framework that you may work withing?
- Are personal suitable trained and in tune with each others?

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Exposure central

- What is the volume that individual are exposed to?
- What is the likely frequency of exposure?
- How many people are exposed? (directly; indirectly)

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How many of these children puts something in their mouths?

Introduction of toilets will have limited impact if the environment
Is contaminated . **Is it?**

Contaminated water and
Ground is part of the
Living environment!

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Fecal material outside a
Communal toilet. Does this
Indicate willingness
But repulsion at site?

Documentation and Monitoring

- Establish a documentation system!
- Establish monitoring requirements!

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Data entry form: for a dynamic system

Definition of Monitoring Functions

Function	Definition
Validation	Testing the system or components thereof to ensure if it is meeting e.g "microbial reduction targets". Mainly relates to new systems/components.
Operational monitoring	Relates to "design specifications" e g turbidity. Indicate proper functions and variations and is the base for "direct corrective actions"
Verification	Methods, procedures and tests to determine compliance with design parameters AND specific requirements (GL values, E coli, helminth eggs, microbial and chemical analysis of crops.

Microbial GL values

- Mainly applicable for verification monitoring in larger systems
- Design criteria (system validation) - the main factor in addition to exposure control to counteract risks and variabilities.
- Storage and treatment additives as aid in the barrier efficiency.

	Helm. Eggs	E. coli
Treated fecals	< 1/ g TS	Helminths. Low incidence *E coli* < 1000/g TS
Greywater: • Restricted	< 1/L	< 10^5 /100 ml Relaxed 10^6 /100 ml <exposure >regrowth
• Unrestricted	< 1/L	< 10^3/100 ml

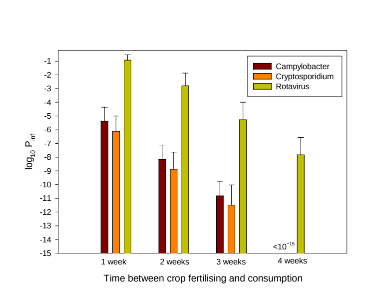

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Table 4.5 Recommendations for storage treatment of dry excreta and faecal sludge before use at the household and municipal levels[a]

Treatment	Criteria	Comment
Storage; ambient temperature 2–20 °C	1.5–2 years	Will eliminate bacterial pathogens; regrowth of *E. coli* and *Salmonella* may be considered if rewetted; will reduce viruses and parasitic protozoa below risk levels. Some soil-borne ova may persist in low numbers.
Storage; ambient temperature >20–35 °C	> 1 year	Substantial to total inactivation of viruses, bacteria and protozoa; inactivation of schistosome eggs (<1 month); inactivation of nematode (roundworm) eggs, e.g. hookworm (*Ancylostoma*/*Necator*) and whipworm (*Trichuris*); survival of a certain percentage (10–30%) of *Ascaris* eggs (≥4 months), while a more or less complete inactivation of *Ascaris* eggs will occur within 1 year (Strauss 1985).
Alkaline treatment	pH >9 during >6 months	If temperature >35 °C and moisture <25%, lower pH and/or wetter material will prolong the time for absolute elimination.

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[a] No addition of new material.

Recommendations for the use of human urine – large systems

Storage temperature	Storage time	Pathogens in the urine*	Recommended crops
4°C	>1 month	viruses, protozoa	food and fodder crops that are to be processed
4°C	>6 months	viruses	food crops that are to be processed, fodder crops
20°C	>1 month	viruses	food crops that are to be processed, fodder crops
20°C	>6 months	probably none	all crops

Inactivation affected by pH (~9) and ammonia, avoid dilution of the urine

*From potential faecal cross-contamination and possibly remaining after storage

Implementation

- Establish an implementation procedure.
- Look into the questions of compliance.
- Who can monitor/check at the local scale?
- What is the likelihood of sustainability of the installation and system?
- Maintenance?

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Implementation approach

- Incidence of different disease in local context?
- Treatment efficiency and variability?
- Exposure; Who? How many? How often?

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Implementation approach

- What crops are wastewater/sludge/excreta applied to?
- When in the crop cycle is it applied? What is the waiting period between last application and harvest?
- Who are exposed? Farmers – Consumers – Others?
- How often? How many? How frequently? Likely volumes of wastewater/sludge/excreta?
- How are the products handled after harvest and before consumption?

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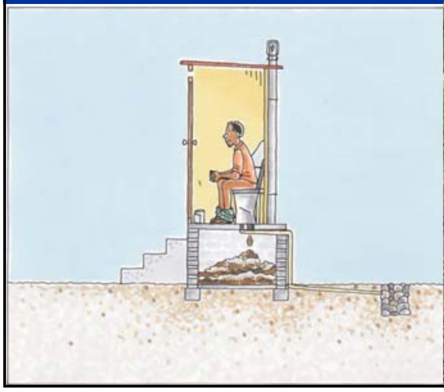
Evidence based epidemio-logical information.
Durban; South Africa 2006
•A GIS-based randomized cohort study of diarrhoeal and worm disease in sanitary source separation interventions; and control areas.
•1337 households; ~7000 individuals,
repeated 6 times with 14 days interval.
•Accounting for water and hygiene habits.
•Total demographic and socio-economic information (Demographic site).
•Database of 1 200 000 entries
•Ethically approved
Acknowledgement:
Nelson Mandela School of Medicine,
University of KwaZulu Natal
Ethekwini Municipality

Urine Diversion Toilet

•Separates urine and faces at source



Results

- A reduction of days with diarrhoea with 70% was achieved in areas with full coverage of dry toilets.
- The incidence of diarrhoea was especially reduced for the young and the elderly.
- Since the very infants are not using the toilets this also shows that secondary transmission to children was reduced in the society
- An additional reduction was achieved when safe water was provided

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Percentage of individuals with Disease outcome by Drinking Water Safety

Water safety	N	% Diarrhoea	% Vomitting	% Worms	% Skin sores
Unsafe	372	32.5%	5.4%	10.5%	5.6%
Safe outside	4086	22.5%	2.7%	2.9%	4.3%
Safe inside	2755	18.2%	1.3%	2.1%	2.5%
Incidence Rate Ratio & Prevalence Ratio					
Safe outside vs. safe inside		IRR 1.23	IRR 2.06	PR 1.38	PR 1.71
Unsafe vs. safe inside		IRR 1.44	IRR 3.31	PR 4.01	PR 1.82

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WHO Guidelines. AIMS for the future.

- The guidelines a starting point for:
- Country-based system studies including risk/epi based approaches. (2007-2009)
- Comparative assessments with uses of WW/others
- Follow-up and implementation of WHO Guidelines site- or country based (2007-2010 and thereafter)

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