Sanitation Systems and their Functionality in Health Protection

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Theme 1 - Water and Sanitation for Development

Session 8 - Sustainable Sanitation and the Role of Hygiene in the Value Chain

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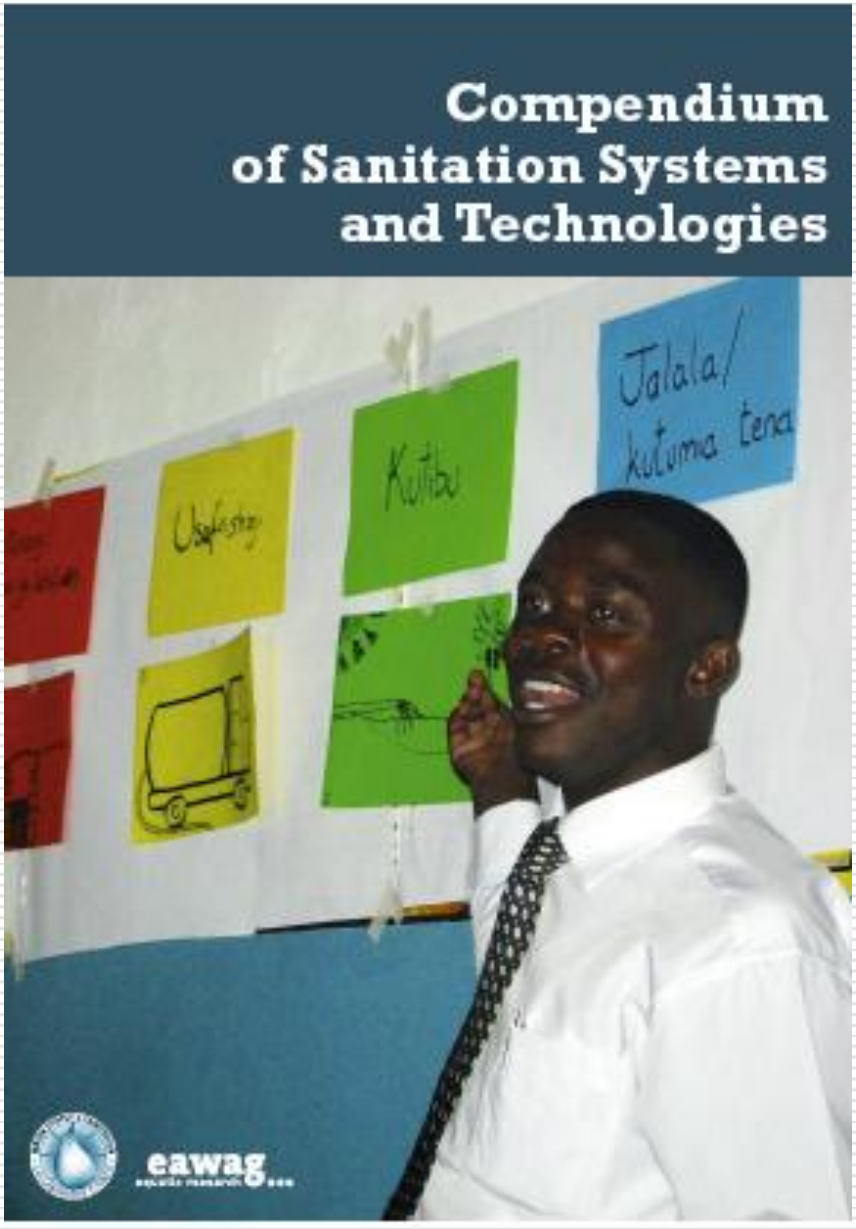
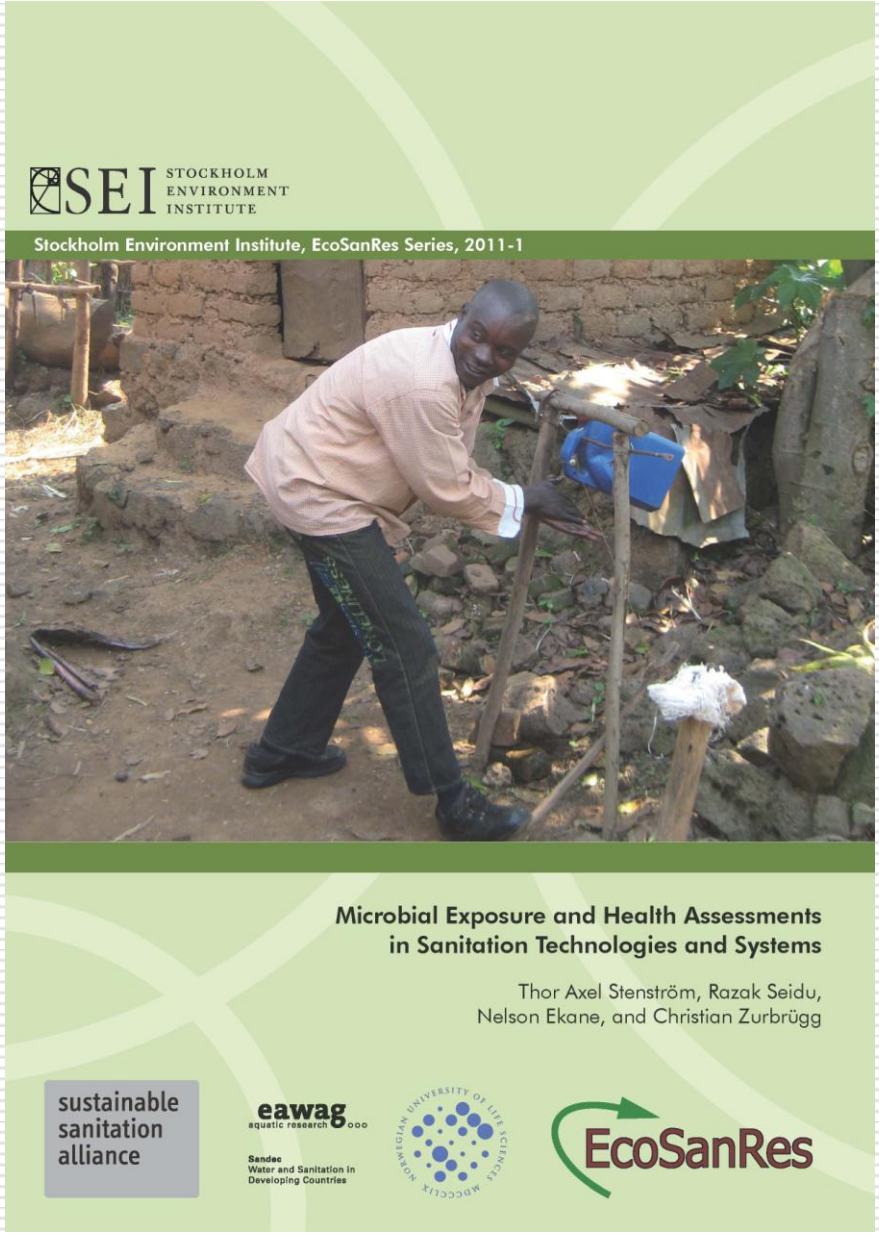
SEI

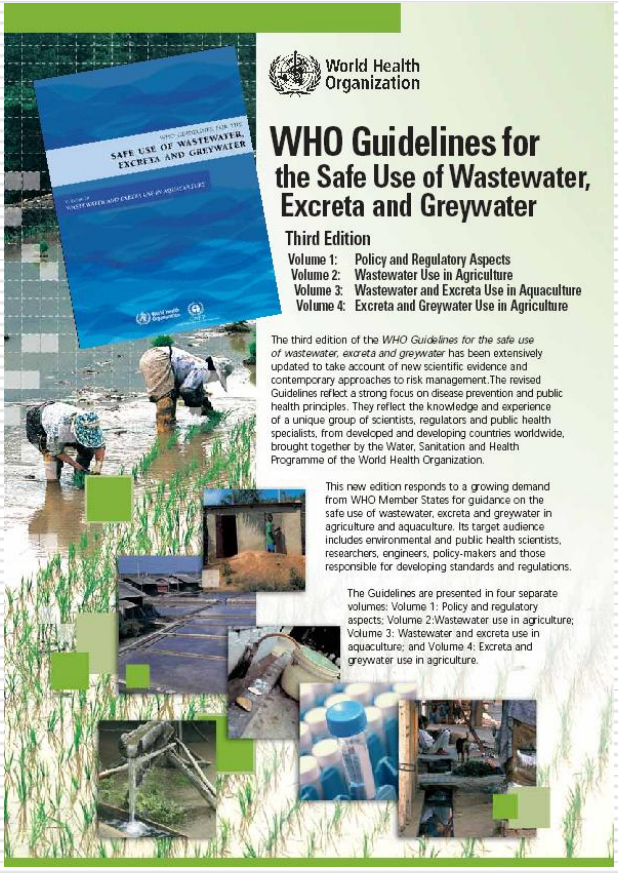


"EAWAG Compendium", 2008



"SEI Health Compendium", 2011

WHO Guidelines for the Safe Use of Wastewater, Excreta and Greywater (2006)

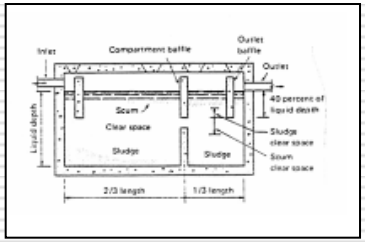
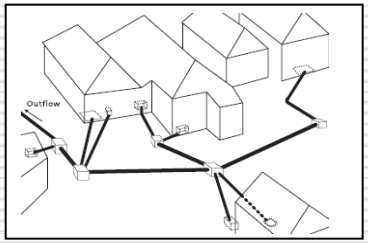
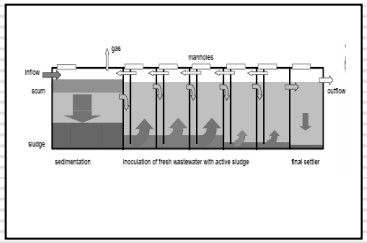
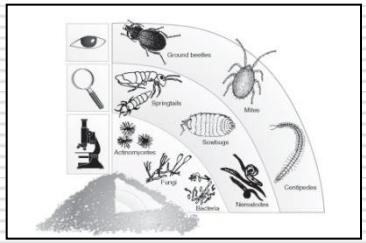


Meaning of Sanitation

- Safe collection, storage, treatment and disposal / reuse / recycling of
  - human excreta (faeces and urine)
  - sludge and sewage effluent
  - grey water
  - solid waste
- Hygiene and behavior change
- Drainage and management of stormwater

SEI

What are the parts of a sanitation system?

User Interface	Collection and Storage	Conveyance	(Semi-) Centralised Treatment	Reuse and Disposal
				
-Dry toilet -Urine diverting dry toilet -Urinal -Pour flush toilet -Flush toilet	-Single pit -Single pit VIP -Alternating dry double pit -Alternating wet double pit -Double dehydr. vaults -Aquaprivy -Septic tank -Composting chamber	-Manual emptying -Mechanical emptying -Simplified sewer -Small bore sewer -Conventional gravity sewer -Jerry can/tank	-Imhoff Tank -Anaerobic baffled reactor -Anaerobic filter -Trickling filter -Waste Stabilization ponds -Finishing pond -Constructed wetland -Co-composting	-Application of urine -Application of dehydr. Faeces -Compost -Irrigation with wastewater -Aquaculture -Soak pit -Leach field -Incineration -Land application -Surface disposal

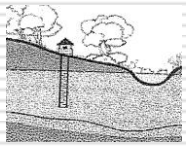
Exposure and Transmission Routes

ingestion of excreta from hands

dermal –contact


contact with flies/mosquitoes

inhalation of aerosols and particles

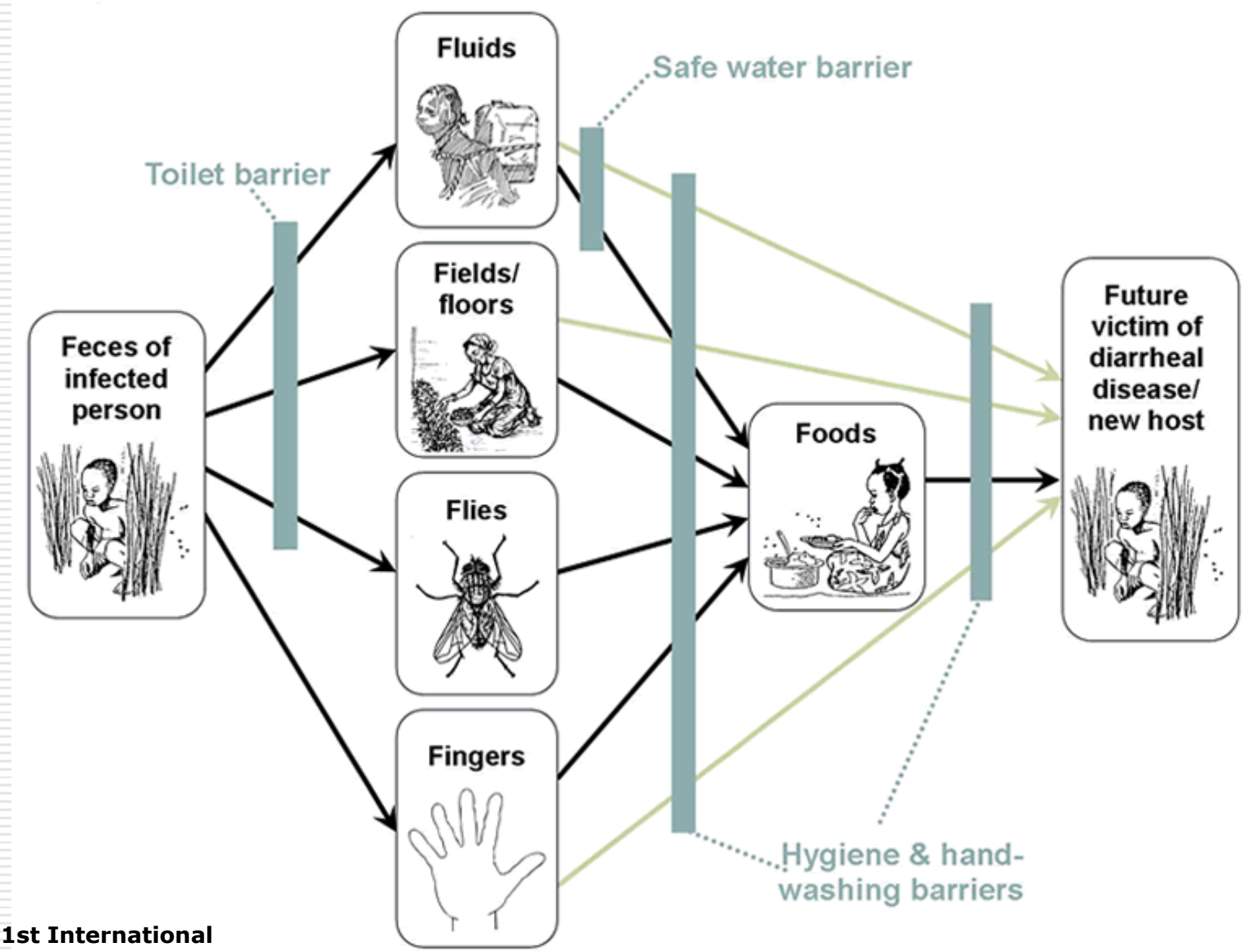


contaminated groundwater/surface water
contact with overflowing/leaking contents

ingestion of excreta

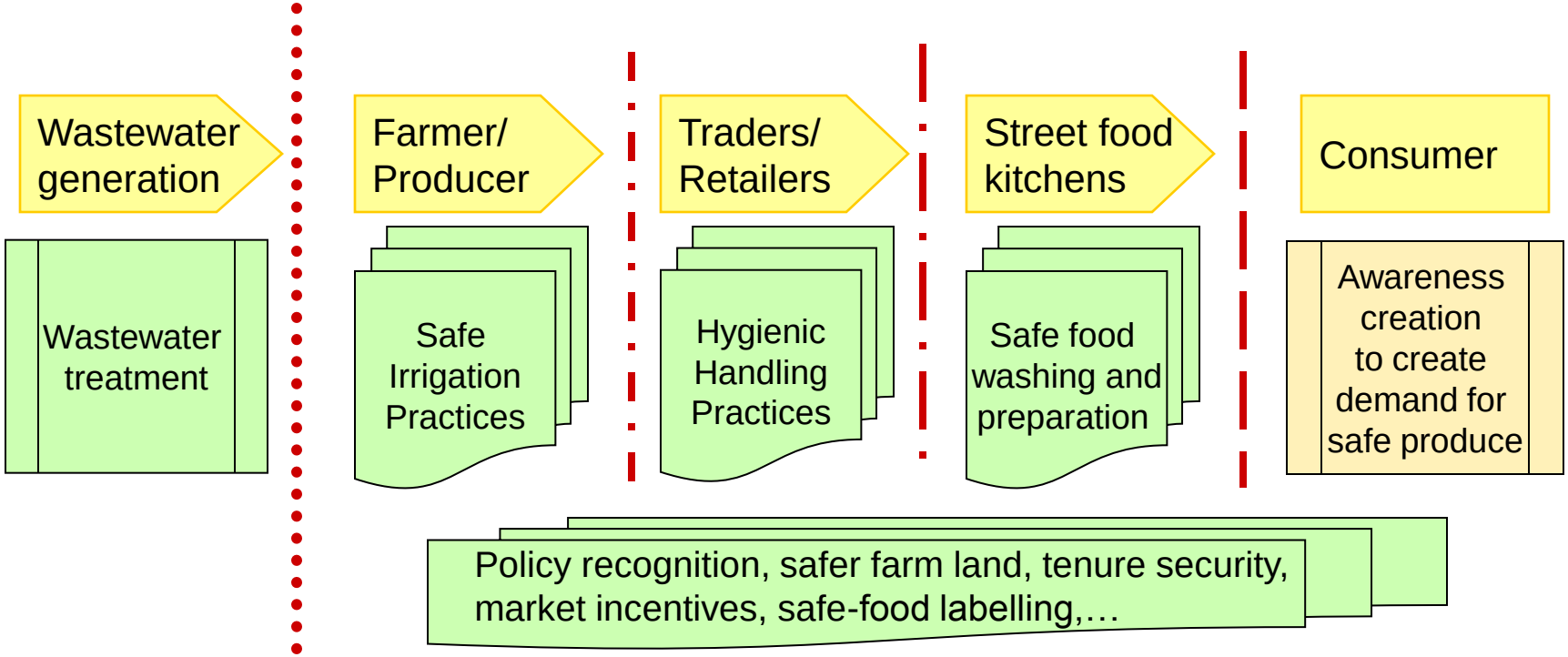
consumption of contaminated produce (vegetables)

Barriers to Prevent Spread of Pathogens: the ”F-Diagram”



Risk reduction strategies

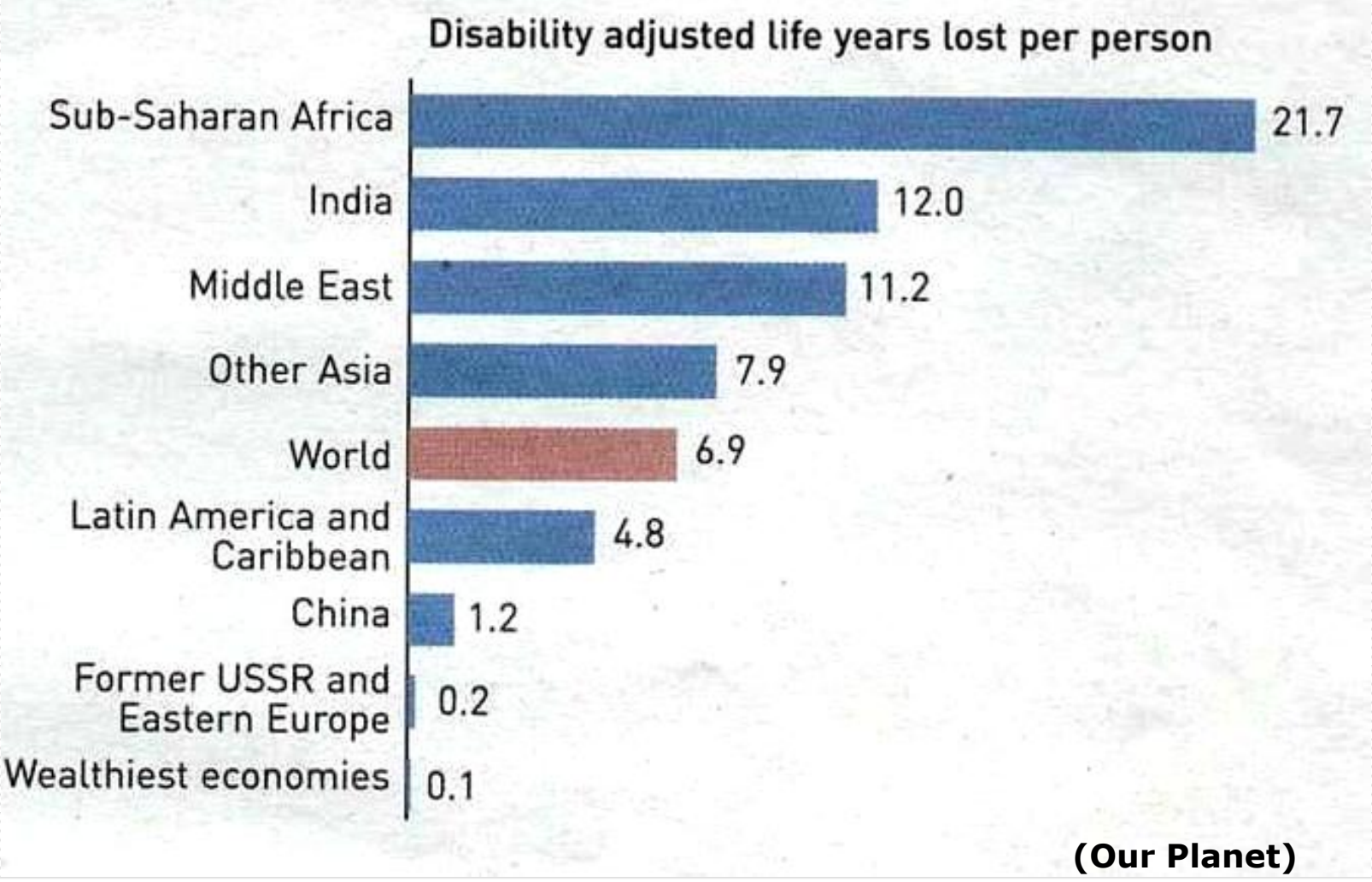
WHO's *multiple barrier* approach from "Farm to Fork"



Pathogens in faeces that can be transmitted through water and improper sanitation

Pathogen	Symptoms
Bacteria	
Aeromonas spp	Enteritis
Campylobacter jejuni/coli	Diarrhoea, cramping, abdominal pain, fever, nausea, joint pain, Guillain-Barré syndrome
Escherichia coli (EIEC, EPEC, ETEC, EHEC)	Enteritis
Plesiomonas shigelloides	Enteritis
Salmonella typhi/paratyphi	Fever - headache, malaise, anorexia, slow pulse, enlarged spleen, cough
Salmonella spp.	Diarrhoea, fever, abdominal cramps
Shigella spp.	Dysentery (bloody diarrhoea), vomiting, cramps, fever
Vibrio cholera	Cholera - watery diarrhoea, lethal if severe and untreated
Yersinia spp.	Fever, abdominal pain, diarrhoea, joint pains, rash
Virus	
Enteric adenovirus 40 and 41	Enteritis
Astrovirus	Enteritis
Calicivirus (incl. Noroviruses)	Enteritis
Coxsackievirus	Various, respiratory illness, enteritis, viral meningitis
Echovirus	Aseptic meningitis, encephalitis, often asymptomatic
Enterovirus types 68-71	Meningitis, encephalitis, paralysis
Hepatitis A	Fever, malaise, anorexia, nausea, abdominal discomfort, jaundice
Hepatitis E	Hepatitis
Poliovirus	Often asymptomatic, fever, nausea, vomiting, headache, paralysis
Rotavirus	Enteritis
Parasitic protozoa	
Cryptosporidium parvum/hominis	Watery diarrhoea, abdominal cramps and pain
Cyclospora cayetanensis	Often asymptomatic, diarrhoea, abdominal pain
Entamoeba histolytica	Often asymptomatic, dysentery, abdominal discomfort, fever, chills
Giardia intestinalis	Diarrhoea, abdominal cramps, malaise, weight loss
Helminths	
Ascaris lumbricoides	Generally no or few symptoms, wheezing, coughing, fever, enteritis, pulmonary eosinophilia
Taenia solium/saginata	
Trichuris trichiura	Unapparent through vague digestive tract distress to emaciation with dry skin and diarrhoea
Hookworm	Itch, rash, cough, anaemia, protein deficiency
Shistosomiasis spp	

Avg Health Burdens from Diarrhoeal Diseases



(Our Planet)

Current annual diarrhea cases in SSA:

1.2 billion which lead to 769.000 dead children, mostly under 5 years

Ascaris: Distribution of Disease Burden

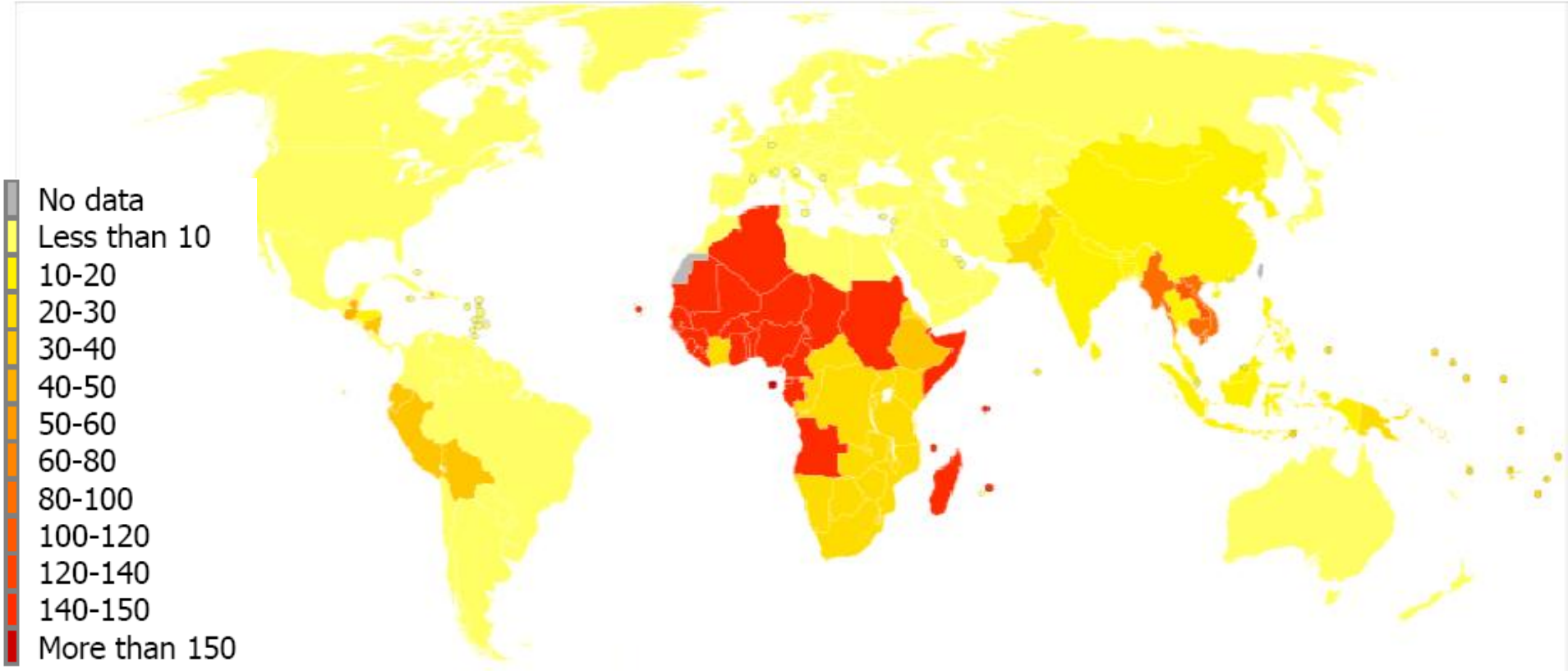


Figure 4: DALY factor for ascariasis per 100,000 inhabitants worldwide in 2002 (WHO, 2002)

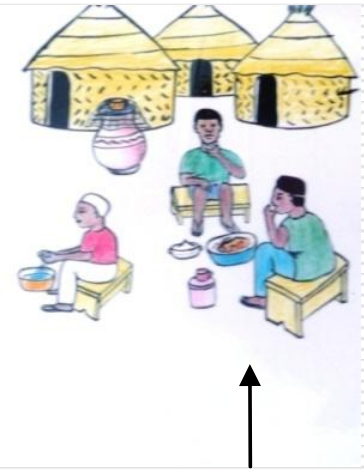
***Ascaris lumbricoides* blocking a 3-yr old child's intestine**

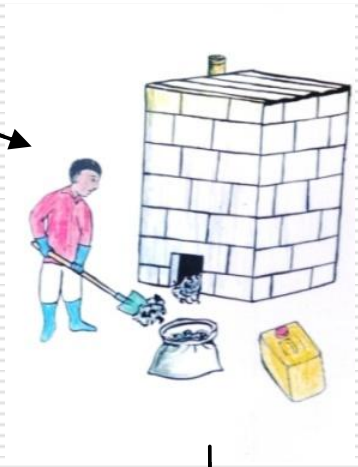
Medical Research Council Policy Brief (2) 2006

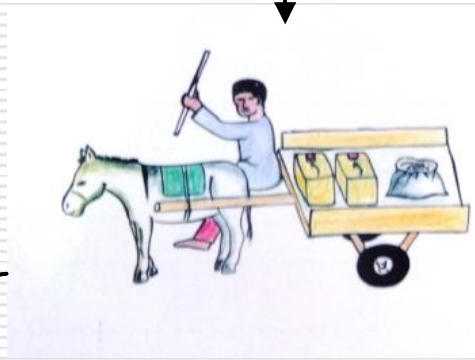
Dumping of Sludge= “Advanced Open Defecation”

Understanding the Nutrient Loop

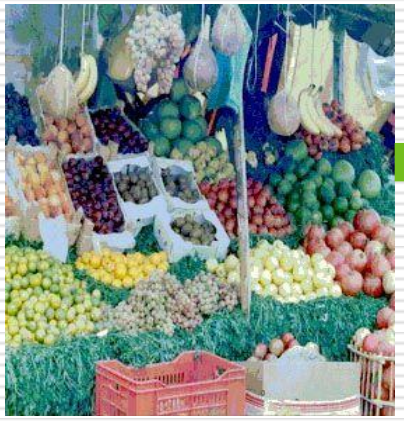
«What we take from the soil, we give back to the soil»







Productive Sanitation
a neglected treasure



N = 2,8 kg
P = 0,4 kg
K ~ 1,3 kg
Per person
per year

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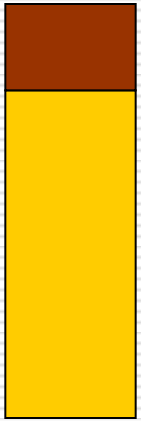

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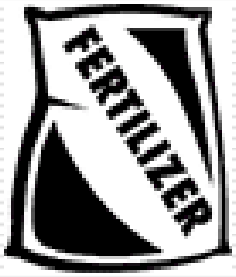


Urea = 6 kg
TSP = 2 kg
KCL ~ 2,6 kg

Urine Collection in Niger

(SEI, 2009)

Storage and hygienisation of urine: ”Takin Ruwa”

Participative Testing of "Takin Ruwa" in Niger

Safe and fertile crops

URINE CONTROL

Construction of Composting Pit Latrines in Zimbabwe Schools

School children making concrete slabs, ringbeams and toilet houses in traditional material and bricks

(Morgan - Aquamor, Zimbabwe)

School Sanitation Garden Experiments

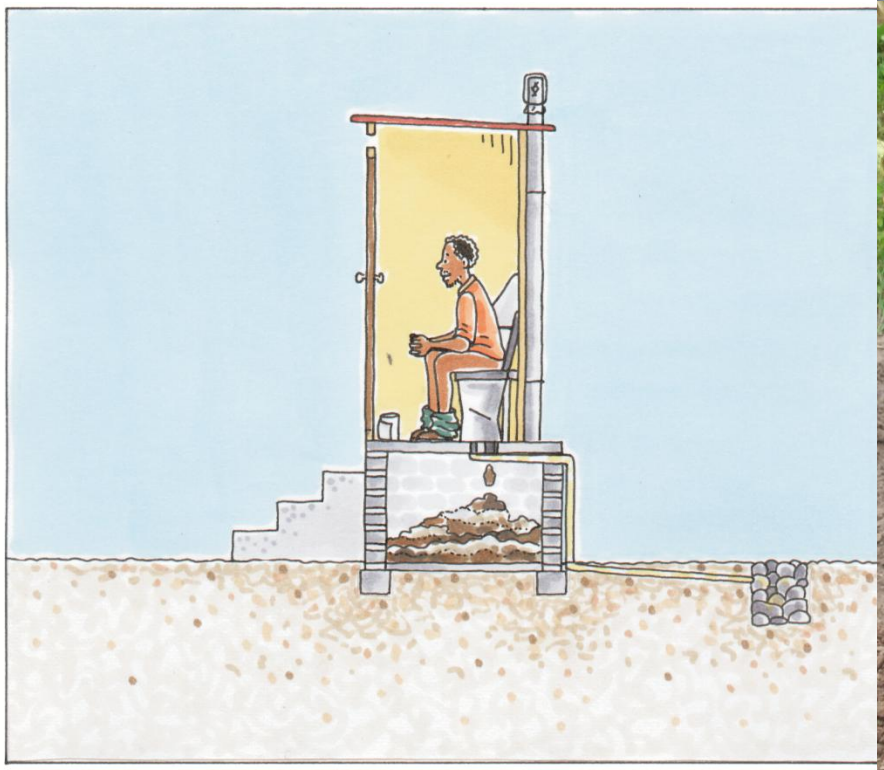
Children recording the results

Taking measurements

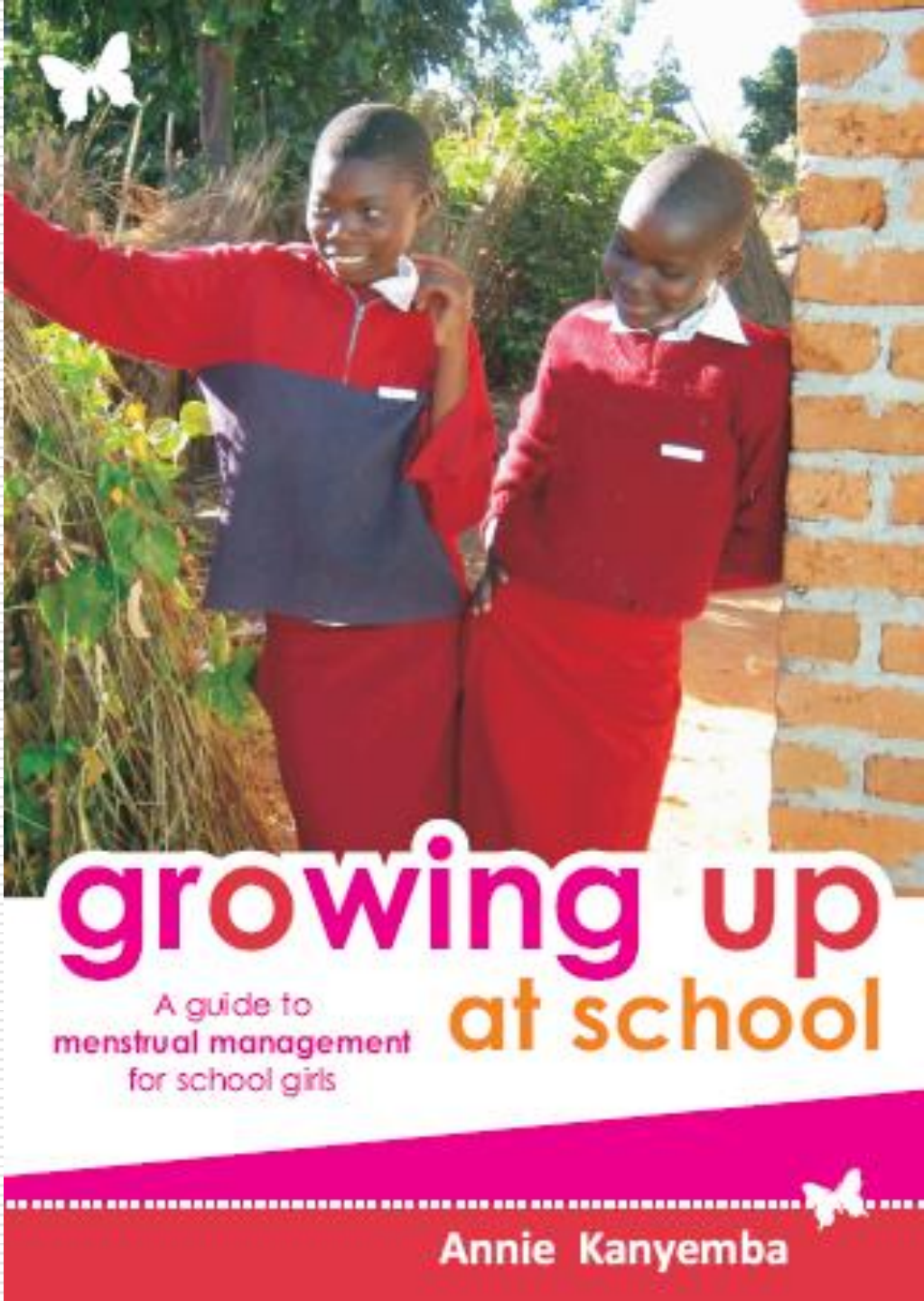
Maize trials using urine fertiliser

Urine Diversion Dry Toilet

Separates urine and faeces at source

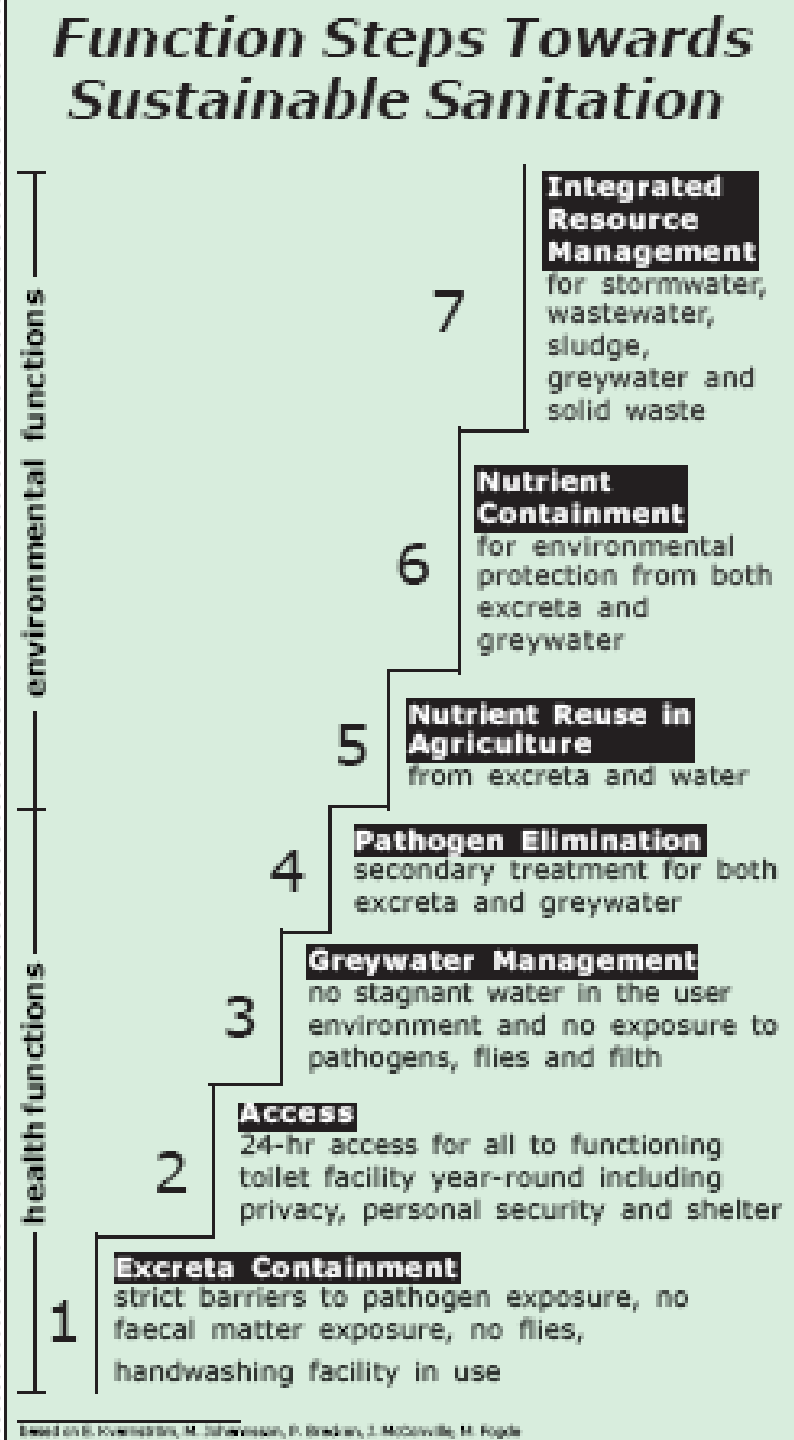


School Sanitation Keeps Girls in Schools



(WRC, 2011)

The New Sanitation Ladder
Based on Function



(Kvarnström et al 2010)

Safe Sanitation Made Possible

- Requires a systems approach – the value chain
- Affordable, functional, maintainable, appropriate and participative
- Design the entire chain including disposal and reuse
- Profits generated from health protection also can include energy (biogas), food production and water savings

SEI

partner of

sustainable sanitation alliance

Stockholm Environment Institute

www.sei-international.org

www.ecosanres.org

www.susana.org