Introduction

- Marij Zwart
- Sanitary engineer
- Focus on wastewater treatment
- WUR (BSc), TU Delft (MSc)
  - Evides, Process engineer
  - British Red Cross, FSM engineer
  - UNHCR, WASH officer
  - UNICEF, WASH cluster coordinator
Introduction

- Tineke (Christine) Hooijmans
- Sanitary engineer
- Focus on WW and FS treatment
- WUR (MSc), TU Delft (PhD)
- IHE Associate Professor

IHE Delft Institute for Water Education is the largest international graduate education institute in the field of water. The institute confers fully accredited MSc degrees and PhDs.

Since 1957 the Institute has provided education to more than 23,000 water professionals from over 190 countries, the vast majority from the developing world.

124 PhD fellows* are currently enrolled in water-related research. The Institute carries out numerous research and capacity development projects throughout the world.

*PhD fellows active per 31-12-2018
Core activities

<table>
<thead>
<tr>
<th>Education &amp; Training</th>
<th>Research &amp; Innovation</th>
<th>Institutional Strengthening</th>
</tr>
</thead>
<tbody>
<tr>
<td>IHE Delft offers a wide range of flexible, high quality, specialized educational programmes to respond to the needs of diverse clients from the water sector. These include MSc and PhD programmes, along with online and short courses.</td>
<td>With over 140 academic staff and 124 PhD fellows active in water-related, problem-focused and solution oriented research on development issues, IHE Delft has a vibrant multicultural and multidisciplinary research atmosphere.</td>
<td>IHE Delft strives to strengthen the programmes of universities and research institutes as well as the knowledge and capacity base of ministries and other water sector organizations.</td>
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</tbody>
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Capacity development

*PhD fellows active per 31-12-2018 including staff

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Education & Training

IHE Delft offers a wide range of flexible, high quality, specialized educational programmes to respond to the needs of diverse clients from the water sector.

- MSc programmes
- Short courses
- Online courses
- Tailor-made training
1. What do you think of when you think of sanitation? What is sanitation to you?
2. What is included in a sanitation system according to you?
3. What is necessary for a sanitation system to be sustainable?
Sanitation “wide definition”

- Safe collection, storage, treatment and disposal/re-use/recycling of human excreta (faeces and urine)
- Drainage and disposal/re-use/recycling of household wastewater (grey water)
- Drainage of storm water
- Treatment and disposal/re-use/recycling of sewage effluents and sludge
- Collection and management of industrial waste products and hazardous wastes
- Management/re-use/recycling of solid wastes

Refers to systems for the collection and safe disposal of excreta and wastewater generated in households, businesses, and communal buildings, rather than the wider definition that also includes storm water management and solid waste management (K. Tayler, 2018)

Similar approach in Compendium

www.unwater.org

Sanitation (system)

- Multi-step process in which human excreta and wastewater are managed from the point of generation to the point of use or ultimate disposal
- Context-specific series of technologies and services for the management of human excreta and wastewater, i.e. for their collection, containment, transport, transformation, utilisation or disposal

Also as interactive online version

www.ecompendium.sswm.info
Main aims of sanitation provision

1. Improve health and quality of life - many illness in the world is caused by fecal matter (cholera, typhoid, hepatitis, polio, many worm infections);

2. Protect the environment:
   - Heavy metals pollution;
   - Toxic organic and inorganic substances;
   - Nutrients: eutrophication -> algae toxins
   - Loss in biodiversity

Money spent on improving sanitation generates economic benefits (about nine times) that far exceed the required sanitation investments.

Why sanitation?

The ‘f’ diagram

Routes of fecal disease transmission and protective barriers

Sanitation  Clean water supply  Hygiene

Feces  Fluids  Fingers  Flies  Food  Fields/floors

Future victim
Why sanitation?

Improved Sanitation MDGs?

**Use of the following facilities:**

**Improved Sanitation**
- Flush or pour-flush to:
  - piped sewer system
  - septic tank
  - pit latrine
  - Ventilated improved pit (VIP) latrine
  - Pit latrine with slab
  - Composting toilet

**Use of the following facilities:**

**Unimproved Sanitation**
- Flush or pour-flush to elsewhere (that is, not to piped sewer system, septic tank or pit latrine)
- Pit latrine without slab/open pit
- Bucket
- Hanging toilet or hanging latrine

Shared facilities of any type
- No facilities, bush or field
Population without improved sanitation in 2015

Number of people with and without access to improved sanitation facilities, World

The total number of people with and without access to an improved sanitation facility, which includes flush/pour flush (to piped sewer system, septic tank, pit latrine), ventilated improved pit (VIP) latrine, pit latrine with slab, and composting toilet.

Source: OurWorldInData based on World Bank, World Development Indicators

Where does the tanker go to?

[Diagram showing tanker connection to a wastewater system]
Vietnam

Cameroon, Senegal
Uganda, Ghana

Urban Sanitation and SDG’s

Provision of facilities and services for the safe disposal of human urine and faeces
SDGs Goal 6 water and sanitation for all

6.2 Achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations.

6.3 Improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally.
What do you think is domestic wastewater, faecal sludge, septage?

**Domestic wastewater:** flush water, excreta, storm water

**Faecal sludge:** FSM book: all the materials collected from pits, vaults, and septic tanks

Kevin Tayler (2018):

**Faecal sludge** = faecal solids and urine at the bottom of a pit, tank, or vault. Above = supernatant water and scum layer

In case of dry pits, containerized systems and wet systems in which percolation from the sides and base of the pit removes all excess water: almost entirely faecal sludge

**Septage** comprises faecal sludge, the supernatant water that accumulates above it, and material that is lighter than water that forms a scum layer on the liquid surface

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**Sanitation options**

Kevin Tayler, 2018, Faecal sludge and septage treatment
Population served by types of sanitation systems

Figure 5.1 Percentage of population served by different types of sanitation systems

- Sewer
- Septic
- Flush/pour flush pit
- Pit - Dry
- Other
- Environment (open defecation)

Current FSM need

Current population of region with need for faecal sludge management (FSM) (million)

Source: Cairns-Smith et al. (2014, Fig. 8, p. 25, based on data from WHO/UNICEF, JMP). Courtesy of the Boston Consulting Group.

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SFD

- Easy-to-understand advocacy and decision-support tool
- Summarise service outcomes in terms of the flow and fate of excreta in urban areas
- SFD Report which contains SFD Graphic
- Excreta Flow Diagram/ Faecal Waste Flow Diagram

SFD Manual
Volume 1 and 2
Version 2.0
Last updated: April 2018
Shit Flow Diagram – King County, WA, USA

King County, Washington, United States of America
Date prepared: 10 Jul 2017
Prepared by: BMGF

Containment  Emptying  Transport  Treatment

99% 1%
Centralised, Decentralised and On-site System

- Suitable for dense cities
- High CapEX and Opex
- Collection cost ~ 70-90%
- Treatment Cost ~ 10-30%
- Less Capital Intensive
- Easier to Implement
- Reduced O&M cost
- Simple, Quick and Low Cost
- No need of sewer Pipes
- Technology as per end use options
- Easier resource recovery

CAPEX/OPEX of sanitation systems

<table>
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<tr>
<th>Types of sanitation systems</th>
<th>Capital costs ($/person)</th>
<th>Annual operating costs ($/person/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Centralized conventional sewer-based</td>
<td>220-940</td>
<td>12-28</td>
</tr>
<tr>
<td>Decentralized simplified sewer-based system</td>
<td>105-155</td>
<td>4-10</td>
</tr>
<tr>
<td>On-site septic tank-based system (Non-Sewered Sanitation)</td>
<td>70-360</td>
<td>4-12</td>
</tr>
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Source: BMGF, 2014
Sanitation – cost vs. conveyance

Citywide piped sewerage
Centralized wastewater treatment

Off-site sanitation

Simplified sewer network
Community Sanitation Center
Decentralized sanitation
Decentralized wastewater treatment

On-site sanitation
Pit toilet
Helicopter toilet

Increasing cost

Increasing complexity

Designing a sanitation system

What do you need to consider for the design of a robust system?
- What goes in
- What comes out
- What needs to be collected, stored, transported, processed, disposed of
- What technologies can perform the required tasks
- How the required technologies can be linked together (compatibility)

Further main considerations:
- Existing infrastructure & services
- Operation & maintenance (O&M) requirements
- Lifecycle cost
Sanitation chain

On-site Systems with Fecal Sludge Management

- WC
- Sewage network
- Pumping stations
- Sewage treatment works
- End-use/Disposal
- Vacuum truck
- Primary emptying
- Transfer
- Treatment plant
- End-use/disposal
- Containment
- Emptying
- Transport
- Treatment
- End-use/Disposal
- Safely covered and replaced in new location

Sanitation chain

User Interface
- Containment
- Conveyance
- Treatment
- Reuse/Disposal
IWK, Malaysia

Containment ➔ Emptying ➔ Transport ➔ Treatment ➔ Disposal

Clean Team, Ghana

Containment ➔ Transport ➔ Emptying ➔ Treatment ➔ Disposal

Source: C. Furlong
Tiger Worm Toilet, India

Source: Furlong

Excreta Management in Emergencies

The Sphere Handbook

Excreta Management in Emergencies by Carmen Paradiso
Which parameters in excreta management might be different in emergency situations as opposed to non-emergency situations?

- Time
- Space
- Location
- Population
- Insecurity
- Access
- Uncertainty
- Resources
**SPHERE – WASH Standards**

Excreta Management in Emergencies by Carmen Paradiso

**SPHERE - Excreta management**

**Excreta management standard 3.1:**
**Environment free from human excreta**
All excreta is safely contained on-site to avoid contamination of the natural, living, learning, working and communal environments.

**Excreta management standard 3.2:**
**Access to and use of toilets**
People have adequate, appropriate and acceptable toilets to allow rapid, safe and secure access at all times

**Excreta management standard 3.3:**
**Management and maintenance of excreta collection, transport, disposal and treatment**
Excreta management facilities, infrastructure and systems are safely managed and maintained to ensure service provision and minimum impact on the surrounding environment.
Thank You!
Any queries?

IHE Delft Institute for Water Education
www.un-ihe.org