الشركة القابضة لمياه الشرب والصرف الصحي

مشروع الاتحاد الأوروبي للدراسات وإعداد الاستراتيجيات

Egypt Rural Sanitation: Understanding Technology Mapping

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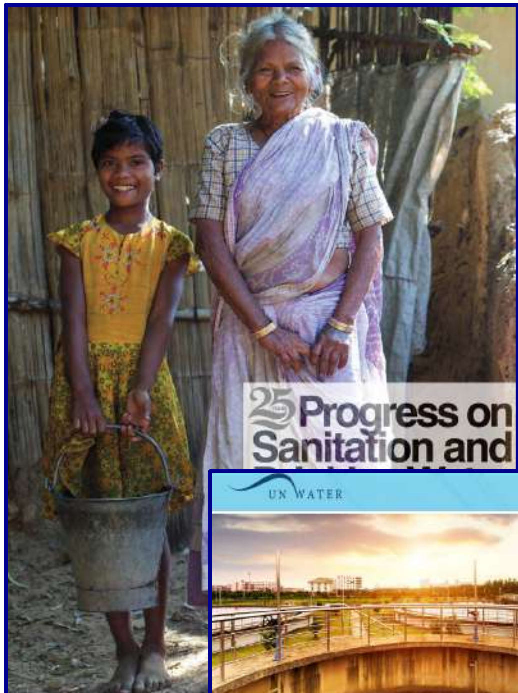
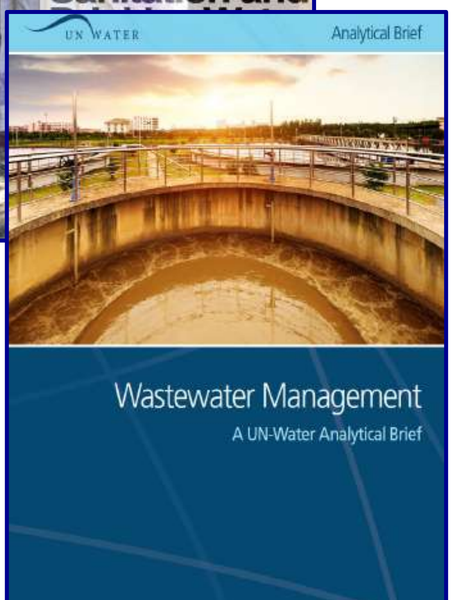
Outline

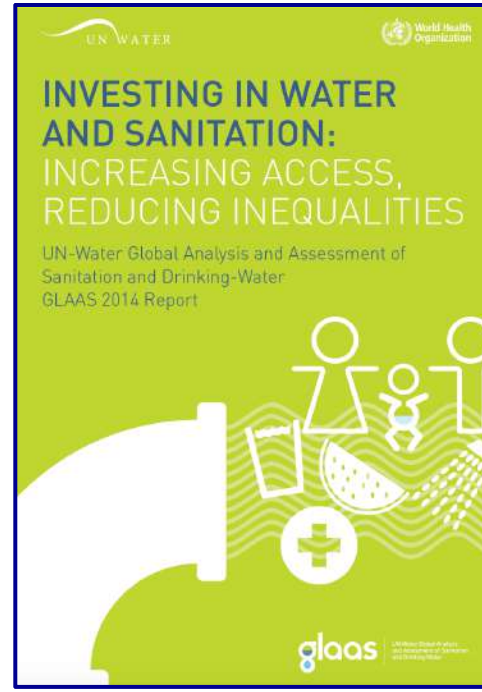
1. Global Overview
2. Regional Overview
   - Arab Countries Region
   - South Asia Region
   - Danube watershed Countries
   - EU member states
3. Faecal Sludge Treatment Technologies
4. Wastewater Treatment Technologies
5. Innovation Directions

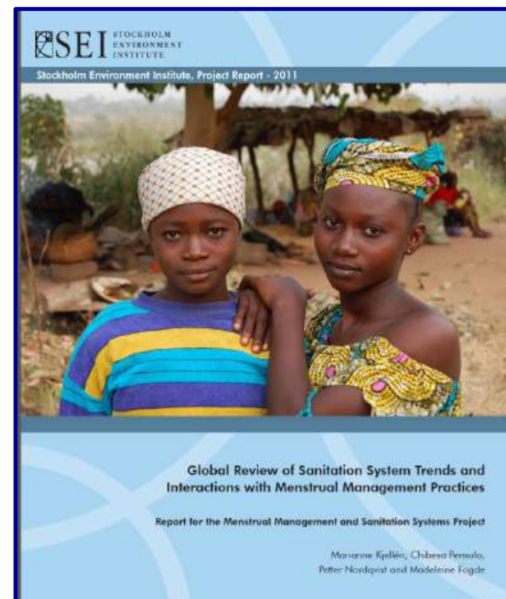
Summing Up

1.Global Overview





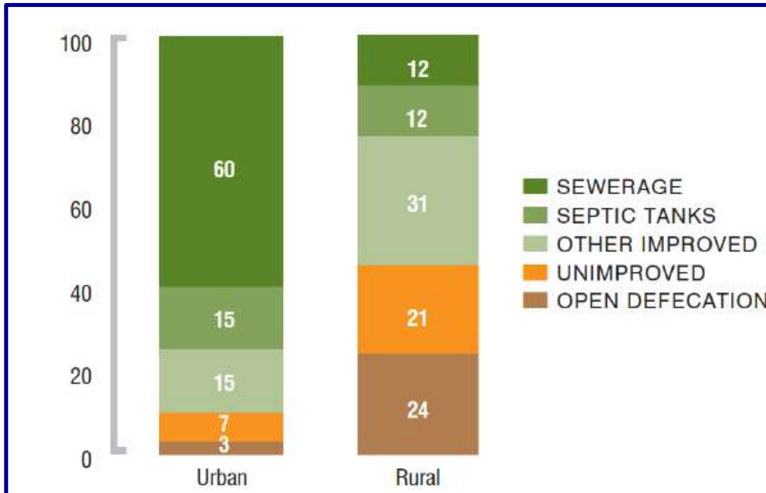




UNICEF/WHO 2015 Update and MDG Assessment

The global Integrated Monitoring Initiative has monitored progress on the first "sanitation ladder".
Open defecation is at the bottom of the ladder and provision of sewerage at the top.
The overall picture is shown in next slides.

The WHO/UNICEF sanitation ladder is focusing on the public health impacts of sanitation. A sanitation facility is considered improved if it hygienically separates human excreta from human contact. Egypt is among the countries positioned high on the sanitation ladder.



World Average 2010

Millennium Development Goals	
Goal 1.	Eradicate extreme poverty and hunger
Goal 2.	Achieve universal primary education
Goal 3.	Promote gender equality and empower women
Goal 4.	Reduce child mortality
Goal 5.	Improve maternal health
Goal 6.	Combat HIV/AIDS, malaria and other diseases
Goal 7.	**Ensure environmental sustainability**
Goal 8.	Develop a global partnership for development

→

Drinking Water and Sanitation Target

Target 7-C:
Halve, by 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation

→

Drinking Water and Sanitation Target

Indicator 7.8
Proportion of population using an improved drinking water source

Indicator 7.9
Proportion of population using an improved sanitation facility

The Joint Monitoring Program(JMP) is the official instrument for measuring progress towards MDG drinking water and sanitation. It is a joint effort of WHO and UNICEF.
The JMP has defined what constitutes an improved drinking water source and improves sanitation facility. The position of goal 7 among the 8 MDG is shown as well as the list of improved and unimproved sanitation facilities.

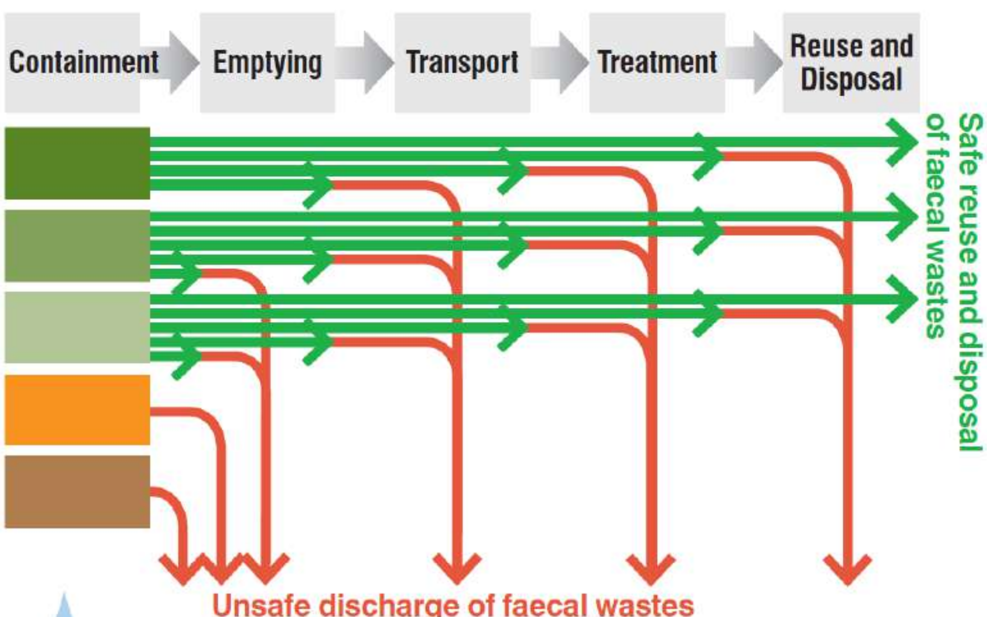
Access to:	
Improved Sanitation Facilities	Use of the these facilities: • Flush or pour-flush to: • Piped sewer system • Septic tank • Pit latrine • Ventilated improved pit (VIP) latrine • Pit latrine with slab • Composting toilet

Access to:	
Unimproved Sanitation Facilities	Use of the following facilities: • 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

Source: ESCWA, ESCWA water development report 5, issues in sustainable water resources management and water services in the Arab region, 2013.

Egypt is doing great on getting to the top of the basic sanitation ladder, as highlighted in the next slide.

This means that we are not facing problems in the "containment" step of the sanitation chain, but we do have problems in managing the treatment and disposal of FS and WW.



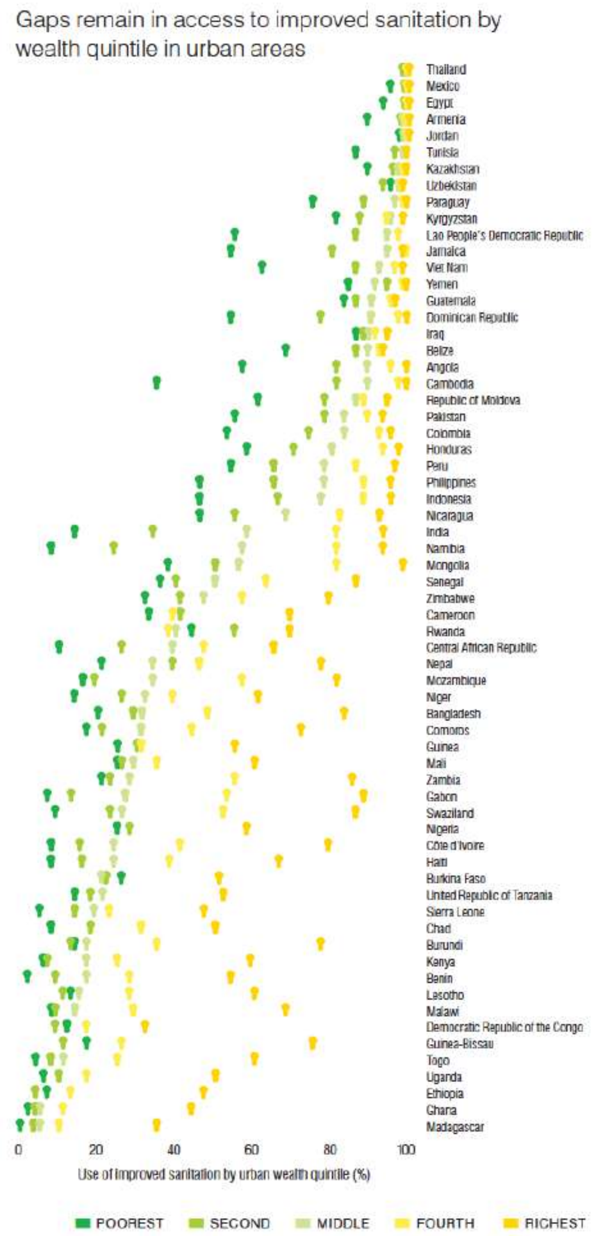


Fig.28 Use of improved sanitation facilities by urban wealth quintile in 2012

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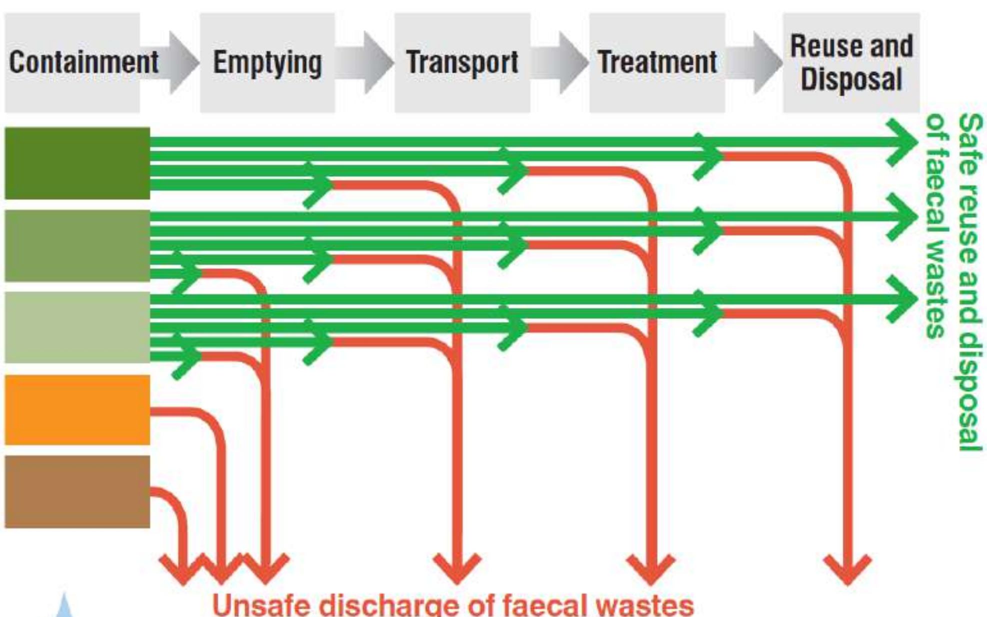

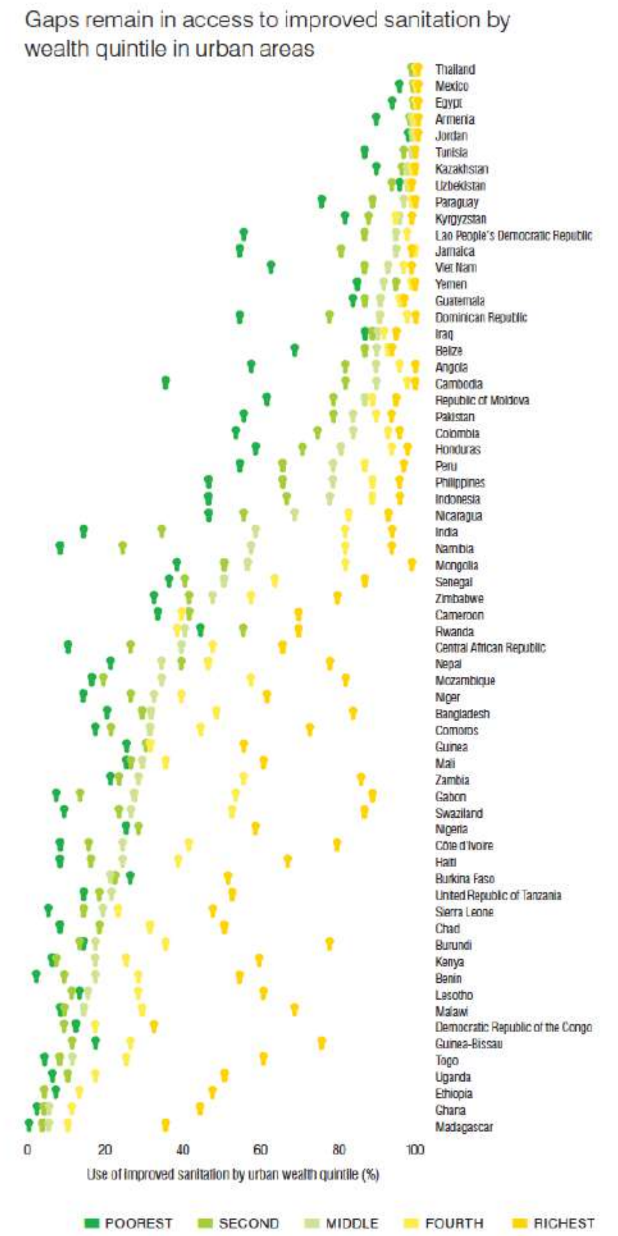

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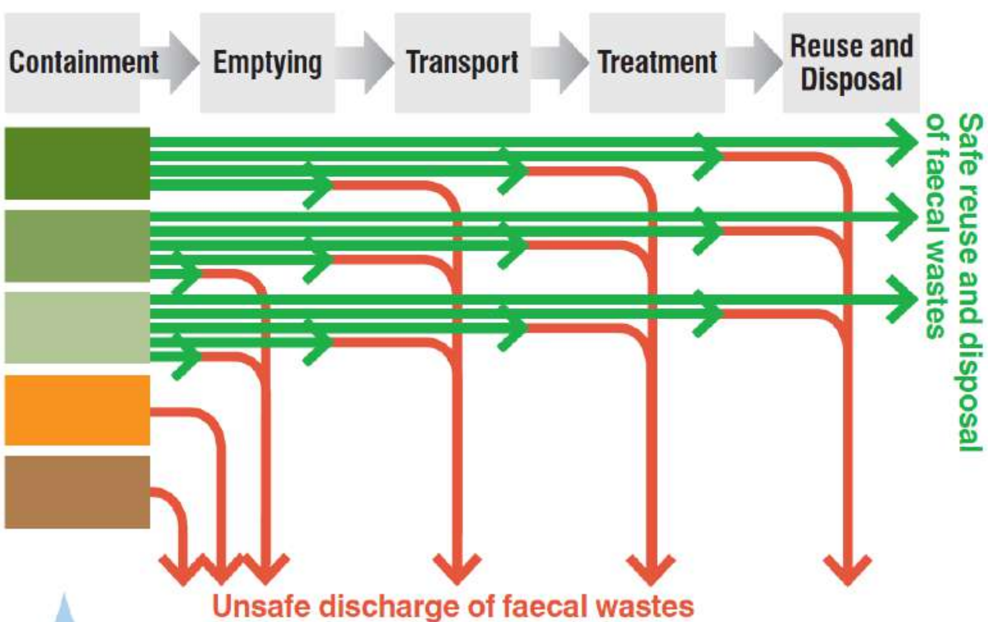

Gaps remain in access to improved sanitation by wealth quintile in urban areas

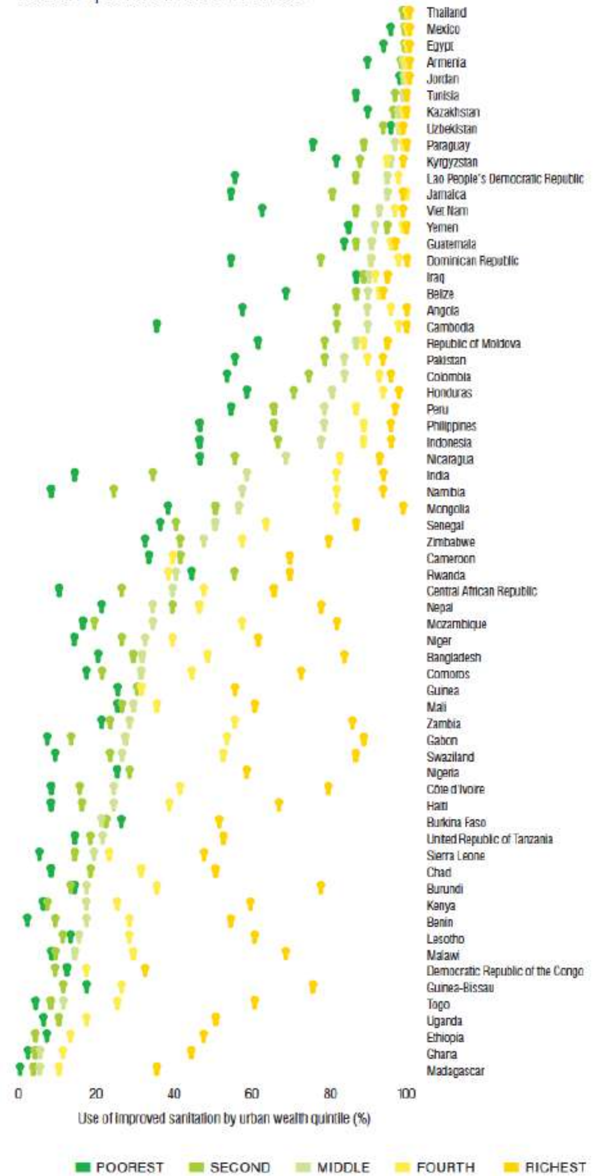

Fig.28 Use of improved sanitation facilities by urban wealth quintile in 2012

Comparative position of Egypt with selected number of Countries, extracted from WHO/UNICEF study published 2015	Year	Population (x1,000)	Percentage urban population	Use of sanitation facilities (percentage of population)												Progress towards MDG target	Proportion of the 2015 population that gained access since 1990 (%)
				Urban				Rural				Total					
					Unimproved				Unimproved				Unimproved				
				Improved	Shared	Other Unimproved	Open Defecation	Improved	Shared	Other Unimproved	Open Defecation	Improved	Shared	Other Unimproved	Open Defecation		
Egypt	1990	56 337	43	92	3	4	1	59	4	21	16	73	4	14	9	**Met target**	46
	2015	84 706	43	97	3	0	0	93	7	0	0	95	5	0	0		
Jordan	1990	3 358	73	98	1	1	0	95	1	1	3	97	1	1	1	**Met target**	56
	2015	7 690	84	99	1	0	0	99	1	0	0	99	1	0	0		
Tunisia	1990	8 135	58	94	2	2	2	43	5	4	48	73	3	2	22	**Met target**	39
	2015	11 235	67	97	2	1	0	80	10	8	2	92	5	2	1		
South Africa	1990	36 793	52	64	24	10	2	38	10	25	27	51	17	18	14	Moderate progress	31
	2015	53 491	65	70	26	3	1	61	16	15	8	66	22	8	4		
India	1990	868 891	26	49	16	6	29	6	1	2	91	17	5	3	75	Moderate progress	28
	2015	1 282 390	33	63	21	6	10	28	5	6	61	40	10	6	44		
Malaysia	1990	18 211	50	90	4	5	1	83	4	5	8	86	4	6	4	**Met target**	45
	2015	30 651	75	96	4	0	0	96	4	0	0	96	4	0	0		
China	1990	1 165 429	26	68	5	24	3	40	2	49	9	48	3	42	7	**Met target**	37
	2015	1 401 587	56	87	6	7	0	64	3	31	2	76	5	18	1		
Romania	1990	23 372	53	88	1	11	-	50	1	49	-	70	1	29	-	Moderate progress	NA
	2015	21 579	55	92	1	7	-	63	1	36	-	79	1	20	-		
Hungary	1990	10 385	66	98	2	0	0	99	1	0	0	98	2	0	0	**Met target**	NA
	2015	9 911	71	98	2	0	0	99	1	0	0	98	2	0	0		
Brazil	1990	149 648	74	79	1	14	6	31	1	20	48	67	1	15	17	**Met target**	34
	2015	203 657	86	88	1	11	0	52	1	34	13	83	1	14	2		
Argentina	1990	32 625	87	90	2	6	2	70	1	28	1	87	2	9	2	**Met target**	29
	2015	42 155	92	96	2	1	1	98	2	0	0	96	2	1	1		

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Urban Sanitation system Trends in the Developing World

- The water-based systems are increasing faster than urban population growth in all five areas except sub-Saharan Africa.
- In China and Latin America, it is extended sewer network that account for growth of water-based systems, while in South East Asia it is predominantly the construction of septic tanks which lies behind the increase.
- In Sub-Saharan Africa, the traditional pit latrines seem to be the only facility type whose prevalence increase at a faster rate than the urban population.

Source: SEI, Global Review of Sanitation System Trends and Interactions with Menstrual Management Practices, 2011.

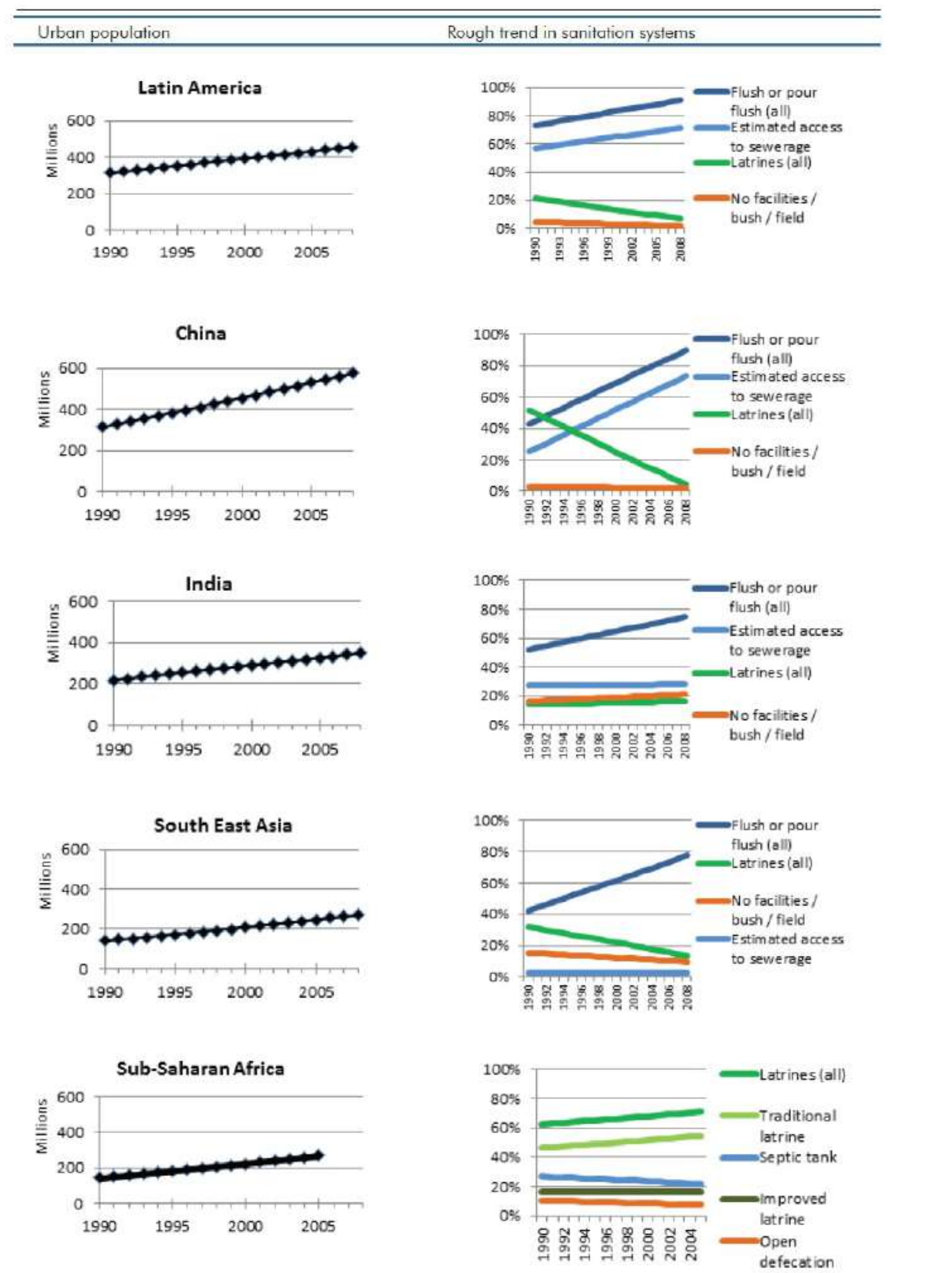
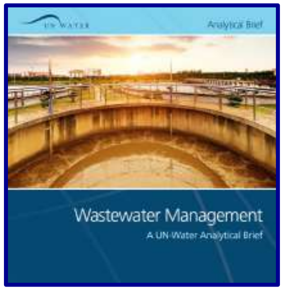


Figure 1: Urban population and sanitation system trends, by region/country



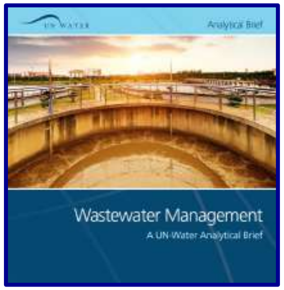
The UN analytical brief (2015) addressed the sewerage systems. Global coverage is shown below. The importance of effective collection systems has been emphasized. They are the most expensive element of the total cost of good operational management. Throughout the world most places have either no collection systems or systems that are dys-functional for reasons discussed in the study.

According to the fourth World Water Development Report, presently only 20% of globally produced wastewater receives proper treatment. Treatment capacity depends on the income level of the country.

Treatment capacity is 70% of the generated wastewater in high-income countries, compared to only 8% in low-income countries

Table 2: Global access to sewerage connection and sewerage connection with treatment in 2010 by country income group (adapted from Baum *et al.*, 2013)

Country income level	Percentage of the population with access	
	Connection	Connection & treatment
Low income	3.6	0.02
Lower middle income	12.7	2.0
Upper middle income	53.6	13.8
High income	86.8	78.9



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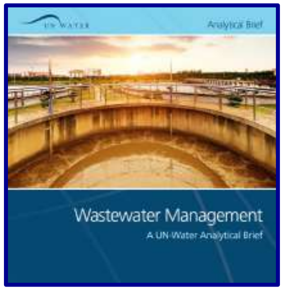

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Cost ranges for on-site and sewered (conventional treatment) options

Economy	Option	Capital Cost[1] ($ / capita)	Capital Plus Operation and Maintenance Cost ($ / capita/ year)
Low-Income Economies	Treatment plant[2]	20–80	5–15
	Sewer + treatment[2]	200–400	10–40[3]
Middle-Income and Transitional Economies	Treatment plant[2]	30–50[2]	Not provided
	Sewer + treatment[2]	300–500[2]	30–60[3]
Industrialized Countries	Treatment plant[2]	150–300[1]	Not provided
	Sewer + treatment[2]	100–200[2]	100–150[3]

Notes:

[1] For primary plus secondary treatment, including land purchase and simple sludge treatment, for a capacity of 30,000 to 40,000 persons. Lower values pertain to low-cost options such as waste stabilization ponds; higher values pertain to mechanized treatment such as oxidation ditches and activated sludge plants.

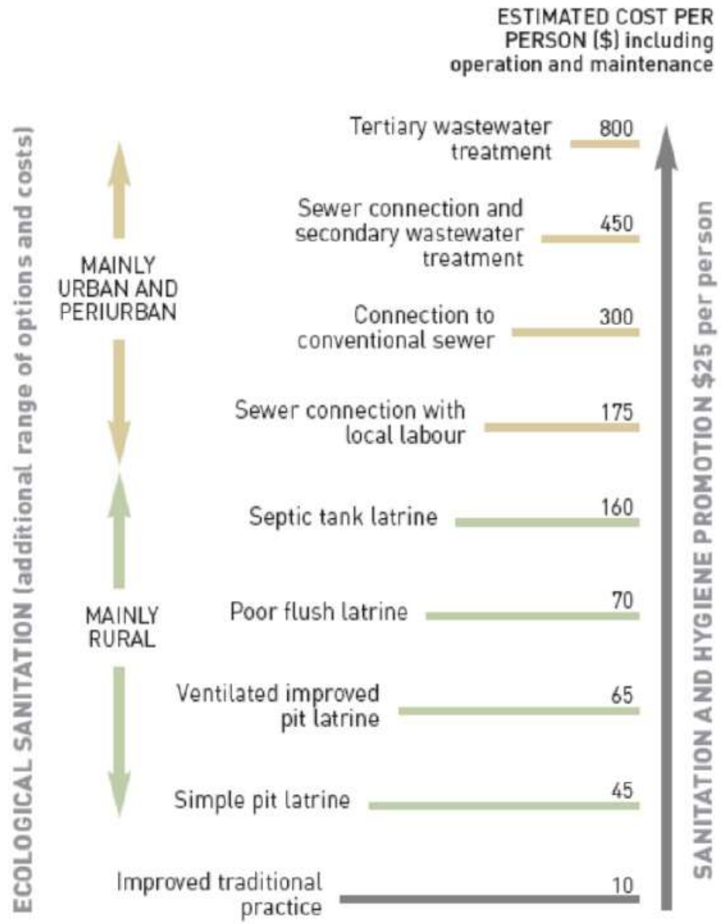
[2] For plant capacity of 100,000 to 250,000 persons.

[3] For industrialized countries, this includes tertiary treatment and full sludge treatment; for other countries, this includes secondary treatment.

Source: UNEP, 2001

Source: Kerata, B. et al, Up and down the sanitation ladder: harmonizing the treatment and multiple-barrier perspective on risk reduction in wastewater irrigated agriculture, Irrigation Drainage Systems, 24, 23-35, (2010)

Figure 2.1 Options for different levels of sanitation services and estimate of their costs



Note: Senior staff from the United Nations Development Programme (UNEP) provided these estimates from their experience in various countries.

Source: Guchte, Cees van de, Vandeweerd, Veerle. "Targeting Sanitation." *Our Planet*, Vol. 4, No. 4, pp. 19–22, United Nations Environment Programme (UNEP), 2004. http://www.unep.org/ourplanet/imgversn/144/images/Our_Planet_14.4_english.pdf.

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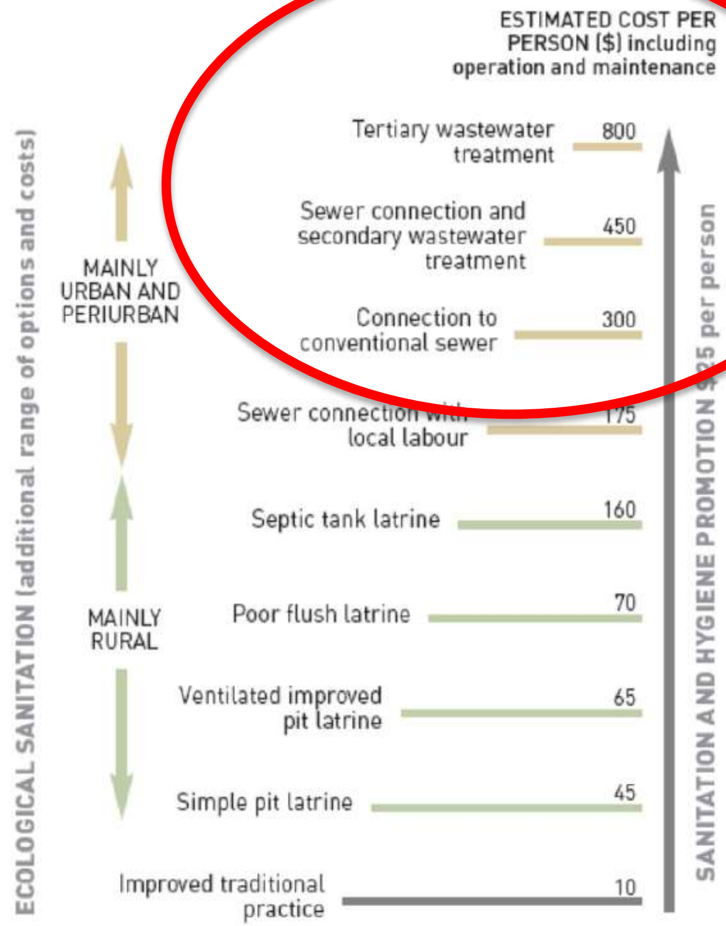

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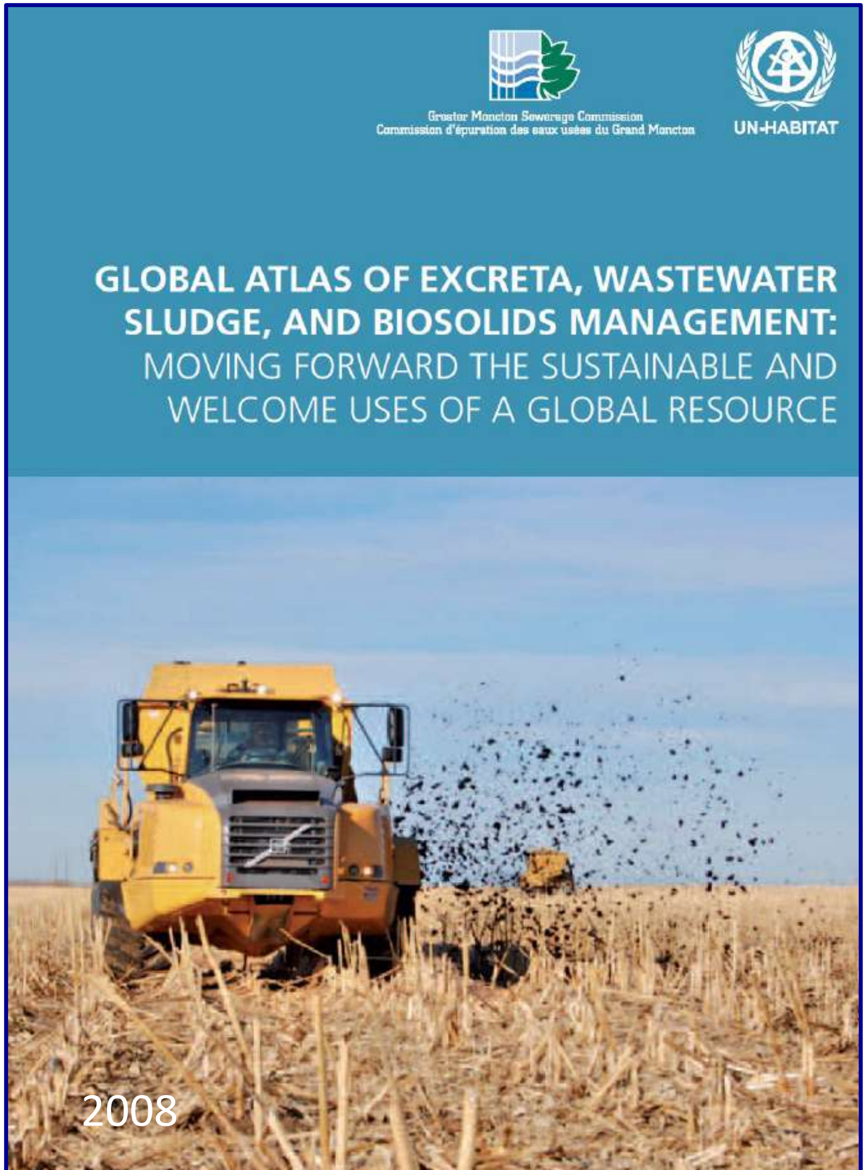
UN HABITAT, Global Atlas of Excreta, Wastewater, Sludge and Biosolids Management



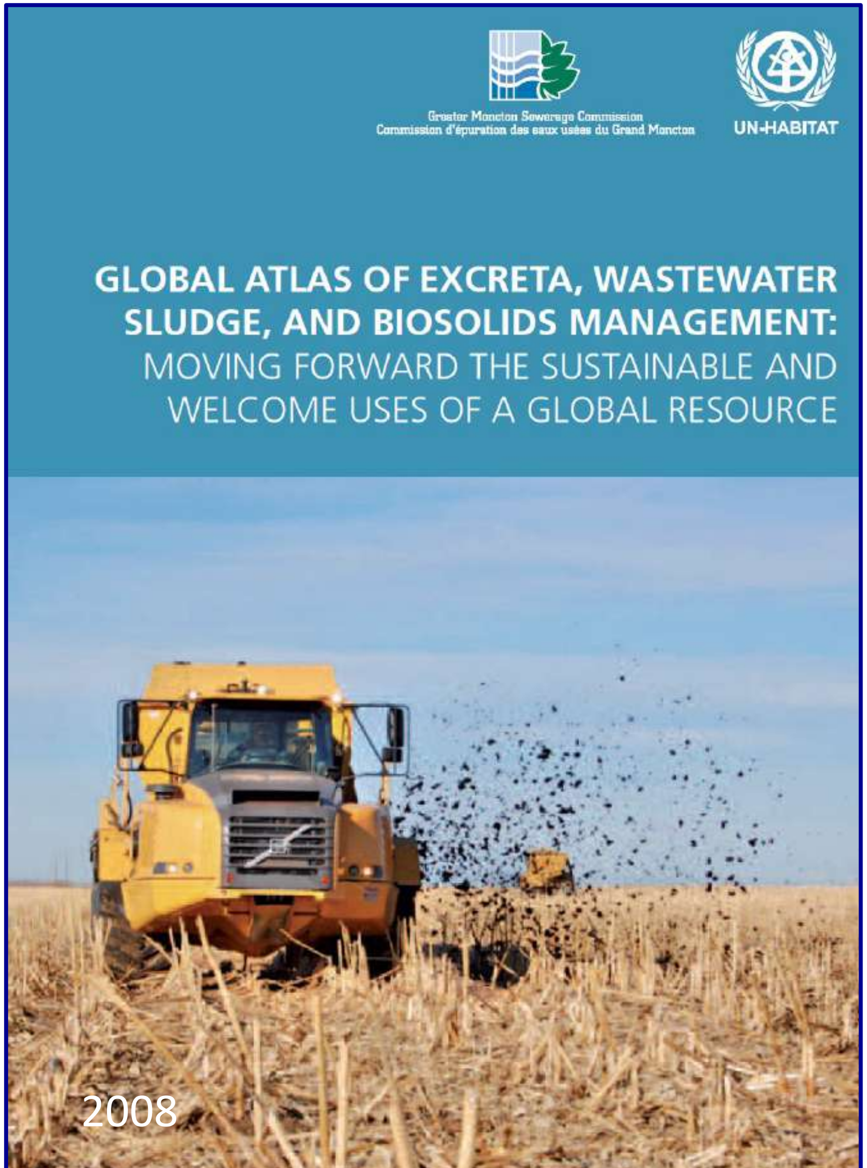
The objectives of the UN-HABITAT Atlas is to present the big picture of global management of excreta and wastewater sludge.

Around 2.6 billions of the world's people lack basic sanitation. The target is to shift them up on the first sanitation ladder.

For countries moving up on the second sanitation ladder by sewerage coverage and wastewater treatment, the concern will be related to safe disposal of treated effluents including sludge.

While basic sanitation necessity in developing countries is a public health concern. Heavy metals and chemicals have been the focus of concern with regards to wastewater sludge management in developed countries.

UN HABITAT, Global Atlas of Excreta, Wastewater, Sludge and Biosolids Management



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Countries which have succeeded to achieve the MDGs are moving ahead to implement sewerage and treatment of wastewater collected from urban and rural communities. Primary treatment is still an option, secondary treatment in the most predominant and tertiary treatment is applied as a necessity to meet stringent requirements for disposal in sensitive areas.

Table 9. Levels of wastewater treatment in some middle and, for comparison, higher-income countries

Country	% of population with no wastewater treatment	% of population with primary treatment only	% of population with secondary and greater treatment
Canada	~0%	10%	90%
China – Hong Kong	30% (preliminary treatment only)	53%	17%
Germany	~0%	6%	94% (including nutrient re-moval & tertiary purification)
Mexico	59% (ponds, advance anaerobic treatment)	41%	
Portugal	39%	19%	43% (24% have tertiary treatment too)
Turkey		9%	91% (up from 63% in 1994)

Countries which have succeeded to achieve the MDGs are moving ahead to implement sewerage and treatment of wastewater collected from urban and rural communities.

Primary treatment is still an option, secondary treatment in the most predominant and tertiary treatment is applied as a necessity to meet stringent requirements for disposal in sensitive areas.

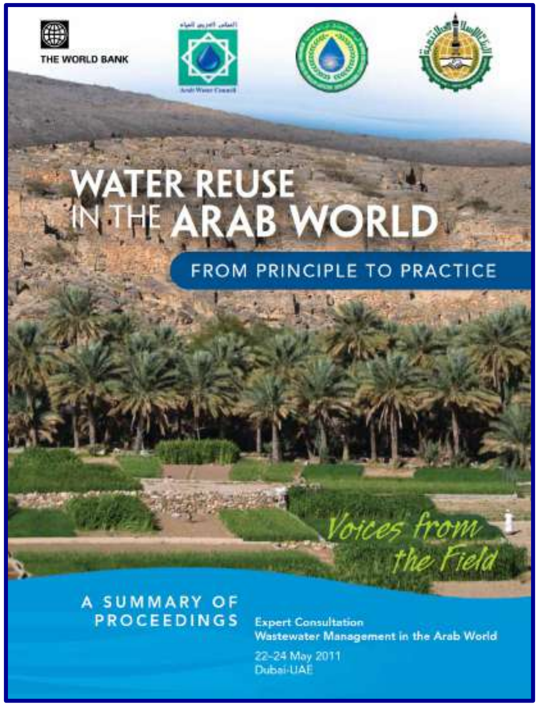
Proper sludge management is coasty and requires proper planning, design and O&M

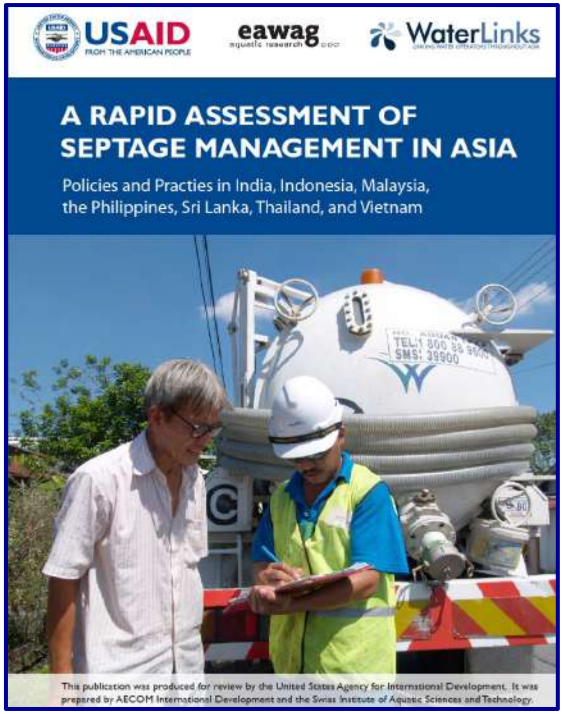
Table 5. Estimated percentage of total wastewater costs required for wastewater sludge management

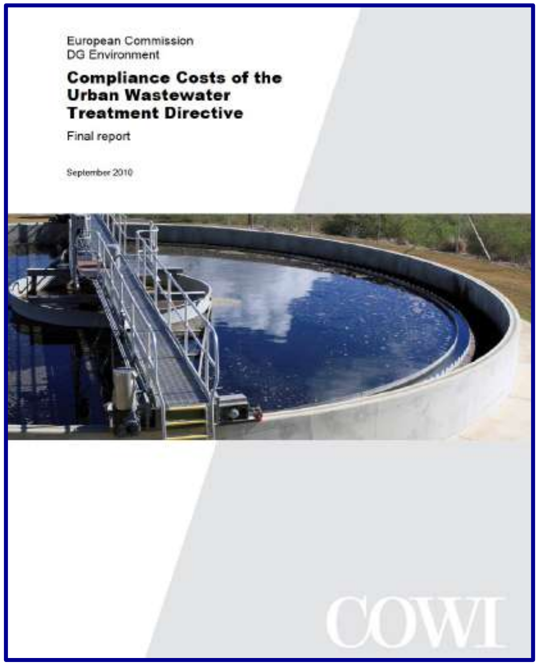
Country or City	Estimated percentage of total wastewater treatment costs attributable to wastewater sludge treatment and management
Austria	45%
Bulgaria	20%
Canada: Greater Moncton	50%
Canada: Ontario	50%
Canada: Montréal, Québec	45% (operations & maintenance only)
Canada: British Columbia	30%
Canada: Alberta	18%
Czech Republic	57% (operations & maintenance only)
China	40%
Columbia	3%
England	18%
Japan: Tokyo	36%
Norway	50% (20% estimated in 1996 Atlas)
Russian Federation	24%
Slovakia	40%
Turkey	45%
USA: Milwaukee, WI	57% (operations & maintenance only)

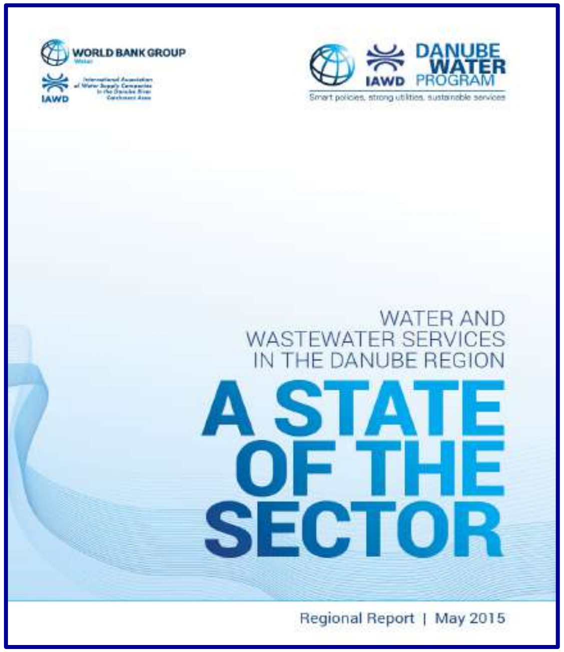
2. Regional Overview

2.1 The Arab Region
2.2 South Asia
2.3 EU Member States
2.4. Danube Watershed Countries





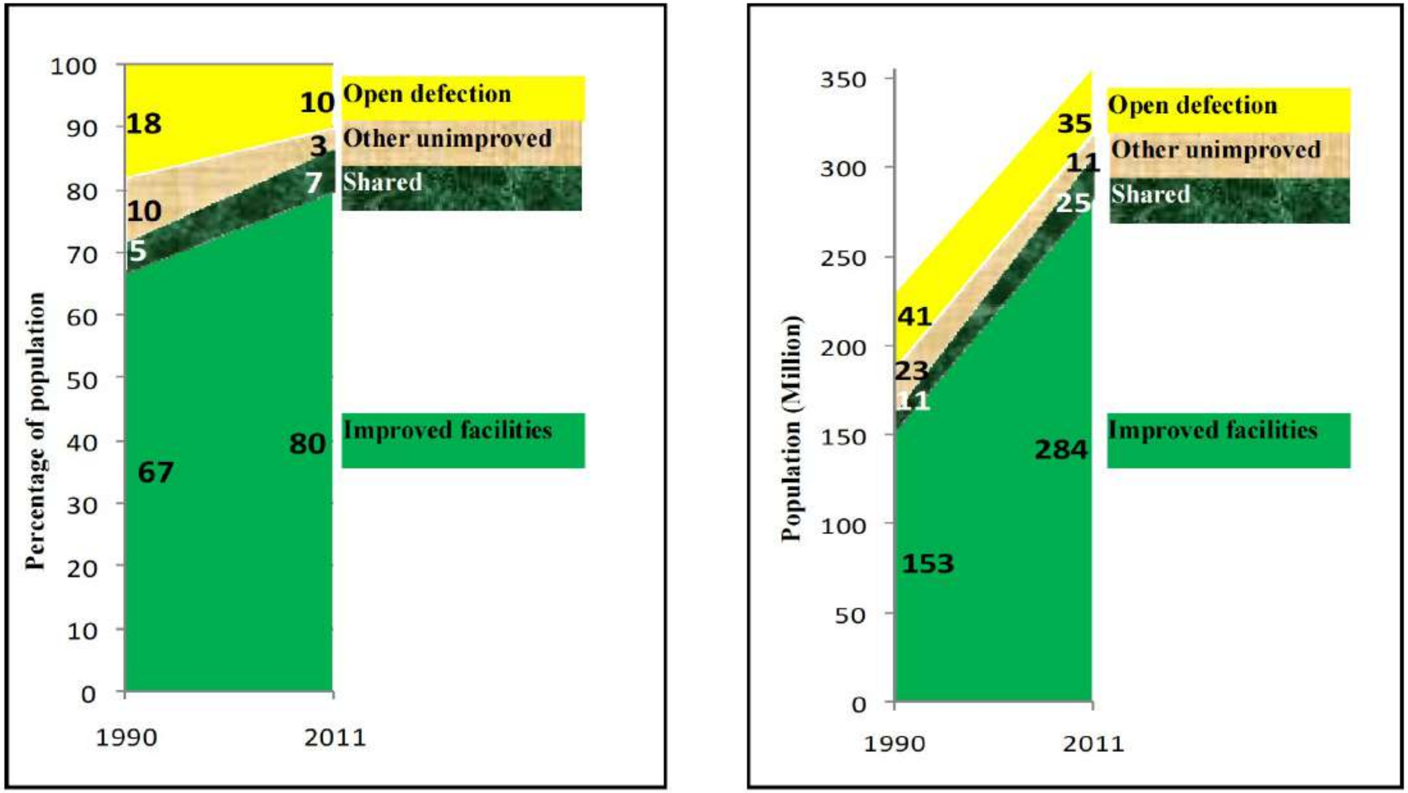




2.1 The Arab Region

Reported results in ESCWA Water Development Report, 2013

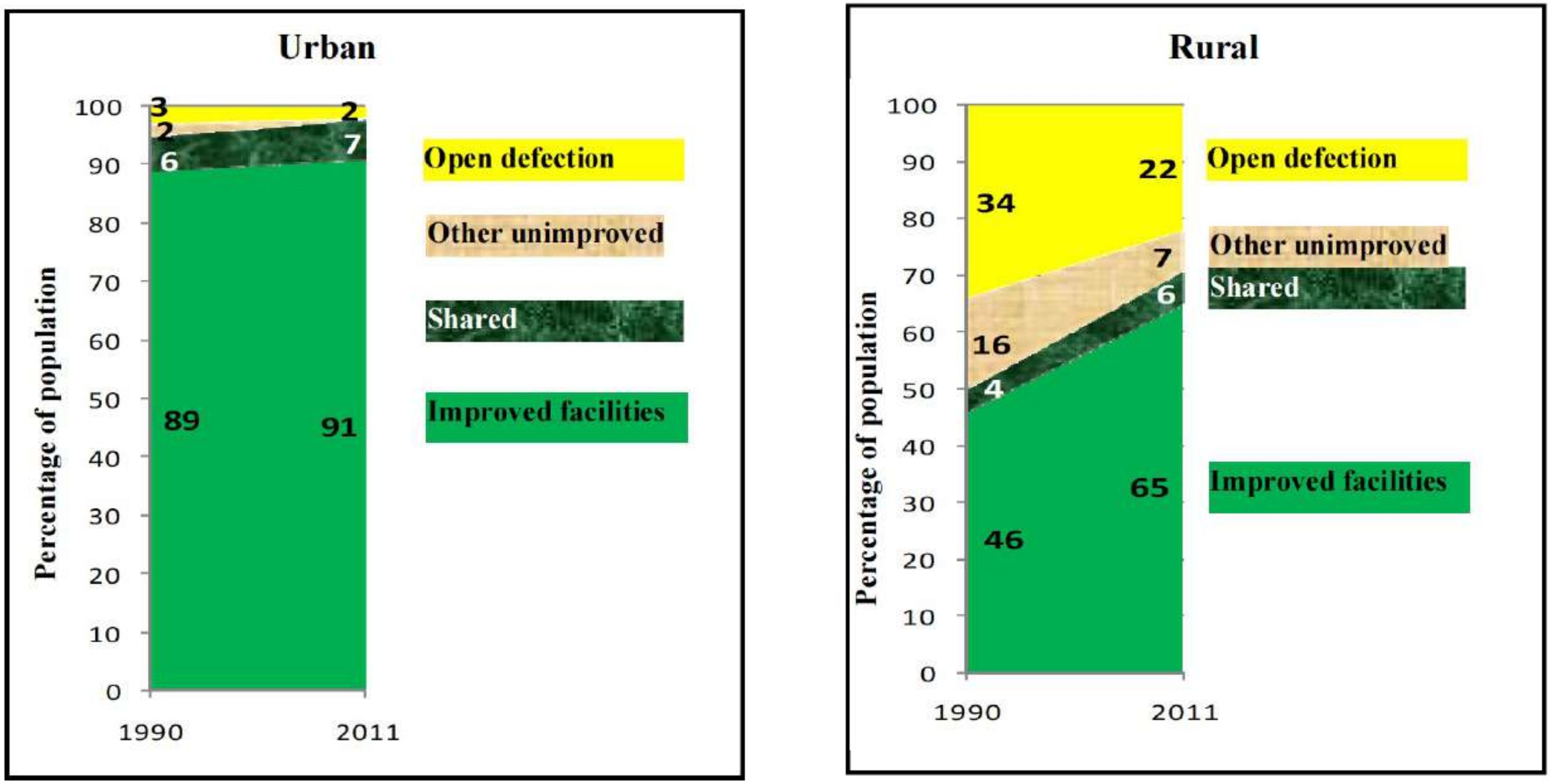
Figure 11. Sanitation coverage trends for the Arab region, 1990-2011



Source: ESCWA, based on the online database of WHO/UNICEF Joint Monitoring Programme – updated data 2011 (accessed June 2013).

Note: In 1990, data were not available for Iraq, Lebanon, Palestine and Somalia. In 2011, data were not available for Comoros and Lebanon.

Figure 12. Urban/rural sanitation coverage trends for the Arab region, 1990-2011

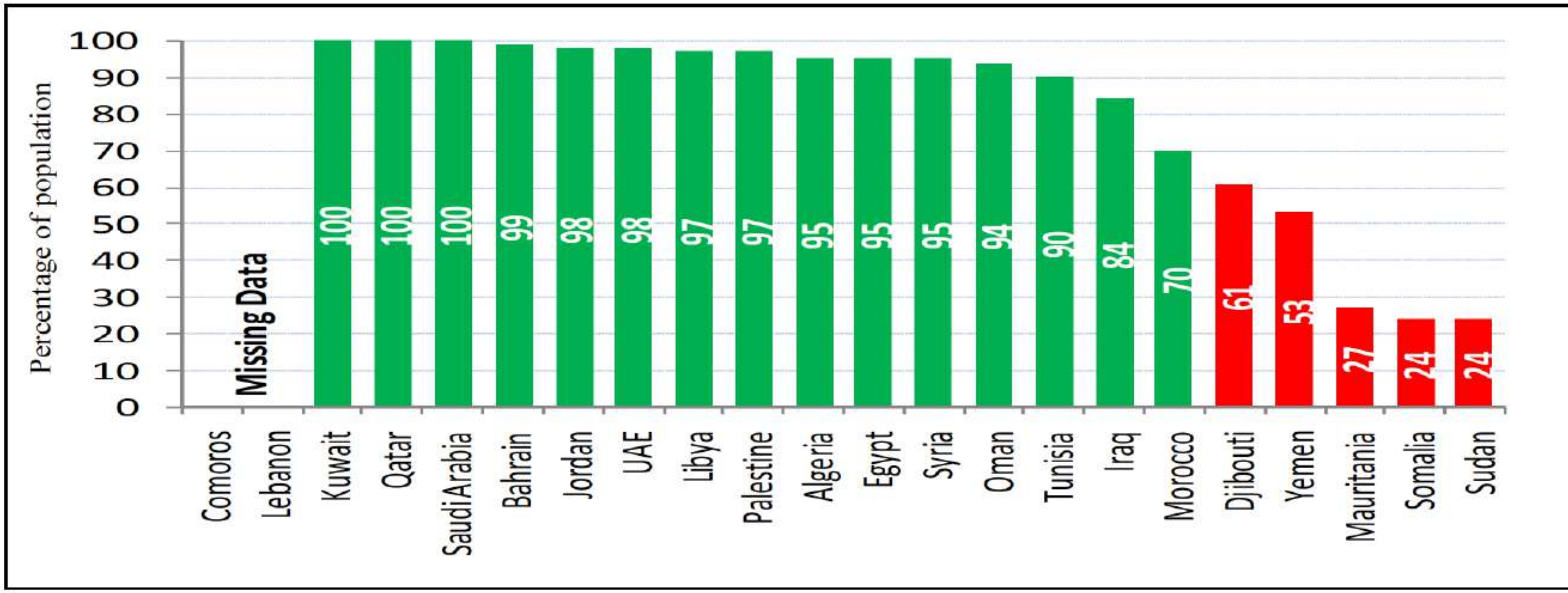


Source: ESCWA, based on the online database of WHO/UNICEF Joint Monitoring Programme – updated data 2011 (accessed June 2013).

Note: In 1990, data were not available for Iraq, Lebanon, Palestine and Somalia. In 2011, data were not available for Comoros and Lebanon.

Basic Sanitation in Arab Countries as per the UNICEF/WHO sanitation ladder

Figure 13. Sanitation coverage in Arab countries, 2011



Source: ESCWA, based on the online database of WHO/UNICEF Joint Monitoring Programme – updated data 2011 (accessed June 2013).

Basic Sanitation in Arab Countries as per the UNICEF/WHO sanitation ladder

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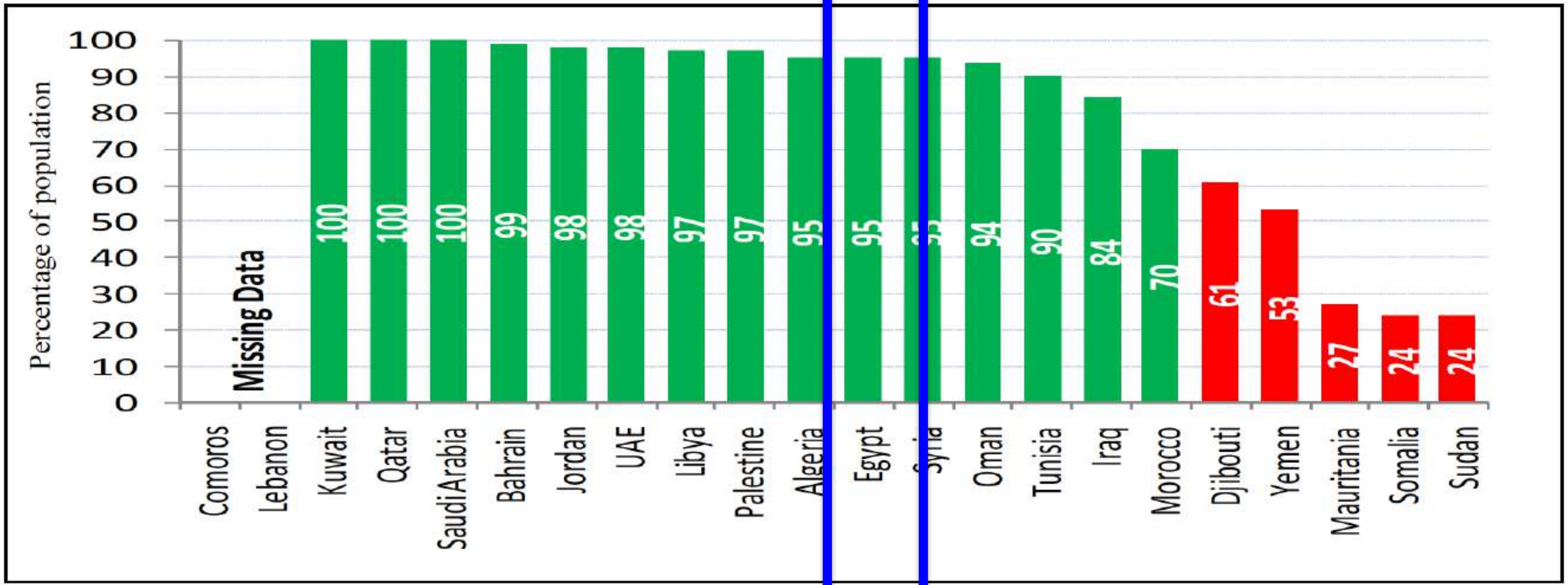
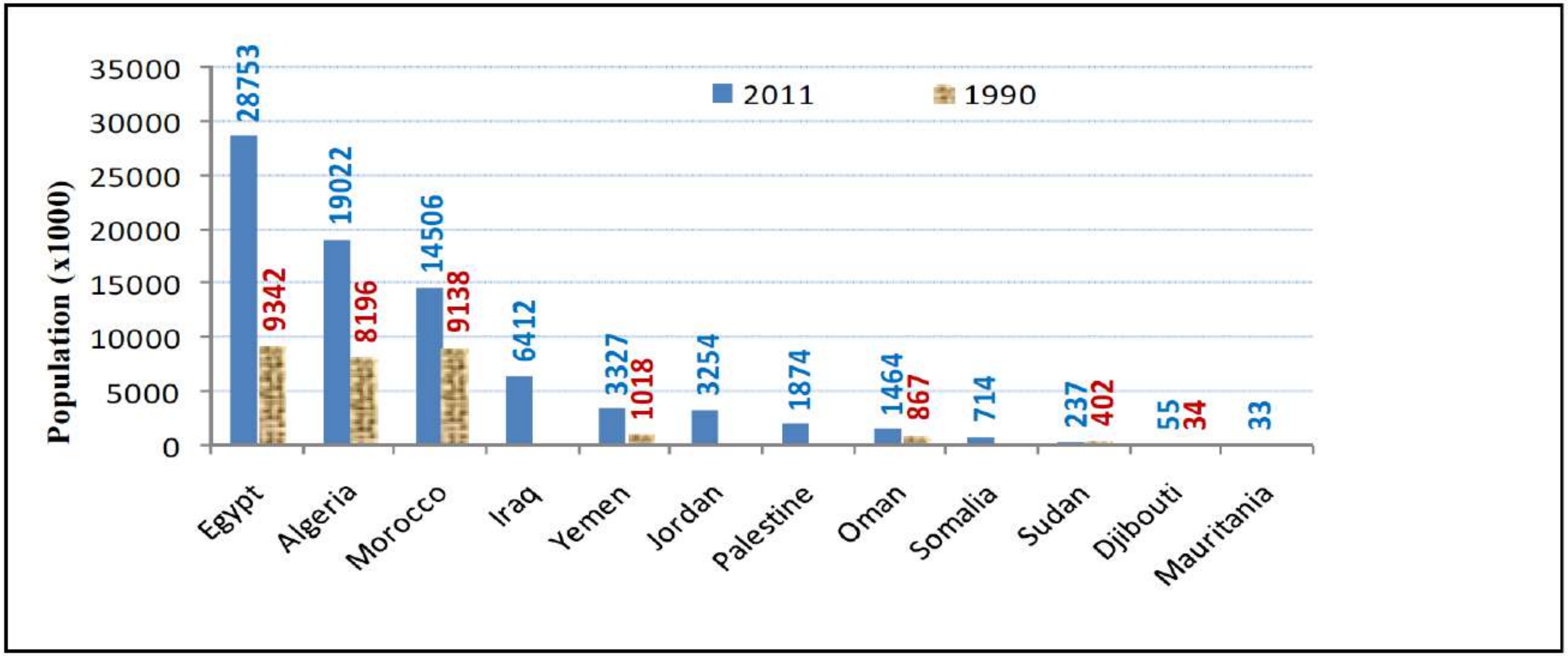


Source: ESCWA, based on the online database of WHO/UNICEF Joint Monitoring Programme – updated data 2011 (accessed June 2013).

Figure 23. Urban population using toilets connected to piped sewer systems, 2011 and 1990



Source: ESCWA, based on WHO/UNICEF – JMP country files.

Note: Data are missing for Bahrain, Comoros, Kuwait, Lebanon, Libya, Qatar, Saudi Arabia, Syrian Arab Republic, Tunisia and United Arab Emirates.

Rural population coverage (%) with sewerage. Egypt reported number is 18.4% in 2011

Percentages of the population using toilets connected to piped sewer systems in rural areas in Arab countries

Country	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Algeria	33.6	33.6	33.6	33.6	35.0	36.3	37.7	39.1	40.5	41.8	43.2	44.6	46.0	47.3	48.7	50.1	51.5	52.8	54.2	54.2	54.2	54.2
Bahrain																						
Comoros	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3		
Djibouti		0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Egypt	3.0	3.8	4.5	5.3	6.1	6.8	7.6	8.4	9.1	9.9	10.7	11.4	12.2	13.0	13.7	14.5	15.3	16.1	16.8	17.6	18.4	18.4
Iraq					0.6	0.6	0.6	0.6	0.6	0.7	0.9	1.0	1.2	1.4	1.5	1.7	1.8	2.0	2.2	2.3	2.3	2.3
Jordan									2.8	2.8	2.8	2.8	2.8	3.1	3.4	3.7	4.0	4.3	4.6	4.9	5.2	5.5
Kuwait																						
Lebanon																						
Libya																						
Mauritania						0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Morocco																						
Oman	70.3	70.3	70.3	70.3	70.3	70.3	70.3	70.3	70.3	70.3	70.3	70.3	70.3	70.3	70.3	70.3	70.3	70.3	70.3	70.3	70.3	70.3
Palestine		3.8	3.8	3.8	3.8	3.8	4.2	4.7	5.1	5.5	6.0	6.4	6.9	7.3	7.8	8.2	8.7	9.1	9.6	9.6	9.6	9.6
Qatar																						
Saudi Arabia																						
Somalia				1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.1	1.1	1.1	1.1	1.1	1.1	1.2	1.2	1.2	1.2	1.2
The Sudan	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Syrian Arab Republic	28.9	28.9	28.9	28.9	28.9	30.2	31.5	32.8	34.1	35.4	36.7	38.0	39.4	40.7	42.0	43.3	44.6	45.9	47.2	47.2	47.2	
Tunisia							5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1		
United Arab Emirates														60.1								
Yemen	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0

Rural population coverage (%) with sewerage. Egypt reported number is 18.4% in 2011

Percentages of the population using toilets connected to piped sewer systems in rural areas in Arab countries

Country	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Algeria	33.6	33.6	33.6	33.6	35.0	36.3	37.7	39.1	40.5	41.8	43.2	44.6	46.0	47.3	48.7	50.1	51.5	52.8	54.2	54.2	54.2	54.2
Bahrain																						
Comoros	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3		
Djibouti		0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Egypt	3.0	3.8	4.5	5.3	6.1	6.8	7.6	8.4	9.1	9.9	10.7	11.4	12.2	13.0	13.7	14.5	15.3	16.1	16.8	17.6	18.4	18.4
Iraq					0.6	0.6	0.6	0.6	0.6	0.7	0.9	1.0	1.2	1.4	1.5	1.7	1.8	2.0	2.2	2.3	2.3	2.3
Jordan									2.8	2.8	2.8	2.8	2.8	3.1	3.4	3.7	4.0	4.3	4.6	4.9	5.2	5.5
Kuwait																						
Lebanon																						
Libya																						
Mauritania						0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Morocco																						
Oman	70.3	70.3	70.3	70.3	70.3	70.3	70.3	70.3	70.3	70.3	70.3	70.3	70.3	70.3	70.3	70.3	70.3	70.3	70.3	70.3	70.3	70.3
Palestine		3.8	3.8	3.8	3.8	3.8	4.2	4.7	5.1	5.5	6.0	6.4	6.9	7.3	7.8	8.2	8.7	9.1	9.6	9.6	9.6	9.6
Qatar																						
Saudi Arabia																						
Somalia				1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.1	1.1	1.1	1.1	1.1	1.1	1.2	1.2	1.2	1.2	1.2
The Sudan	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Syrian Arab Republic	28.9	28.9	28.9	28.9	28.9	30.2	31.5	32.8	34.1	35.4	36.7	38.0	39.4	40.7	42.0	43.3	44.6	45.9	47.2	47.2	47.2	
Tunisia							5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1		
United Arab Emirates														60.1								
Yemen	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0

Table 1: Sewerage Coverage in Urban and Rural Areas, and Wastewater Treatment and Reuse Rates in the Middle East and North Africa

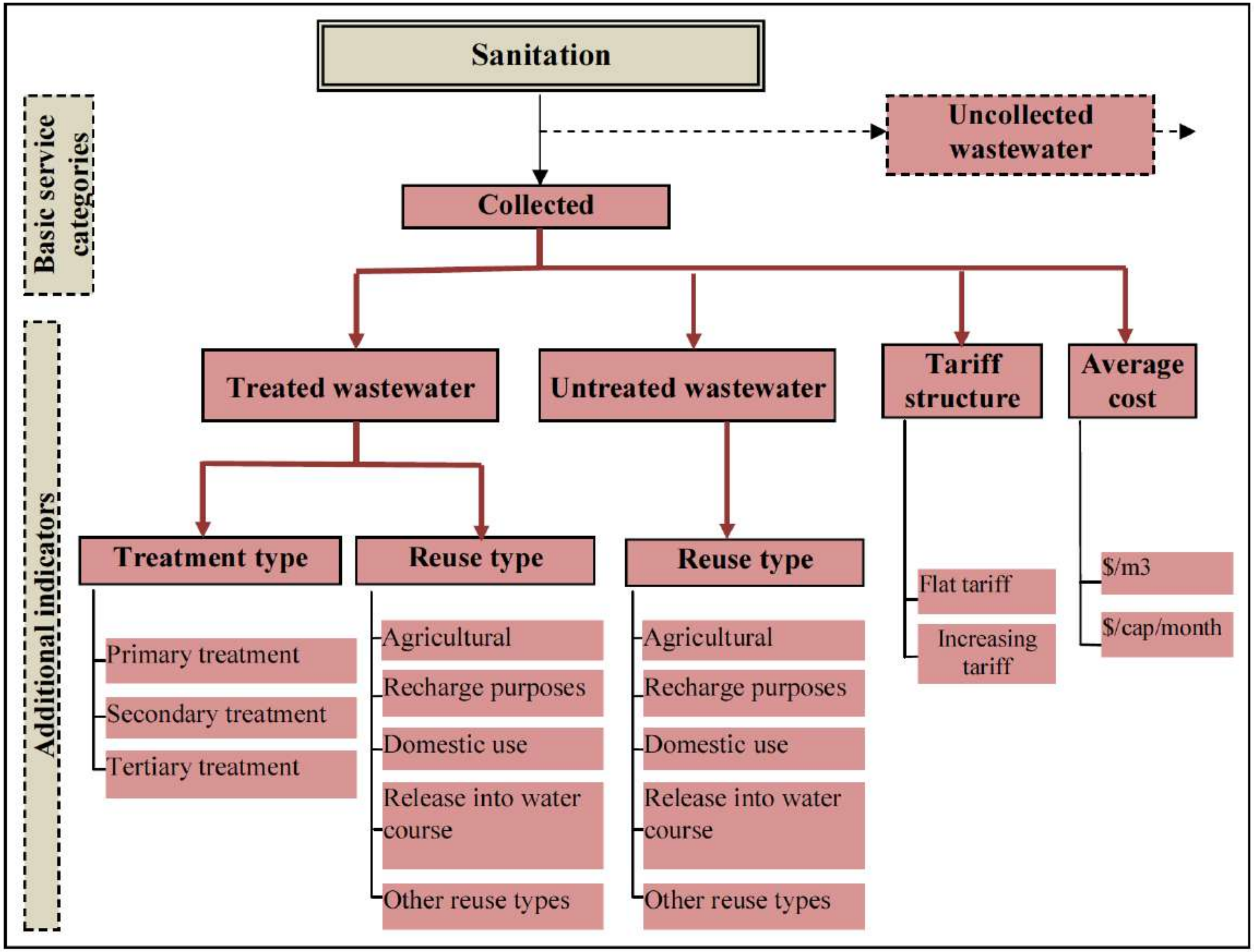
Country	Sewerage rate to piped network (% of households connected) A. Urban	B. Rural	C. Overall	D. Treatment rate (% of collected wastewater by volume)	E. Treatment rate (Est. % of wastewater by volume)[a]	F. Reuse efficiency (% of treated wastewater by volume)	G. WRI (Est. % of all wastewater by volume)[a]
Algeria	92	50	77	73	56	Na	Na
Bahrain	Na	Na	77	100	77	16-20	14
Egypt	74	18	42	79	33	24	9
Iran	17	0.2	11	4	0.4	Na	Na
Iraq	37	2.4	25	Na		Na	Na
Israel	100	Na	92-95	63	60	99	59
Jordan	67	5.9	54	88	47	76	39
Kuwait	Na	Na	>99	100	99	63	63
Lebanon	100	22	89	2	2	50	1
Libya	54	54	54	7	4	100	5
Morocco	86 (old data)	3.3 (old data)	73	20	3	6	0
Oman	90	51	79	34	27	66	23
Palestine	57	7	43	Na		Na	Na
Qatar	Na	Na	78	100	78	50	44
Saudi Arabia	44	0	35	75	26	40	12
Syria	96	45	72	40	29	78	27
Tunisia	79	8.9	54	79	43	20	11
UAE	93	63	87	Na	87	25	25
Yemen	42	0.4	12	62	8	40	11

Notes: Na: Data not available; [a] Estimate only since the sewerage rate does not correspond to the volume collected but rather to the % of households connected. WRI = Wastewater Reuse Index.

Sources: Author's calculations using data from Aquastat database (FAO 2010), Kfouri et al. (2009), Jimenez and Asano (2008), Global Water Intelligence 2010 (http://www.globalwaterintel.com), and country reports from the JMP (World Health Organization and UNICEF 2010).

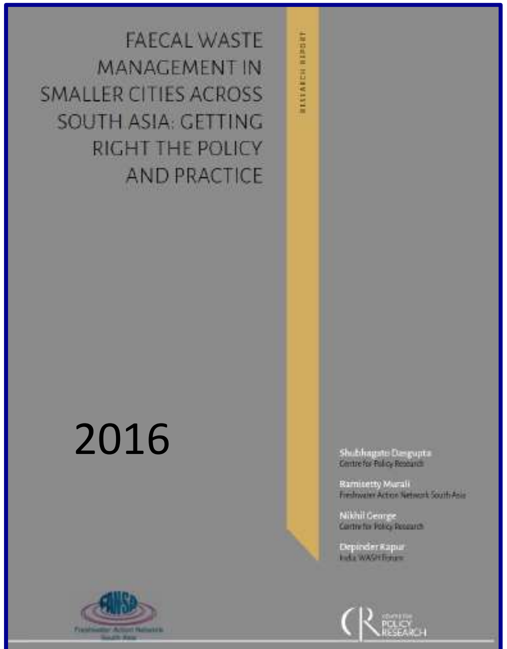
Source: Jeuland, M., Creating Incentives for more Effective Wastewater reuse in MENA Region, September, 2011

ESCWA proposed scheme for future data collection, which goes beyond the sanitation ladder as presented in the Global Overview



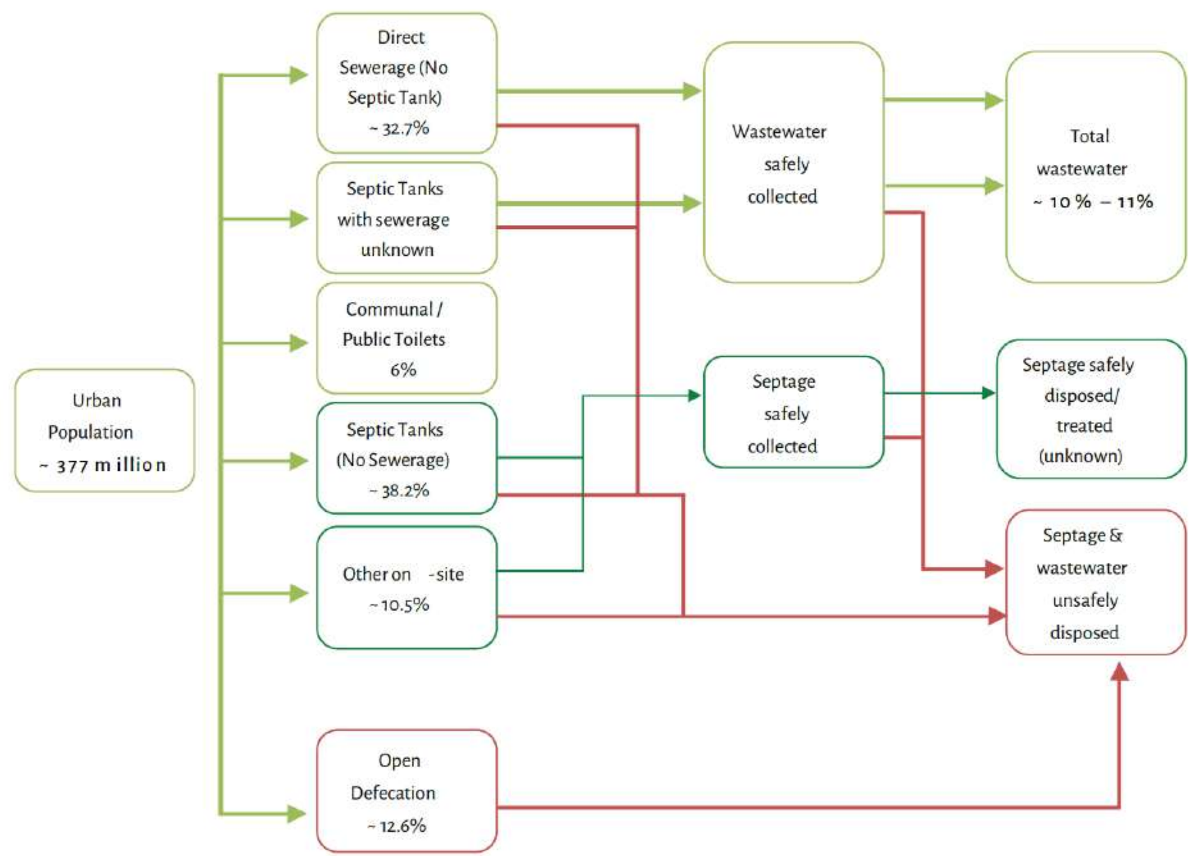
Source: ESCWA.

2.2 South Asia



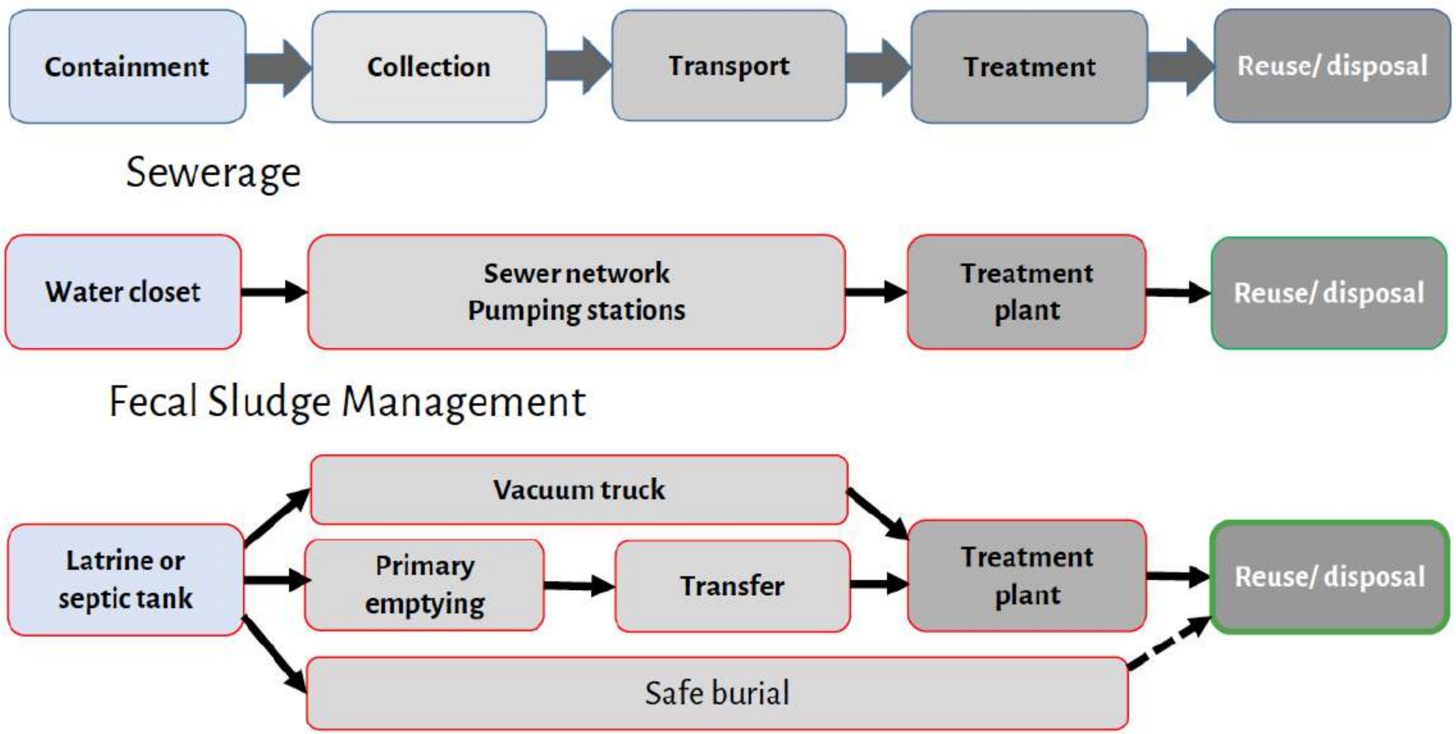
Example: Urban India

Figure 5: Outline wastewater flow diagram for all census urban areas in India



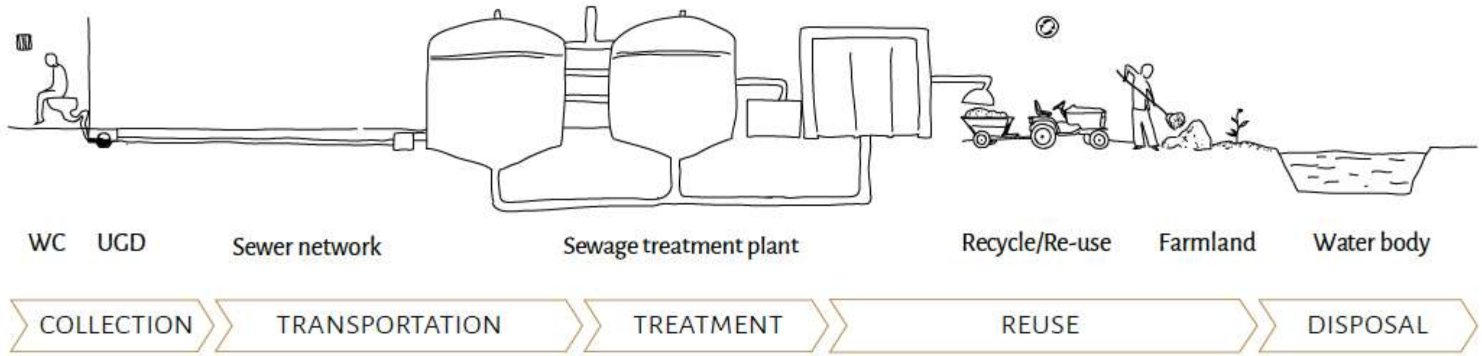
Source: Office of the Registrar General and Census Commissioner of India (2011) and Central Pollution Control Board, India (2009)

Figure 8: Schematic Representation of Wastewater Management



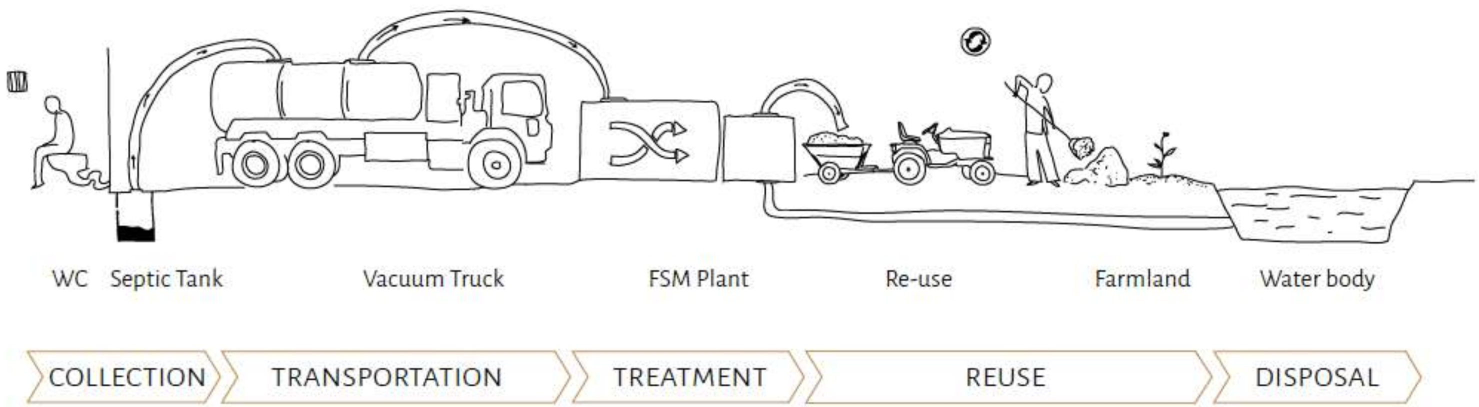
Source: Blackett, Hawkins, & Peal (2014)

Figure 9: Underground Sewerage based urban sanitation system



Source: Dasgupta, et al. (2015)

Figure 10: Faecal sludge management based urban sanitation system



Source: Dasgupta, et al. (2015)

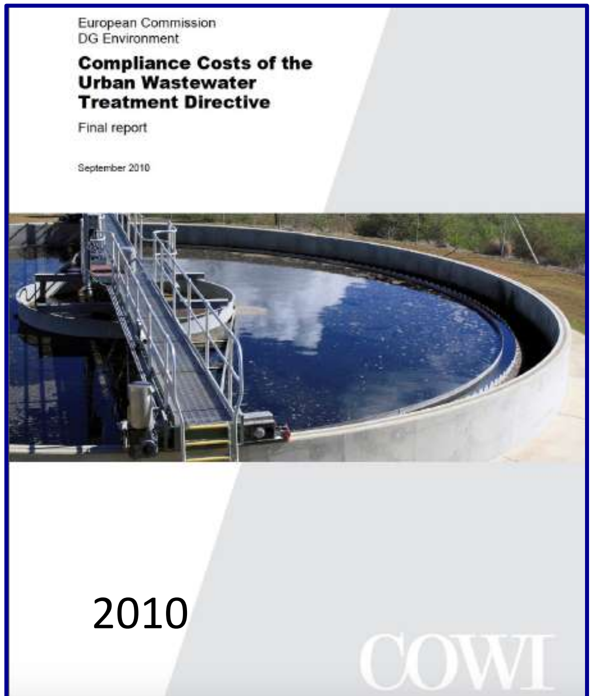
Malaysia Faecal Sludge Management

Source: Presentation from workshop on innovations & scaling-up to city-wide sanitation, October 2012, Ahmedabad

Malaysia Faecal Sludge Management

Source: Presentation from workshop on innovations & scaling-up to city-wide sanitation, October 2012, Ahmedabad

2.3 EU Member States



The overall objective of the study is to estimate the compliance costs related to the Urban Wastewater Treatment Directive (UWWTD) in 27 member states and to assess whether the estimated investment cost can be covered by available finance.

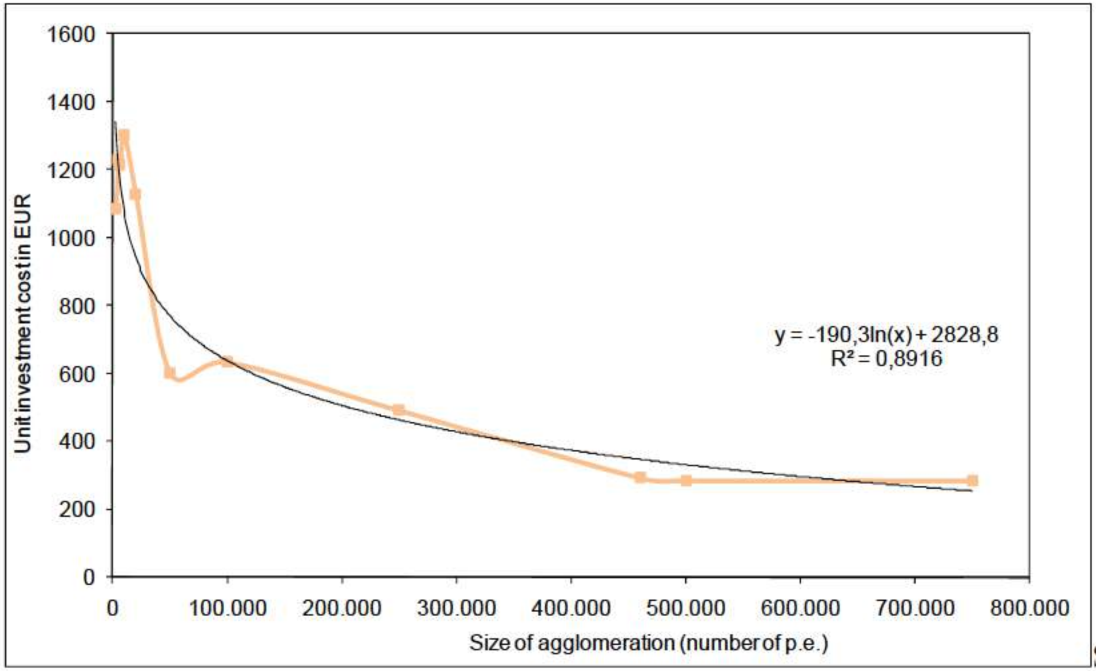
The key requirements in the directive are articles 3,4 and 5. Article 3 is about the collection of wastewater in agglomerations above 2000 p.e while article 4 is main requirement of secondary treatment of collected wastewater. Article 5 relates to the demand for more stringent treatment when discharge is to sensitive water bodies.

Collection Systems Cost Estimation

The generic cost function for the collection system has been developed based on the following:

- Function of the total length of pipe with number of p.e
- Distribution of pipe length on pipe diameters
- Cost for each diameter size

Figure 3-1 Replacement value function for wastewater collection networks



Source: Consultant's estimate

Wastewater Treatment Cost

Wastewater treatment cost functions were developed based on the following combinations:

1 Primary treatment (mechanical)

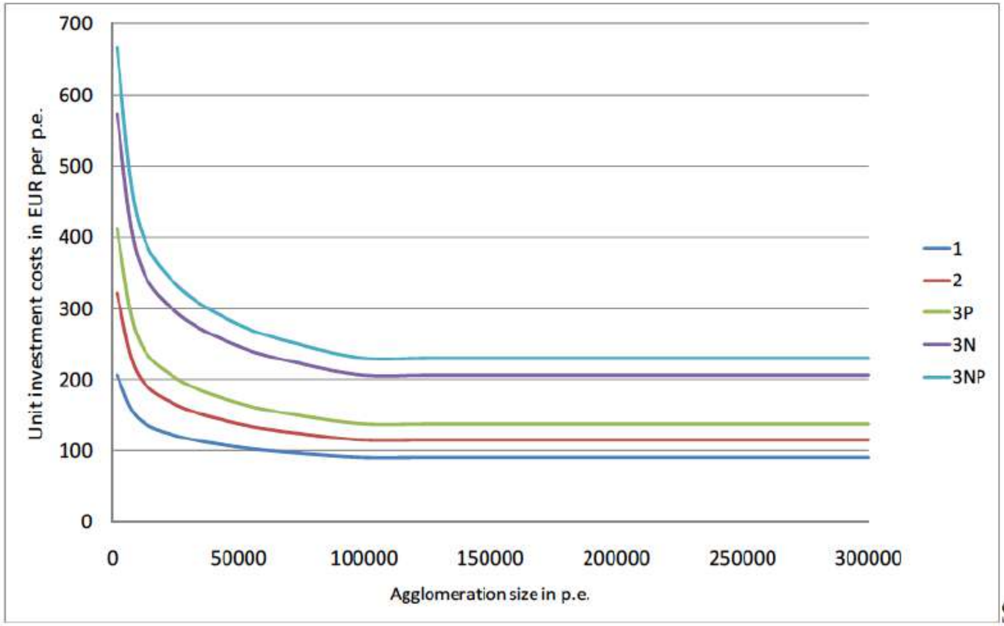
2 Secondary treatment (Mechanical-Biological)

3P Advanced treatment with P removal (mechanical-Biological-Chemical)

3N Advanced treatment with N removal (Mechanical-Biological-Chemical-Nitrification)

3NP Advanced treatment with removal of both N and P (Mechanical-Biological-Nitrification-DE nitrification-Organic P)

Figure 3-2 Investment expenditure functions for wastewater treatment



Source: Consultant's estimate

Sample summary table showing investments required for each country to comply with the three relevant articles in the UWWTD.

The study addressed:

- Supply of finance
- Financing gap

Table 4-3 Overview of investment compliance cost estimates - million EUR from 2005/2006 until relevant compliance date

	Article 3	Article 4	Article 5	Total
Austria	0	0	0	0
Belgium	223	107	832	1,161
Bulgaria	4,208	126	790	5,125
Cyprus	295	50	18	363
Czech Republic	845	244	435	1,524
Denmark	0	0	13	13
Estonia	117	4	58	178
Finland	0	0	243	243
France	0	198	1,424	1,623
Greece	599	279	12	890
Germany	1	4	0	4
Hungary	0	2	8	10
Ireland	0	53	195	248
Italy	2,040	714	650	3,404

2.4 Danube Watershed Countries

2015

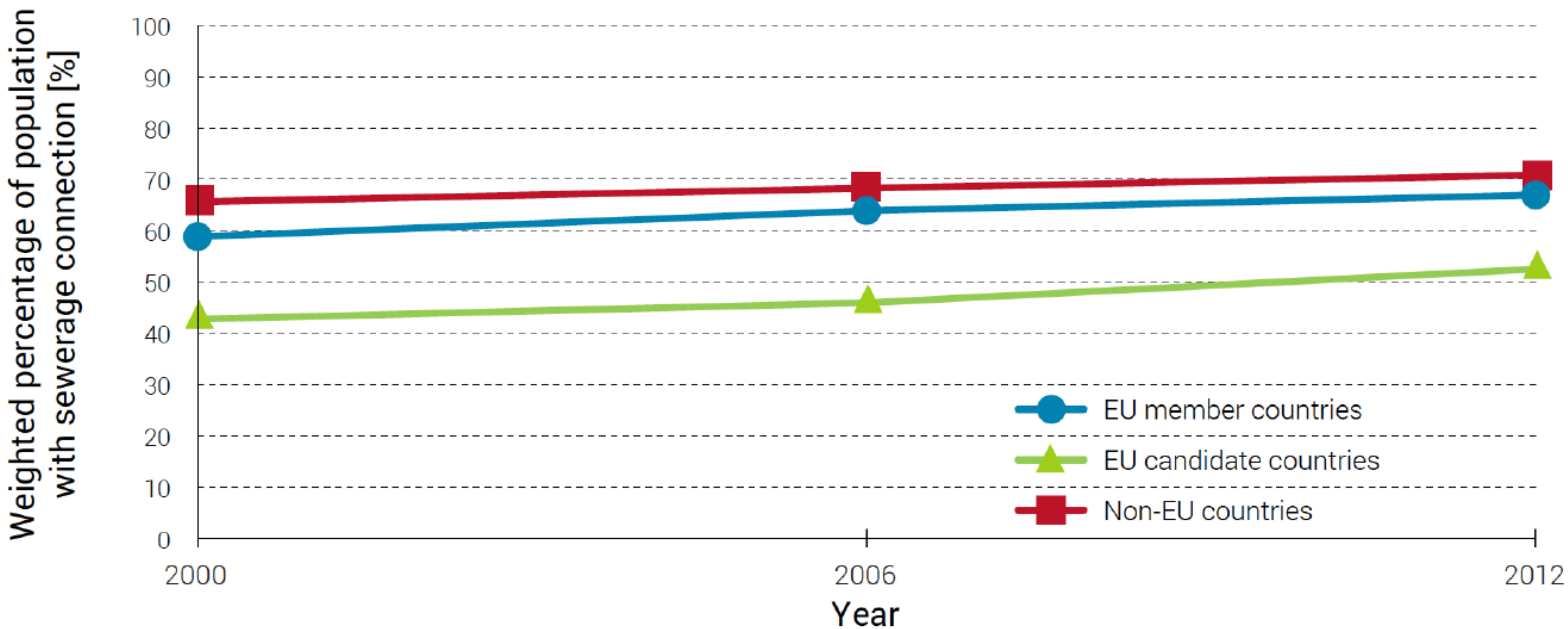
This is an excellent report summarizing the progress and challenges of 16 countries in the Danube watershed in delivering sustainable water and wastewater services.

The report analyzes the organization of services in the region and the level of access to service, that is, how well countries are doing in terms of providing access to water and wastewater service for the entire population. It then looks at the performance of the sector, including the quality of services provided and customer satisfaction with it. It also draws a picture of the efficiency of services, including whether they reflect accepted good practice. Finally, it analyzes the financing of services, looking at whether the financing of O&M and investments is secured and affordable.

Coverage with Sanitation and Sewerage:

Almost 80% of the population in Danube watershed countries report using flush toilet in their dwelling, yet only 66% are connected to public sewer networks. Although progress has been made in the region since 2000, but the rate of progress is indicative to the capacity of countries to increase the coverage level with public sewer networks.

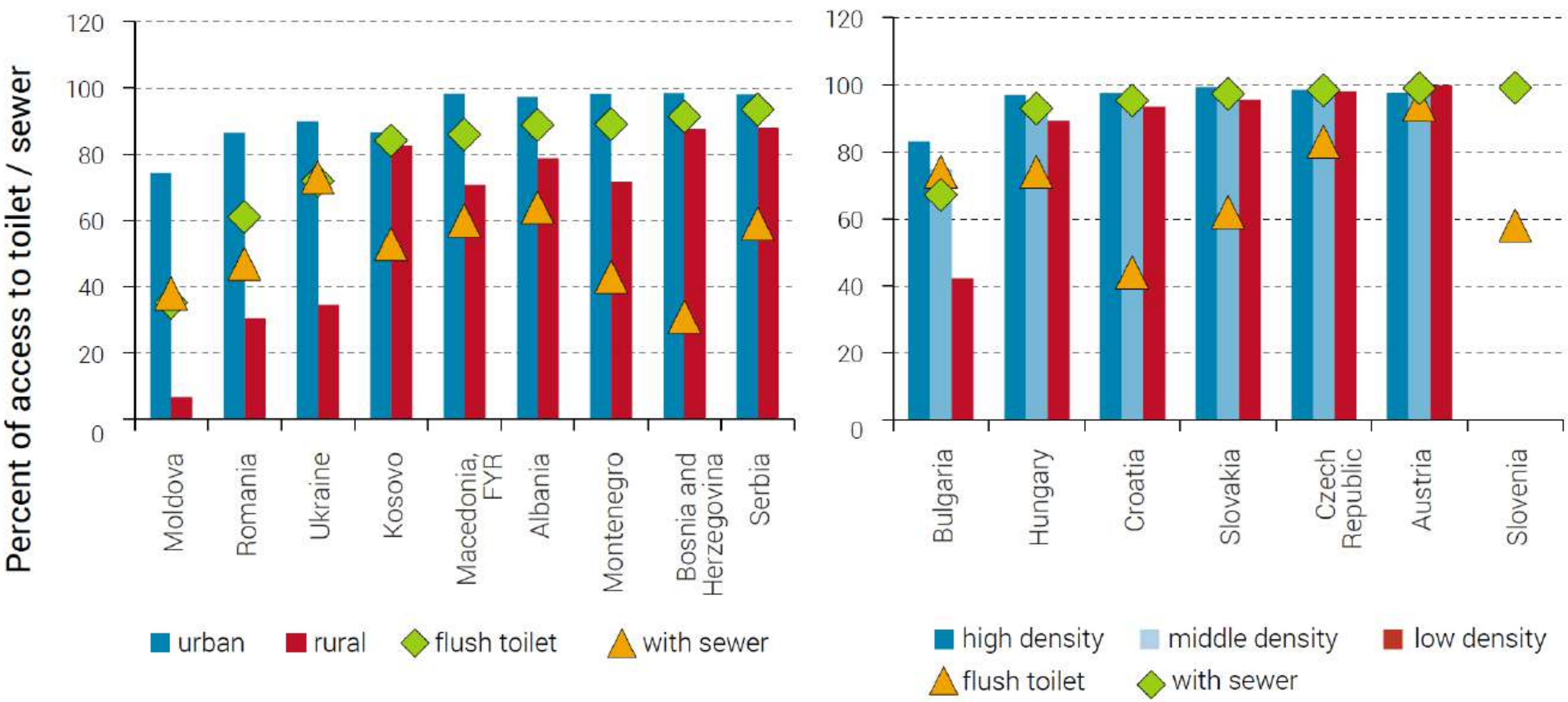
FIGURE 27: SEWERAGE COVERAGE, 2000–12



SOURCE: AUTHORS' ELABORATION FROM SOS DATA COLLECTION.

The figure shows the variation in coverage with different sanitation systems

FIGURE 28: PERCENT OF POPULATION WITH PRIVATE FLUSH TOILET AND SEWER CONNECTIONS, BY LOCATION

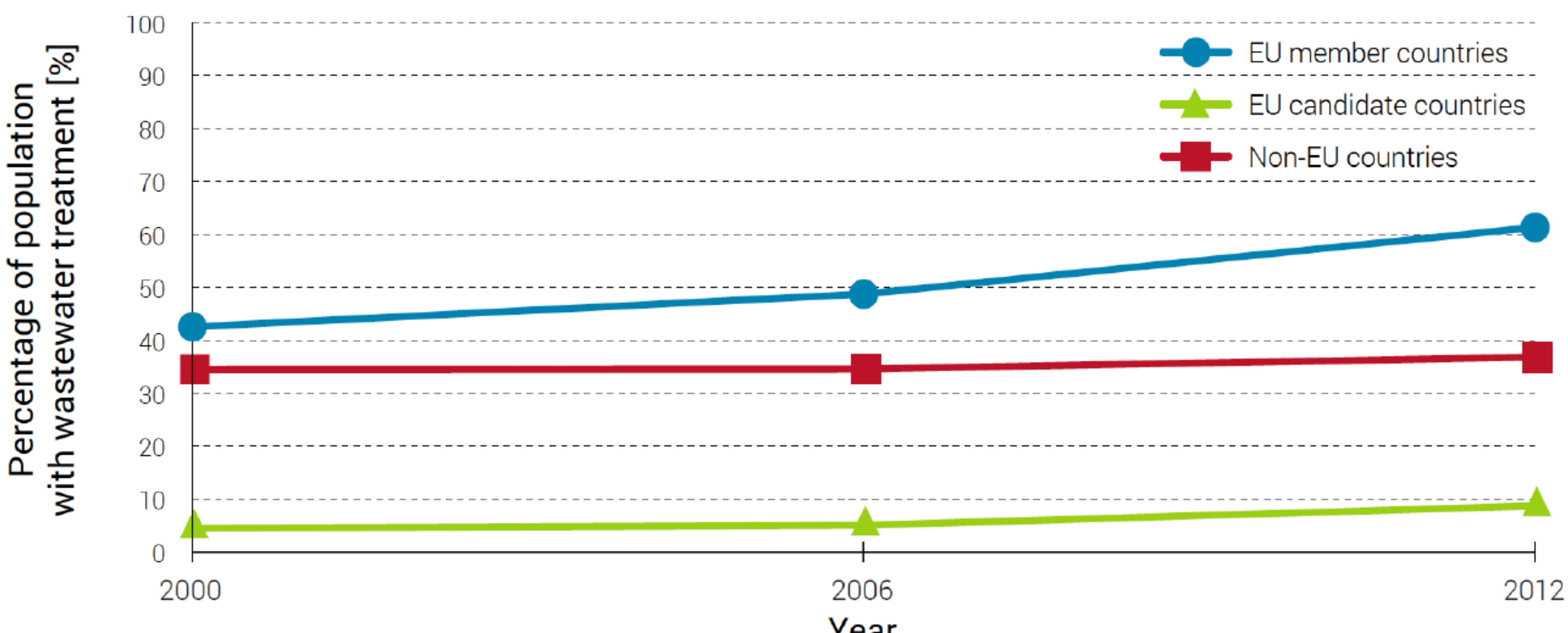


SOURCES: SPATIAL AND AVERAGE ACCESS IS COMPUTED FROM VARIOUS HOUSEHOLD SURVEYS; ACCESS TO SEWERS IS FROM SOS DATA COLLECTION.

Wastewater Treatment:

At present 45% of the total population in the Danube region is connected to wastewater treatment plants, but there are major differences in the percentage of population in individual countries connected to wastewater treatment plants, ranging from 97% in Austria to 2% in Kosovo. The increase of coverage over 12 years period is noticed.

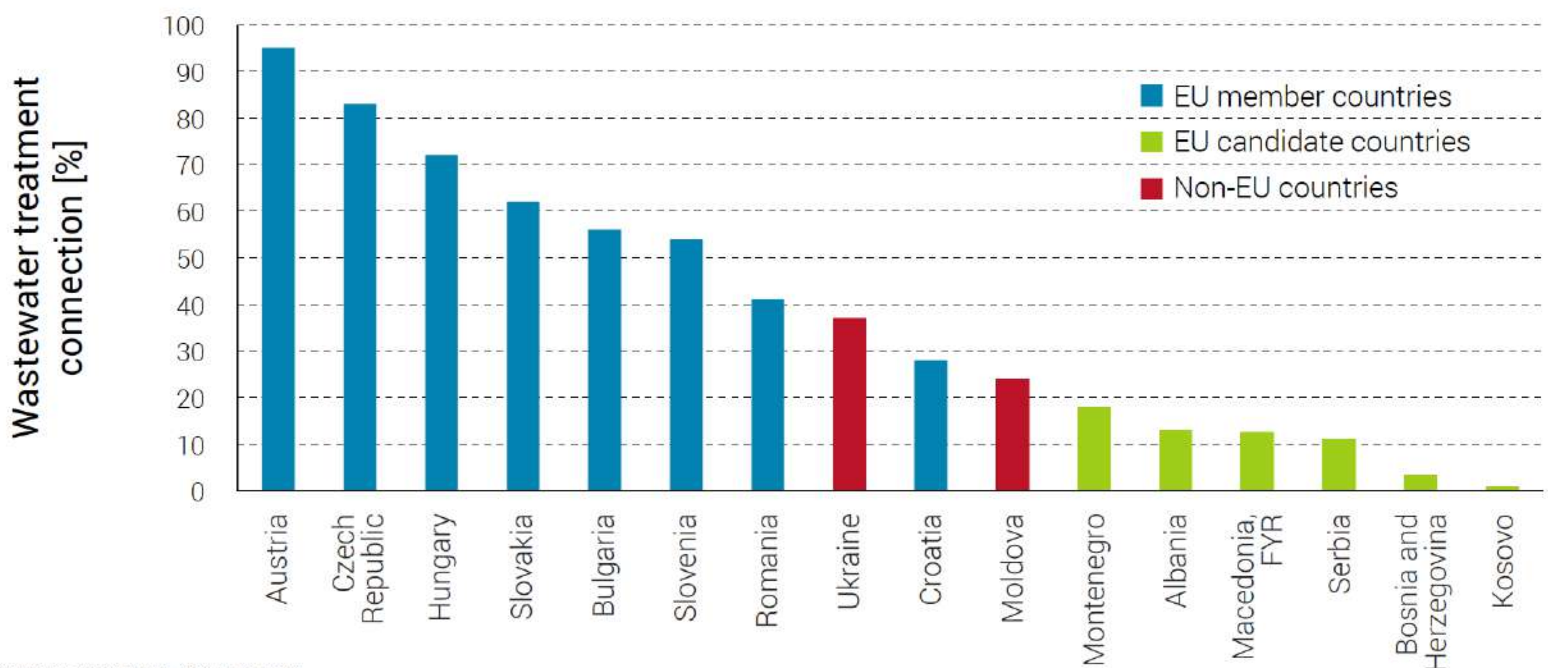
FIGURE 32: COMPARISON OF WASTEWATER TREATMENT COVERAGE CHANGE AMONG EU MEMBER COUNTRIES, EU CANDIDATE COUNTRIES, AND NON-EU COUNTRIES



SOURCE: AUTHORS' ELABORATION BASED ON SOS DATA COLLECTION.

The figure shows the variation in access to public sewers and wastewater treatment coverage among the countries in the Danube region. The data excludes those that have other safe means of excreta disposal such as septic tanks.

FIGURE 31: WASTEWATER TREATMENT COVERAGE IN THE REGION, 2012

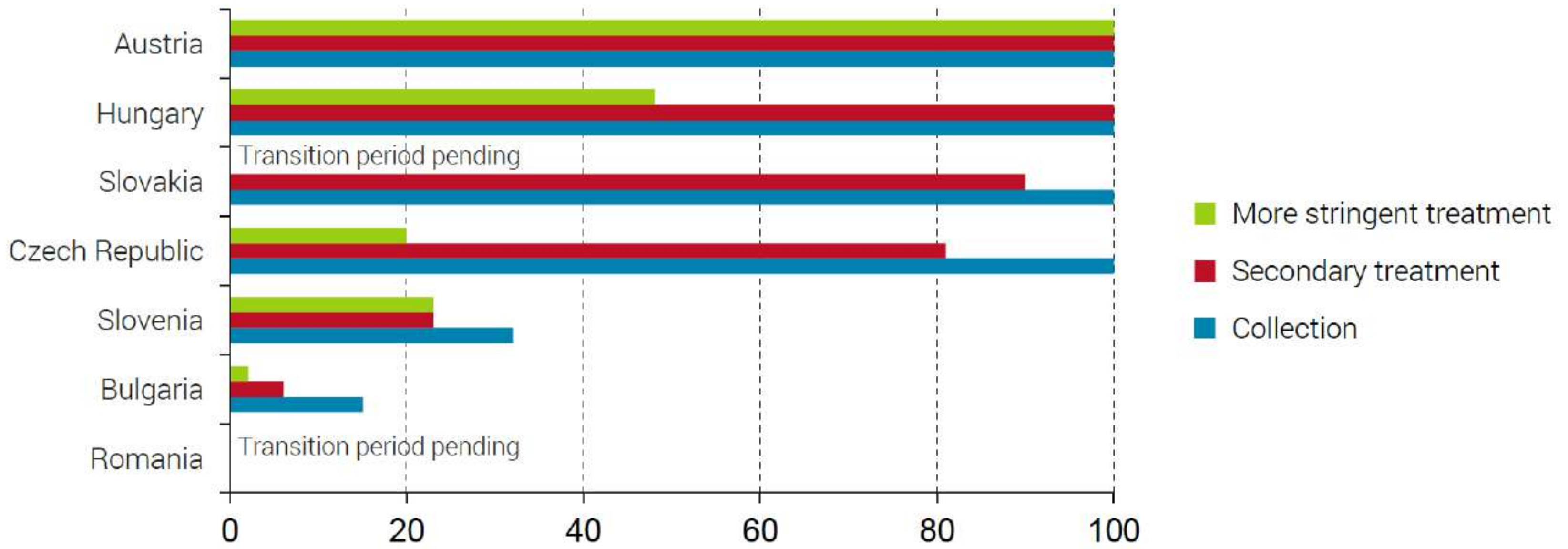


SOURCE: SOS DATA COLLECTION.

Nutrient Removal Requirements in the Danube Basin:

The need to reduce nutrients in the Danube water shed is to protect sensitive areas like the Danube delta and the coastal waters of the Black see suffering from eutrophication. Significant part of the Danube river basin population is required to have tertiary treatment. Deadlines to comply with the UWWT directive have been set according to staged transitional periods. We must study the process of setting these regulations.

FIGURE 33: COMPLIANCE RATES WITH URBAN WASTE WATER DIRECTIVE REQUIREMENTS: COLLECTION, SECONDARY TREATMENT, AND MORE STRINGENT TREATMENT

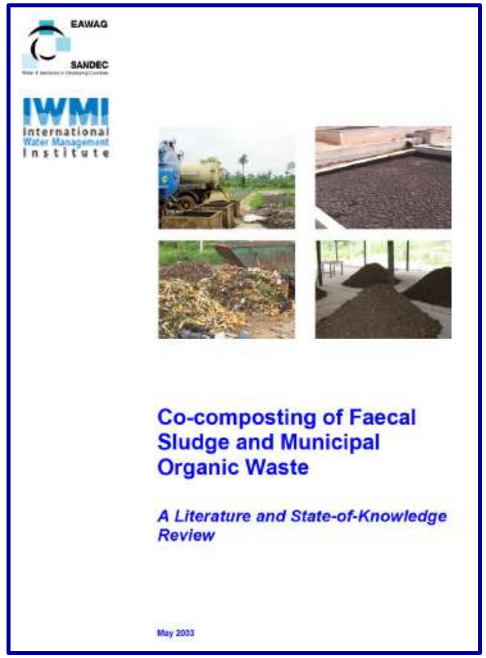


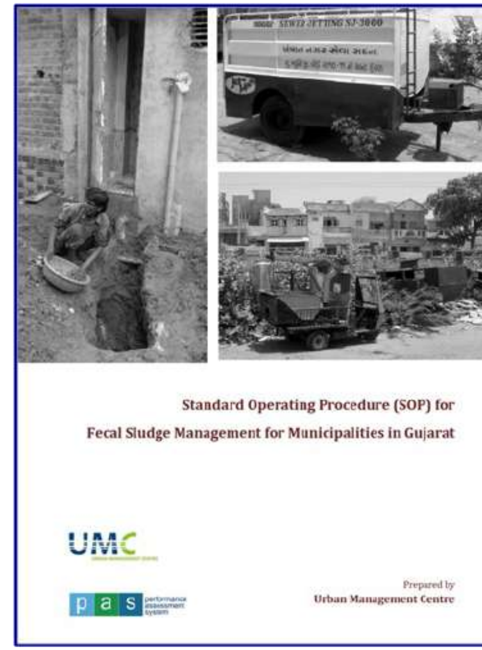
SOURCE: EC 2013, 2, ANNEX.

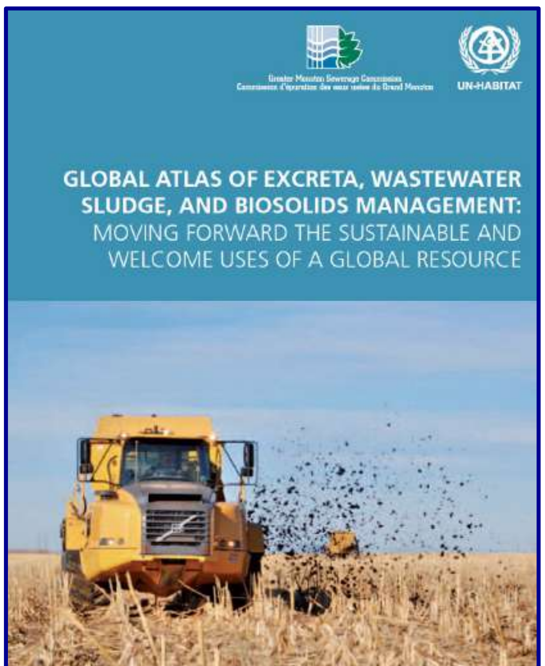
The Danube region study applies an excellent conceptual model for sector analysis and assessment. The model focuses on: (1) Access, (2) Quality, (3) Efficiency and (4) Financing.

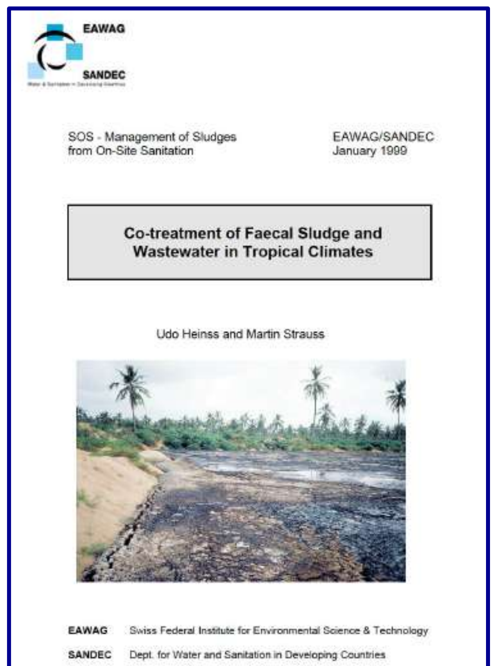
FIGURE 60: ASSESSING THE SECTOR'S PROGRESS IN PROVIDING SUSTAINABLE SERVICES TO ALL

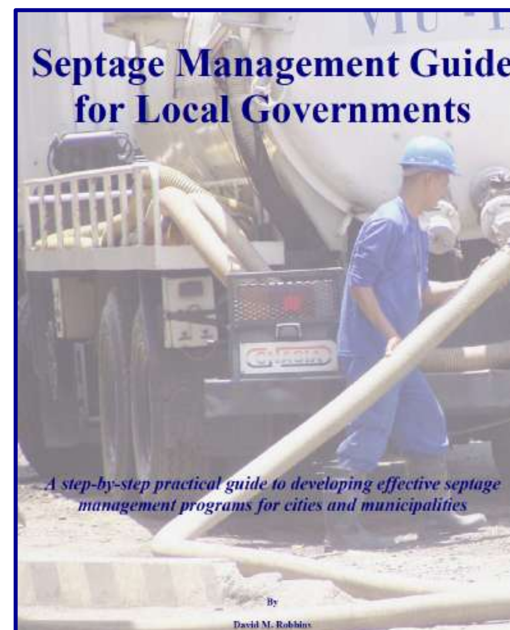
3. Faecal Sludge Treatment Technologies



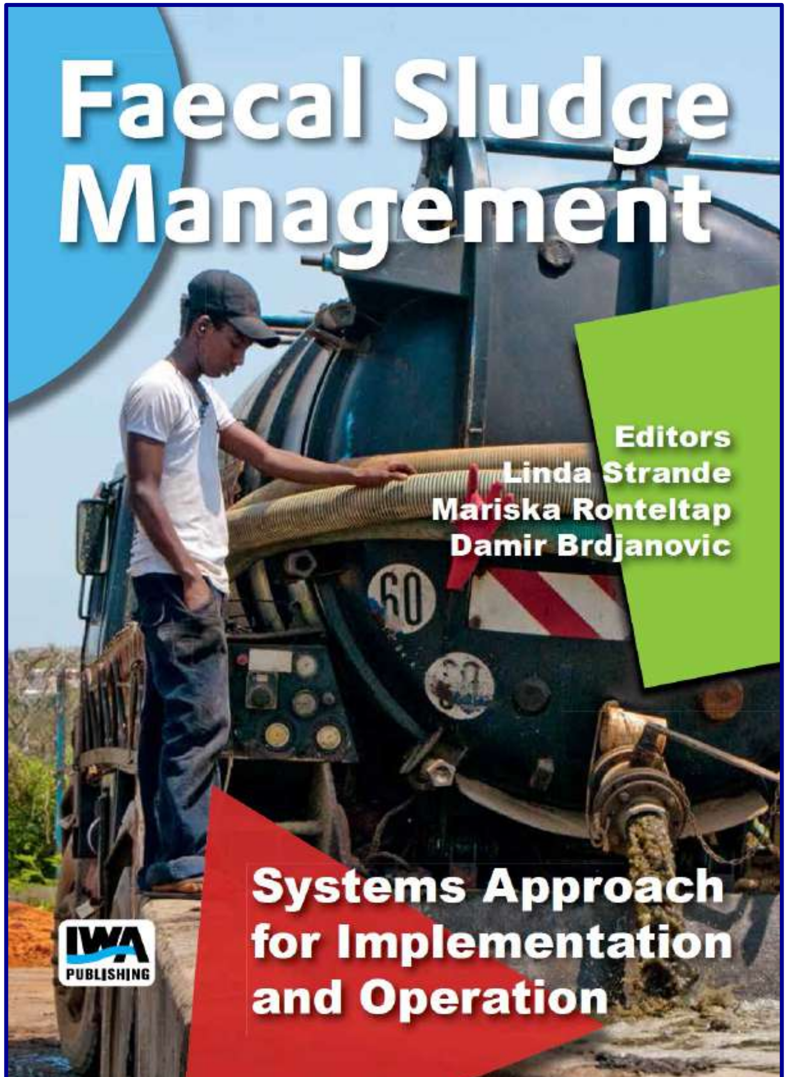








One of the best and comprehensive references on the subject. We recommend to translate to Arabic.



Chapter1: The Global Situation
Chapter2: Faecal Sludge Quantification, Characterization and Treatment Objectives
Chapter3: Treatment Mechanisms
Chapter4: Methods and means for Collection and transport of Faecal Sludge
Chapter5: Overview of Treatment Technologies
Chapter6: Settling-Thickening tanks
Chapter7: Unplanted Drying Beds
Chapter8: Planted Drying Beds
Chapter9: Co-treatment of Faecal Sludge in Municipal Wastewater treatment Plants
Chapter10: Enduse of Treatment Products
Chapter11: Operation, Maintenance and Monitoring of Faecal Sludge Treatment Plan
Chapter13: Financial Transfers and responsibility in Faecal Sludge Management Chains
Chapter14: Assessment of the Initial Situation
Chapter15: Stakeholder Analysis
Chapter16: Stakeholders Engagement
Chapter17: Planning Integrated Faecal Sludge Management Systems
Chapter18: The Way Forward

Developing solutions for FSM is a serious global problem that has limited attention over the past twenty years. Compared to wastewater management practices, there is a hundred year gap in knowledge of FSM in urban areas. Over the last 15 years, the thinking of engineers worldwide has started to shift words designing integrated FSM systems.

2030 projection: 5 billions. In many cities, onsite technologies have much wider coverage than sewer systems

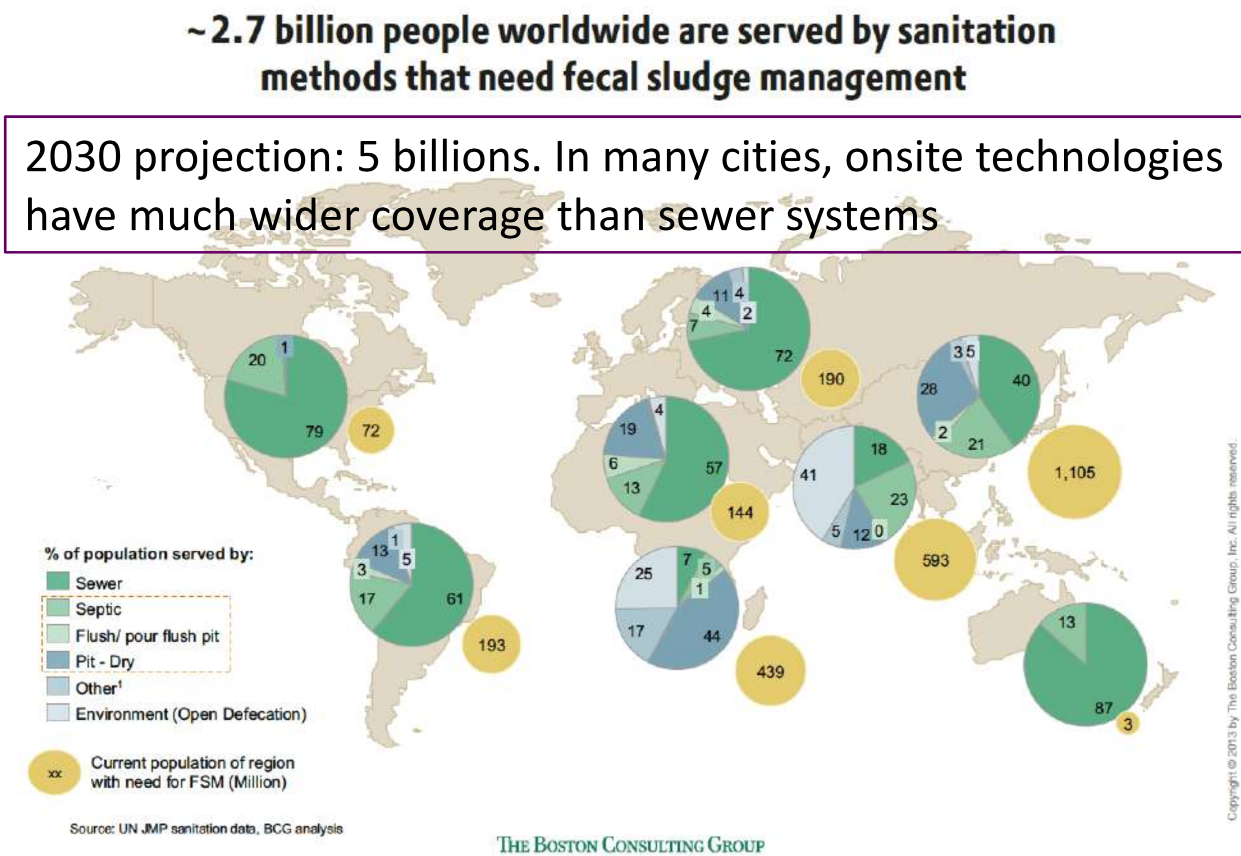


Figure 1.1 Percent of population served by onsite sanitation technologies (Reproduced with permission from the Boston Consulting Group; 2013).

According to the study, the expansion and development of functioning conventional sewer networks is not likely to keep pace with the rapid urban expansion typical of low and middle-income countries.

Developing solutions for FSM is a serious global problem that has limited attention over the past twenty years. Compared to wastewater management practices, there is a hundred year gap in knowledge of FSM in urban areas. Over the last 15 years, the thinking of engineers worldwide has started to shift words designing integrated FSM systems.

~2.7 billion people worldwide are served by sanitation methods that need fecal sludge management

2030 projection: 5 billions. In many cities, onsite technologies have much wider coverage than sewer systems

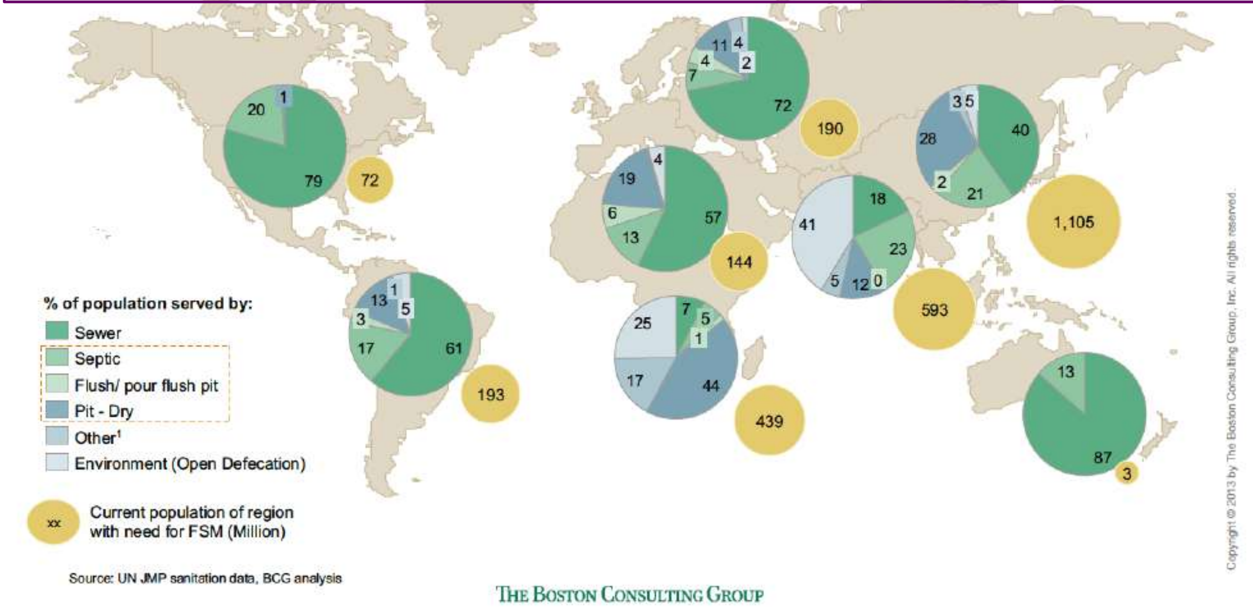


Figure 1.1 Percent of population served by onsite sanitation technologies (Reproduced with permission from the Boston Consulting Group; 2013).

According to the study, the expansion and development of functioning conventional sewer networks is not likely to keep pace with the rapid urban expansion typical of low and middle-income countries.

The figure presents an overview of FS treatment technologies with their treatment objectives. It is important to realize the requirements to convert FS into products that is safe for enduse or disposal. Dewatering is a first important step, followed by other processes depending on the end goal. Converting organic matter into stabilized form and/or pathogenic reduction may be achieved using several options.

This reference presents technologies and technology selection schemes.

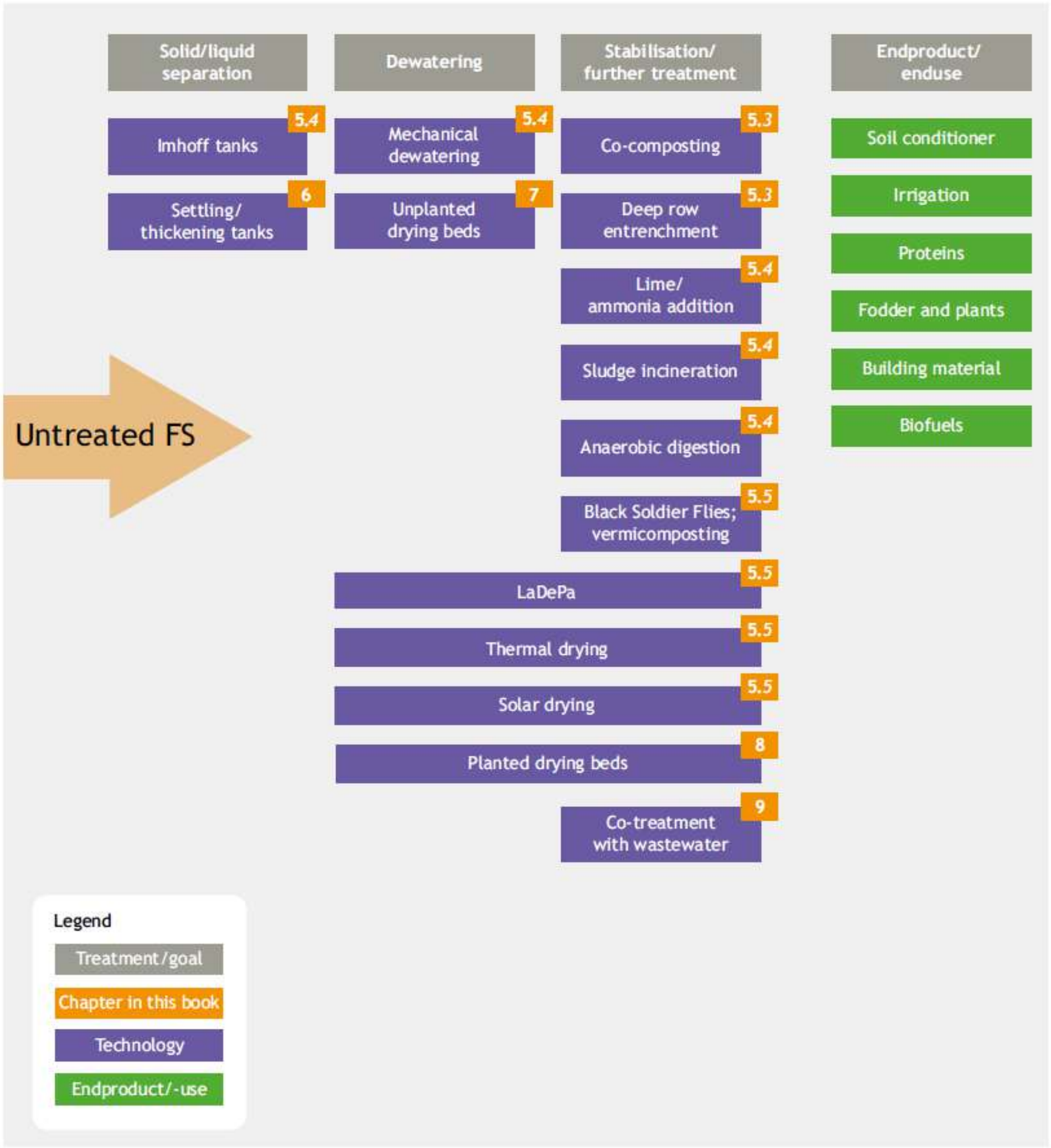


Figure 5.1 Grouping of treatment technologies according to their treatment goal. Endproducts are discussed in Chapter 10. Specific flows from one technology into the next is presented in the Technology Selection Scheme of Chapter 17.

The book supports FSM projects on the following basis:

- Many countries are struggling to cover rural and urban populations with basic sanitation(WHO/UNICEF) sanitation ladder. FSM objective is to stop unsafe discharge of waste by completing the sanitation service chain.
- FSM projects are faster to implement than wastewater management projects. In some cases, it is an interim solution tell the community is covered with sewerage. In other communities it is a final sustainable solution.
- It has been demonstrated that, depending on local conditions, the cost of FSM technologies are five times less expensive than conventional sewer-based solutions.

Table 5.2 Comparison of FSM and sewer based systems on existing side-by-side operational systems in Dakar, Senegal (Dodane *et al.*, 2012)

ANNUALISED CAPITAL COSTS (PER CAPITA*YEAR)									
	SEWER BASED (SB)				FAECAL SLUDGE MANAGEMENT (FSM)				
	House	ONAS	Enduser	TOTAL	House	C&T	ONAS	Enduser	TOTAL
Household Connection[1]	0.00	-4.98	0.00		-2.74	0.00	0.00	0.00	
Collection Conveyance[2]	0.00	-30.20	0.00		0.00	-0.28	0.00	0.00	
Treatment Plant[3]	0.00	-7.49	0.00		0.00	0.00	-1.03	0.00	
TOTAL	0.00	-42.66	0.00	-42.66	-2.74	-0.28	-1.03	0.00	-4.04
ANNUAL OPERATING COSTS (PER CAPITA*YEAR)									
	SEWER BASED (SB)				FAECAL SLUDGE MANAGEMENT (FSM)				
	House	ONAS	Enduser	TOTAL	House	C&T	ONAS	Enduser	TOTAL
Collection Conveyance[4]	0.00	-6.64	0.00		-5.00	0.26	0.00	0.00	
Sanitation Tax[5]	-2.00	2.00	0.00		-2.00	0.00	0.00	0.00	
Treatment Plant[3]	0.00	-6.46	0.00		0.00	0.00	-0.84	0.00	
Valorisation Endproducts[6]	0.00	1.13	-0.01		0.00	0.00	0.01	-0.01	
TOTAL	-2.00	-9.97	-0.01	-11.98	-7.00	0.26	-0.83	-0.01	-7.58
CAPITAL AND ANNUAL OPERATING COSTS COMBINED (PER CAPITA*YEAR)									
TOTAL	-2.00	-52.63	-0.01	-54.64	-9.74	-0.02	-1.86	-0.01	-11.63

1 Household Connection (capital) = household sewer connection, septic tank
2 Collection Conveyance (capital) = sewer, pumping stations, vacuum trucks
3 Treatment Plant (capital and operating) = wastewater treatment plant, faecal sludge treatment plant
4 Collection Conveyance (operating) = sewer, pumping stations, onsite emptying fee, truck transport
5 Sanitation Tax (operating) = sanitation tax paid by every resident based on water consumption
6 Valorisation End-products (operating) = biogas, reclaimed water, biosolids

As will be discussed in Chapter 14.5.3, the comparison of treatment technologies is also complicated by factors such as the level of centralisation or decentralisation. FSM technologies tend to be more decentralised or semi-centralised than centralised sewer-based systems. In terms of meeting long-term urban growth requirements, decentralised technologies are more flexible as they can be built in a modular basis as needed (Maurer, 2009). On a management and capital cost basis, the economy of scale results in larger plants being more cost effective than smaller plants. However, when haulage of sludge is taken into account, it appears that smaller decentralised plants are more affordable as travel distances and time can be reduced. For this reason, it is important to consider the whole supply chain when making a decision. The correlation between scale and cost is not linear, and typically a breakeven point can be found. For example, in Japan decentralised wastewater treatment including reclamation is more affordable than conventional dual-pipe water delivery and sewer systems at flows greater than 100 m^3/day (Gaulke, 2006). All of these factors are very dependent on the local context and the specificities of each city (see Section 14.4.8).

The book supports FSM projects on the following basis:

- Many countries are struggling to cover rural and urban populations with basic

FSM projects are faster to implement than wastewater management projects. In some cases, it is an interim solution tell the community is covered with sewerage. In other communities it is a final sustainable solution.

- It has been demonstrated that, depending on local conditions, the cost of FSM technologies are five times less expensive than conventional sewer-based

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ANNUALISED CAPITAL COSTS (PER CAPITA*YEAR)									
	SEWER BASED (SB)				FAECAL SLUDGE MANAGEMENT (FSM)				
	House	ONAS	Enduser	TOTAL	House	C&T	ONAS	Enduser	TOTAL
Household Connection[1]	0.00	-4.98	0.00		-2.74	0.00	0.00	0.00	
		20	0.00		0.00	-0.28	0.00	0.00	
		49	0.00		0.00	0.00	-1.03	0.00	
		66	0.00	-42.66	-2.74	-0.28	-1.03	0.00	-4.04
AL OPERATING COSTS (PER CAPITA*YEAR)									
	ER BASED (SB)				FAECAL SLUDGE MANAGEMENT (FSM)				
		AS	Enduser	TOTAL	House	C&T	ONAS	Enduser	TOTAL
		4	0.00		-5.00	0.26	0.00	0.00	
		0	0.00		-2.00	0.00	0.00	0.00	
		6	0.00		0.00	0.00	-0.84	0.00	
		3	-0.01		0.00	0.00	0.01	-0.01	
		7	-0.01	-11.98	-7.00	0.26	-0.83	-0.01	-7.58
UAL OPERATING COSTS COMBINED (PER CAPITA*YEAR)									
		63	-0.01	-54.64	-9.74	-0.02	-1.86	-0.01	-11.63

l) = household sewer connection, septic tank
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perating) = wastewater treatment plant, faecal sludge treatment plant
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The book supports FSM projects on the following basis:

- Many countries are struggling to cover rural and urban populations with basic sanitation(WHO/UNICEF) sanitation ladder. FSM objective is to stop unsafe discharge of waste by completing the

- It has been demonstrated that, depending on local conditions, the cost of FSM technologies are five times less expensive than conventional sewer-based solutions.

Table 5.2 Comparison of FSM and sewer based systems on existing side-by-side operational systems in Dakar, Senegal (Dodane *et al.*, 2012)

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	House	ONAS	Enduser	TOTAL	House	C&T	ONAS	Enduser	TOTAL
Household Connection[1]	0.00	-4.98	0.00		-2.74	0.00	0.00	0.00	
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Treatment Plant[3]	0.00	-7.49	0.00		0.00	0.00	-1.03	0.00	
TOTAL	0.00	-42.66	0.00	-42.66	-2.74	-0.28	-1.03	0.00	-4.04

ANNUAL OPERATING COSTS (PER CAPITA*YEAR)									
	SEWER BASED (SB)				FAECAL SLUDGE MANAGEMENT (FSM)				
	House	ONAS	Enduser	TOTAL	House	C&T	ONAS	Enduser	TOTAL
			0.00		-5.00	0.26	0.00	0.00	
			0.00		-2.00	0.00	0.00	0.00	
			0.00		0.00	0.00	-0.84	0.00	
			0.01		0.00	0.00	0.01	-0.01	
			0.01	-11.98	-7.00	0.26	-0.83	-0.01	-7.58
ERATING COSTS COMBINED (PER CAPITA*YEAR)									
			0.01	-54.64	-9.74	-0.02	-1.86	-0.01	-11.63

isehold sewer connection, septic tank
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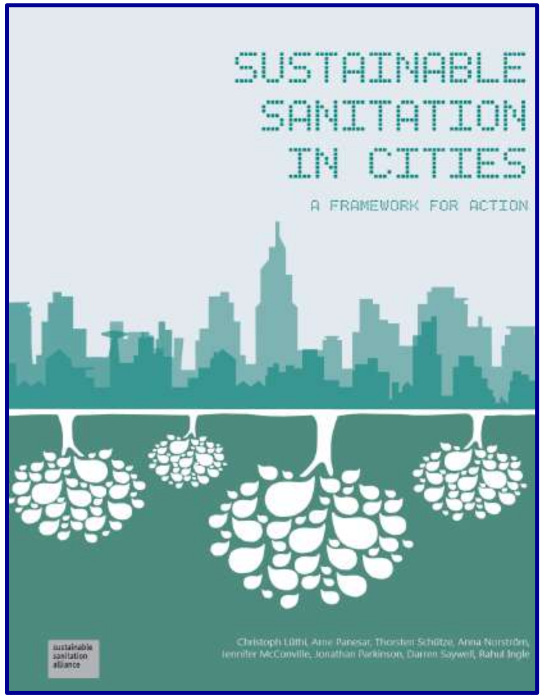
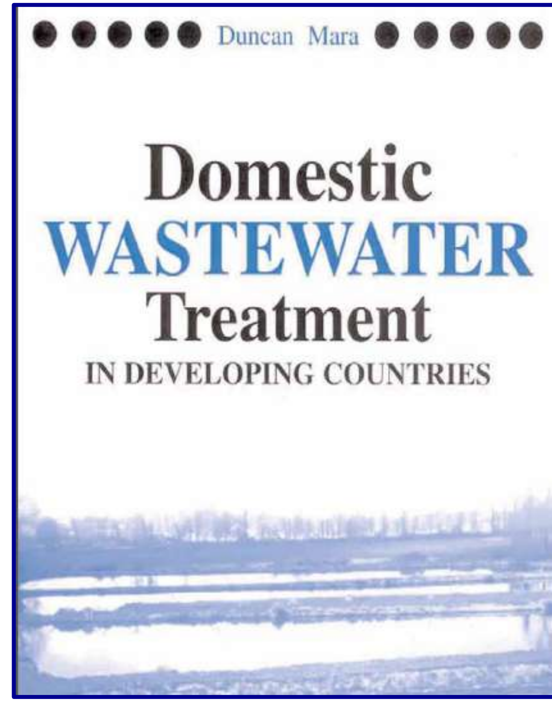
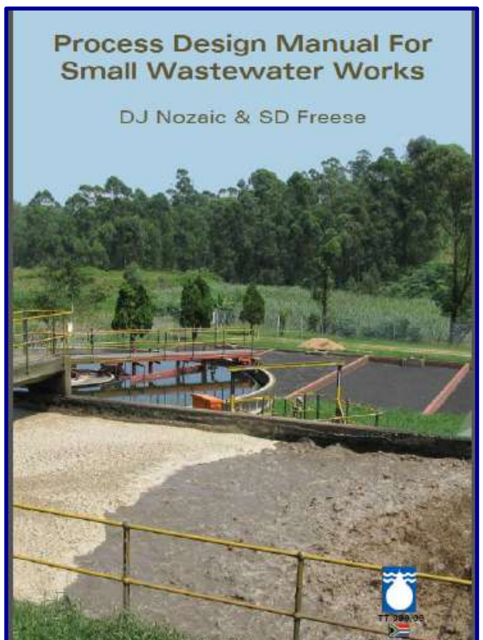
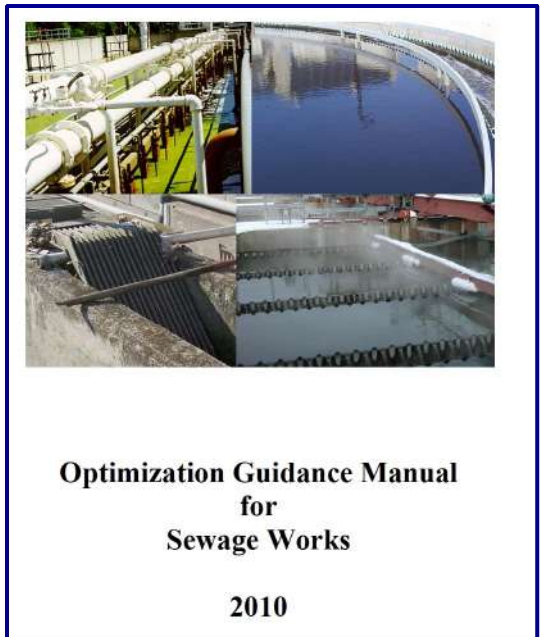
4. Wastewater Treatment Technologies









Biological Wastewater Treatment Series

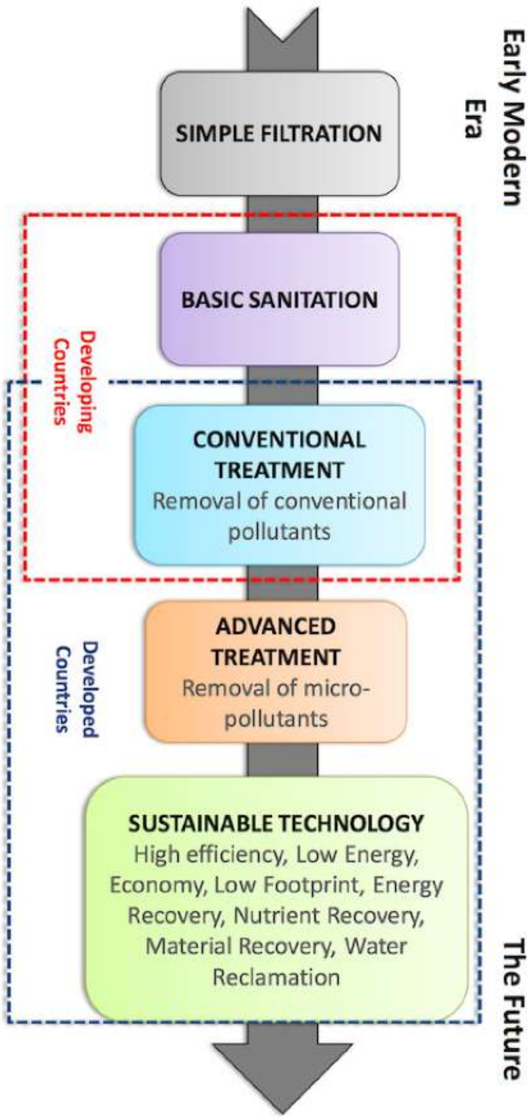
The *Biological Wastewater Treatment* series is based on the book *Biological Wastewater Treatment in Warm Climate Regions* and on a highly acclaimed set of best selling textbooks. This international version is comprised by six textbooks giving a state-of-the-art presentation of the science and technology of biological wastewater treatment.

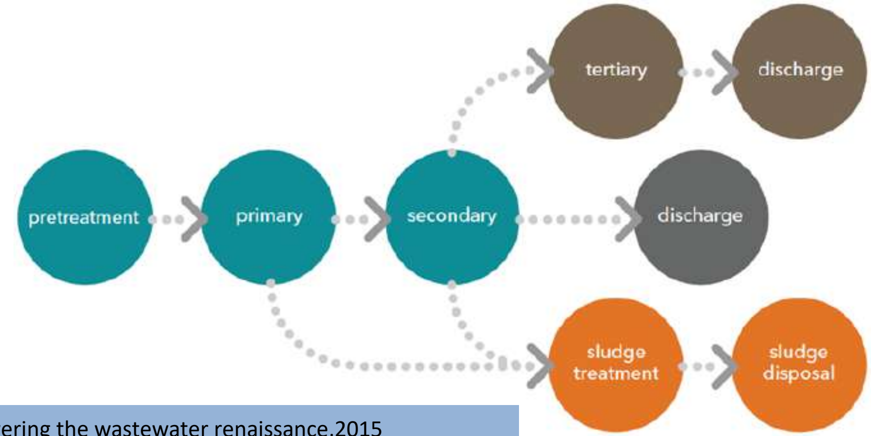
Titles in the *Biological Wastewater Treatment* series are:

Volume 1: *Wastewater Characteristics, Treatment and Disposal*
Volume 2: *Basic Principles of Wastewater Treatment*
Volume 3: *Waste Stabilisation Ponds*
Volume 4: *Anaerobic Reactors*
Volume 5: *Activated Sludge and Aerobic Biofilm Reactors*
Volume 6: *Sludge Treatment and Disposal*

IWA 2007

Stages and evolution of wastewater treatment





Source: Xylem, Powering the wastewater renaissance,2015
Zulkifli,Y., Water related R&D in Malaysia, June 2014

- **Pumping,** to assist in the transport of wastewater from its initial collection point to a treatment point.
- **Pretreatment,** involving basic processes such as screening wastewater for large solid constituents.
- **Primary treatment,** which involves settling of the wastewater (also known as sedimentation) to physically separate suspended solids from wastewater, further removing organic matter.
- **Secondary treatment,** which involves further treatment (e.g. aeration and introduction of activated sludge) to reduce biodegradable organic materials that would create a demand for oxygen in receiving streams or water bodies, plus nutrients such as nitrogen and phosphorus in the wastewater.
- **Tertiary treatment,** which can involve a range of treatments including filtration to remove residual particulate matter (solids) and nutrients, which may be followed by disinfection and/or advanced processes to inactivate pathogens or complex organics such as pharmaceuticals.
- **Discharge,** where the treated wastewater effluent is discharged back into a water body or aquifer.
- **Sludge treatment,** also known as excess sludge treatment, which involves breaking down organic matter contained in sludge by-products and/or the dewatering of sludge to reduce its weight for transport and disposal.
- **Sludge disposal,** where the residual sludge is used as a fertilizer, incinerated or disposed of in a landfill.

Figure 5-1
Overview of Collection, Treatment, and Dispersal Technologies Suitable for Cluster Wastewater Systems

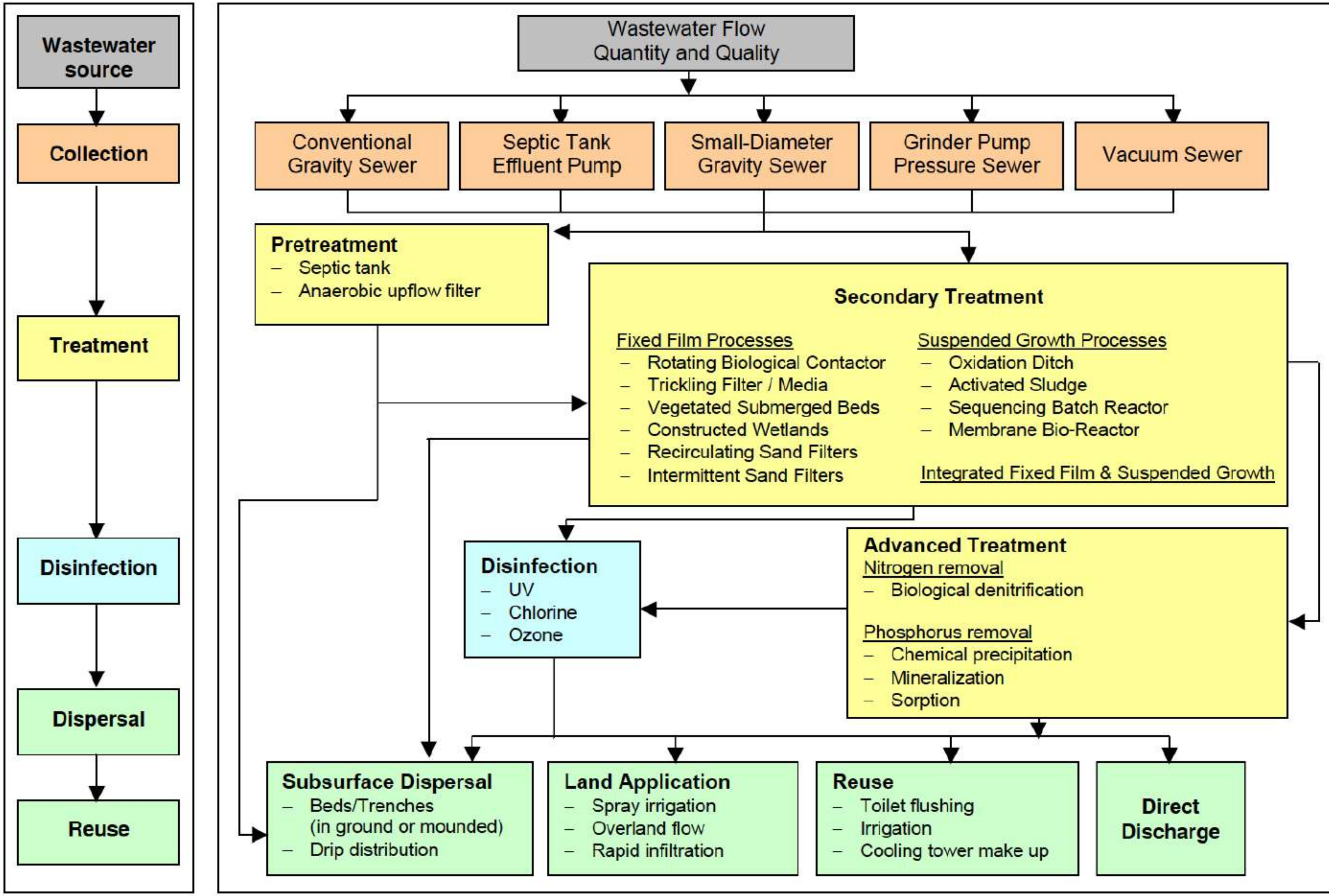
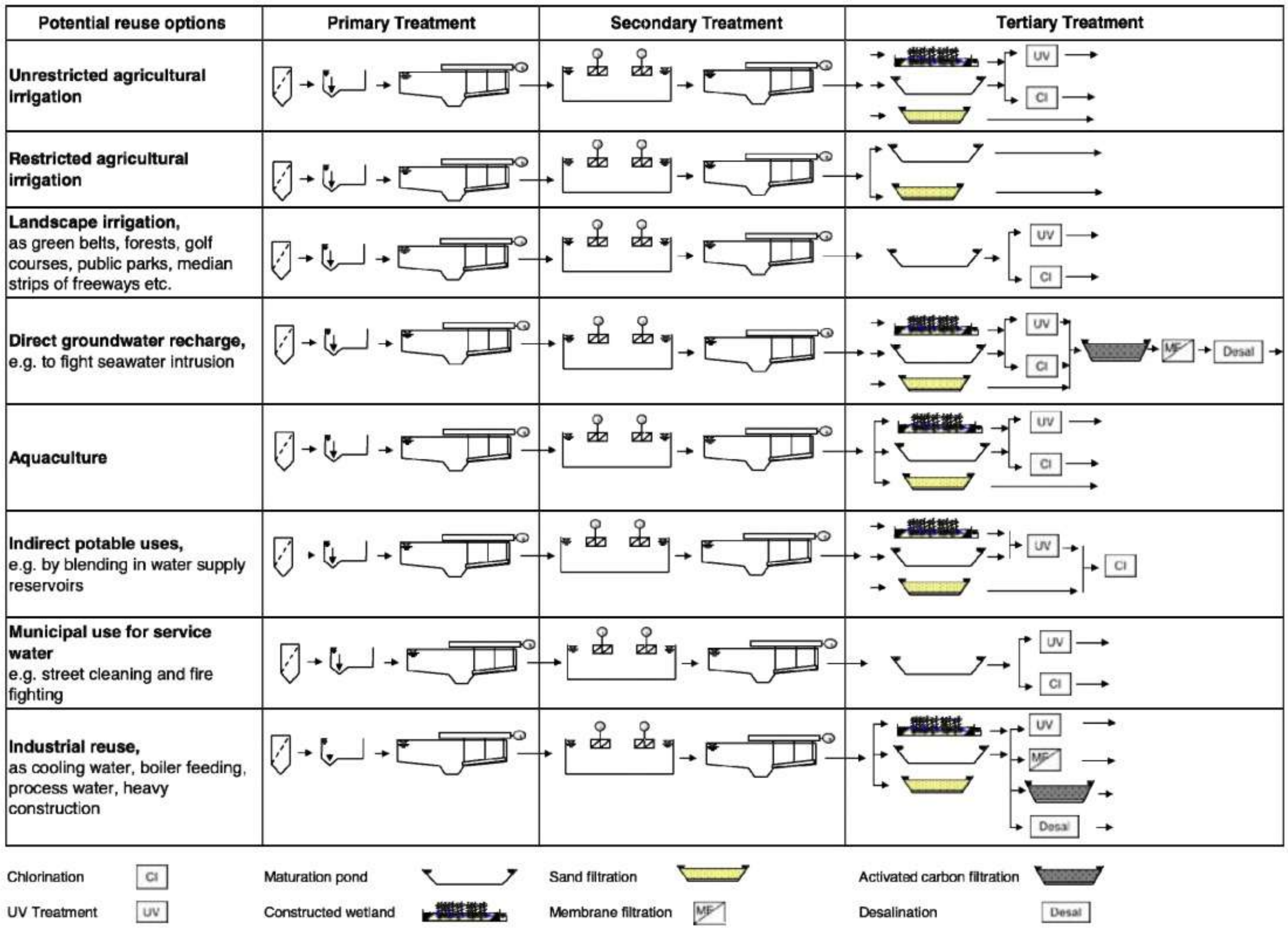


Figure 2: Example of a treatment matrix for reuse



Note: This figure has been adapted, based on the source AQUAREC, Deliverable D17, May 2006.

Figure 4: Economic considerations for different wastewater treatment systems

System	Land Requirements (m^2/inhabitant)	Construction Costs (€[4]/inhabitant)	O&M Costs (€/inhabitant/year)
Conventional primary treatment	0.02 – 0.04	9 – 15	0.4 – 0.8
Facultative pond	2.0 – 4.0	11 – 23	0.6 – 1.2
Anaerobic pond + facultative pond	1.2 – 3.0	9 – 23	0.6 – 1.2
Anaerobic pond + facultative pond + maturation pond	3.0 – 5.0	15 – 30	0.8 – 1.5
Facultative aerated lagoon	0.25 – 0.5	15 – 27	1.5 – 2.7
Constructed wetlands	3.0 – 5.0	15 – 23	0.8 – 1.2
Rapid infiltration	1.0 – 6.0	9 – 23	0.4 – 1.2
Overland flow	2.0 – 3.5	12 – 23	0.6 – 1.2
Conventional activated sludge	0.12 – 0.25	31 – 50	3.0 – 6.1
Activated sludge + extended aeration	0.12 – 0.25	27 – 38	3.0 – 6.1
Conventional activated sludge + tertiary filtration	0.15 – 0.30	38 – 58	4.6 – 7.7
Trickling filter	0.12 – 0.3	38 – 46	3.0 – 4.6

Source: Adapted from WHO Guidelines for the Safe use of Wastewater, Excreta and Greywater (2006) – Volume 2

Energy Requirements, Efficiency and Recovery

Renewable and Sustainable Energy Reviews 16 (2012) 4818–4848

Contents lists available at SciVerse ScienceDirect

Renewable and Sustainable Energy Reviews

journal homepage: www.elsevier.com/locate/rser

Energy requirements for water production, treatment, end use, reclamation, and disposal

A.K. Plappally, J.H. Lienhard V*

Center for Clean Water and Clean Energy, Department of Mechanical Engineering, Massachusetts Institute of Technology, 77 Massachusetts Avenue, Room 3-162, Cambridge, MA 02139-4307, USA

Energy Requirements

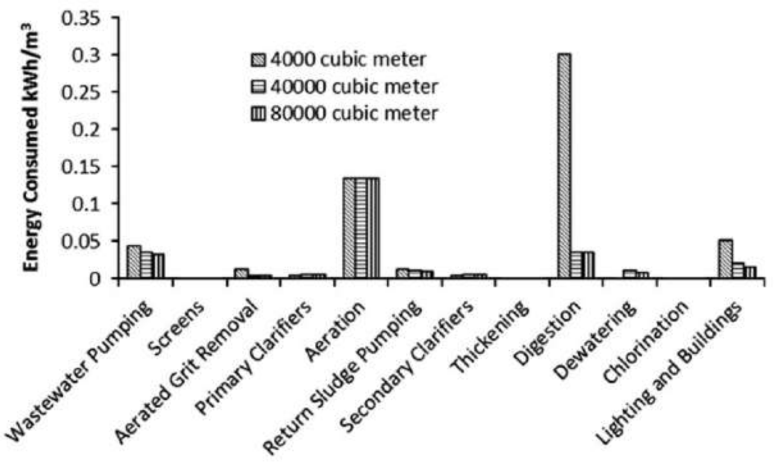


Fig. 26. Energy use for activated sludge wastewater plants [45].

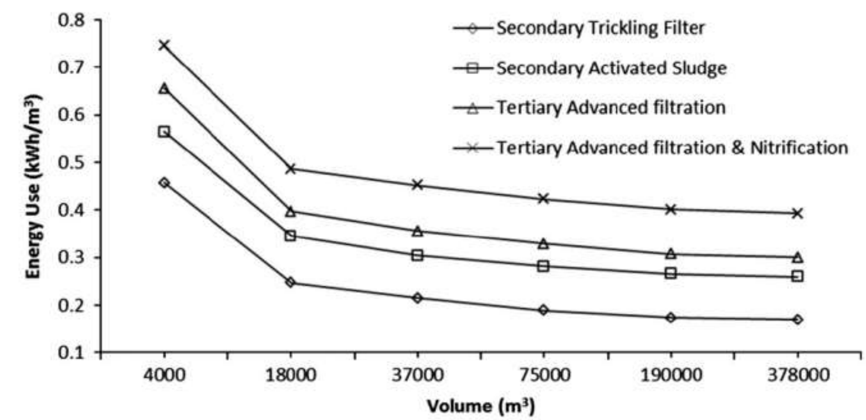


Fig. 28. Secondary and Tertiary treatment energy use as a function of waste water volume processed per day [153].

Study of energy efficiency options in wastewater treatment systems and its relation to abatement objectives

This study assesses the cost and abatement potential of 18 abatement opportunities

Code	Abatement option	Treatment stage	Brief description
1	High efficiency pumping	Transport	Use of sustained high efficiency non-clog pumps
2	Optimal speed pumping	Transport	Use of variable speed pumps, allowing the pump to operate at its optimal efficiency
3	High efficiency pumping	Secondary	Use of sustained high efficiency non-clog pumps for in-plant pumping
4	Efficient variable speed blowers	Secondary	Use of efficient blowers to aerate wastewater during the secondary treatment stage
5	Optimized aeration control and aeration systems	Secondary	Use of intelligent optimized control systems and fine bubble aeration to reduce energy consumption in activated sludge process
6	Efficient mixing	Secondary	Use of highly efficient treatment mixing and process control within the activated sludge secondary treatment process
7	High efficiency pumping - aerobic sludge	Sludge	Use of sustained high efficiency non-clog pumps for in-plant pumping
8	Efficient variable speed blowers	Sludge	Use of efficient blowers and intelligent control in aerobic sludge treatment
9	Optimized mixing solutions	Sludge	Use of intelligent optimized control systems to reduce energy consumption in aerobic sludge process
10	High efficiency pumping - anaerobic sludge	Sludge	Use of sustained high efficiency non-clog pumps for in-plant pumping
11	Improved biogas production	Sludge	Enhancing the production of biogas (methane) during anaerobic digestion, allowing greater energy production
12	High efficiency pumping	Tertiary	Use of sustained high efficiency non-clog pumps for in-plant pumping

Sludge Resource Recovery and Energy Recovery

Table 4-4. Categories of treatment processes for energy recovery.

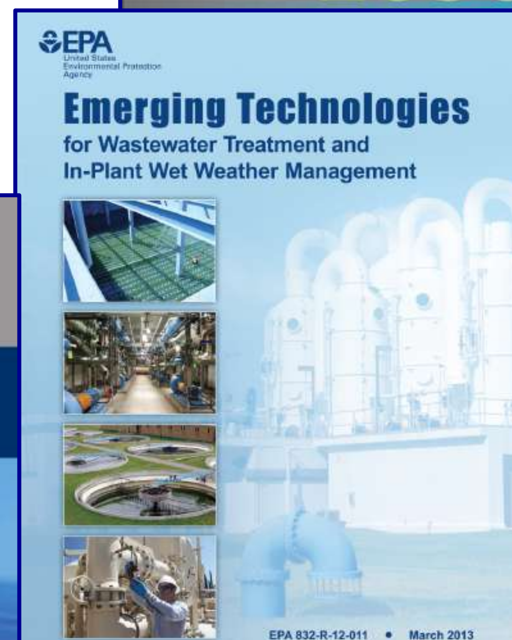
Processes	Example of Technology
Sludge-to-Biogas	
Anaerobic digestion	Bioterminator[24/85]
Thermal hydrolysis	Cambi®, BioThelys®,
Physical-chemical Cell destruction	MicroSludge™, Ultrasonic, Ozonation, Pulse electric
Sludge-to-Syngas	
Gasification	KOPF, EBARA
Incineration	Thermylis® HTFB
Sludge-to-Oil	
Pyrolysis	Enersludge™, SlurryCarb™
Hydrothermal	STORS
Sludge-to-Liquid[a]	
SCWO	Aqua Reci®, Aqua citrox®, Athos®

[a]Sludge is converted to a liquid form and heat is recovered

Table 4-1. Categories of treatment processes for resource recovery.

Processes	Example of Technology
Phosphorus	
Chemical processes	KREPO, Seaborne, Aqua-Reci, Kemicond, BioCon, SEPHOS
Crystallization processes	Crystalactor®, Phostrip
Building material	
Thermal solidification	GlassPack®
Incineration	Portland cement
Nitrogen	
Chemico-process	ARP Technology
Volatile acids	
Microbiological	Fermentation
Hydrothermal	Wet air oxidation

5. Innovation Directions



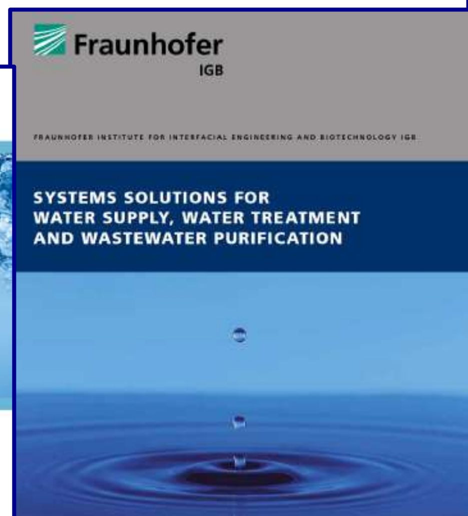
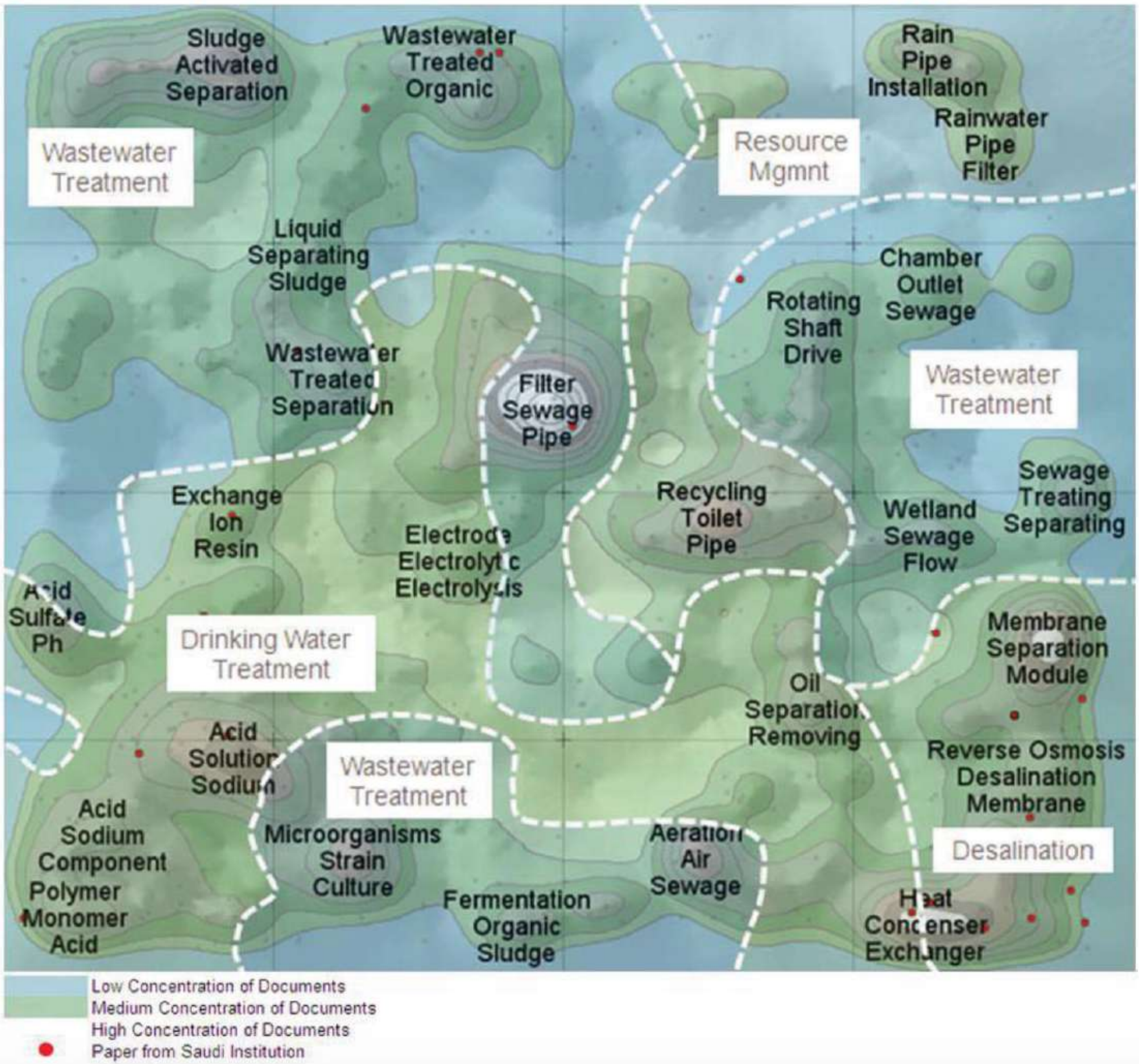


Figure 32 - ThemeScape Map of Water Patent Collection; Annotated by Major Theme. Saudi Patents Highlighted.

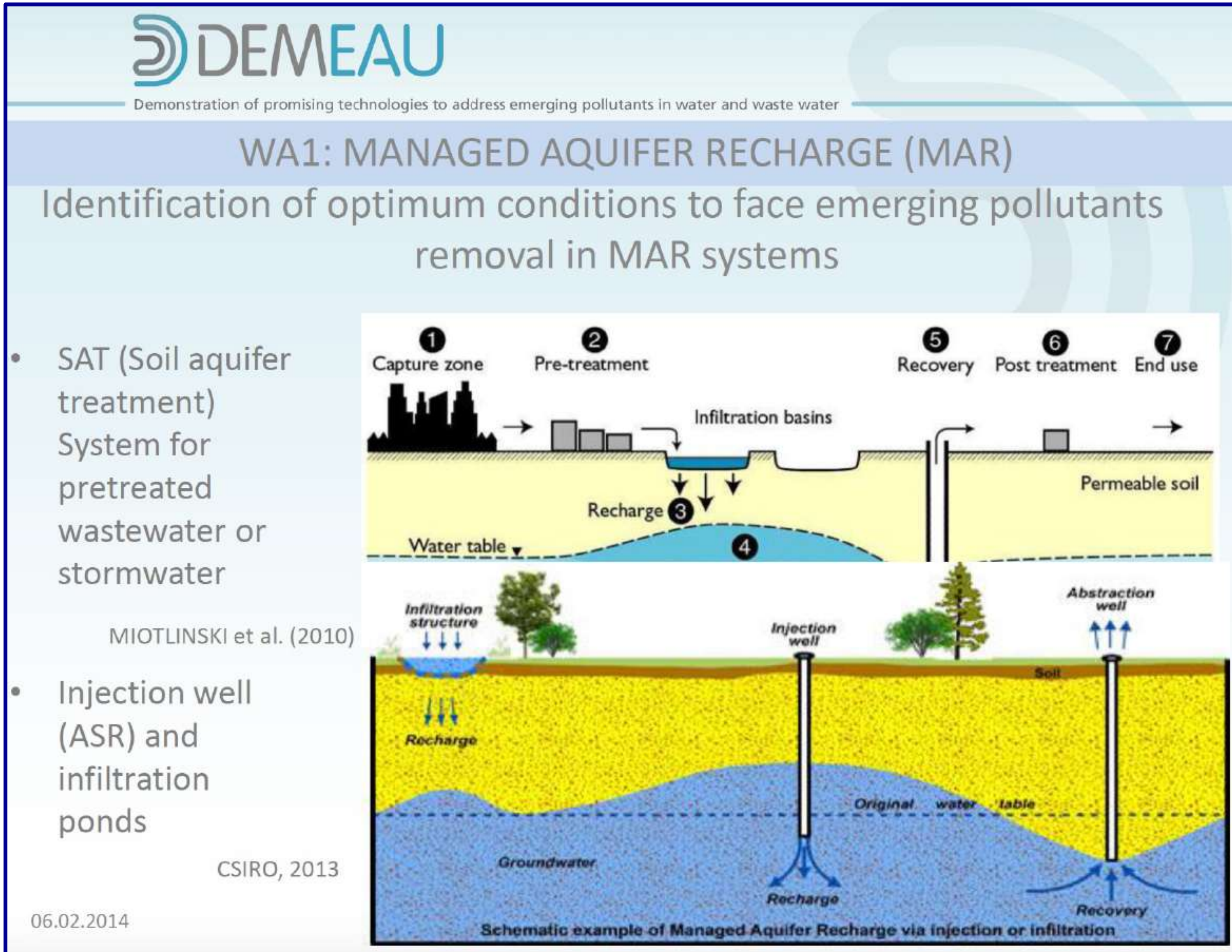


ThemeScape Map of Water Patent Collection

KACST-THOMSON REUTERS wonderful work published 2013, strategic review of scientific papers and patents in 15 technology areas.

The output is valuable and the applied process and tools are as valuable

Soil Aquifer Treatment (SAT)



Source: DEMEAU, Promising technologies to face emerging pollutants removal, February 214 presentation

An overview of all WWT stages

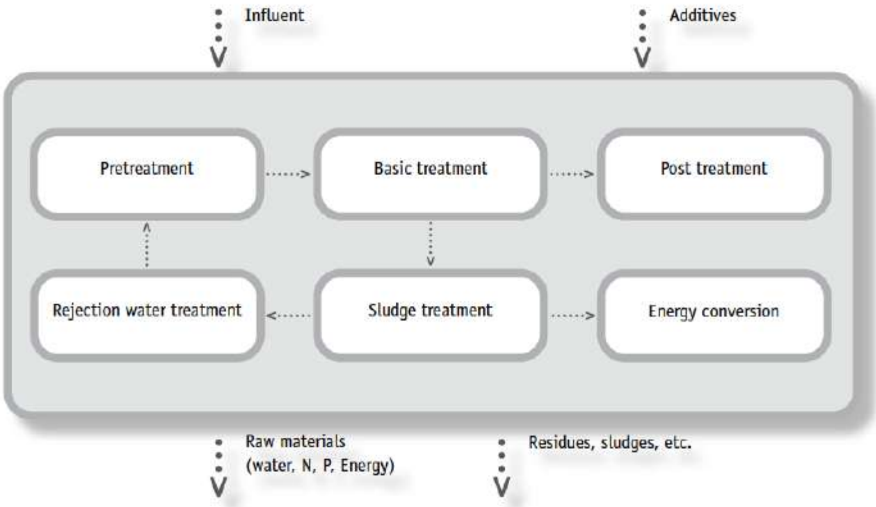


Figure 4.1. Scheme of various process steps of a wastewater treatment plant.

The Water Factory

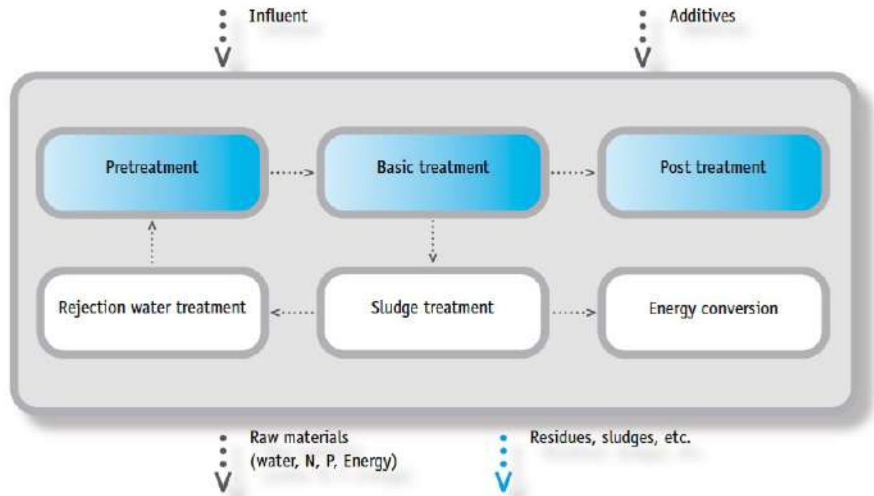
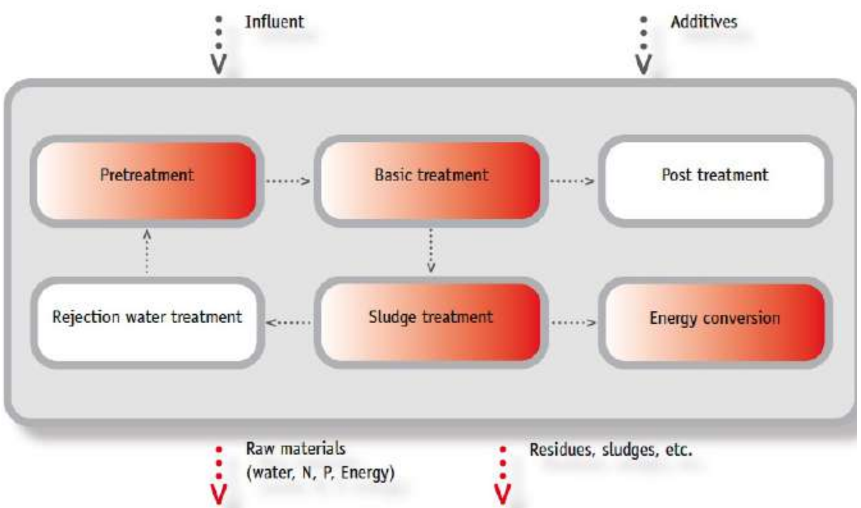


Figure 5.1. Scheme of various process steps of a wastewater treatment plant, in blue treatment scheme for a Water Factory.

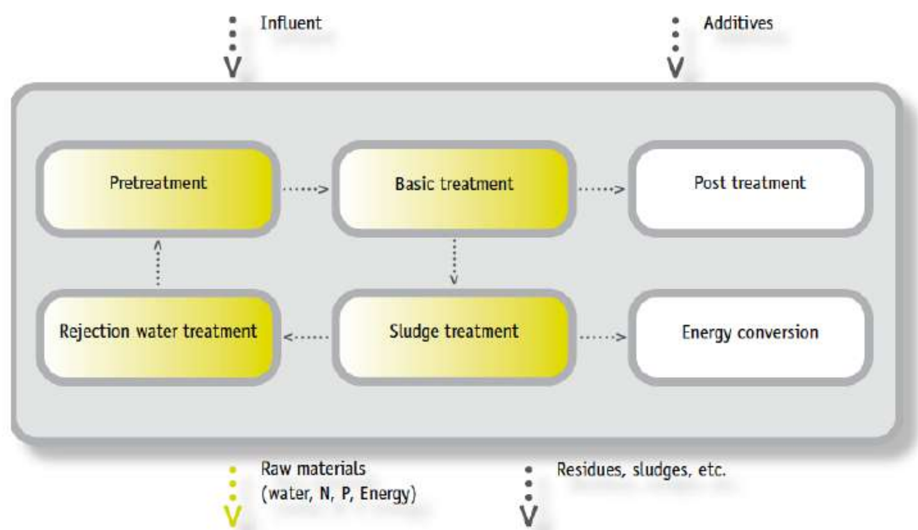
Dutch Roadmap 2030

The Energy factory



Figuur 5.7. Scheme of various process steps of a wastewater treatment plant, in red treatment scheme for a Energy Factory

The Nutrient Factory



Figuur 5.14. Scheme of various process steps of a wastewater treatment plant, in green treatment scheme for a Nutrient Factory

The Dutch Waterharmonica Innovation

What is Waterharmonica? (I)

- Conceptual idea developed by Kampf & Claassen in order to use constructed wetland systems for polishing treated wastewater and provide a simultaneous nature enhancement
- Double goal:
  - Water treatment / effluent polishing – EU WFD compliance
  - Ecosystem recreation and restoration / biodiversity enhancement
- Website - http://www.waterharmonica.nl
- Reference paper – R. Kampf & T. H. L. Claassen (2005) "*The Use of Treated Wastewater for Nature: The Waterharmonica, a Sustainable Solution as an Alternative for Separate Drainage and Treatment*" - Water Intelligence Online

Waterharmonica Grou, NL

Waterharmonica Soerendonk, NL

Floating wetland innovation

Figure 10:
Cross section of a floating wetland treatment system for treatment of periodic wastewater discharges from combined sewer overflows in Belgium.

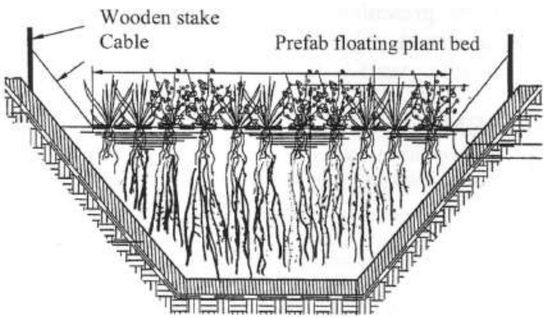
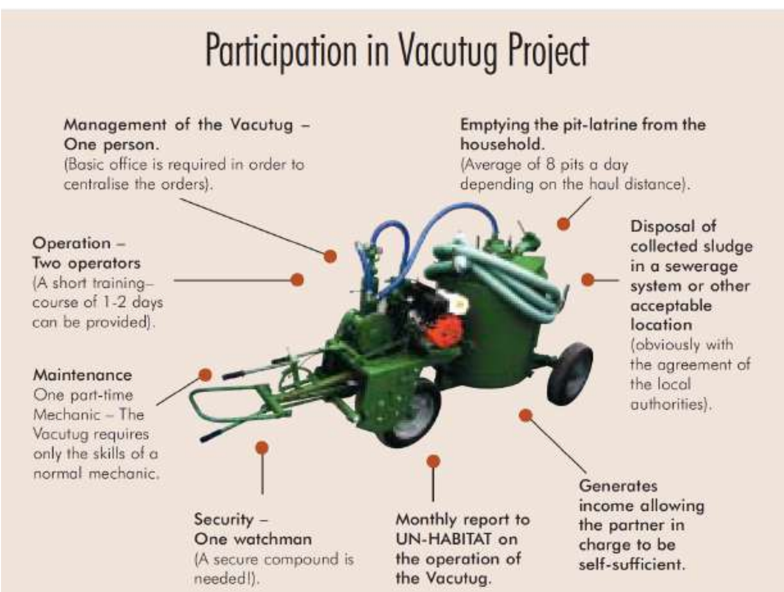
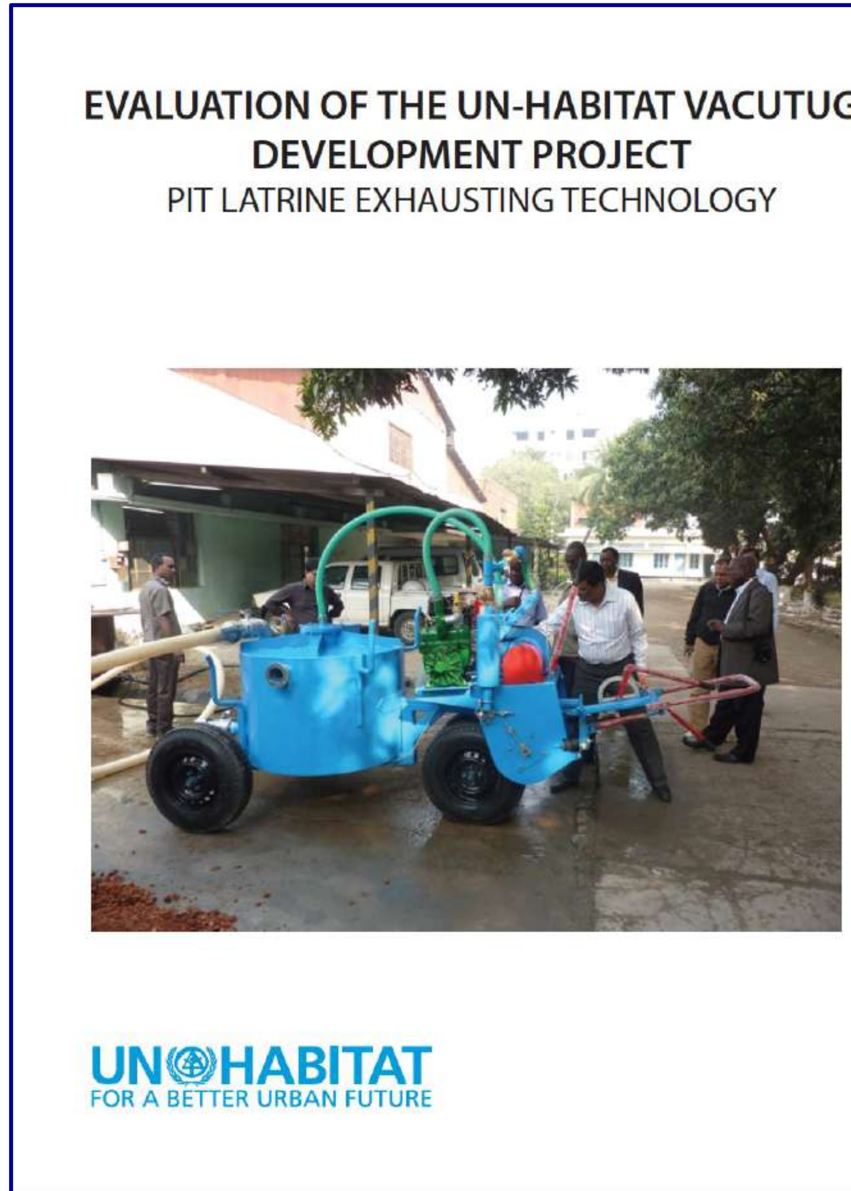


Figure 13:
Demonstration floating wetland installed on the River Kshipra in India.

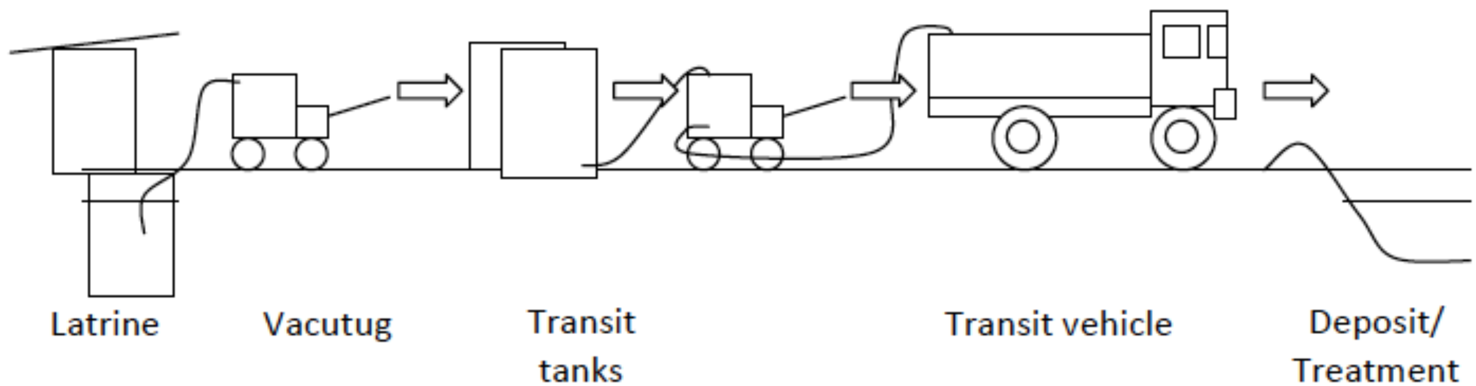
Source: Auckland Regional Council, Application of floating wetland for enhanced storm water treatment, a review (November 2006)

UN HABITAT Vacutug




EVALUATION OF THE UN-HABITAT VACUTUG DEVELOPMENT PROJECT
PIT LATRINE EXHAUSTING TECHNOLOGY

UN-HABITAT
FOR A BETTER URBAN FUTURE



The emptying process

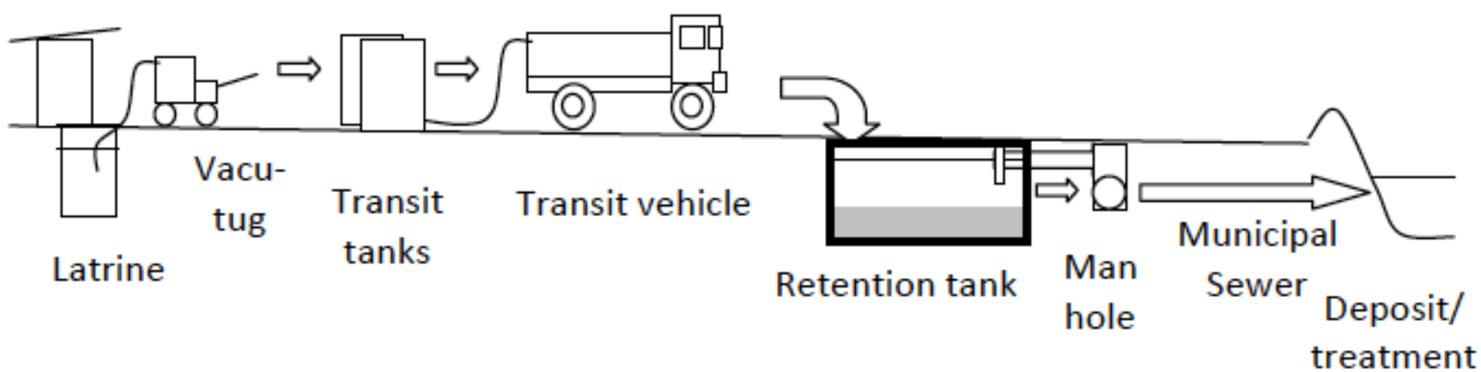


Figure 3: Retention tank to protect municipal sewer

Use of geo-synthetic materials for sludge and faecal sludge dewater-ing

Source: Presentation from workshop on innovations & scaling-up to city-wide sanitation, October 2012, Ahmedabad

Emergency Sanitation, Emerging Technologies For Faecal Sludge Management

Emergency Sanitation

Faecal Sludge Treatment Field-work Summary

Field Summary Report
June 2014

Jan Spit, Dennis Malambo, Maria Elliette Gonzalez, Happiness Nobela, Lobke de Pooter, Katie Anderson

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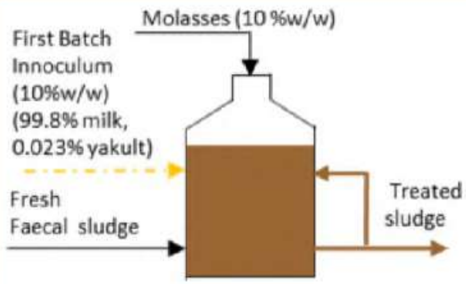
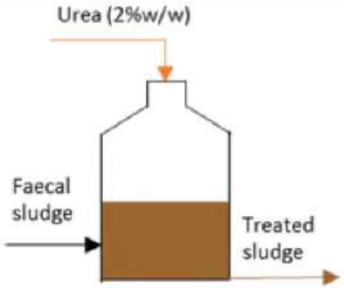
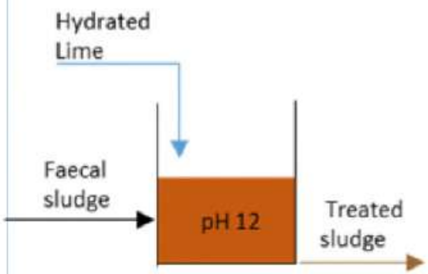
Criteria	Lactic Acid	Ammonia	Lime
Technology	Biological Treatment	Bio-Chemical Treatment	Chemical Treatment
Process			
Sanitisation time	7-15 days	4-8 days	2 hours
End pH of Faecal Sludge	3.8-4.2	9-9.5	11-12.5
Chemical Use	**Sugar Additive**	**Urea**	**Hydrated Lime**
Chemical Use	2g simple sugar[1]/kg sludge 10% w/w pre culture (Pre-culture: 0.2% Yakult, 99.8% Milk)→ 30g/L Lactic Acid	2%w/w Urea (20g Urea/kg Sludge – 9g TAN/kg Sludge)	17-30g Hydrated Lime/ kg Sludge
Chemical cost per m^3 faecal sludge[2]	**€2.20/m^3** (100L Molasses) **€31.20/m^3** (Pre culture: 100L Milk, 0.2L Yakult)	**€16/m^3** (20kg Urea)	**€12/m^3** (25kg Lime)
Limitations	Temperature dependence for Lactic Acid Bacteria fermentation	Initial homogeneous mixing required Air-tight container	Homogeneous mixing required
Additional Treatment/ Re-use	Drying bed/ inoculum for subsequent batches	Drying bed/ fertilizer	Drying bed/ soil conditioner for acidic soils

1 Simple sugar refers to glucose, fructose and sucrose

2 Chemical cost are based on Malawian market prices and converted from Malawian Kwacha

Summing up

1. It is a tremendous fascinating amount of knowledge, experience and lessons learned on country, regional and global levels. Part of it "is a must-to-study" and some of it "is a must-to-translate" and disseminate.
2. Faecal sludge management is "our weakness", we know very little about it. We need to transfer/adopt the well established technologies from South Asia.
3. Integrating rural sanitation in watershed management is recommended for Egypt. We may learn a lot from Danube river watershed countries.
4. Our chance to improve/update the quality of data on rural sanitation is coming !. We recommend to maximize the benefits from the upcoming CAPMAS 2016 census.