Water Harmony
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What is wastewater

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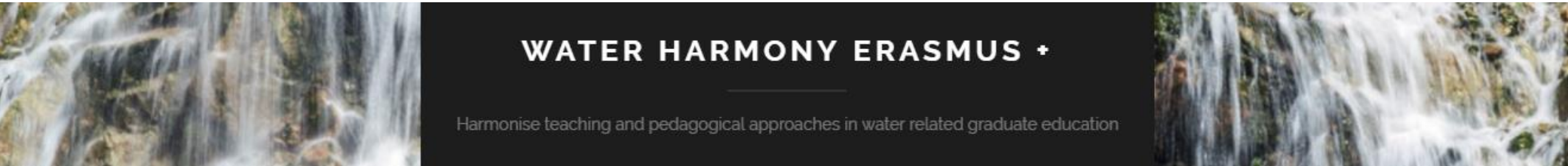

Content

- Definition of wastewater
- classification of wastewater
- Domestic wastewater
  - quantity of domestic wastewater
  - quality of domestic wastewater
  - classification of domestic wastewater
- Industrial wastewater
  - Concept
  - Source, type, typical pollutant of industrial wastewater
  - Water pollution and characteristic of industrial wastewater
- Storm water

1. Definition of wastewater

- Any water that has been adversely affected in quality by anthropogenic influence
- originate from a combination of domestic, industrial, commercial or agricultural activities, surface runoff or storm water, and from sewer inflow or infiltration.

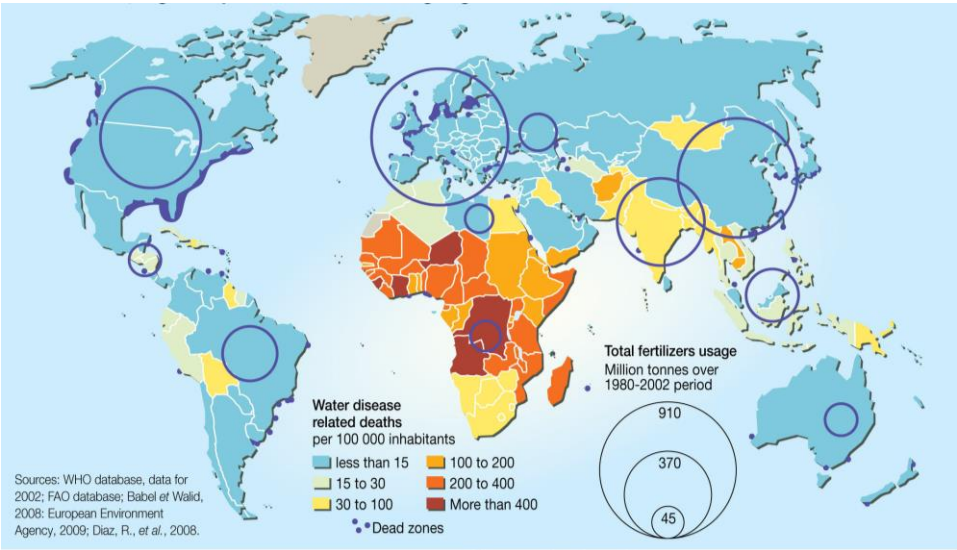

Fig.1 water disease related deaths per 100 000 inhabitants

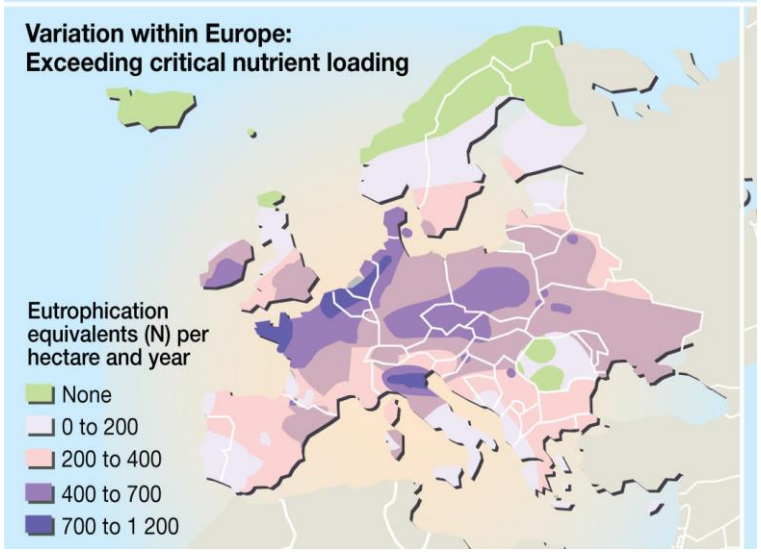

Fig.2 Eutrophication equivalents (N) per hectare and

2. classification of wastewater

- classification according to source
- Domestic WW (sanitary ww): residence, commercial, public facilities
- Industrial WW: industrial wastes predominate
- Infiltration/inflow: water entering into the collection system through
- indirect and direct means
- Stormwater: runoff resulting from rainfall and snowmelt

3. Domestic wastewater

- Quality of domestic wastewater:
  - Quality depends on the pollutant constituents

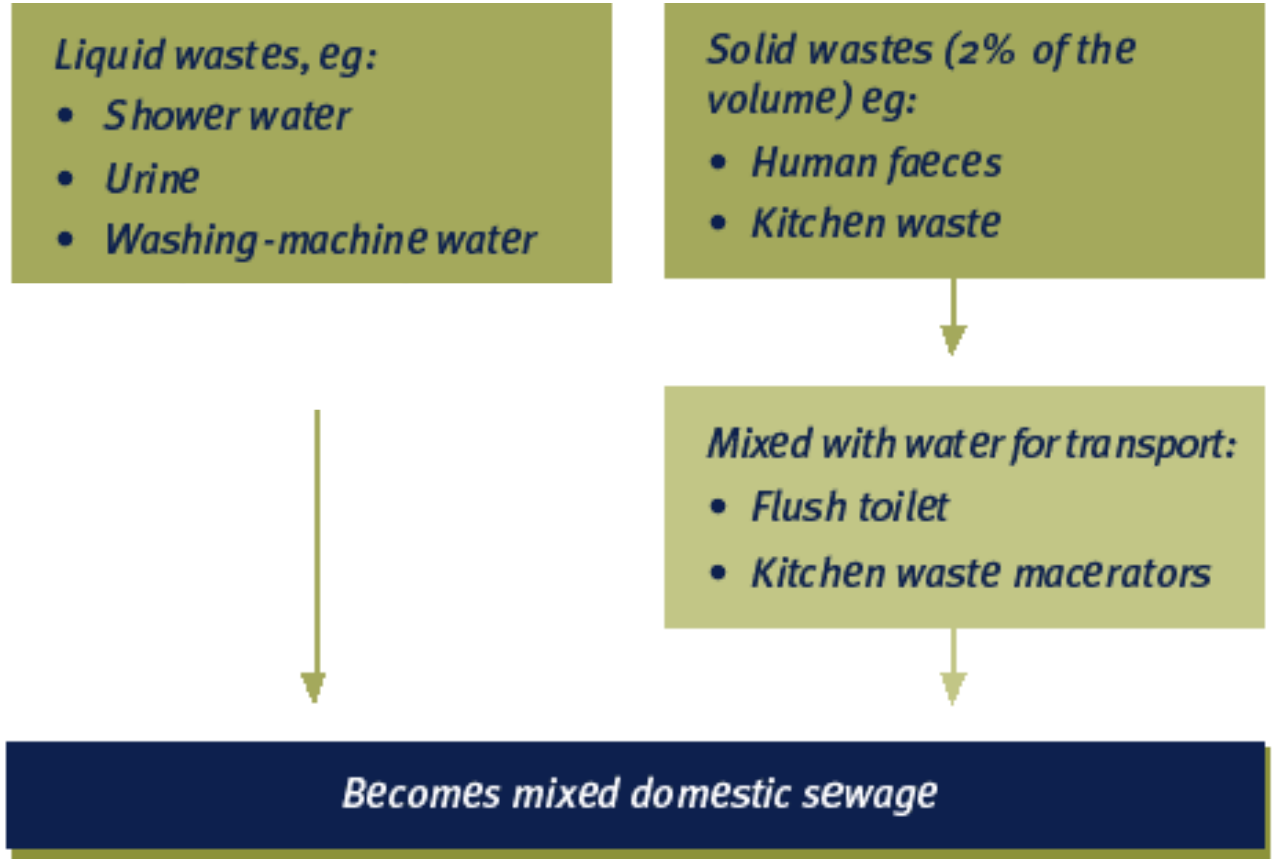

Fig.8 Water as a liquid waste and as a medium for solid wastes in the domestic situation

Domestic wastewater

- Components in domestic wastewater:
  - *Table 3: components in domestic wastewater*

Components in domestic WW		source
Organic matter	Human waste	faeces, urine, blood
	Food waste	usually from kitchen waste grinder
Oils and fats		usually from kitchen, food
Metals		found in foods, via human wastes
Solvents		cleaning
Chemicals		via human wastes; via cleaners, soaps etc, washing, bathing and cooking
Paints		households

Domestic wastewater

- Typical domestic WW compositions
  - *Table 4: typical domestic wastewater compositions*

Pollutant	Concentration, mg/l		
	Weak	Average	Strong
Total solids	350	800	1200
Total suspended solids	100	240	350
Total dissolved solids	250	500	850
Settleable solids (ml/l)	5	10	20
Volatile suspended solids	80	180	280
Volatile dissolved solids	100	260	300
Ammonia nitrogen	10	20	35
Total nitrogen	20	35	80
Phosphorus	5	10	15
Alkalinity as $CaCO_3$	50	100	250
Oil & grease	50	100	150
5-Day biochemical oxygen demand	120	225	400
Chemical oxygen demand	175	325	575
Total organic carbon	65	125	220

Table 5 Specific pollution loads per person

pollutant	g/d·C
BOD_5	20~50
SS	40~60
TN	5~11
TP	0.7~1.4
COD	40~100

Source: “Code for design of outdoor wastewater engineering” GB50014-2006 (2016) P.R.China

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Domestic wastewater

- Classification of domestic wastewater
- What is **greywater**?
  - Low pollutant load
  - Generated from **wash hand basins, showers and baths**, (but (not from a kitchen sink or toilet)
  - Can be recycled on-site for uses such as Water Closet (WC) flushing, landscape irrigation and constructed wetlands
- what constitutes greywater
  - UK: showers, bath tubs, wash basins,
  - excludes washing machines, kitchen sinks, toilet flushing
  - Israel: showers, bath tubs, wash basins, washing machines, kitchen sinks
  - Yemen: kitchen sink, hand wash basins, bath room showers, washing machine

Domestic wastewater—grey water-quantity

- *Table 6 Average quantity of grey water*

Country/ region	Rural area	Big city
Jordan	14 L/c·d	59 L/c·d (Amman)
European communities	66 L/c·d	274L/c·d
Yemen		35L/c·d (Sana'a)
Australia	704L/d for family of two adults and four children (117L/c·d)	

Domestic wastewater—grey water-quantity

- Grey water represents over 60% of the total wastewater stream
  - *Table 7: approximate generation percentage of wastewater and greywater*

Wastewater type	Total Wastewater		Total Greywater	
	% Total	(L/day)	% Total	(L/day)
Toilet	32	① 186	-	-
Hand Basin	5	28	8	28
Bath/shower	33	193	54	193
Kitchen	7	44	-	-
Laundry	23	135	38	135
Total	100	586	100	356

② 230L/d 39%

③ 61 %

[16] DWE. 2008. NSW Guidelines for Greywater Reuse in Sewered, Single Houshold Residential Premises. Department of Water & Energy, NSW government. www.dwe.nsw.gov.au.

Domestic wastewater—grey water-quantity

- in the western countries the high percentages of in-house greywater are produced from bathrooms and wash machines while the low percentages are produced from kitchens and hand wash basins

- *Table 8 Household greywater quantities in the literatures*

Location	kitchen sink	Hand wash basin	bathroom shower	washing machine	Greywater Percentage
Sydney	29		41	30	① 80
US	27.8		41.7	30.5	72
	11	55		34	
	11	7	48	34	68
Oman	34	7	51	8	82
Sana'a	37	32	18	13	87

Domestic wastewater—grey water-quality

- Affecting factors:
  - Number of household occupants
  - Ages of household occupants
  - Health status
  - Lifestyle
  - Tap water sources
  - Water usage patterns
  - Household products used
    - Soaps
    - Shampoos
    - Detergents
    - Mouthwash
    - Toothpaste
    - Hair dyes
    - Shaving cream
    - Body oils

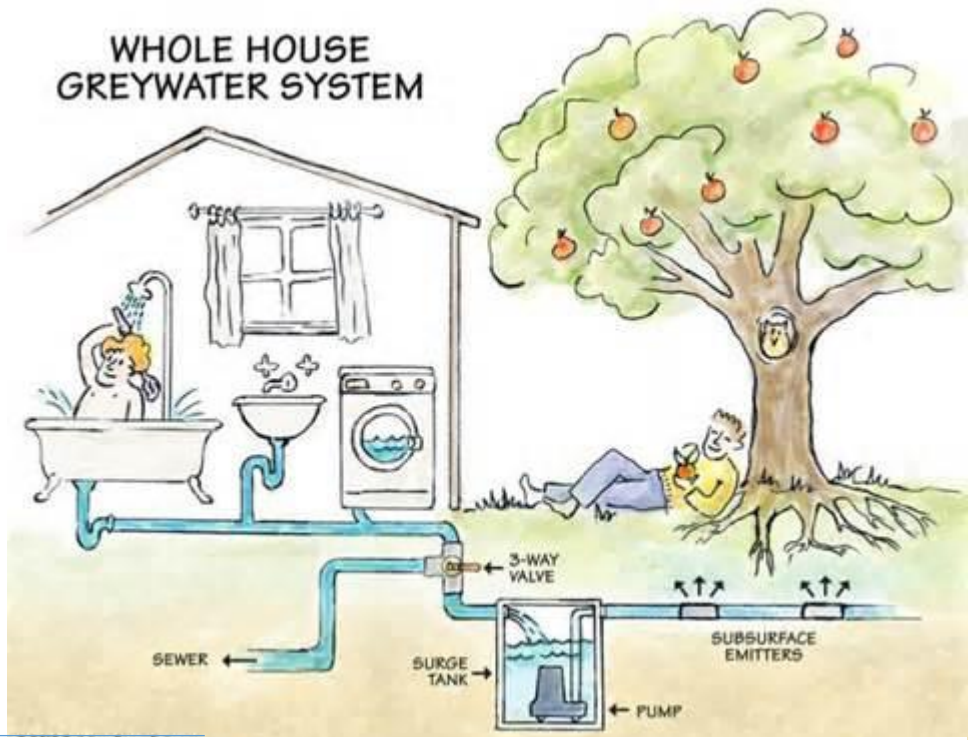


Fig.10 greywater production in daily life

Domestic wastewater—grey water-quality

- *Table 9 Household greywater quality in the Arab counties*

Parameters	Unit	Qebia (Palestine)	Karak (Jordan)	Kuwait (Kuwait)	Sana'a (Yemen)	WHO/FAO guidelines
pH		6.60-6.86	5.93-7.82	7.5	6.0	6.5-8.4[b]
TSS	Mg/L	36-396	23-358	204	510.80	20[c]
Turbidity	FAU	-	-	120	618.60	-
NO_3^-	Mg/L	0-1.3	-	5	98.12	9.5–518.5[b]
NH_4-N	Mg/L	25-45	-	4.8	11.28	-
PO_4^-	Mg/L	-	-		16.10	-
BOD_5	Mg/L	941-997	110-1240	40	518	20[c]
COD	Mg/L	1391-2405	92-3330	-	2000	-
F.C	N/100 ml	10^4-$37x10^4$	-		19×10^6	200[a]

a WHO 1989 guidelines for public parks and crops likely to be eaten uncooked
b FAO guideline for water quality for irrigation
c WHO/AFESD Consultation, limit for vegetables likely to be eaten uncooked

Domestic wastewater—grey water-quality

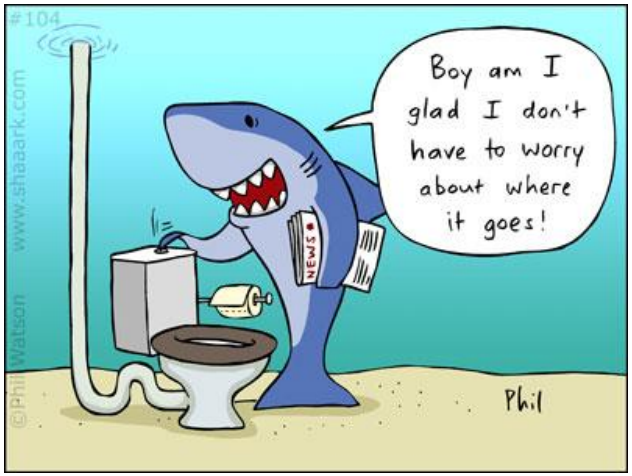
- *Table 10 Household greywater quality in some western countries*

Parameters	Unit	USA	Sweden	Australia	Range
pH		6.8	-	7.3	6.6-8.7
TSS	Mg/L	-	-	-	45-330
Turbidity	FAU	-	-	113	22->200
NO_3^-	Mg/L	-	-	-	<0.1-0.8
NH_4-N	Mg/L	-	-	-	<1-25.4
PO_4^-	Mg/L	7.8	-		-
BOD_5	Mg/L	164	196	159	90-290
COD	Mg/L	366	-	-	-
F.C	N/100 ml	$8.8x10^5$-$13x10^6$	-	-	-

Sources: Jefferson, B., et al. 2000. Technologies for domestic wastewater recycling. Urban Water 1 (4): 285-292.
Jeppesen, B., et al. (1994) Urban Water Research Association of, A. 1994. *Domestic greywater reuse: overseas practice and its applicability to Australia:*Published for the Urban Water Research Association tion.

Domestic wastewater

- Classification of WW
- What is **blackwater**?
  - High load
  - From **WC flushing, kitchen sinks, (dish washers)**
  - High risk of contamination by bacteria, viruses and pathogens
  - Should not be reused in the home
  - Components: faeces, urine, toilet paper, flushing water



Domestic wastewater—black water-quality

- Blackwater samples were collected from 44 similar small houses consisting of 141 persons—92 adults and 49 children (Vibyasen South,Sweden)
  - *Table 11: Flows and concentration of ordinary wastewater parameters*

		Greywater (GW)			Blackwater (BW)		
		Average	Range		Average	Range	
			Min	Max		Min	Max
Q	m^3/h	0.54	0.16	1.02	0.17	0.16	0.18
P_{tot}	mg/L	7.53	4.6	11	42.7	21	58
N_{tot}	mg/L	9.68	8.0	11	150	130	180
BOD_7	mg/L	418	350	500	1037	410	1400
COD_{Cr}	mg/L	588	495	682	2260	806	3138
TS	mg/L	630	570	700	3180	920	4320
VS	mg/L	330	300	360	2560	420	3660
pH	–	7.50	6.06	8.38	8.94	8.87	9.08

Sources: Helena Palmquist, Jorgen Hanæus. Hazardous substances in separately collected grey- and blackwater

Total Environment, 348 (2005) 151– 163

Domestic wastewater—black water-quality

- Each person on average excretes about 4 kg N and 0.4 kg P in urine, and 0.55 kg N and 0.18 kg P in faeces per year.
- In Sweden it has been estimated that the nutrient value of urine from the total population was equivalent to 15–20 % of chemical fertilizer use in 1993

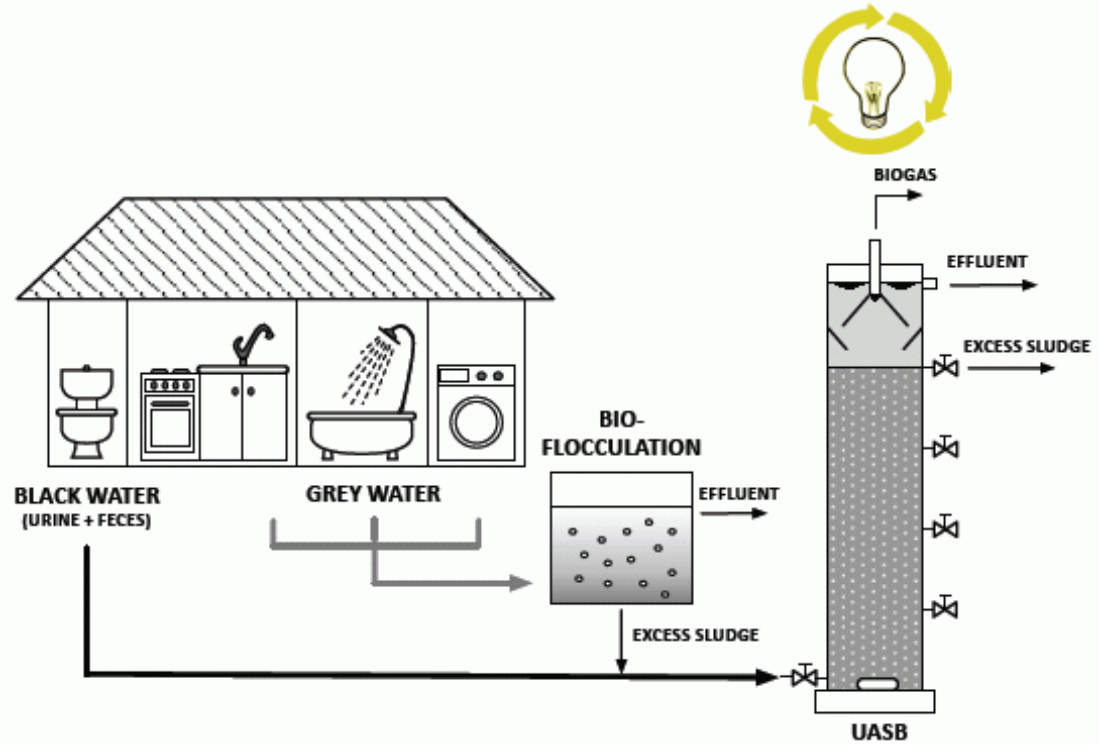


Fig.11 wastewater discharge and treatment in household

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Thank you for your attention!

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