



Versorgung durch Entsorgung

b.is_{water}

Characterisation of Greywater Estimation of Design Values

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GEFÖRDERT VOM



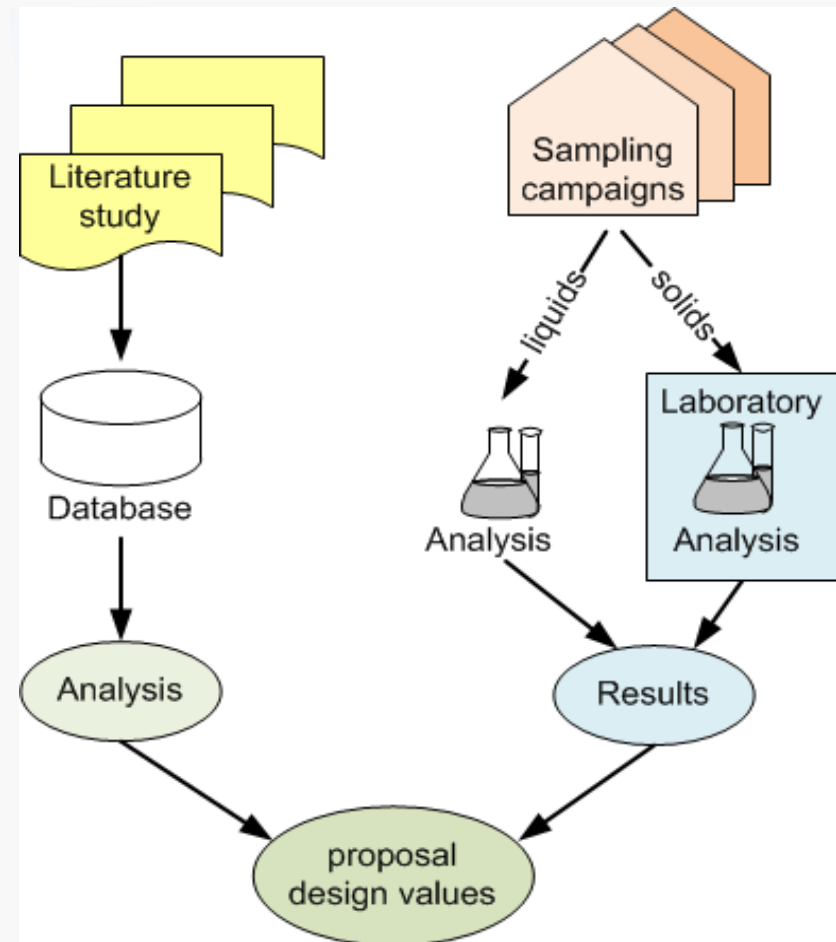
- Introduction
- Material and Methods
- Results
 - Literature study
 - Sampling campaigns
- Conclusion and outlook

Greywater

- 🌍 Greywater is defined as household wastewater, excluding wastewater from toilets
- 🌍 Greywater is a multi component mixture
- 🌍 Largest domestic wastewater flow
 - 🌍 About 50 – 75 % of the total wastewater flow
 - 🌍 In Germany about 60 – 90 l/(c•d) of greywater
- 🌍 For the design of treatment units and the knowledge of loads and concentrations is fundamental
- 🌍 Germany: no design values for greywater treatment units are available

Material and Methods

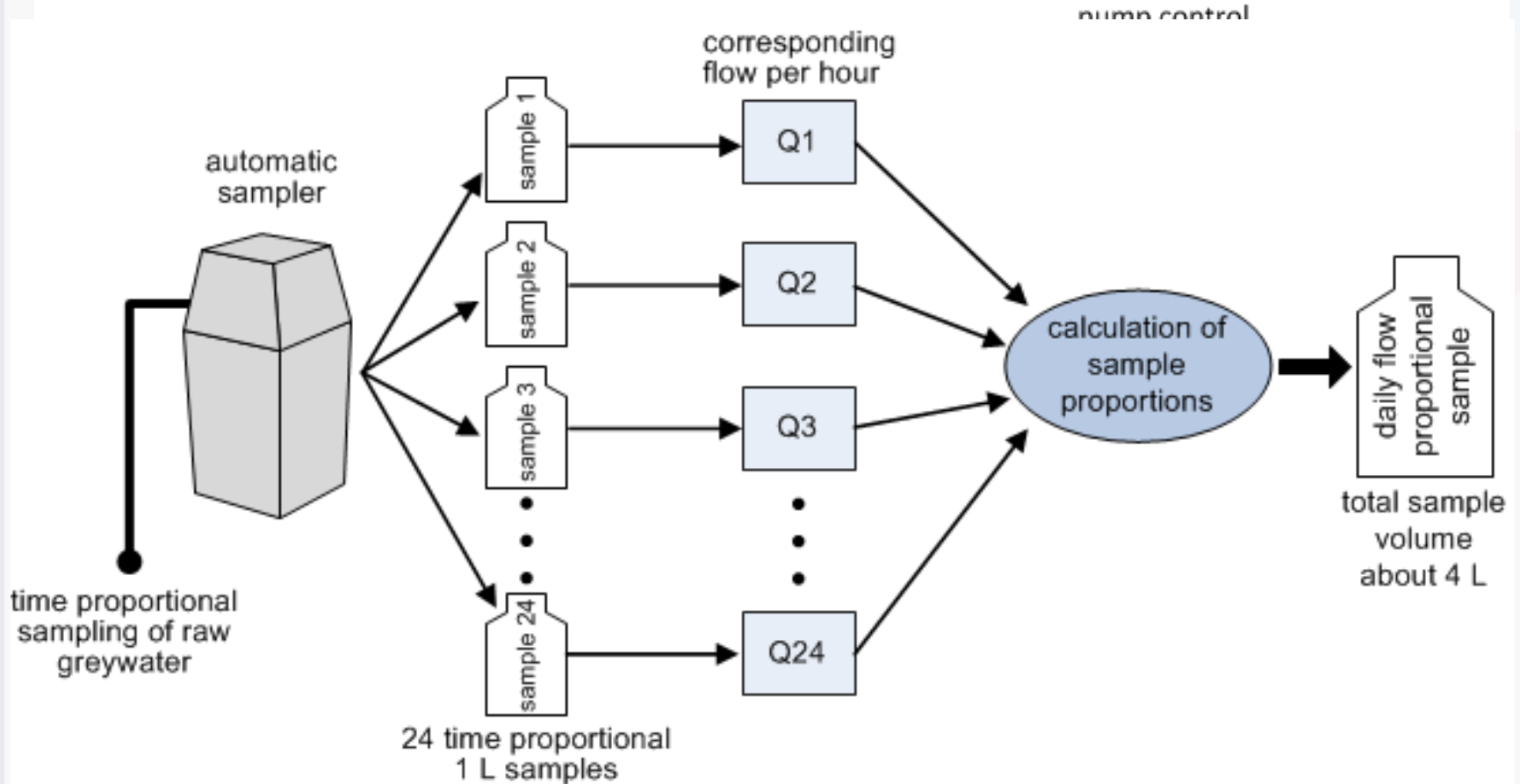
- 🌐 A literature study was conducted
- 🌐 **Sampling campaigns** were performed
- 🌐 The results were compared to each other



Literature study

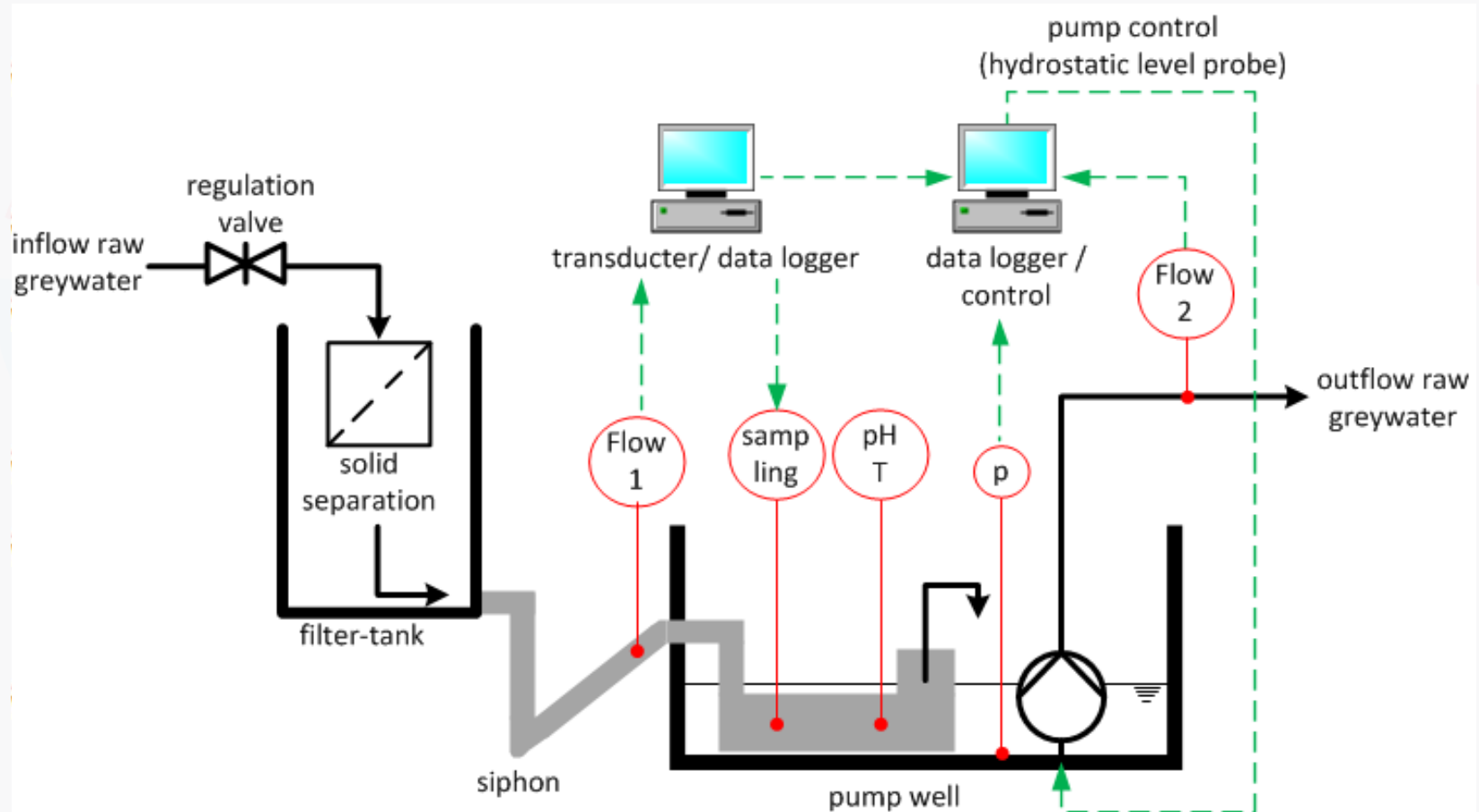
- 🌐 Literature study with more than 130 references was performed with a focus on european data
- 🌐 60% of the European data are from Germany, 20% from Sweden, 10% from Netherlands and the remaining from other countries
- 🌐 45 % of the references are dealing with light greywater
- 🌐 Statistical analyses of the literature data
- 🌐 Inconsistent data quality
 - 🌐 Lack of information about number of samples, analytical procedures

Sampling campaigns in Berlin „Block 6“



Sampling procedure and compilation of daily flow proportional samples in "Block 6" samples were subsequently analysed



Sampling campaign - Lübeck „Flintenbreite“



Sampling device for sampling campaign in Lübeck “Flintenbreite”

Literature study – Loads per capita and day

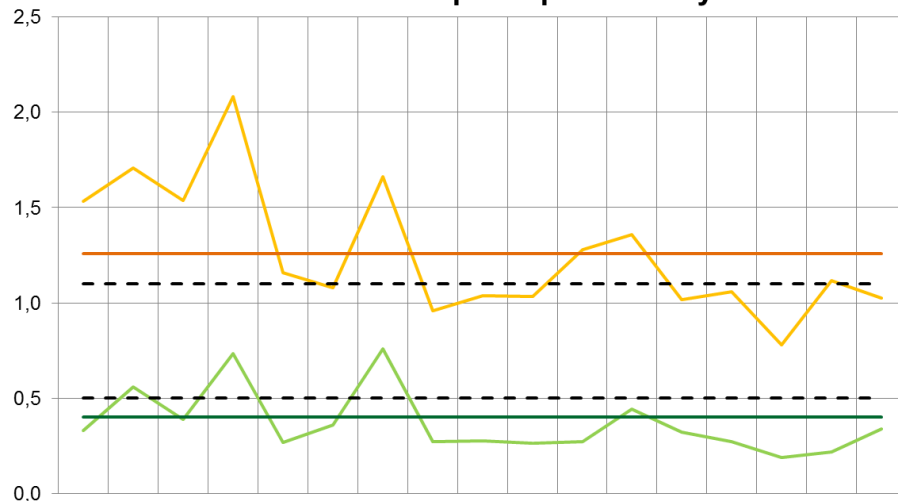
Parameter	n	Unit	Mean	STD	Median	Range	
Volume	43	l/(c*d)	82	23	74	33 - 150	
solid Matter	TSS	25	g/(c*d)	26	24	13	1 - 71
org. Matter	BOD ₅	28	g/(c*d)	17	6	18	4 - 27
	COD	40	g/(c*d)	40	14	41	9 - 71
Nutrients	TP	41	g/(c*d)	0.5	0.2	0.5	0.1 - 0.8
	TN	40	g/(c*d)	1.1	0.5	0.9	0.4 - 2.9
	NH ₄ -N	11	g/(c*d)	0.2	0.2	0.2	0.1 - 0.7

-  Greywater flow is high variable
-  The loads of organic matter and nutrient loads are low compared to total domestic wastewater

Berlin „Block 6“ – Loads per capita and day

Parameter	n	Unit	Mean	STD	Median	Range	
Flow	17	l/(c*d)	77	16	76	62 -114	
solid Matter	TSS	16	g/(c*d)	9	3,1	8	6 - 16
org. Matter	VSS	16	g/(c*d)	7	2,9	6	5 - 14
	BOD ₅	15	g/(c*d)	35	11	32	19 - 54
	COD	17	g/(c*d)	66	21	59	46 - 105
Nutrients	TP	17	g/(c*d)	0,4	0,2	0,3	0.2 - 0.8
	PO ₄ -P	17	g/(c*d)	0,1	0,1	0,1	0.1 - 0.3
	TN	17	g/(c*d)	1,3	0,3	1,1	0.8 - 2.1
	NH ₄ -N	17	g/(c*d)	0,2	0,1	0,2	0.1 - 0.4

TN and TP -loads per capita and day

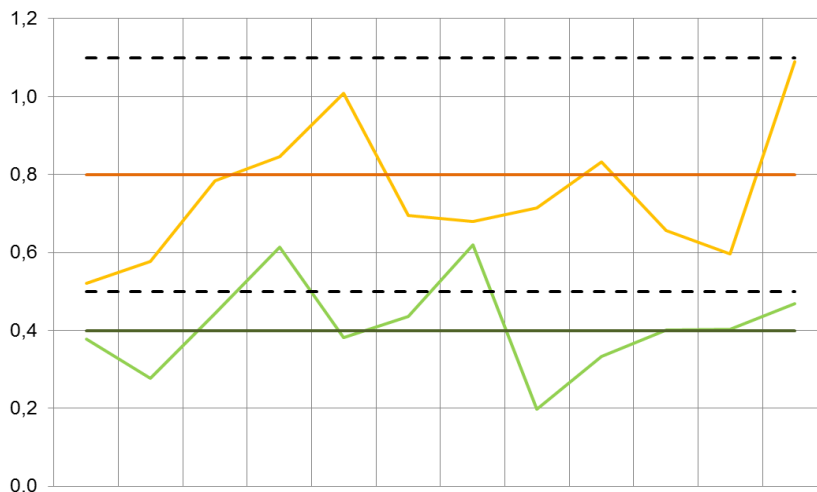






- TN and TP loads in the same range of literature values
- TSS loads significantly lower than literature values. - average 9 g/(c*d)
- Greywater flow in „Block 6“ slightly lower than literature values

Lübeck „Flintenbreite“ - Loads per capita and day

Parameter	n	Unit	Mean	STD	Median	Range	
Flow	12	l/(c*d)	56	5,0	56	47 - 65	
solid Matter TSS	11	g/(c*d)	4	1,6	4	1.3 - 6.7	
org. Matter VSS	11	g/(c*d)	3	1,3	4	1 - 5.4	
	BOD ₅	12	g/(c*d)	26	6,5	25	18 - 43
	COD	12	g/(c*d)	45	7,7	42	36 - 64
Nutrients TP	12	g/(c*d)	0,4	0,12	0,4	0.2 - 0.6	
	PO ₄ -P	12	g/(c*d)	0,1	0,03	0,1	0.05 - 0.2
	TN	12	g/(c*d)	0,8	0,16	0,7	0.5 - 1.1
	NH ₄ -N	12	g/(c*d)	0,1	0,04	0,12	0.06 - 0.2

TN and TP - Loads per capita and day



-  Low greywater flow with 56 l/(c*d) on average, ranging from 46 – 66 l/(c*d)
-  Very low TSS load with only 4 g/(c*d)
-  TN loads are slightly lower than values from Berlin „Block 6“
-  TP loads in a similar range

Conclusion

- Major problem in the evaluation of literature data is the inconsistent data quality
- Greywater volumes are highly variable,
 - Depending on living habits and the equipment of the houses (e.g. dishwashers, water saving devices)
- COD and BOD₅, the concentrations and load per capita and day observed during the sampling campaigns were notably higher compared to literature values.
- TSS concentrations and loads found during sampling campaigns are significantly lower compared to literature values
- Literature values of TN- and TP- content and the results of sampling campaigns are in a similar range

Conclusion - Proposal for Design Values

- Literature values and the results of the sampling campaigns for TP fit very well
- TSS, COD and BOD₅ values show a large variability
- The Flow and TN –loads are in a similar ranges

Parameter	Unit	Literature	Block 6	Flintenbreite	proposal for design values		
		Mean	Mean	Mean	Mean	85%- Percentile	
Flow	l/(c*d)	82	77	56	68	80	
solid Matter	TSS	g/(c*d)	26	9	4	7	11
	BOD ₅	g/(c*d)	17	35	26	31	42
	COD	g/(c*d)	40	66	45	57	83
Nutrients	TP	g/(c*d)	0.5	0.4	0.4	0.4	0.5
	TN	g/(c*d)	1.1	1.3	0.8	1.0	1.4



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