Summary

of the presentations held at the meeting of the SANIRESCH project partners
(June 2012)

Explanation

There is a periodic meeting of all SANIRESCH project partners every 6 months. In June 2012, the 7th meeting was held.

All partners have presented their latest results. Various Powerpoint presentations are available in German. The most important content of these presentations was translated into English and is summarised in this document.

Content

- Presentation 1: Plant technology and outlook (Celine Schlapp, Huber SE)

- Presentation 2: Management and operation of the MAP precipitation reactor (Johanna Heynemann, THM)

- Presentation 3: Analysis results and operating parameters of the brown- and greywater MBR (Franziska Nun, THM)

- Presentation 4: Analysis results of the urine as well as brown- and greywater treatment (Bettina Schürmann, RWTH Aachen)

- Presentation 5: Acceptance study regarding using urine and MAP as a fertiliser in the agriculture (Katrin Spoth, University of Bonn)

- Presentation 6: Selective results of the third period of user surveys (Manfred Romich, RWTH Aachen)

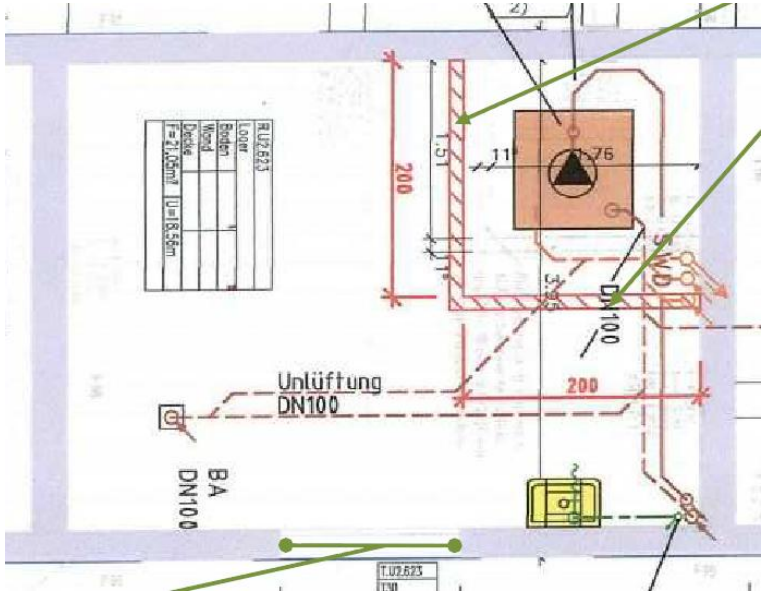
- Presentation 7: International transferability, economic feasibility and climate balancing (Enno Schröder, GIZ, Alexandra Dubios, KIT Karlsruhe)

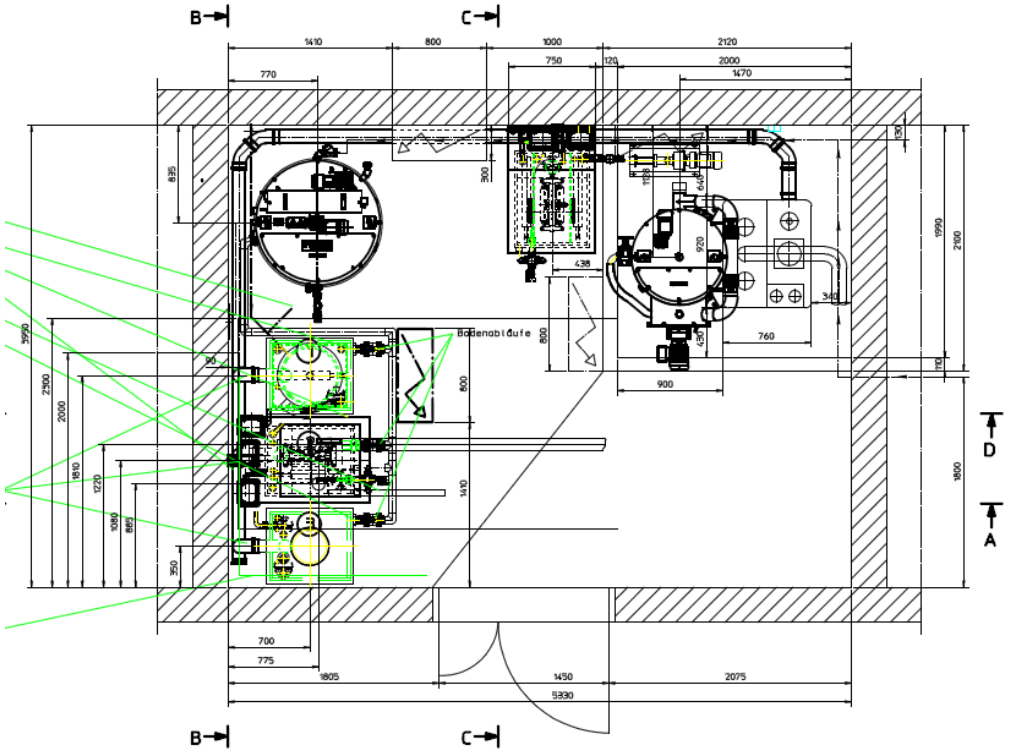
Presentation 1:

Celine Schlapp
(Huber SE)

Plant technology and outlook

Layout plan reactor room (top view)





- Concept design in coordination with all project partners
- Optimal spatial use (length 5.3 m x width 4 m x height 2.6 m)
- Adaptations of construction for the placement in the basement (prevention resp. decline of odour and aerosol formation)
- Configuration of all plants with data transfer and remote monitoring

Urine treatment

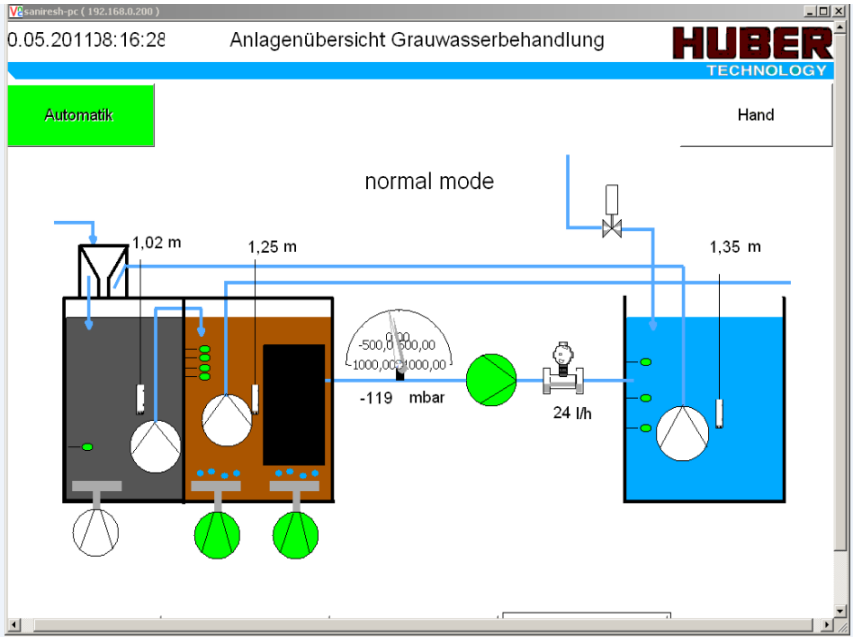
- Installation and first operation in the basement of the GIZ main building (May 2010)

Brownwater treatment

- Installation and first operation of the pre-treatment (April 2011)
- Installation and first operation of the whole treatment (July 2011)

Greywater treatment

- Installation and first operation in the basement of the GIZ main building (May 2011)



Training

- Training of the involved project partners (GIZ/ THM/ RWTH Aachen) in Berching and Eschborn

Interval maintenance

- Biannual maintenance by HUBER service technicians
- Provision of spare parts
- Implementation of a chemical cleansing (exemplary) of the membrane module of the greywater treatment plant in cooperation with the THM and GIZ

Outlook - standardised membrane bio reactor system

smart MBR®

- Solution for water recycling in buildings
- Grey- and brownwater treatment (10 – 75 m³/d)
- Application in hotels, shopping centers and housing complexes
- Complete preinstallation (mechanical and electric) takes place at the factory
- Easy transport
- Connections following the „plug and play“ principle
- Reuse e.g. for irrigation or toilet flush water

Presentation 2:

Johanna Heynemann
(THM)

Operation and maintenance of the

MAP precipitation reactor

MAP-precipitation reactor

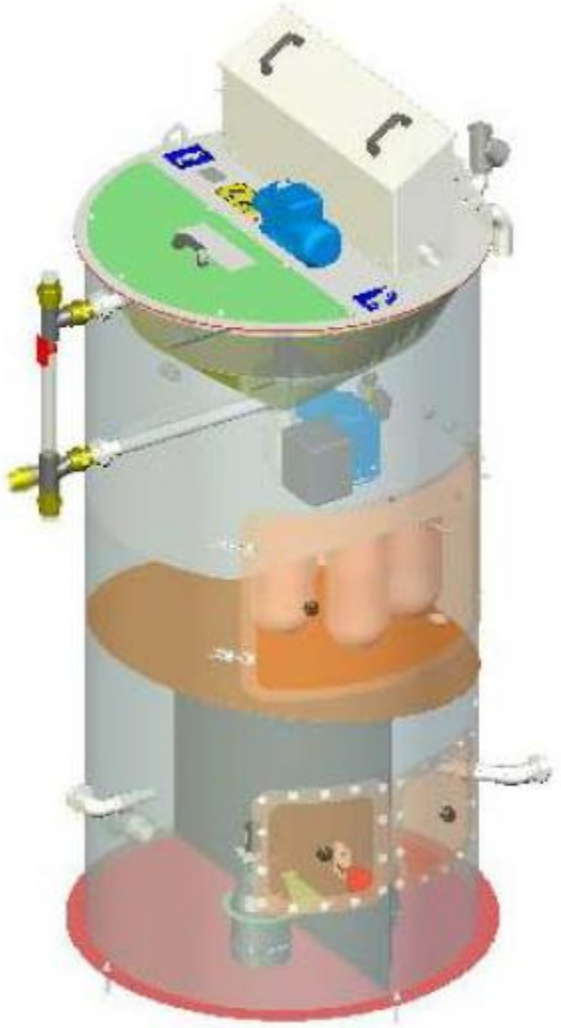
Beginning of operation:	May 2010
Flow rate:	≈ 1400 l/week
ß-factor:	1.5
MAP-yield:	0.7 to 1.3 g/l urine
Sedimentation duration:	90 min

MAP-precipitation reactor – current operation

TECHNISCHE HOCHSCHULE MITTELHESSEN

Results since February 2012

- Production of MAP for agricultural application by the University of Bonn
- Production of MAP for public relations by GIZ
- Urine tests by a master student of TU Darmstadt

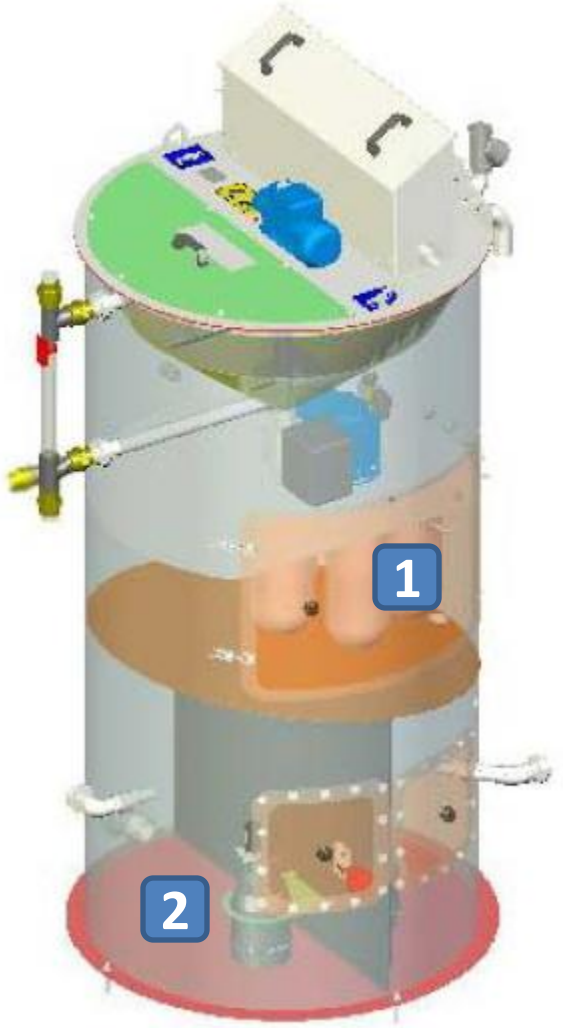


MAP-precipitation reactor – current operation

TECHNISCHE HOCHSCHULE MITTELHESSEN

Results of the MAP analytics for agricultural application

	Molar nutrient ratio N : P : Mg
Produced MAP 1	1,00 : 0,96 : 1,27
MAP out of the sump pit 2	1,00 : 0,98 : 1,02
	1,00 : 0,99 : 1,03



Presentation 3:

Franziska Nun
(THM)

Brown- and Greywater- membrane bioreactor (MBR):

Analysis results and
operating parameters

Greywater – membrane bioreactor

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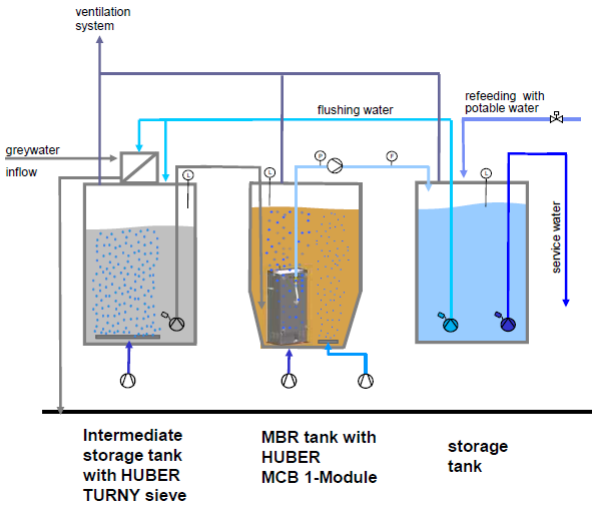
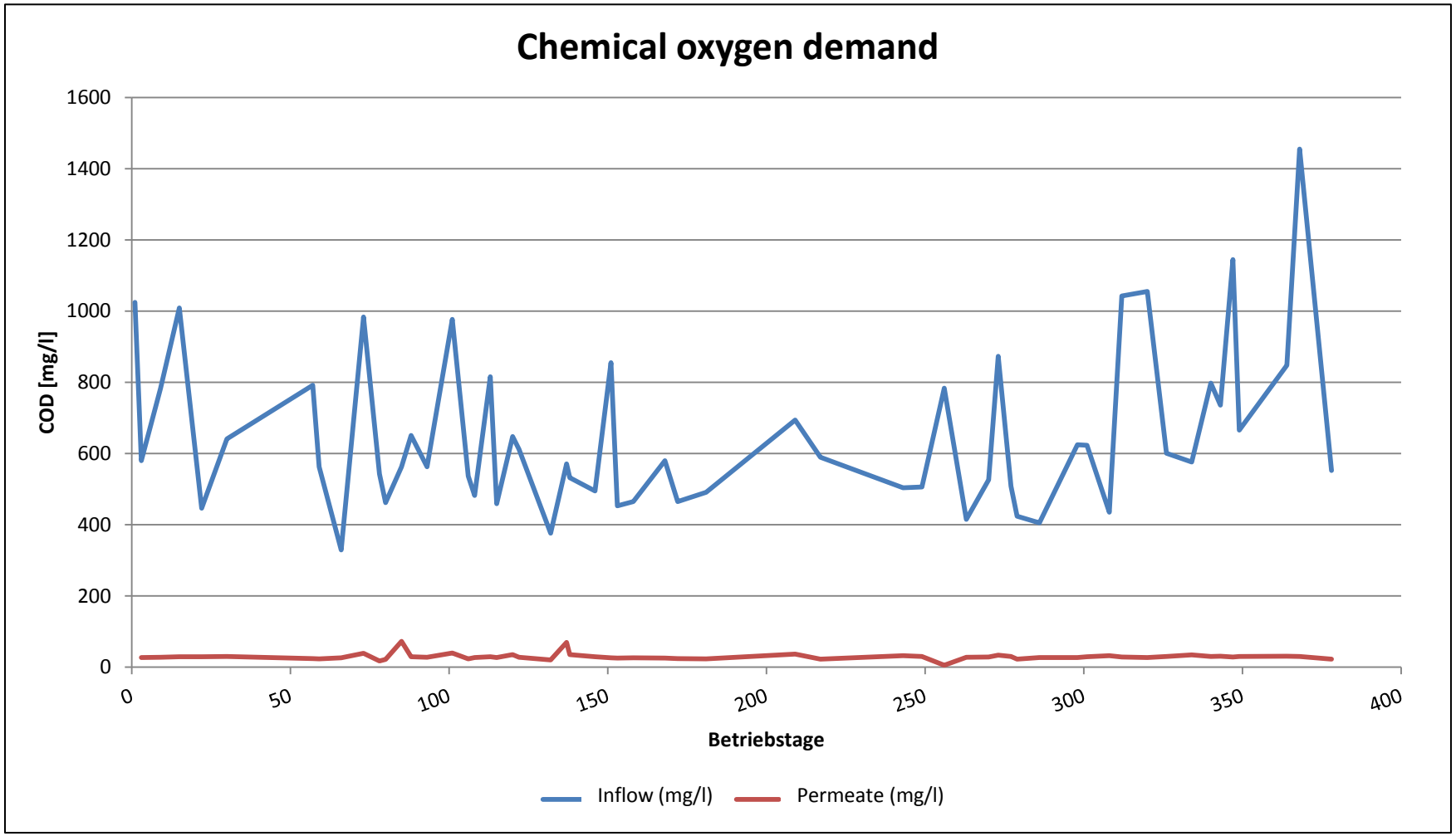


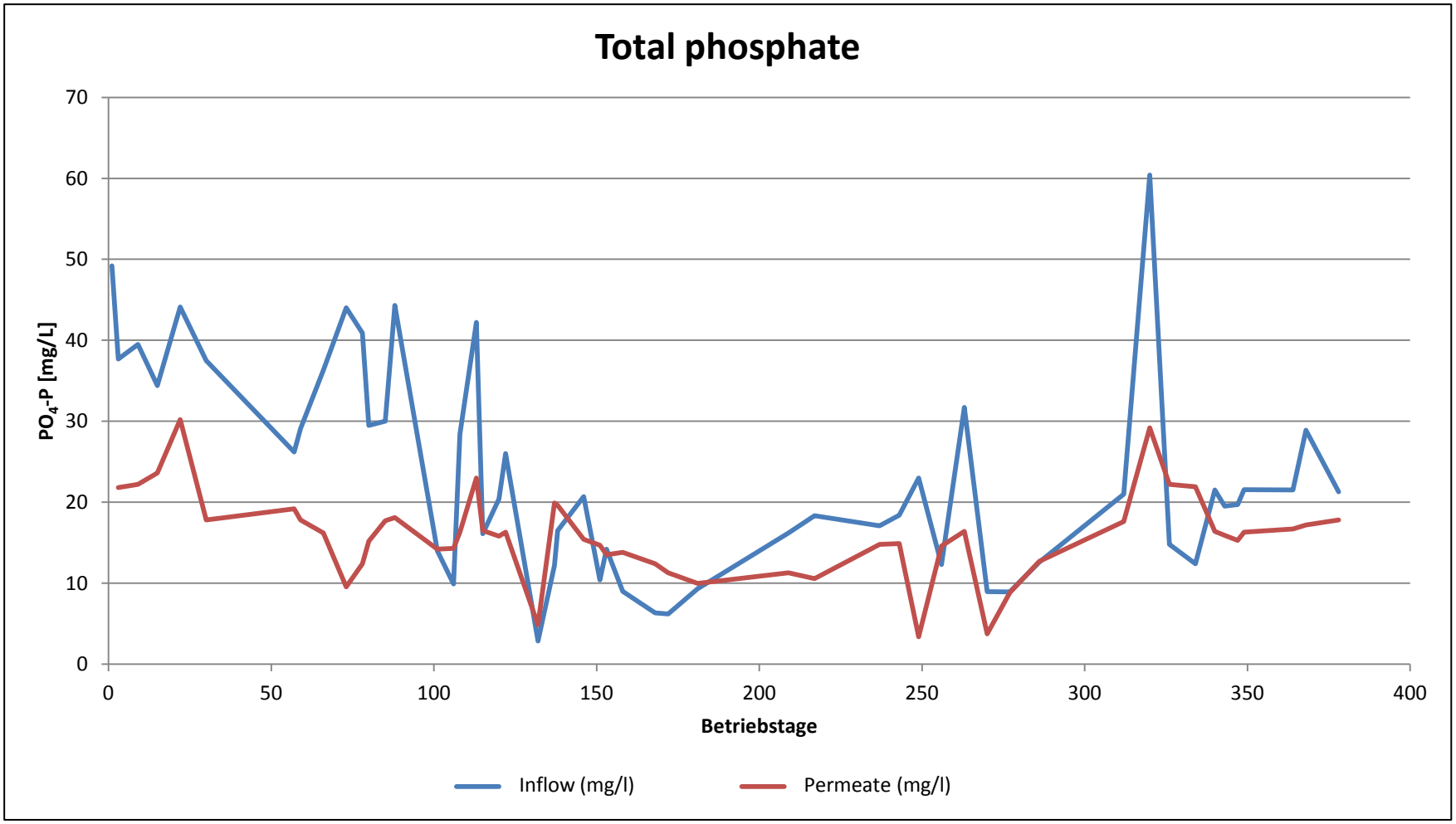
Beginning of operation:	13.05.2011
Flow rate:	≈ 26 l/h
Flow rate [l/d]:	≈ 480 l/d
TS_{MBR}:	4 to 5 g/l
Turny (mesh width): (Pre-treatment – sieve for solids)	3 mm
Break:	10 pm – 6 am
Filtration:	270 s
Break:	120 s
Transmembrane pressure:	61 mbar

Greywater operation parameters



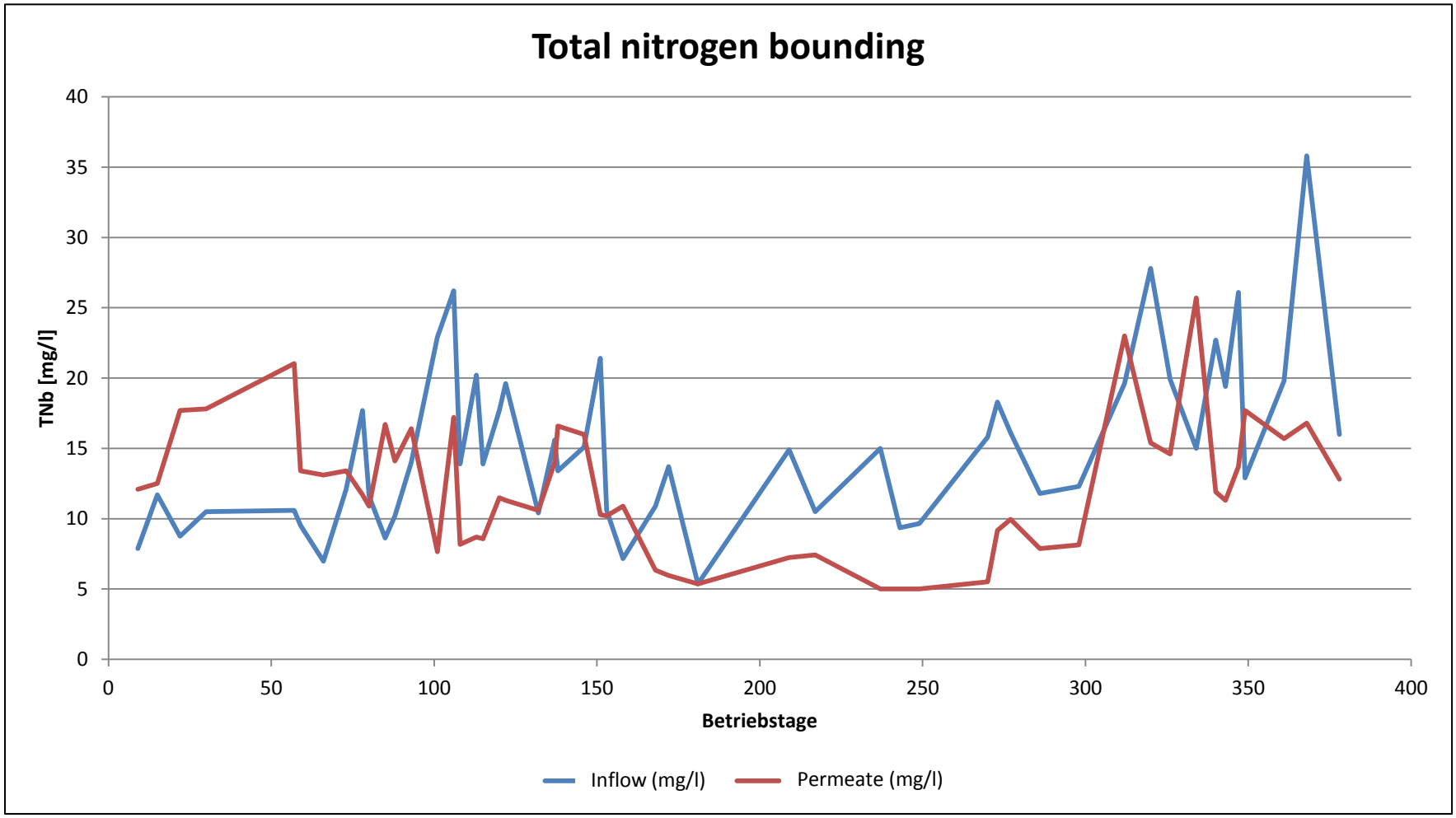
COD – decomposition rate: 95%

Greywater operation parameters



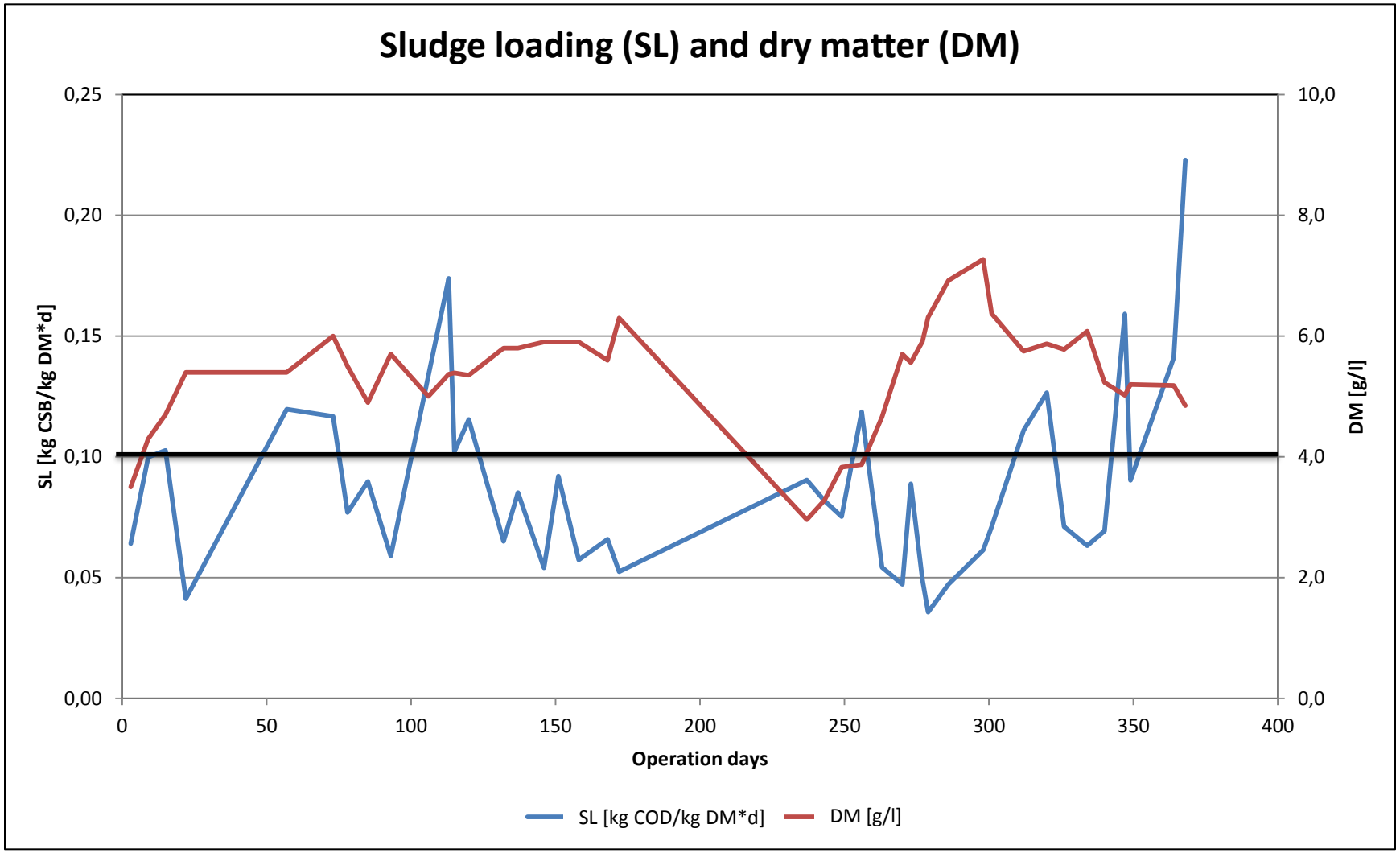
Nutrient ratio: C : N : P = 100 : 2,3 : 1,2

Greywater operation parameters

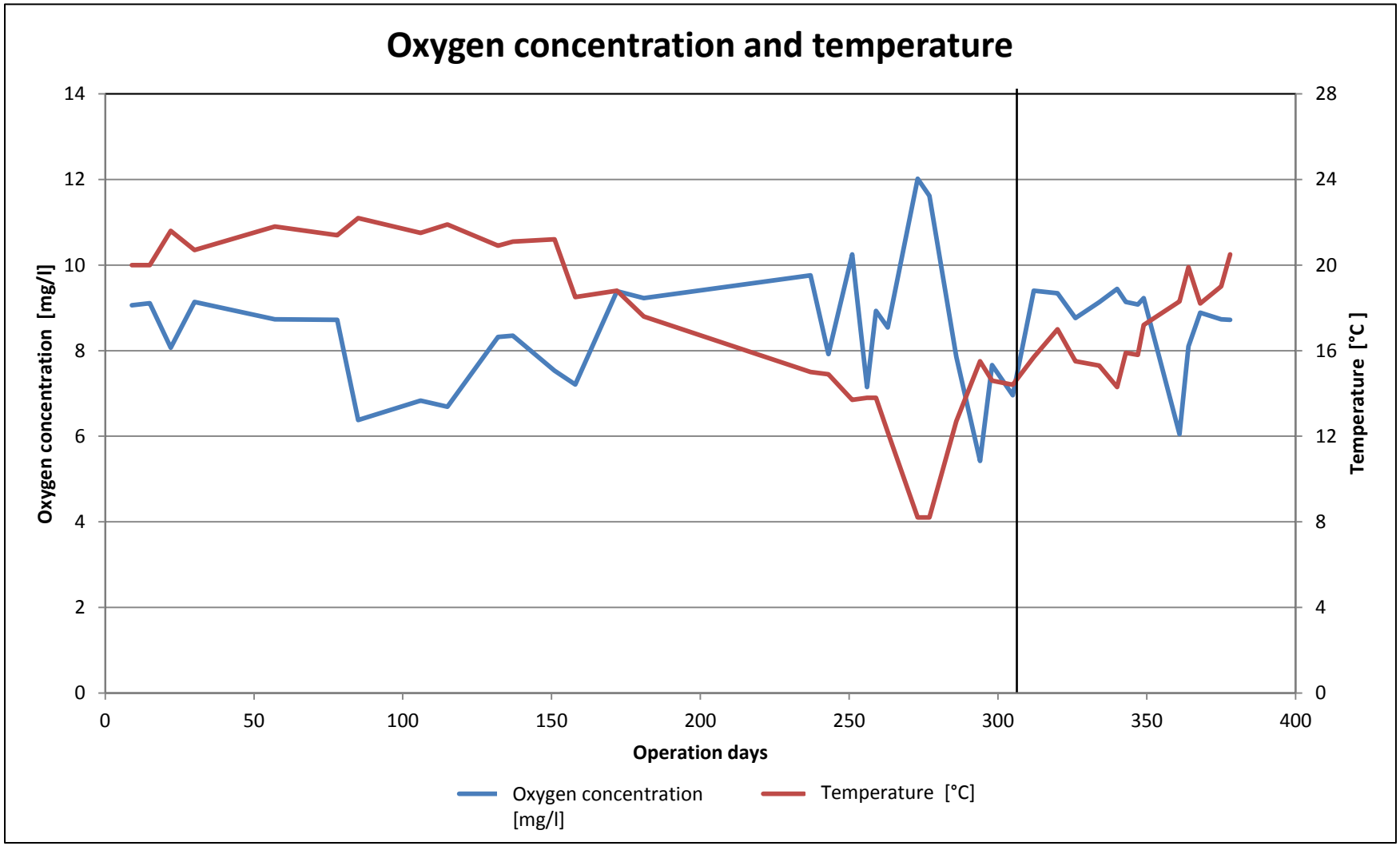


Nutrient ratio: C : N : P = 100 : 2,3 : 1,2

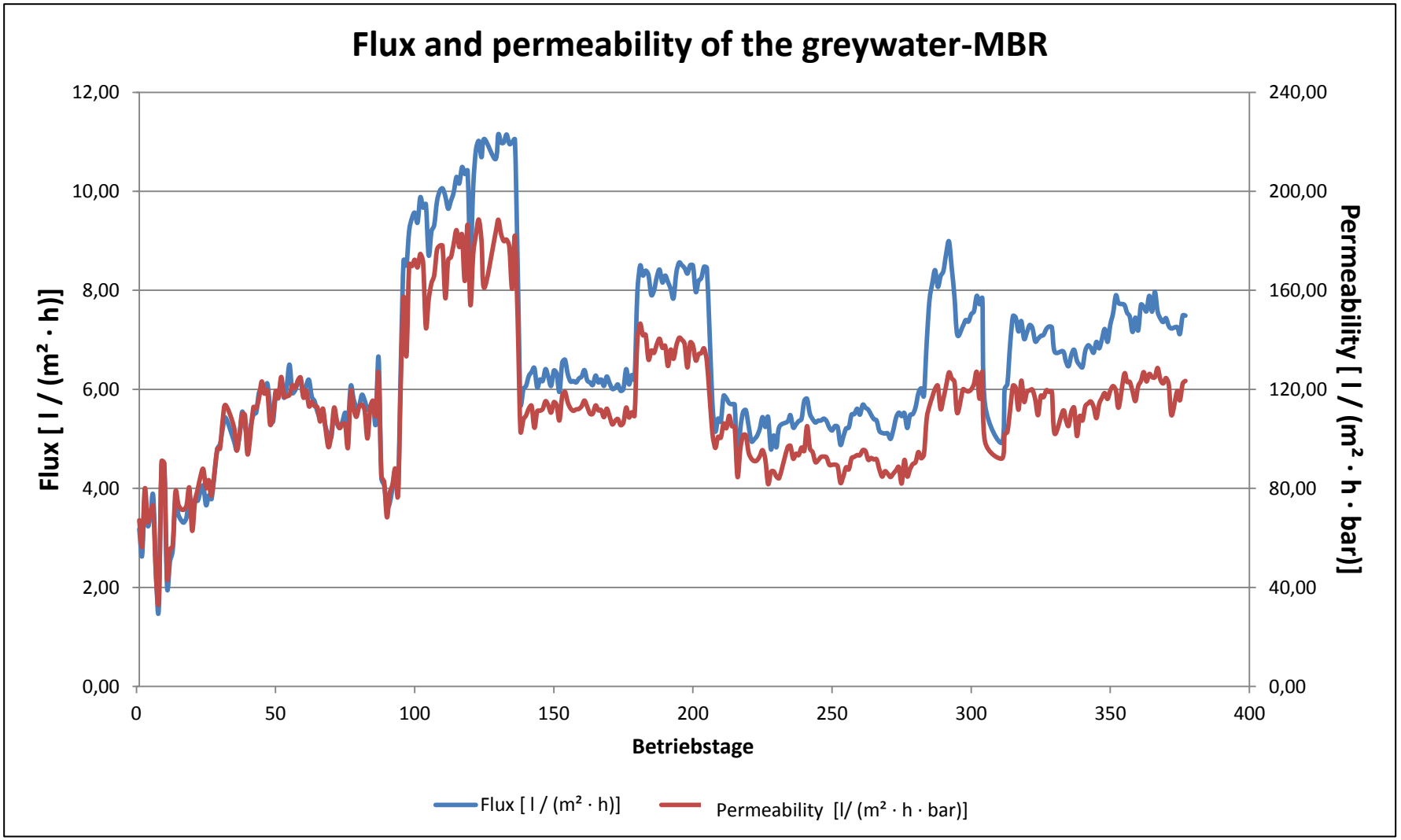
Greywater operation parameters



Greywater operation parameters

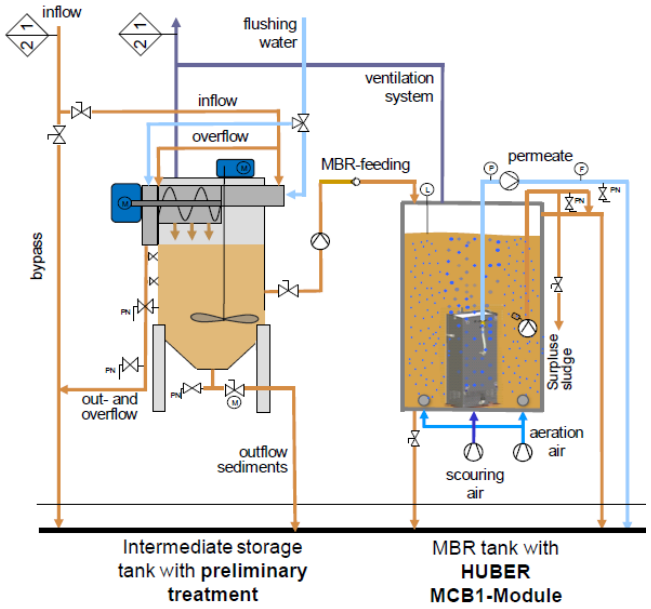


Greywater operation parameters



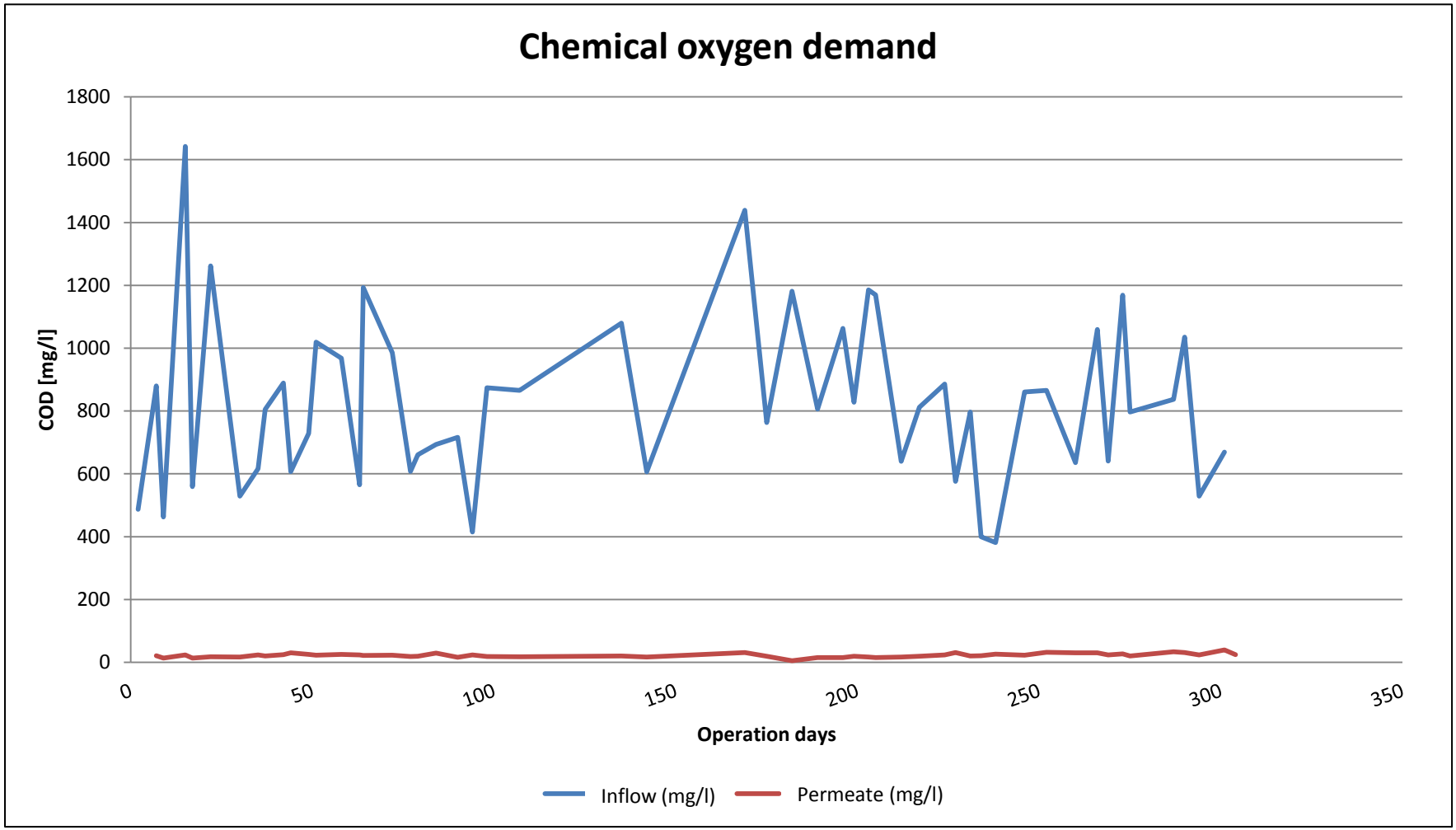
Brownwater - membrane bioreactor

TECHNISCHE HOCHSCHULE MITTELHESSEN



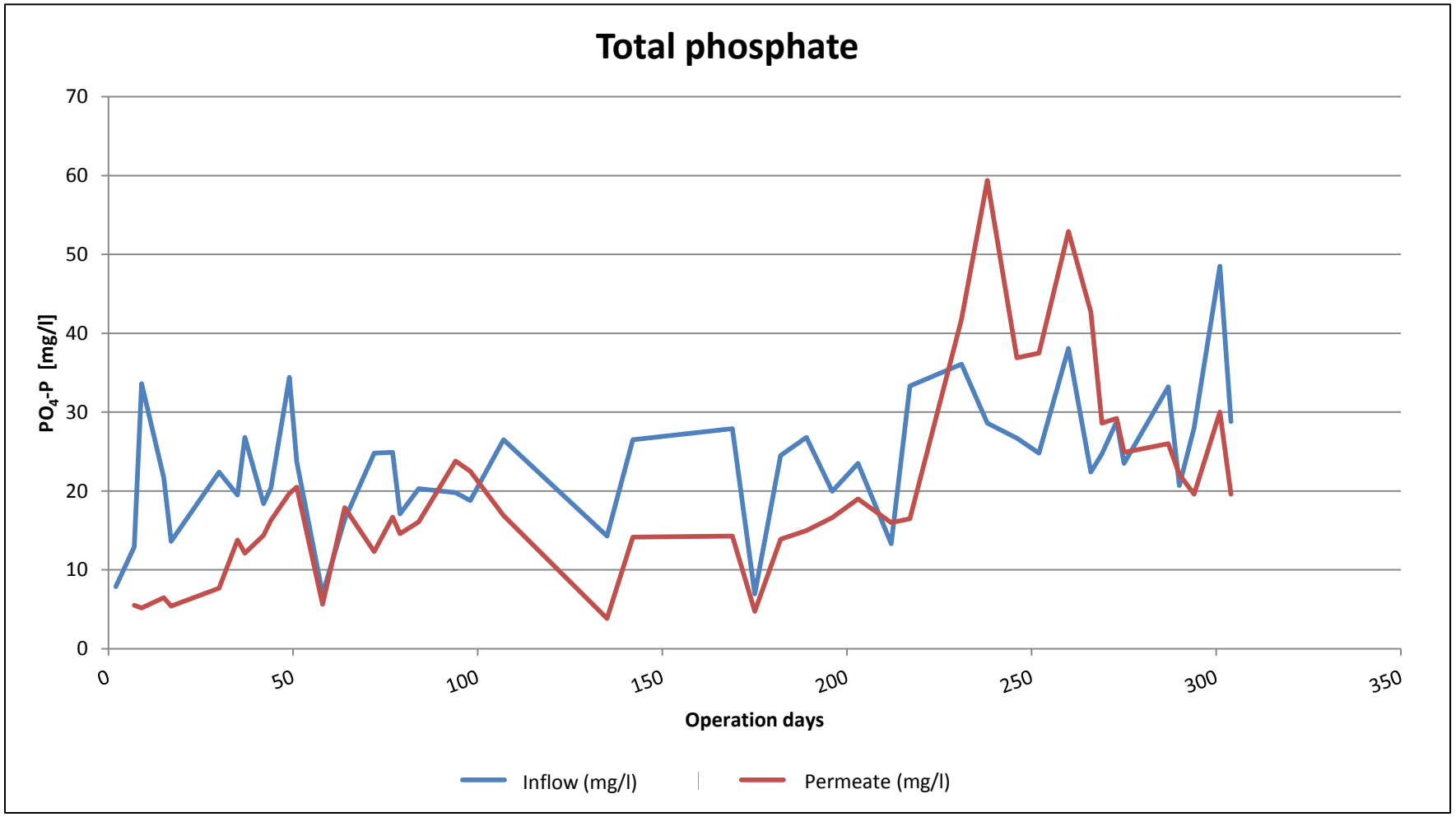
Beginning of operation:	27.06.2011
Flow rate:	≈ 44 l/h
Flow rate [l/d]:	≈ 725 l/d
TS_{MBR}:	9 to 10 g/l
Pre-treatment (mesh size):	3 mm
Break:	11 pm – 4 am
Filtration:	270 s
Break:	30 s
Transmembrane pressure:	54 mbar

Brownwater operation parameters



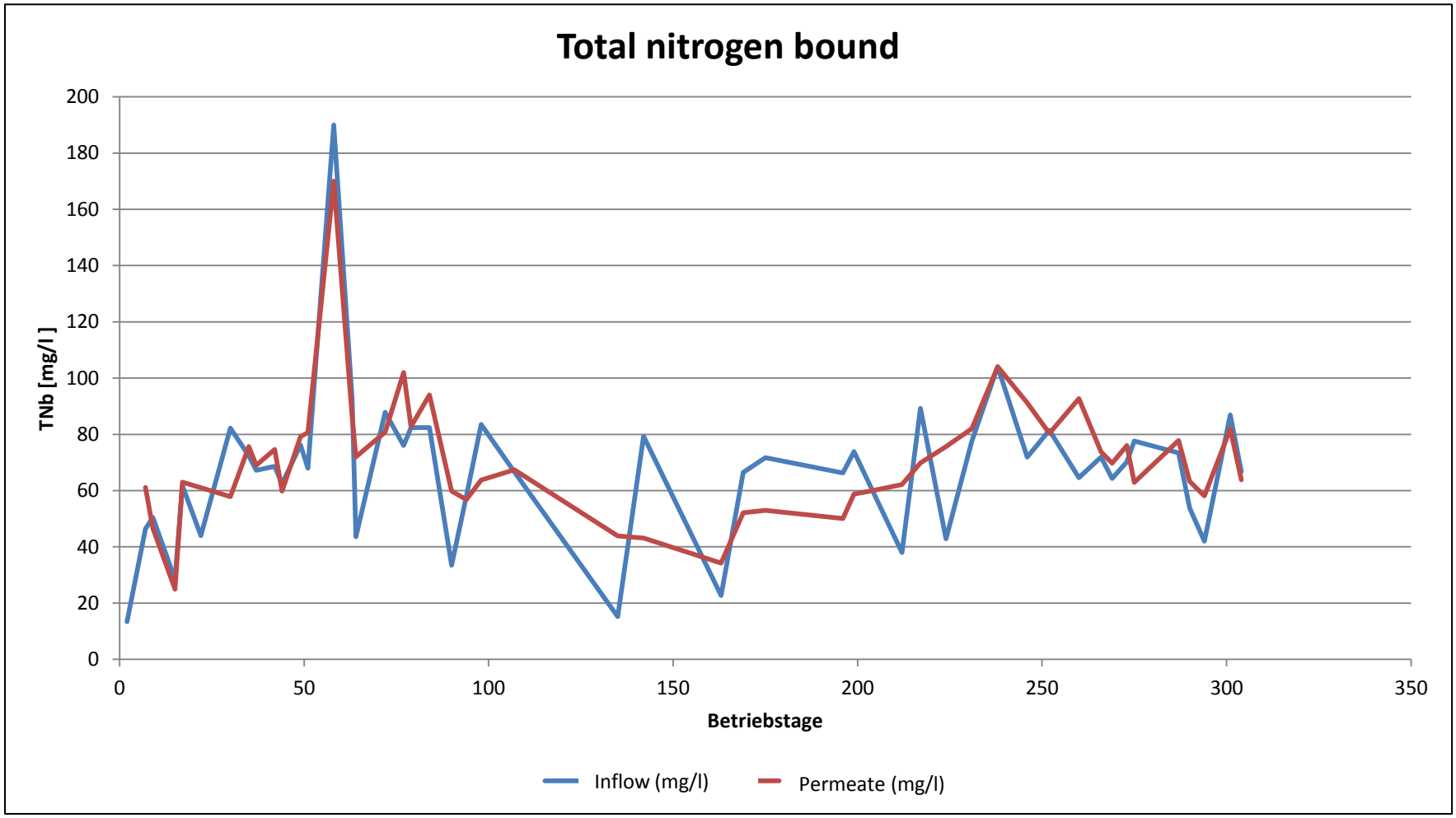
COD – Decomposition rate: 97%

Brownwater operation parameters



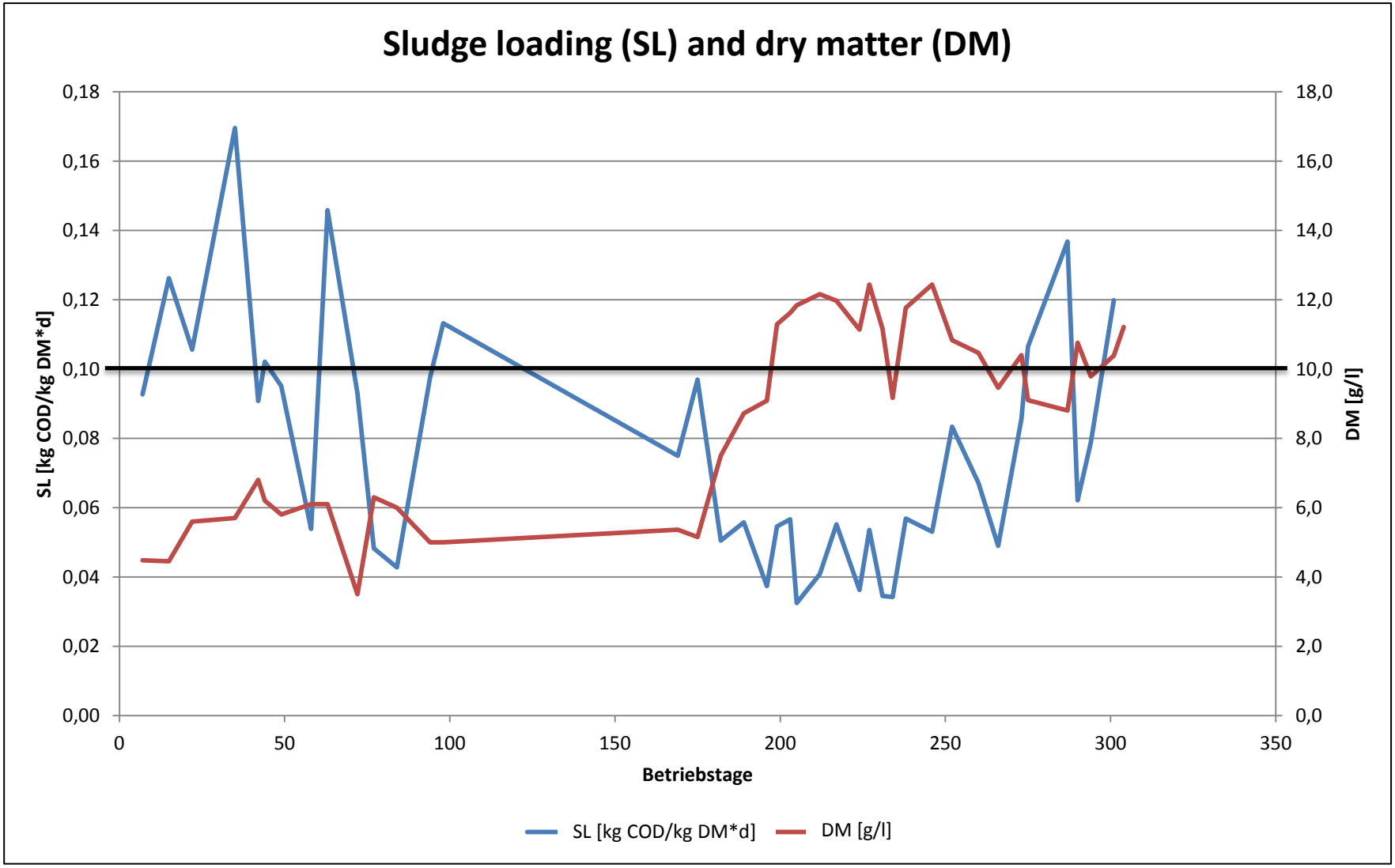
Nutrient ratio: C : N : P = 100 : 8,6 : 1,3

Brownwater operation parameters

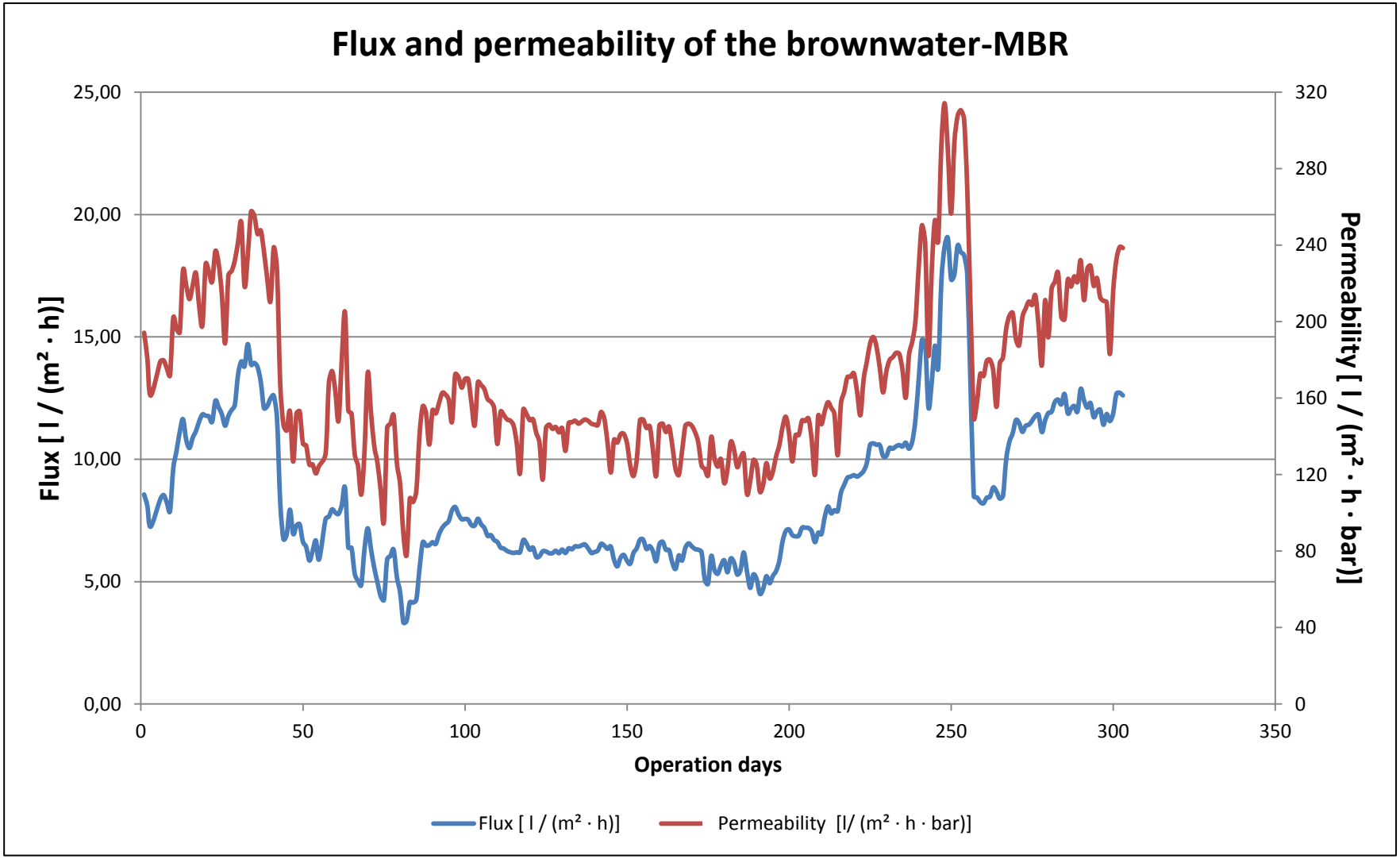


Nutrient ratio: C : N : P = 100 : 8,6 : 1,3

Brownwater operation parameters



Brownwater operation parameters



Permeate – evaluation

Parameter	Permeate Greywater	Permeate Brownwater	Comparison fbr-H 201	Comparison DIN 19650	German drinking water regulation
COD [mg O_2/l]	30	23		< 60 [1)]	
BOD [mg O_2/l]	1,4 [3)]	1,6 [3)]	< 5 [3)]	< 10 [1),2)]	
O_2 - saturation [%]	94	89	> 50		
Turbity [NTU]	0,3	0,5			1
Microbiology					
Coliform bacteria [1/ml]	0,7	2	< 100	EK [4)]	0/100 ml
E. coli [1/ml]	0,4	1	< 10	EK [4)]	0/100 ml
Complete bacteria count [1/ml]	125	165			100

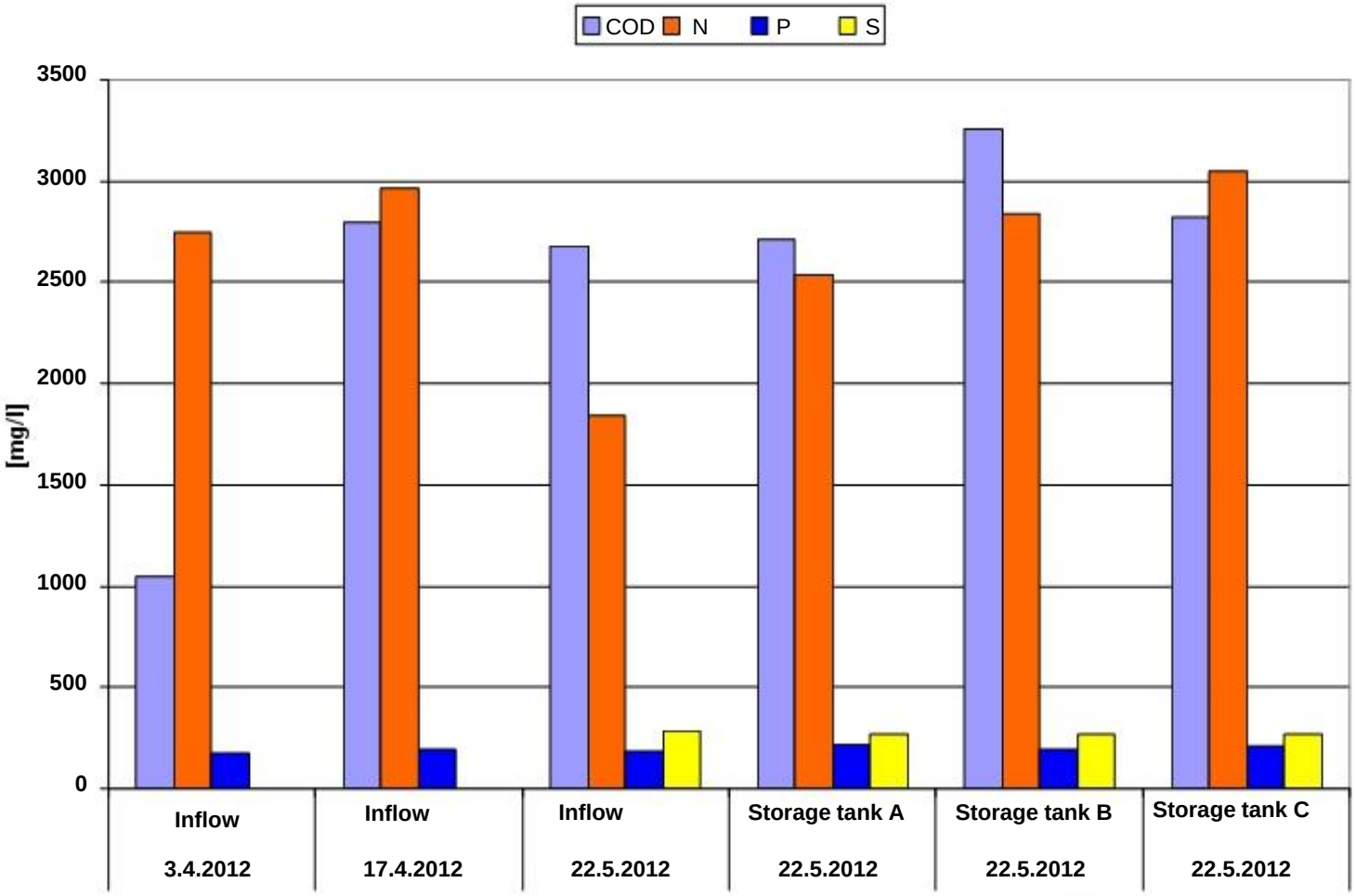
1) A transgression indicates indirectly a risk for a health hazard.
2) BOD 5
3) BOD 7
4) A classification depends on the colony count number

Presentation 4:

Bettina Schürmann
(University RWTH Aachen)

Storage of urine: Behaviour of problematic matter in urine, grey and brownwater treatment

Urine



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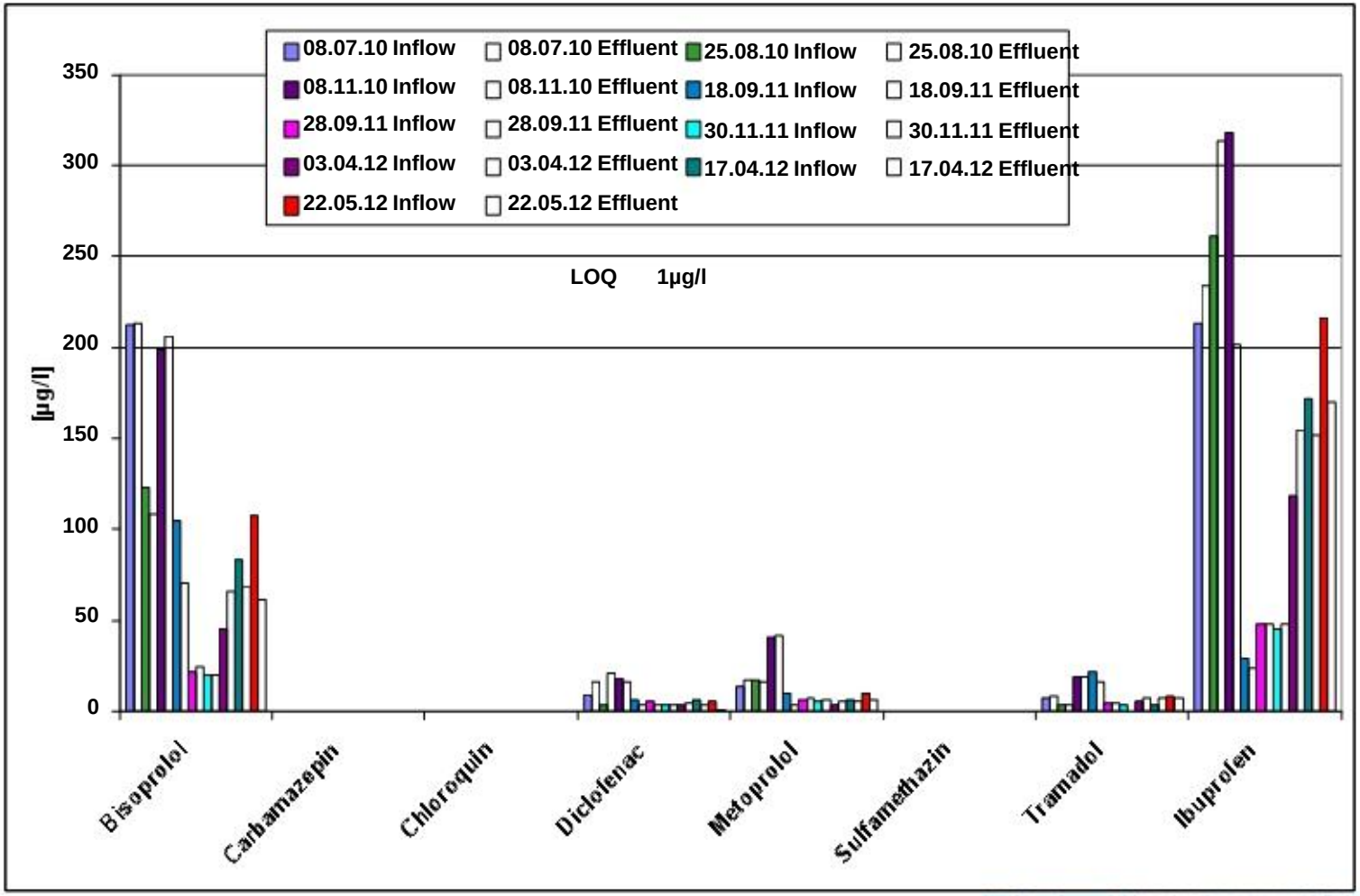
Urine

Pharmaceuticals



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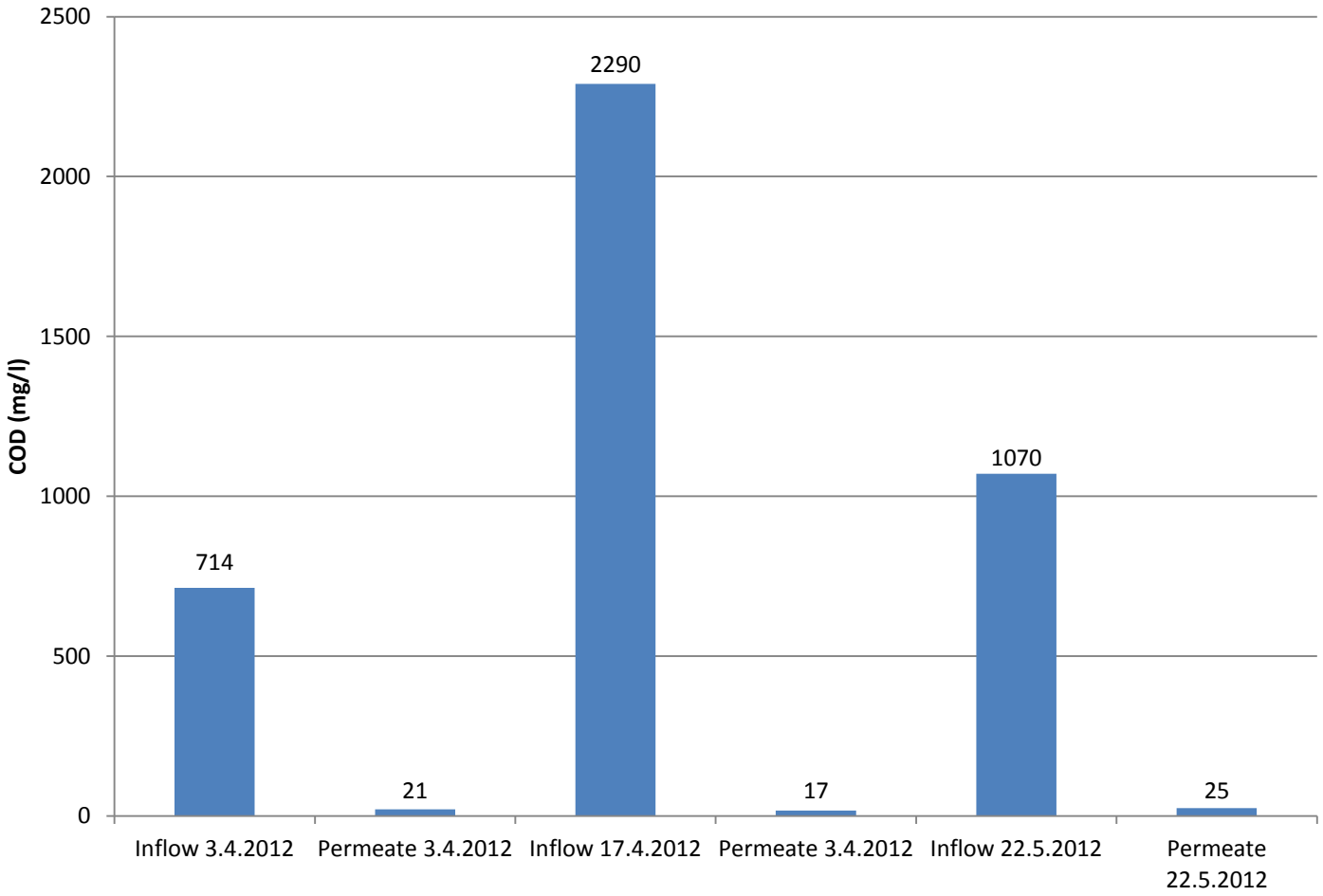
Brownwater



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Brownwater

Microbiology

Date	Sample	E. Coli	Coliform bacteria	intestinal Enterococcus
		100 ml	n/100 ml	n/100 ml
18.8.2011	Permeate	>24196	>24196	
28.9.2011	Permeate	7	980	56
30.11.2011	Permeate	68	91	0
3.4.2012	Permeate	2	2	0
16.4.2012	Permeate	2	2	0
22.5.2012	Permeate	3,1	18,5	58

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Greywater

Microbiology

Date	Sample	E. Coli n/100 ml	Coliform bacteria n/100ml	intestinal Enterococcus n/100ml
18.8.2011	Permeate fresh	1	17,1	-
28.9.2011	Permeate stored	0	0	<1
	Permeate fresh	0	1	<1
30.11.2011	Permeate fresh	0	0	0
	Permeate stored	0	0	0
3.4.2012	Permeate fresh	0	0	0
	Permeate stored	0	0	0
17.4.2012	Permeate fresh	0	1	0
	Permeate stored	0	0	0
22.5.2012	Permeate fresh	1	1	0
	Permeate stored	0	0	0

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Greywater

Assay on surfactants

With enrichment factor 50:

- Positive ionisation – verification of neutral surfactants
  - No marked range of surfactants

- Negative ionisation – verification of anionic surfactants
  - Verification of secundary alcyl sulphonates and linear alcyl sulphonates from usual detergents
  - **The concentration of surfactants in the permeate is ten times lower than in the inflow**

Membrane reactors

Daphnia test

No toxicity in both permeates with respect to Daphnia magna

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Presentation 5:

Katrin Spoth
(University Bonn)

Acceptance study on urine and MAP as a fertiliser in the agricultural application

State 2012

- Written surveys of farmers (400 questionnaires sent) and consumers (500 questionnaires sent) from North-Rhine-Westphalia were conducted

- Acquisition of:
  - socio-economic context
  - size and type of the farm
  - ecological background knowledge
  - attitudes and opinions regarding urine and MAP as a fertiliser

- Farmer survey was finished in February 2012
  - Rate of return: 27% (108 returns)
  - Results are statistically analysed

- Consumer survey was finished in May 2012
  - Rate of return: 15% (75 returns)
  - Statistical analyse is still in the course of preparation

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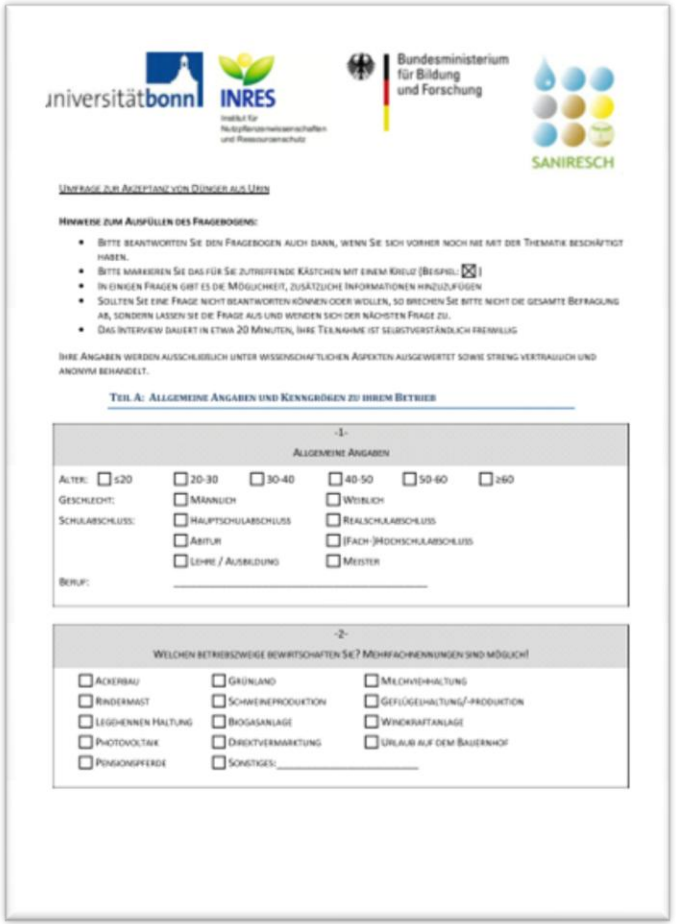
Questionnaire

- Questionnaire with four sections
  - General information
  - Ecological background knowledge
  - Opinion on urine and MAP as a fertiliser
  - Acceptance of urine application as a fertiliser



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Bundesministerium für Bildung und Forschung

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Umfrage zur Akzeptanz von Dünger aus Urin

Hinweise zum Ausfüllen des Fragebogens:

- Bitte beantworten Sie den Fragebogen auch dann, wenn Sie sich vorher noch nie mit der Thematik beschäftigt haben.
- Bitte markieren Sie das für Sie zutreffende Kästchen mit einem Kreuz (Beispiel: ☒)
- In einigen Fragen gibt es die Möglichkeit, zusätzliche Informationen hinzuzufügen
- Sollten Sie eine Frage nicht beantworten können oder wollen, so brechen Sie bitte nicht die gesamte Befragung ab, sondern lassen sie die Frage aus und wenden sich der nächsten Frage zu.
- Das Interview dauert in etwa 20 Minuten, Ihre Teilnahme ist selbstverständlich freiwillig

Ihre Angaben werden ausschließlich unter wissenschaftlichen Aspekten ausgewertet sowie streng vertraulich und anonym behandelt.

Teil A: Allgemeine Angaben und Kenngrößen zu ihrem Betrieb

-1-

Allgemeine Angaben

Alter: ☐ ≤20 ☐ 20-30 ☐ 30-40 ☐ 40-50 ☐ 50-60 ☐ ≥60

Geschlecht: ☐ Männlich ☐ Weiblich

Schulabschluss: ☐ Hauptschulabschluss ☐ Realschulabschluss ☐ Abitur ☐ (Fach-)Hochschulabschluss ☐ Lehre / Ausbildung ☐ Meister

Beruf: _____

-2-

Welchen Betriebszweige bewirtschaften Sie? Mehrfachnennungen sind möglich!

☐ Ackerbau ☐ Grünland ☐ Milchviehhaltung
☐ Rindermast ☐ Schweineproduktion ☐ Geflügelhaltung/-produktion
☐ Legehennen Haltung ☐ Biogasanlage ☐ Windkraftanlage
☐ Photovoltaik ☐ Direktvermarktung ☐ Urlaub auf dem Bauernhof
☐ Pensionspferde ☐ Sonstiges: _____

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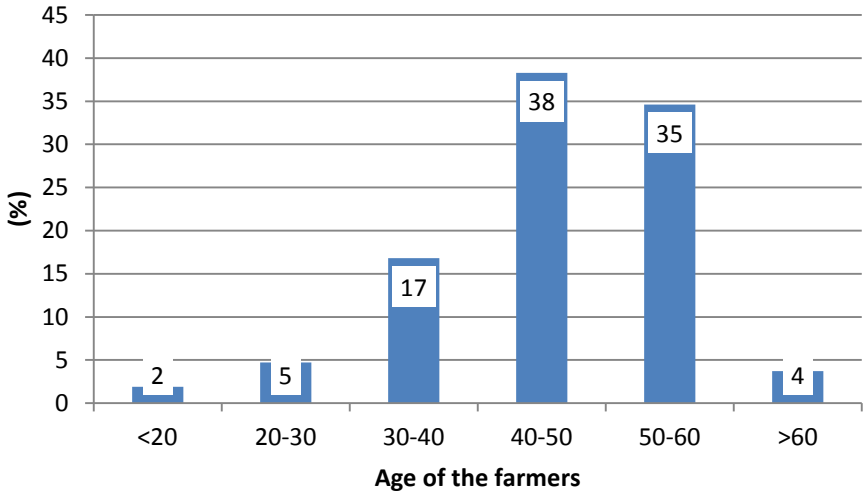
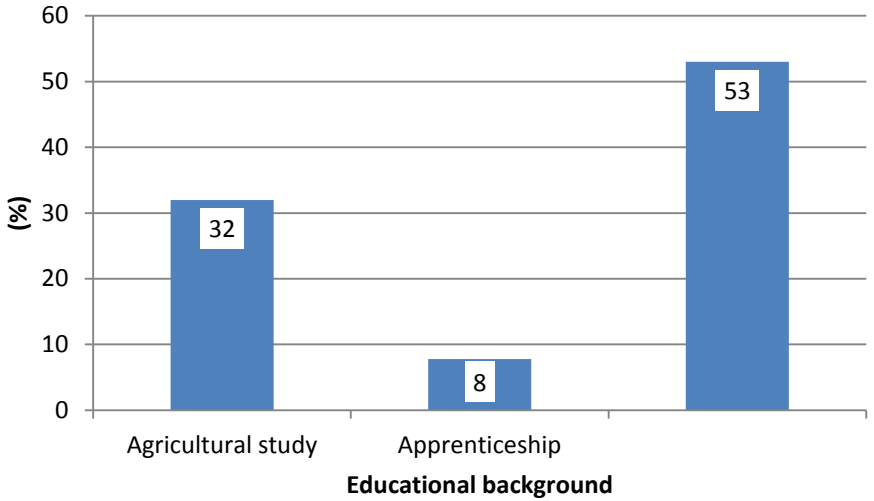
Socio-economic background





- 95% are male, 5% female
- Mostly represented age-set: 40-60 year-old persons
- Education: 55% were foremen, 32% with degree in agricultural sciences, 7.8% with apprenticeship

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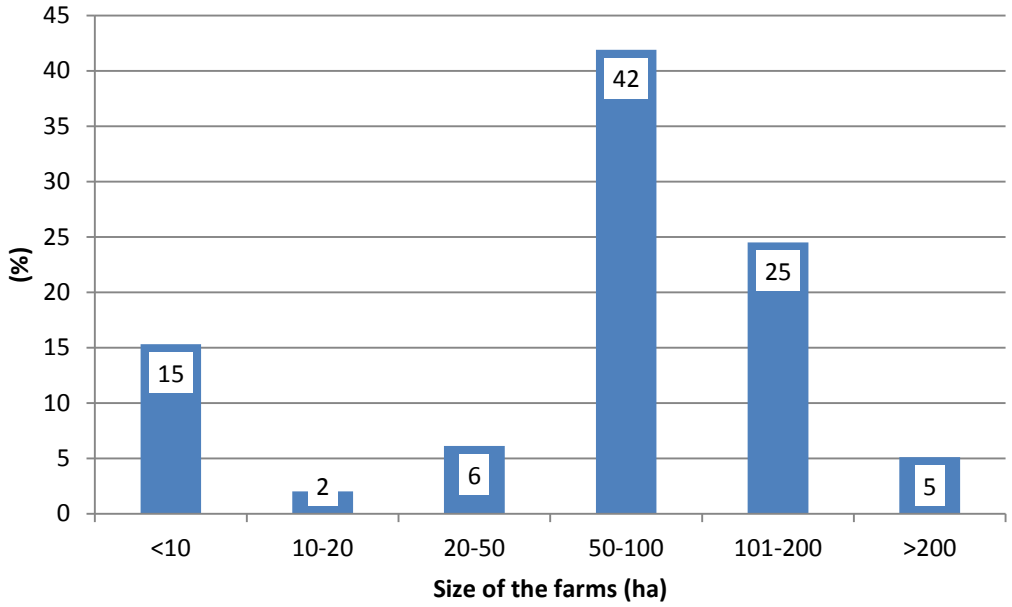
Socio-economic background

Size of the farms



- Mostly represented the sizes 50-200 ha
- Noticeable: farms with medium size are underrepresented

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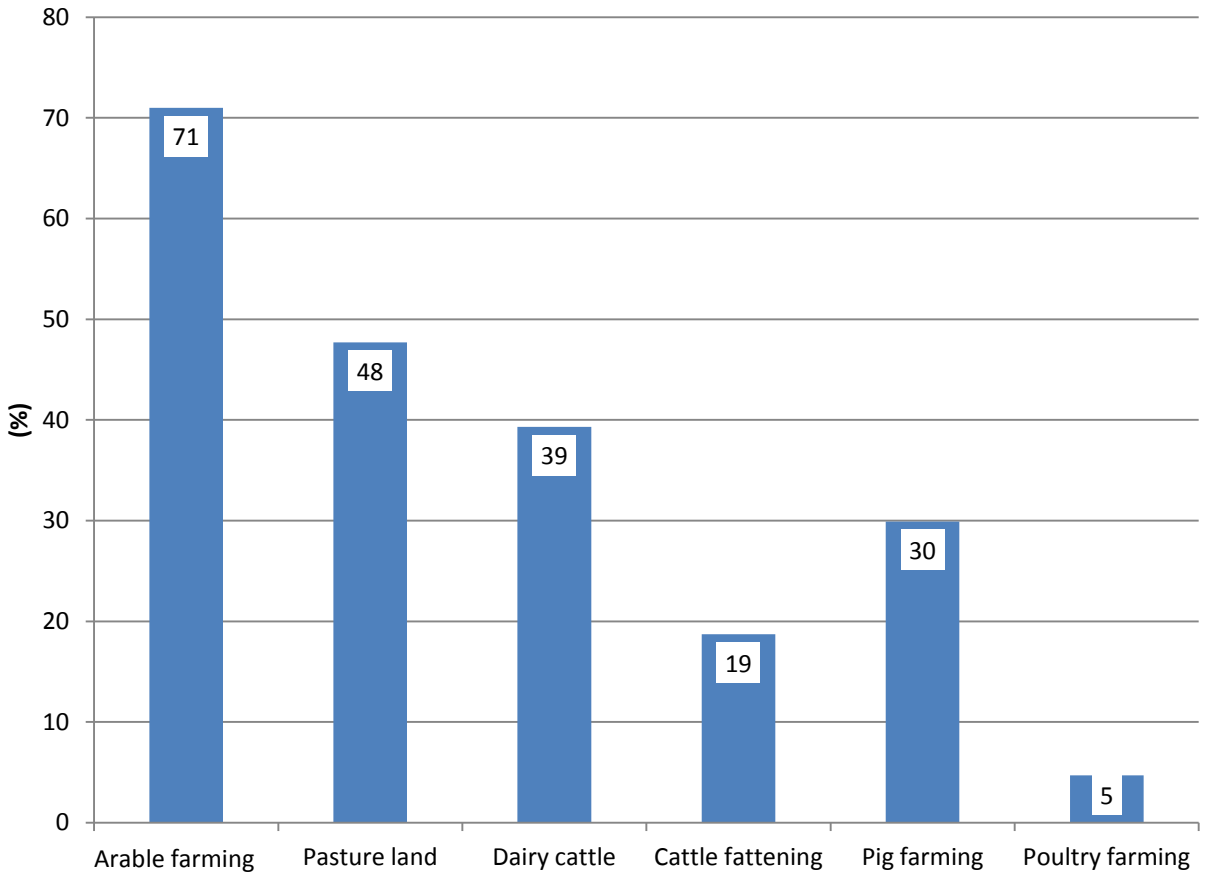
Socio-economic background

Types of farming



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Background knowledge

Was it common to use human excreta in the agriculture in earlier times ?

- 84 % of the interviewees answered with “yes”, 6.7% with “no” and 9,5% gave no answer

Does urine contain a high amount of nutrients and is it easy to reuse as a fertiliser?

- 62 % of the interviewees answered with “yes”, 10% with “no” and 28% gave no answer

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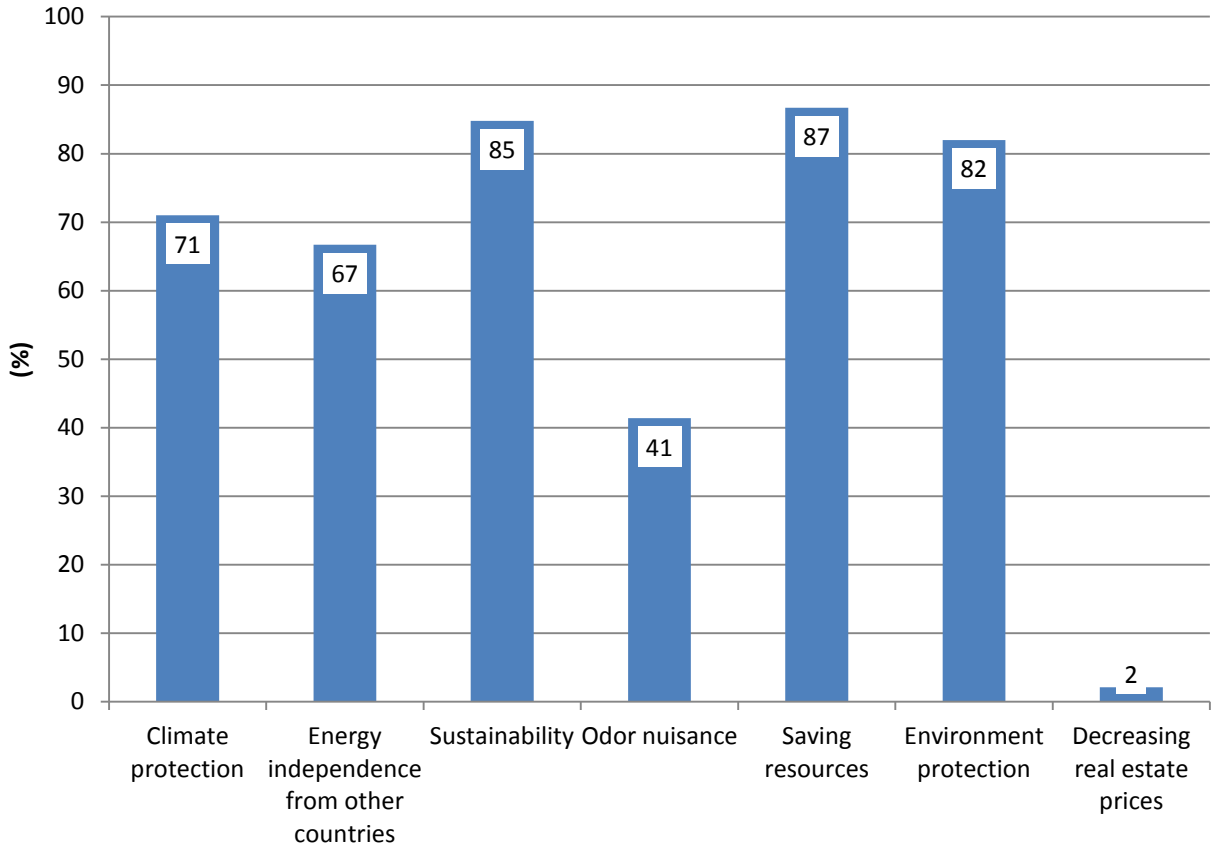
Attitudes and opinions of the interviewees

What are your first thoughts when thinking about using urine and MAP as fertiliser in the agriculture?



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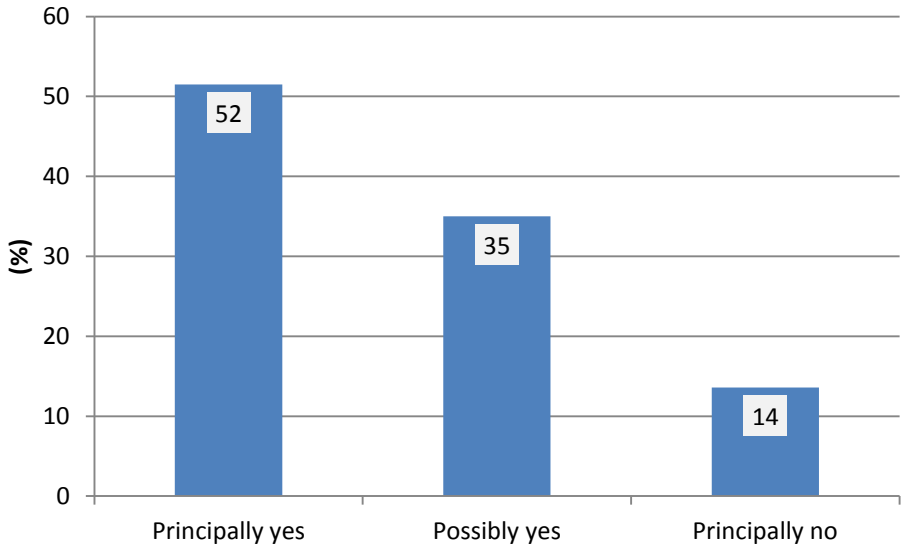
Attitudes and opinions of the interviewees

Would you principally use urine or MAP as a fertiliser?



By taking following conditions for granted:

- Assurance that no pharmaceutical residues and hormones are contained
- Acceptance of the consumer level is guaranteed
- Environmental impact assessment and fertiliser certification do exist
- Experience reports do exist
- Nutrient content is exactly clarified
- Assurance that no heavy metals are contained

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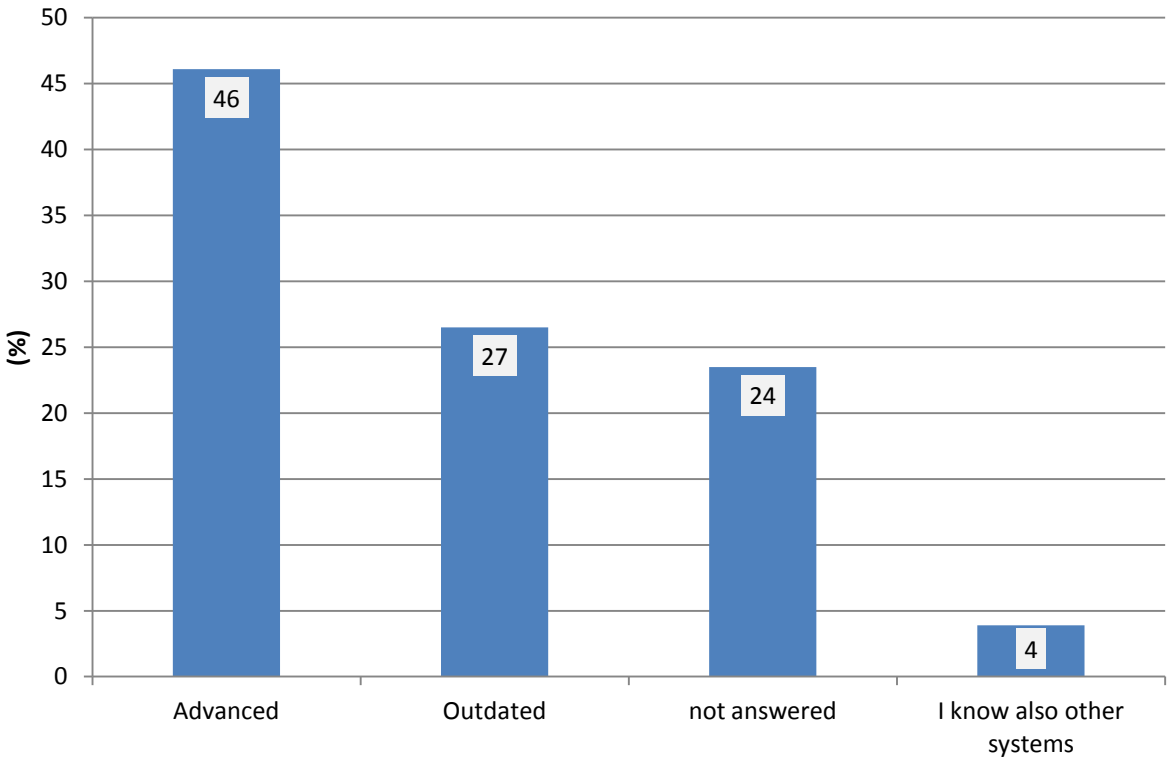
Attitudes and opinions of the interviewees

How do you appraise the current German sewerage system?



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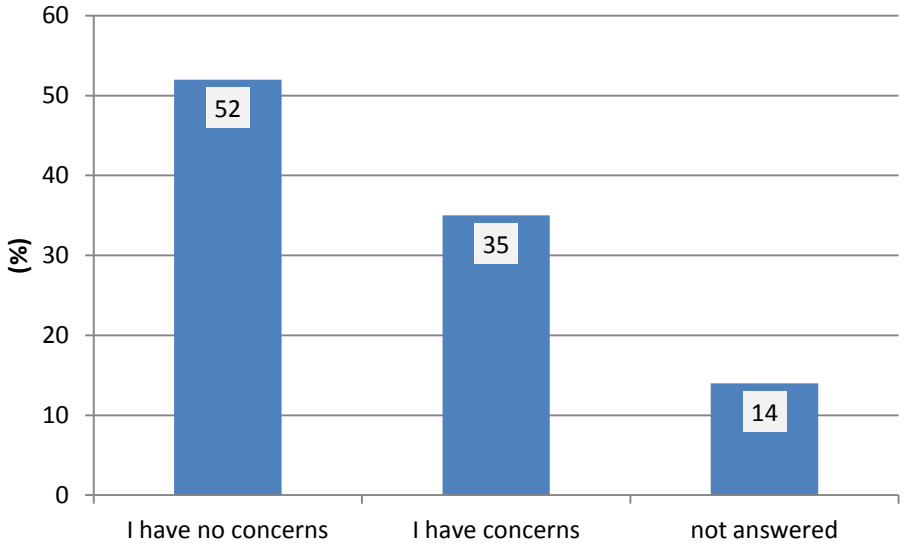
Attitudes and opinions of the interviewees

Do you have concerns regarding the application of urine and MAP as a fertiliser?



Most often mentioned concerns:

- Safety
- Pharmaceutical residues
- Consumer acceptance of the fertilised products
- Harmful substances

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Attitudes and opinions of the interviewees regarding urine as or MAP as fertiliser

- Positive vs. Negative

  79% of the interviewees tend to rate the reuse rather positive
- Natural vs. Unnatural

  84% of the interviewees tend to rate the reuse rather natural
- Outdated vs. Advanced

  70% of the interviewees tend to rate the reuse rather natural
- Necessary vs. Superfluous

  66% of the interviewees tend to rate the reuse rather necessary
- Controllable vs. Uncontrollable

  72% of the interviewees tend to rate the reuse rather controllable
- Useful vs. Harmful

  About 50% of the interviews tend to rate the reuse rather useful
- Proofed vs. Doubtful

  About 50% of the interviews tend to rate the reuse rather doubtful

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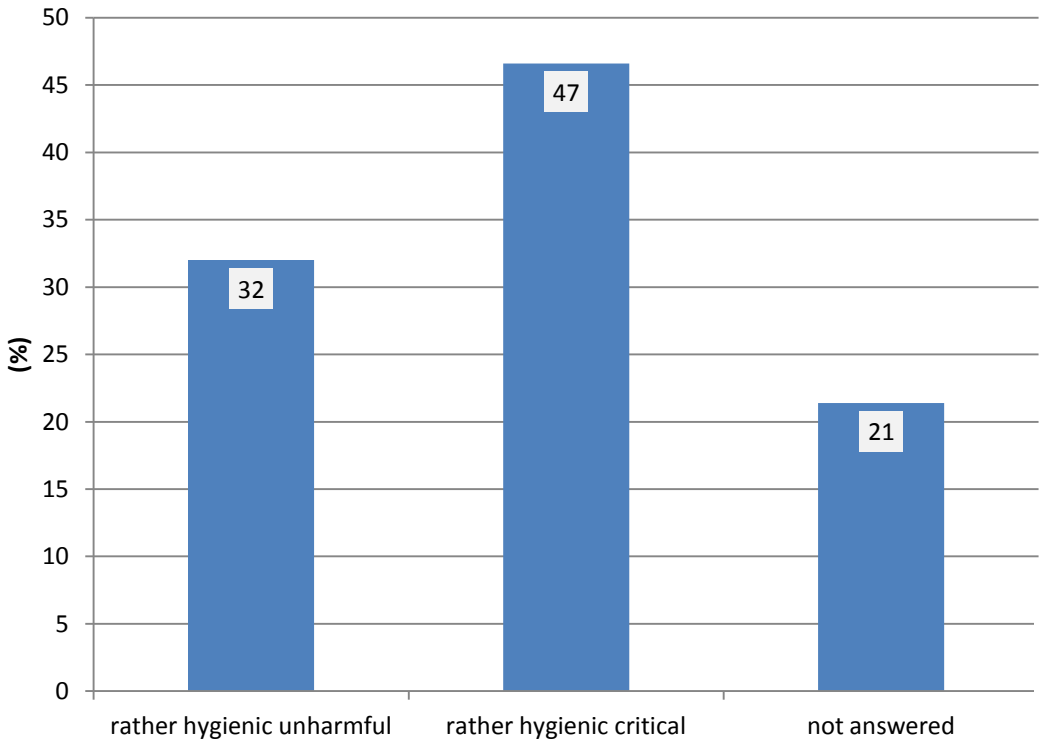
Attitudes and opinions of the interviewees

How do you rate the application of urine and MAP as a fertiliser in hygienic terms?



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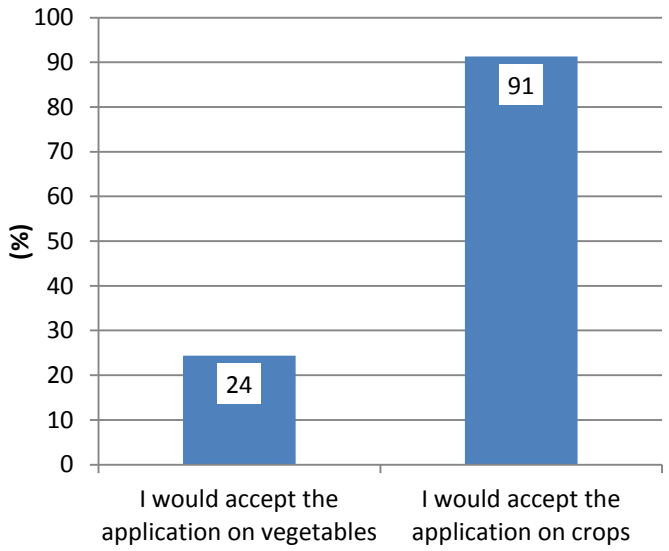
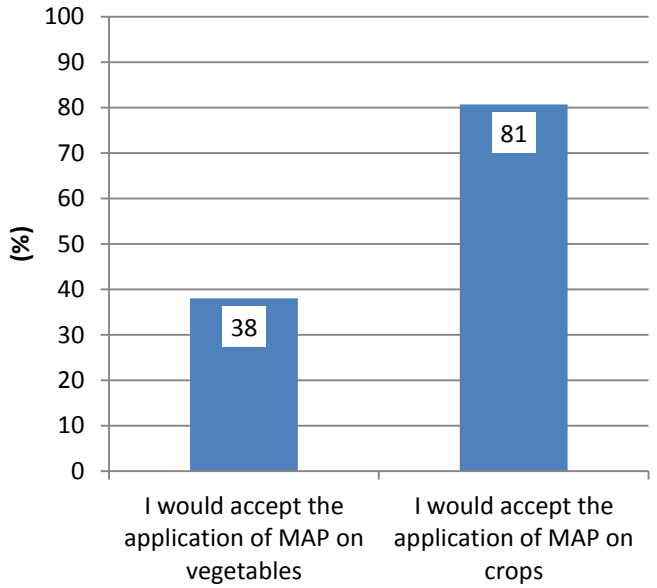
Attitudes and opinions of the interviewees

Which of the following products would you fertilise with urine or MAP?

Application of urine on vegetables and crops



Application of MAP on vegetables and crops



Facts which have to be considered in this context:

- Vegetables are already excluded in the German sewage sludge regulation
- Liquid fertilisers are commonly used and are get more popular

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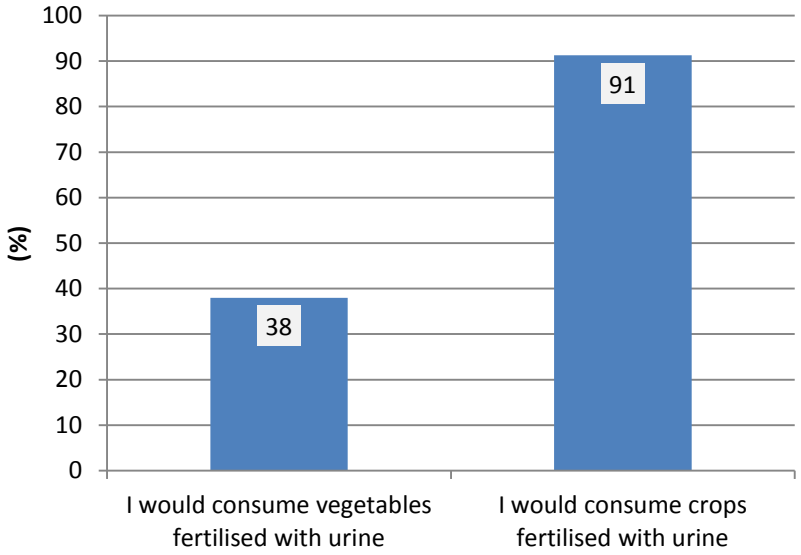
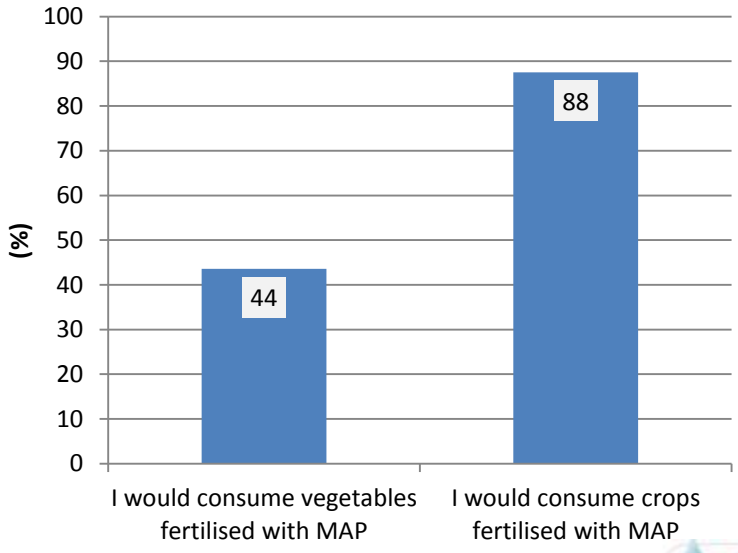
Attitudes and opinions of the interviewees

Would you consume products which were fertilised with urine or MAP?

Consumption of vegetables
And crops fertilised with urine



Consumption of vegetables
and crops fertilised with MAP



Facts that have to be considered in this context:

- Vegetables are already excluded within the application of sewage sludge
- Liquid fertilisers are common to use and are increasing

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Summary / conclusions

- Based on these results, trends and further action focuses can be deducted
- In sum very positive appraisal of the farmers regarding the application of urine and MAP in the agriculture
- Concerning the safety (e.g. pharmaceutical residues or treatment) further research as well as educational work has to be done
- Acceptance of the consumer and agricultural level has to be conducted on a larger scale

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Presentation 6:

Manfred Romich
(Institute of Sociology, RWTH Aachen University)

Selected results of the third period of user surveys

Third survey

- Participants: 36 (61,1% of them took also part on a prior survey)
  - male: 9
  - female: 27

  With academic degree: 79,4 %

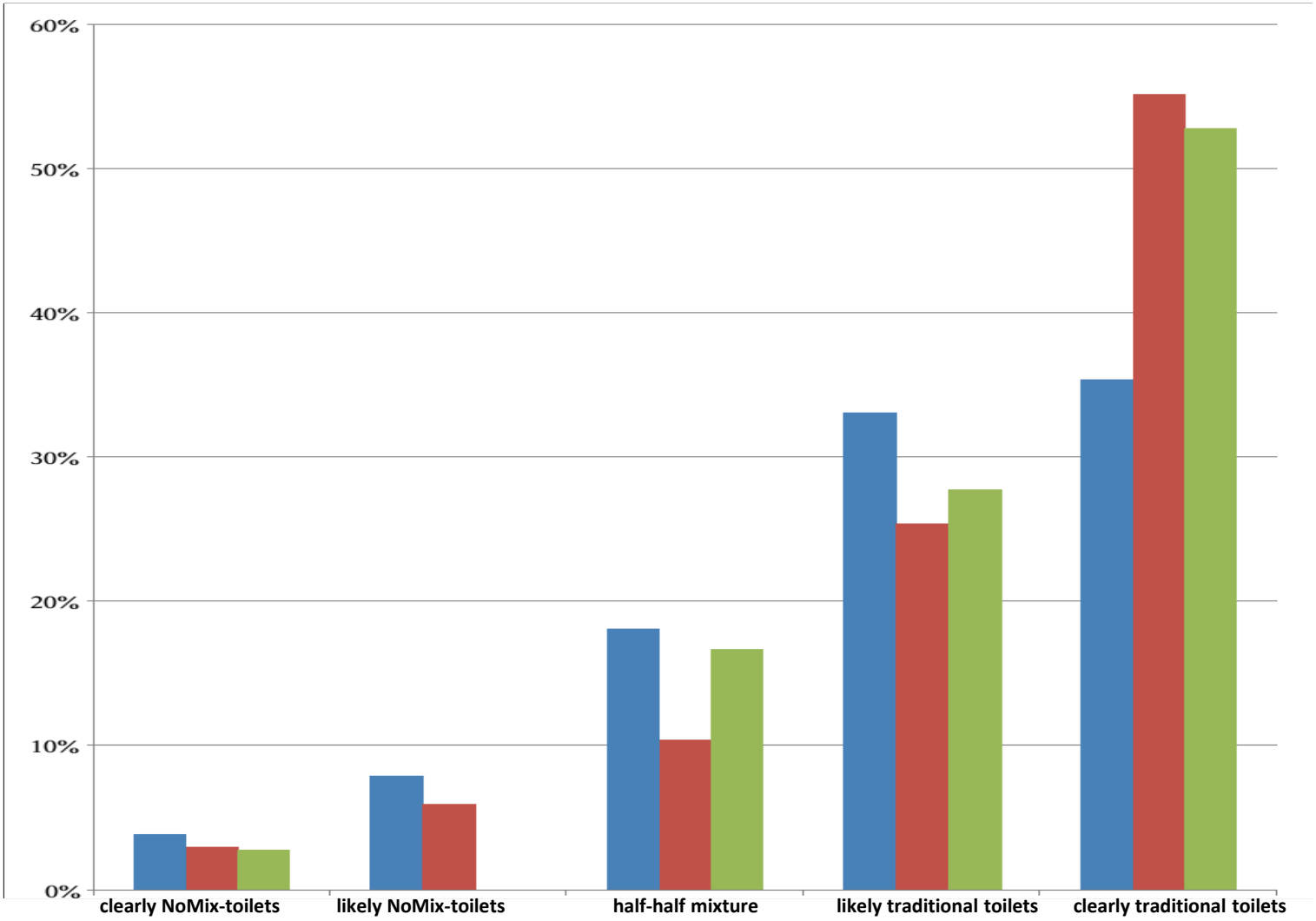
  Economic sciences: 38,5 %

  Social sciences: 34,6 %

  Age: 24-63 years

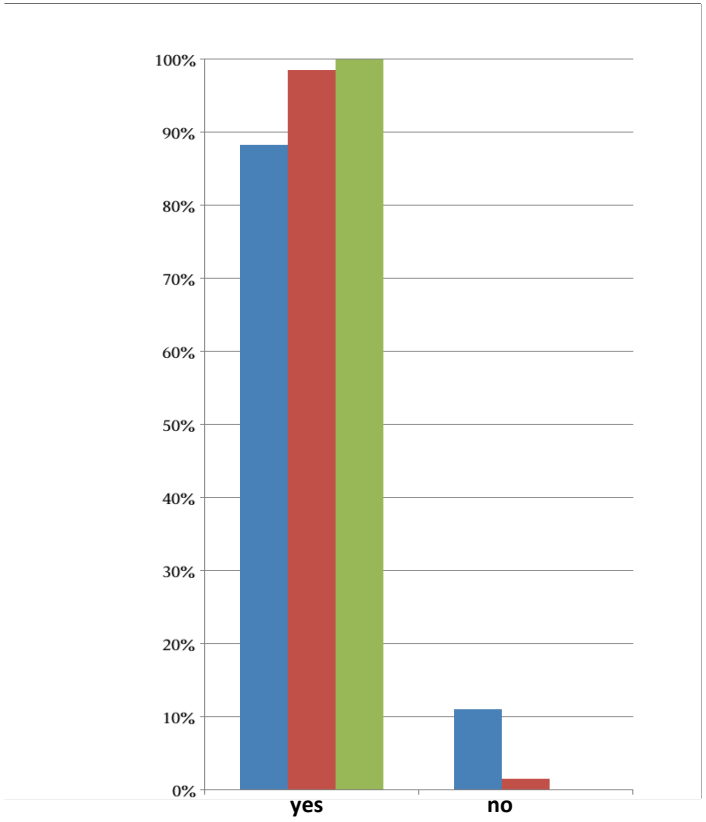
  Totally anonymised → not possible to backtrack participant

Preferred toilet systems



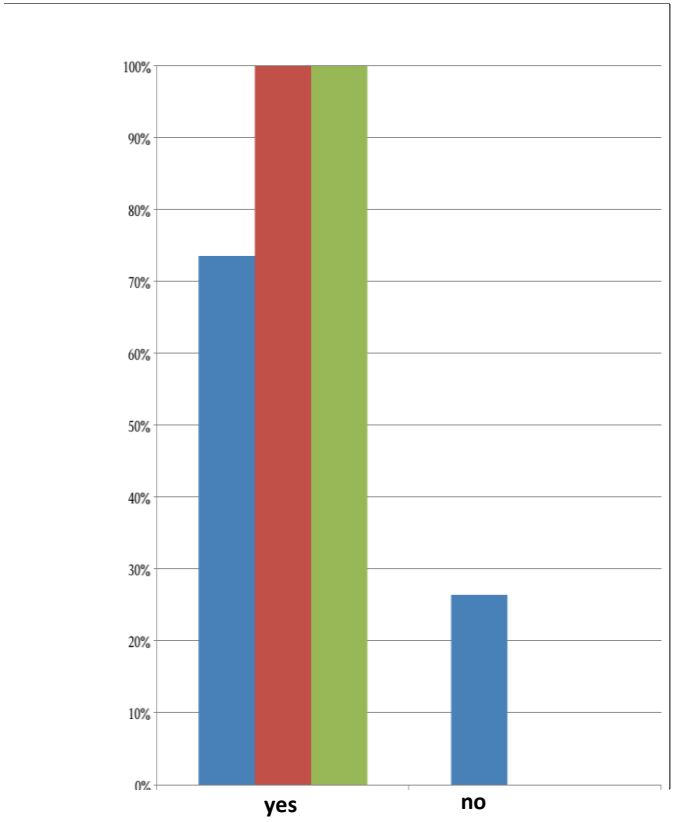
Knowledge improvement of the users

Did you know that the urine diversion mechanism is activated by sitting on the toilet seat?



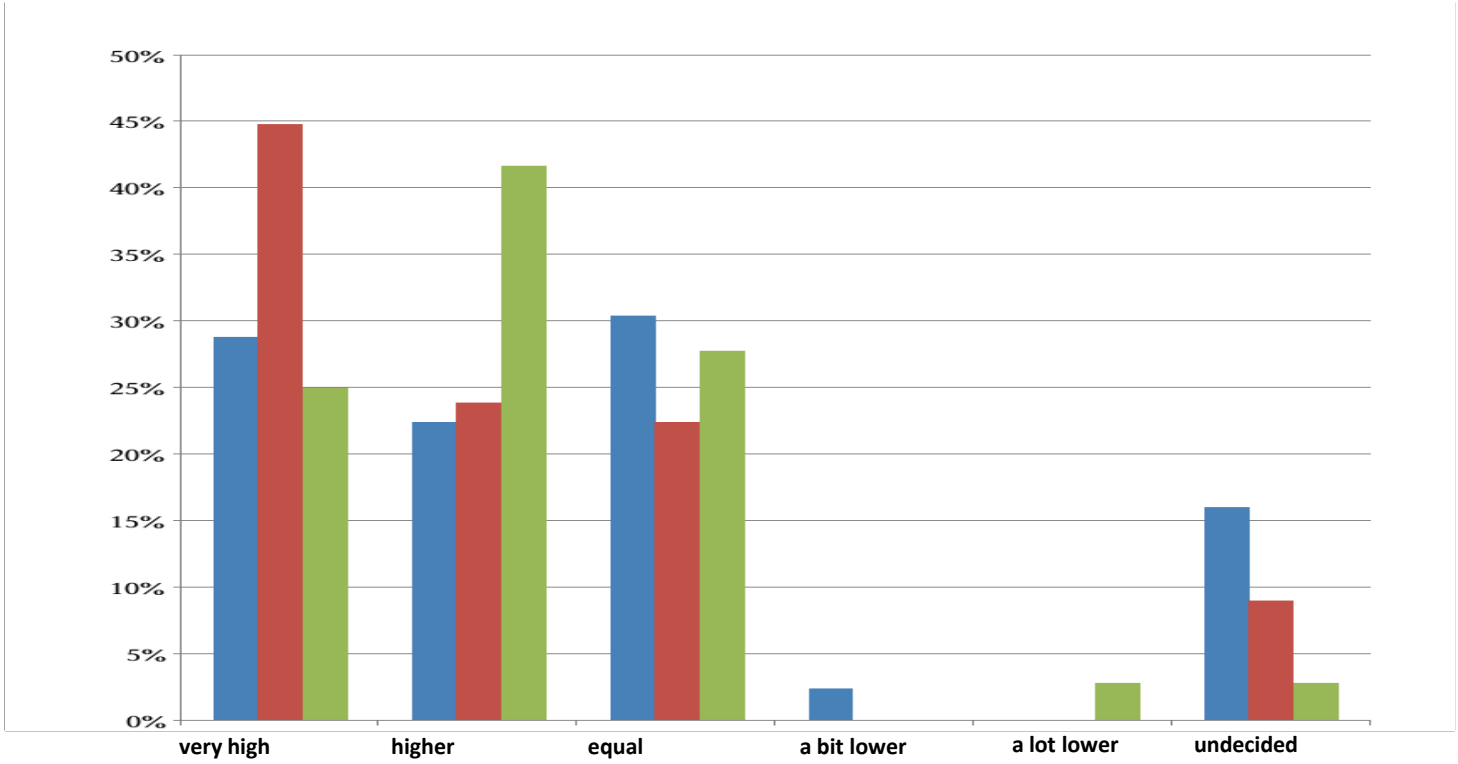
1. survey
2. survey
3. survey

Did you know that used toilet paper has to be disposed of in the back hole?



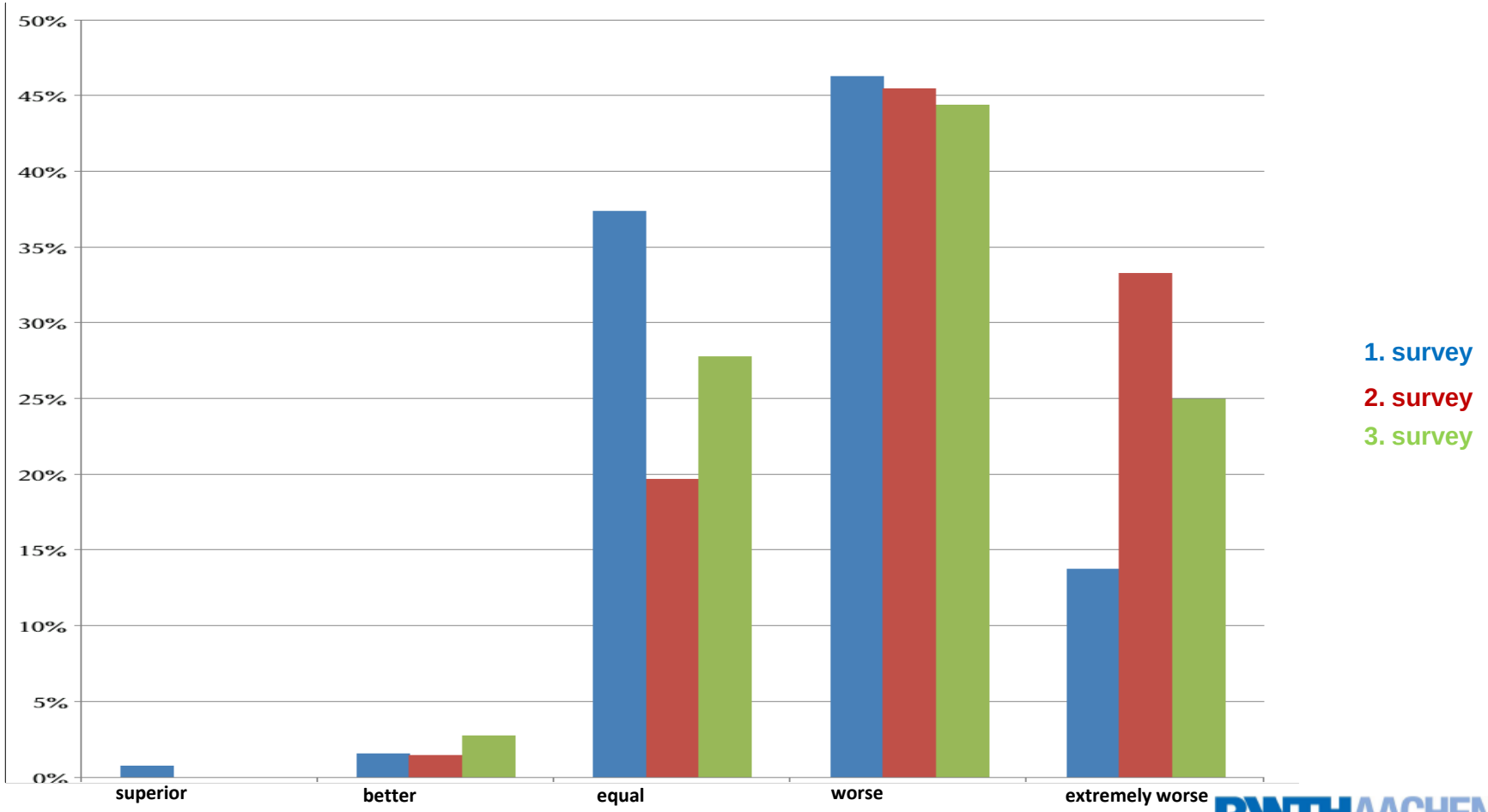
Perception of smell

What do you think about the odour nuisance of NoMix toilets compared to conventional toilets?



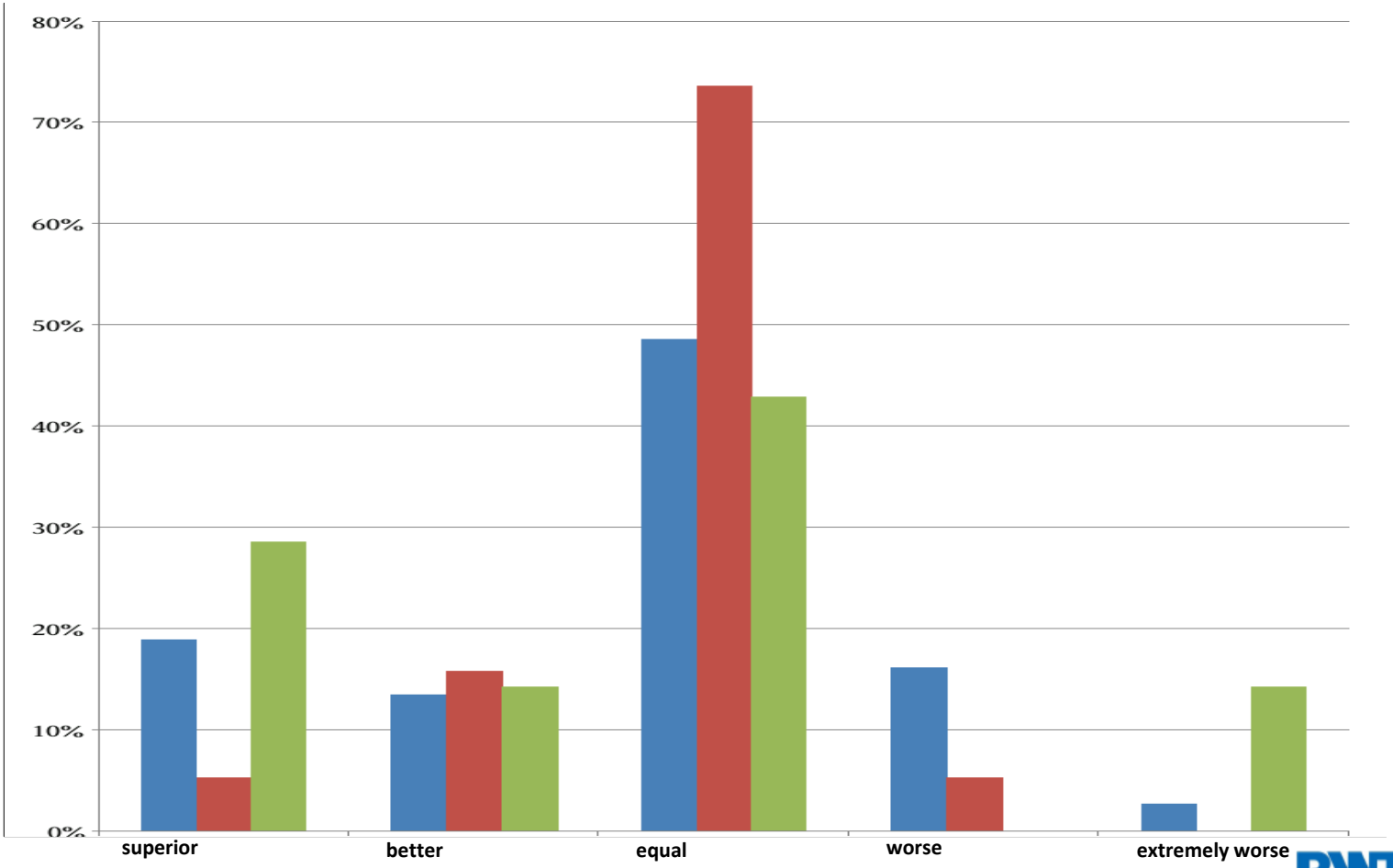
Sense of cleanliness of NoMix-toilets

What do you think about the cleanliness of NoMix toilets compared to conventionel toilets?



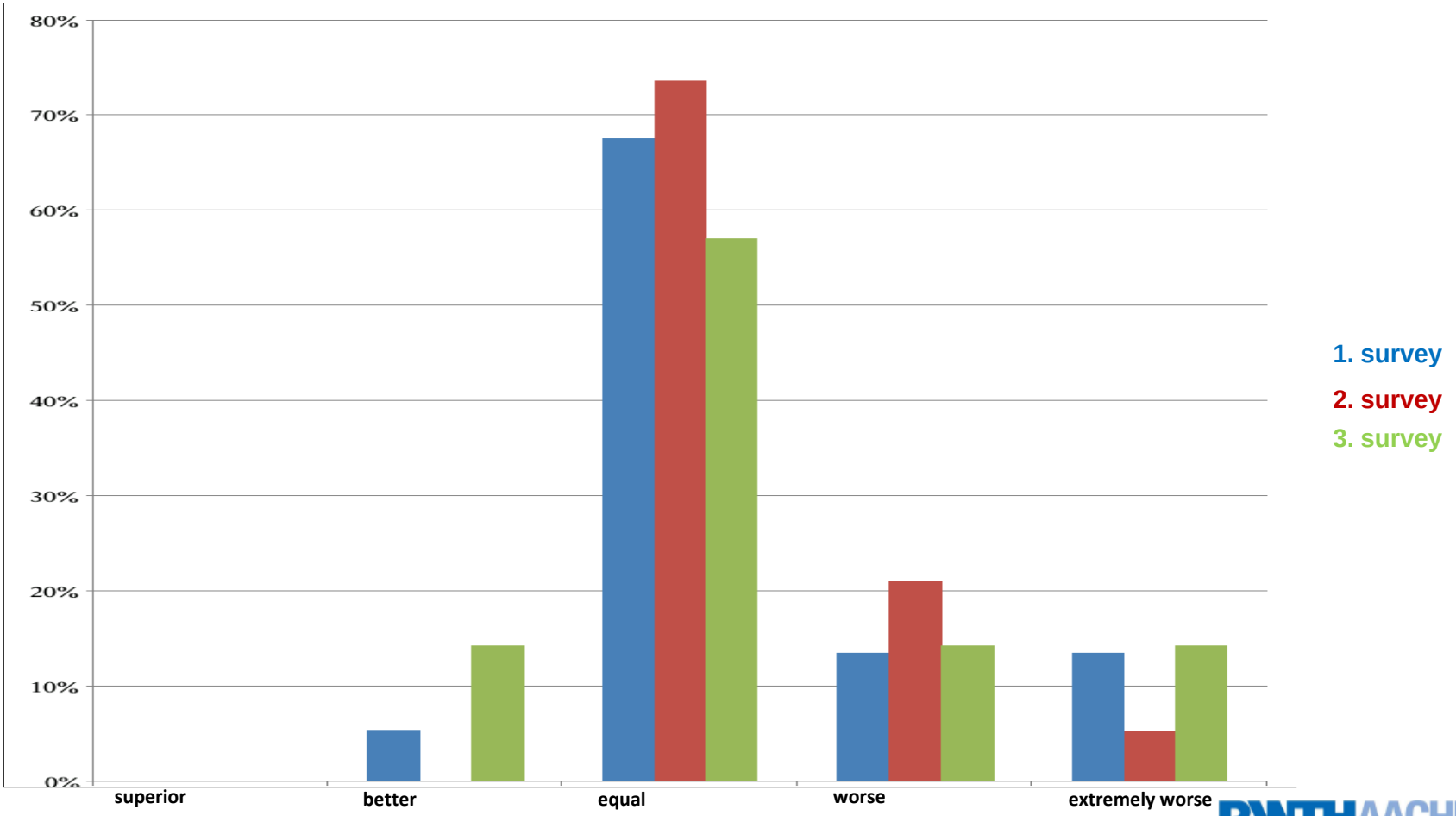
Usability of urinals

What do you think about the usability of NoMix toilets compared to conventionel toilets?



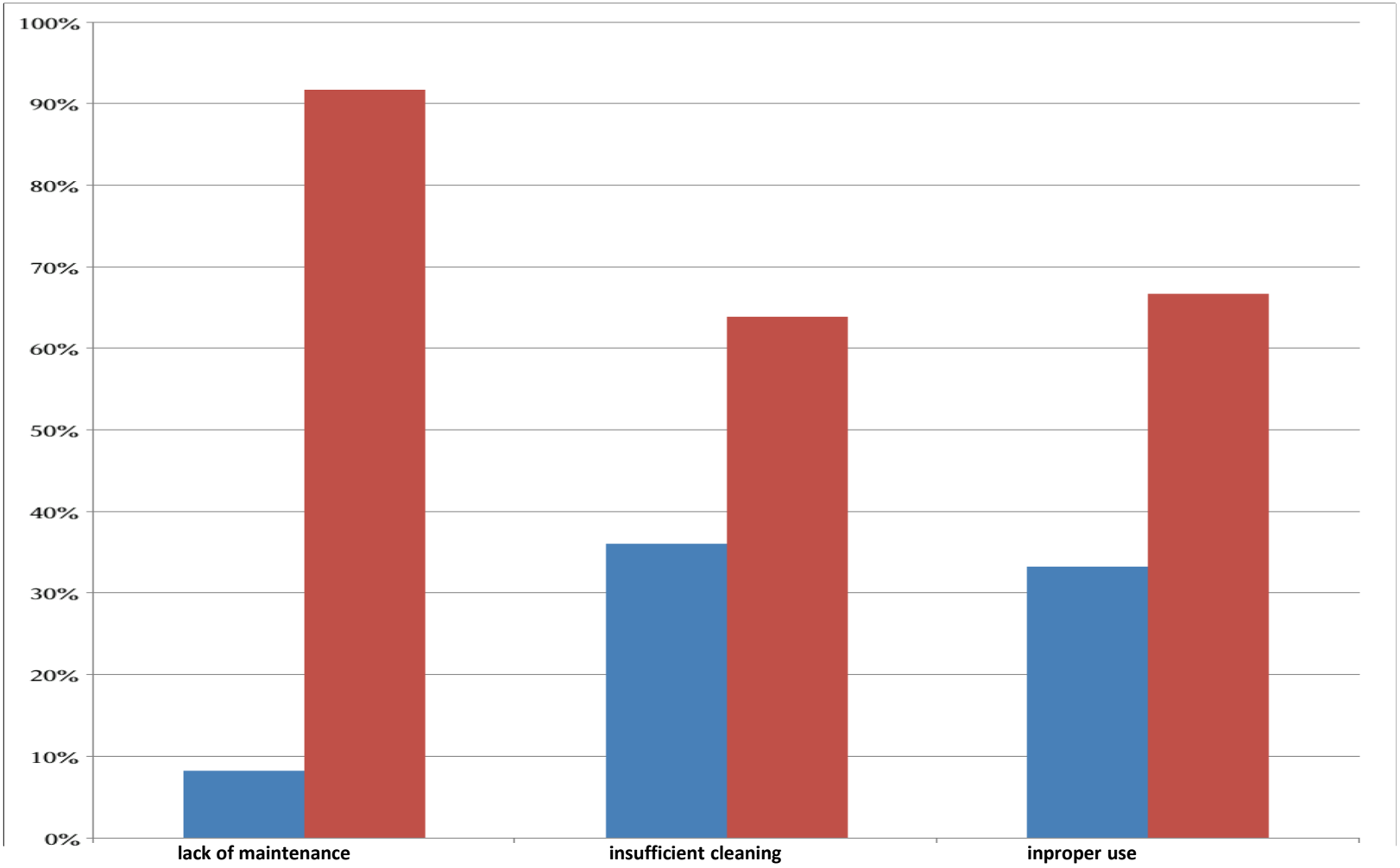
Sense of cleanliness of urinals

What do you think about the cleanliness of the waterless urinals compared to conventional urinals?



Third survey – mentioned reasons of problems

What are the reasons for possible problems with the NoMix toilets?



Further mentioned problems – short overview

Question 11: Paper problem 77,8 %

Question 15: Usage problems 86,1 %

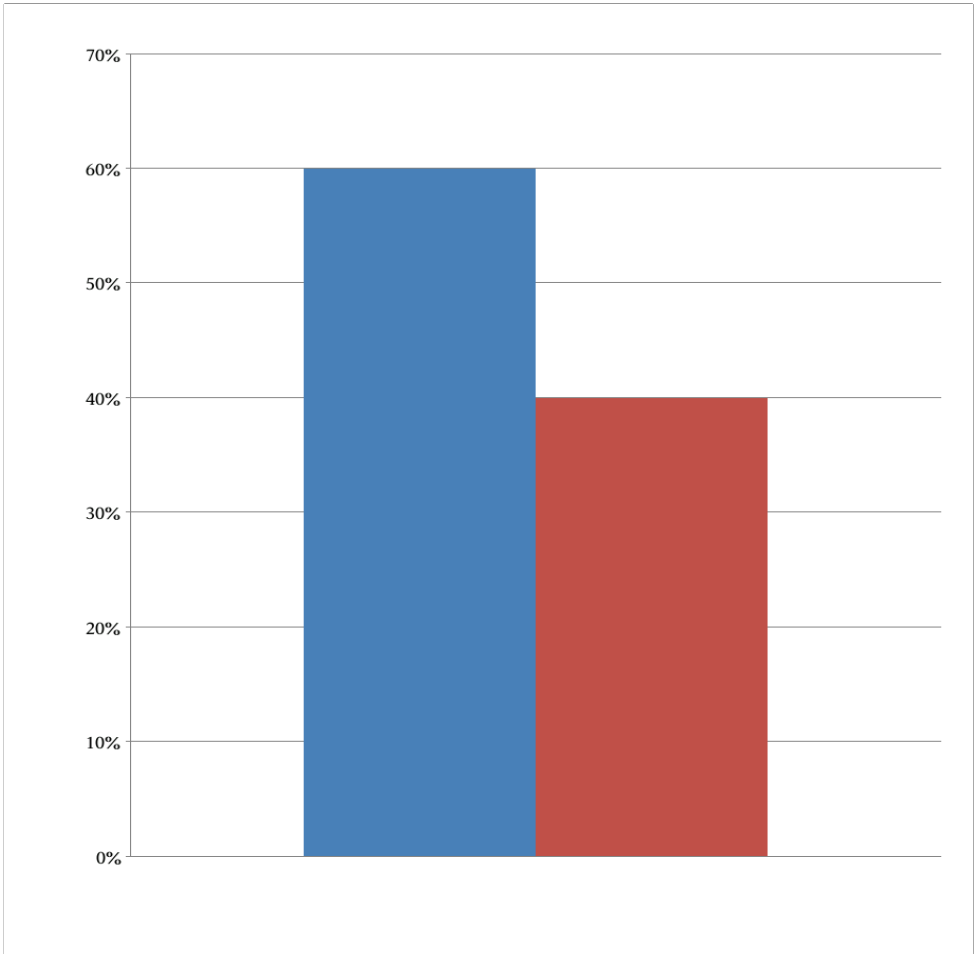
Question 16: Flush of the toilets 68,8 %

Question 17: Dirty toilet pan 77,8 %

Question 24: **Main problem is the design of the toilet: NO 72,2 %**

Toilet brushes

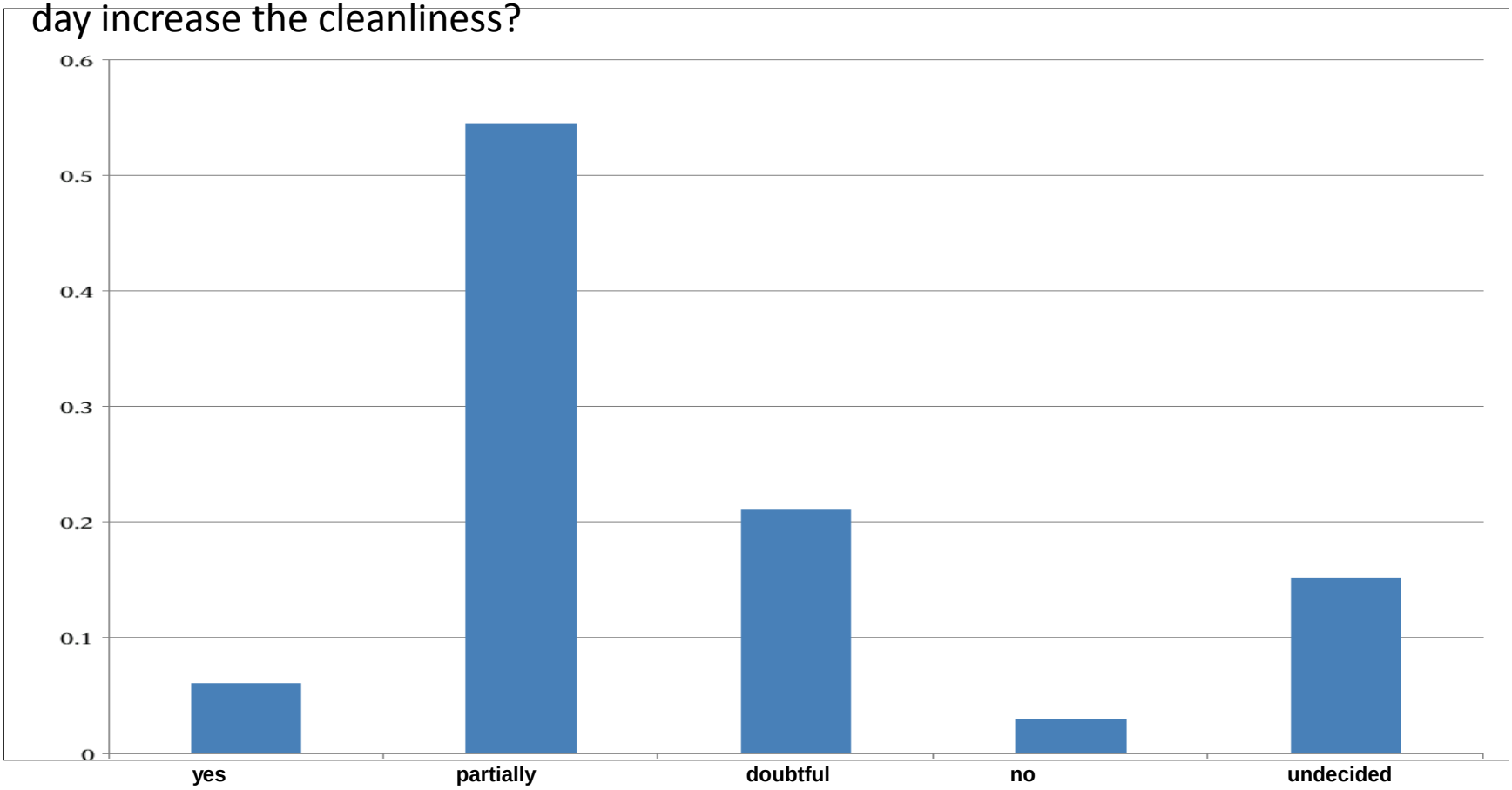
Do you think that the current toilet brushes are suitable for the NoMix toilets?



1. Yes
2. No

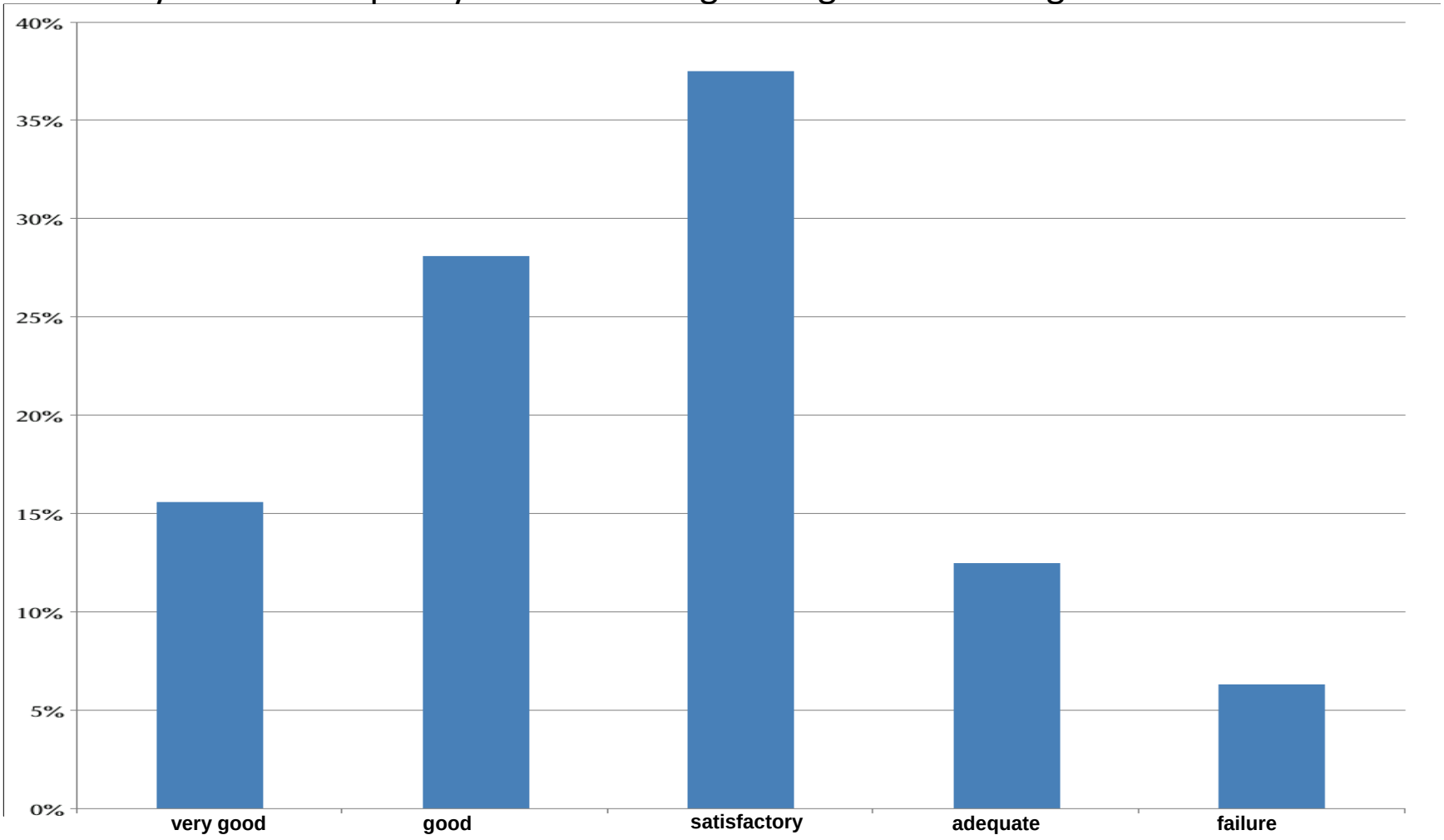
Cleaning frequency

Would cleaning the NoMix toilets multiple times per day increase the cleanliness?



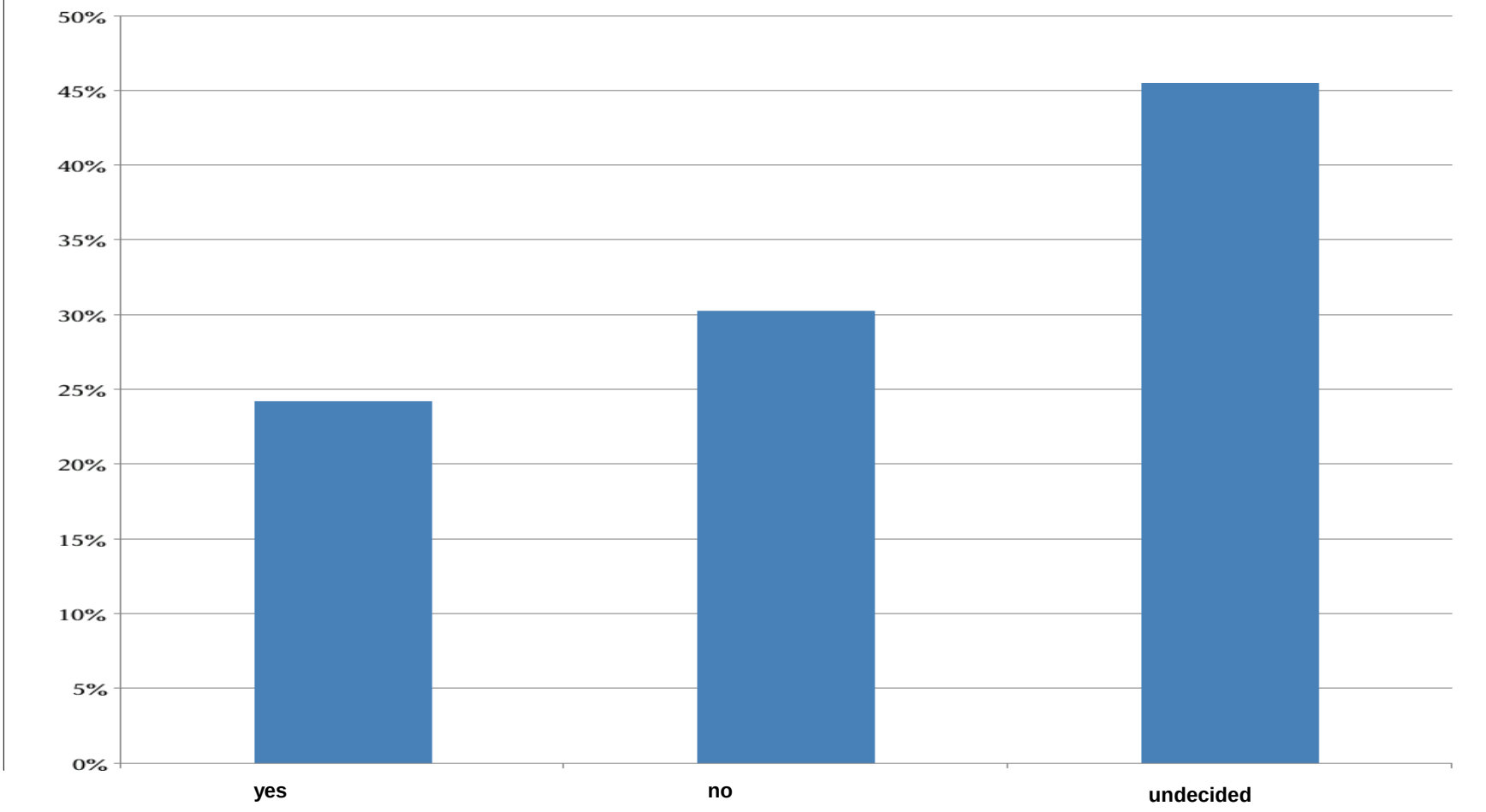
Cleaning staff

How do you rate the quality of the cleaning through the cleaning staff?



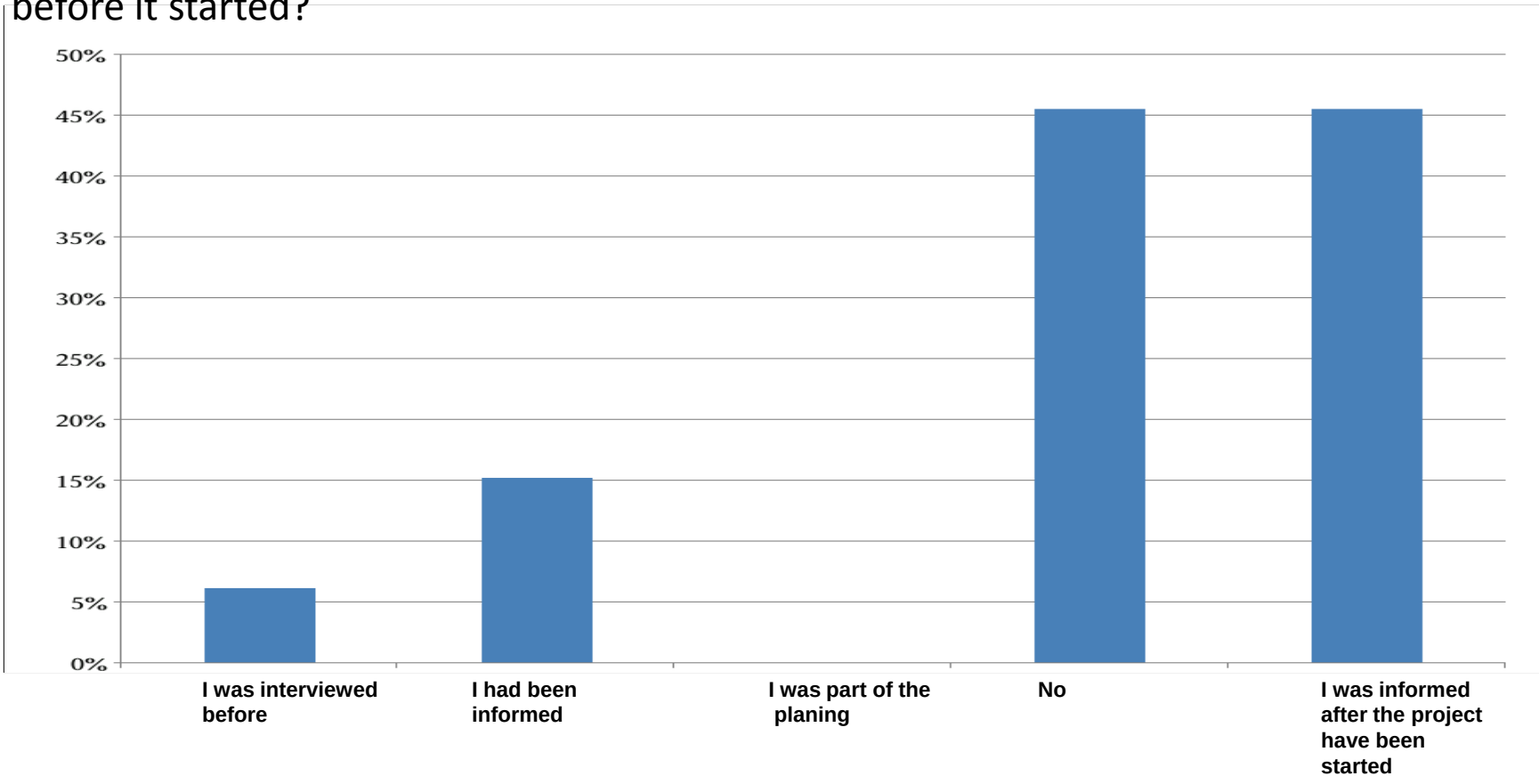
Cleaning list

Do you think that a cleaning list for the responsible staff members would improve the cleanliness of the NoMix toilets?



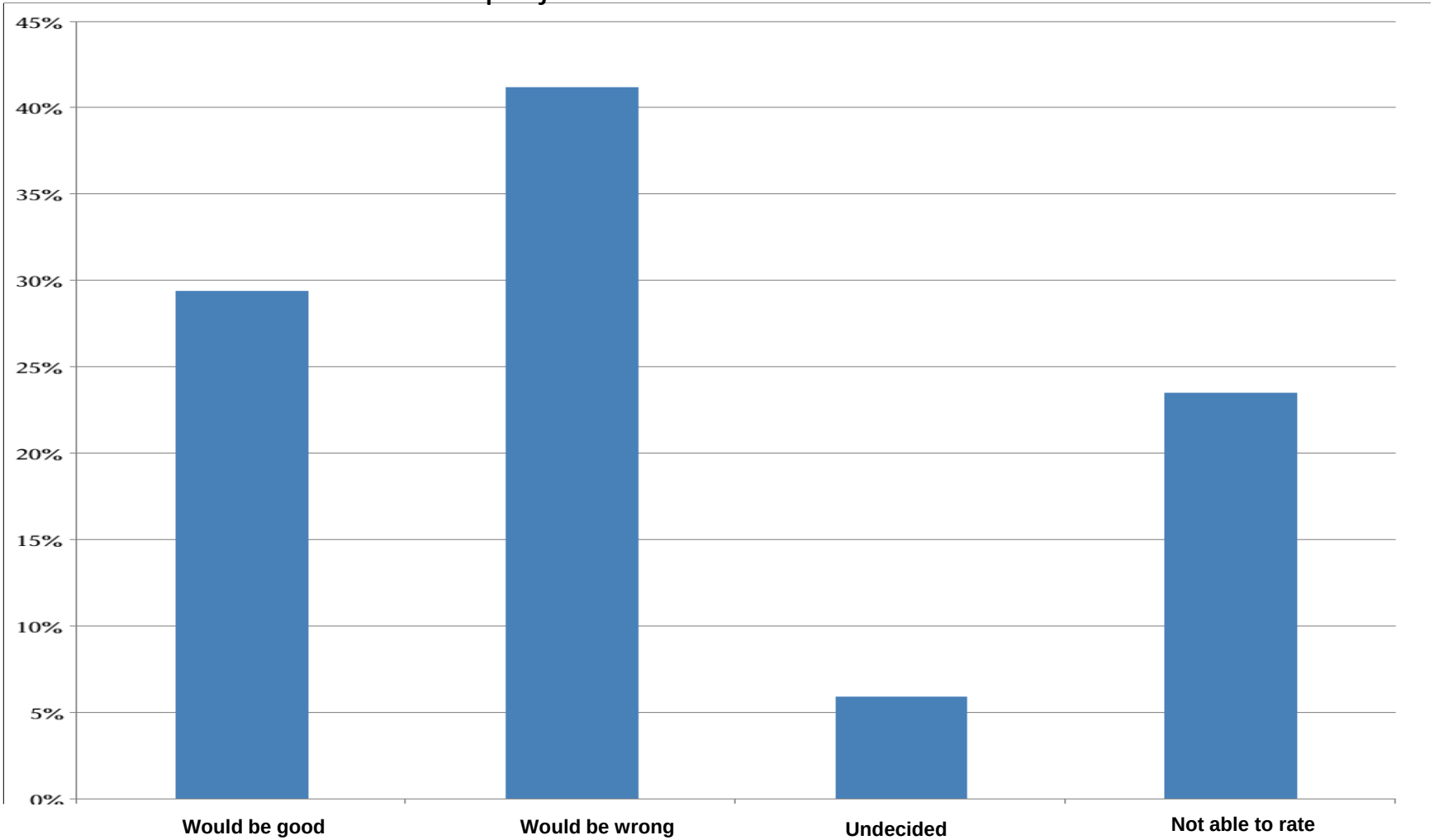
Project participation

Had you been informed about the project before it started?



Removal of the toilets

What would you think about the total removal of all NoMix toilets after the project?



Presentation 7:

Enno Schröder & Alexandra Dubois
(GIZ and KIT Karlsruhe)

International transferability of the installed wastewater treatment system

Students‘ theses

- **International transferability of the MAP precipitation process of urine**

  Jingjing Peng (TU Darmstadt)

- **Economic feasibility** of the SANIRESCH concept compared to conventional sewage treatment – using the example of a GIZ office building in Eschborn

  Lisa-Marie Bischer (TU Darmstadt)

- **Climate impact assessment** of the sustainable sanitation system implemented by the GIZ within the SANIRESCH project

  Alexandra Dubois (KIT Karlsruhe)

International transferability (Jingjing Peng)

- International transferability of the MAP precipitation of urine
- Analogous to former approaches from Katharina Löw & Yue Wu (available on the SANIRESCH website)
- Phosphorus balancing of MAP precipitation process (tests are finished, outcome is analysed)

Economic feasibility of the complete system (Lisa-Marie Bischer)

Methodology and objectives:

- Consideration of the economic feasibility of the complete system based on the cost comparative method from LAWA
  - Check-up and integration of former results (in-house installations, urine system)
  - Calculation of the costs of brown- and greywater treatment
- Comparison of those results with a conventional sewage treatment system
- Sensitivity analysis: Determining of leverage points to improve the economic efficiency

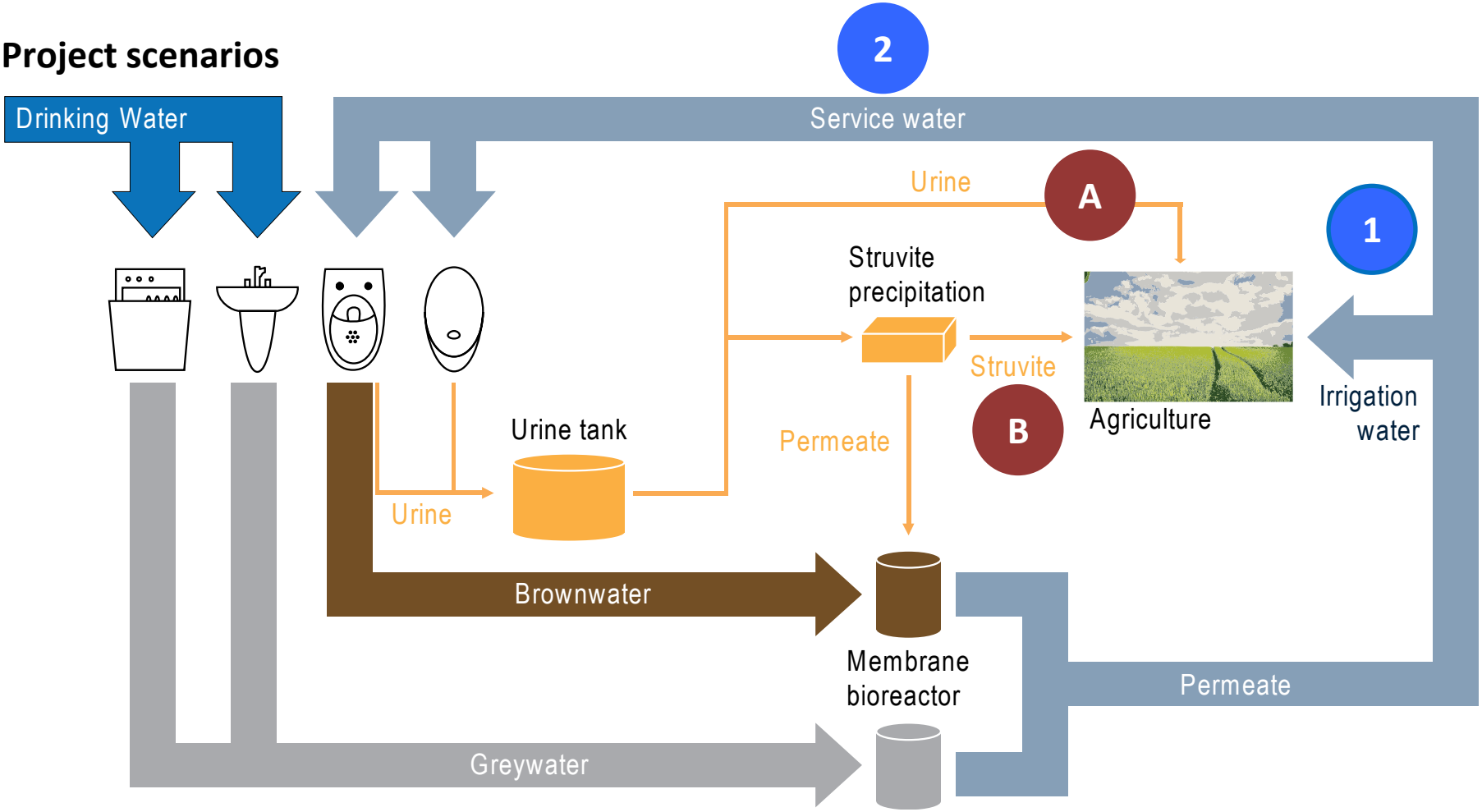
Economic feasibility of the complete system (Lisa-Marie Bischer)

State of progress:

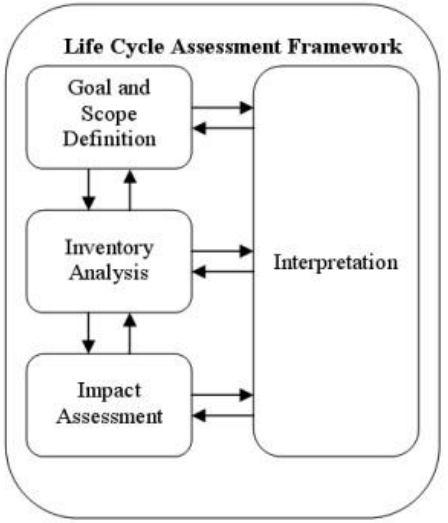
1. **Sanitary installations**:
   - Costs of wearing parts
   - Additional maintenance costs
   - Additional cleansing costs and additional working time of the cleaning stuff
   - Interim conclusion: running costs of the wearing parts are very high.
2. **Brownwater MBR**
3. **Greywater MBR**
4. **MAP reactor**
5. **Conventional system**

Climate balancing (Alexandra Dubois)

Project scenarios



Climate balancing (Alexandra Dubois)



Methodology / approach:

- **Life cycle assessment - methodology**
  - Definition of objective and system borders
  - Life cycle inventory analysis
  - Impact analysis
  - Evaluation
- Ecobalance software **SimaPro** with the help of the **IPCC 2007 method** (100-year-greenhouse potential)

Climate balancing (Alexandra Dubois)

System borders: