



# Towards an optimal water quality for Flemish swimming ponds

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*GreenSupport: Knowledge centre for biodiverse and climate robust green infrastructure (1/1/2023 – 31/12/2025)*





PCS?



# Organization

Integrative approach

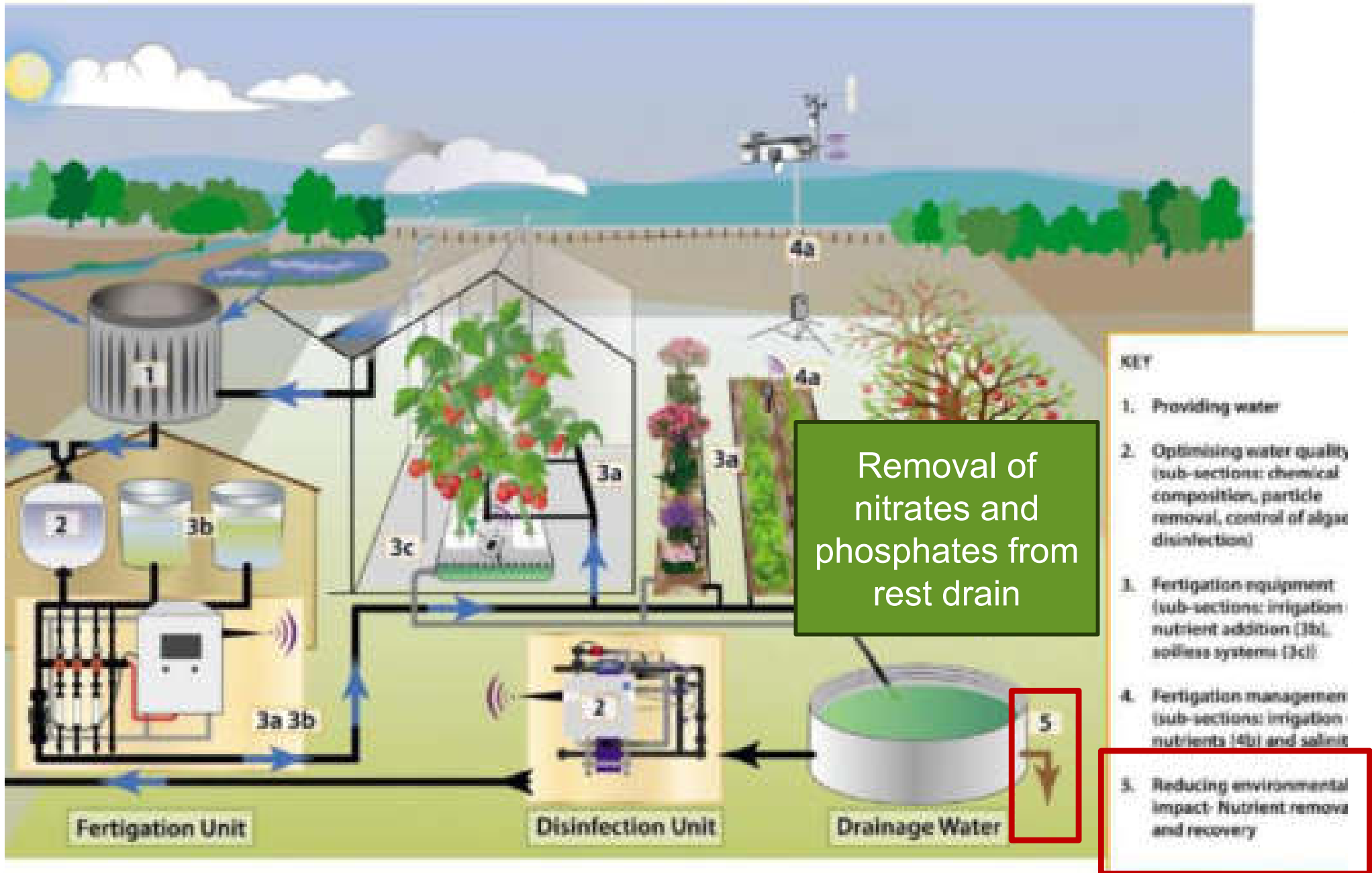
## Main sectors

### Main topics

	Azalea	Cut flowers	Potted plants	Tree nursery	Green
Water	●	●	●	●	●
Nutrients	●	●	●	●	●
Crop Protection	●	●	●	●	●
Energy	●	●	●	●	●
Market & rentability	●	●	●	●	●



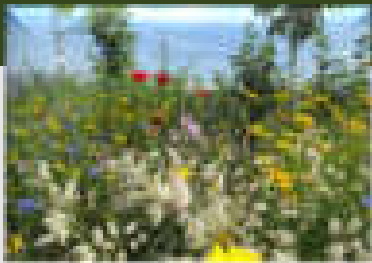
# Water quality for potted plants



# Department of Landscape and Gardening

## Functionality

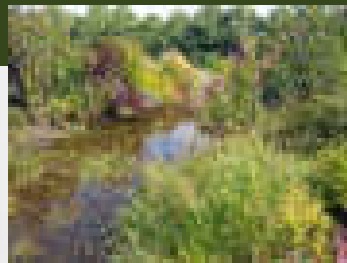
Plant choice i.f.v.  
ecosystem services



- ✓ Advisory service assortment
- ✓ Biodiversity
- ✓ Digitalization with iTree
- ✓ ...

## Specialisation

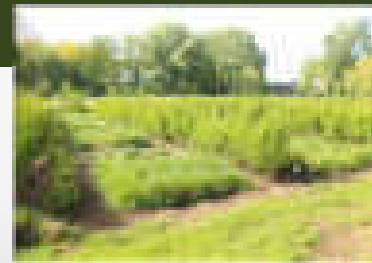
Greening of urban  
areas



- ✓ Raingardens
- ✓ Green walls
- ✓ Swimming ponds
- ✓ Food forests
- ✓ ...

## Planting

The basis of succes



- ✓ Soil quality
- ✓ Biostimulants
- ✓ Plant systems
- ✓ Water buffering
- ✓ ...

## Maintenance

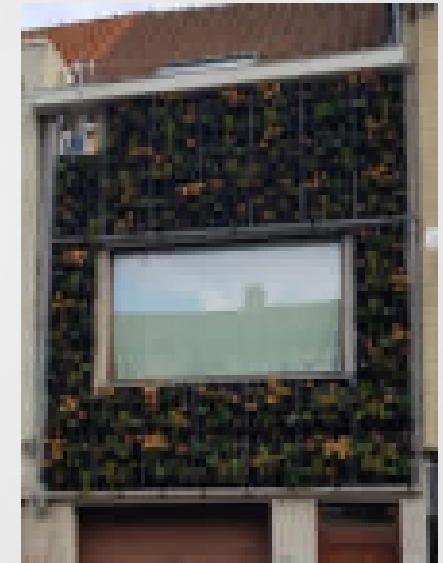
Healthy plants with  
minimal input



- ✓ Monitoring
- ✓ Irrigation
- ✓ Weeding, crop protection
- ✓ Mowing
- ✓ ...

**Learning Network and practical knowledge centre:**  
**Knowledge building and transfer**  
landscapers – policy – research institutes - growers – other sectors

# Research partner Ghent University



**constructed wetlands – helofyt filters – plantbased filtering**





## Swimming ponds in Flanders



# Flemish guidelines on water quality

- Private: no guidelines on water quality
- Public: since October 2019: definition of natural swimming pools and new guidelines (VLAREM II)

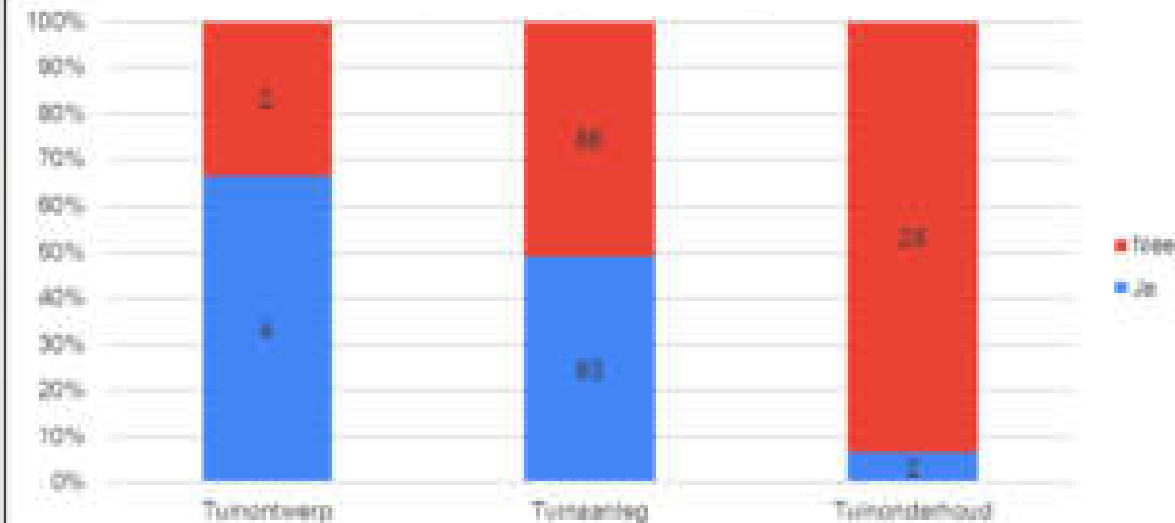
parameter	Unity	Limit value (*)
a) chemical parameters:		
pH (meting ter plaatse)	Sörensen	
- Lower limit		6
- Upper limit		8,5
Phosphorous	mg/l	< 0,01 (*)
nitrate	mg/l	< 30 (*)
b) bacteriological parameters:		
Echerichia coli	KVE/100ml	<100
intestinale enterokokken	KVE/100ml	<50
Pseudomonas aeruginosa	KVE/100ml	<10
c) Fysical parameters:		
temperature	°C	< 23 (*)
clarity		Transparent to the bottom of the swimming pond
Visible contamination		Not present
sent		Not present
foam		Not present
Oxygen saturation (meting ter plaatse)	%	80-120

(\*) Target value in case of P, NO<sub>3</sub><sup>-</sup> and temperature.



# Swimming ponds in Flanders

Are you constructing or designing swimming ponds?



2021, 192 responses

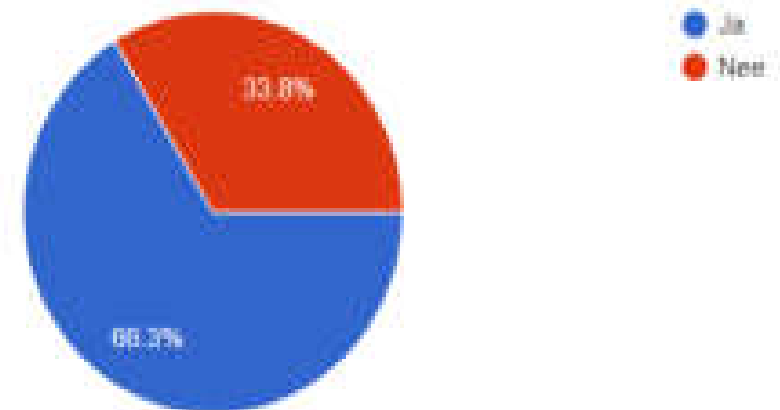
14 000 – 15 000 professional landscapers and gardeners  
→ Approximately 800 swimming pond constructors



41 % swimming ponds

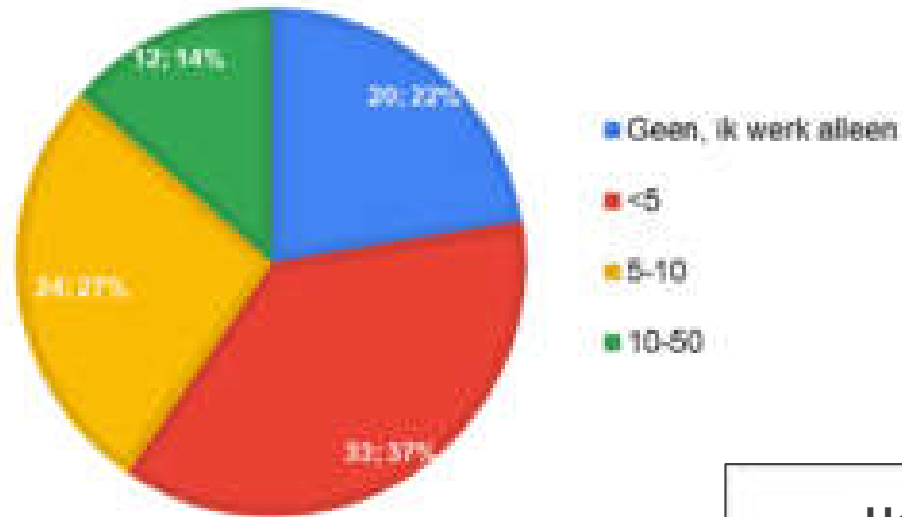
Are you constructing or designing swimming ponds?

60 responses



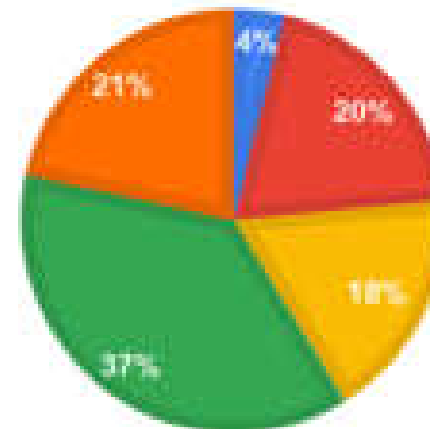
# Swimming ponds in Flanders

How many employees do you have?



How many years of experience do you have in swimming pond construction?

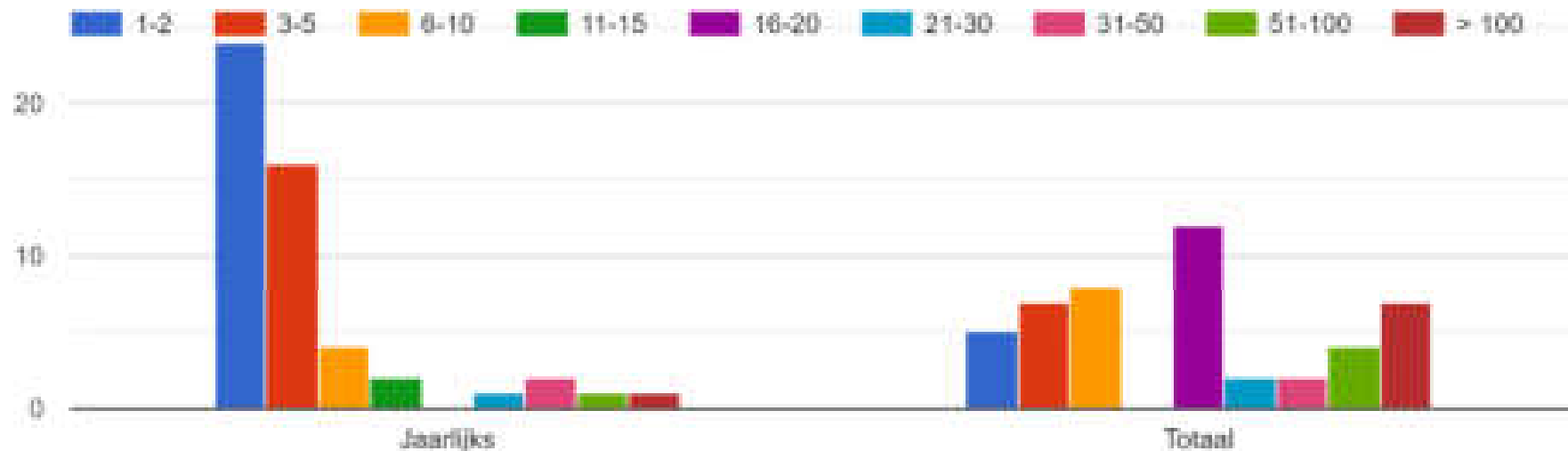
0-1 (nieuw in de sector) 2-5 jaar 6-10 jaar 11-20 jaar >20 jaar



# Swimming ponds in Flanders

How many swimming ponds do you construct annually, and how many swimming ponds have you constructed in total?

Source: PCS, 2022. Data based on 100% of respondents.

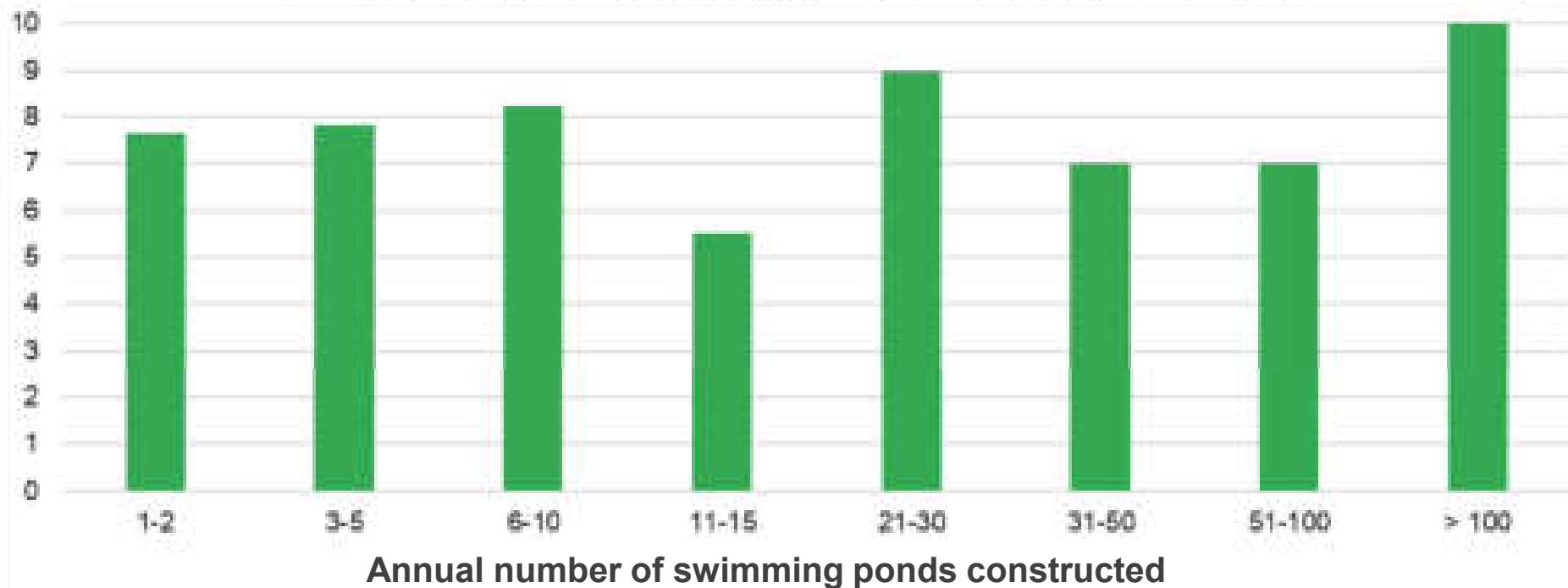


Total number of newly constructed swimming ponds on an annual basis: 5714 !



# Swimming ponds in Flanders

We need more applied scientific research to control water quality in swimming ponds

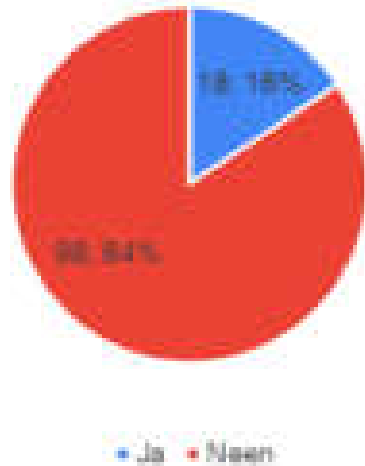


Every company size has knowledge needs



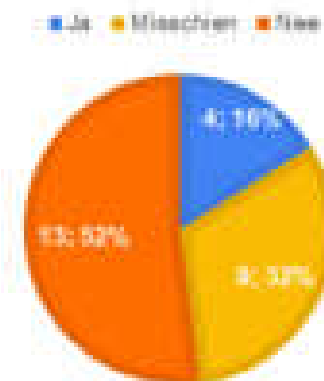
# Potential

Would you be interested to start with the construction of swimming ponds?



Questionnaire professional landscapers 2021, 192 responses

Would you be interested to start with the construction of swimming ponds?



Questionnaire 2022, 80 responses



**Research focus**

# Research needs

## Design

- Upflow vs. downflow
- Dimensioning of the plant filter vs swimming area
- Extra mechanical filtering

## Construction

- Substrates
- Type of liner
- flow speed
- Plant choice

## Maintenance

- P filtration
- Type of filling water (tap water, rainwater, groundwater)

## Externe factors

- Number of swimmers
- Atmospheric deposition
- Leaves
- Fauna

## Water quality & hygiëne

### Monitoring of water quality

- Lab-analyses
- On-site analyses
- Online monitoring





# Research needs

2 main groups of swimming pond constructors

- Startups (1-5 projects/year): 78 %, 625 companies
  - Sustainable filter techniques (other than lava)
  - Effect of external inputs
  - Design dimensions
  - Plant choice
- Experienced companies (> 6 projects/year): 22 %, 175 companies
  - Knowledge on inputs (rainwater as refilling water)
  - Sustainable materials
  - Knowledge-efficient monitoring techniques
  - Differences between filter systems
  - Flow speed



# Research needs at the end of IOB 2021



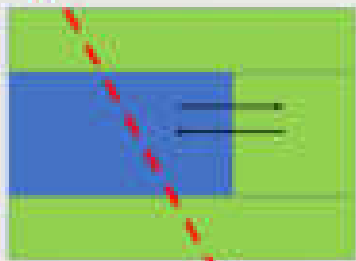
5. Main problem parameter? (N, P, Ca, pathogens, ...)?

13 respondents

LETS GO SWIMMING  
FHOSFOR  
PHOSPAAT PHOSPHATE  
GUESTS  
P PHOSFATE  
BELGUIM ROCKS  
BEERS ANYONE



# Focus



**Types I & II – Hydrobotanisch**  
 Voornamelijk natuurlijke  
 circulatie (wind, zwemmen),  
 geen aparte filter, plantzone  
 > 50% zwemzone

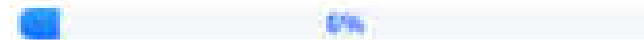


**Types III & IV – Substraatfilters**  
 Pompcirculatie, langzaam of snel  
 doorstroomd, filters meestal  
 beplant, > 20% zwemzone



**Type V – Technische eenheid**  
 Pompcirculatie, technische  
 biofilter zonder beplanting

Type I  
 (hydrobotanisch,  
 alleen natuurlijke  
 circulatie)



1 vote

Type II  
 (hydrobotanisch,  
 oppervlakteafvoer  
 en natuurlijke  
 circulatie)



4 votes

Type III  
 (plantenfilter,  
 langzaam  
 doorstroomd)



15 votes

Type IV  
 (plantenfilter, snel  
 doorstroomd)



12 votes

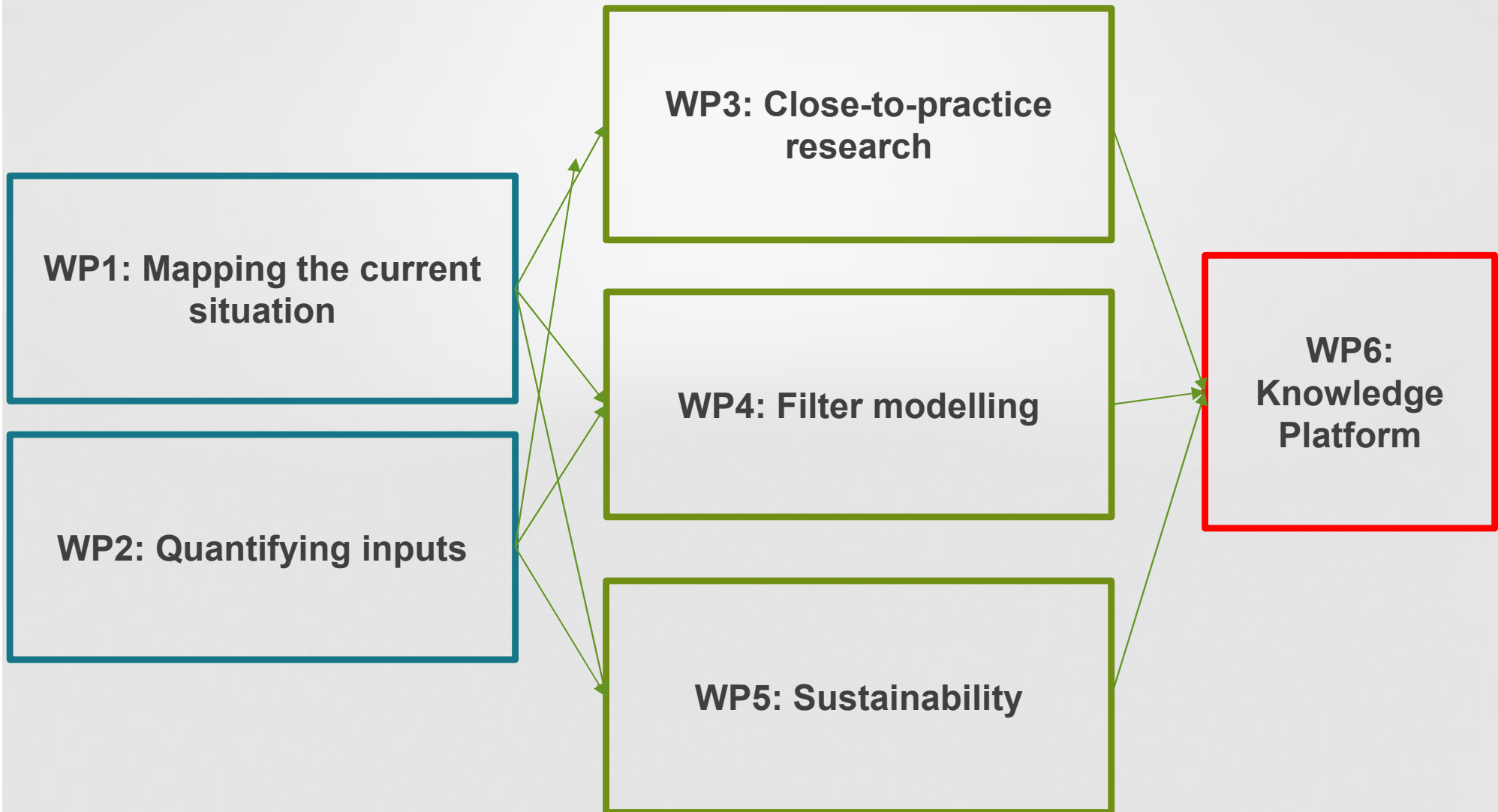
Type V (biofilter)



2 votes



# Research organisation



# Mapping the current situation



Location  
Usage ?  
Dimensions?  
Filtering type?  
Materials used?  
Filling water?  
Plant choice?  
Water quality (problems)?  
...



Own dB or DANA 2.0

→ To be decided

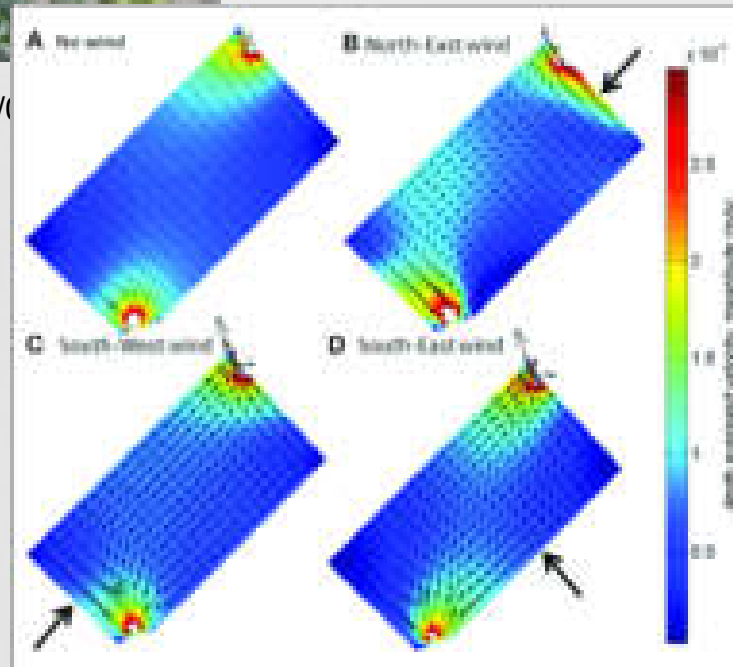


# WP1: Mapping the current situation



Intense monitoring

<https://mirjamglessmer.com/2018/>

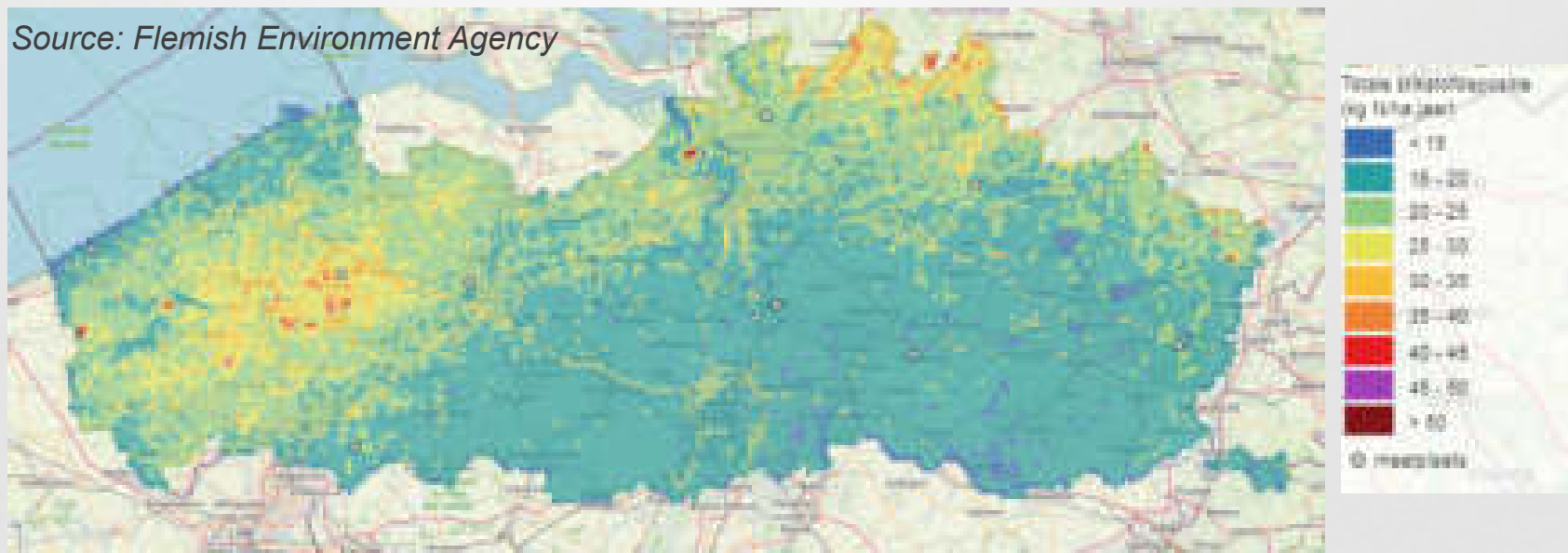


Endress+Hauser



# WP2: Quantifying inputs

- Review on available data: atmospheric deposition, leaf litter decomposition, swimmers, sun cream,...

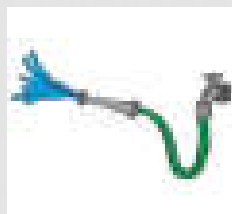


- Inputs from materials

- Fauna

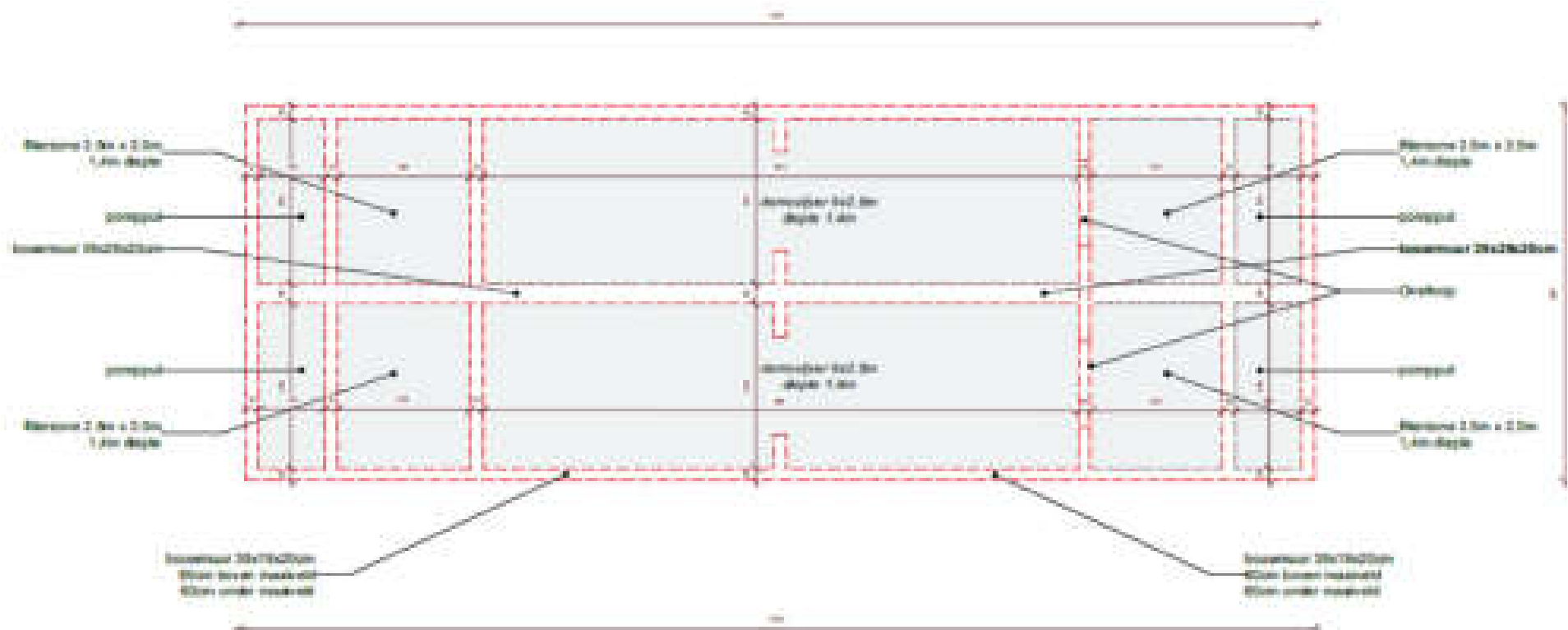


- Filling water



# WP3: Experimental research

## Swimming ponds for research at PCS Ornamental Plant Research





# WP3: Experimental research

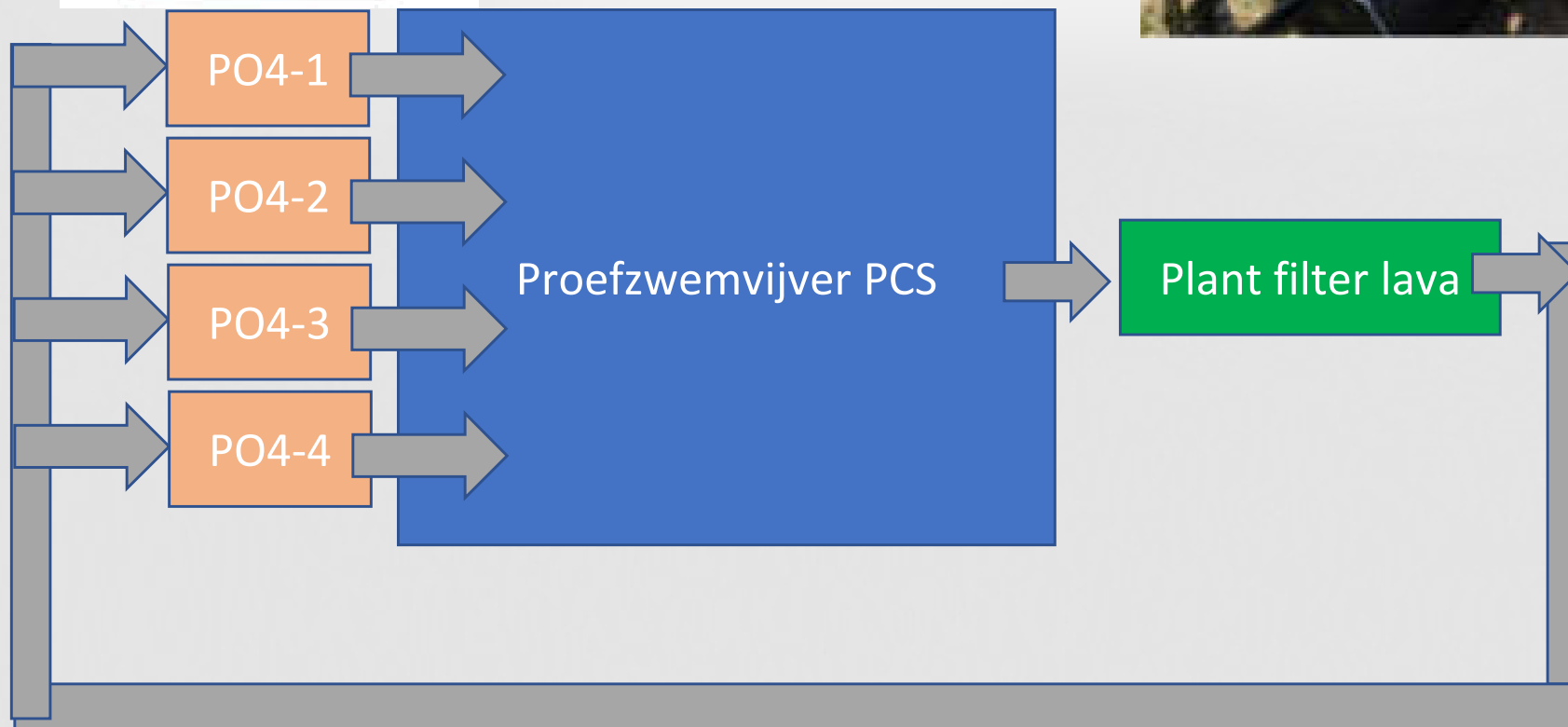
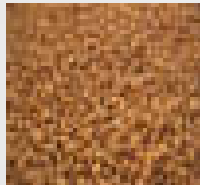


- Impact of plant filter/swimming area
- downflow vs upflow

- 1 Downflow 15 %
- 2 Downflow 30 %
- 3 Downflow 45 %
- 4 Upflow

# P filtering materials

Set-up based on  
Agnieszka  
Karczmarczyk  
(Poland)



# P-removal in rest drain: selection of filtermaterials



Screening/selection of 11 filter materials → 4

Kumar et al., 2019

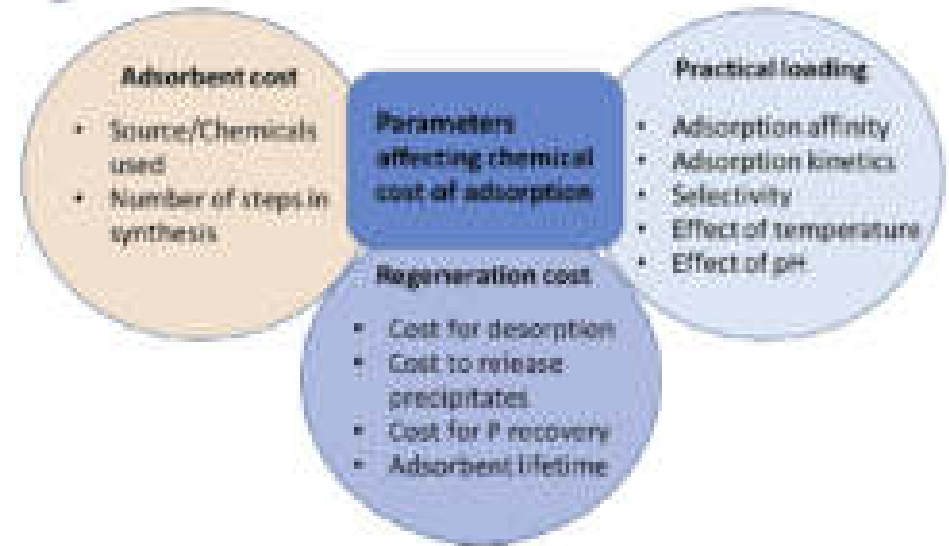


Fig. 1. Summary of factors governing the chemical costs of phosphate adsorption.

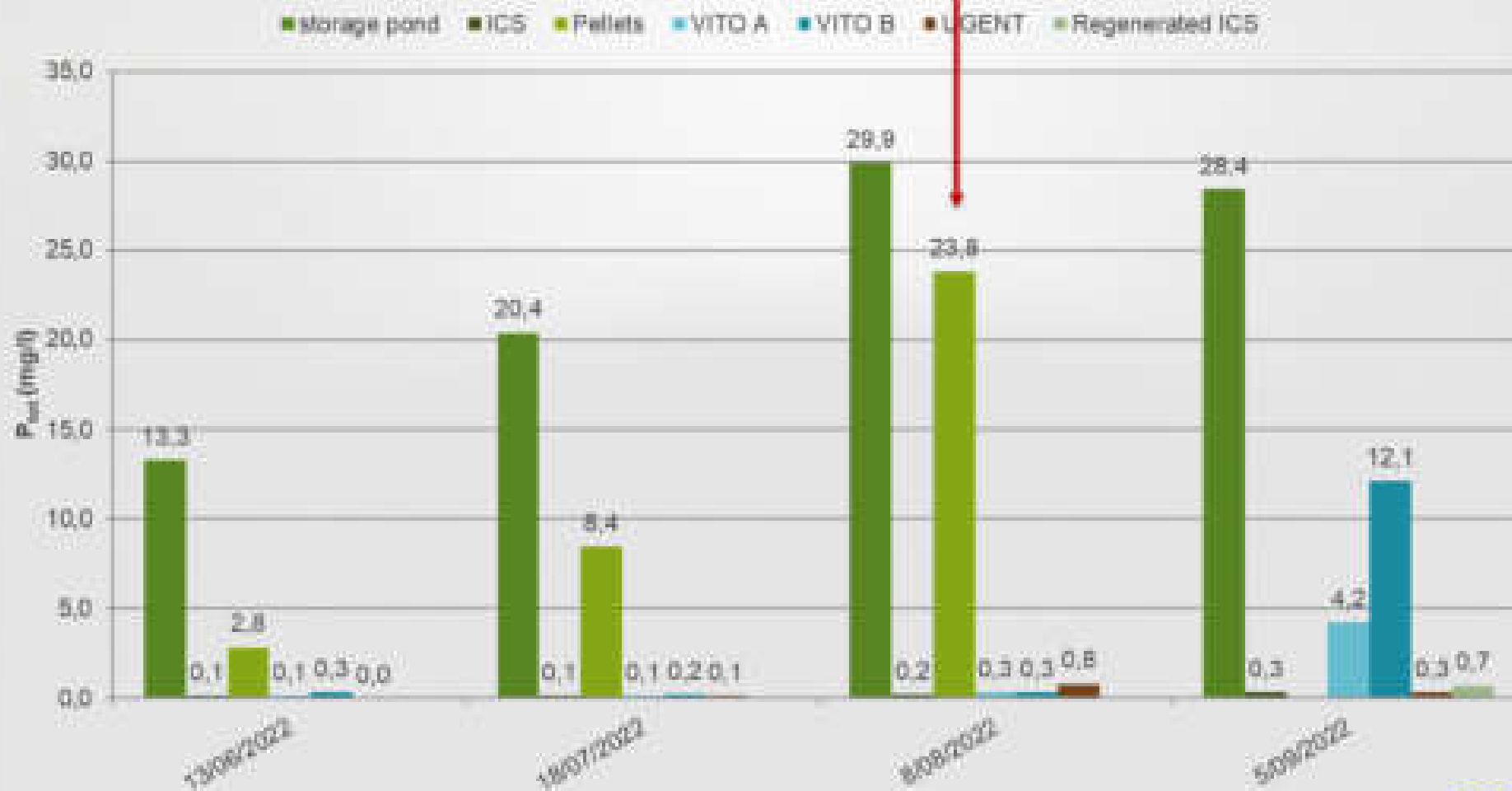
FerroSorb	Redmedite	ICS	LiDonit	BaseLith	Vito sorbent A	DiaPure	Phoslock
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# P-removal in rest drain: evaluation of filter materials



Pellets verzadigd



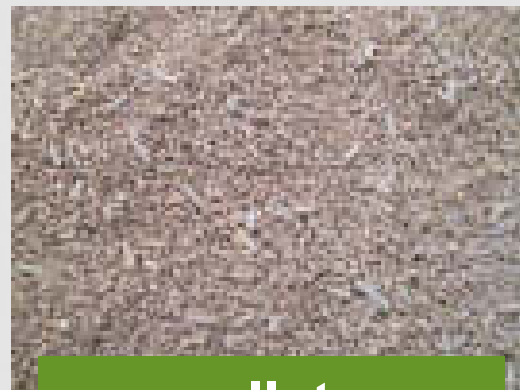
# P-removal at low concentrations

Iron sludge or iron coated sand is a waste product from drinking water production



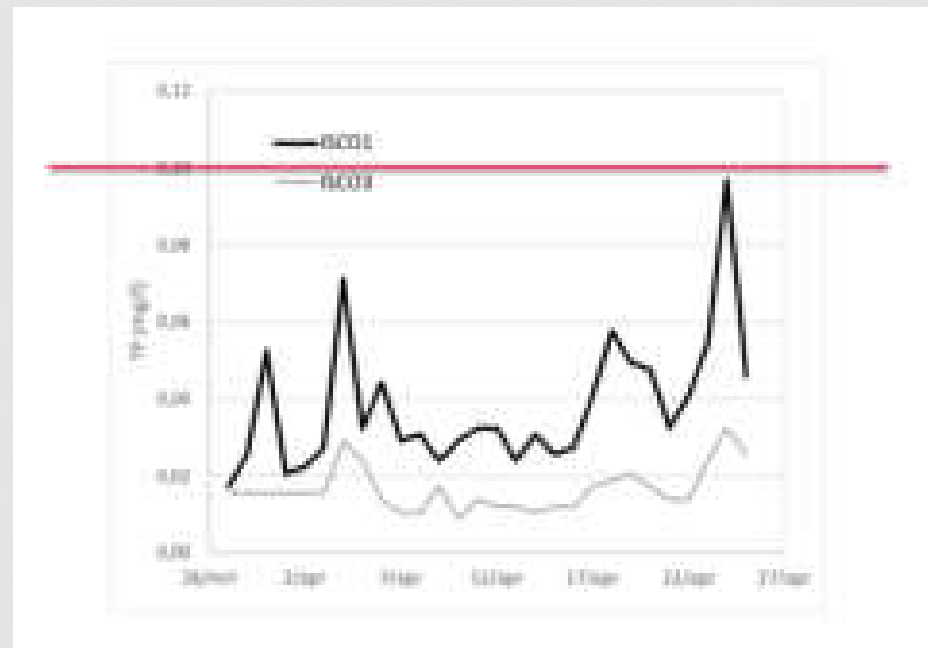
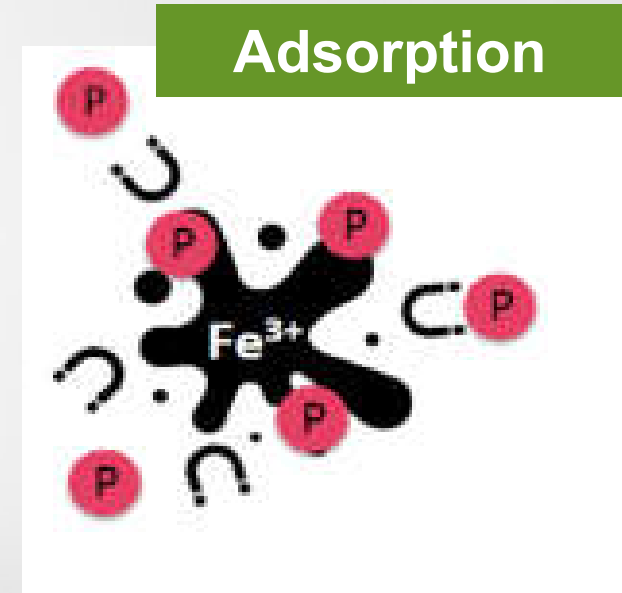
95% P-removal

ICS grains



pellets

Removal from drainage water



# WP3: Experimental research

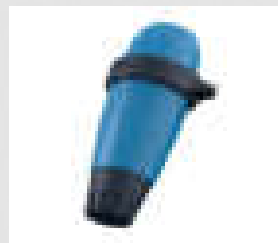
- Simulating disturbances (sun cream, deposition,...)
- Testing different substrates
- Impact of plant choice
- Flow speed
- ...
- Comparison of monitoring equipment



Hanna photometer



Spintouch



Blue Connect

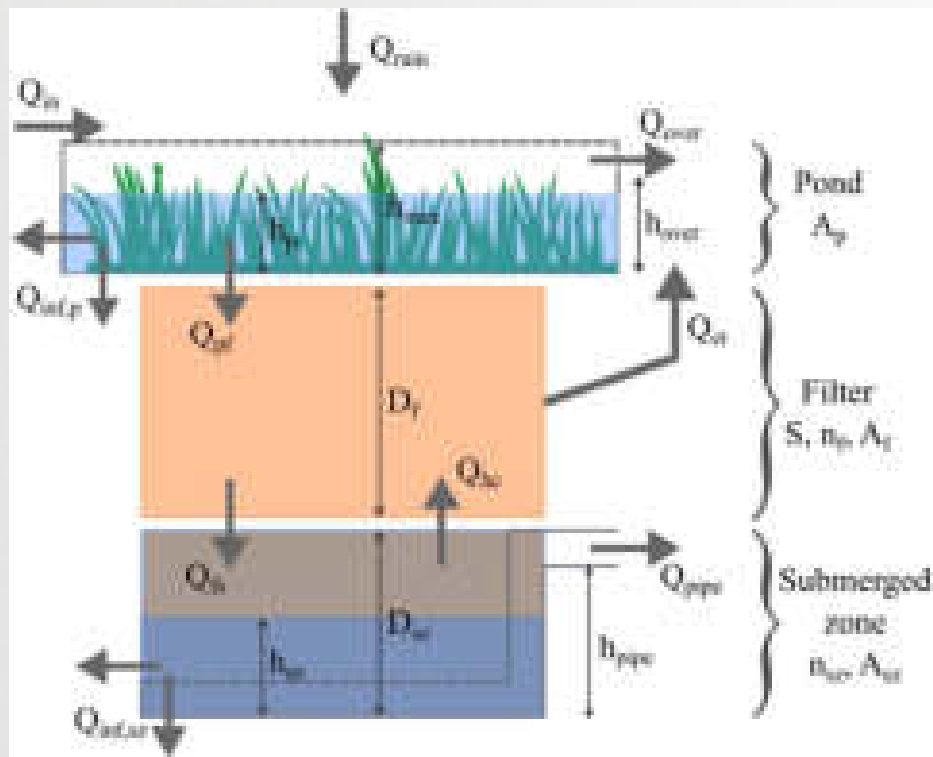
## Lab analysis

### Resultaat analyse:

	Eenheid	Waarde	Grenswaarde
V vertroebeling	NTU	0,38	<1,0
Stroomgeleiding	$\mu\text{S/cm}$	700	$\leq 1000$
pH-waarde	log H <sup>+</sup>	8,06	8,0 – 9,0
Totale hardheid	°dH	11,4	
Carbonaathardheid	°dH	7,6	5,8-10
Nitraat (NO <sub>3</sub> <sup>-</sup> )	mg/l	<5	10,0 - 50,0
Kalium (K <sup>+</sup> )	mg/l	25,28	
Totaalfosfor	ppm P	<10	$\leq 10$
Chloride (Cl <sup>-</sup> )	mg/l	264	$\leq 200$
Sulfaat (SO <sub>4</sub> <sup>2-</sup> )	mg/l	<40	$\leq 200$
Kleur bij 436 nm (geel-bruin)	col	<0,01	<0,5
Kleur bij 625 nm (roze-violet)	col	<0,01	<0,5
Kleur bij 680 nm (groen-blauw)	col	<0,01	<0,5

# WP4: filter models

- Model calibration and validation with measurement data
- Scenario-analysis



**Water flow model equations**

General form of equations  
 Flow = min (physically possible, available upstream, available downstream)

Max. infiltration to surrounding soil through filter and submerged zone

$$Q_{infiltration} = \begin{cases} 0, & \text{if } h_{pond} < h_{sub} \\ K_f (A_f + C_f \cdot P_f), & \text{otherwise} \end{cases}$$

Flowing over soil

Infiltration from pond to filter media

$$Q_{infiltration} = \min \left( K_f \frac{h_{pond} - h_{sub}}{D_f} A_f, \frac{1}{2} (h_{pond} + h_{sub}) A_f + \int Q_{infiltration} - \int Q_{out} \right)$$

Water overflow

$$Q_{out} = \min \left( C_o K_o \sqrt{2g(h_{pond} - h_{sub})}, \frac{1}{2} (h_{pond} + h_{sub}) A_o + \int Q_{infiltration} - \int Q_{out} \right) \cdot A_o$$

Infiltration from pond to surrounding soil

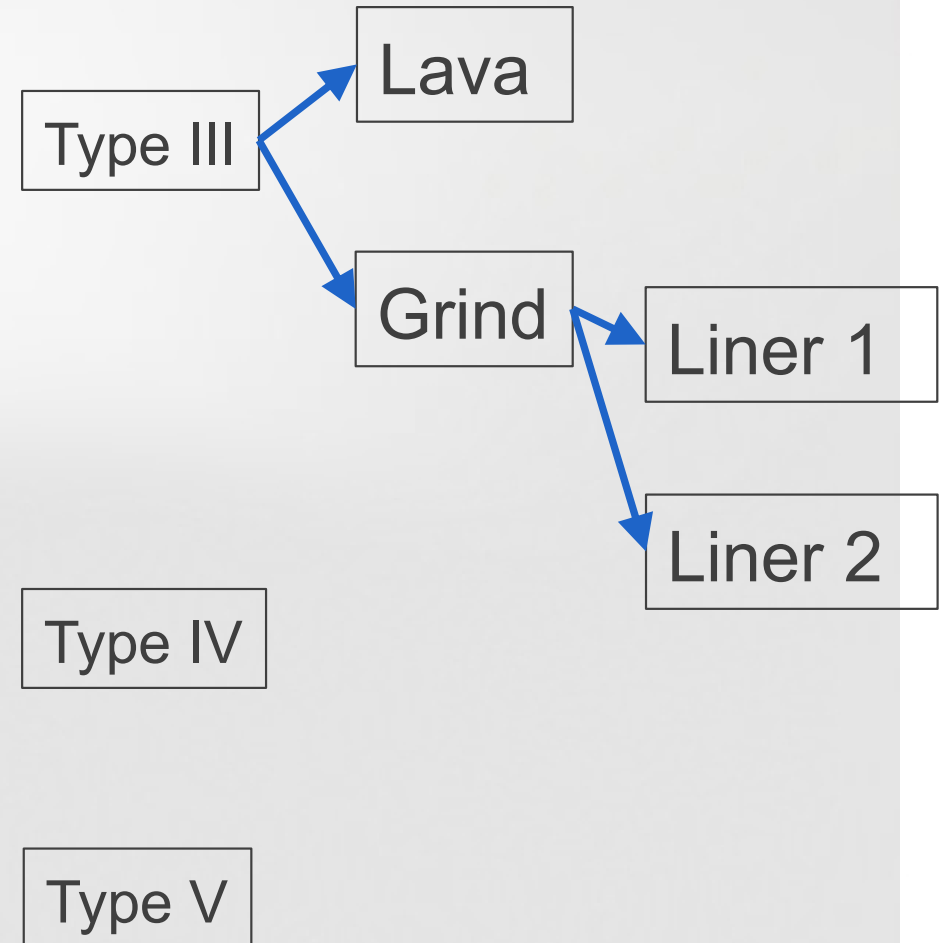
$$Q_{infiltration} = \min \left( K_s (A_s - A_f) + C_s \cdot P_s, \frac{1}{2} (h_{pond} + h_{sub}) A_s - \int Q_{infiltration} - \int Q_{out} \right)$$

Randelovic et al (2016), Water Research



# WP5: Sustainability

- Life cycle analysis





# Knowledge transfer and implementation

- Steering group committee
- Demonstration visits
- Local and international seminars (IOB meeting?)
- Best practices brochure
- Courses
- Online knowledge database and project website with results



# Bottom-up research



## Swimming pond constructors



## Suppliers





Any questions?

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