

# Environmental benefits of floating development

## Co-chairs:

Rui Lima (Indymo; MARE)

Ase Johannessen (Global Center on Adaptation)

Learn about **sand mining impacts on water and floating development** as a solution, as well as learn about **aquaculture and nature-inclusive design of floating developments**.

Learn **how floating developments interact with water quality** and how **drones** can support future research into this topic.

Discuss broadly **potential environmental benefits of floating developments** and identify knowledge and **research gaps and opportunities**.

**1. Short presentations to share research findings and examples** and identify specific opportunities where their work connects to floating developments, and highlight environmental benefits of floating development

**Presenters:**

- Rui Lima (Indymo; MARE)
- Chris Hackney (Newcastle University)
- Robbert Jak (Wageningen Marine Research)

**2. Questions and answers about the specific work of the presenters**

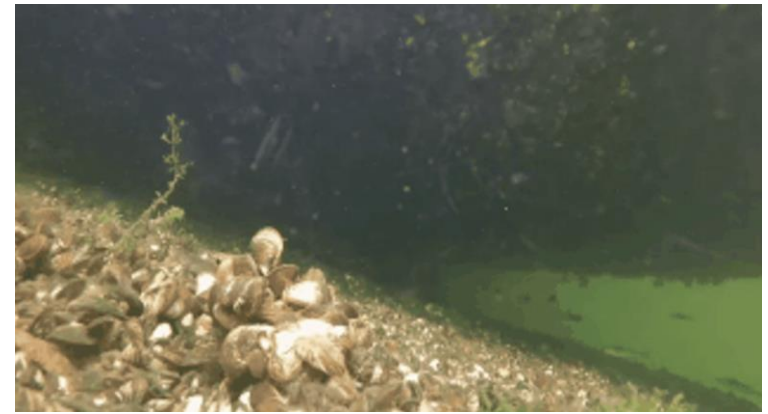
- Participants can raise their hands and be called upon (use the raise hand button)

**3. Group discussions on general questions regarding this topic**

- We will hear multiple people per question, and we encourage people to participate and to share each other's work in the chat.

# indymo Innovative Dynamic Monitoring

We use aquatic drones to collect underwater images, water samples and water quality and ecology data for public and private entities who want to inspect and monitor water systems. The mobility of sensors and cameras provide a unique 3D understanding of water bodies.



## Rui Pedroso de Lima

- MSc Civil Engineering (water resources and environment)
- Working in the applications and development of aquatic drones for water quality research (<https://www.mdpi.com/2073-4441/12/4/1196>)
- Research on the topic of impact of floating buildings and solar panels (<https://www.mdpi.com/2071-1050/13/11/6421>)
- Ambition to pursue PhD on innovative and unmanned monitoring techniques

We worked with:



Hoogheemraadschap van Delfland



WATERFRHIER: VEILIG EN OP MAAT



Rijkswaterstaat  
Ministerie van Verkeer en Waterstaat



- Startup from the Netherlands (founded in 2015)
- Strong link to education institutions
- Founders Floris Boogaard and Rutger de Graaf
- 1st international projects in 2017
- Located in Delft



# Impacts of floating structures



INNOVATIVE  
DYNAMIC  
MONITORING



# What happens when a floating structure is built?



Sunlight  
blocked/reflected

Attraction of birds



Noise, light, heat and waste from  
structures/human activities

Less area for  
air-water  
interactions



Changes in  
wind patterns



Changes in  
currents/flow

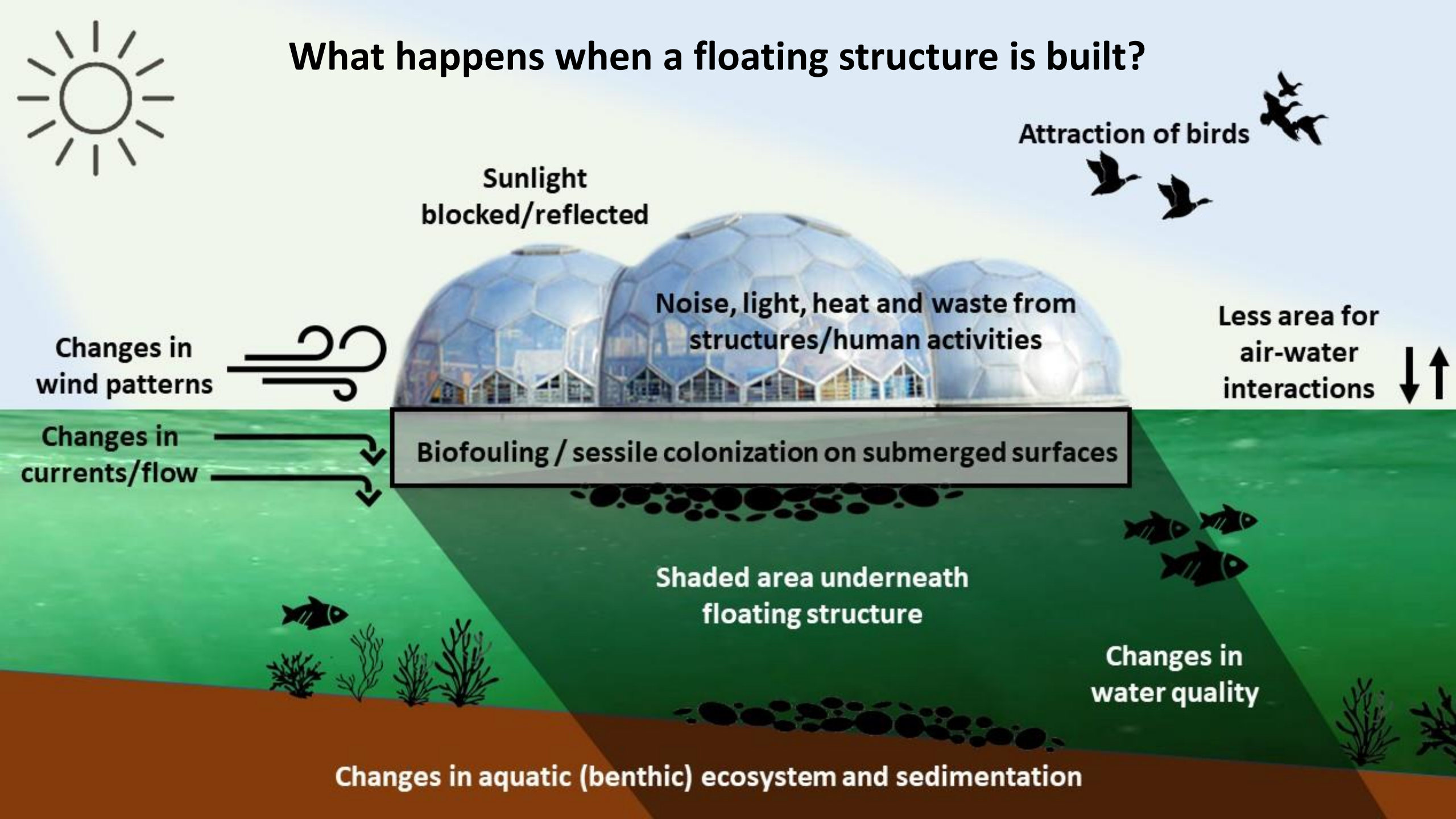


Biofouling / sessile colonization on submerged surfaces

Shaded area underneath  
floating structure

Changes in  
water quality

Changes in aquatic (benthic) ecosystem and sedimentation



Example Study Location:  
Floating Pavilion  
(Rotterdam, The Netherlands)

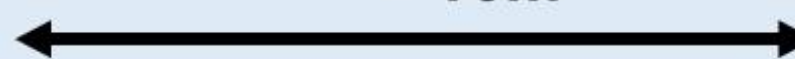
Position of continuous sensors  
and mooring/fixing systems:



Locations of scan with  
underwater drone:



$> 10m$



Buoy



1.5 m

1.5 m

Cable

Under floating  
structure



Near



Same depth

Open water



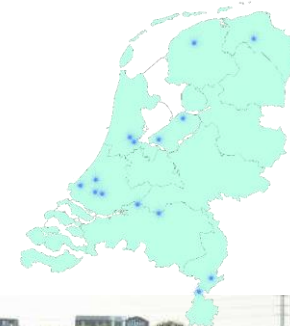
Cable



Nr	Name	Location	Type of floating construction	Year	Size (m <sup>2</sup> )	Type of water system	Measurement campaign
1	Harnaschpolder	Delft	Houses in row (6)	2010	1,200	Pond	A
2	Himpenser Wielen	Leeuwarden	Houses in row (7)	2008	1,050	Gully (Himpenser Wielen)	A, B, C
4	Ijburg (Steigereiland)	Amsterdam	Neighbourhood (76)	2010	8,715	Harbour (urban)	A, B
5	Watervillas Gouden Kust	Maasbommel	Houses in row (7)	2005	1,477	Lake (Gouden Ham)	A, C
6	Noorderhaven	Groningen	Houseboats (approximately 50)	N/A	N/A	Canal	A
7	Drijvende Kas	Naaldwijk	Pavilion for events (1)	2005	900	Pond	A, B
8	Warande	Lelystad	Houses in row (8)	2012	800	Canal (dredged/widened)	A, C
9	Expo SeaLife Almere	Almere	Housing complex (4)	2010	500	Harbour (Pampushaven)	A
10	Havenpaviljoen Schiedam	Schiedam	Support Pavilion (1)	2009	64	Canal (urban)	A, C
11	Sea Palace (Oosterdok)	Amsterdam	Restaurant (1)	1985	900	Harbour (urban)	A
12	Zwaneneiland (Woldmeer)	Groningen	Houses (15)	2013	390	Lake (Woldmeer)	A, C
13	Oolderhuske Marina's	Roermond	Houses (40)	1998	5,760	Lake (Zuidplas)	A, C
14	Maasvillas	Ohé en Laak	Houses grouped (6)	2010	618	Lake, connected to river (Schroevendaalseplas)	A
15	Gouden Wok	Rotterdam	Restaurant/Hotel (1)	1985	1,700	Harbour (Parkhaven)	A
16	Floating Pavilion	Rotterdam	Pavilion for events (1)	2010	1,600	Harbour (Rijnhaven)	A, B, C
17	Watervilla (Koperwiekade)	Middelburg	House (1)	2002	160	Pond (Koperwiek)	A
18	Limonadefabriek (Liesveld Marina)	Streefkerk	Hotel/Restaurant (1)	2011	2,727	Harbour (Nieuwehaven)	A

In the measurement campaign column, letter A corresponds to water quality scan, comparison under floating structure with open water; letter B corresponds to continuous measurements for longer periods of time and letter C corresponds to underwater images of aquatic ecology.

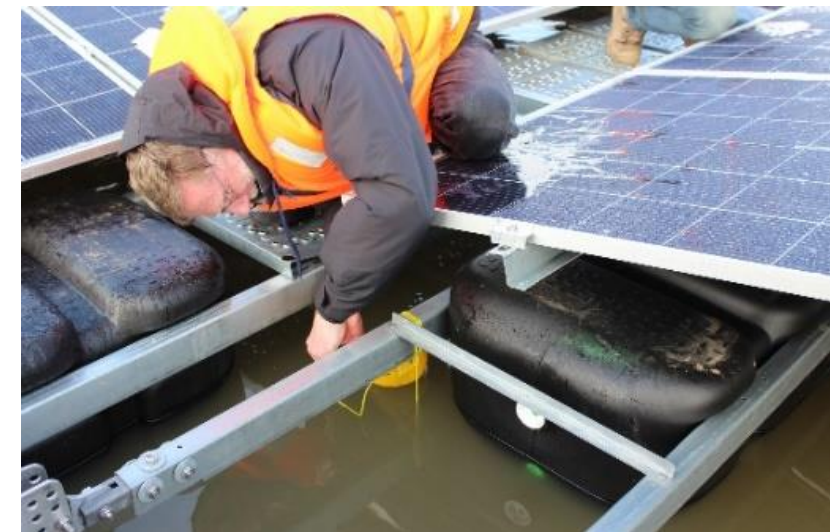
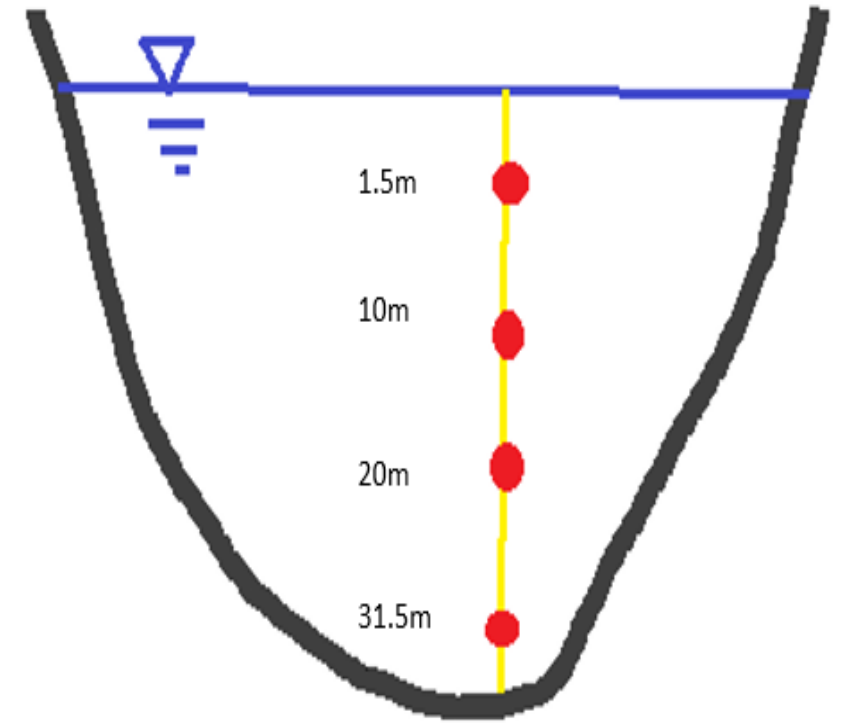
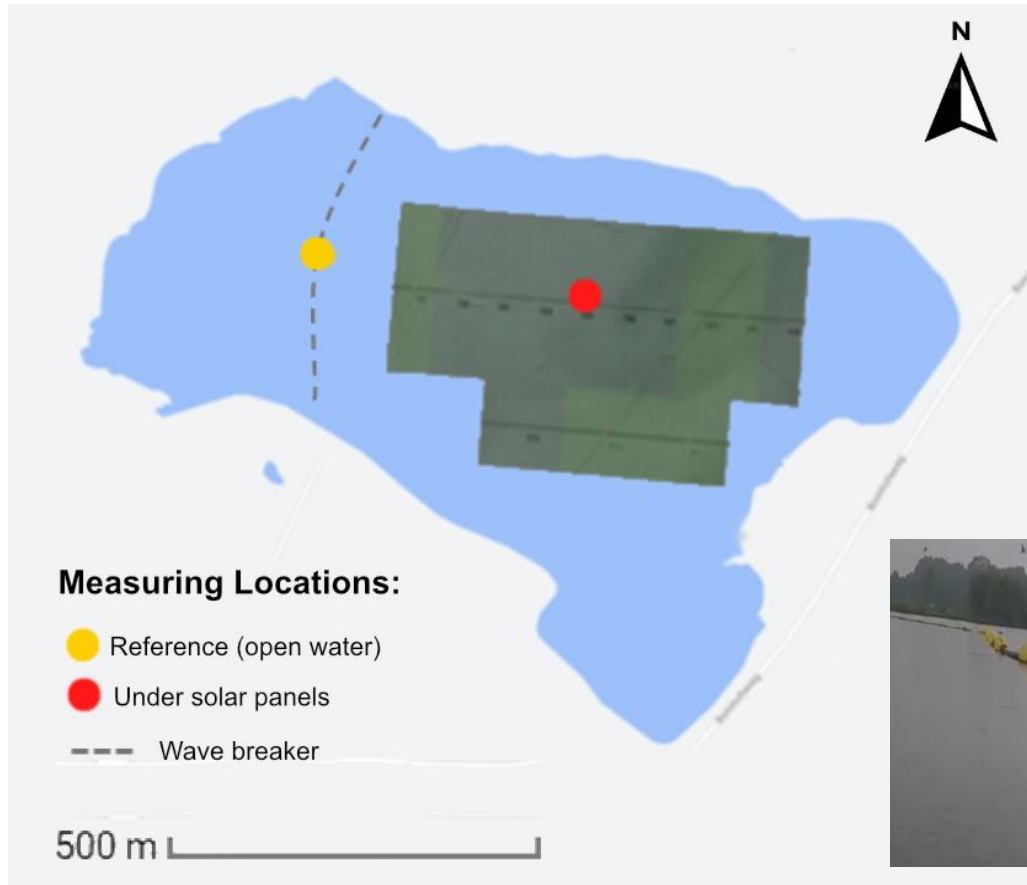
# Case study locations



# Solar Park Bomhofsplas

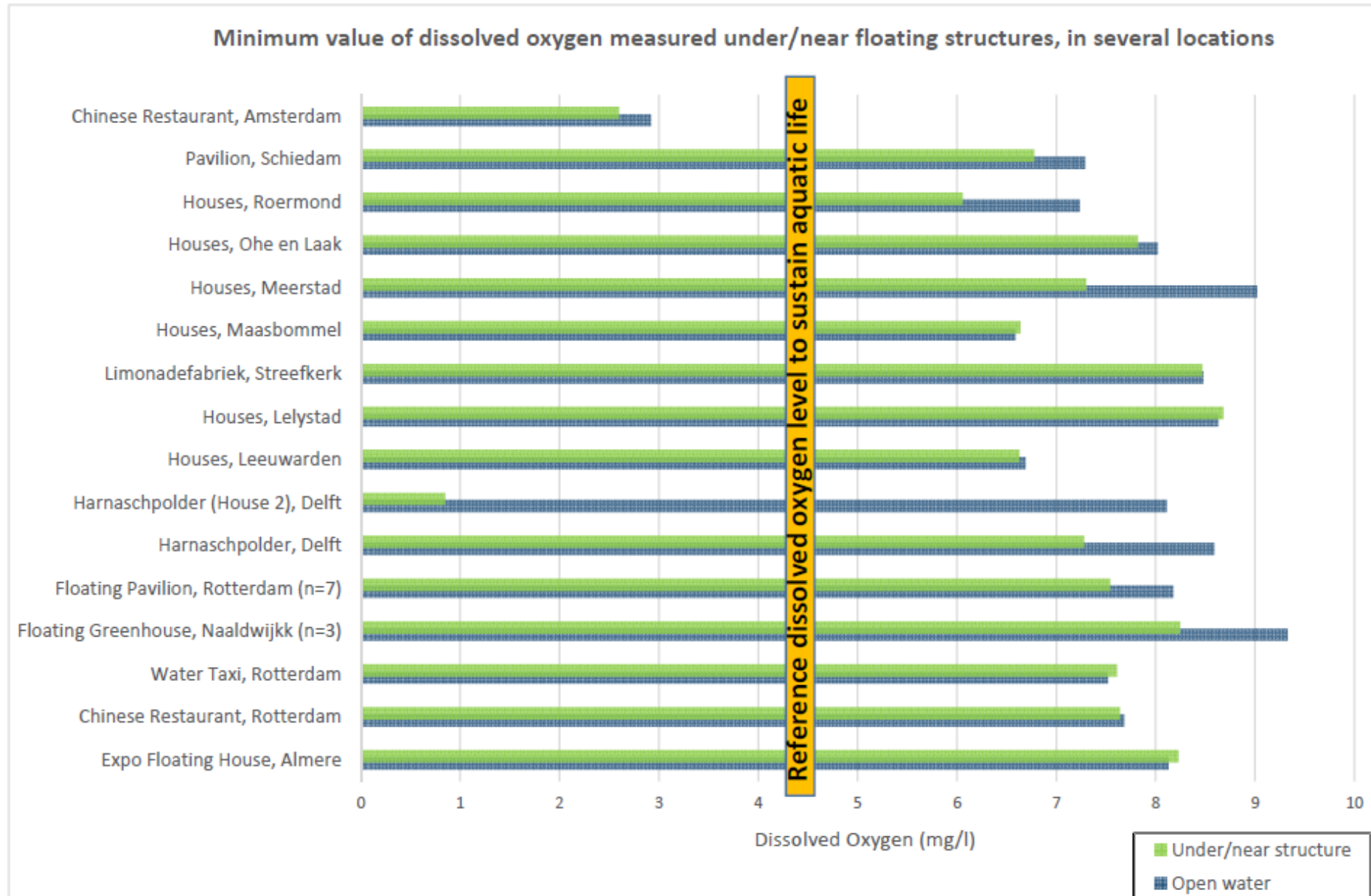
Installed between January and March 2020, the floating solar park at the Bomhofsplas is currently the largest floating solar park in Europe.

- 72.000 solar panels with a 27.4MWp capacity (megawatt-peak)
- covers an area of 18.25ha (30% of the lake)
- Produces electricity for more than 7.200 households.

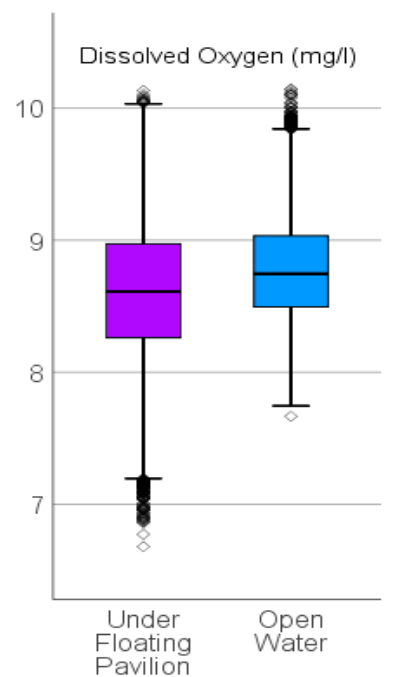
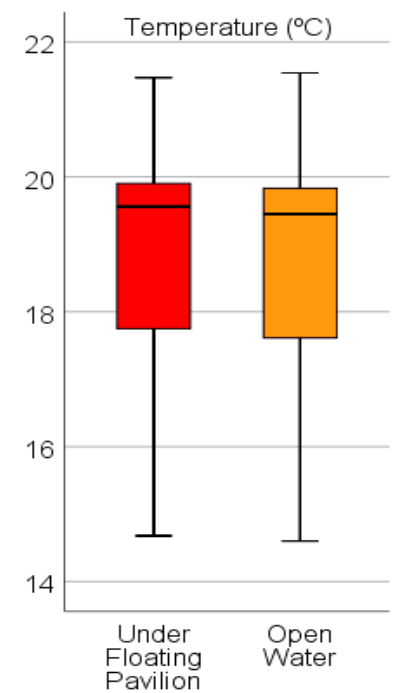
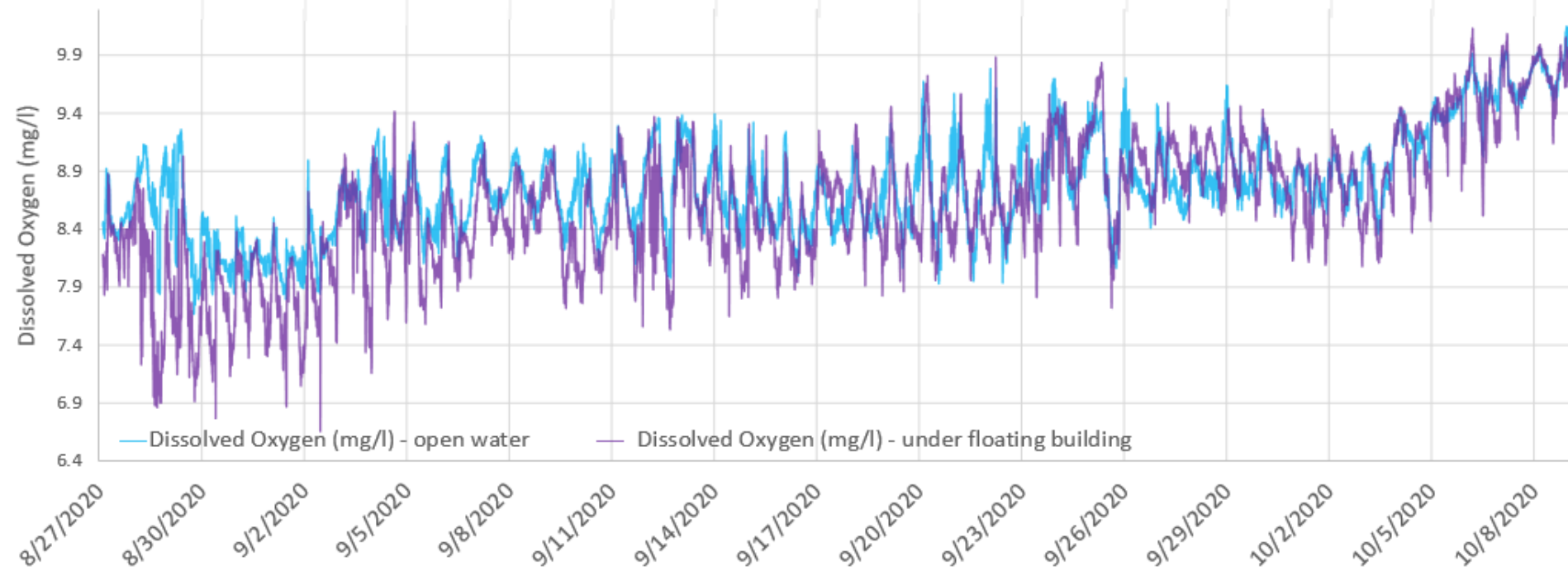
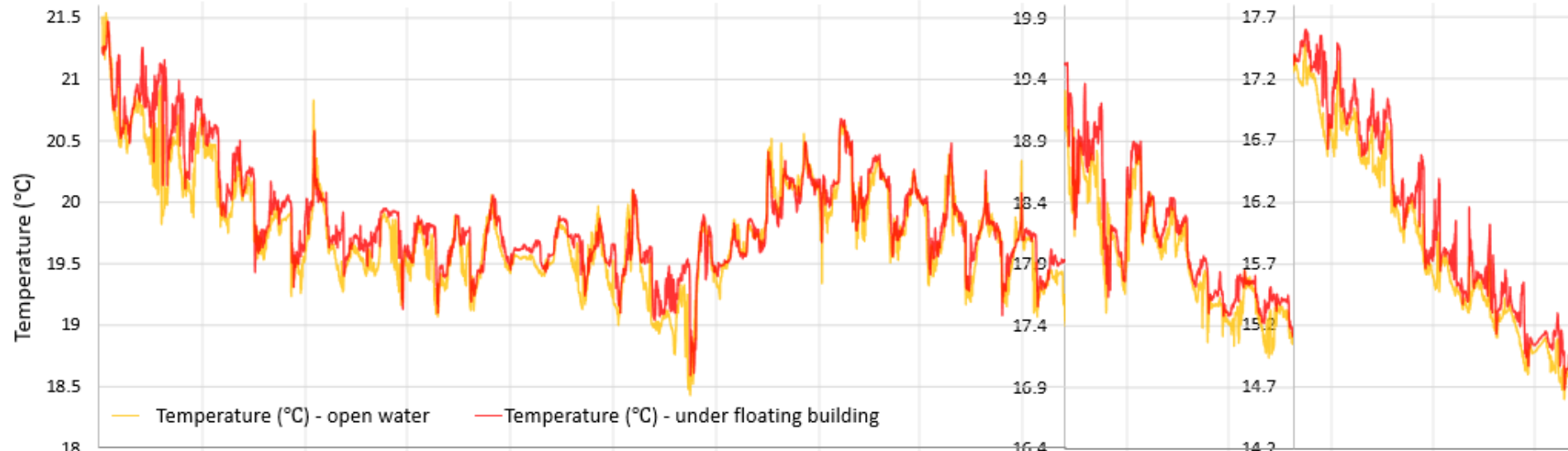




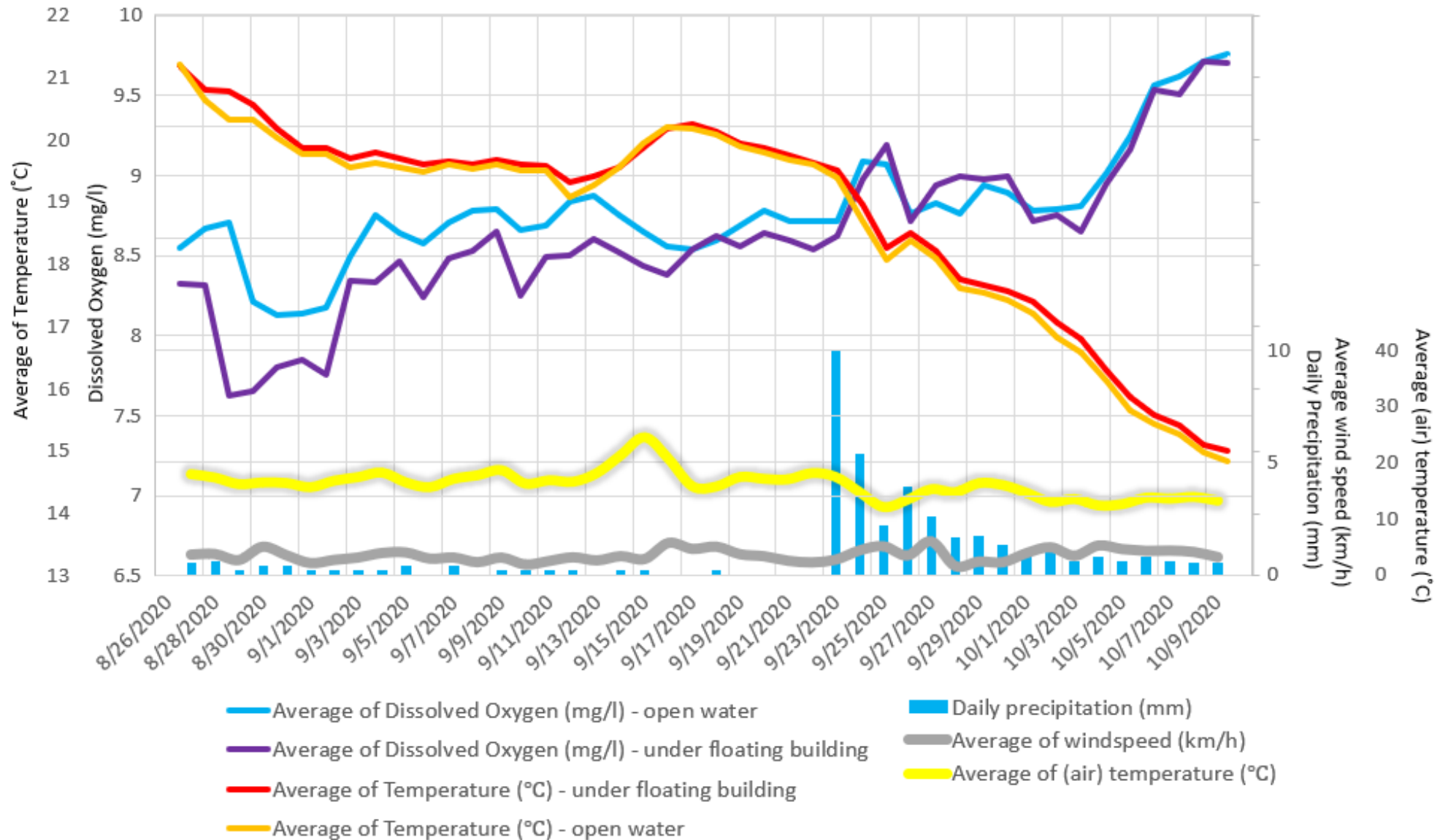
# Minimum values measured under floating houses compared to open water



# Continuous/Static measurements under the Floating Pavilion, Rotterdam (2020)

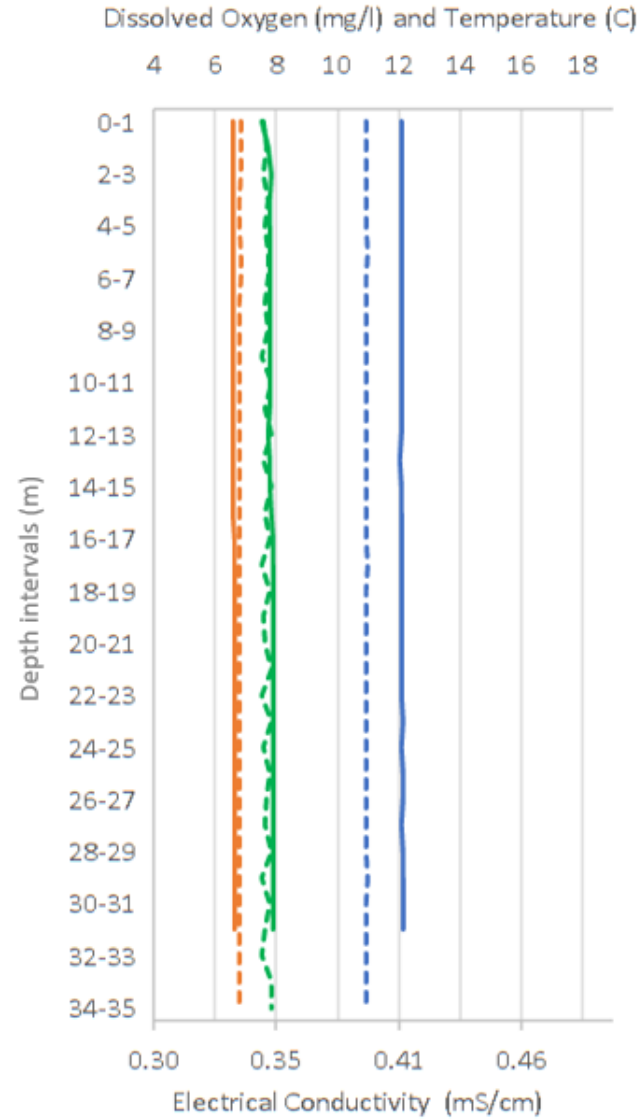


# Daily averages of dissolved oxygen collected in relation to meteorological data during the monitoring period at the Floating Pavilion, Rotterdam

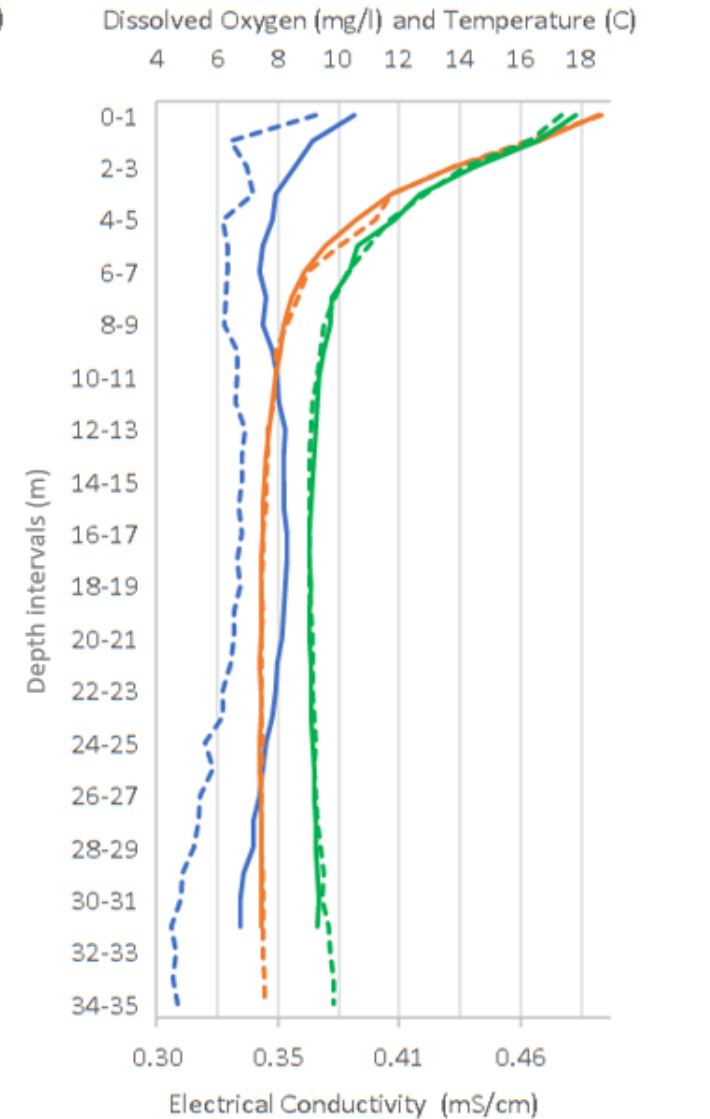




### Winter (Jan/Feb 2020)



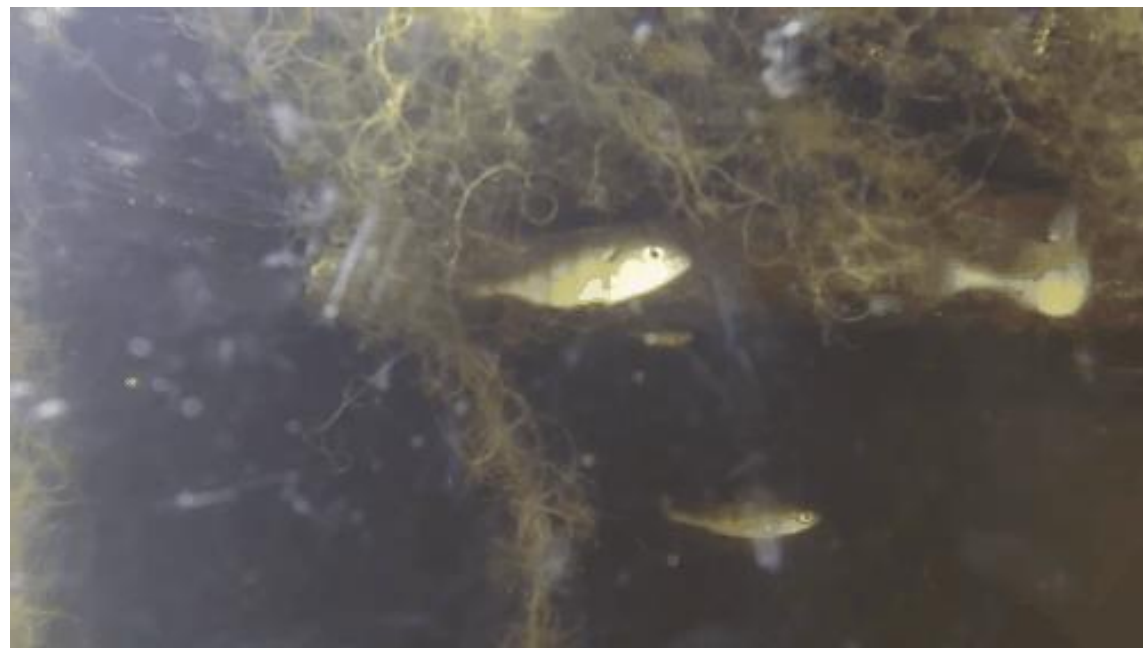
### Summer (July 2020)



- Temperature (Reference/Open Water)    — E.Conductivity (Reference/Open Water)    — Dissolved Oxygen (Reference/Open Water)
- - - Temperature (Under floating solar panels)    - - - E.Conductivity (Under floating solar panels)    - - - Dissolved Oxygen (Under floating solar panels)



**Submerged wall of floating foundation**



**Underside of floating foundation**



**Benthic cover in shaded areas**

**Benthic cover under floating houses**

# Project conclusions and remarks

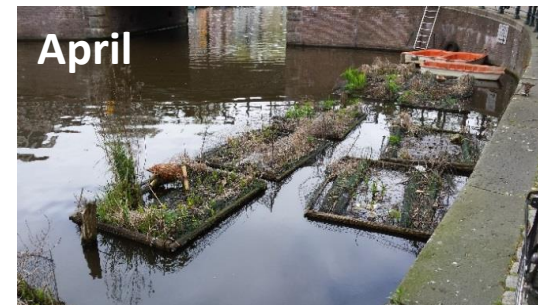
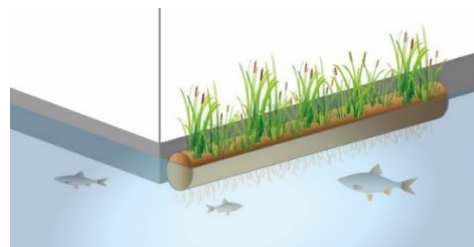
- Small differences on water quality parameters (existing small-scale projects).
- Characteristics of the water body plays important role (e.g. tides, current)
- Further research necessary to infer about larger scale floating projects (water quality modelling)

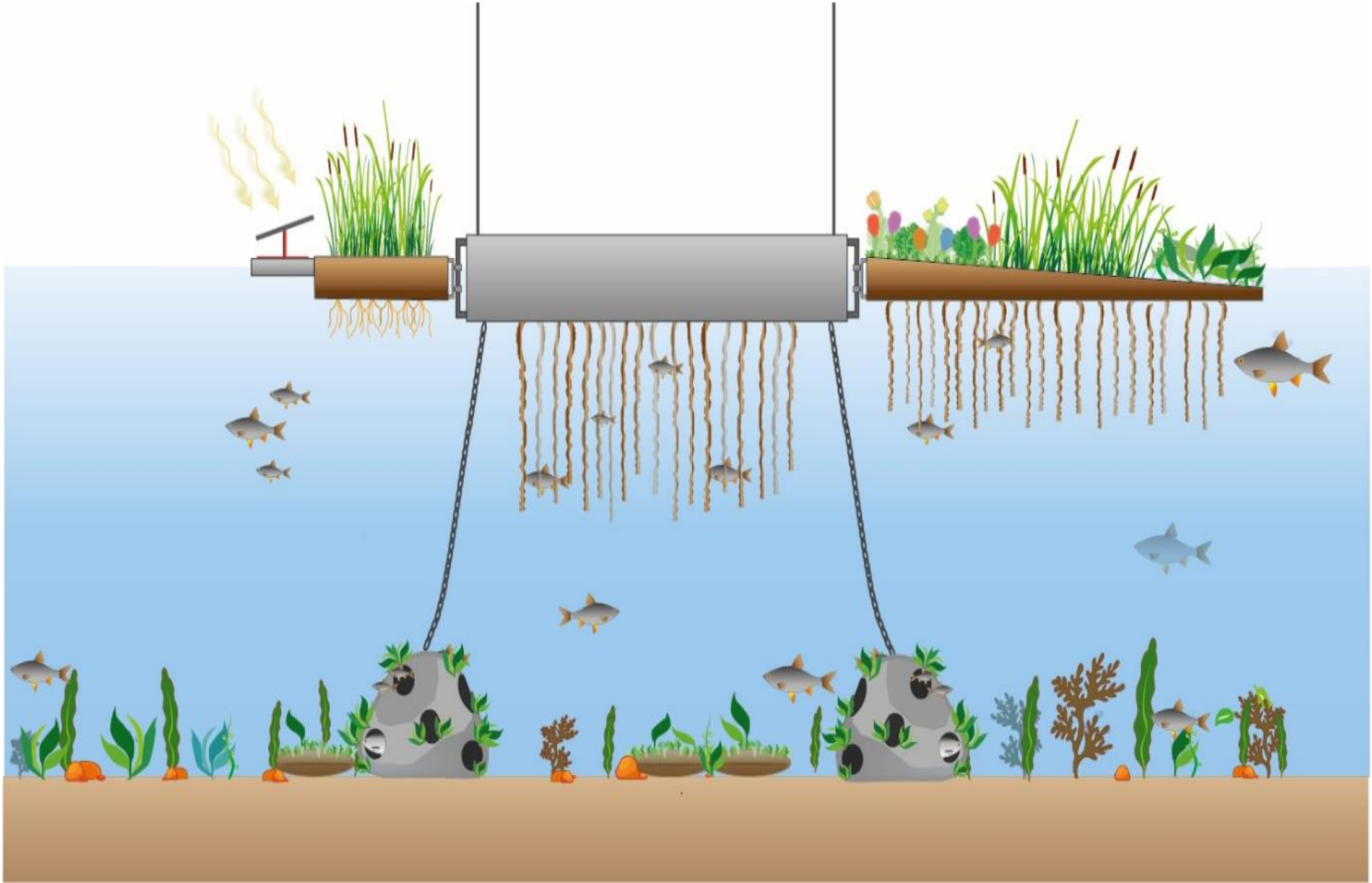


Opportunity for the implementation of ecological measures to ensure/maximize positive impacts

Measures add value to floating projects, by performing functions such as:

- water treatment
- habitat enhancement (bio-diversity)
- wave protection
- green landscaping





## Impacts of floating urbanization on water quality and aquatic ecosystems: a study based on *in situ* data and observations

Rui L. Pedrosa de Lima <sup>id</sup>ab,\*, Rutger E. de Graaf-van Dinther<sup>a,c</sup> and Floris C. Boogaard <sup>id</sup>a,d,e

<sup>a</sup>Indymo – Innovative Dynamic Monitoring, Paardenmarkt 1, 2611 PA Delft, The Netherlands

<sup>b</sup>MARE – Marine and Environmental Sciences Centre, Rua da Matemática 49, 3004-517 Coimbra, Portugal

<sup>c</sup>Blue21, Paardenmarkt 1, 2611 PA Delft, The Netherlands

<sup>d</sup>NoorderRuimte, Centre of Applied Research and Innovation on Area Development, Hanze University of Applied Sciences, Zernikeplein 7, P.O. Box 3037, 9701 DA Groningen, The Netherlands

<sup>e</sup>Deltares, Daltonlaan 600, 3584 BK Utrecht, The Netherlands

\*Corresponding author. E-mail: rui.plima@indymo.nl

<sup>id</sup> RLPdL, 0000-0003-0441-7236; FCB, 0000-0002-1434-4838

## In-Situ Water Quality Observations under a Large-Scale Floating Solar Farm Using Sensors and Underwater Drones

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Water Practice & Technology Vol 15 No 3  
doi: 10.2166/wpt.2020.062

### Potential impact of floating solar panels on water quality in reservoirs; pathogens and leaching

D. Mathijssen<sup>a,\*</sup>, B. Hofst<sup>a</sup>, E. Spierenburg-Sack<sup>a</sup>, R. van Asperen<sup>a</sup>, B. van der Wal<sup>IWA</sup>ab, J. Vreeburg<sup>IWA</sup>c and H. Ketelaars<sup>IWA</sup>a

<sup>a</sup>Evides Water Company, Schaardijk 150, 3063 NH, Rotterdam, The Netherlands

<sup>b</sup>Department of Environmental Technology, Wageningen University, Bornse Weiland 9, 6708 WG, Wageningen, The Netherlands

<sup>c</sup>KWR Watercycle Research Institute, P.O. Box 1072, 3433 PE, Nieuwegein, The Netherlands

\*Corresponding author. E-mail: d.mathijssen@evides.nl

<sup>1,3,4</sup> <sup>id</sup>, Olof Akkerman<sup>3</sup> and Fen-Yu Lin<sup>5</sup>

raaffsingel 12, 2629 JD Delft, The Netherlands;

re, Rua da Matemática 49, 3004-517 Coimbra, Portugal  
novation on Area Development, Hanze University of  
01 DA Groningen, The Netherlands;  
nze.nl (O.A.)

herlands  
etherlands; vicky@blue21.nl

le floating solar panels has consequences to water  
impacts depend on the dimensions, design and pro-

# Recent publications found in (2020-2022) Addressing impacts of floating developments



Article

## Effect of Solar Canals on Evaporation, Water Quality, and Power Production: An Optimization Study

Energy Conversion and Management

journal homepage: [www.elsevier.com/locate/enconman](http://www.elsevier.com/locate/enconman)



## Floating photovoltaic plants: Ecological impacts versus hydropower operation flexibility

J. Haas<sup>a,e,\*</sup>, J. Khalighi<sup>a</sup>, A. de la Fuente<sup>c</sup>, S.U. Gerbersdorf<sup>d</sup>, W. Nowak<sup>a</sup>, Po-Jung Chen<sup>a,b</sup>



Journal of Cleaner Production

journal homepage: [www.elsevier.com/locate/jclepro](http://www.elsevier.com/locate/jclepro)

Review

## Recent technical advancements, economics and environmental impacts of floating photovoltaic solar energy conversion systems

Shiva Gorjian<sup>a,\*</sup>, H. Sharon<sup>b</sup>, Hossein Ebadi<sup>c</sup>, Karunesh Kant<sup>d</sup>, Fausto Bontempo Scavo<sup>e</sup>, Giuseppe Marco Tina<sup>e</sup>



**Next speaker:**

**Chris Hackney**

Newcastle University

**1. Short presentations to share research findings and examples** and identify specific opportunities where their work connects to floating developments, and highlight environmental benefits of floating development

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## **QUESTION 1:**

**Thinking at a systems level, what are some other potential or confirmed environmental benefits of floating development?**

## **QUESTION 2:**

**How could more knowledge on the environmental benefits of floating support uptake and upscaling? What knowledge gaps exist on this topic? What research could be done to address the knowledge gaps?**

## **QUESTION 3:**

**All development has environmental impacts, what are some of the possible environmental impacts that floating entrepreneurs and city planners should be aware of? And share any ideas on how the issues could be combatted or better researched.**

# **Additional comments?**

Feel free to also share your work and activities, research and interest that brought you to this discussion room!

You can also share your work focus, interest, needs and contact information in the chat

# Thank you!

**Let's use the opportunity at this stage of expansion of floating developments to think about the environment and create/design new opportunities for ecosystem development and increase of biodiversity**

Learn more from resources available on the WAC portal:

<https://communities.adaptationexchange.org/knowledge-base/floating-development/environmental-benefits-and-impacts-of-floating-development>

Let's stay connected in the discussion forum and continue this conversation:

<https://communities.adaptationexchange.org/forum/floating-and-resilient-development-knowledge-exchange-2022>