

MODEL TO PREDICT IMPACT OF FLOATING SOLAR ON WATER QUALITY – BASED ON COLLECTED DATA

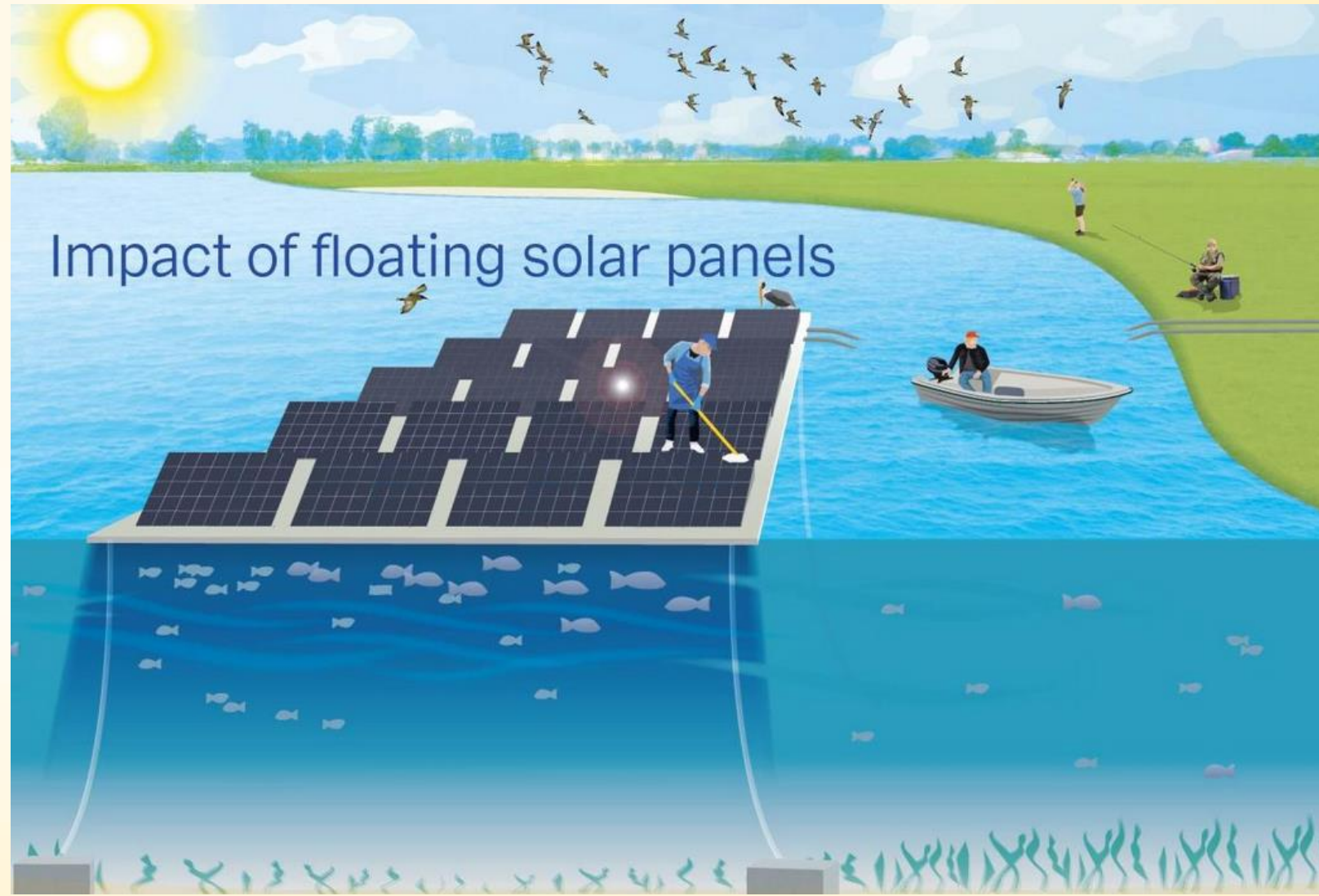
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IMPACT ON WATER QUALITY

- Ecosystem
- Possible effects on
 - Light availability
 - Phyto-plankton production
 - O₂ concentration
 - CO₂ concentration
 - Nutrients
 - Plant growth and decay
 - CH₄ concentration
 - Fish behaviour
 - Water temperature



<https://www.stowa.nl/deltafacts/waterkwaliteit/diversen/drijvende-zonnepanelen-effecten-op-waterkwaliteit-en-ecologie>

CONTENTS

- The project
- The set-up
- Measurements performed
- Measurement results
- The model
- Model results
- Model applicability
- Conclusions



- **Aim**

- Measure impact on water quality for 3 different set ups, for 3 years
- Set up model to predict impact for large scale floating systems

- **Funding through Dutch Ministry of Economic Affairs (project DEI5919007)**

- **April 2020 – December 2024**

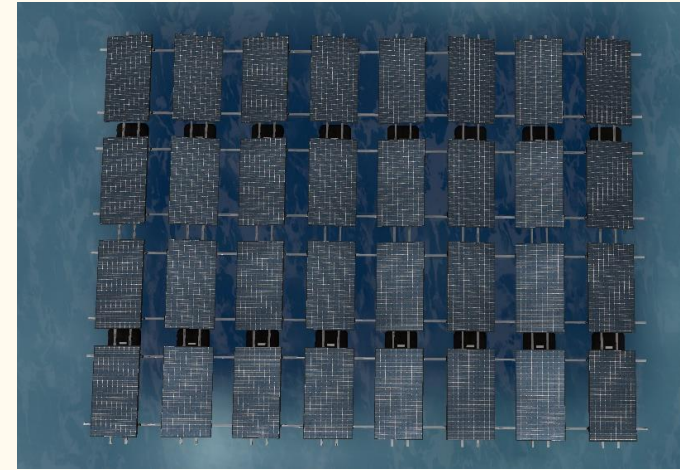
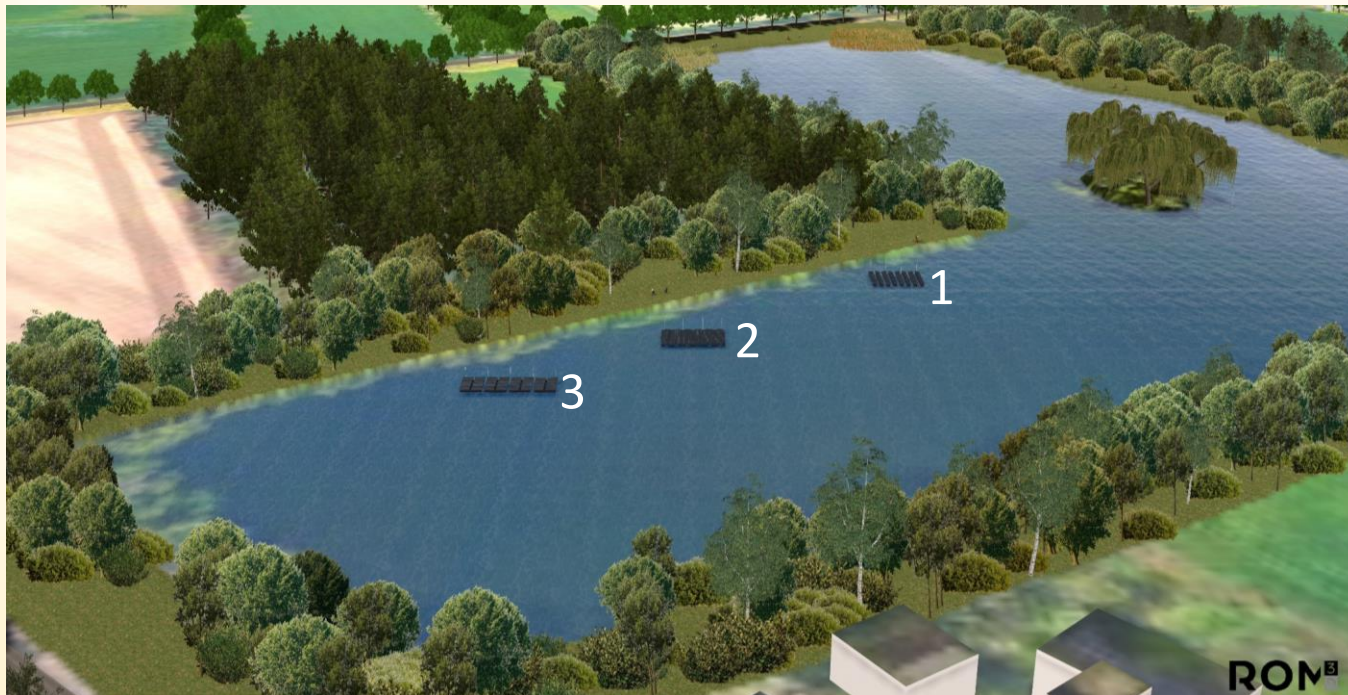
- **Partners**

- EasyFix Solar
- NIOO
- Renergize Consultancy
- ROM3D
- Wageningen University – De Marke

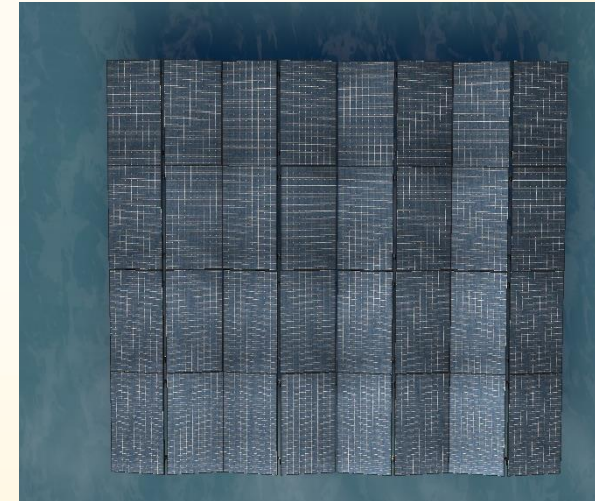


PILOT SET-UP

- 3 floating pilot systems
- Different levels of openness to the water
- Installed at former sand minig location, (Marker Plas)



1. Panels East-West
Open



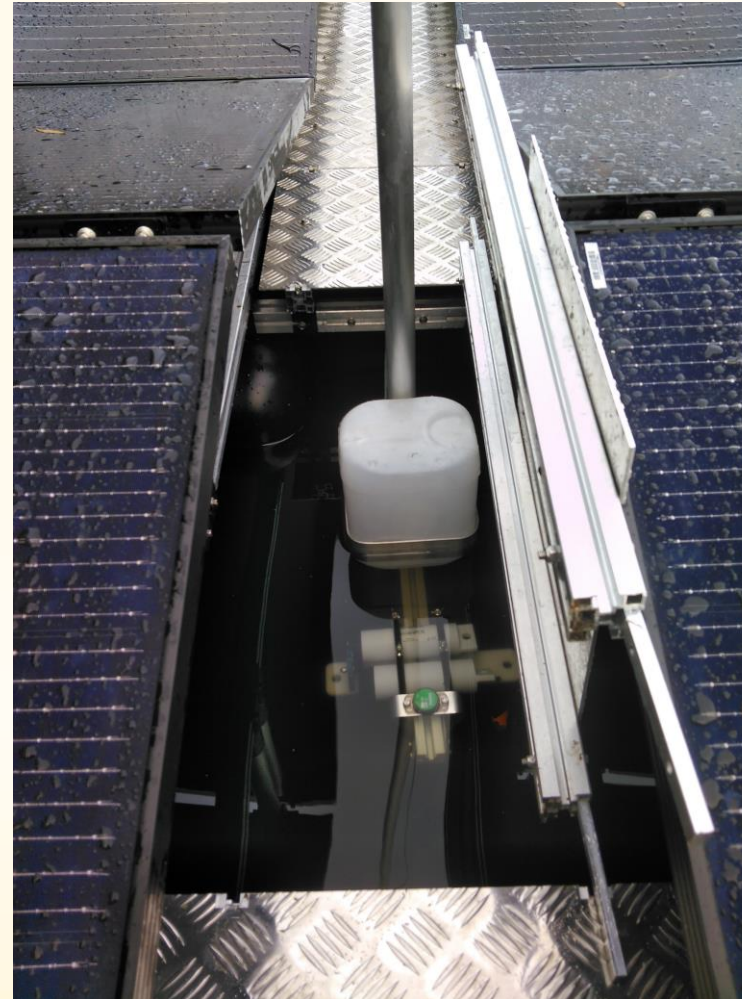
2. Panels East-West
Closed



3. South, open

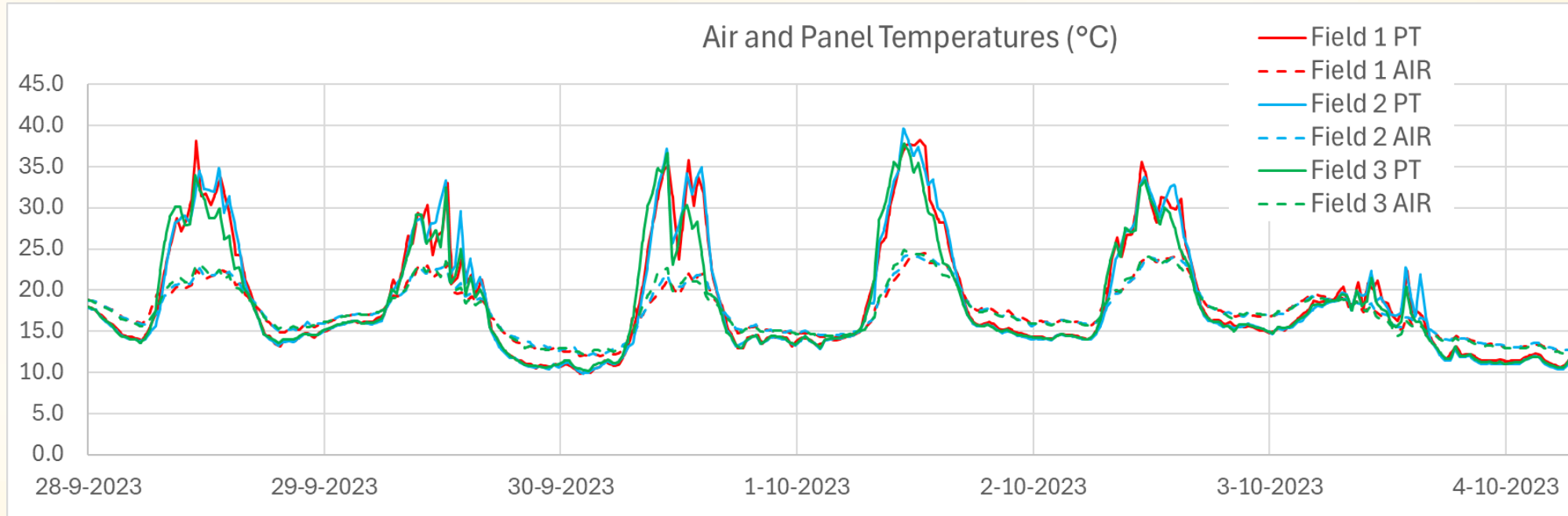
MEASUREMENTS PERFORMED

- **For 3 years, by NIOO**
 - O_2
 - CO_2
 - CH_4
 - Water temp
 - Light availability
 - Nutrients (N and P)
 - Carbon balance
- **For 1 year**
 - Panel temperature
 - Air temperature below panels



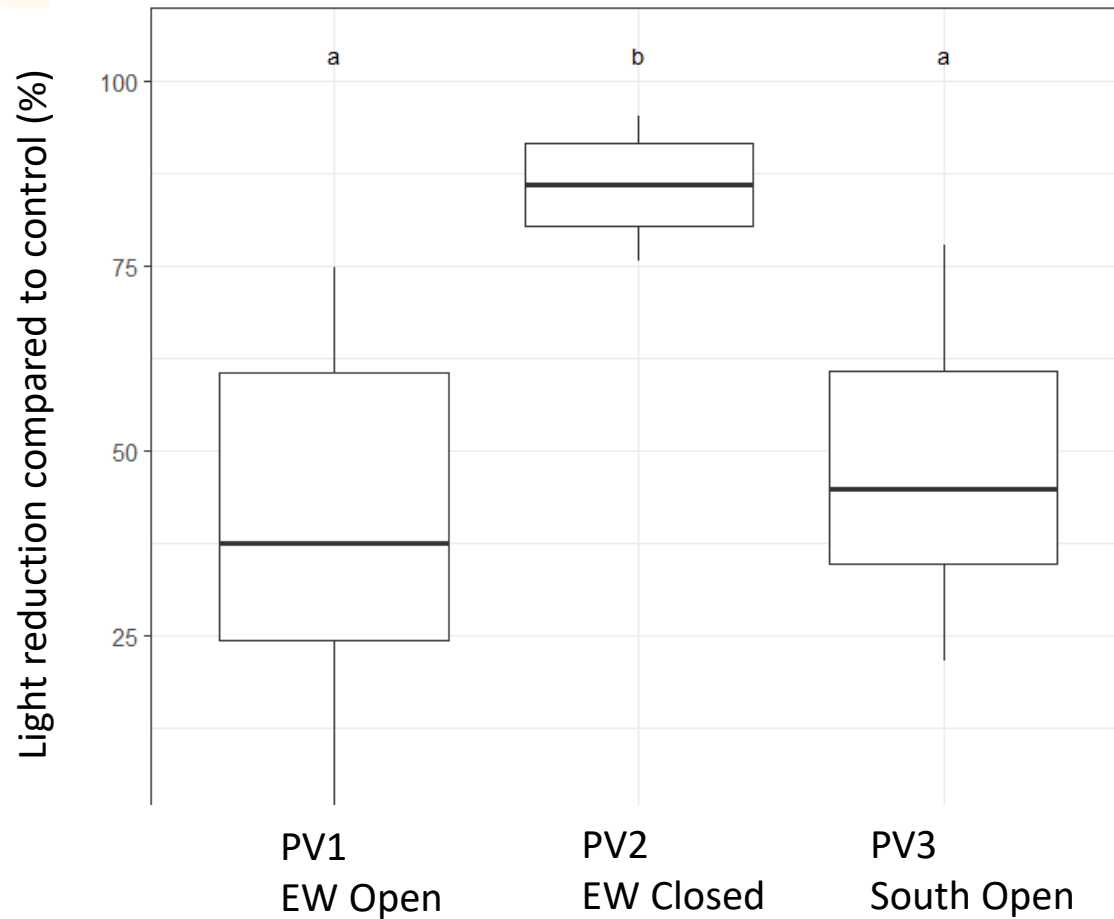
PANEL, AIR AND WATER TEMPERATURE

- **Average** panel temperature of closed field ~ 1° higher than for the open fields
- 2.3 degrees on sunny day → 0.3-0.8% yield difference
- Air temperature remains higher than panel temperature at night

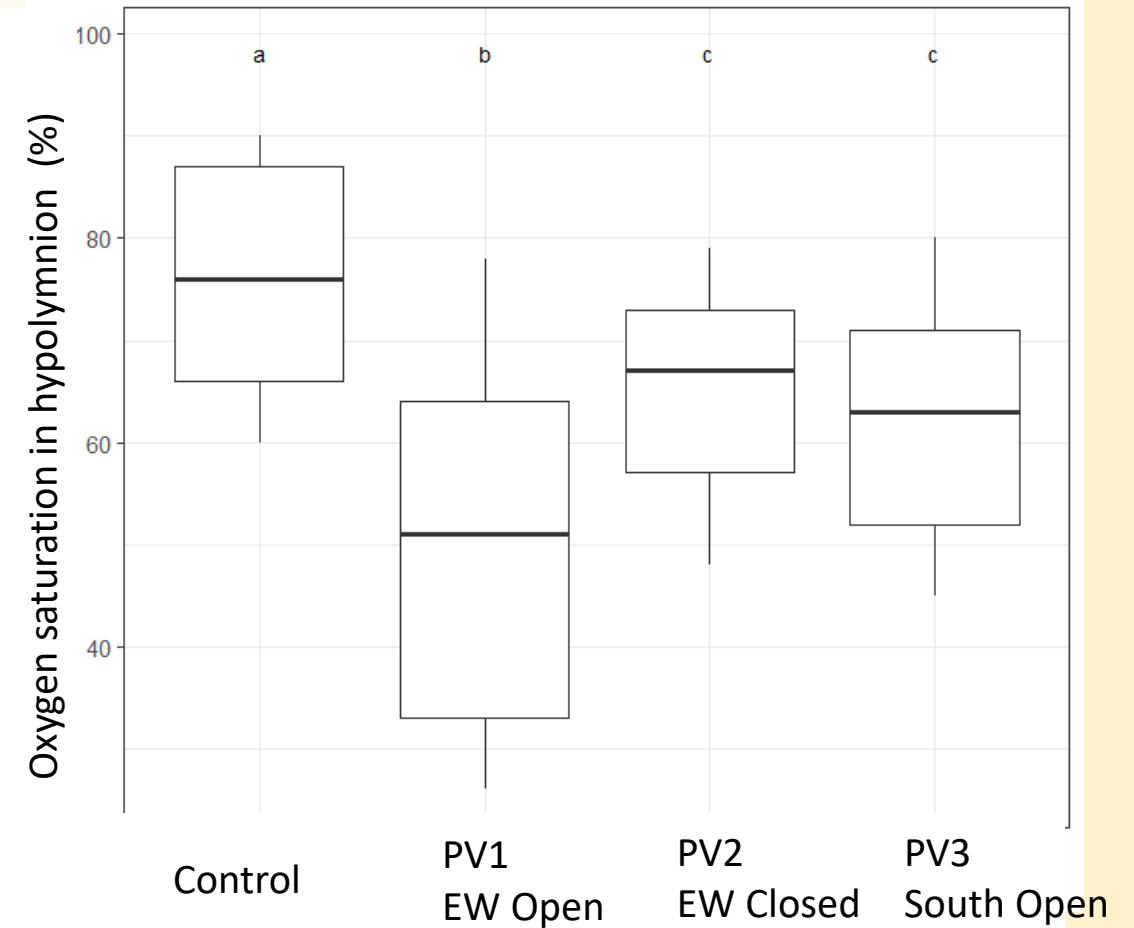


- No difference measured in water temperature
- Corresponds to other findings, see e.g. P. Yang et al, NPU Singapore:
 - Impacts of a floating photovoltaic system on temperature and water quality in a shallow tropical reservoir. Limnology **23**, 441 (2022).
<https://doi.org/10.1007/s10201-022-00698>

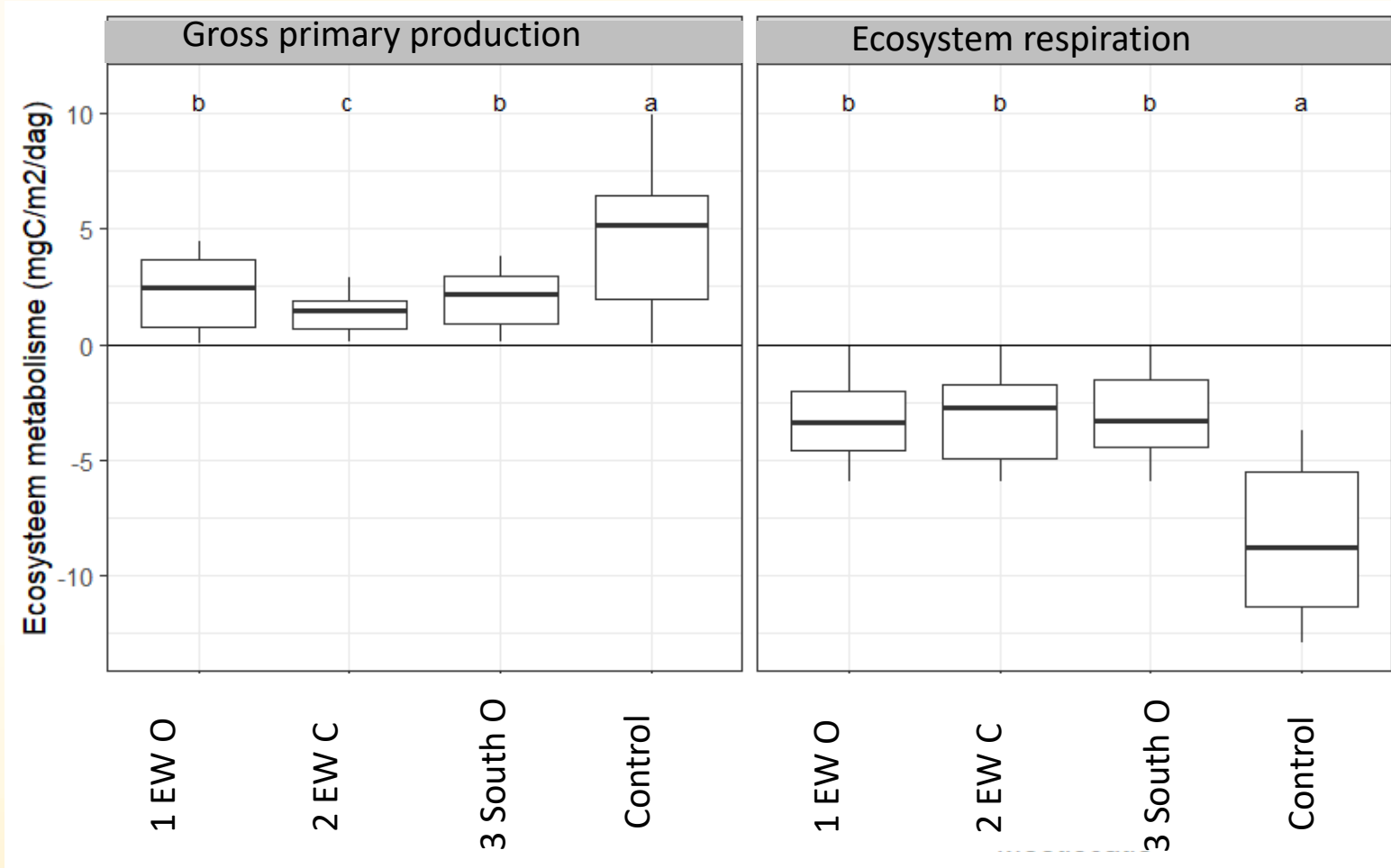
- Light – strong reduction at closed system



O₂ saturation



- **System performance: oxygen production and consumption (respiration)**



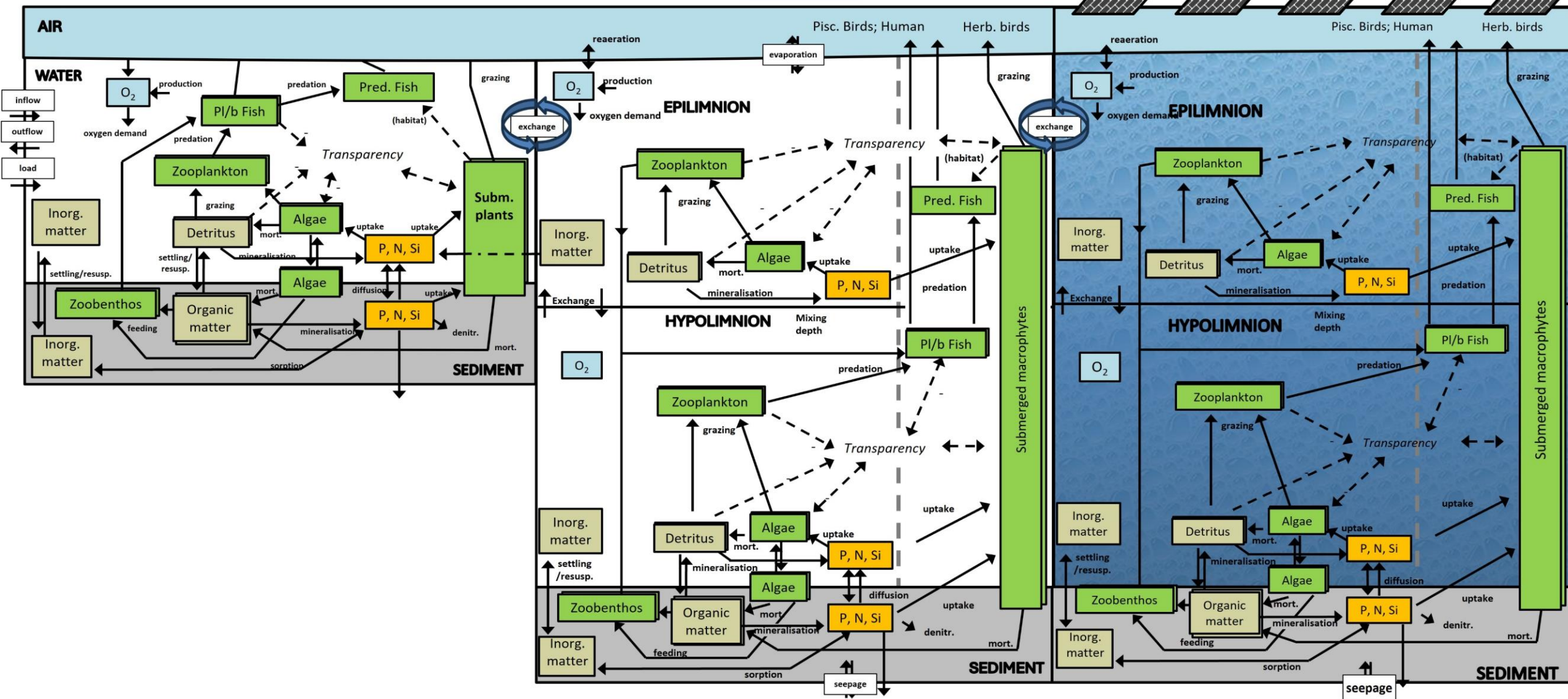
Change in processes

- PCLake+
- **Common model to compute eutrophication impacts**
 - Ecosystem state
 - Increased growth of organism (ie algal bloom or bacterial growth)
 - Oxygen depletion
- **Models most important biotic groups and their interrelations**
- **Takes into account stratification**
- **Models when the lake switches from clear to turbid state**
 - Without panels: Largely driven by the input of nutrients (P and N) to the ecosystem
 - With panels: compute effects of light reduction and mixing on all components
- **Broadly used by water managers – water framework directive**
- **Then possible to assess if floating solar is possible, and at which coverage**

Shallow part

Deep Part

PV system on deep part



Potential plant growth

Algal bloom
Reduction of O₂ deeper layer

Impact PV on water

SYSTEM ANALYSIS AT START

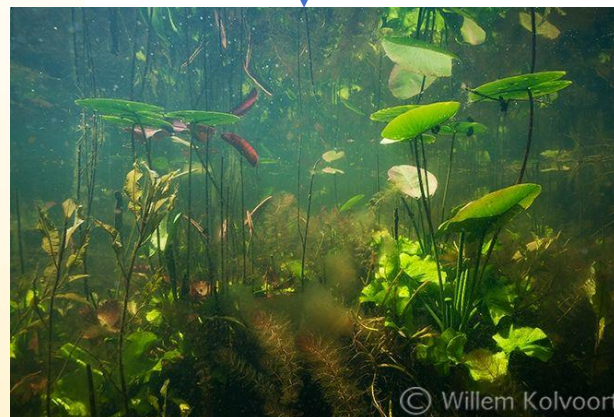
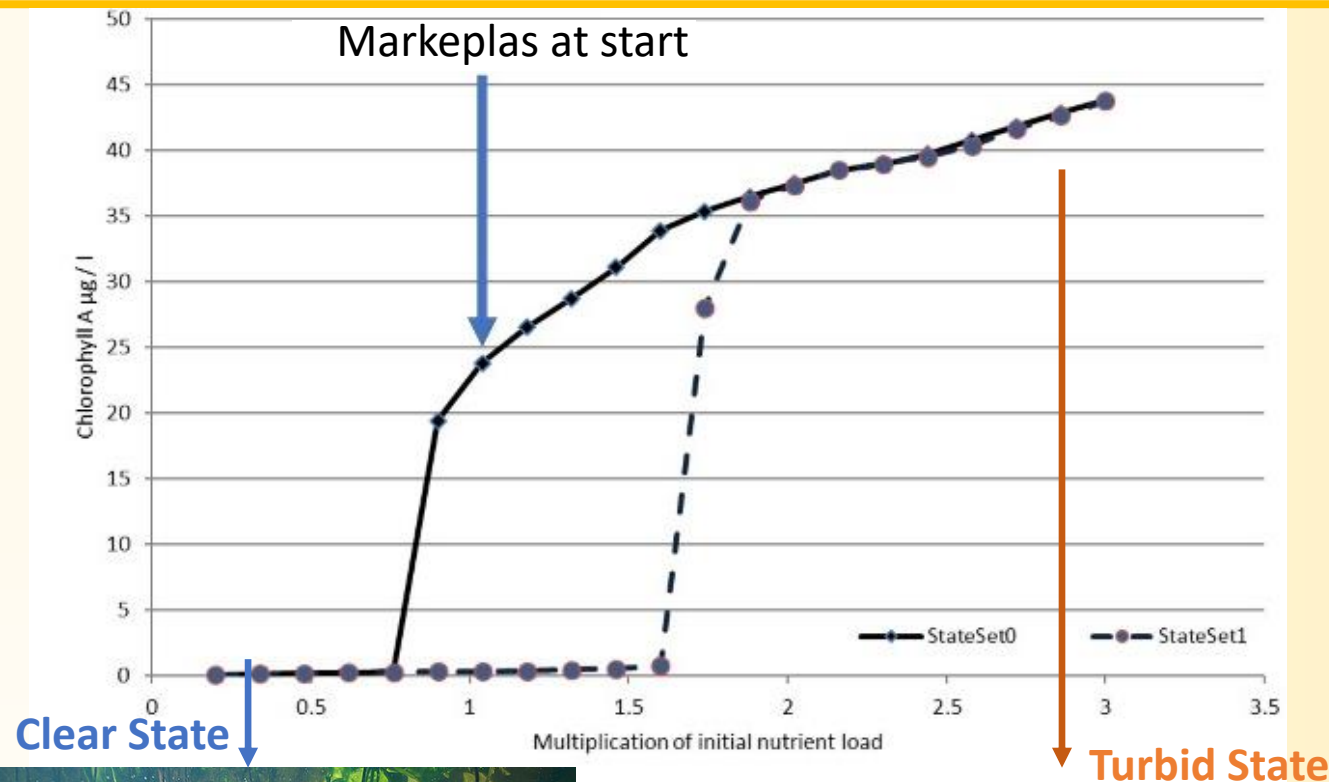
- **Water Flow Analysis**

- Location NOT connected to other water ways
- Strong influence drinking water company (ground water fluctuations)

- **Nutrient analysis**

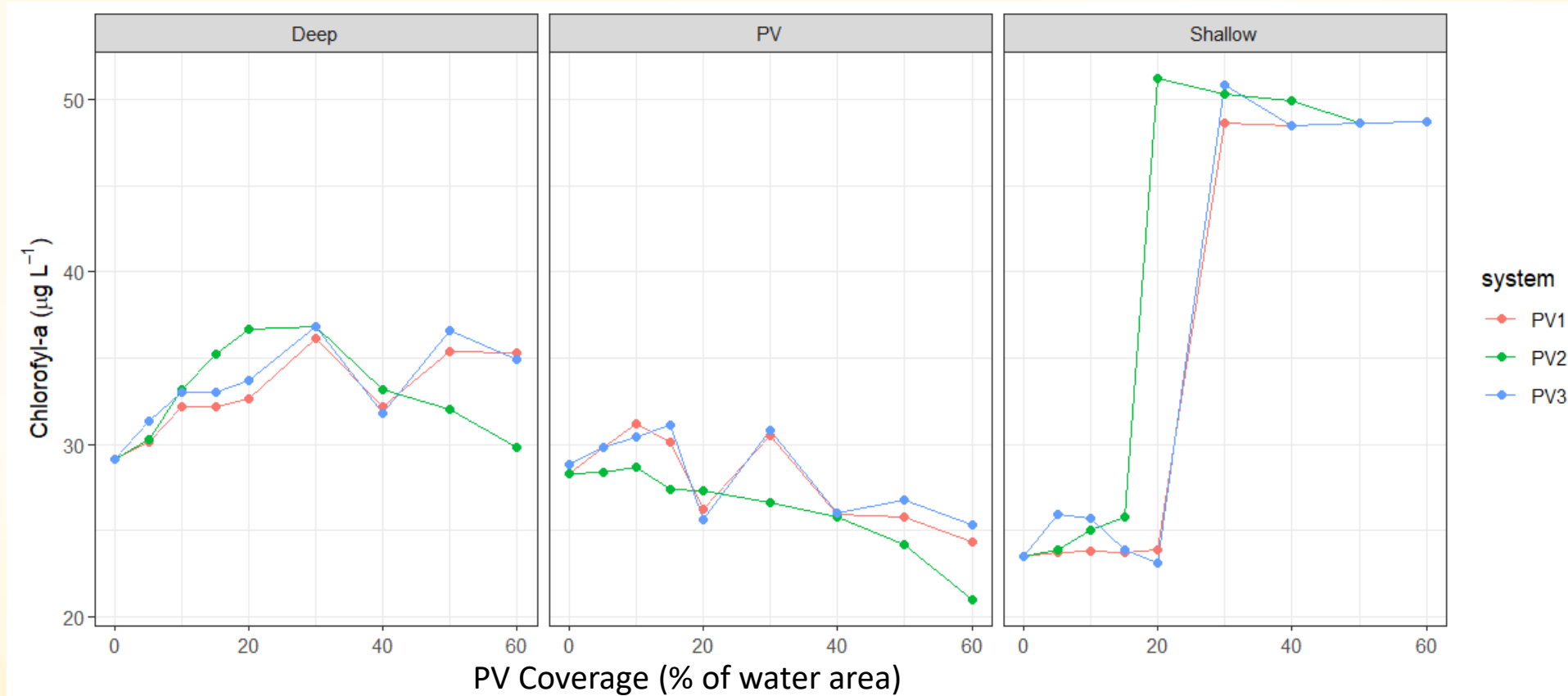
- N concentration high – high levels in ground water from agriculture

- Location Markeplas close to tipping point from clear to turbid

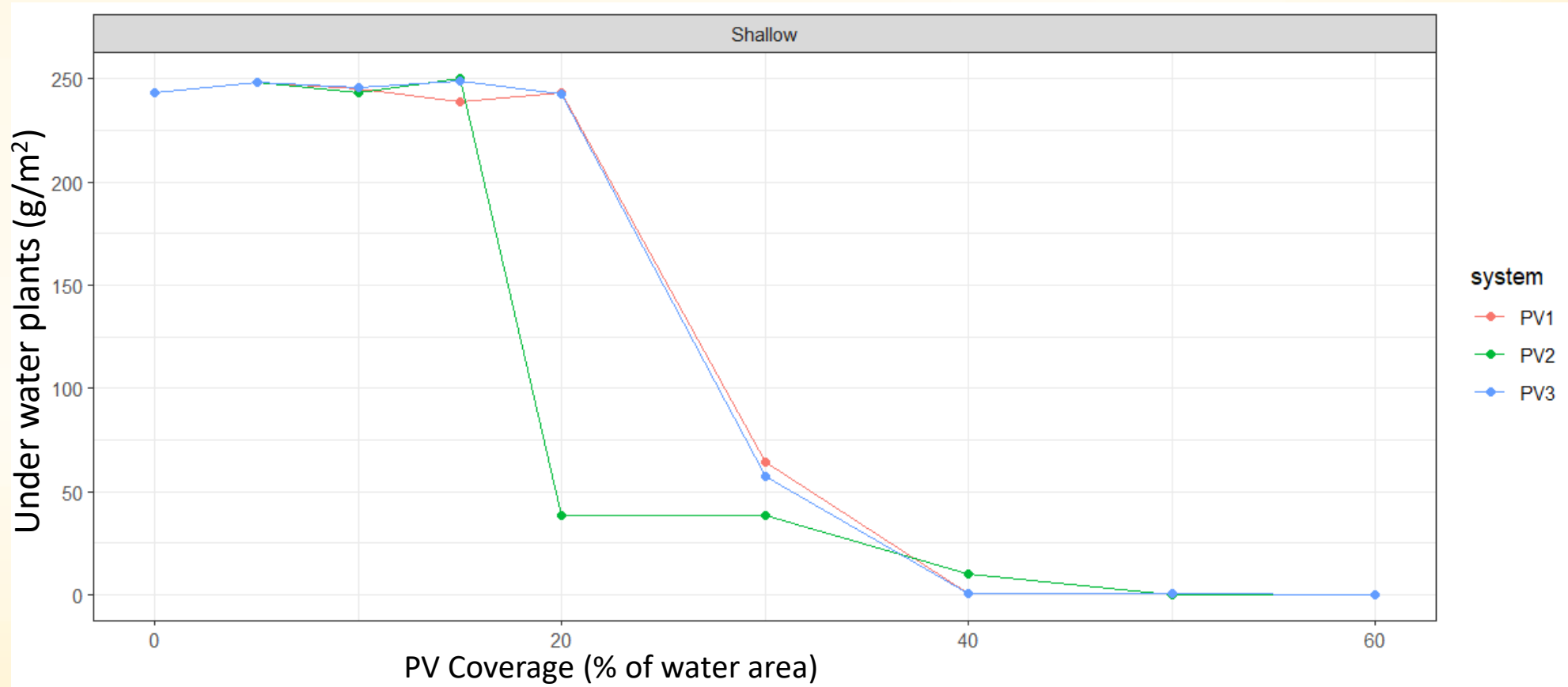


MODEL RESULTS

- With increasing coverage of PV
 - Chlorofyl-A increases in shallow part

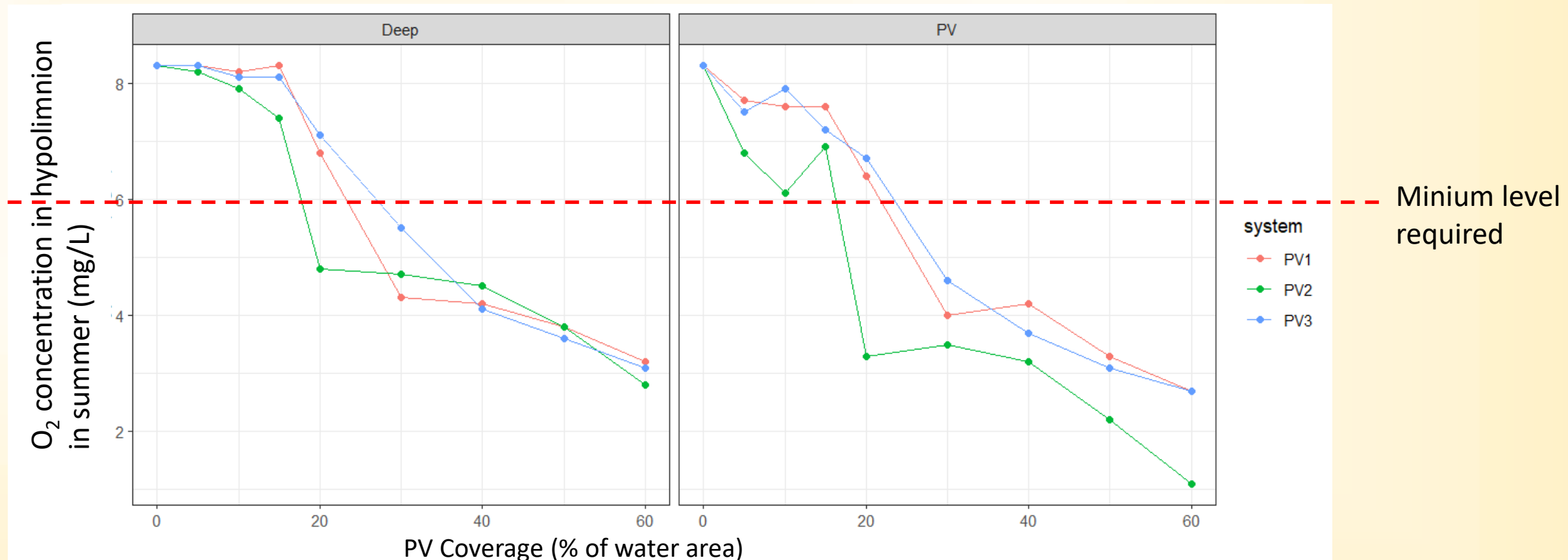


- **With increasing coverage of PV**
 - Corresponding drop in plant growth in shallow part



MODEL RESULTS

- **With increasing coverage of PV**
 - Drop in O₂ concentration in deep parts of the lake
 - Closed system (PV2) drops at lower coverage (less light)



- PCLake+ Model available
- Suitable for 'quick scan'
- Small PV systems already impact ecosystem processes
- Floating solar is safely possible
- Coverage location dependent
 - Water flows
 - Nutrient levels at start
- Data important
 - Multiple locations
 - Proper control
 - Not just value of 1 parameter, but process analysis important

If you have data, please contact us!

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