The future of algal blooms in lakes globally is in our hands

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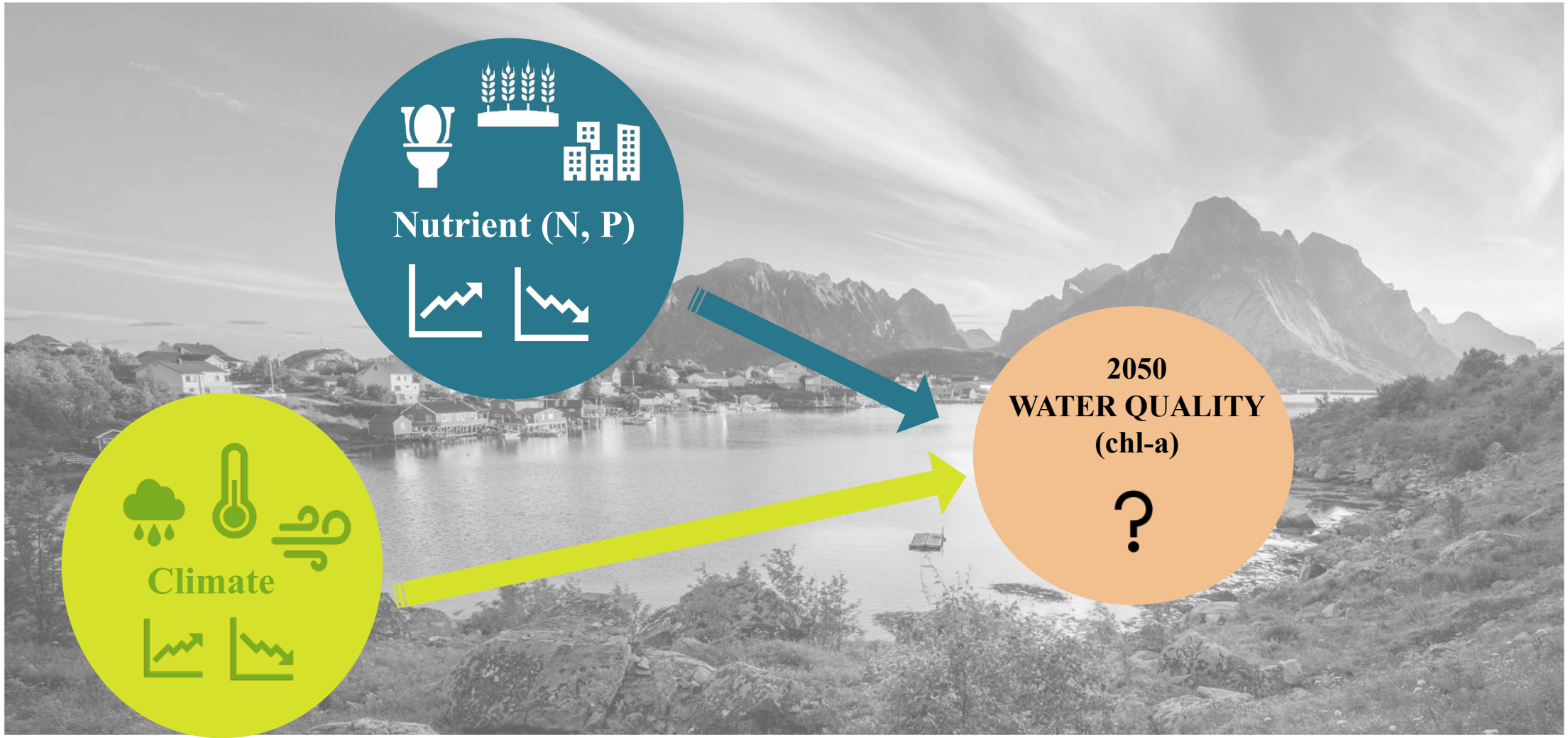
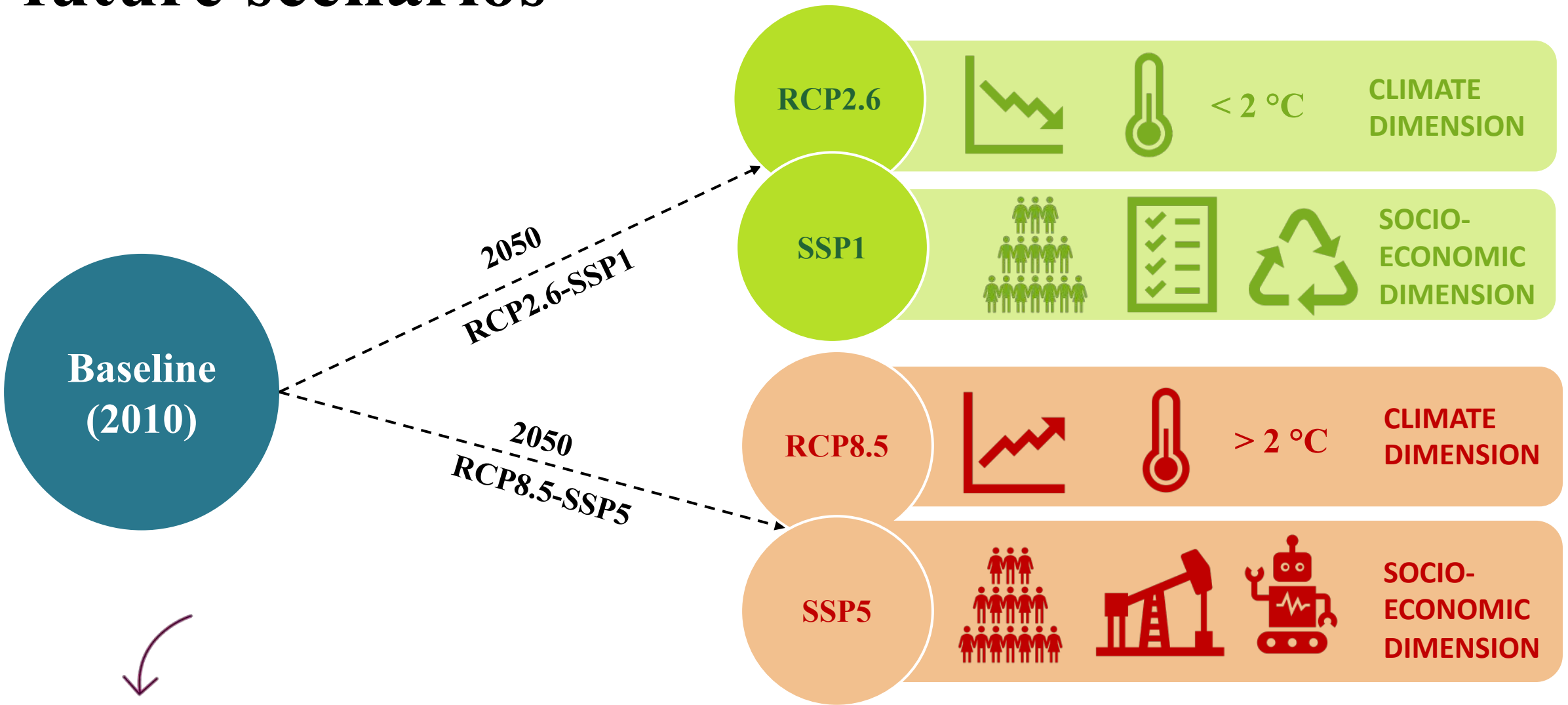
others involved: Jan Janse, Maryna Strokal

Problem description

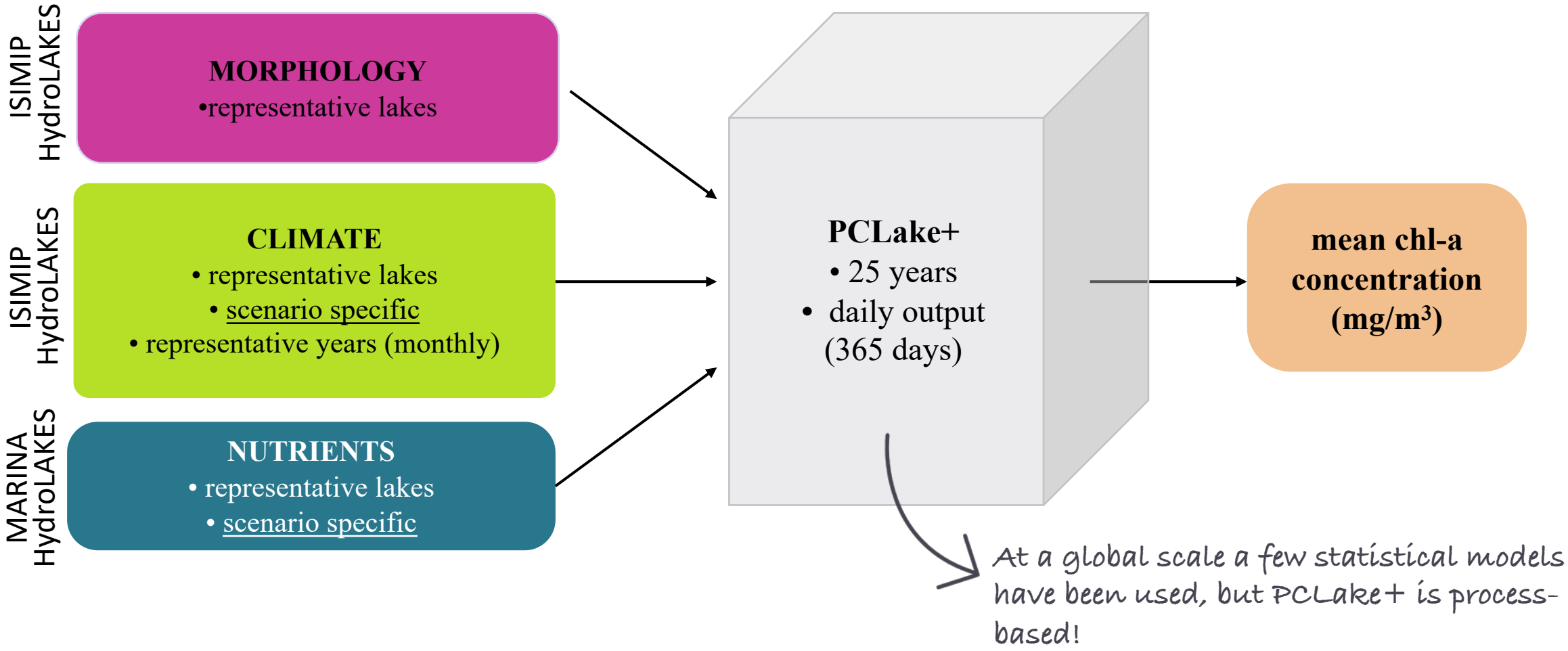


2 future scenarios



We purposely chose opposite scenarios, rather than "most likely" scenarios

Methodology



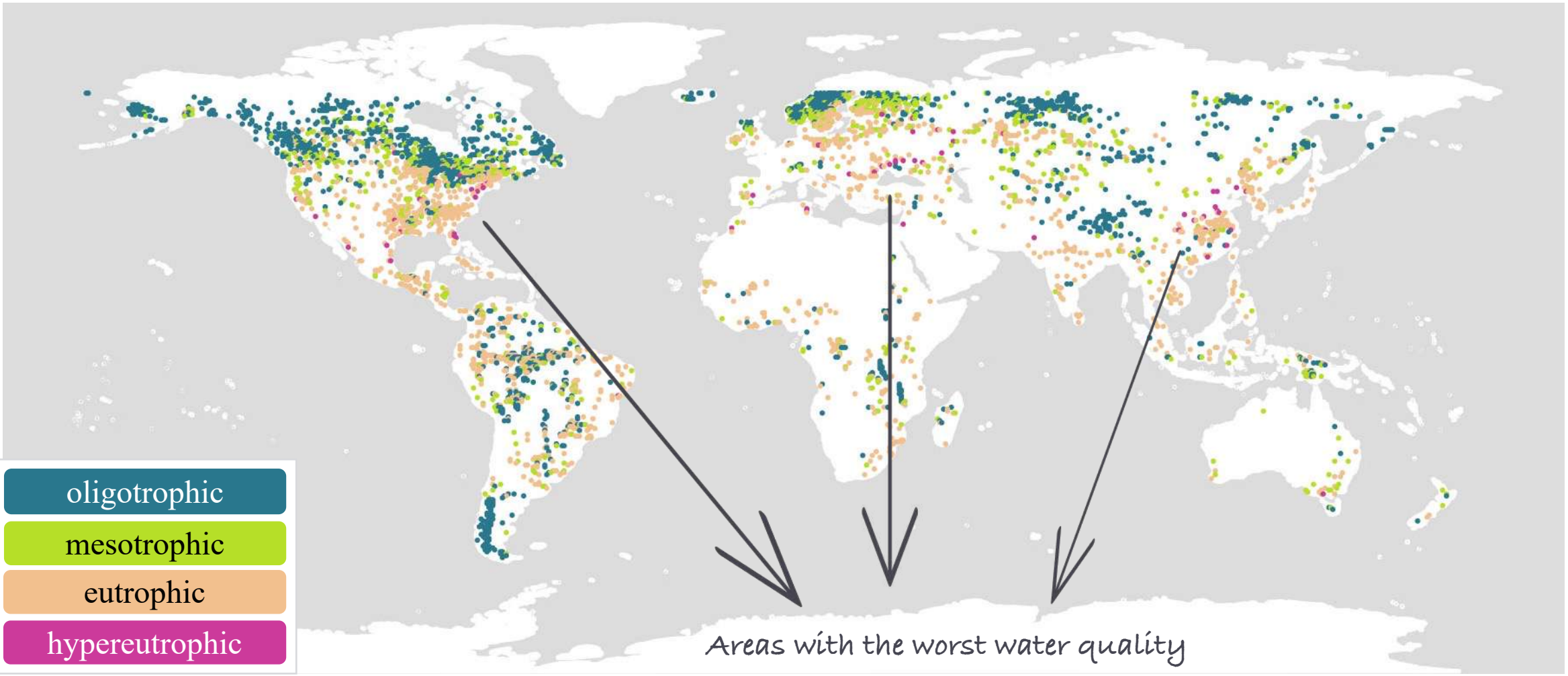
Results

To interpret the chlorophyll-a concentration we used the Trophic State Index (TSI) developed by Carlson (1977):

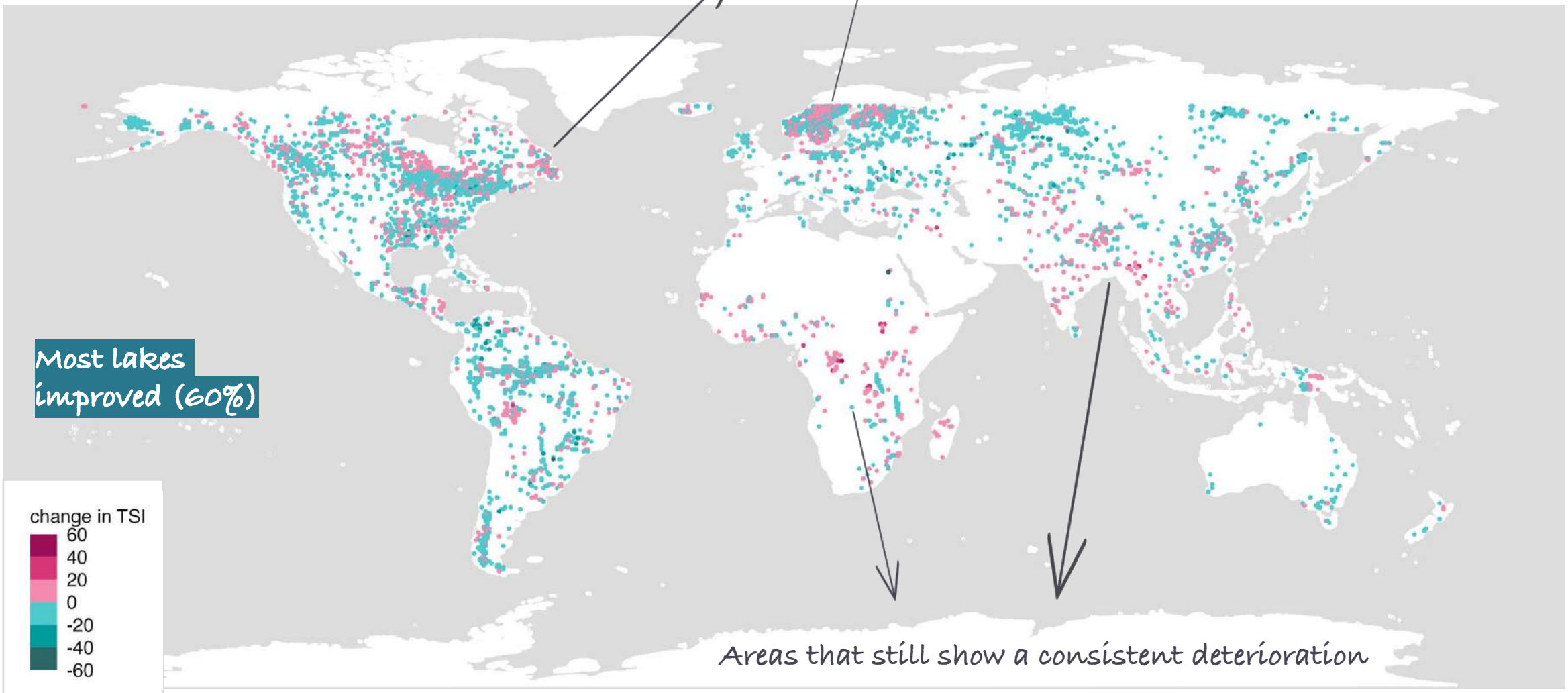
$9.81 \times \ln(\text{Chl-a}) + 30{,}6$

TSI	Chl-a (mg/m^3)	Category
<40	< 2.6	oligotrophic
40-50	2.6 – 7.3	mesotrophic
50-70	7.3 – 55.5	eutrophic
>70	> 55.5	hypereutrophic

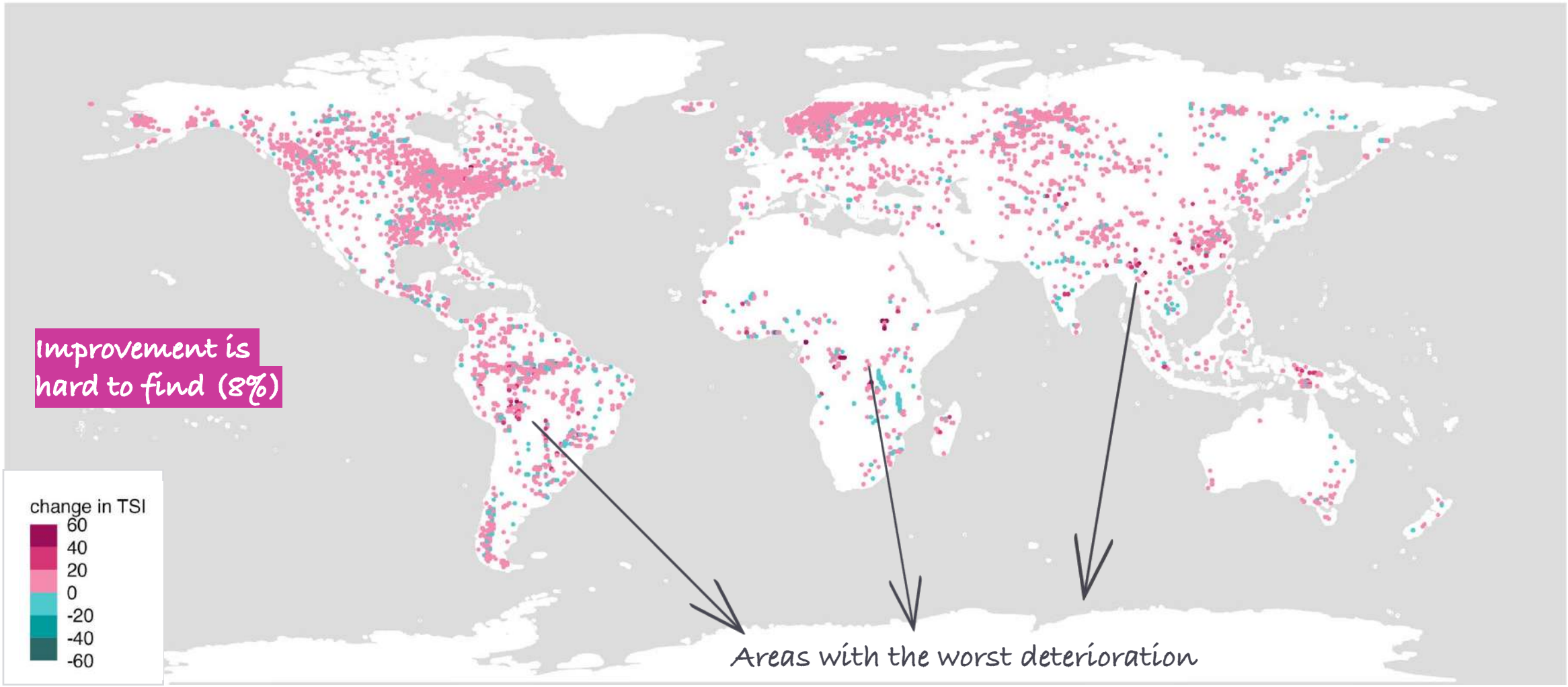
Baseline (2010)



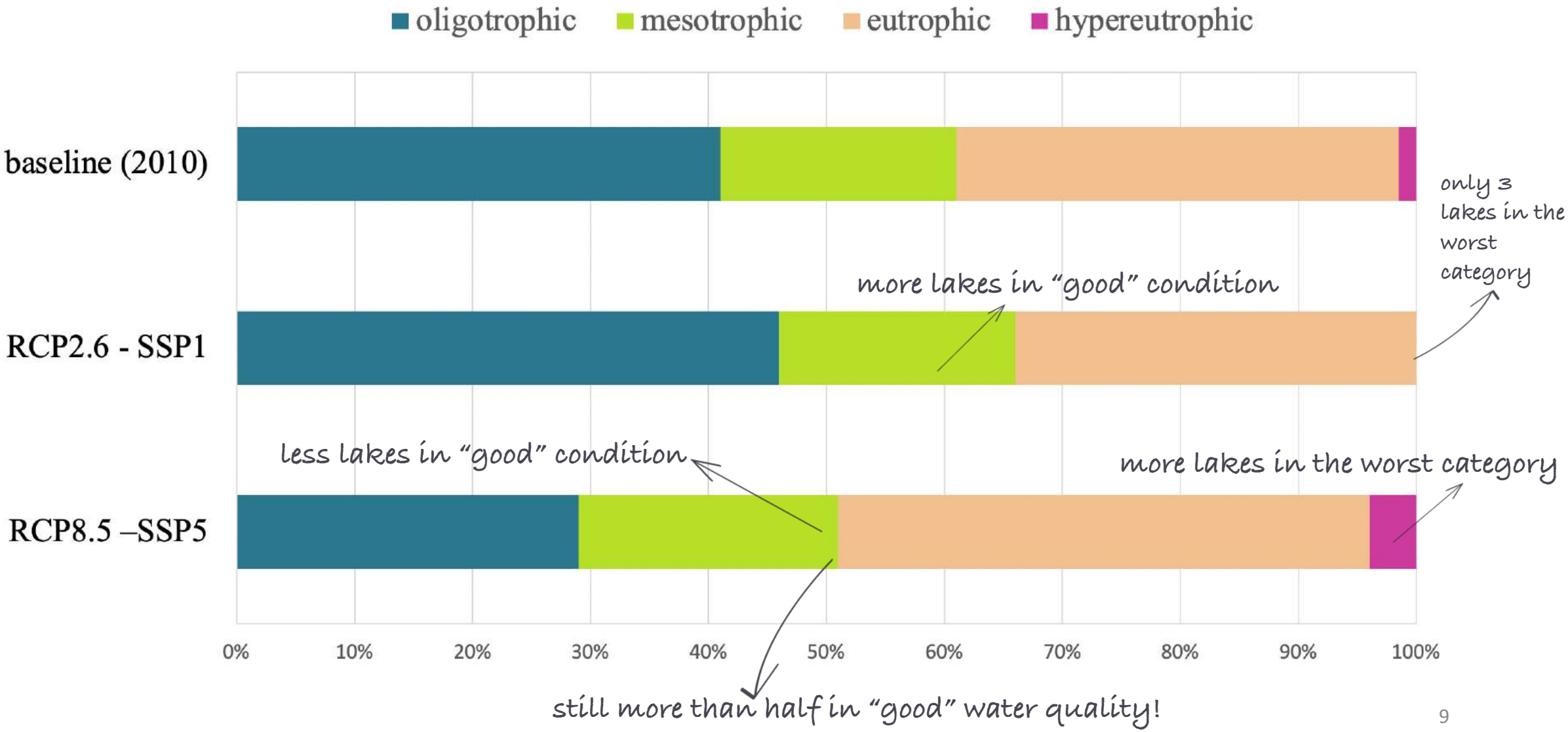
RCP2.6 – SSP1


Areas that still show some deterioration
Most lakes improved (60%)
change in TSI
60
40
20
0
-20
-40
-60
Areas that still show a consistent deterioration

RCP8.5 – SSP5


Improvement is hard to find (8%)
change in TSI
60
40
20
0
-20
-40
-60
Areas with the worst deterioration

Long story short



Climate vs. nutrients

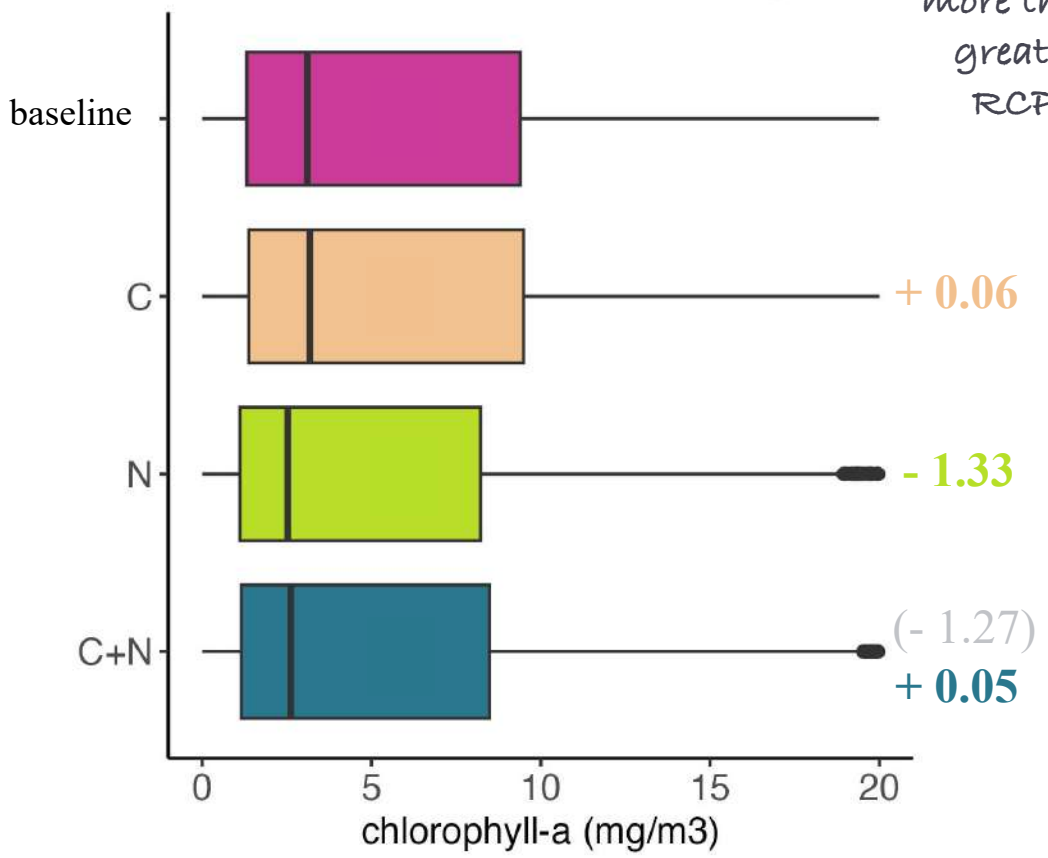
opposite effect

the combined effect increased the chl-a...

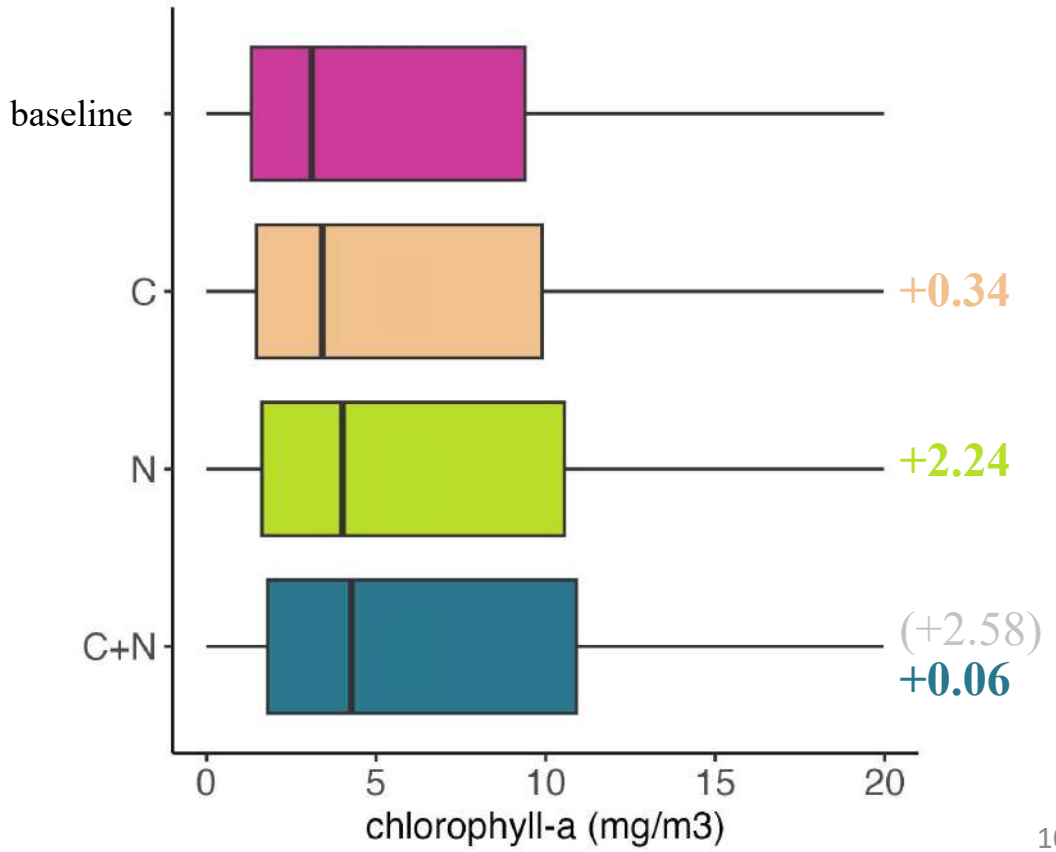
$$\Delta \text{Chla} = E(C) + E(N) + E(C+N)$$

more than 5x greater in RCP8.5

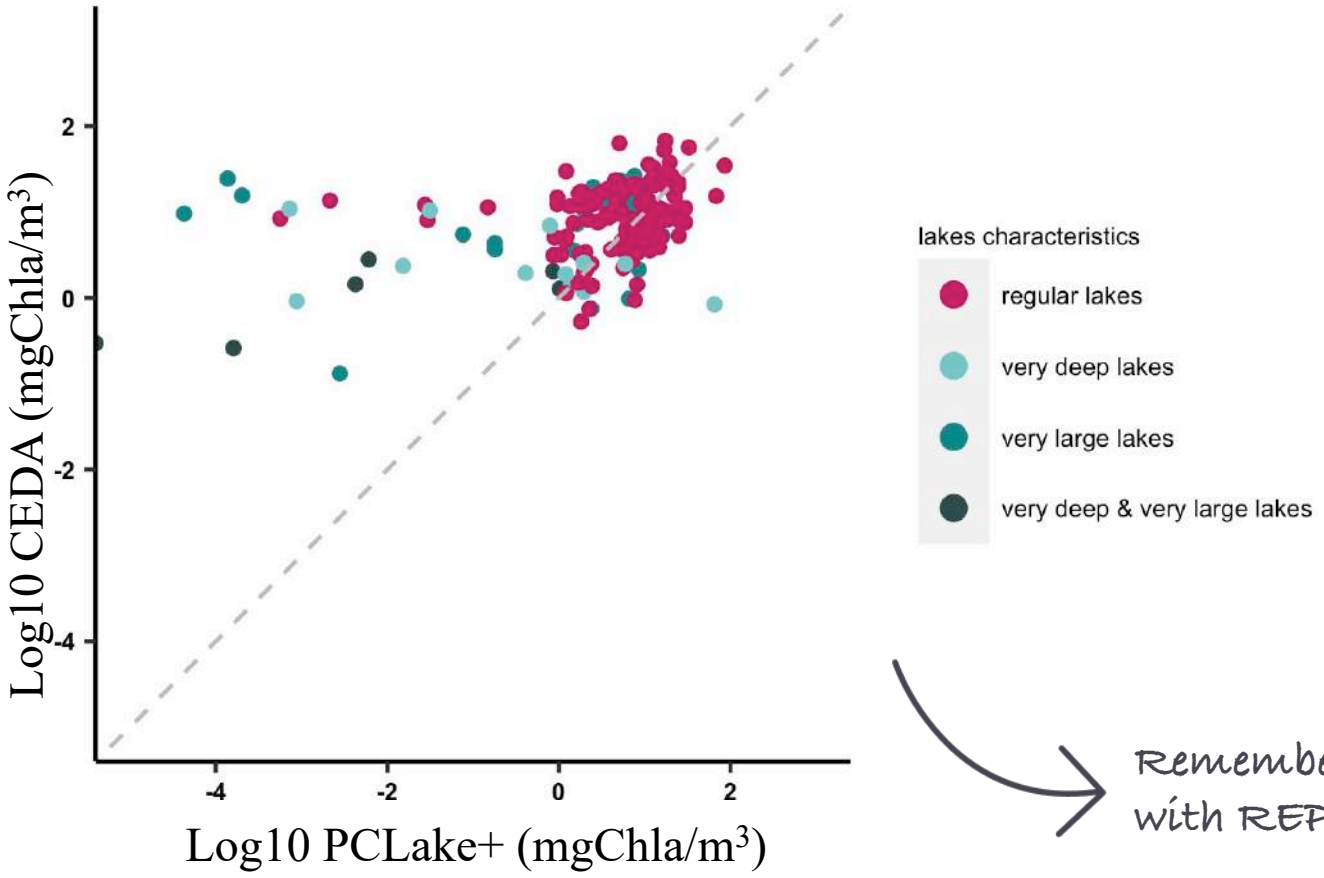
RCP2.6 – SSP1



RCP8.5 – SSP5



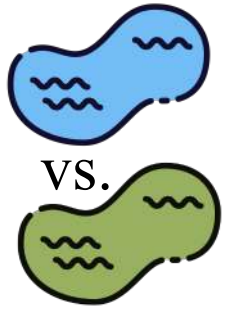
Validation (Satellite data)



- The model performed better with “regular lakes”.
- When we excluded the “very deep” and “very large” lakes. ***the narrative remained unvaried***.

Remember that this compares REAL lakes with REPRESENTATIVE lakes

Discussions

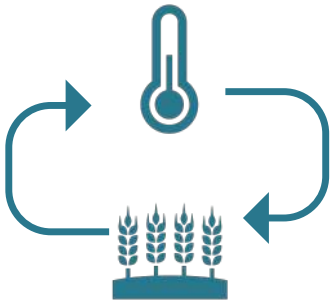


Janssen *et al.*, 2020

RCP2.6-SSP1 is preferred

Paerl & Huisman, 2008

The effect of climate: RCP8.5-SSP5 > RCP2.6-SSP1



Moss *et al.*, (2011)

The combined effect was "+"

Vuuren *et al.*, 2014

The effect of climate might be bigger in the future

Conclusions

- RCP2.6 – SSP1 resulted in an overall improvement in water quality. But it is not "evenly distributed".
- RCP8.5 –SSP5 resulted in further deterioration of the water quality.

*We can **impact** the state of lakes **significantly**, even in a relatively short period of time (i.e., 40 years). This should serve as motivation to **promote responsible climate and socio-economic policies.***

Opportunities for ISIMIP3?

ISIMIP 2b (this study)	ISIMIP 3 (Disney scenario)
Representative lakes	Real lakes
Basic water balance - *4000 (36.000 lakes of ISIMIP 2b were water balance limited by HydroLAKES)* - *Independent on scenario*	Water balance - *All lakes of ISIMIP 3* - *Scenario dependent*, daily or yearly* - *Ideally from the global water sector*
Nutrient balance - *Specific years (2010,2050)* - *Based on MARINA model*	Nutrient balance - *Based on various models* - *Yearly from 1661-2100* - *Scenario dependent**
Run with PCLake	Run with multiple WQ models

* scenarios
- Pre industrial (1860 soc, pi-control)
- Historical (2005soc, historic, historical, pi-control)
- Projections (2005 soc, rcp 8.5, rcp 6.0, rcp 6.0 with ewembi, rcp 2.6, pi-control)
- (extended projections)

Making a realistic shopping *list* for ISIMIP3

ISIMIP 3 (Disney scenario)	ISIMIP 3 (realistic list)
Real lakes	An 'offline' dataset for real lakes
Water balance - *All lakes of ISIMIP 3* - *Scenario dependent*, daily or yearly* - *Ideally from the global water sector*	How to get from grid to lake scale? - HydroLAKES = first-order estimate ~ 1950-2000 - Scale with gridded data global water sector? - Validation?
Nutrient balance - *Based on various models* - *Yearly from 1661-2100* - *Scenario dependent**	How to get from grid to lake scale? - Use nutrient input from the Water Quality Sector? - Use method Maddalena et al
Run with multiple WQ models	- What else do WQ models need?

General:
Who might be interested to join this effort?

Question to Global Water Sector:
What would be your suggestions to the lake sector to make this work?

Question to Water Quality Sector:
Which scenarios are available for which model and on what temporal scale to the lake sector?

Question to Lake Sector:
Is an 'offline' dataset with a water and nutrient balance sufficient to run your model?

Contact

- How do we want to get into contact?

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