Sofia La Fuente[1], R. Iestyn Woolway[2], Eleanor Jennings[1]
[1]Dundalk Institute of Technology, Centre for Freshwater and Environmental Studies
[2]School of Ocean Sciences, Bangor University, Menai Bridge, Anglesey, Wales

Global lake evaporation responses to climate change

EGU General Assembly 2022
Vienna 23rd - 27th May

@LFSofi8

Motivation

- Global lake evaporation plays an important role in the earth's water cycle.
- Accurate quantification of lake evaporation is crucial to understanding lake energy budgets, land-atmosphere interactions, as well as water availability.

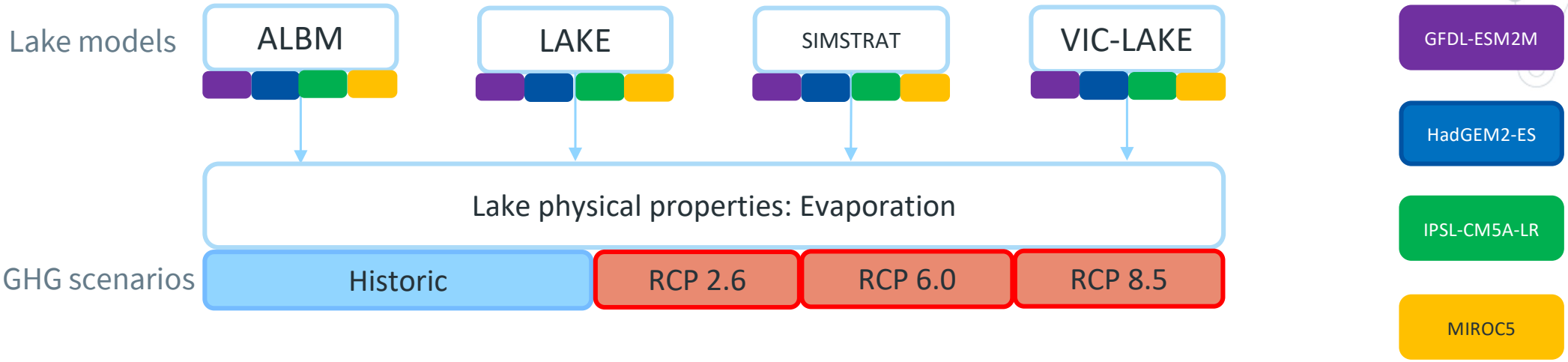
(Lenters et al. 2005; Friedrich et al. 2018; Zhao et al. 2020)

General objective

- Investigate global lake evaporation responses to climate change using an ensemble of 16 lake-climate models (4 lake models driven by 4 GCMs)

Data – Global lake ISIMIP2b

- Daily simulations of lake physical properties for **~17500 lakes**, with 0.5° by 0.5° spatial resolution.

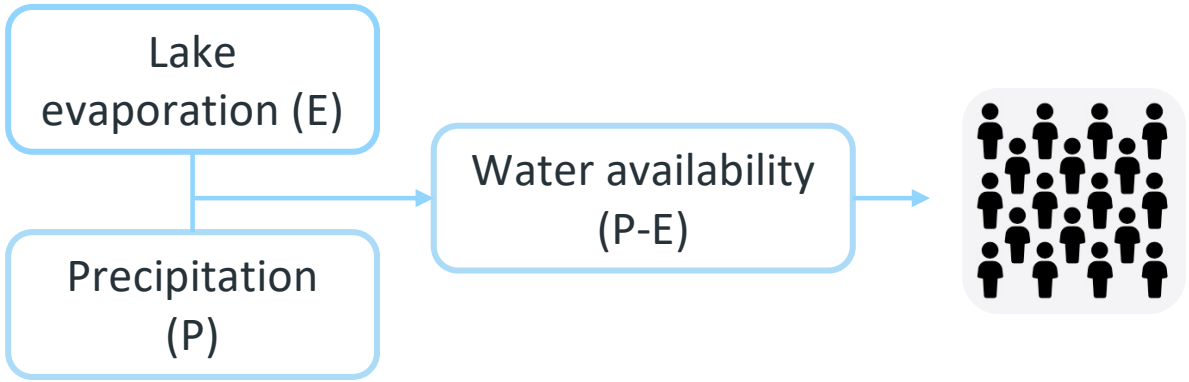


- Gridded Population of the World, version 4 (GPWv4) from the Center for International Earth Science Information Network (CIESIN)

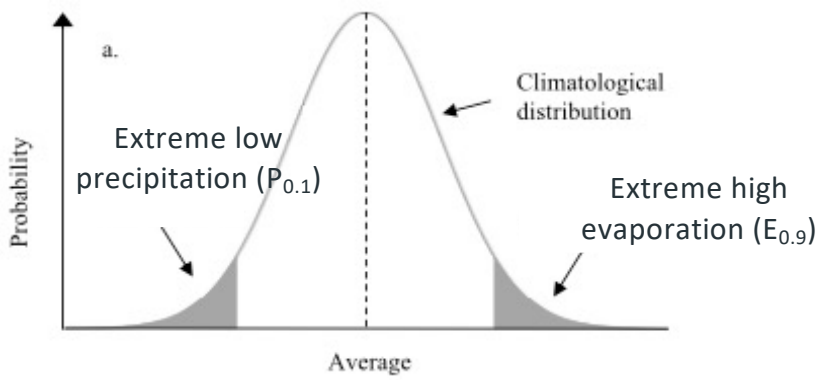
Data available at https://esg.pik-potsdam.de/search/isimip

Methodology

1. Long-term changes



2. Co-occurrence of extreme events



1970-1999

Likelihood Multiplication Factor (LMF)

$$LMF = \frac{f(Compound\ E_{0.9}\ \&\ P_{0.1})}{f(E_{0.9}) \times f(P_{0.1})}$$

$LMF > 1$ $E_{0.9}$ and $P_{0.1}$ are dependent, more likely to co-occur

$LMF < 1$ $E_{0.9}$ and $P_{0.1}$ are independent, less likely to co-occur

Zscheischler and Seneviratne (2017)
Woolway et al. (2021)

1. Long-term changes on average E and P

Global lake ΔE by the end of 21st century

(average 2070-2099 minus average 1970-1999)

9%

RCP 2.6

18%

RCP 6.0

28%

RCP 8.5

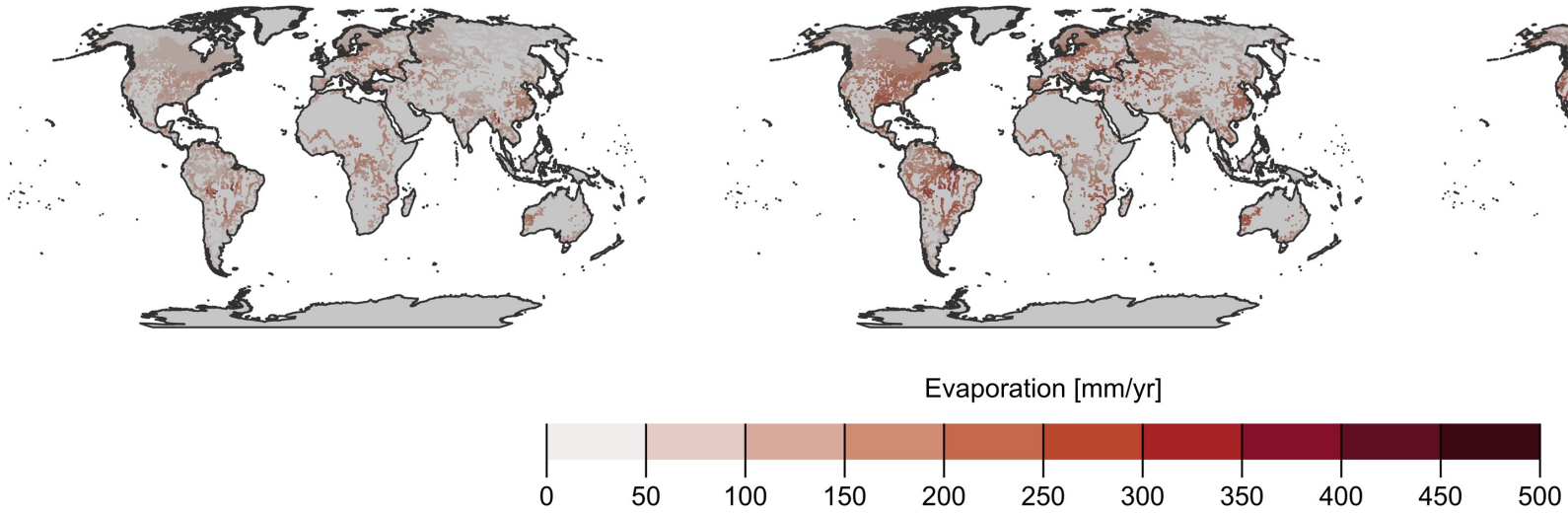
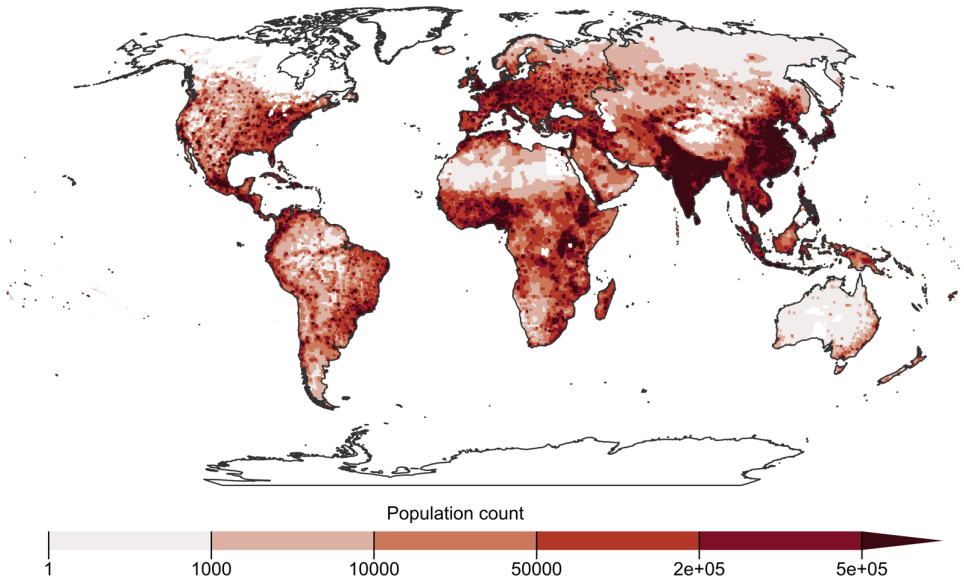


Figure 1.

Persistent increase in lake E across all lakes globally

Δ(P-E) effects on population (2070-2099)

- Future projections of Δ(P-E) indicate that there will be less water available in lakes globally, particularly in highly populated regions. These changes are likely to exacerbate water scarcity in various regions of the world.



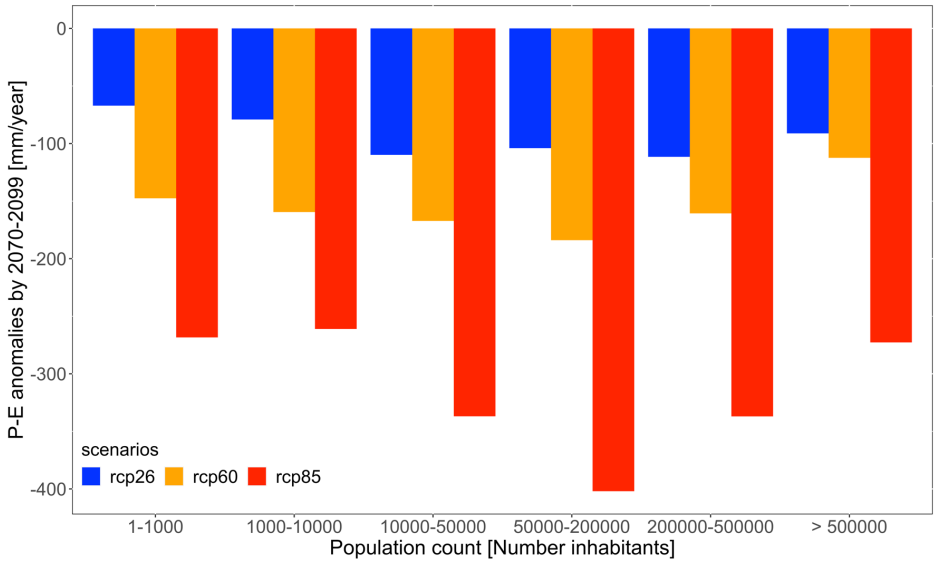


Figure 2.

2. Compound extreme high E and extreme low P events in global lakes

$E_{0.9}$ exceedance in the 20th and 21st century

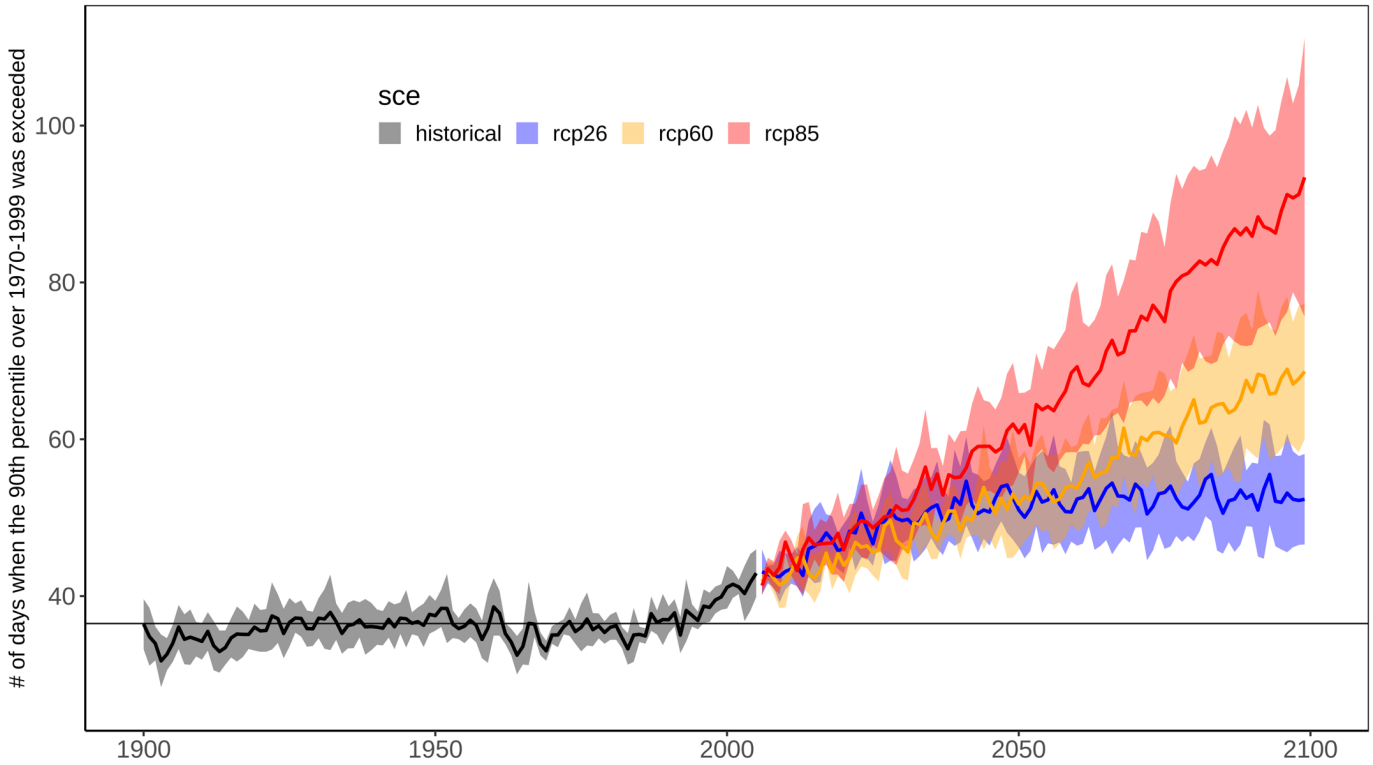


Figure 3.

Scenario	Exceedance [days]	Increase [%]
Historical	37	-
RCP 2.6	53	123
RCP 6.0	64	175
RCP 8.5	83	227

Under scenarios of climate change all models projected that lakes will experience more extreme evaporation globally.

Preliminary conclusions

- All models projected an increase in lake E, meaning that water availability in lakes will be negatively affected under scenarios of climate change.
- The occurrence of extreme values of lake E is projected to increase, indicating that towards the end of this century more lakes will experience extreme evaporation.
- Increasing population and decreasing water availability in lakes will further exacerbate the existing water scarcity in many regions of the world.

Acknowledgements

This project is funded by the Irish HEA Landscape programme and DkIT Research Office. RIW was funded by a UKRI Natural Environment Research Council (NERC) Independent Research Fellowship [grant number NE/T011246/1]. For their roles in producing, coordinating, and making available the ISIMIP climate simulations, we acknowledge the support of the ISIMIP cross sectoral science team.

@LFSofi8 ruthsofia.lafuentepillco@dkit.ie