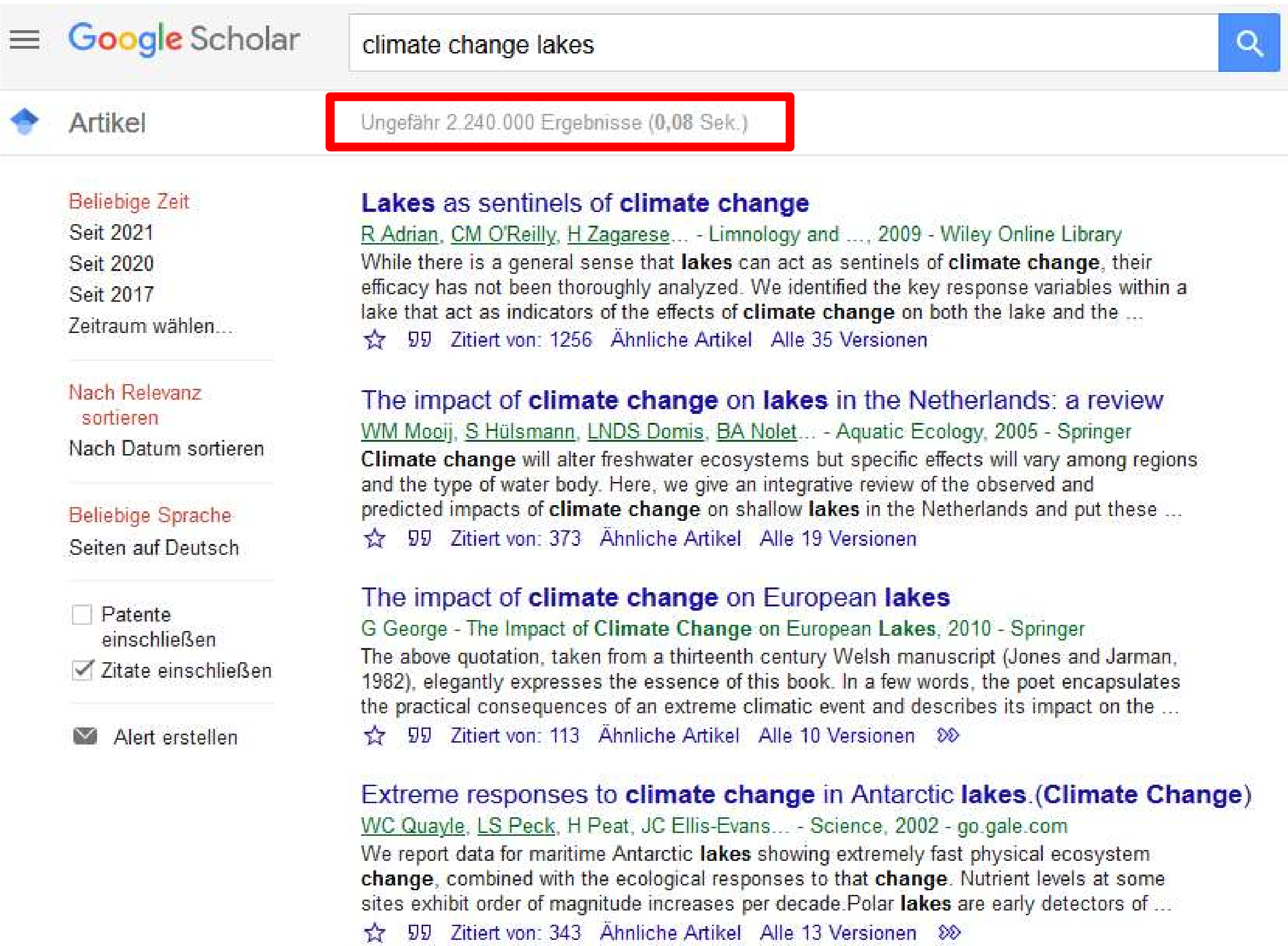
Online Seminar: Gewässer, Seen und Feuchtgebiete im Klimastress

Research on Climate Change and Lakes - International Context

Are we moving forward?

Dr. Marlene Bär Lamas

What is known and how is progress being made?



Hydrological Sciences–Journal

A review of the potential in water quality

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Wetlands Ecol Manage (2009) 17:71–
DOI 10.1007/s11273-008-9119-1

ORIGINAL PAPER

The vulnerability of lak an altitudinal gradient

Love Råman Vinnå [1✉], Iselin Medhaug [2], Ma

Studies of future 21st century climate warming in lakes al partially obscured by local atmospheric phenomena unre forced the physical lake model Simstrat with locally dowr future scenarios to investigate the i tudinal gradient. Results from the w

Limnol. Oceanogr., 54(6, part 2), 2009, 2283–2297

Lakes as sentinels of climate change

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Wetlands and global climate change: the r restoration in a changing world

Aquatic Ecology (2005) 39:381–400
DOI 10.1007/s10452-005-9008-0

The impact of climate change on lakes in the Netherlands: a review

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Received 21 April 2004; accepted

Key words: Biodiversity, Transparency

Abstract

Climate change will alter fr water body. Here, we give a shallow lakes in the Netherl are man-made and have pre these ecosystems are temper

Global lake responses to climate change

R. Iestyn Woolway [1,2✉], Benjamin M. Kraemer [3,11], John D. Lenters [4,5,6,11], Christopher J. Merchant [7,8,11], Catherine M. O'Reilly [9,11] and Sapna Sharma [10,11]

Abstract | Climate change is one of the most severe threats to global lake ecosystems. Lake surface conditions, such as ice cover, surface temperature, evaporation and water level, respond dramatically to this threat, as observed in recent decades. In this Review, we discuss physical lake variables and their responses to climate change. Decreases in winter ice cover and increases in lake surface temperature modify lake mixing regimes and accelerate lake evaporation. Where not balanced by increased mean precipitation or inflow, higher evaporation rates will favour a decrease in lake level and surface water extent. Together with increases in extreme-precipitation events, these lake responses will impact lake ecosystems, changing water quantity and quality, food provisioning, recreational opportunities and transportation. Future research opportunities, including enhanced observation of lake variables from space (particularly for small water bodies), improved in situ lake monitoring and the development of advanced modelling techniques to predict lake processes, will improve our global understanding of lake responses to a changing climate.

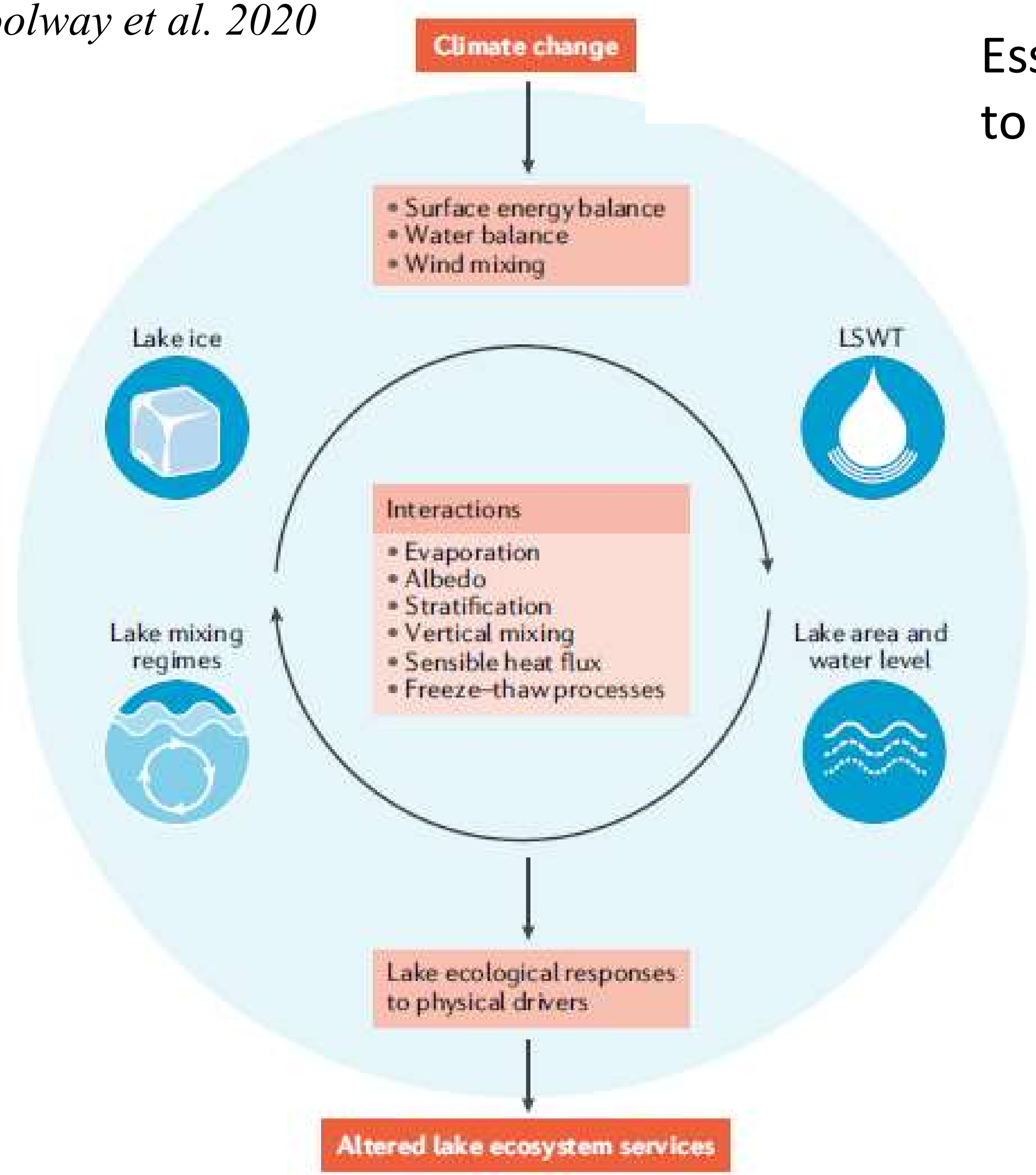
nature ecology & evolution
ARTICLES
https://doi.org/10.1038/s41559-017-0407-

Homogenization of lake cyanobacterial communities over a century of climate change and eutrophication

Marie-Eve Monchamp [1,2*], Piet Spaak [1,2], Isabelle Domaizon [3], Nathalie Dubois [4,5], Damien Bouffard [6] and Francesco Pomati [1,2*]

Human impacts on biodiversity are well recognized, but uncertainties remain regarding patterns of diversity change at differ spatial and temporal scales. Changes in microbial assemblages are, in particular, not well understood, partly due to the lac community composition data over relevant scales of space and time. Here, we investigate biodiversity patterns in cyanob terial assemblages over one century of eutrophication and climate change by sequencing DNA preserved in the sediment ten European peri-Alpine lakes. We found species losses and gains at the lake scale, while species richness increased at regional scale over approximately the past 100 years. Our data show a clear signal for beta diversity loss, with the composit and phylogenetic structure of assemblages becoming more similar across sites in the most recent decades, as have the gen

Woolway et al. 2020



nature reviews earth & environment

Essential physical lake variables, their response to climate change and their interaction

e.g. decreasing ice cover, increasing water temperature and altered lake mixing regimes

↓

evaporation rates

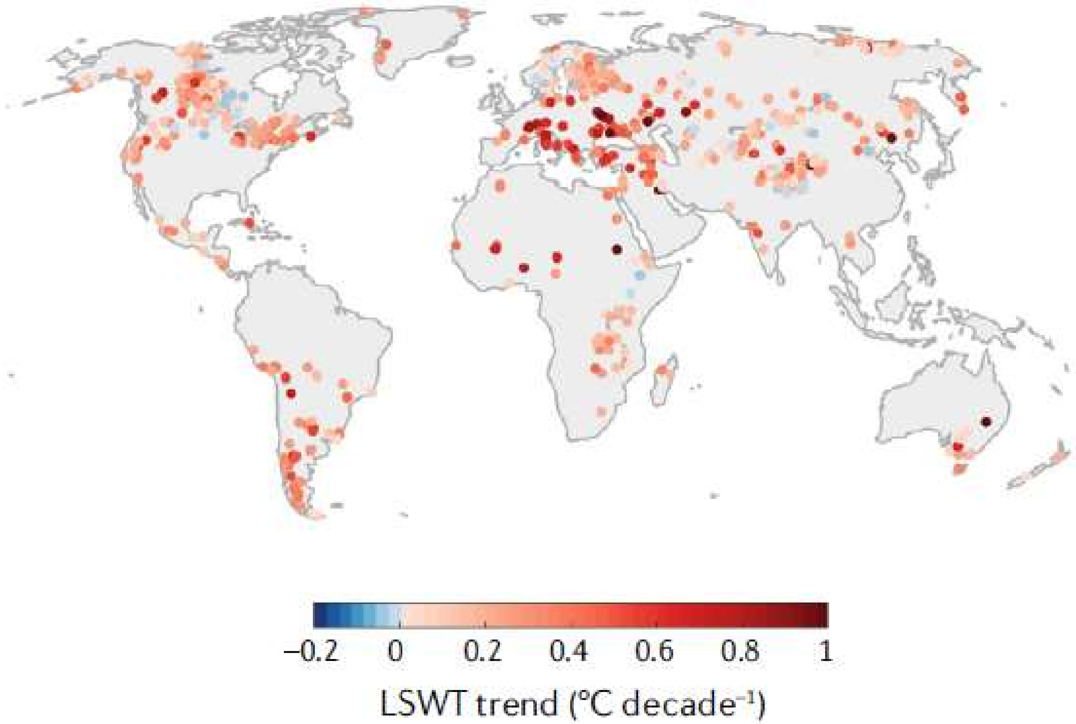
↓

lake water levels and extent

LSWT: lake surface water temperature

Lake surface water temperatures (LSWT) have increased worldwide

Global average rate= 0.34 °C decade^{-1}



MULTIPLE FEEDBACKS IN THE SURFACE ENERGY

- ❑ Amount of incoming radiation
- ❑ The advection and storage of heat within the lake
- ❑ The proportion of solar irradiance absorbed at the lake surface (albedo)
- ❑ Loss of heat at the air–water interface

Woolway et al. 2020

These drivers are affected by many climatic variables, including cloud cover, over-lake wind speed, atmospheric humidity and air temperature & LSWT and ice cover

Lakes are experiencing less ice cover


Photo: Pexels

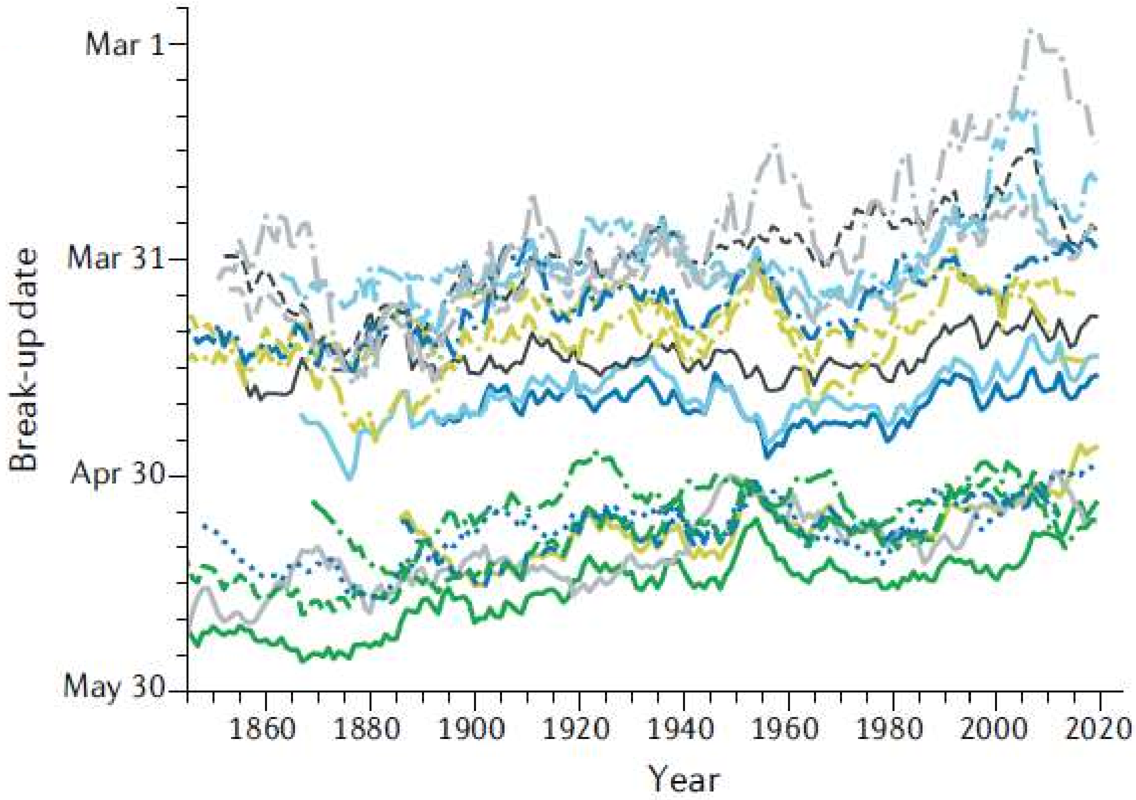
More than 100,000 lakes at risk of having ice- free winters if air temperatures increase by 4 °C

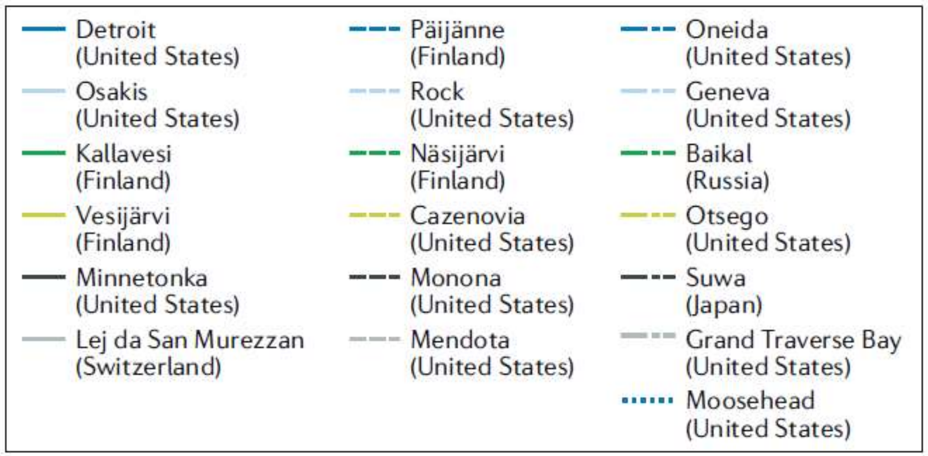
Ice duration has become 28 days shorter on average over the past 150 years for Northern Hemisphere lakes

Higher rates of change in recent decades.

Magnuson et al. (2000) calculated trends in ice freeze dates, ice break-up dates and ice duration from ~1855 to 1995 for 20 lakes in the Northern Hemisphere.

Woolway et al. (2020) updated the ice phenology records by an additional 24 years, to 2019





ice duration is now 19 days shorter per century on average

Increase of global annual mean lake evaporation rates

increase of 16% is expected by 2100

INTERNATIONAL JOURNAL OF REMOTE SENSING
2020, VOL. 41, NO. 14, 5321–5337
https://doi.org/10.1080/01431161.2020.1739354
Taylor & Francis

Evaporation rates in a vital lake: a 34-year assessment for the Karaoun Lake

Mario Mhawej, Ali Fadel and Ghaleb Faour

Theor. Appl. Climatol. 79, 11–21 (2004)
DOI 10.1007/s00704-004-0059-2
Theoretical and Applied Climatology
Printed in Austria

Evaporation tre…

E. T. Linacre

nature geoscience
ARTICLES
https://doi.org/10.1038/s41561-018-0114-8

Global lake evaporation accelerated by changes in surface energy allocation in a warmer climate

Wei Wang[1,2,5], Xuhui Lee[1,3]*, Wei Xiao[1,2,5], Shoudong Liu[1,2], Natalie Schultz[3], Yongwei Wang[1,2], Mi Zhang[1,2] and Lei Zhao[1,4]

Lake evaporation is a sensitive indicator of the hydrological response to climate change. Variability in annual lake evaporation has been assumed to be controlled primarily by the incoming surface solar radiation. Here we report simulations with a numerical model of lake surface fluxes, with input data based on a high-emissions climate change scenario (Representative Concentration Pathway 8.5). In our simulations, the global annual lake evaporation increases by 16% by the end of the century, despite little change in incoming solar radiation at the surface. We attribute about half of this projected increase to two effects: periods of ice cover are shorter in a warmer climate and the ratio of sensible to latent heat flux decreases, thus channelling more energy into evaporation. At low latitudes, annual lake evaporation is further enhanced because the lake surface warms more slowly than the air, leading to more long-wave radiation energy available for evaporation. We suggest that an analogous change in the ratio of sensible to latent heat fluxes in the open ocean can help to explain some of the spread among climate models in terms of their sensitivity of precipitation to warming. We conclude that an accurate prediction of the energy balance at the Earth's surface is crucial for evaluating the hydrological response to climate change.

In the climate system, lakes represent wet surfaces at which evaporation is controlled only by atmospheric conditions[1,2] and is therefore highly sensitive to climate change[3]. Current understanding of the influence of climate variability on annual lake evaporation E is that E is primarily limited by incoming surface solar radiation[4] ($K_\downarrow$), a view supported by the close relationship between pan … a negative feedback on E. These mechanisms are fundamentally different from those involved in pan evaporation.

Here we hypothesize that the changes in surface energy allocation are a key driver of the response of lake E to rising temperatures. We test this hypothesis using a lake simulator forced with the Representative Concentration Pathway (RCP) 8.5 climate warming …

Theor Appl Climatol
DOI 10.1007/s00704-016-1768-z
ORIGINAL PAPER

Trends in evaporation of a large subtropical lake

Cheng Hu[1,2] · Yongwei Wang[1] · Wei Wang[1] · Shoudong Liu[1] · Meihua Piao[1,3] · Wei Xiao[1] · Xuhui Lee[1,4]

Received: 9 June 2015 / Accepted: 5 March 2016

Abstract How rising temperature and changing solar radiation affect evaporation of natural water bodies remains poorly understood. In this study, evaporation from Lake Taihu, a large (area 2400 km²) freshwater lake in the Yangtze River Delta, China, was simulated by the CLM4-LISSS offline lake model and estimated with pan evaporation data. Both methods were calibrated against lake evaporation measured directly with eddy covariance in 2012. Results show a significant increasing trend of annual lake evaporation from 1979 to 2013, at a rate of 29.6 mm decade⁻¹ according to the lake model and 25.4 mm decade⁻¹ according to the pan method. The mean annual evaporation during this period shows good agreement between these two methods (977 mm according to the model and 1007 mm according to the pan method). A stepwise linear regression reveals that downward shortwave radiation was the most significant contributor to the modeled evaporation trend, while air temperature was the most significant contributor to the pan evaporation trend. Wind speed had little impact on the modeled lake evaporation but had a negative contribution to … effect. Reference evaporation was not a good … lake evaporation because it was on average 20.6 … and its increasing trend was too large (56.5 mm d…

1 Introduction

There are 304 billion lakes in the world, occupying … 3 % of the continental land surface (Downing … Evaporation from these lakes plays a vital role i… energy distribution and the hydrological cycle (T… 2004; Fu et al. 2004; Subin et al. 2012a; Rong … There are several methods for quantifying lake e… The water balance method determines the lake … from precipitation and the amounts of water that … out of the lake. The energy balance method deriv… oration rate by distributing the available energy … heat and latent heat fluxes (Rosenberry et al. 19… et al. 1995; Rosenberry et al. 2007; Elsawwaf e…

Regional variations dependent on factors such as ice cover, stratification, wind speed and solar radiation.

Implications for lake ecosystems

Climate change has unquestionably altered lakes worldwide

Changes in water quality

increases in phytoplankton biomass and shifts in community composition

Increased cyanobacteria populations and greater toxin production

Increases in chlorophyll and cyanobacteria are also often associated with a lowering of water level

shifts from clear to turbid waters

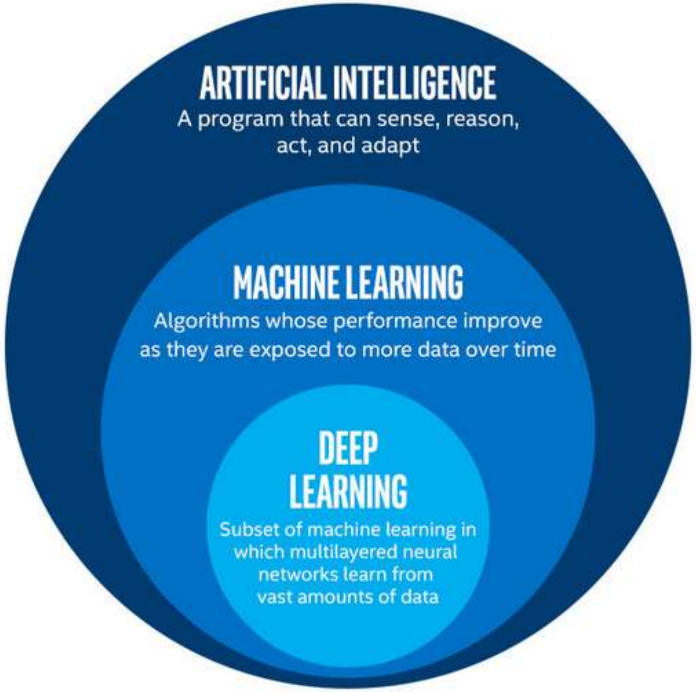
Increased stratification results in declines in algal biomass

which adversely impact fish yields

The scientific literature addresses in detail only a small proportion of lakes worldwide

Need to have sustainable, systematic, multivariate observations for a consistent set of lakes.

European Space Agency (ESA) Climate Change Initiative for Lakes (CCI Lakes), coordinates a range of remote-sensing techniques



New modelling paradigm

PROCESS-GUIDED DEEP LEARNING

(aims to integrate process understanding from lake models into advanced machine-learning modelling techniques)

should provide substantial improvements to our ability to predict lake responses to climate change

Future research, including

- ✓ enhanced observation of lake variables from space
- ✓ improved in situ lake monitoring and the
- ✓ development of advanced modelling techniques to predict lake processes,

will improve our global understanding of lake responses to a changing climate

and our capacity to react to these changes

Laguna de los tres - Patagonia Argentina
Photo: Pixabay

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