Climate change and ecological assessment in Europe – using remote sensing and climate data to contextualize change

7th LAKES Workshop / 20-21-22 November / Milan

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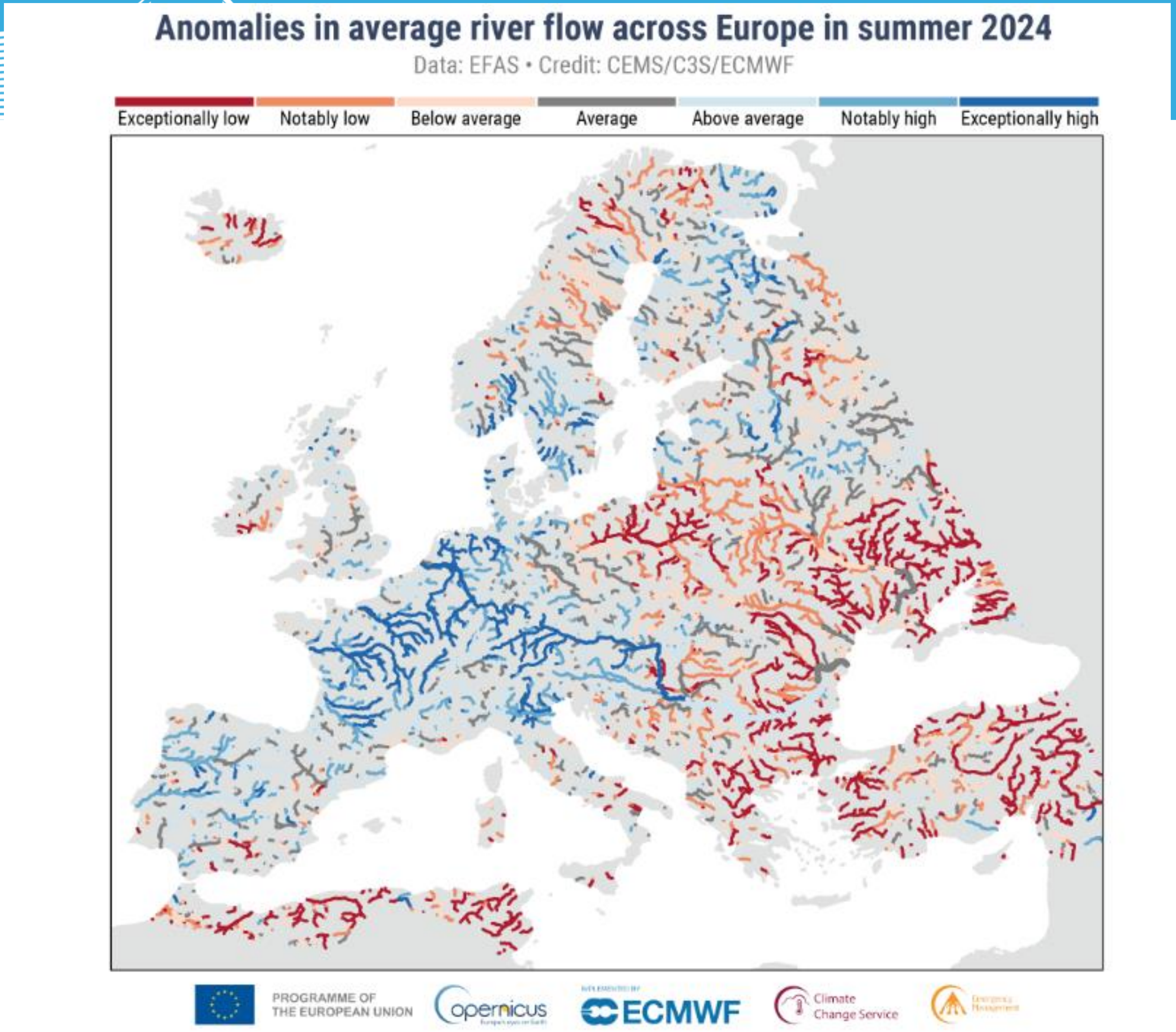
Copernicus:

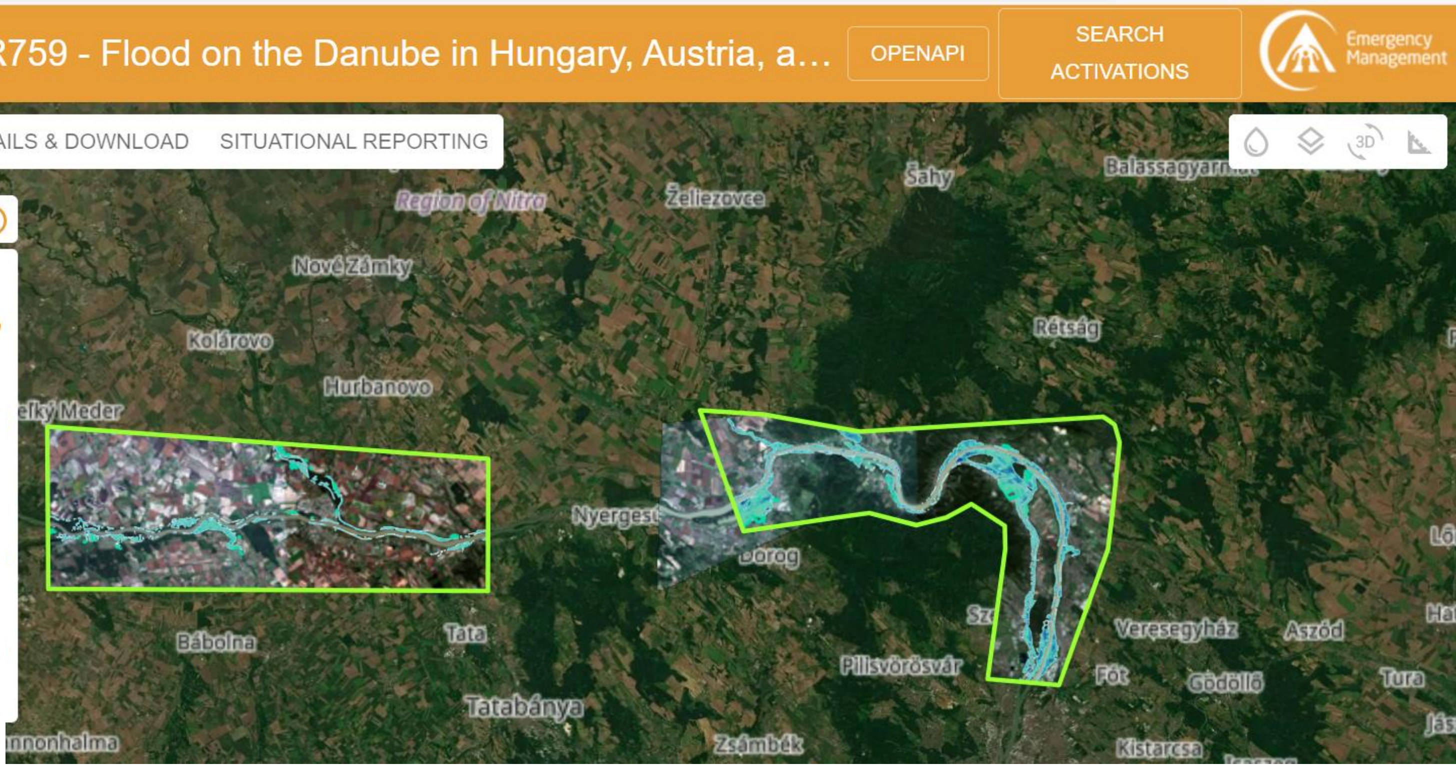
August 2024 was the joint-warmest August globally (together with August 2023)

Record-breaking heat stress in southeastern Europe during summer 2024

Anomalies in river flow in summer 2024



Anomaly in average river flow for June to August 2024, relative to the average for the 1991–2020 reference period. The categories 'exceptionally high (low)', 'notably high (low)', 'above (below) average' and 'near average' relate to the percentile ranges >90 (<10), 75–90 (10–25), 60–75 (25–40) and 40–60 for the 1991–2020 reference period. Shades of blue indicate higher, and shades of red indicate lower flow than average, respectively. Grey indicates near-average flow. Only rivers with drainage areas greater than 1,000 km2 are shown. Data source: EFAS v5. Credit: CEMS/C3S/ECMWF.



The CEMS On-demand mapping component has received the following activations to monitor the flood extent and assess the damage:

1. EMSR766 Flood in Croatia
2. EMSR764 Flood in Lower Austria, Austria
3. EMSR763 Flood in Germany
4. EMSR762 Flood in Emilia-Romagna, Italy
5. EMSR761 Flood in Dresden, Germany
6. EMSR759 Flood on the Danube in Hungary, Austria, and Slovakia
7. EMSR758 Flood in Galati and Vaslui counties, Romania
8. EMSR757 Flood in March, Morava Basins, Slovakia
9. EMSR756 Flood in South West Poland
10. EMSR755 Flood in Brandenbourg, Germany

Storm Boris:
Floods in central-eastern Europe 11th September 2024

Copernicus Emergency Management Service:
On-demand activations = 10

https://emergency.copernicus.eu/news/floods-in-central-eastern-europe-september-2024/

European Commission

- Classification of ecological status in a changing climate was ranked a the top priority for ECOSTAT to address
- The survey on the WP25-27
- (27 replies from 4 stakeholders and 23 MS)

1. Climate change	91
2. River continuity	81
3. Environmental flows	75
4. WFD measures	68
5. Ecological Potential	65
6. Intercalibration	64
7. Overall classification	63
8. Hydromorphology Assessment	60
9. Sediment Management	60
10. Remote sensing	60
11. Environmental DNA	60
12. Physico-chemical standards	57
13. Eutrophication criteria	57
14. Harmonised monitoring	55
15. Temporary rivers	54
16. Online methods availability	54
17. Spatial coverage	51
18. Hydromorphological classification	48
19. CEN standards	46
20. Salinity criteria	37

The threat from Climate Change
What is at stake?

- Achievement of Environmental quality objectives – good surface water status or higher
- Our Business as usual model in Europe for managing water – the Water Framework Directive

EUROPE IS INVESTED IN THIS IN A BIG WAY:

- WFD published in 2000
- Transposition into national legislation
- Currently 38 guidance documents (with associated technical reports and annexes)
- Intercalibrated BQEs,
- Thresholds of supporting standards,
- Now entering the fourth six-year management cycle
- the planned capital investment costs for the measures in the 2nd RBMPs have been estimated as at least EUR **142 billion**

1. Economics - WATECO
2. Identification of water bodies
3. Pressures and impacts
4. Heavily modified water bodies
5. Characterisation of coastal waters
6. Intercalibration
7. Monitoring
8. Public participation
9. GIS
10. References conditions
11. Planning Process
12. Wetlands
13. Classification of Ecological Status
14. Intercalibration process
15. Groundwater Monitoring
16. Groundwater in DWPAs
17. Direct and indirect inputs
18. Groundwater Status-Trend
19. Surface water chemical
20. Exemptions Environmental Objectives
21. Reporting under the WFD
22. Update WISE GIS
23. Eutrophication
24. River Basin Management
25. Chemical Monitoring of Sediment and Biota
26. GW risk assessment
27. Environmental Quality Standards
28. PS emissions inventory
29. Floods Reporting
30. Classification methods
31. Ecological flows

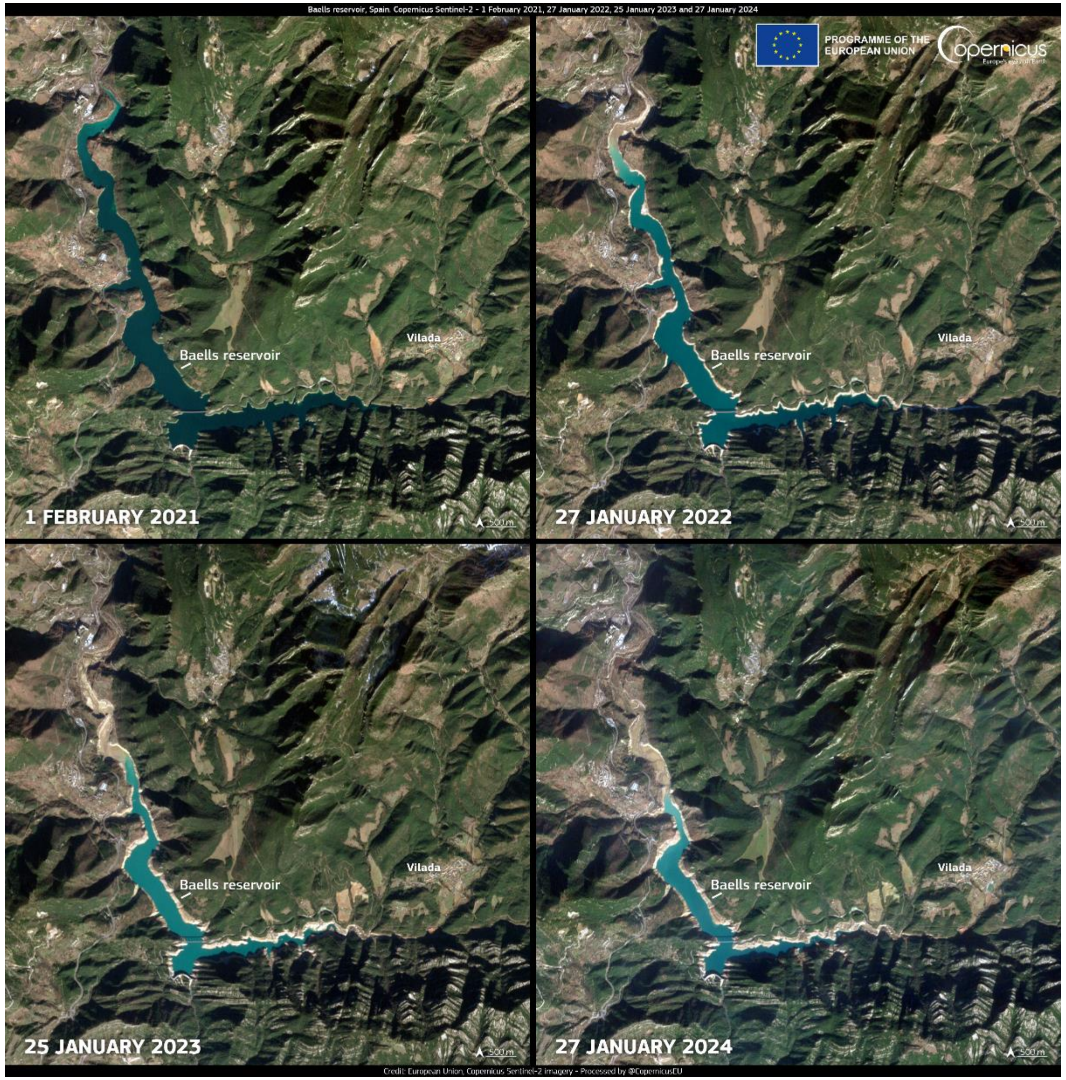
We present 3 ideas on how to include Climate change into WFD <u>ecological assessment</u>

1. Change type
2. Tag the EQR with the proportion of change ascribed to climate change
3. Formally include Climate change as a pressure

- **We present examples as illustrations for now but main objective is really to figure out ways of including climate change in ecological assessment.**

- **We are also trying to gather case studies of climate change and ecological quality in Europe.**

How to play? You need water



Copernicus Sentinel 2 image showing declining water levels in Baells reservoir in Cataluña in Spain as a result of extreme drought. Image from https://www.copernicus.eu/en/media/image-day-gallery/severe-drought-cataluna-spain [accessed 22/03/2024].

Revised guidance document No. 24:

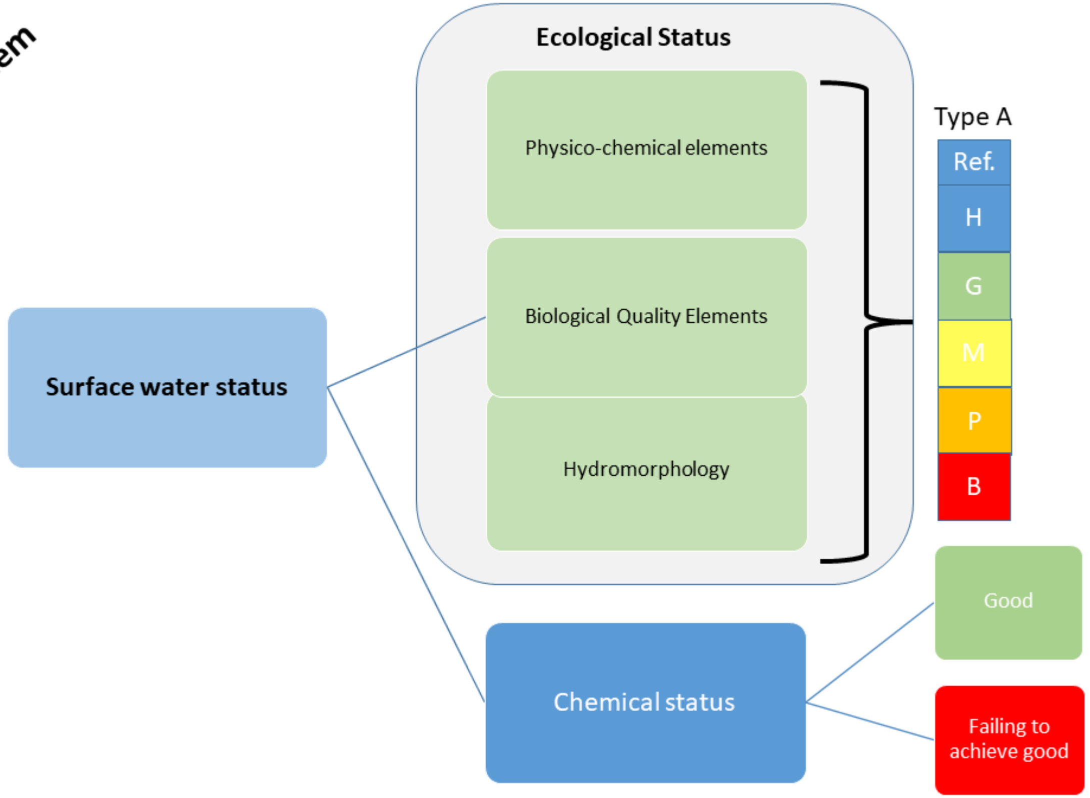
“River basin management in a changing climate” (European Commission and Directorate-General for Environment, 2024).

https://environment.ec.europa.eu/publications/river-basin-management-changing-climate_en

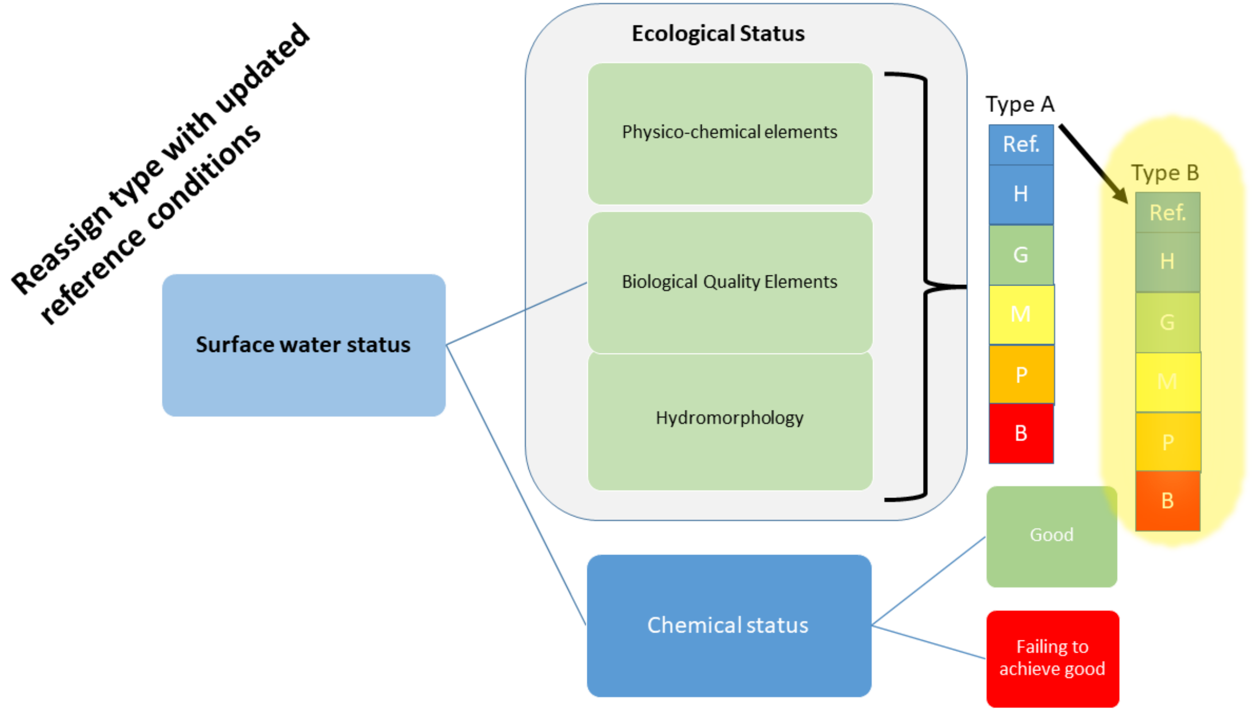
Original assessment components of the WFD classification system for surface water status.

The WFD has a reference based system
– type specific reference conditions
-5 classes of deviation away from this

Original system



Reassignment of waterbody type

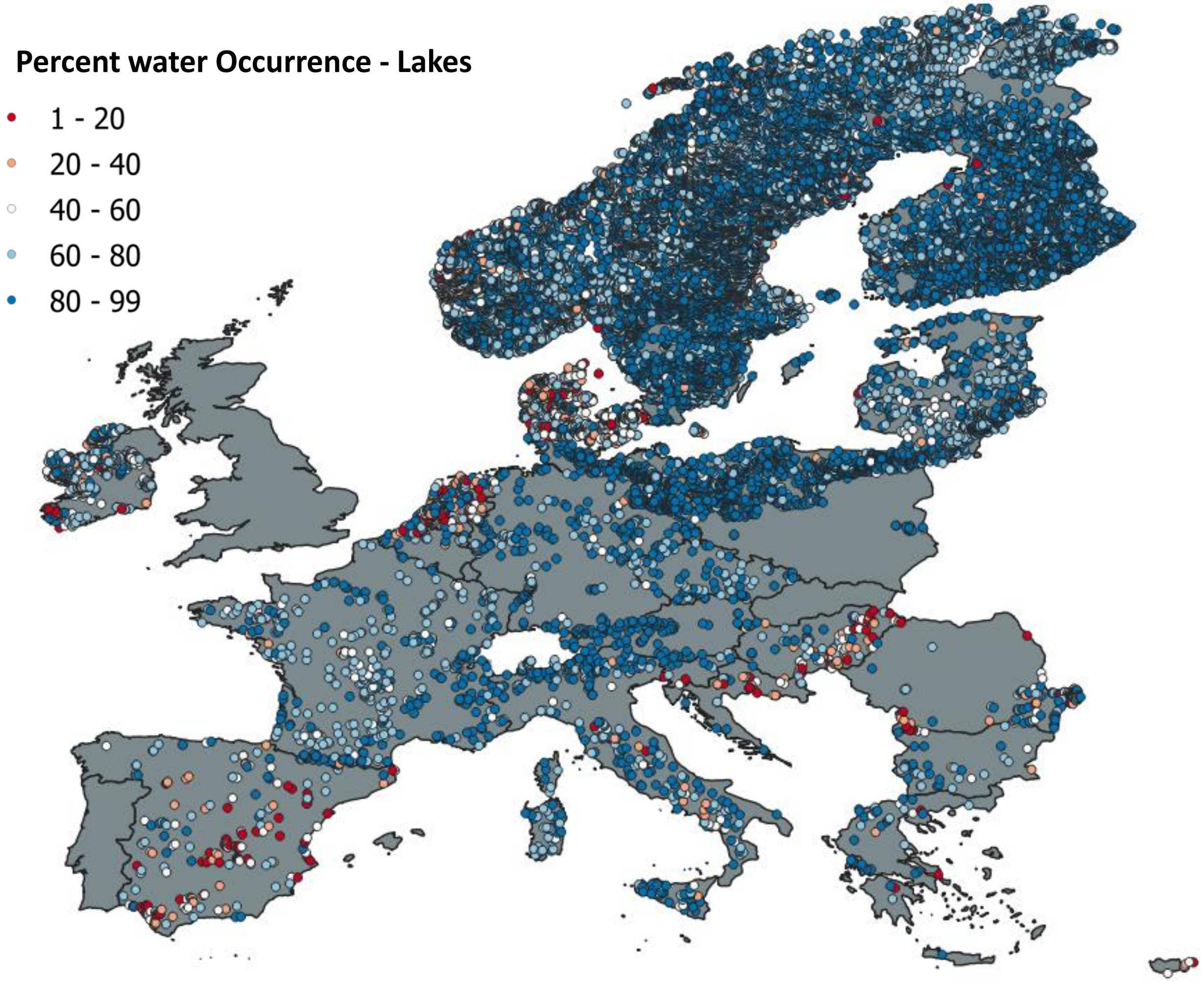


e.g. river changes to an intermittent stream type

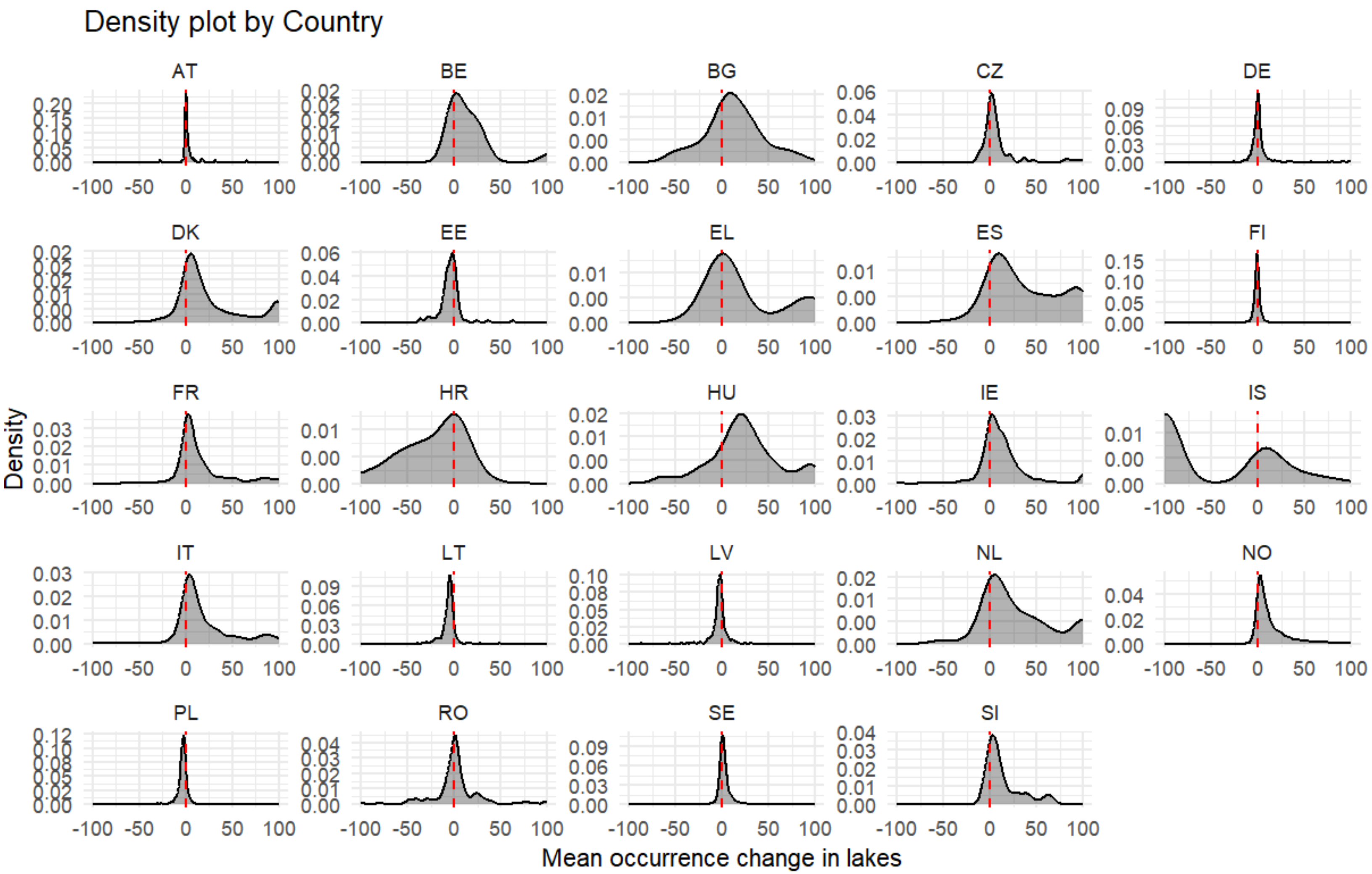
Advantages
*Allows a framework where realistic management objectives can be achieved in the context of a changed climate.

*Recognises that reference conditions are not static over time.

Is a shift from the natural type occurring in lakes?



- Density plots showing data distribution by country of mean occurrence change intensity between 1984-1999 and 2000-2021 in WFD lakes in Europe
- Global Surface Water layer (Pekel et al., 2016).
- Red line indicates zero mean change.
- values can range from -100% loss to +100% gain and were expressed as average values per lake extent.
- Europe, 6 countries had a significant decrease (FI, HR, IS, LT, LV, PL), 13 had an increase (CY, CZ, DE, DK, EL, ES, FR, HU, IE, IT, NL, NO, SE)



O’Briain, R., 2019. Climate change and European rivers: An eco-hydromorphological perspective. Ecohydrology 12, e2099. https://doi.org/10.1002/eco.2099

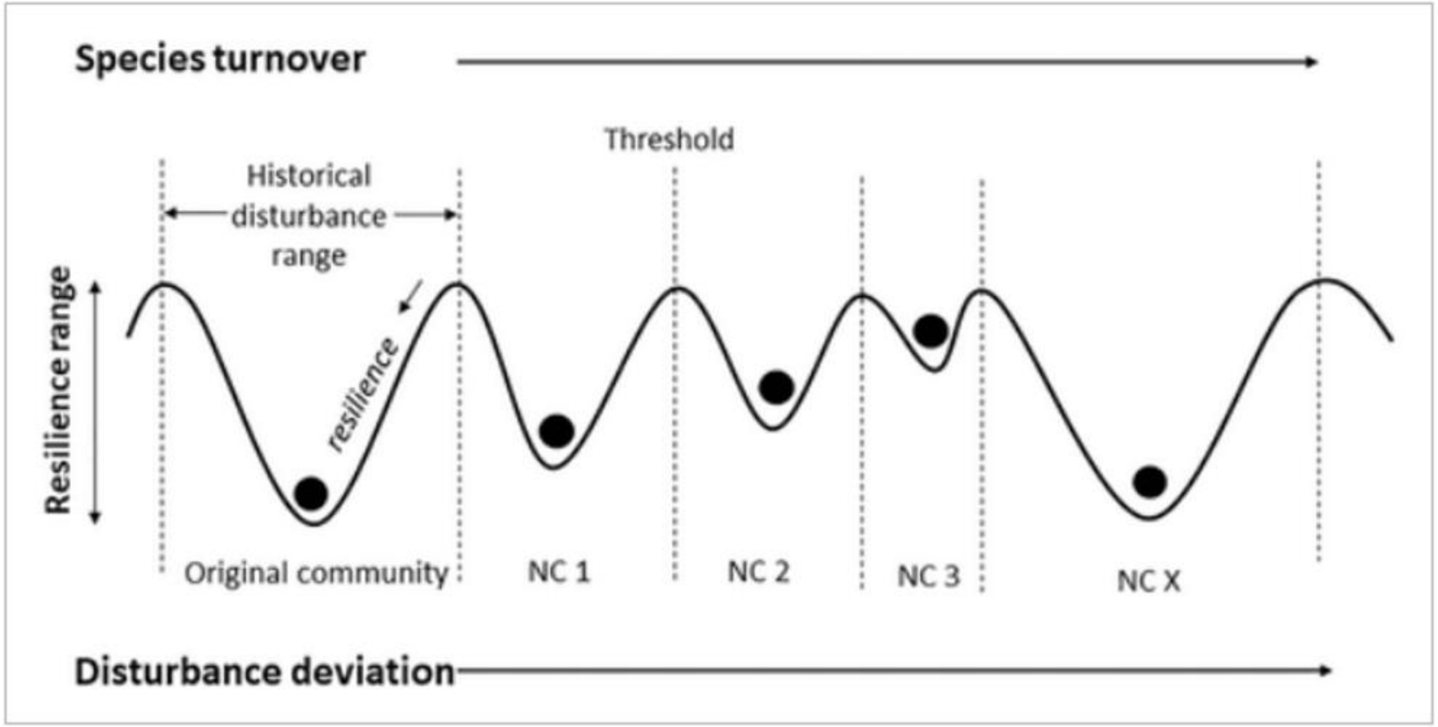
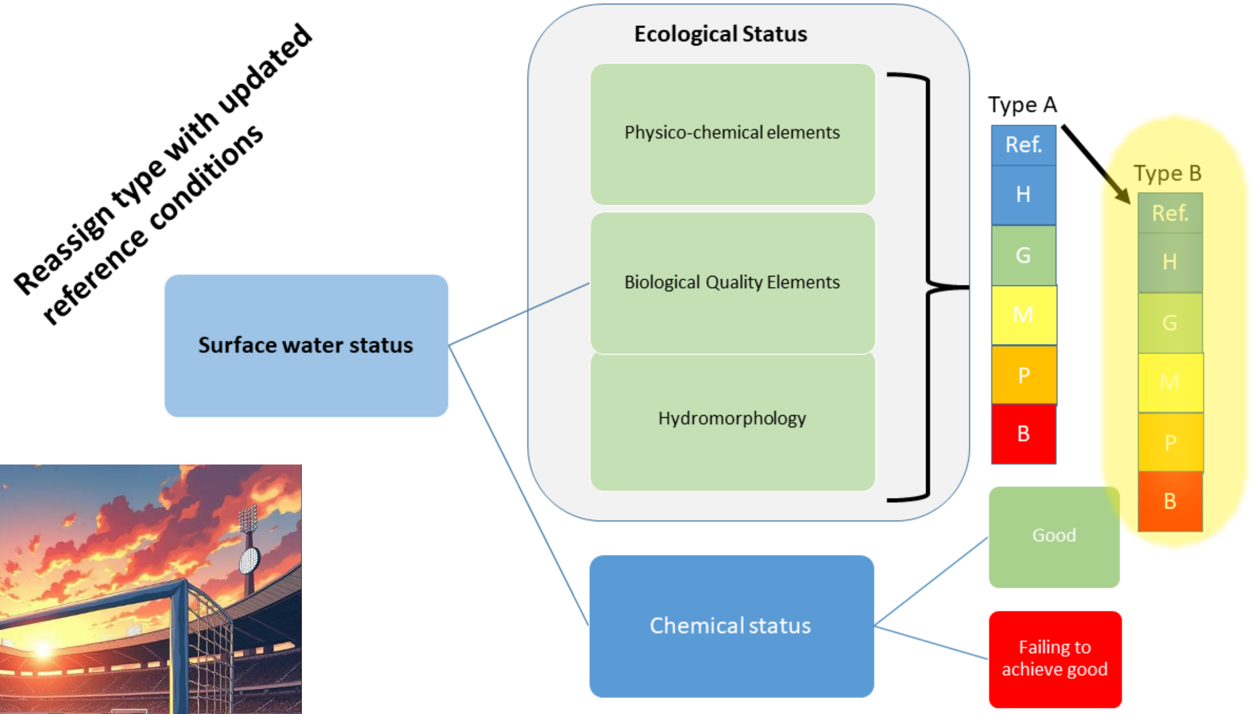
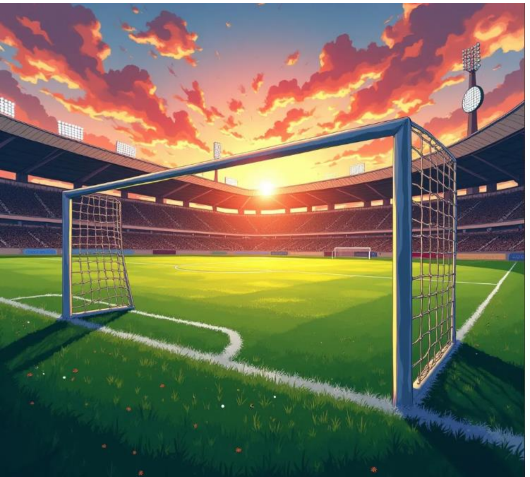


Figure 3 Open in figure viewer | PowerPoint

Conceptual biotic community response to increasing deviation from the historical disturbance regime driven by climate change. New communities (NC 1–3) are less resilient to environmental change and are more likely to transition as disturbance regime deviates further from the historical disturbance range. Increasing disturbance deviation from background conditions accelerates species turnover until a threshold tipping point is exceeded and new community composition is realised. This process may continue until all species constituting the original community are replaced or lost, that is, NC X

Reassignment of waterbody type





e.g. river changes to an intermittent stream type

Disadvantages

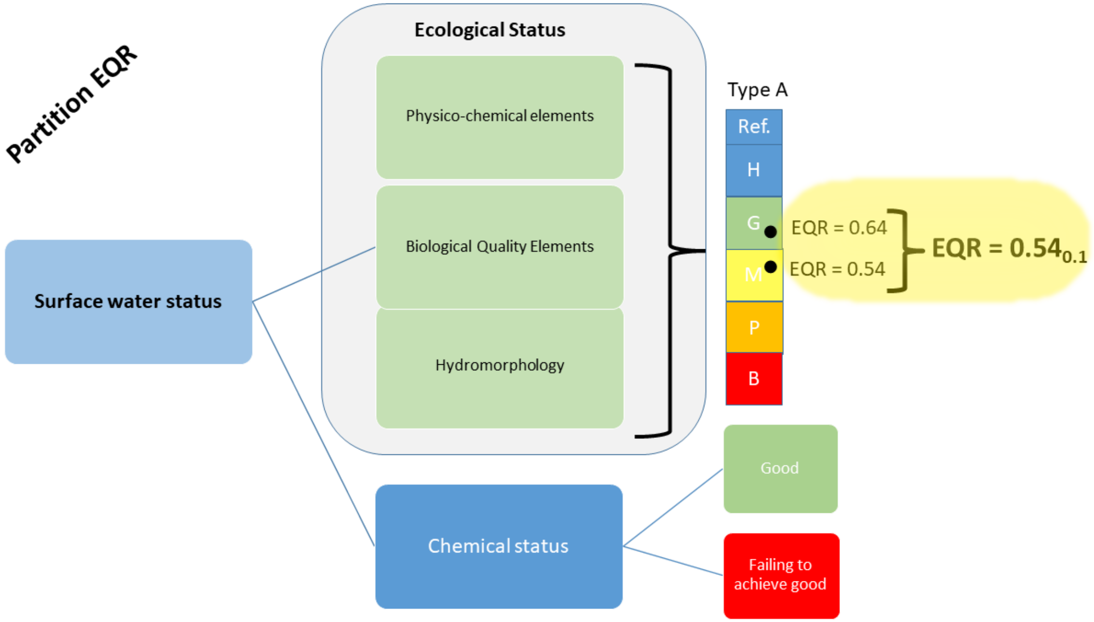
*Climate change may continually occur rather than fitting a type change framework.

*Difficult to maintain a timeseries

*Could be interpreted as a de facto lowering of environmental objectives.

*Reduces transparency in status and objectives assignment.

Quantify the portion of EQR driven by climate change



Advantages

*Allow a continued focus on pressures such as nutrients apart from CC.
*Maintains timeseries.

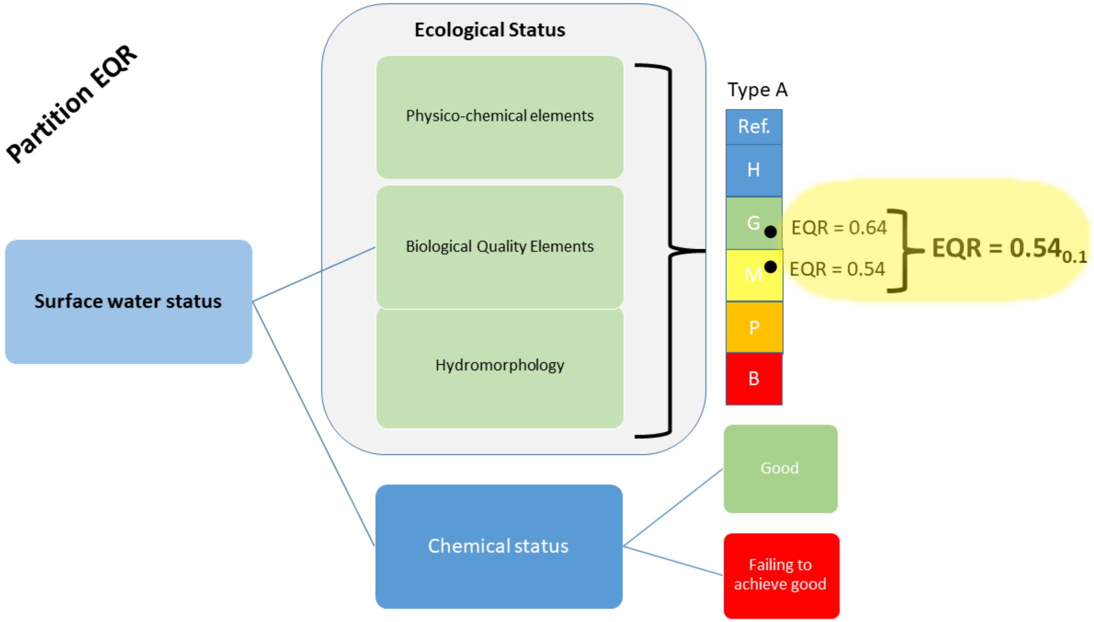
*Allows measures to focus on CC aspect.

*Could provide evidence for exemptions under the WFD.

*Allows for transparency.

*Allows an estimation at European level how CC is affecting aquatic ecology.

Quantify the portion of EQR driven by climate change



Disadvantages

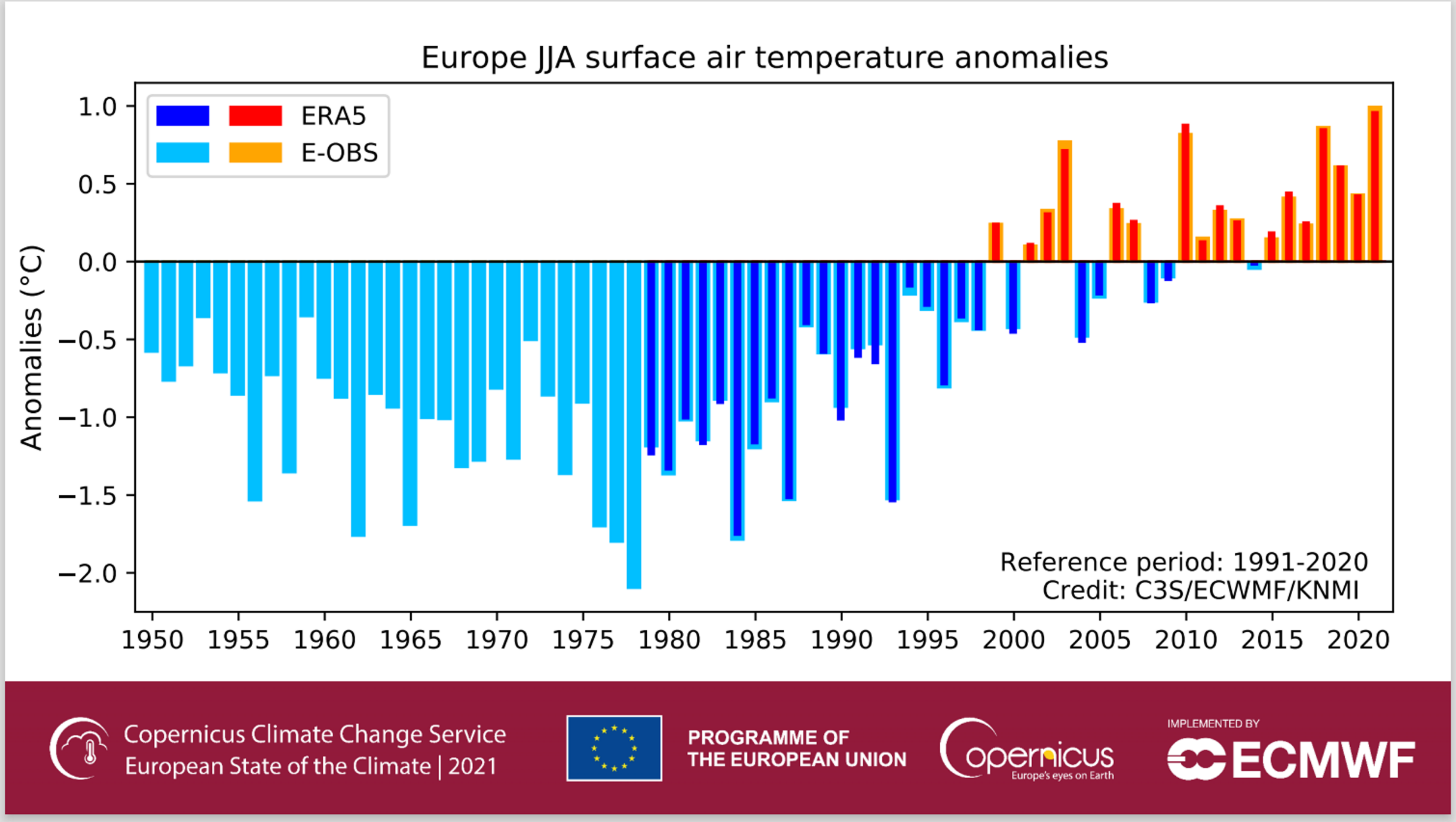
*Technically difficult to precisely define.

*Original reference conditions may no longer be appropriate.

*Environmental objectives may no longer be achievable.

*CC may influence nutrient loading or hydromorphology - impacts on a BQE may be indirect and not straightforward.

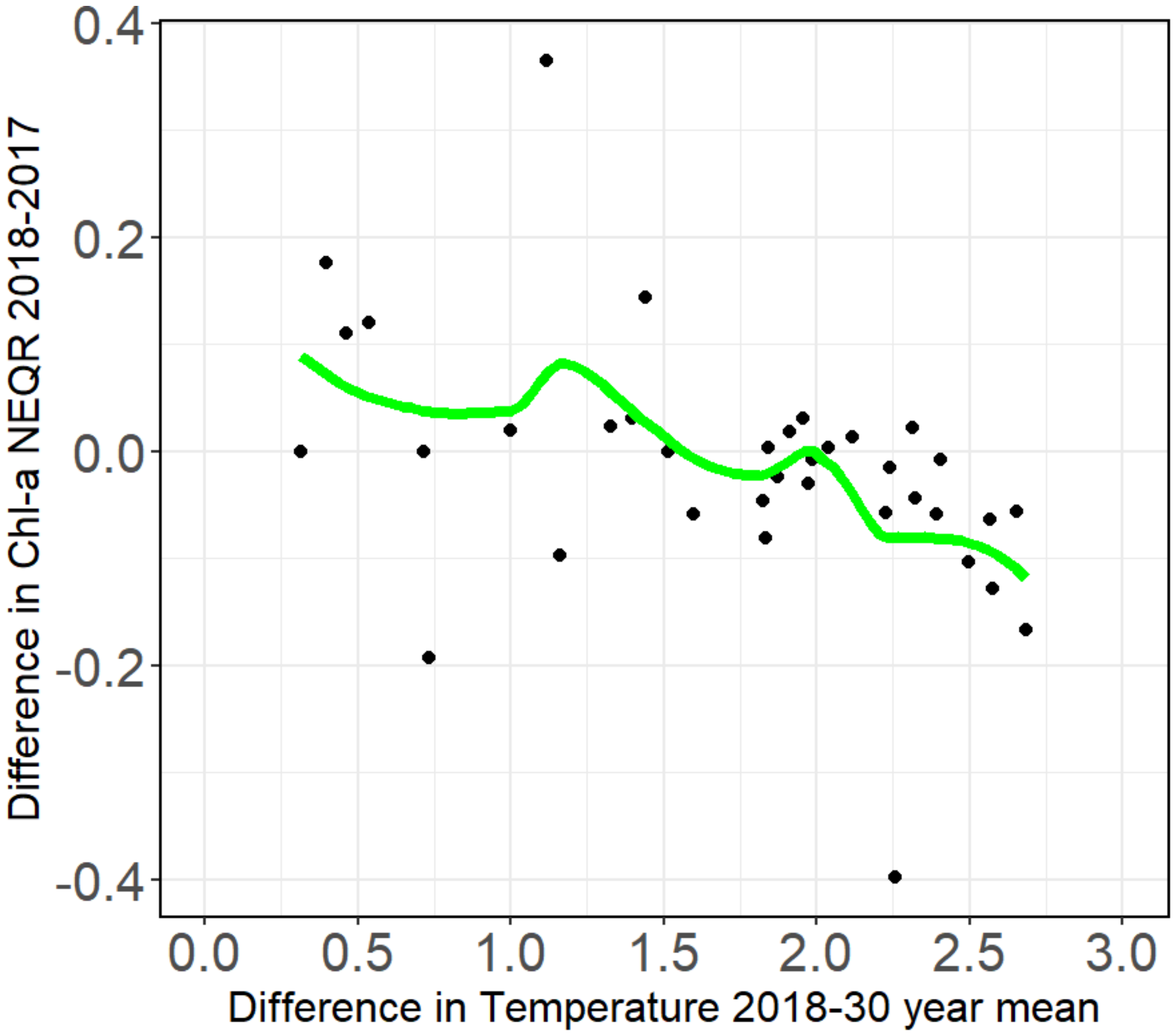
Adjacent years that allow a normal – heatwave comparison were 2017 and 2018



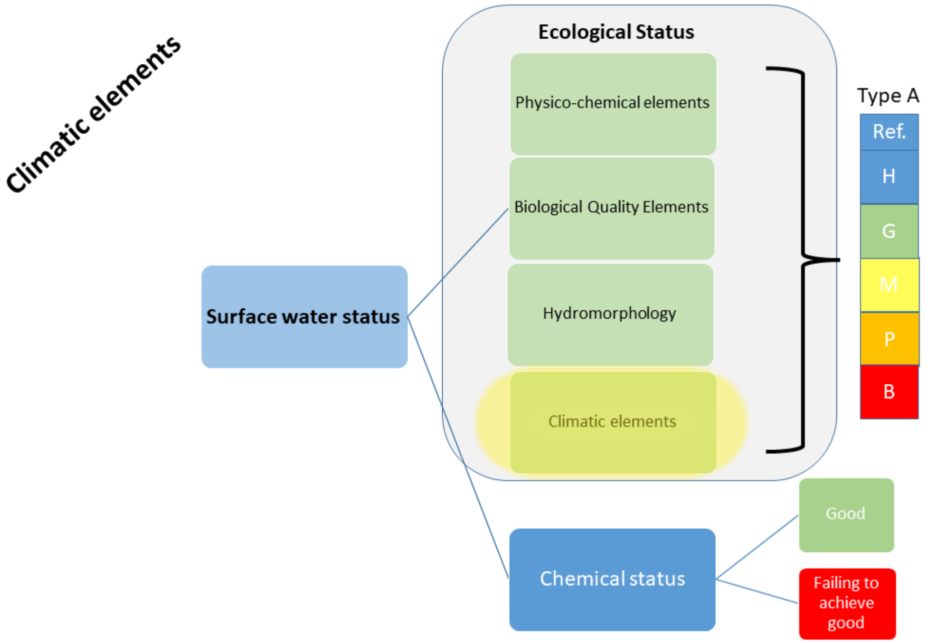
Copernicus Climate Change Service, 2021. European State of the Climate 2021. Copernicus Climate Change Service, Reading, United Kingdom.

Difference in chlorophyll-a normalised Ecological Quality Ratio (NEQR) between 2017 and the 2018 against the temperature anomaly (2018-30 year mean) for 36 European lakes.

All values June-September inclusive. Loess smoothed line fit to data.



Including climate as a supporting element



Incorporation of a climate elements component (yellow oval highlighted)
as a new group of supporting parameters to update assessment components of the WFD classification system for surface water status in response to climate change.

Advantages

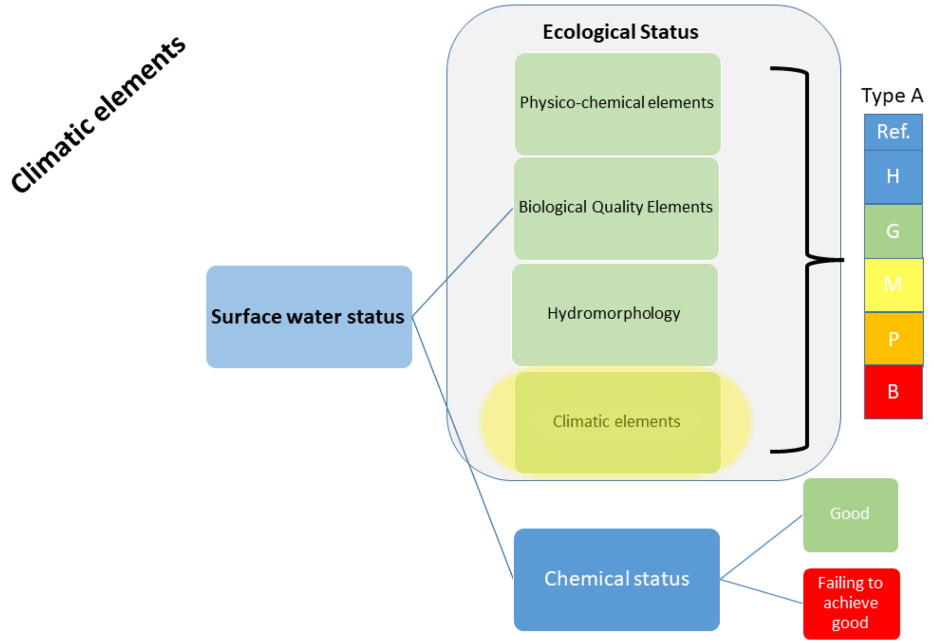
*Provides context for waterbodies decline in status.
*Provides data for developing a multi-stressor model of status.

*Could provide evidence for exemptions under the WFD in cases where additional adaptation measures fail.

*Many metrics of climatic and weather related stress already exist and are available at appropriate spatial level.

*Allows for transparency in effect of CC and subsequent decision making.

Including climate as a supporting element



Incorporation of a climate elements component (yellow oval highlighted)
as a new group of supporting parameters to update assessment components of the WFD classification system for surface water status in response to climate change.

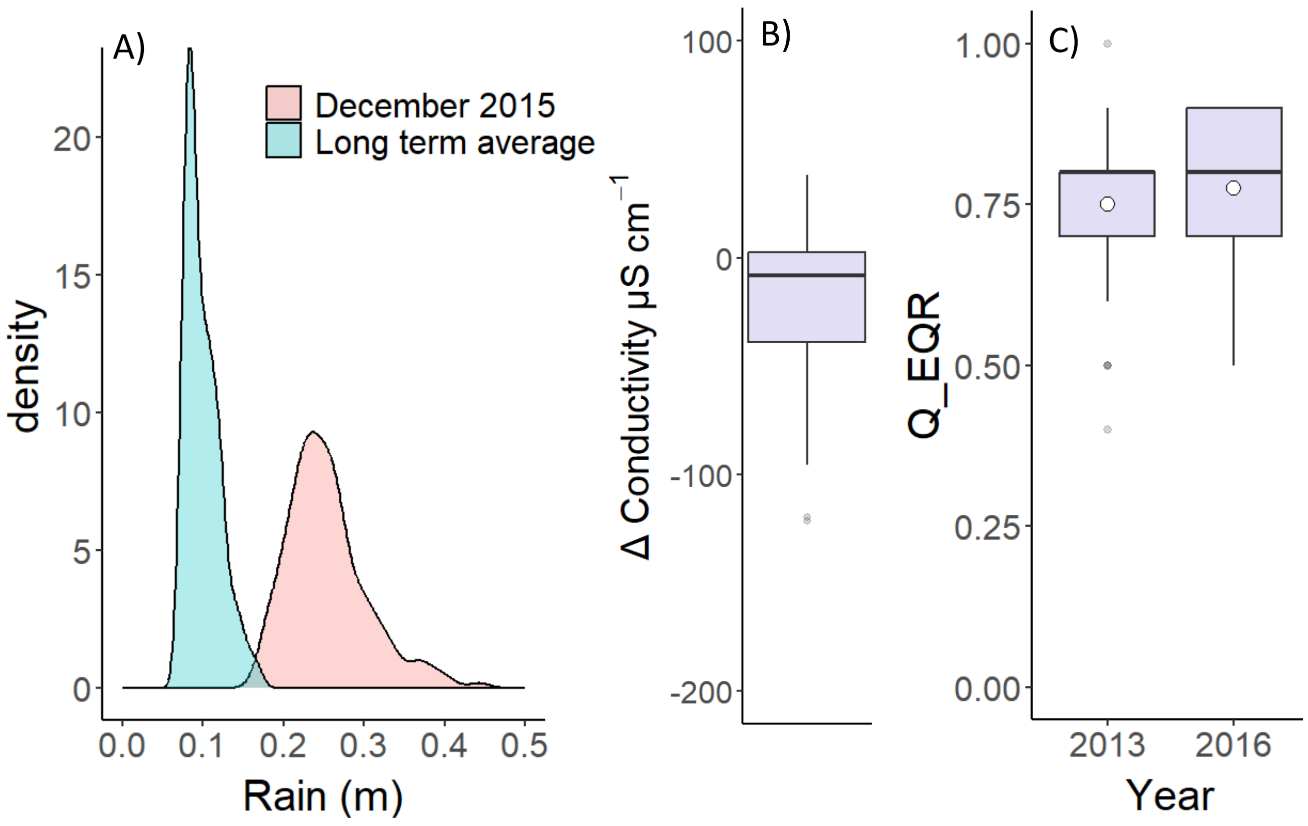
Disadvantages

*Introduces a supporting element that can cause status decline for which remediation may not be feasible.

*Confounds typology and supporting parameters.

*Interacts with other supporting elements, which makes it difficult to know whether the impact on BQEs are direct (e.g. warming) or indirect through impacts on other supporting QEs (e.g. increasing nutrient loads and concentrations).

*Difficult to maintain a timeseries.



A) Comparison of long term average rainfall in December with that of December 2015 in Ireland.

Differences between 2013 and 2015 for B) conductivity and C) Q_EQR – the ecological quality ratio (macroinvertebrates).

Key challenges

- Adapting the framework to manage aquatic systems in the context of climate change, while maintaining focus on implementing measures to tackle key pressures such as nutrients and hydromorphological alteration (including water abstraction) to achieve environmental objectives.

What to avoid

- Avoid blaming climate change when other pressures in WFD assessment need to be addressed. – Focus should be on implementing measures to counteract negative effects of climate change in combination with other pressures.
- Widespread use of derogations for CC by every MS

The start of a process

- Questionnaire to gather opinions and case studies to represent the clear diversity of climate change impacts in Europe on ecological status.

- Workshops and report to provide solutions and way forward for ecological assessment.

European Commission

The start of a process

- We are looking out for some nice case studies where climate change is impacting lake ecological quality that can test a variety of approaches. **Gary.FREE@ec.europa.eu**

- We don’t have a clear winner of an approach yet and are open to ideas.

- It is necessary to Tame the wicked problem of climate change with “virtuous challenges” Weaver et al., 2023

Climate change and ecological assessment in Europe under the WFD – Hitting moving targets with shifting baselines? - ScienceDirect

Weaver, D., Moyle, B.D., McLennan, C., Casali, L., 2023. Taming the wicked problem of climate change with “virtuous challenges”: An integrated management heuristic. Journal of Environmental Management 347, 119136. https://doi.org/10.1016/j.jenvman.2023.119136