ICP Waters

Norwegian Ministry of Climate and Environment

UNECE

International Cooperative Programme on Assessment and Monitoring Effects of Air Pollution on Rivers and Lakes

Chair: Heleen de Wit.
Leader of programme centre: Kari Austnes

Aims

- Assess the *degree* and *geographic extent* of the impact of atmospheric pollution, in *particular acidification*, on *surface waters*
- Collect information to evaluate *dose/response relationships*
- Describe and evaluate *long-term trends and variation* in *aquatic chemistry and biota* attributable to atmospheric pollution

Progress & results

- Status participation
- Report from Task Force meeting
- Recent and planned activities

	Chemical data (last year with data)	Biological data (last year with data)	Participation in TF meetings 2020-2022	Participation in chemical intercomparison 2020-2022	Participation in biological intercalibration 2020-2022
Armenia	2021		•		
Austria	2018		•	•	
Belarus	2014				
Belgium				•	
Denmark			•		
Canada	2021		•	•	
Czech Rep.	2022	2019	•	•	
Estonia	2021		•	•	•
Finland	2021		•		
France			•	•	
Georgia					
Germany	2021	2021	•	•	
Ireland	2021	2020	•		
Italy	2021	2020	•	•	
Latvia	2021	2021	•		•
Lithuania			•	•	
Moldova	2021			•	
Netherlands	2018			•	
Norway	2021	2022	•	•	•
Poland	2021		•	•	
Russia	2018		•	•	
Serbia				•	
Slovakia	2022				
Spain	2022		•	•	
Sweden	2021	2022	•	•	•
Switzerland	2021	2021	•	•	
UK	2021	2019	•	•	
USA	2021		•		
Total	**21**	**9**	**21**	**19**	**4**

- 25 countries participate in various activities
- Stable participation

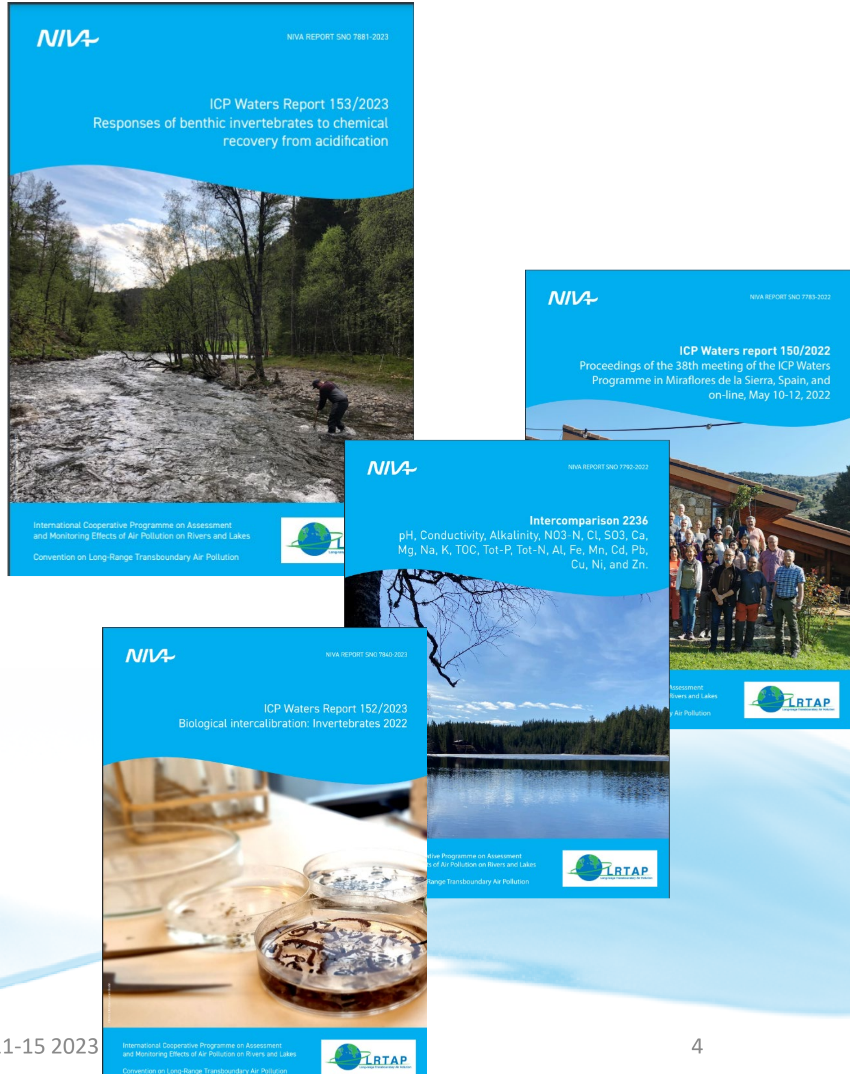
Joint (hybrid) ICP Waters and ICP IM Task Force meeting Lunz am See, Austria, May 9-11 2023

- Chemical and biological recovery is ongoing, but there are more variable trends for nitrogen and biota than for sulphate
- Climate change impacts are increasingly important as deposition declines
- Understanding recovery processes is vital for dynamic modelling and predictions
- Long-term monitoring is of great value to the effects work
- Open data policy is supported and work towards increased openness is continued
- Minutes available at www.icp-waters.no/meetings

Recent publications

Year	Title	Authors	Journal
2023	Shifts in the composition of nitrogen deposition in the conterminous United States are discernable in stream chemistry	Lassiter, M. G., Lin, J., Compton, J. E., Phelan, J., Sabo, R. D., Stoddard, J. L., McDow, S. R. & Greaver, T. L.	Science of The Total Environment, 881, 163409.
2023	Long-term rise in riverine dissolved organic carbon concentration is predicted by electrolyte solubility theory	Monteith, D. T., Henrys, P. A., Hruška, J., de Wit, H. A., Krám, P., Moldan, F., Posch, M., Räike, A., Stoddard, J. L., Shilland, E., Pereira, M. G., & Evans, C. D.	Science Advances, 9(3), eade3491.
2023	Changing Water Chemistry in One Thousand Norwegian Lakes During Three Decades of Cleaner Air and Climate Change	de Wit, H. A., Garmo, Ø. A., Jackson-Blake, L. A., Clayer, F., Vogt, R. D., Austnes, K., Kaste, Ø., Gundersen, C. B., Guerrerro, J. L., & Hindar, A.	Global Biogeochemical Cycles, e2022GB007509
2023	A century of diatom monitoring in acidified and warmed Dutch moorland pools	van Dam, & Mertens, A.	Limnologica 99, 126059
2023	The Role of Hydromorphology in the Partial Recovery of Chemistry in Acidified and Warmed Dutch Moorland Pools	van Dam, H.	Water, Air, & Soil Pollution, 234(1), 10

www.icp-waters.no/publications



Workplan 2022-2023

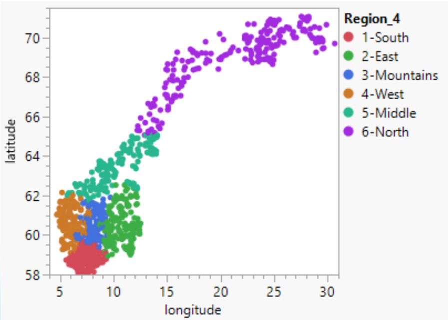
- Specific to ICP Waters
  - 1.1.1.11: Report on biological recovery and responses to changing water chemistry (published, presented at thematic session)
  - 1.1.1.12: Report on trends in base cations, potential drivers and implications for acidification status and biological recovery (in progress)
- WGE joint items
  - Review of the Gothenburg protocol
  - Inputs to the Scientific Strategy

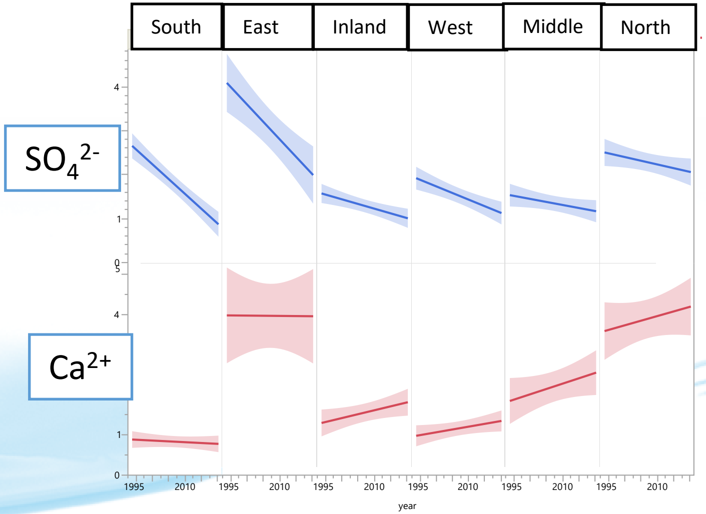
Base cation report 2023

- Base cations, essential for acid-buffering capacity of surface waters, have shown some surprising increases recently
- Understanding changes in base cations is necessary to predict recovery from acidification for surface waters, especially in the era of low S deposition
- Calcium in particular is vital for aquatic organisms with shells/exoskeletons (example: crayfish, freshwater shrimps (*Crustaceans*), snails)
- Aim of report
  - Analyse trends in base cations and variability between sites and regions
  - Investigate if *expected* and *surprising* trends in base cations can be explained with current process understanding (cation exchange, charge balance, weathering, deposition)

Background: surprising upward calcium trends in Norwegian 1000 lake study (1995-2019)

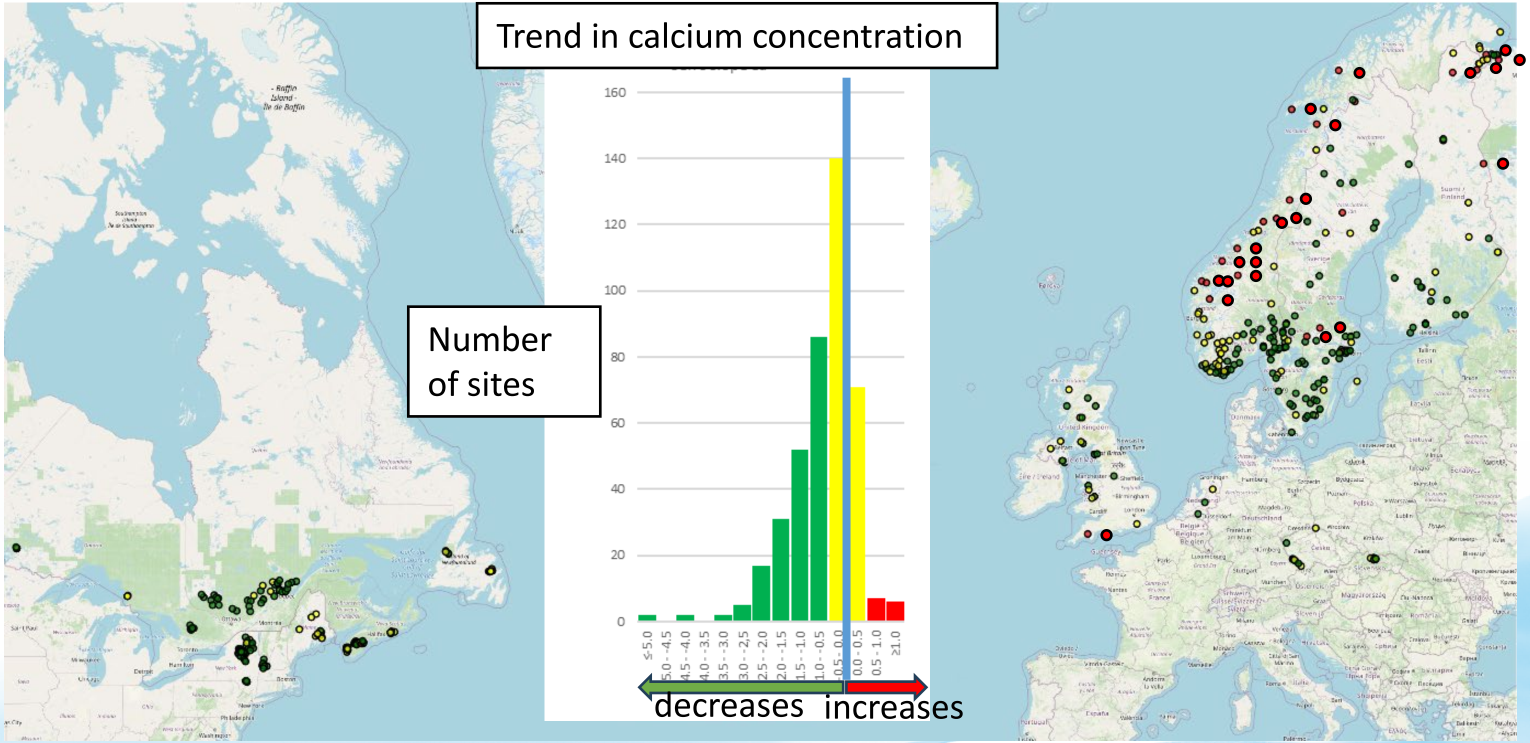
- Despite significant decreases in sulphate everywhere, calcium concentrations increased everywhere except in southern Norway (most acid-sensitive and acidified region)





After Table 2 in de Wit et al. (2023)

Increasing and neutral calcium trends also observed at several ICP Waters sites



Why is the increase in calcium surprising?

- Law of electroneutrality: Changes in anions are balanced by changes in cations
  - Declines in sulphate anion concentrations are expected to be balanced by declines in calcium and magnesium cation concentrations in acid-sensitive regions (Reuss & Johnson, 1985)
- But we are now in an era of low S deposition, so changes in other anions than SO_4^{2-} may become increasingly important for acidification processes
  - Organic anions (from organic acids) and bicarbonate (HCO_3^-)

Recapturing - acidification

- Acid-sensitive sites are characterized by
  - Low weathering rates and low buffering capacity
  - Naturally low bicarbonate (lack of calcareous soils)
  - Varying levels of organic acidity (from dissolved organic matter (DOM), related to catchment forests and wetlands)
- Acid-sensitive sites need NOT be acidified – only when exposed to elevated acid deposition
- Acidified sites have elevated sulphate concentration
  - Declines in sulphate lead to increases in DOM and organic acidity
  - Chemical recovery can lead to an increase in bicarbonate (provided pH is high enough)

ICP Waters sites

- ICP Waters sites were selected because they are acid-sensitive and exposed to acid deposition
  - Depending on geology, acid-sensitivity varies
  - Range in acid deposition
- Sites with both declining sulphate and declining calcium
  - Behave (mostly) as expected
  - Usually the decline in sulphate anions is partly compensated by an increase in organic anions (DOM)
  - The decline in calcium is usually less than the decline in sulphate
- Sites with declining sulphate but with increasing (or no change in) calcium
  - Characterized by relatively low sulphate, relatively high bicarbonate and relatively low in organic anions
  - Implying: Sites of relatively low acid-sensitivity and low exposure to acid deposition
  - Increases in calcium are usually linked to increases in bicarbonate

Unexpected increases in calcium – a ‘new’ mechanism?

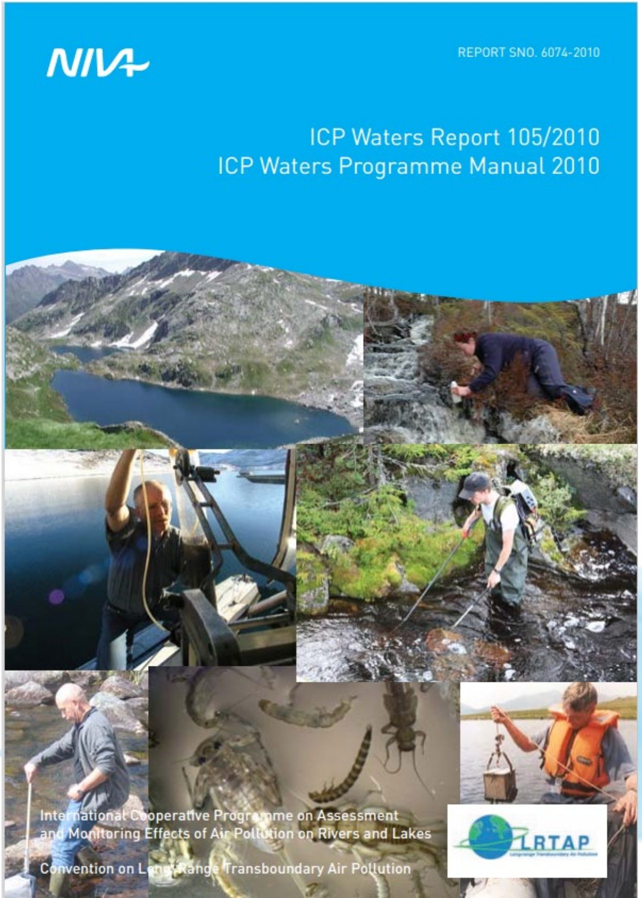
- Increases in calcium only in sites of relatively low acid-sensitivity, and associated with increasing bicarbonate
  - Consistent with increased weathering rates, related to climate change (direct: warming and longer growing season; indirect: higher productivity)
- The models used for predicting future recovery of surface waters usually assume constant weathering rates
  - Whether this needs a change is a new topic
- Preliminary conclusions
  - The increases in calcium appear to be limited to less acidified sites
  - Time will show if more acidified sites show the same patterns
  - This phenomenon is important to understand in the era of low S deposition
- Report will be finished in 2023

Workplan 2024-2025

- 2024: Update the ICP Waters manual
- 2025: Assess dose-response relationships between water chemistry and biology

2024: Updating the manual

- Methodology for surface water monitoring for studying effects of air pollution
  - General guidance and recommended methods
  - Harmonization for joint analyses
- Aim of update
  - Last update 2010: New methods/requirements/uses since then
  - Improve structure/content: Condense and make more user-friendly
  - Reconsider coverage
    - Better alignment with NEC Directive needs
    - More on use of data
    - Downscale less central topics (e.g. POPs)

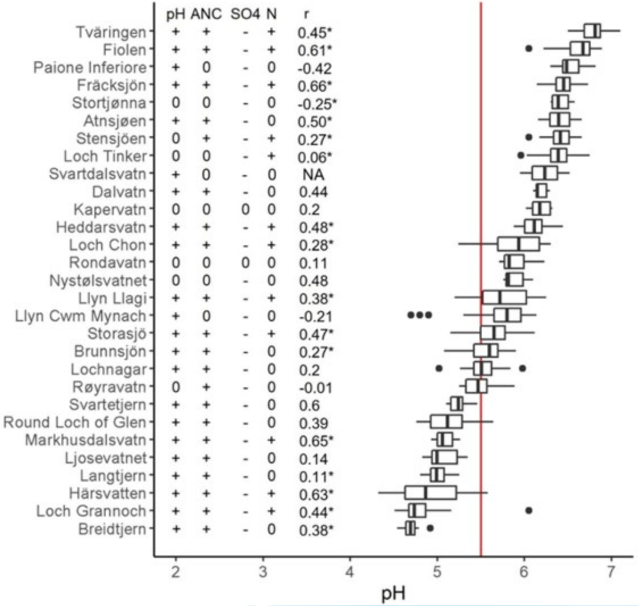


Updating the manual

- Progress
  - 2022-2023: New structure suggested, revision team established
  - Discussion at TF 2023: Scope, potential users
  - Draft by TF 2024, final version end of 2024
- Central issues in discussions
  - Should be useful for countries wanting to establish new monitoring (e.g. NECD)
  - Better overviews and more background on biological indices
  - Include emerging techniques/methods
  - More on evaluation on data, references to existing classification systems (e.g. Water Framework Directive)
  - More on quality assurance, incl. intercalibration, and data sharing
- Any feedback on existing manual most welcome!

2025: Dose-response relationships

- Building on the recent report on biological recovery
- Looking more specifically at individual sites with good parallel chemical and biological data
  - Thresholds/step changes
  - Delays in biological response
  - Stabilisation – at which level?
  - Effects of climatic events
- Ground-truthing of existing thresholds and classification systems (e.g. Water Framework Directive), usually based on space-for-time relationships
- Ideas to be further developed and discussed at TF 2024



Other ongoing/planned activities

- Open data - explore possibilities before next TF meeting
  - Data paper, letter of agreement (with possibility for reservation)
  - Online database too resource-demanding
- Regular activities:
  - Intercalibrations water chemistry, invertebrates
  - Maintainance of databases: New QC tool for data providers in place, further improving site metadata

Task Force meeting 2024

- Joint with ICP Integrated Monitoring
- Most likely in Prague, Czechia, in May