# Evaluating the critical loads using data from the national lake survey 2019

Kari Austnes

ICP Modelling & Mapping TF meeting 2021

Critical loads for acidification of surface waters in Norway

- SSWC and FAB models
- Calculated for grid cells, not individual water bodies
  - Each grid cell assigned a water chemistry from monitoring data
- Original base cation concentration (BC*$_0$) indirectly from MAGIC modelling
  - Regression of BC*$_0$ vs «present» BC* using MAGIC model output for a set of acid-sensitive lakes
- Variable ANC$_{limit}$
  - Depending on BC*$_0$ and TOC

Critical loads for acidification of surface waters (meq/m^2/yr)

- 0 - 12.5
- 12.5 - 25.0
- 25.0 - 37.5
- 37.5 - 50.0
- 50.0 - 75.0
- > 75.0
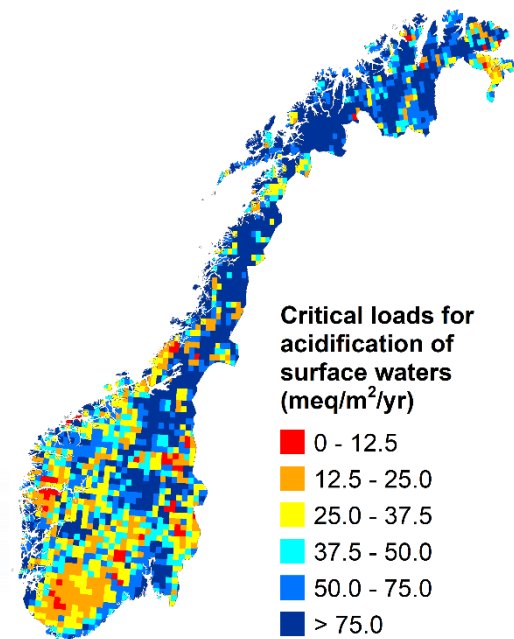
2019 national lake survey

- 1000 statistically selected lakes across the country

- Re-survey of lakes sampled in 1995
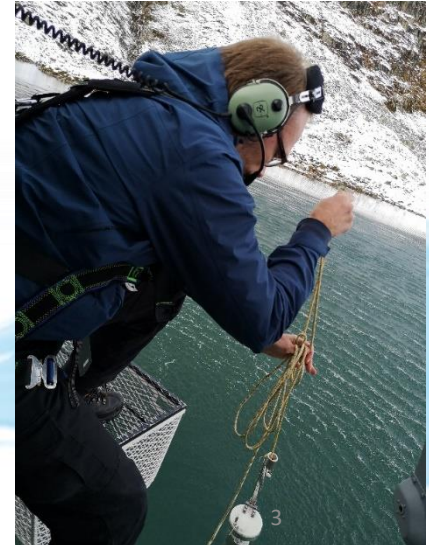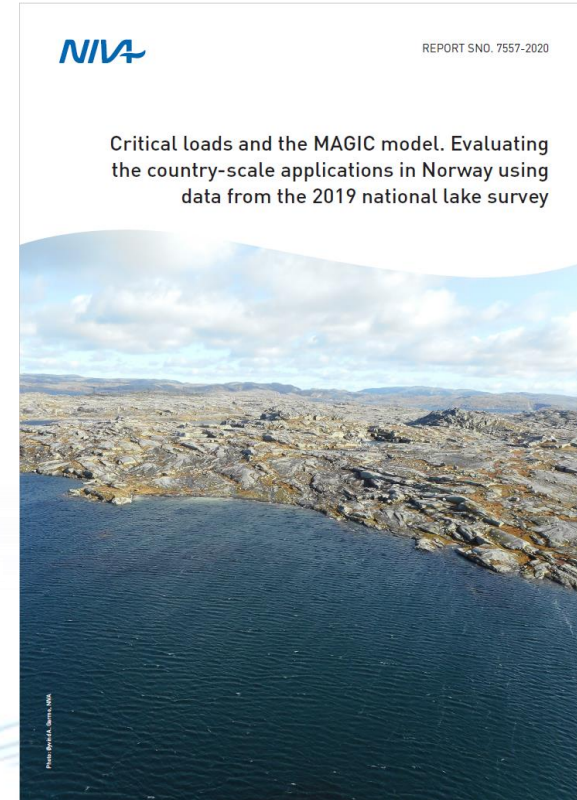

Pictures from Frida Eklund (Helitrans) ®

Kari Austnes   21.04.2021   3

2020 evaluation

- MAGIC model performance
  - Comparing MAGIC projections for 2019 with measured concentrations
  - Aim: What could/should be changed in a re-calibration
  - Very brief conclusion: MAGIC generally performs well, but some steps for further improvement suggested
- The CL methodology
  - Comparing CL exceedance with measured concentrations
  - Sensitivity analysis CL parameters
  - Aim: How could the CLs be improved

REPORT SNO. 7557-2020

Critical loads and the MAGIC model. Evaluating the country-scale applications in Norway using data from the 2019 national lake survey

Kari Austnes, Richard F. Wright, James E. Sample, Francois Clayer

CL exceedance vs ANC

- Most lakes are not in an area with CL exceedance
  - SSWC 922, FAB 653
- With SSWC lakes in areas with CL exceedance mainly had ANC < 50 µeq/l
  - Exceptions often have high TOC
- With FAB several lakes in areas with CL exceedance had ANC > 50 µeq/l
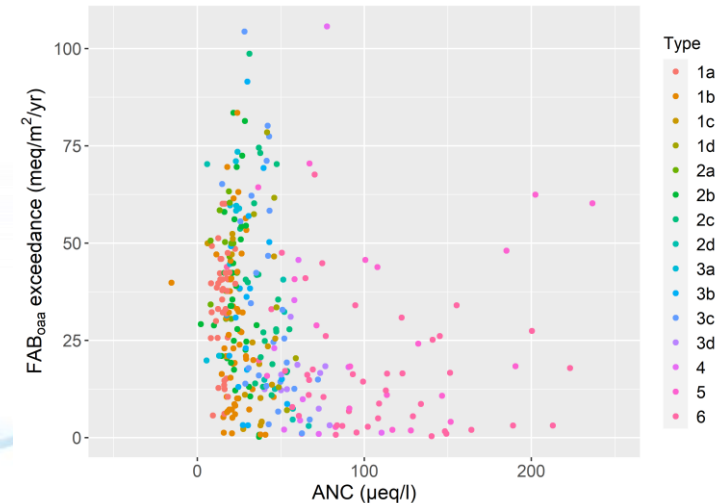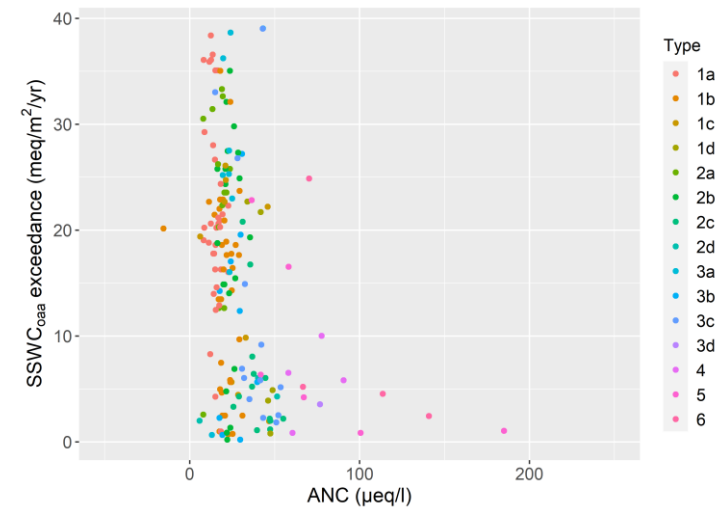
Only lakes with CL exceedance

CL exceedance vs nEQR

- nEQR = normalised ecological quality ratio (WFD)
- Only 10 lakes acidified
  - Some were not in areas with CL exceedance, but this is expected – delayed recovery
- 174 (SSWC) or 339 (FAB) lakes were in areas with CL exceedance, but were not acidified
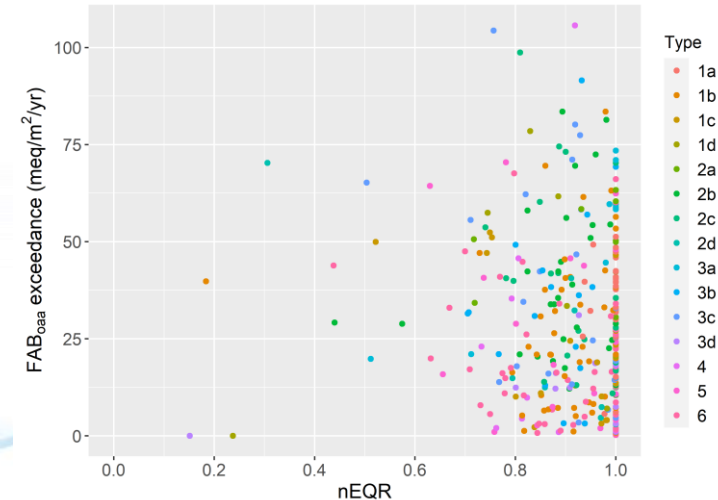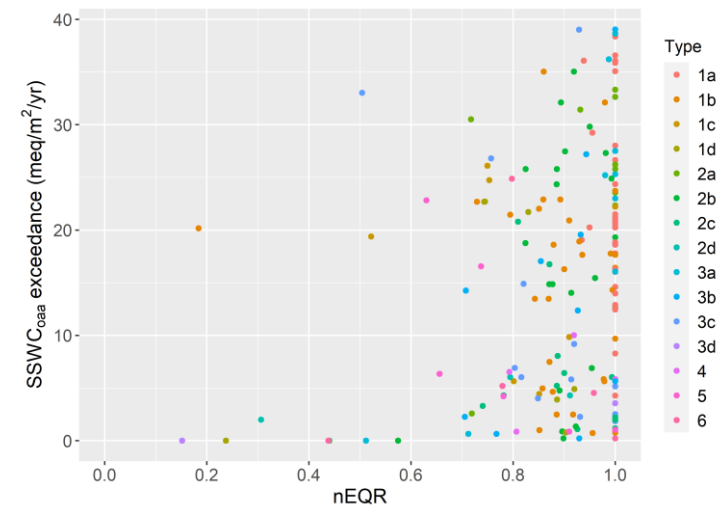
Non-acidified (nEQR > 0.6) lakes with no exceedance omitted

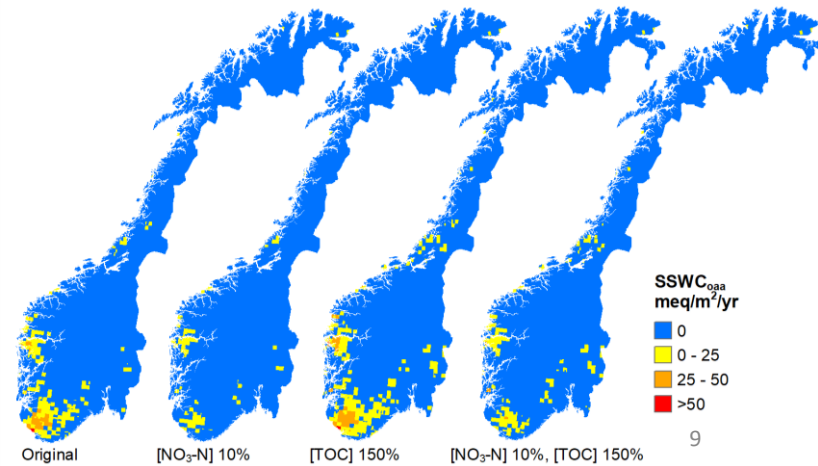# Mismatch CL exceedance and acidification status

- Data of very different nature – are they really comparable?
- CLs set to protect the most sensitive lakes, while the 1000 lakes are randomly selected
- The Ca concentration was unusually high in 2019
- 2019 deposition was lower in some of the sensitive areas than the deposition used in the exceedance calculations (2012-2016 average)
- The Norwegian WFD classification is not sufficiently strict..?
  - Or the ANC ranges for the different classes are simply very narrow
- Could the CL exceedance be overestimated?
  - FAB certainly, in this type of comparison - does not assume current N immobilisation

Testing/evaluating various elements

- Some data not up to date – rough «sensitivity analysis»

- Evaluating some alternative approaches

- ANC_{limit}: Not evaluated at this stage
  - Previously shown to be fairly in line with WFD good/moderate boundary and any changes should be dealt with in parallel

- $BC*_0$: Evaluated, but a longer story

- Discharge
  - Realistic increase (3-5%) hardly any effect on exceedance
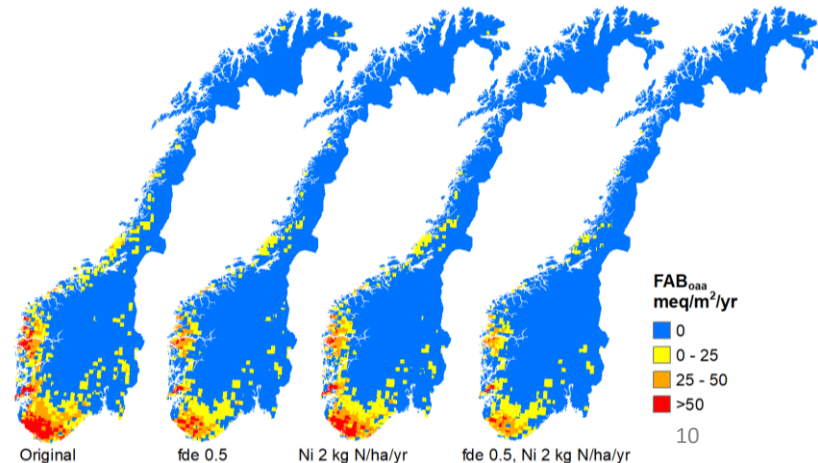 - Will nonetheless update to the new normal (1991-2020) when available

Testing/evaluating - SSWC specific

- TOC conc has increased and NO_3 conc has declined compared to the data applied in the CL calculations

- The combined effect depends on the actual size of the changes – if similar they cancel out
  - May have marked effects locally, but the national exceeded area may be similar
  - More up to date values should be applied

SSWC$_{oaa}$ meq/m^2/yr
- 0 (blue)
- 0 - 25 (yellow)
- 25 - 50 (orange)
- >50 (red)

Original   [NO$_3$-N] 10%   [TOC] 150%   [NO$_3$-N] 10%, [TOC] 150%

Testing/evaluating – FAB specific

- Increasing nitrogen retention in FAB gives exceedance more similar to SSWC
  - Partly counteracted by increasing TOC concentration
  - But adjusting and/or differentiating constants could be considered
- Do we need FAB?
  - I.e. do we need to apply the long-term N immobilisation as a precautionary principle – in case of nitrogen saturation?
  - Or is most of the N immobilised at any deposition level, i.e. SSWC CLs provide sufficient protection?
  - Probably still yes..

Kari Austnes

FAB_{oaa}
$meq/m^2/yr$

- 0
- 0 - 25
- 25 - 50
- >50

Original   fde 0.5   Ni 2 kg N/ha/yr   fde 0.5, Ni 2 kg N/ha/yr

10

Recommendation

- 1) Using the 1000-lake survey as basis for the CLs
  - Calculating CLs for the lakes and extrapolating using spatial modelling (could also add more lakes/rivers)
  - BC^*_0 from MAGIC after re-calibration
- Or 2) Keep existing BC^*_0, but update TOC and NO_3
- In any case
  - Keep both SSWC and FAB (FAB as worst-case scenario)
  - Revisit some of the FAB parameters
  - Update land cover distribution and discharge

Way forward

- Re-calibration of MAGIC to the 1000 lakes using the new Mobius platform
  - Useful also for other purposes
  - Building on recommendations from the evaluation
  - Starting in 2021, continued in 2022
- Updating CLs 2022-2023??
  - If and how not decided
- Hence – no new data in response to the Call for data
  - But maybe some news on progress in the 2022 CCE Status report – national chapter?