Hydrological status assessment of Finnish streams

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Hydrological impacts in Finnish rivers

- Damming and flow regulation, especially for hydropower and flood protection is obvious and well-know impact on river hydrology
- Water level/flow is typically monitored in regulated rivers so it is easier to assess and measure human impacts on natural flow regime
- River flow regime is also impacted by land use practices, such as agriculture and forestry
- Drainage is often needed to lower water table and remove excess water from crop fields and to enhance forest growth in peatlands
- In Finland, over 50 % of peatlands have been drained by ditch networks for peatland forestry

Development of hydrological status assessment

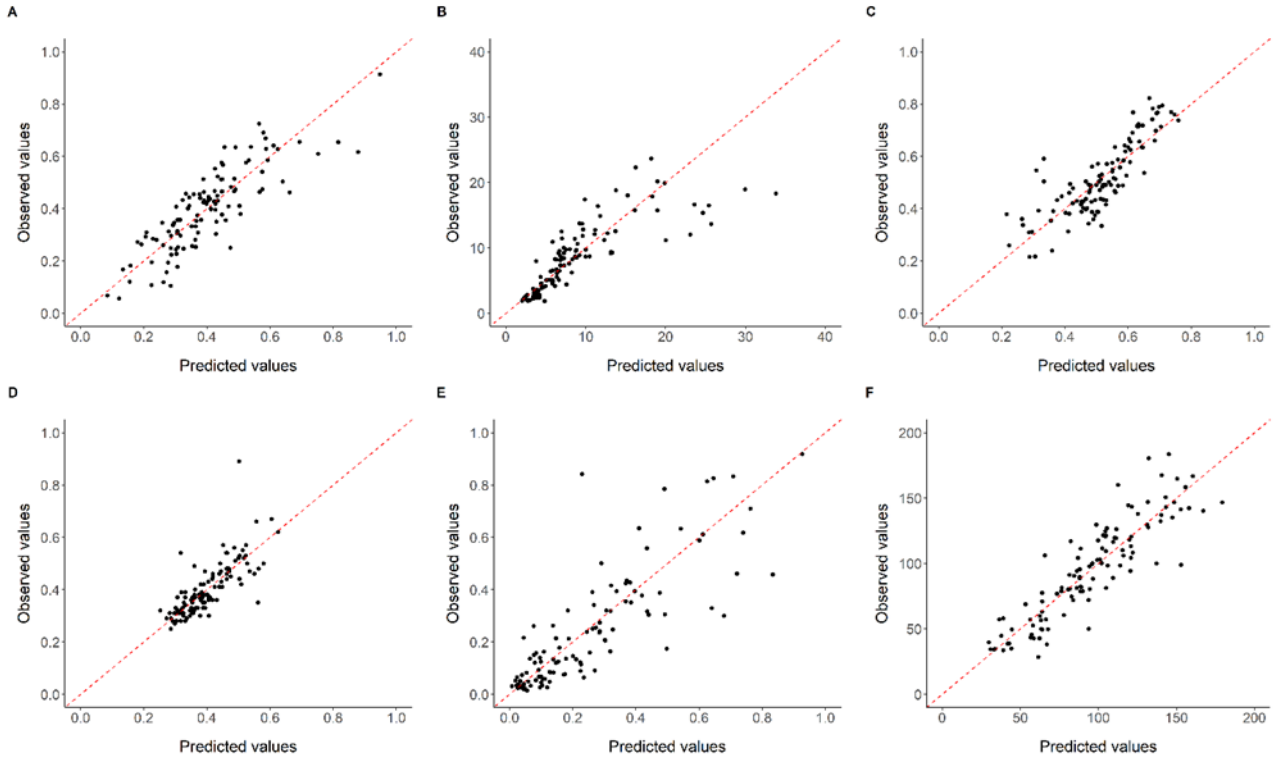
- In Finland, hydromorphological status assessment of rivers is done by using scoring system
- 1-3 metrics for each hymo quality element (Hydrology, Morphology, Connectivity)
- The hydrological metrics (Intensity of hydropeaking, change in spring HQ/ occurence of critical low flows)
- Assessment of land use impacts on flow are primarily based on expert judgment if assessed at all

The approach

- We complied 10 year (2011-2020) daily flow data from over 400 flow gauging sites in Finland
- Different flow metrics were calculated that describe different facets of the flow regime
- 112 river sites were considered as near-natural reference-sites and were used to model flow metric values in unaltered conditions
- Various types of regression models were used to model and predict the metric values in natural conditions
- Catchment area, lake%, soil type, annual air temperature, precipitation, snow cover etc. were used as model predictors

The performance of the models

- Overall in reference models the predictors explained 70-80% of the variation in flow metrics
- In 10-fold cross validation R2 values were similar (0.7-0.8)



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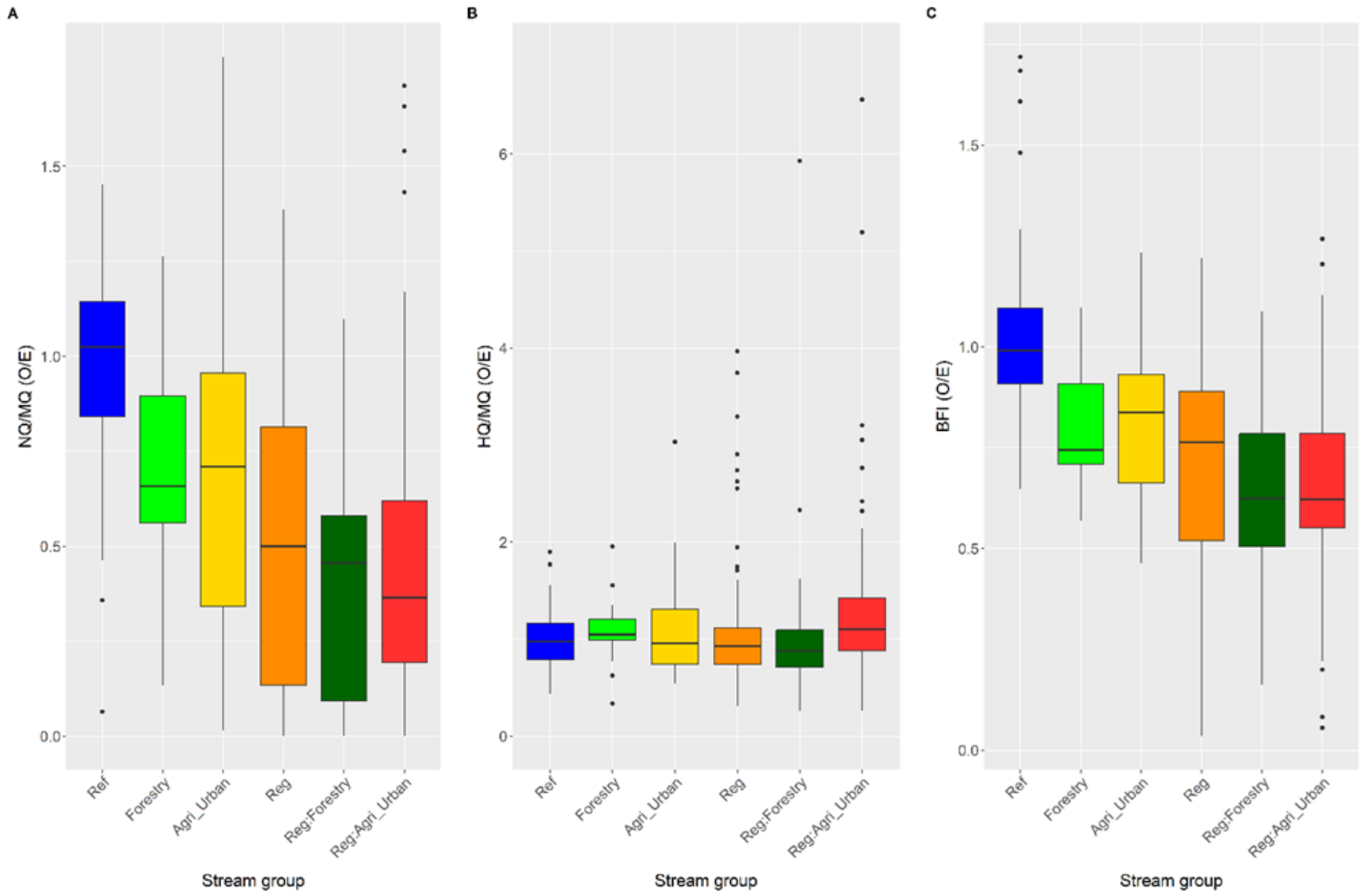
Response to pressures (observed to expected ratio)

- NQ/MQ ratio and base flow index (BFI) were the most sensitive metrics to human pressures
- The +400 sites were classified based on metric deviation from expected values (O/E-ratio) to above good status (O/E >= 0.6) or bad-moderate status (O/E < 0.6)



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Coarse hydrological status assessment of Finnish river waterbodies

- Random Forest machine learning algorithms were used to build a model that could predict hydrological status of the +400 sites based on catchment variables and flow regulation
- The models classified > 80% sites correctly when 75 % of the sites were used to train the models and 25 % as test sites
- Catchment data were compiled for all 1960 river water bodies and were used to predict the hydrological status by the RF model

Hydrological status of Finnish streams

- Of the 1960 river waterbodies 1430 (73 %) were predicted to be in good or better status
- 530 (27 %) were predicted in bad-moderate status
- In the assesment of local environmental authorities 1831 WBs in good or better status, of these the model predicted 310 (17%) to be in worse than good status
- In the assesment of local environmental authorities 129 WBs were in worse than good status, of these the model predicted all (100%) in worse than good status

Conclusions

- The flow metrics in natural conditions could be predicted quite accurately with just few variables (Catchment area, lake% and air temperature)
- However, there is quite a lot of variation in O/E ratios when flow deviation is quantified in the impacted sites
- The data used in building the models represent mostly larger streams as there is limited number of small catchments where flow is gauged
- Classification was only based on deviation from natural flow regime not on relevance to biota
- Although imperfect, could aid authorities to better assess hydrological status, especially the effects of land use in hymo status asssessment

Thank you!

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