

A REVIEW OF STABLE WATER ISOTOPE STUDIES DONE IN FINLAND

Riku Eskelinen^{1,2}, Anna-Kaisa Ronkanen¹, Pekka Rossi¹, Elina Isokangas¹, Hannu Marttila¹, and Bjørn Kløve¹

¹University of Oulu, Finland ²Thule Institute, Finland

Early stages of stable isotope hydrology in Finland

The use of stable isotopes of water in Finland begun about 30 years ago through a need to search for a safe location to store nuclear waste within the bedrock (Blomqvist et al., 1986). For this purpose samples of ¹⁸O, ²H and ³H were taken from deep boreholes across Finland. The results helped decipher the age of groundwater at a certain level in the boreholes, which further on made it possible to give trustworthy statements how likely threat the stored nuclear waste would pose for the population.

Recently the advantages in spectroscopy have succeeded in bringing the analyzer purchase and running costs down which has helped to popularize the isotope analysis as a standard tool in hydrology. However the wider use of isotopes in Finland has been dragging due to lack of analyzers and the awareness of what can be studied and achieved with the water isotopes.

First nationwide sampling campaign

The results of the first larger campaign for defining the isotopic composition of Finnish waters was published by Kortelainen and Karhu (2004). They monitored groundwater wells from 19 different locations for six years and sampled 953 wells scattered around Finland. In addition precipitation was sampled monthly for two years time period. As a conclusions of the study a national meteoric water line for Finland was defined from the groundwater data as $\delta D = 8.5 \delta^{18}O + 16.55$. $\delta^{18}O$ and the δ^2H values were found to decrease towards the northern Finland together with the mean annual surface temperature.

Recent studies

Recent and on-going studies have added detail by forming regional meteoric waterlines and local evaporation lines, which help the researchers to improve their studies of local water cycle. In recent years at University of Oulu, the water isotopes have been used in various ways for example taking spatially distributed samples across wetlands to define which the active or stagnant flow zones are (Ronkanen and Kløve, 2008) or for quantifying groundwater dependence of lakes (Isokangas et al., 2015). On-going studies also include stable isotope of water to identify groundwater dependent ecosystems and groundwater recharge/discharge areas. Also continuous sampling of precipitation has been started in Oulu to get more detailed knowledge about variation of $\delta^{18}O$ and δ^2H values in precipitation.

Future plans

The aim of this project is to build a database of isotope studies done in Finland (maybe include Sweden and Norway) in order to help future researches to use the stable isotopes of water more easily and to increase co-operation between different facilities in Finland and elsewhere. Results of data collected so far to now are plotted in Figure I, which shows the locations of isotope studies done in Finland found from peer reviewed journals and also the known study sites from which the data is not yet published.

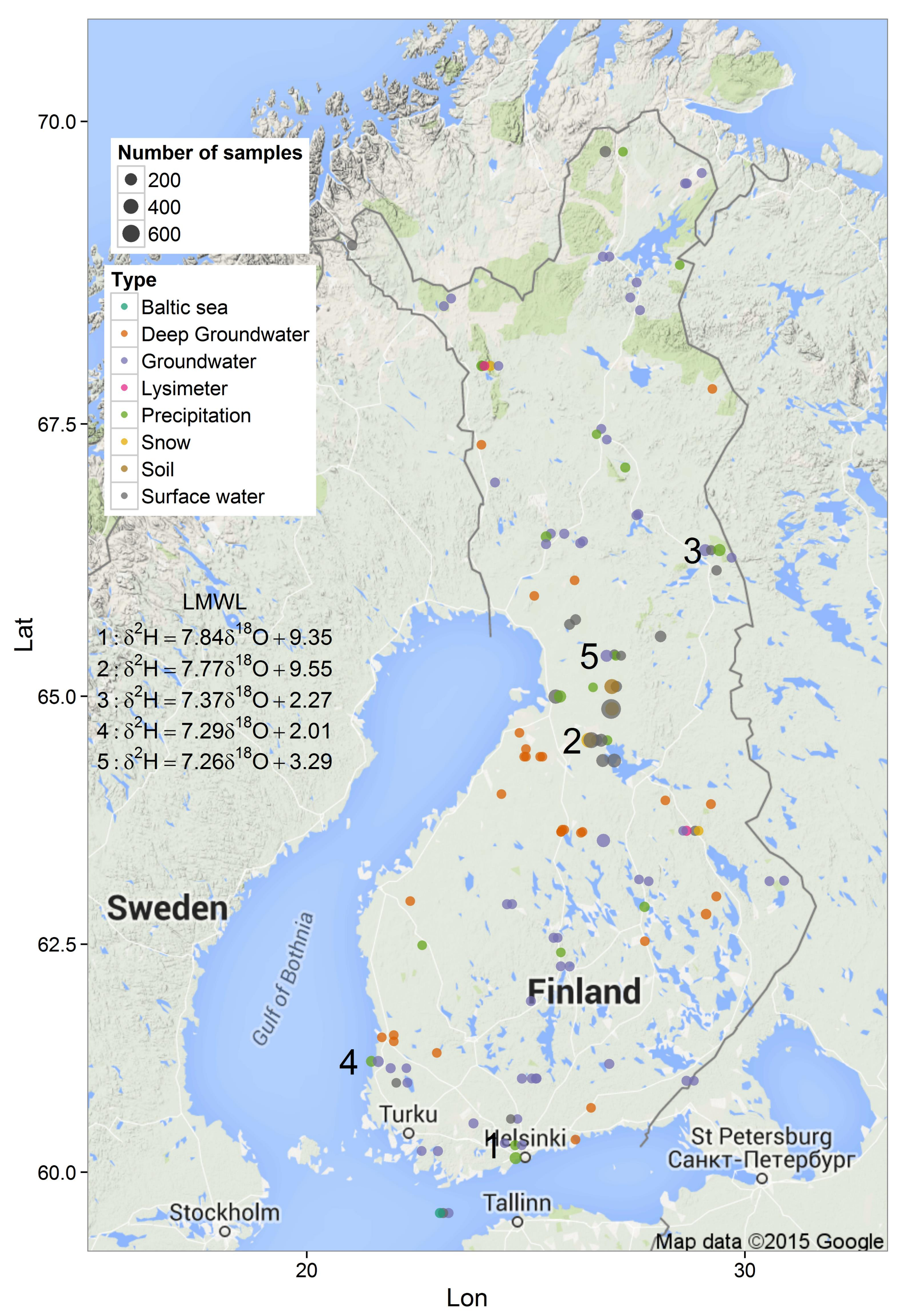


Figure I. The use of stable isotopes of water in hydrological studies in Finland.

References

Blomqvist, R., Lahtinen, R., Lahermo, P., Hakkarainen, V., Halonen, S., 1986. Kalliopohjaviesien geokemia: tutkimustulokset syvistä kairareijistä vuonna 1986. Geological Survey of Finland, Finland.

Isokangas, E., Rozanski, K., Rossi, P., Ronkanen, A.-K., Kløve, B., 2015. Quantifying groundwater dependence of a sub-polar lake cluster in Finland using an isotope mass balance approach. Hydrology and Earth System Sciences.

Kietäväinen, R., Ahonen, L., Kukkonen, I., Hendriksson, N., Nyssönen, M., Itävaara, M., 2013. Characterisation and isotopic evolution of saline waters of the Outokumpu Deep Drill Hole, Finland – Implications for water origin and deep terrestrial biosphere. Applied Geochemistry 32, 3751.

Korkka-Niemi, K., Lahti, A.-L., Nygård, M., Rautio, A., Pellikka, V.-P., 2012. Observations on groundwater-surface water interactions at River Vantaa, Finland. Management of Environmental Quality: An International Journal 23, 22231.

Kortelainen, N., 2007. Isotopic composition of oxygen and hydrogen in Finnish groundwaters based on groundwater monitoring in 1995-2001 and “One thousand well”-project in 1999: Tables

Kortelainen, N., Karhu, J., 2004. Regional and seasonal trends in the oxygen and hydrogen isotope ratios of Finnish groundwaters: a key for mean annual precipitation. Journal of Hydrology 285, 143157.

Lamminen, S., 1995. Kiven ja veden välinen vuorovaikutus erilaisissa kivilajiympäristöissä. Geologic Survey of Finland, Finland.

Luoma, S., Olkonen, J., Korkka-Niemi, K., Hendriksson, N., Backman, B., 2014. Confronting vicinity of the surface water and sea shore in a shallow glaciogenic aquiferin southern Finland. Hydrology and Earth System Sciences Discussions 11, 8651–8695.

Ronkanen, A.-K., Kløve, B., 2008. Hydraulics and flow modelling of water treatment wetlands constructed on peatlands in Northern Finland. Water research 42, 3826–36.

Acknowledgements
Maa- ja vesitekniiikan tuki (MVTI).

Contact details
Riku Eskelinen (riku.eskelinen@oulu.fi)

