Stable isotopes studies to increase knowledge from the role of peatlands in catchment hydrology

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1. Glance to the theory of stable isotopes method

2. Examples how to use the method to study
   A. Preferential flow area and flow paths in peatland
   B. Source of the water
   C. Water residence time in systems
   D. Role of peatland to local groundwater level
   E. Effects of peatland restoration on catchment hydrology

3. Summary
1. Background and theory of isotope method

Stable isotope of water

- $^{16}\text{O} = 99.763\%$
- $^{17}\text{O} = 0.0375\%$
- $^{18}\text{O} = 0.1995\%$
- $^{2}\text{H}$ (Deuterium)
- $^{1}\text{H}$

($^{3}\text{H}$ or Tritium, radioactive)

http://www.geog.ucsb.edu/~williams/Isotopes.htm
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Fractionation processes of oxygen

Evaporation
- lighter isotopes evaporate

Ocean
0 ‰

Evapotranspiration
-7 ‰

Rain -3 ‰
- heavier isotopes condense

Precipitation
-5 ‰

Vapor -15 ‰

Vapor -18 ‰

\[ \delta(\text{o}‰) = 1000 \cdot \frac{^{18}/^{16}O_{\text{sample}} - ^{18}/^{16}O_{\text{standard}}}{^{18}/^{16}O_{\text{standard}}} \]
2. Examples: Preferential flow area in peatlands (Kompsasuo, 2.2 ha)

4 studied peatlands purifying
- peat harvesting runoff (2 sites)
- municipal wastewater (2 sites)

Deviation from the inflow means a higher evaporation effect and longer residence time in the peatland


Link between preferential flow area and nutrient processes

Ruka peatland, 0.6 ha (municipal wastewater)
Ongoing studies

Wastewater from a mine of gold ore

Inflow rate = 1 400 m$^3$/d

Area = 44 ha

Residence time is too long for a tracer injection
Research questions

1. How much runoff is flowing from the upper catchment area to the peatland?

2. What is the role of forest areas in generating flow paths in the peatland?

3. Where is the border of the treatment peatland?

4. How long the water stays in the peatland (residence time)?

ISOTOPE METHOD
Role of peatland in Rokua esker
Role of peatland in Rokua esker

- Understanding role of peatlands surrounding eskers
- Modelling of groundwater flow patterns of the esker
- To find out what is the impact of climate and peatland drainage to the lake levels
Peatland restoration

Iijoki catchment area

Metsähallitus
Finnish Forest Institute

How large peatland areas should be rewetted for sufficient water storage

Water samples before and after the restoration
- precipitation
- groundwater
- ditches
- ponds
SUMMARY:
Isotopes are useful tools for characterizing several different water dynamics within a watershed

• Residence time of water in different water bodies
• Sources of water: mixing and flow paths of water within a system
• Characterizing how water moves within the watershed

If studied systems is sampled before and after restoration or reconstruction, the effects of actions would be possible to specify.
Strength of isotopes

Isotopes are environmental tracers
  - no injection
  - are ideal conservative tracers
  - follow the natural flow processes
  - large time scale
  - winter is not problem
Thank you