

Effects of snowmelt on the runoff dynamics in two catchments with different forest stands

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**Two forested lake catchments
Bohemian Forest – Central
Europe**

Mature forest

**Regenerating forest after
bark beetle infestation**

**Using water stable isotopes to
determine snowmelt
contribution to runoff**

**Comparing basic element
fluxes**

Different snow cover duration

**Different snowmelt dynamics
affecting the streamflow**

**Different solutes
concentration in the
snowpack and precipitation**

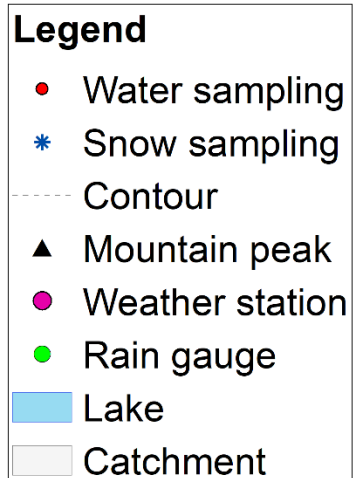
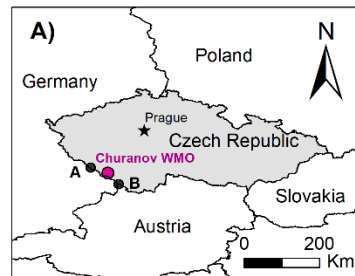
**Forest canopy changed
isotopic and chemical
composition of snowpack**

Photo: @Roman Juras

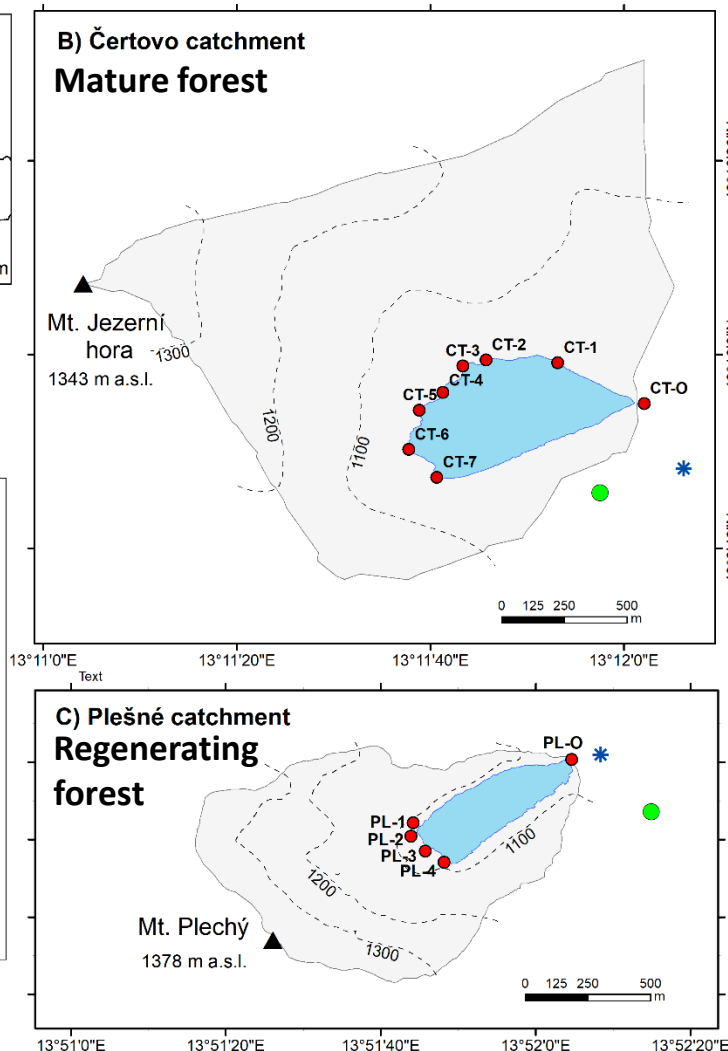
Motivation and Research goals

- Bark beetle infestation and wind storms damaged several head water catchments in the Bohemian Forest National Park (Czechia)
 - Ongoing debates regarding the forest management
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- What are the differences in runoff dynamics and composition in mature and regenerating forest catchments?
 - We focused on water and elements fluxes from snowpack during the seasonal snow cover period, using natural stable water isotopes and chemistry

Methods – study locality



Coordinate System: GCS WGS 1984



Catchment characteristics:

Catchment	Čertovo – Mature forest	Plešné – Regenerating forest
Area including lake (ha)	89	67
Lake surface level (m a.s.l)	1,027	1,087
Lake surface area (ha)	10.7	7.2
Lake maximum depth (m)	36	18
Average lake water residence time (2000-2019) (year)	1.7	0.9
Number of surface inlets	7	3



Photo: @Roman Juras

Čertovo catchment – 11 March 2020

Mature forest

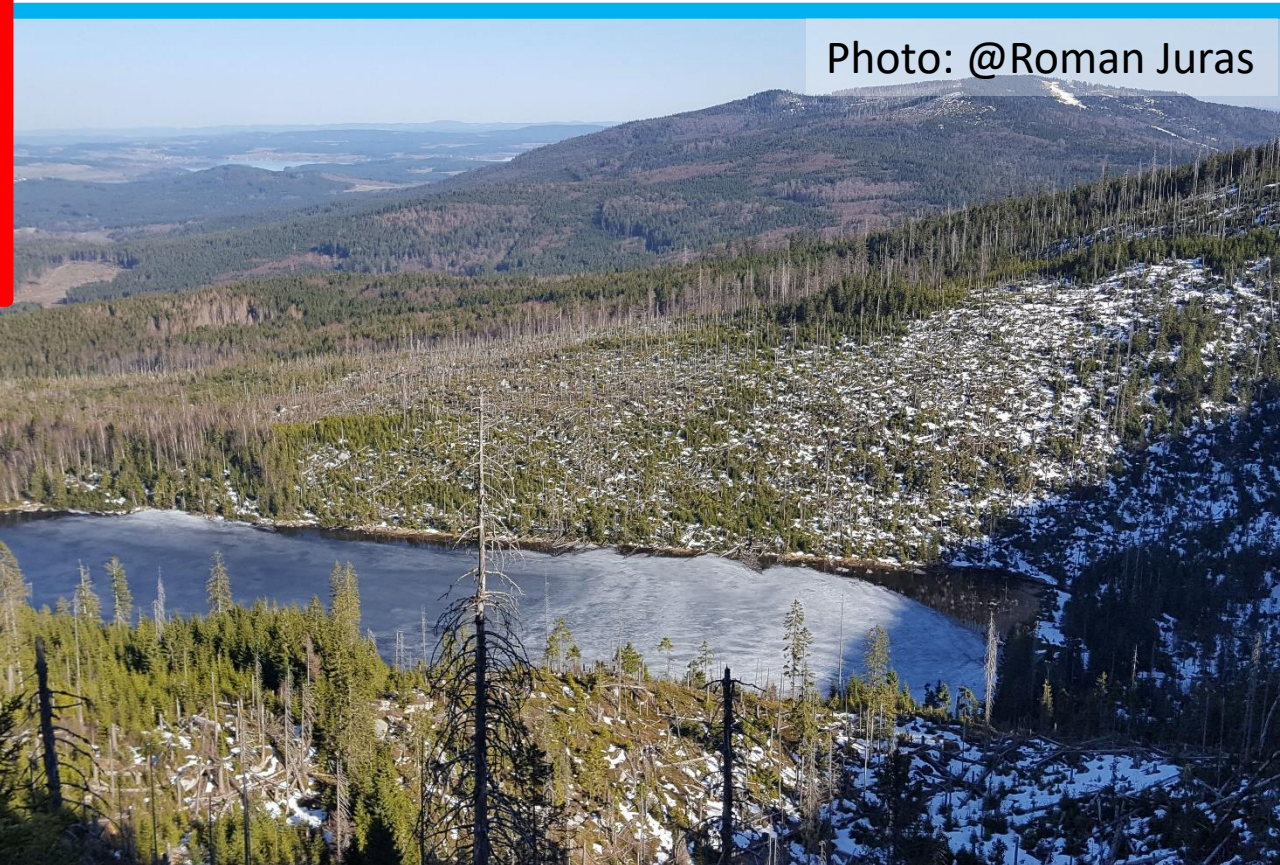


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Plešné catchment – 8 April 2020

Regenerating forest



Methods – chemical analysis, sampling

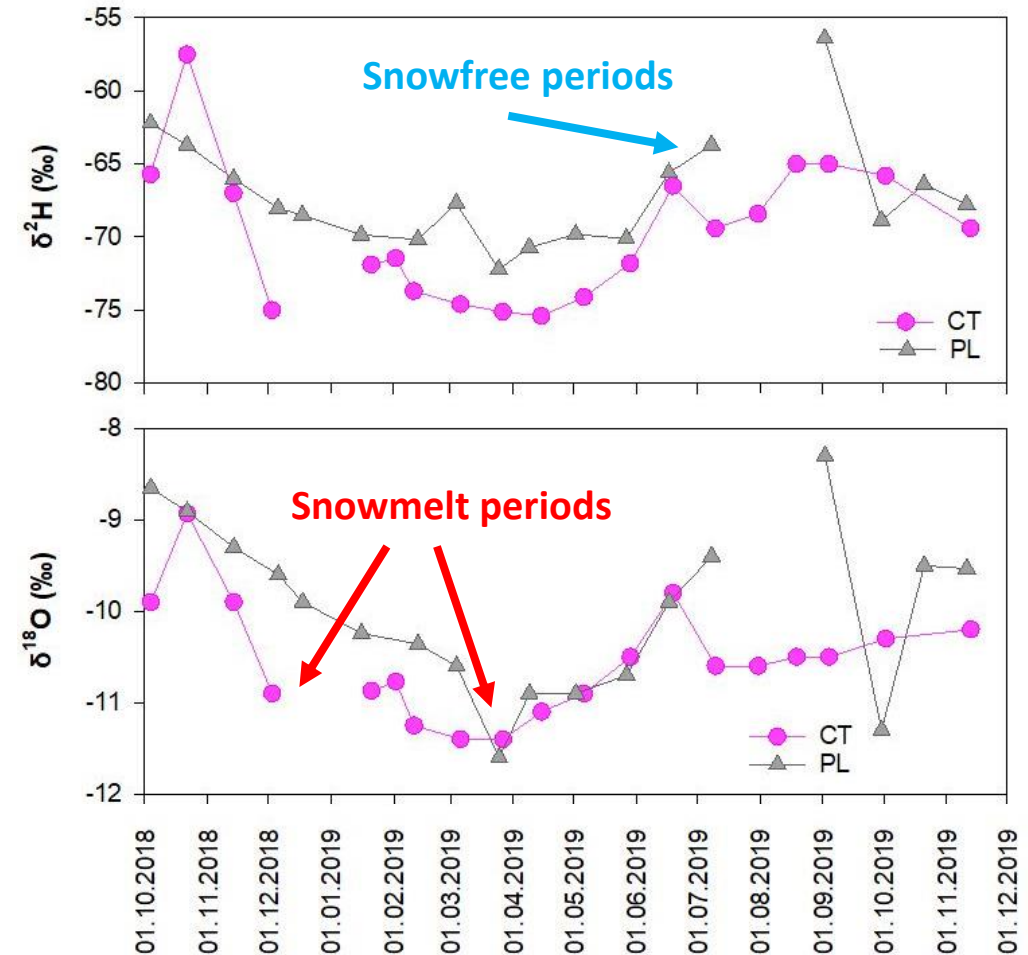
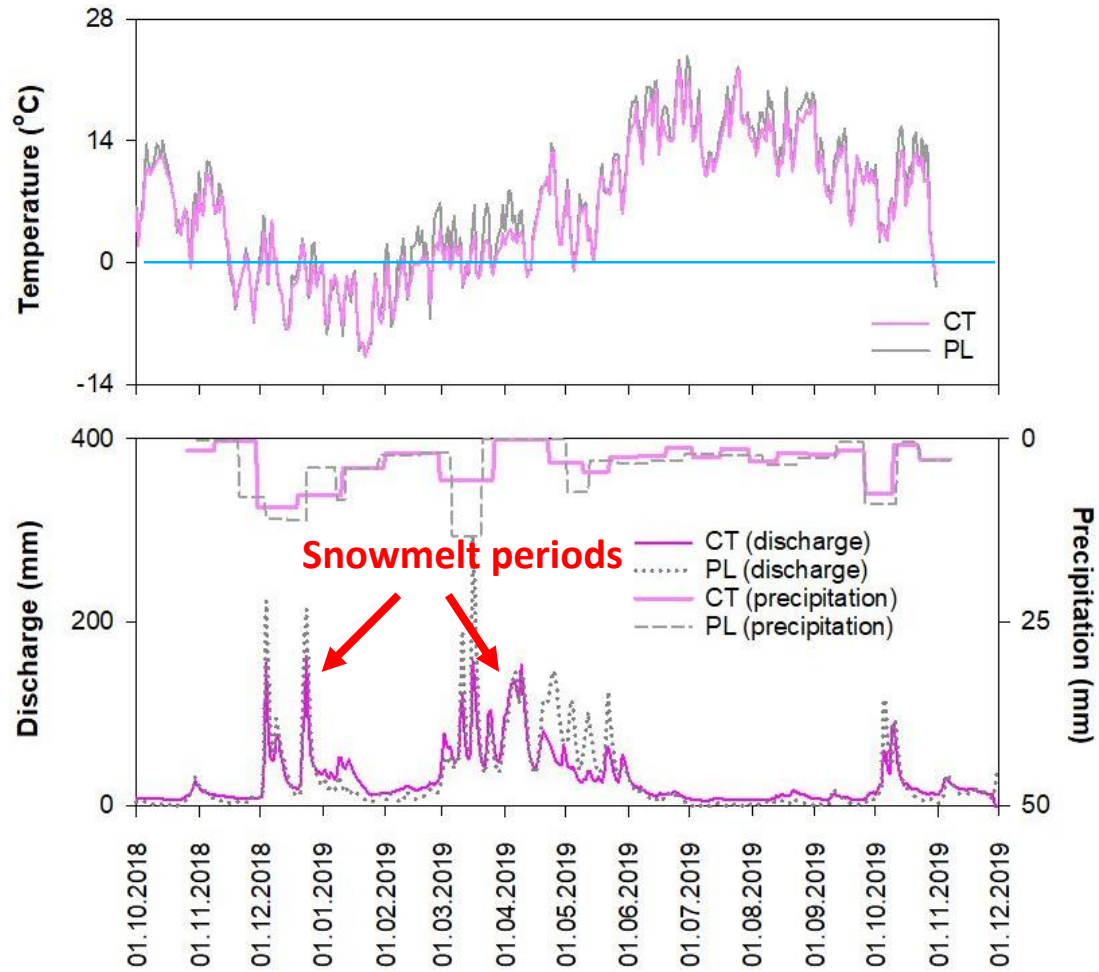
- **Solutes analysis:** Ion Chromatography (ions), TOC-L_{cph} analyser (TN, DOC), molybdate method (TP)
- **Isotope analysis:** Laser Spectroscopy (Los Gatos Research®)
- **Sampling:** Precipitation, snowpack, lake inflow, lake outflow
- **Snowmelt contribution:**

$$Q_{tot} \cdot C_{tot} = Q_{pre} \cdot C_{pre} + Q_{ev} \cdot C_{ev}$$

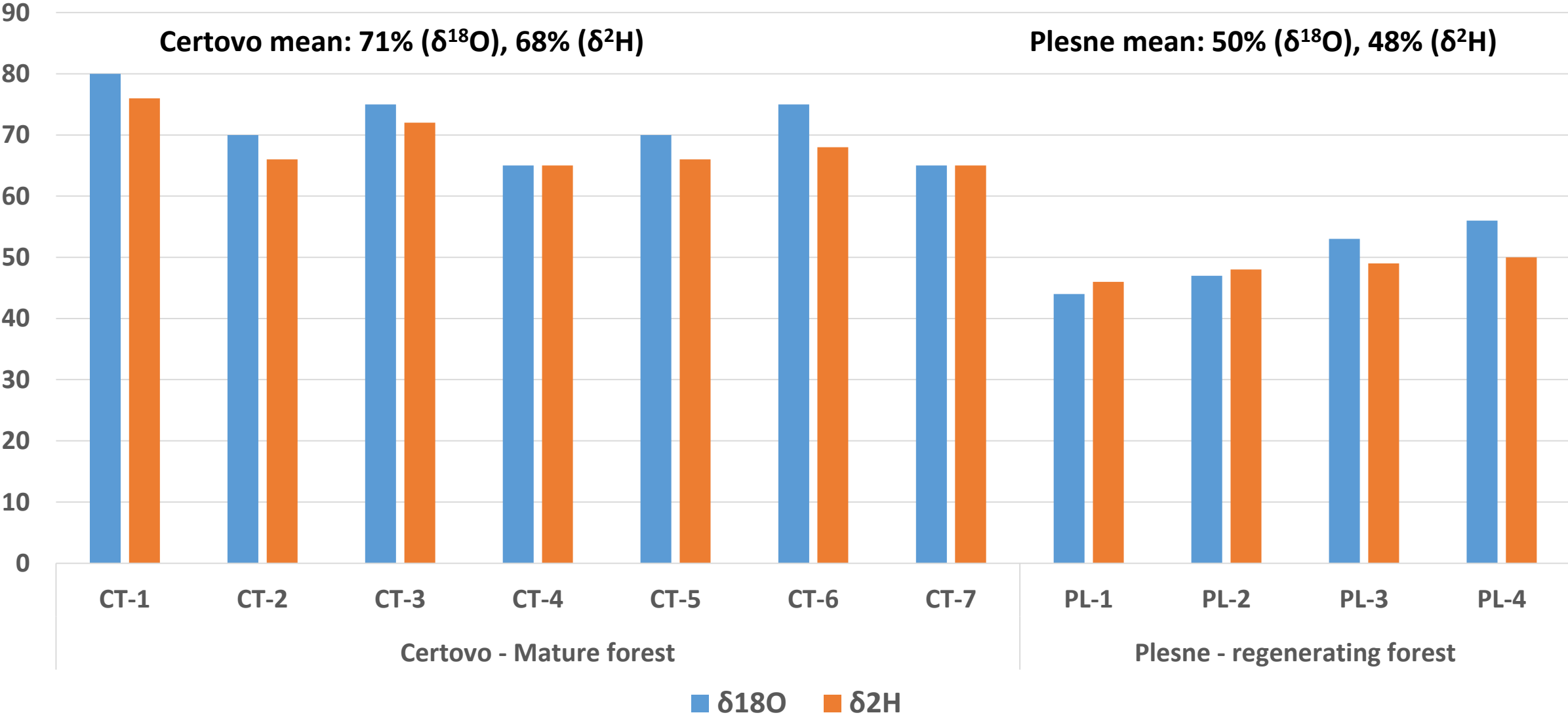
Q – discharge, C - $\delta^2\text{H}$ values in the lake outlet

Indices: *tot* – discharge peak, *pre* – before snowmelt event, *ev* – snowmelt event

Results – discharge comparison

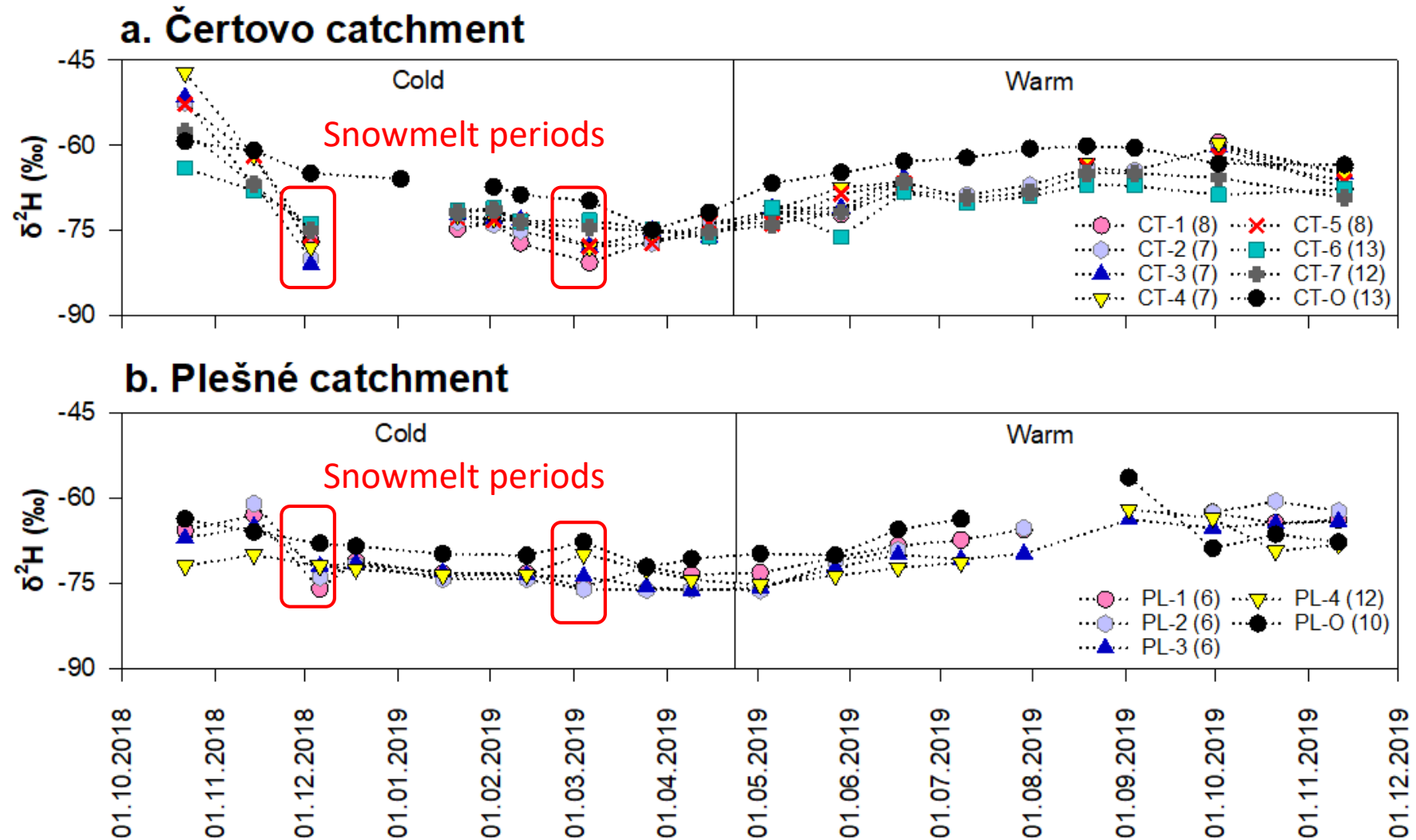


Snowmelt contribution to runoff

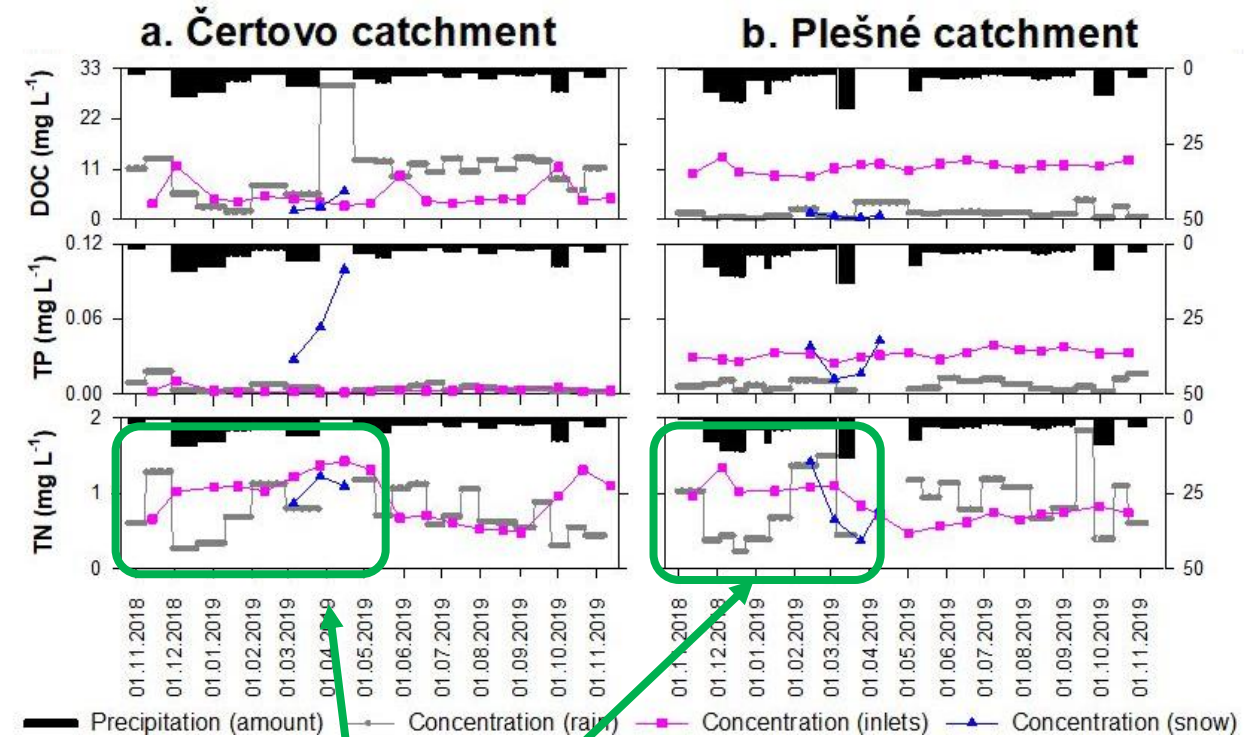
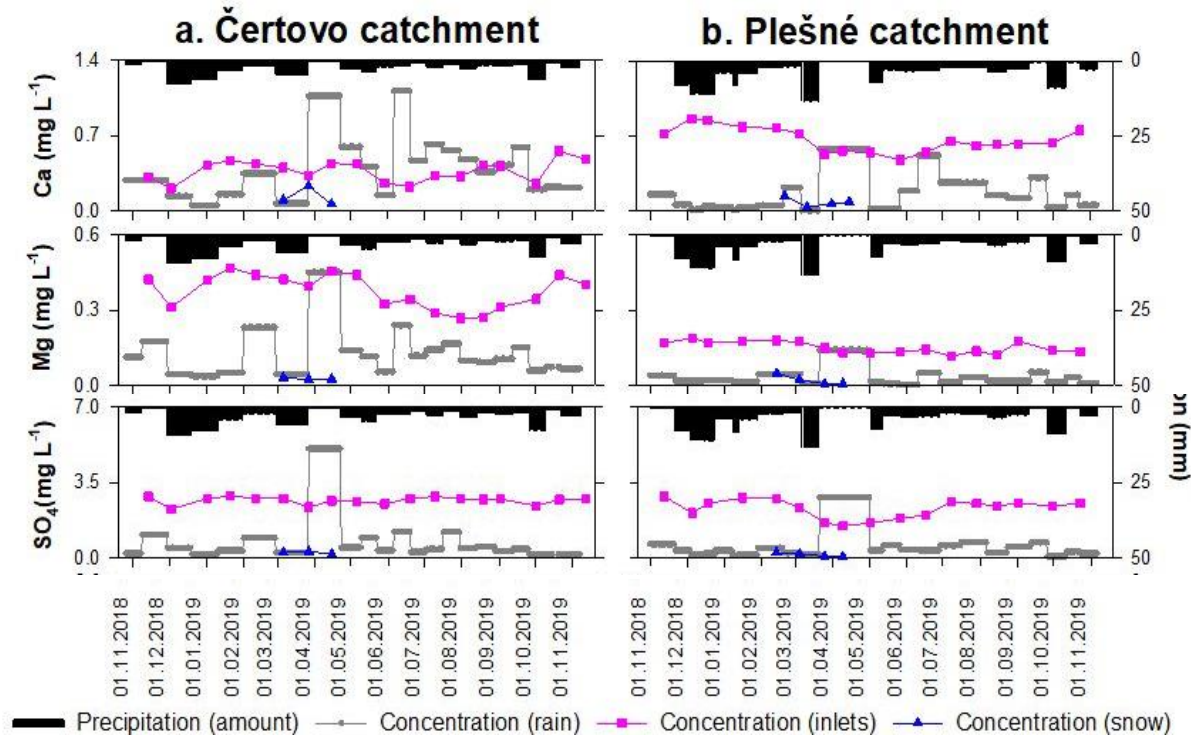


Inflow/outflow isotopic signature

Clearer decrease
in CT catchment



Concentration of solutes



Higher concentrations
during the cold period

Take home message

- Snowmelt effects the runoff 1 month longer in mature than in regenerating forest catchment
- Snowpack contained higher solutes concentration in mature than in regenerating forest.
- Interception by forest canopy changed isotopic and chemical composition of snowpack
- Continuous release of NO_3^- and SO_4^{2-} from snowpack reduces spring snowmelt acidity.

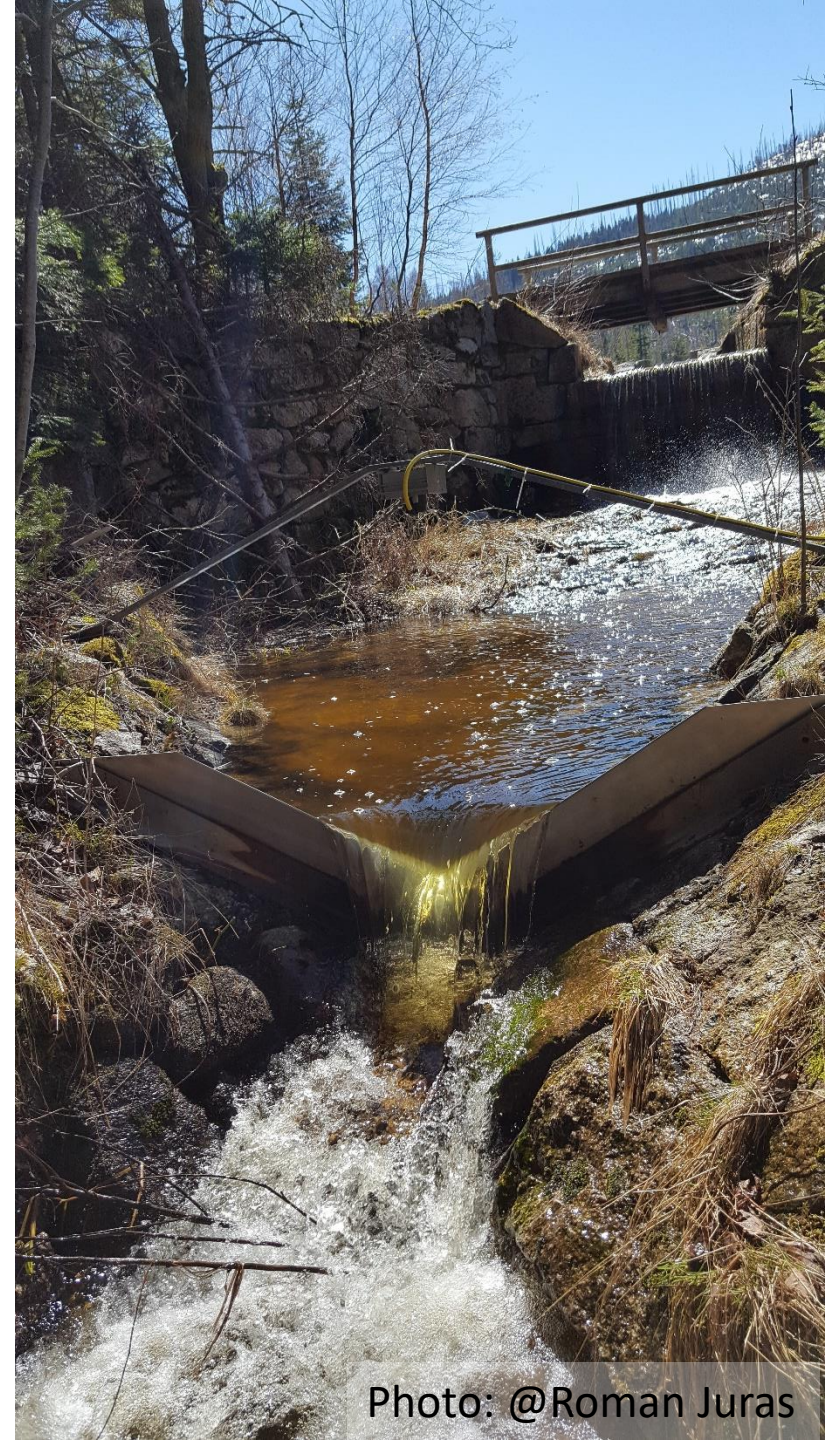


Photo: @Roman Juras

Conclusions

- During November – December 2018 the snowpack was isotopically enriched, suggests rainwater storage.
- Heavy isotopes - ^{18}O and ^2H (from the stored rainfall) were preferentially eluted.
- Increase of some elements concentration (particularly Ca^{2+} and Mg^{2+} , and leaching NO_3^-) in both catchments inlets
- Snowpack showed lower concentration of heavy isotopes and ions compared to precipitation in both catchments
- Higher frequency of episodic snowmelt events can intensify the elution of ions, particularly strong acid anions (SO_4^{2-} and NO_3^-)

References and Acknowledgement

The study is currently under review:

Vystavna Y., Paule-Mercado M., Juras R., Schmidt S.I. , Kopáček J., Hejzlar J., Huneau F.:
Effect of snowmelt on the dynamics, isotopic and chemical composition of runoff in mature and regenerated forested catchments, Journal of Hydrology, under review.

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