Session HS2.1.5
EGU22-859
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On the identification of hydrogeological reservoirs in a proglacial catchment and their future groundwater storage

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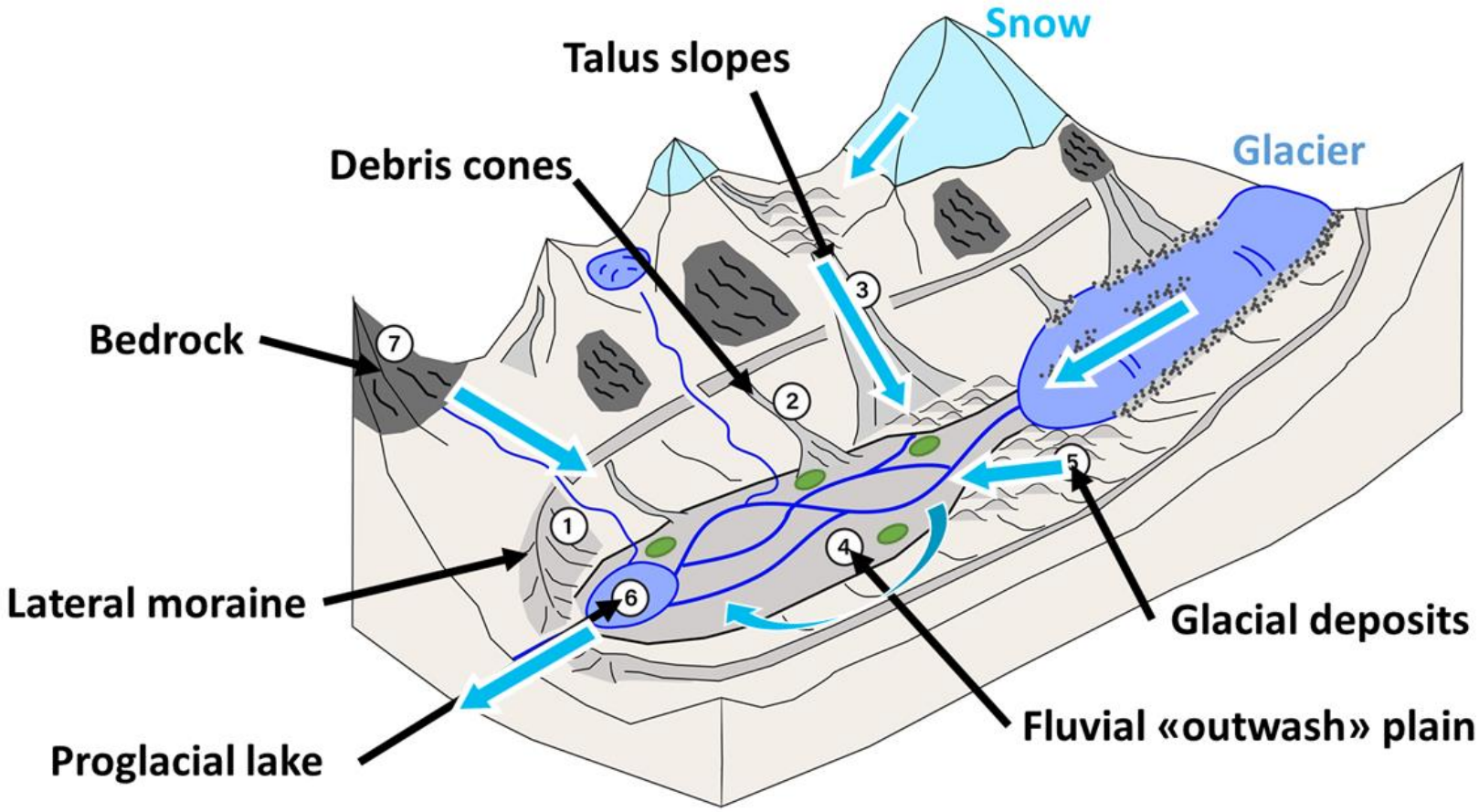
FNSNF Swiss National Science Foundation

Where is water stored ?
Geomorphological landforms in proglacial zones

- Ice retreat leads to **new landforms**
- Water **storage and release time** depends on landforms
- In a context of **rapid ice, early snow melt** :

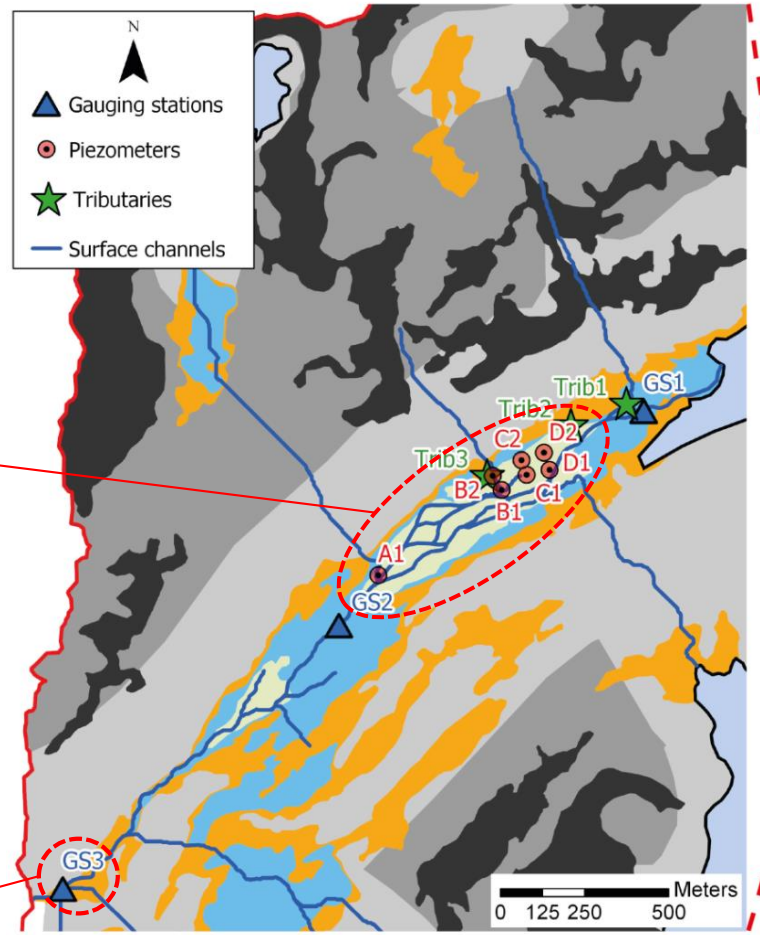
1. Maintaining **baseflow** and ecosystem diversity
2. Transmission/attenuation of future **floods**
3. Providing water for **downstream usage**

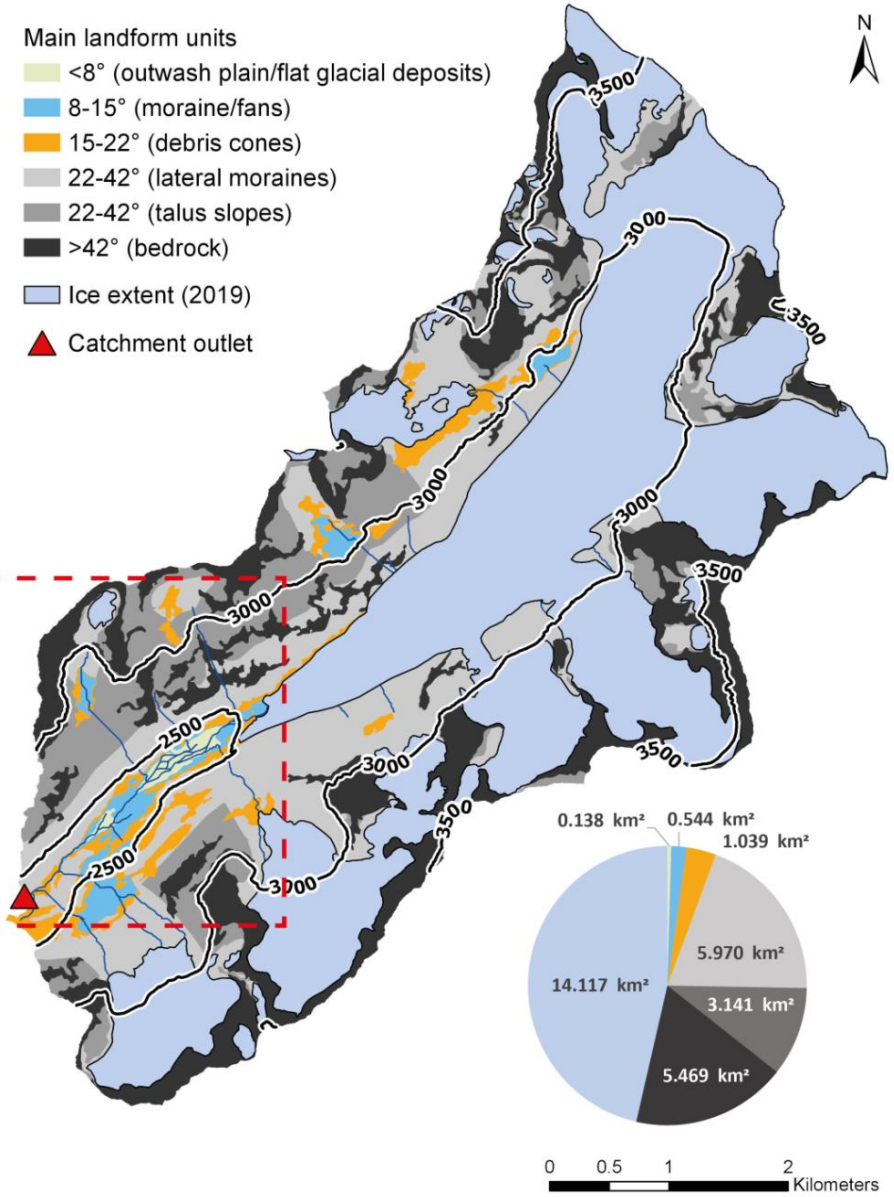


Experimental site – Otemma glacier (CH)

Outwash plain

Gauging station



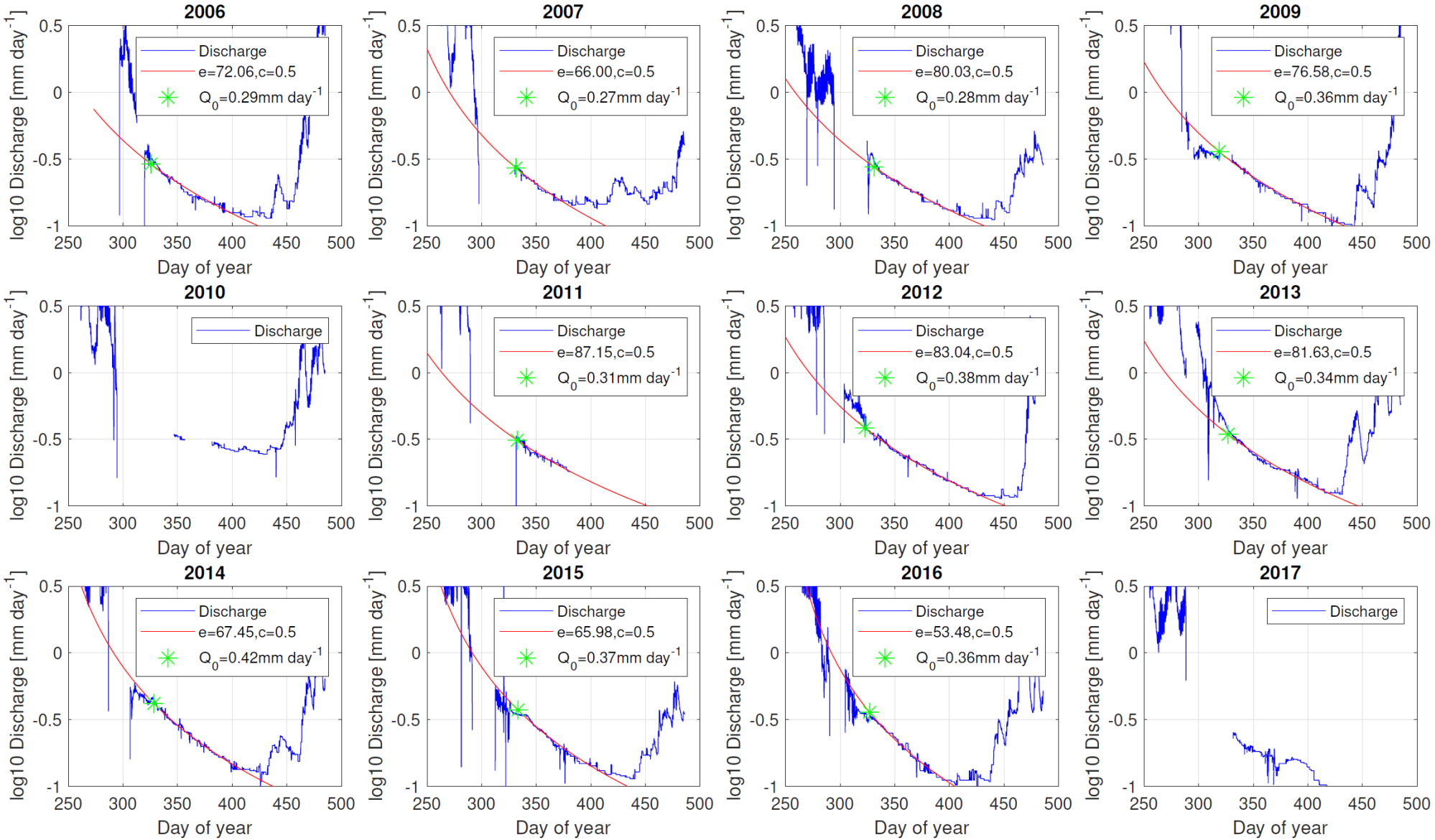


Winter discharge recession at catchment scale

$$S = eQ^{0.5}$$

$$Q_t = Q_0(1+\alpha t)^{-2}$$

$$\alpha = \frac{Q_0^{0.5}}{e}$$



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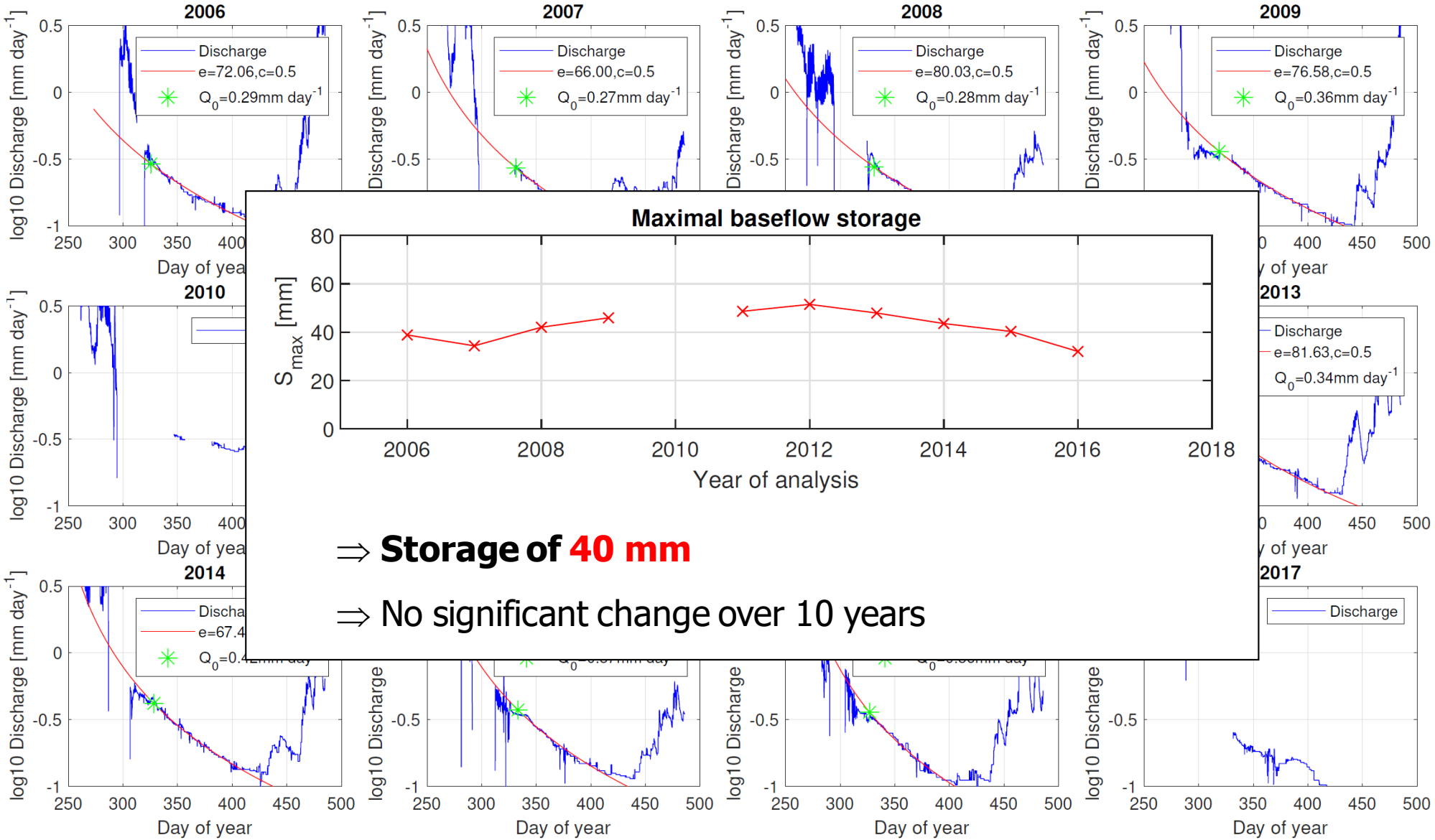


Proglacial superficial landform storage

$$\frac{\delta S}{\delta t} = Q_{in} - Q_{out}$$

$$Q_{out} = \left(\frac{S}{e}\right)^{1/c}$$

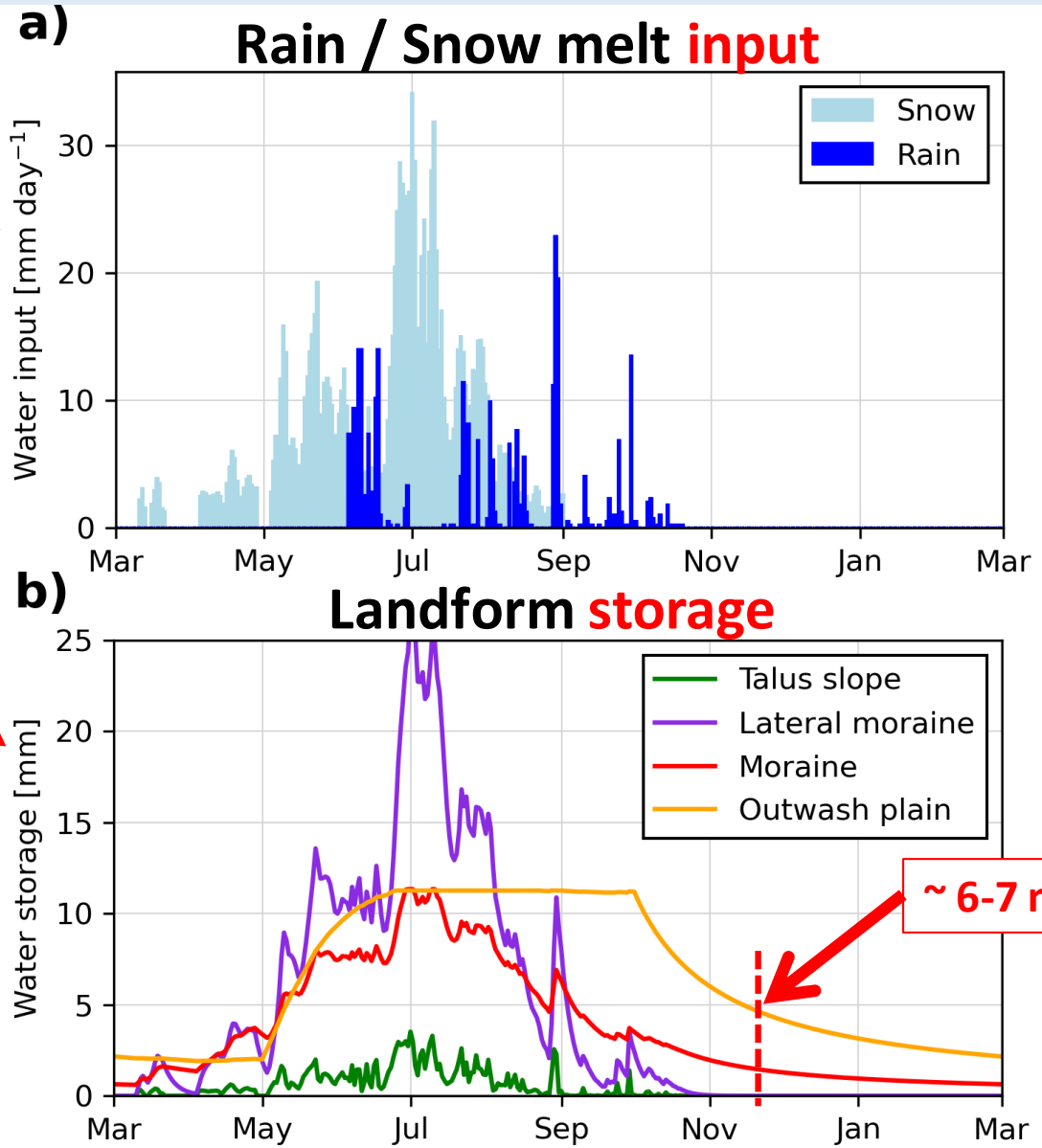
$$\alpha = \frac{Q_0^{0.5}}{e} \approx \frac{K_s h_m}{\phi L^2}$$

Physical parameter of landform

Q_{in}

S_t

- **Steep** landforms = **short timescales** (days)
- **Outwash plain** = **longer recharge** & **longer recession** constant
- Winter storage <40 mm => **missing storage**

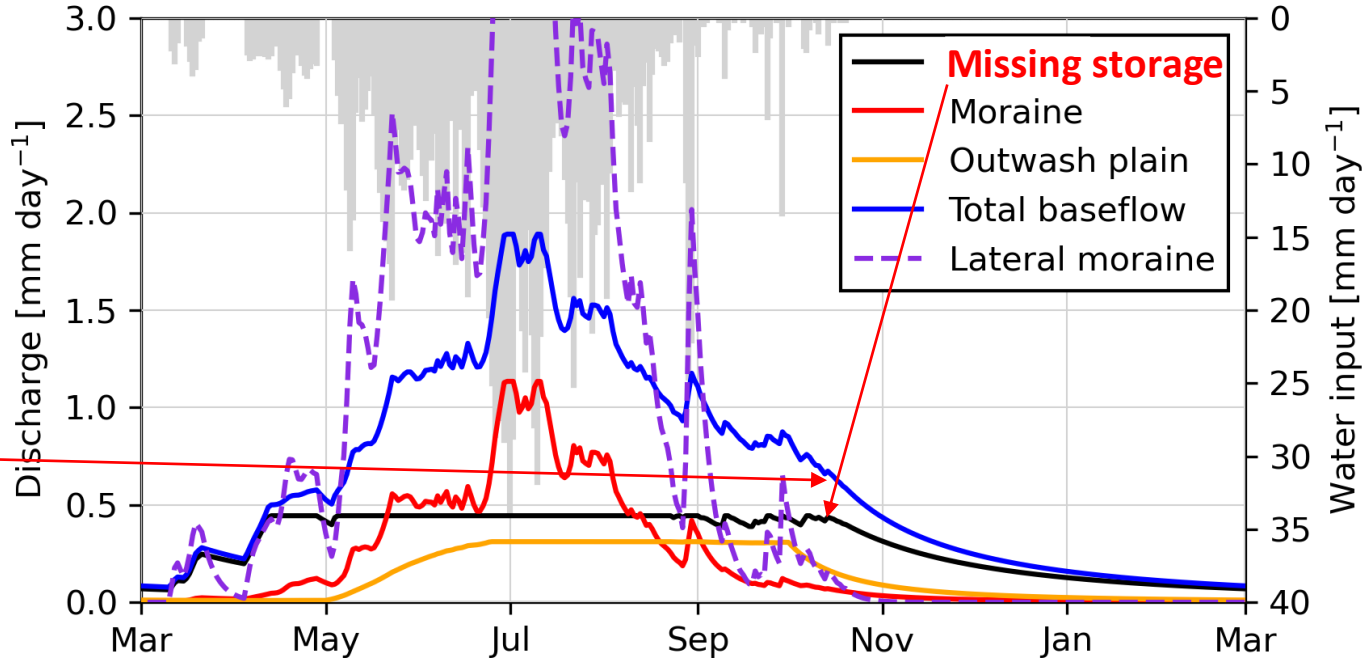


Proglacial superficial landform storage

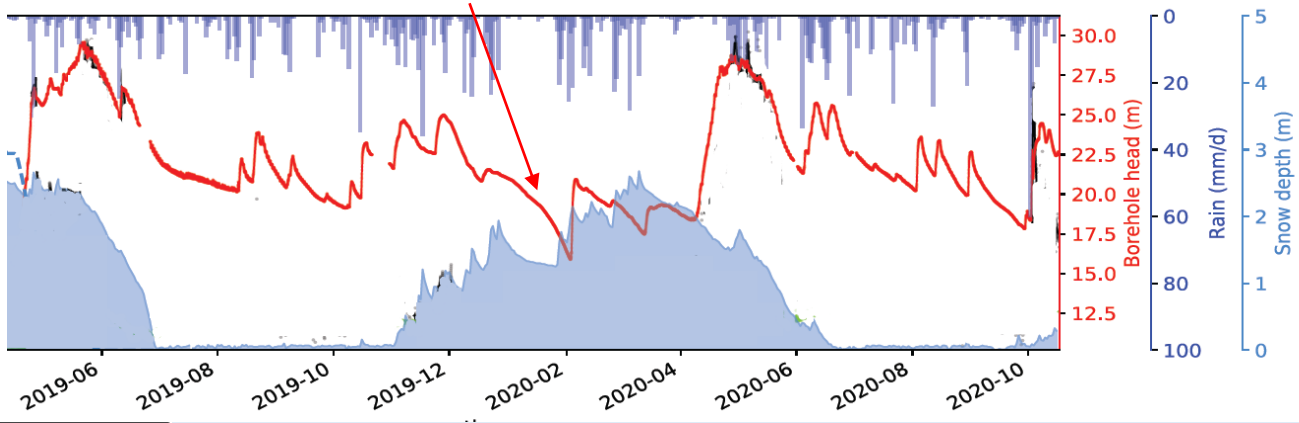
Missing storage !

- Bedrock storage of ~35 mm ?
- Or subglacial melt ?

The missing storage is the main source of water during winter



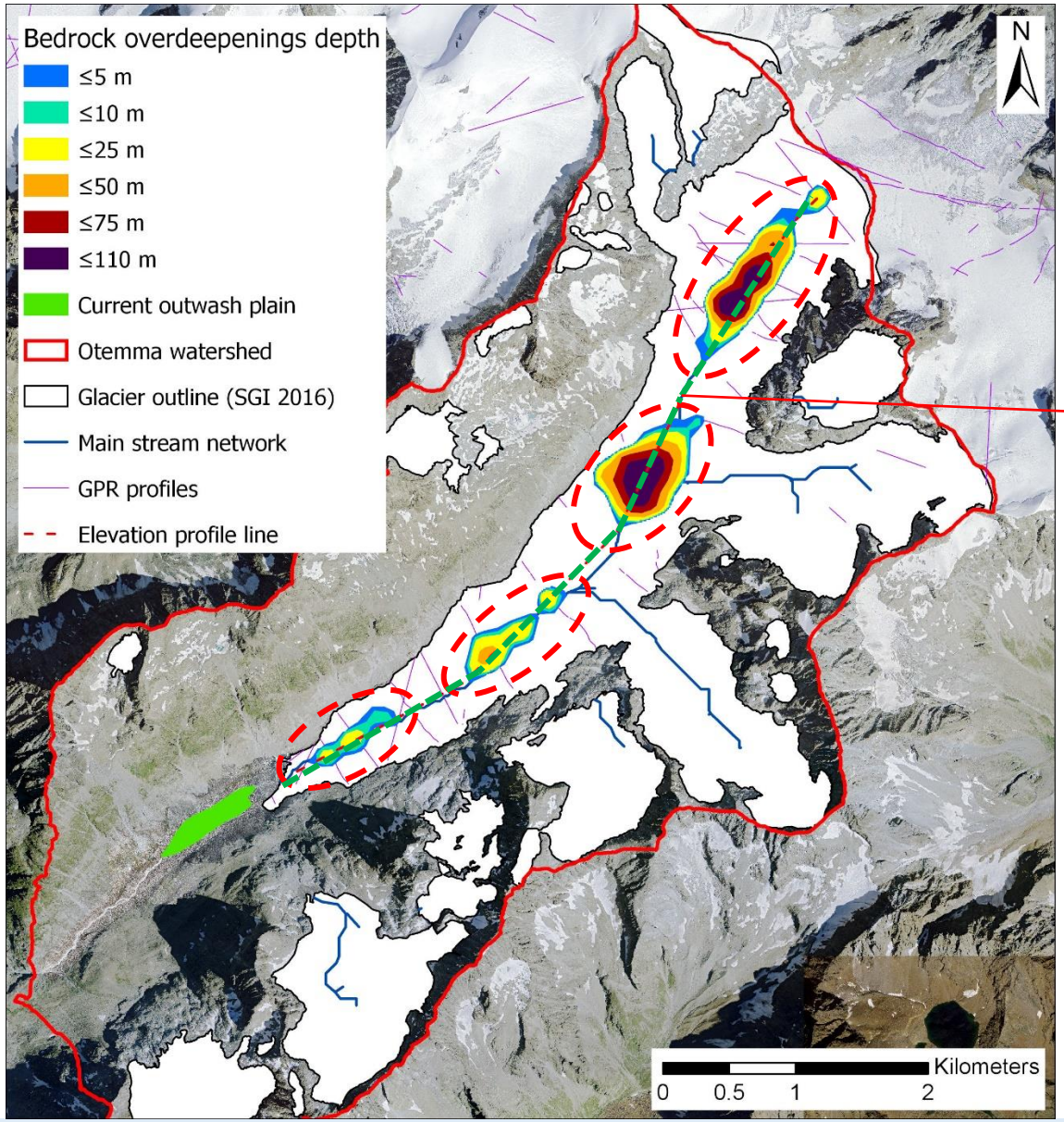
Bedrock borehole head at Aletsch Glacier

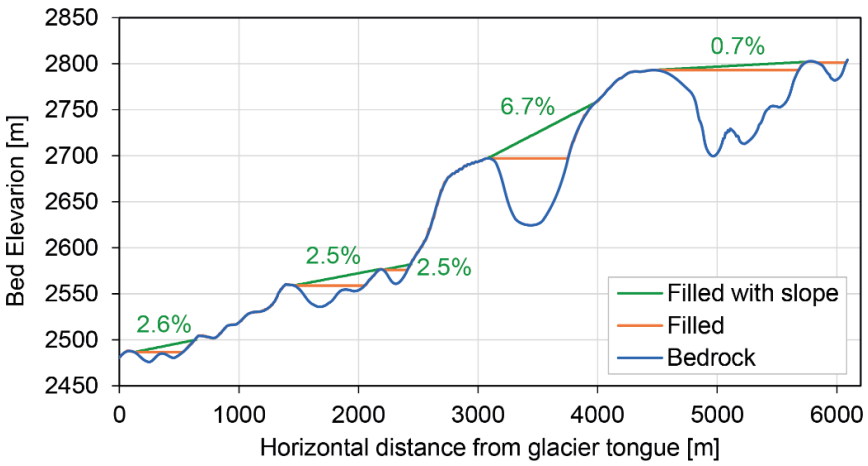


From : Oestreicher et al., 2021
https://doi.org/10.1002/essoar.10507494.1

Future landforms in a deglaciated catchment

Future outwash plain in glacier **overdeepenings** ?





	Area [m²]	Volume [m³]	Volume [mm]	Active storage [mm]
Overdeepening 1	114 000	746 354	24.6	19.0
Overdeepening 2	148 300	1 899 117	62.5	31.2
Overdeepening 3	34 200	286 527	9.4	3.1
Overdeepening 4	403 400	16 837 733	553.9	267.5
Overdeepening 5	410 600	14 527 905	477.9	64.5

Based on : Grab et al., 2021. **Swiss Glacier Thickness.** https://doi.org/10.3929/ethz-b-000434697

Take home message

- **Superficial landforms** are **not able to store groundwater** at timescales larger than days

- **Bedrock** should not be neglected !

- **Outwash** plain may have a **future role** to maintain baseflow ?

Thank you for your attention

Don’t hesitate to contact me : tom.muller.1@unil.ch

Towards a hydrogeomorphological understanding of proglacial catchments: review of current knowledge and assessment of groundwater storage and release in an Alpine catchment, **Hydrol. Earth Syst. Sci. Discuss**. [preprint], https://doi.org/10.5194/hess-2022-110, in review, 2022.

https://zenodo.org/communities/otemma/ -> data on discharge, EC, piezometer, weather, water isotopes (to come), …

Bonus : River electrical conductivity