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What happens after glaciers disappear? Lessons from the Otemma glacier, Switzerland

Stuart N. Lane, stuart.lane@unil.ch

Institute of Earth Surface Dynamics

PhD students : Pascal Egli, Matt Jenkin, Davide Mancini, Tom Müller, Matteo Roncoroni

Technicians : Floreana Miesen, Aurélien Ballu

Collaborators : Pascal Vittoz (UNIL), Tom Battin (EPFL), Bettina Schaepli (U Berne), Micha Dietze (Göttingen) amongst many others

... **and many many students**

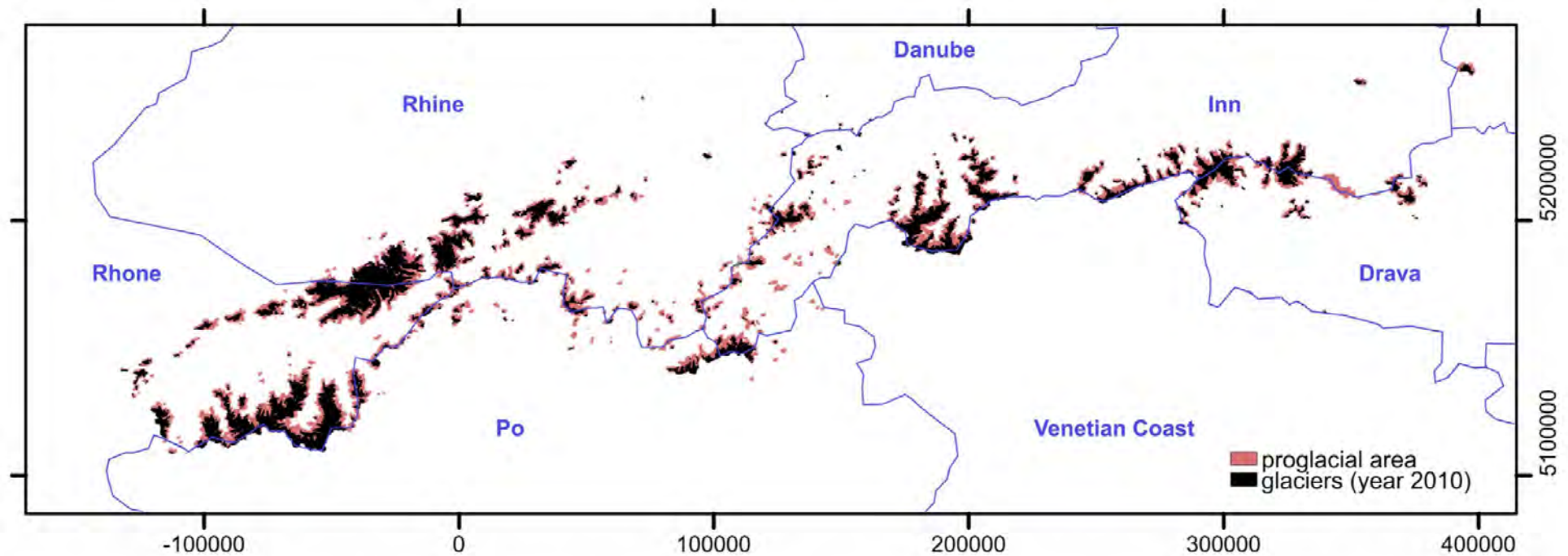
| le savoir vivant |



ALPWISE

Alpine Environments: Water, Ice, Sediments and Ecology

Proglacial margins



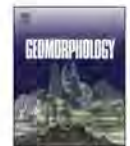
c. 1'500 km² increase in area in Europe since the middle of the 19th century



Contents lists available at ScienceDirect

Geomorphology

journal homepage: www.elsevier.com/locate/geomorph



An assessment of landform composition and functioning with the first proglacial systems dataset of the central European Alps

Jonathan L. Carrivick ^{a,*}, Tobias Heckmann ^b, Andy Turner ^a, Mauro Fischer ^c

^a School of Geography, University of Leeds, Woodhouse Lane, Leeds, West Yorkshire LS2 9JT, UK

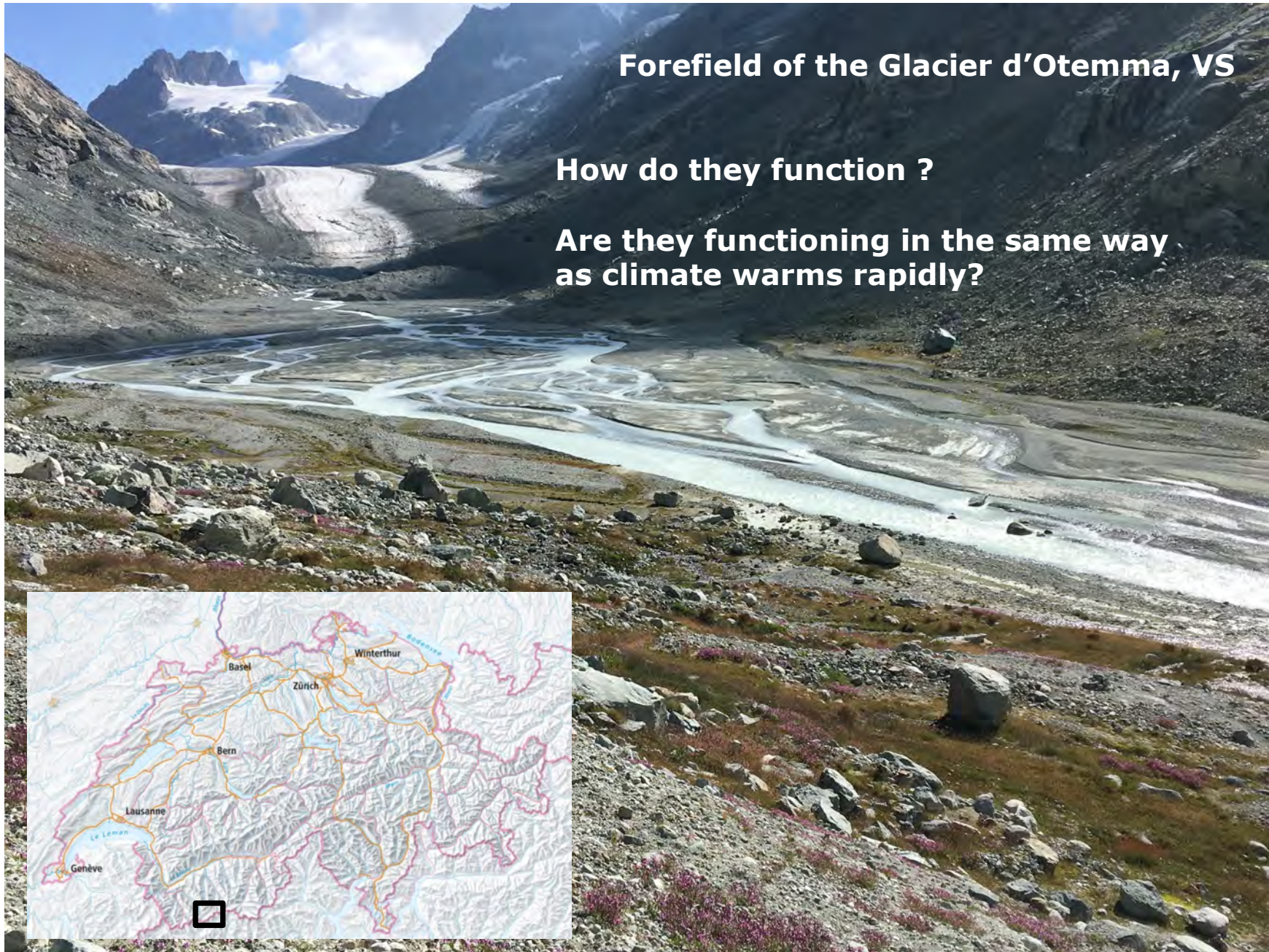
^b Physical Geography, Catholic University of Eichstaett-Ingolstadt, Germany

^c Institute of Geography, University of Bern, Hallerstrasse 12, 3012 Bern, Switzerland

Forefield of the Glacier d'Otemma, VS

How do they function ?

Are they functioning in the same way as climate warms rapidly?





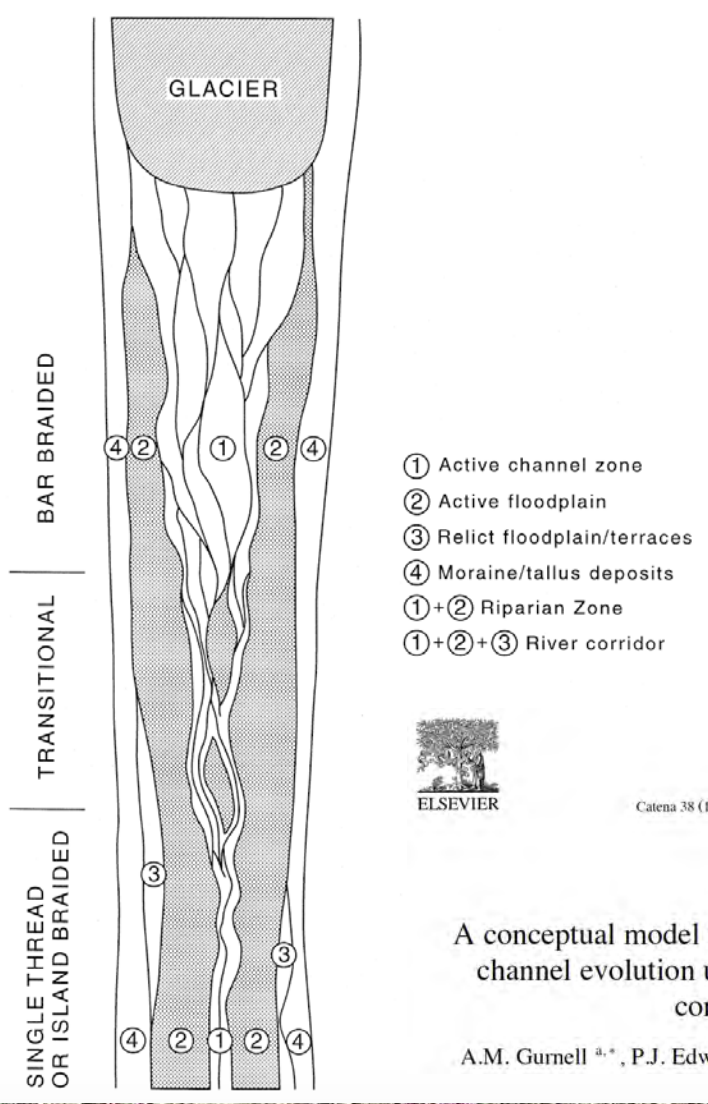
RQ1 : Does the classical chronosequence model still apply ?



Matthews (1992)
after Schreckenthal (1935)



Val Roseg
GR



- ① Active channel zone
- ② Active floodplain
- ③ Relict floodplain/terraces
- ④ Moraine/talus deposits
- ①+② Riparian Zone
- ①+②+③ River corridor



Catena 38 (1999) 223–242

CATENA

www.elsevier.com/locate/catena

A conceptual model for alpine proglacial river
channel evolution under changing climatic
conditions

A.M. Gurnell ^{a,*}, P.J. Edwards ^b, G.E. Petts ^a, J.V. Ward ^c

TABLE 9.—TIME SERIES OF MORAINIC SOILS (SCHRECKENTHAL)

Locality	Age, years	Depth of sampling centimeters	pH	N, per cent	Composition of fine earth (<2mm), per cent	
					2-20μ	<2μ
Sand in front of glacier	0?	10	6.18	0.012	0.8	0.8
Skeleton soil above side Moraine	—	—	6.65	0.009	—	—
Between glacier and 1890 moraine	30-40	10	6.08	0.041	7	3
Between 1890 moraine and 1850 moraine:						
Under spruce	50-60	10	.75	0.12	20	4
Under grass	50-60	10	6.0	0.11	15	4
Meadow in front of 1850 moraine	80	10	5.82	0.26	—	—

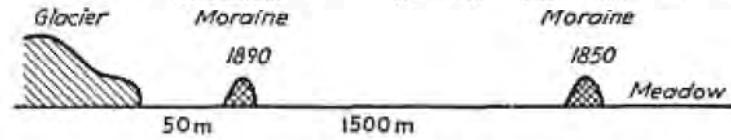
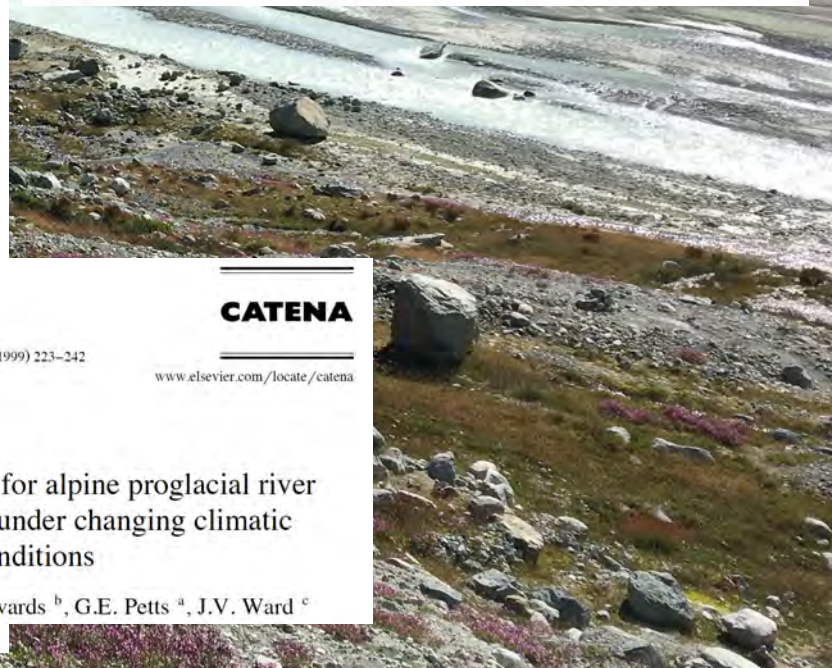


FIG. 18.—This graph shows in a sketchlike manner the front of the Mittelberg Glacier in Tirol and the position of two terminal moraines. Distances are given in meters.



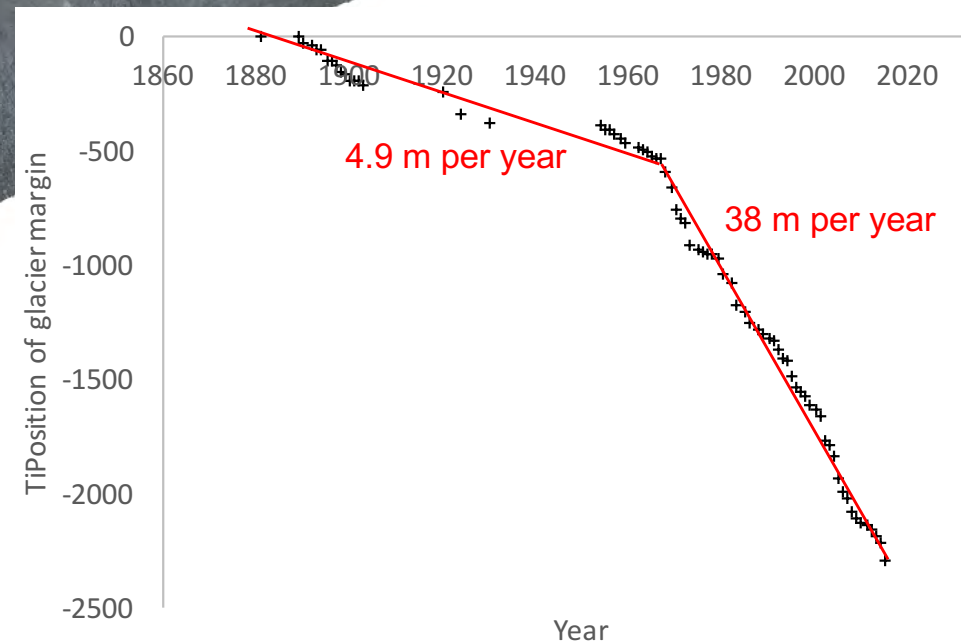
Proglacial Margin Glacier d'Otemma

Glacier recession

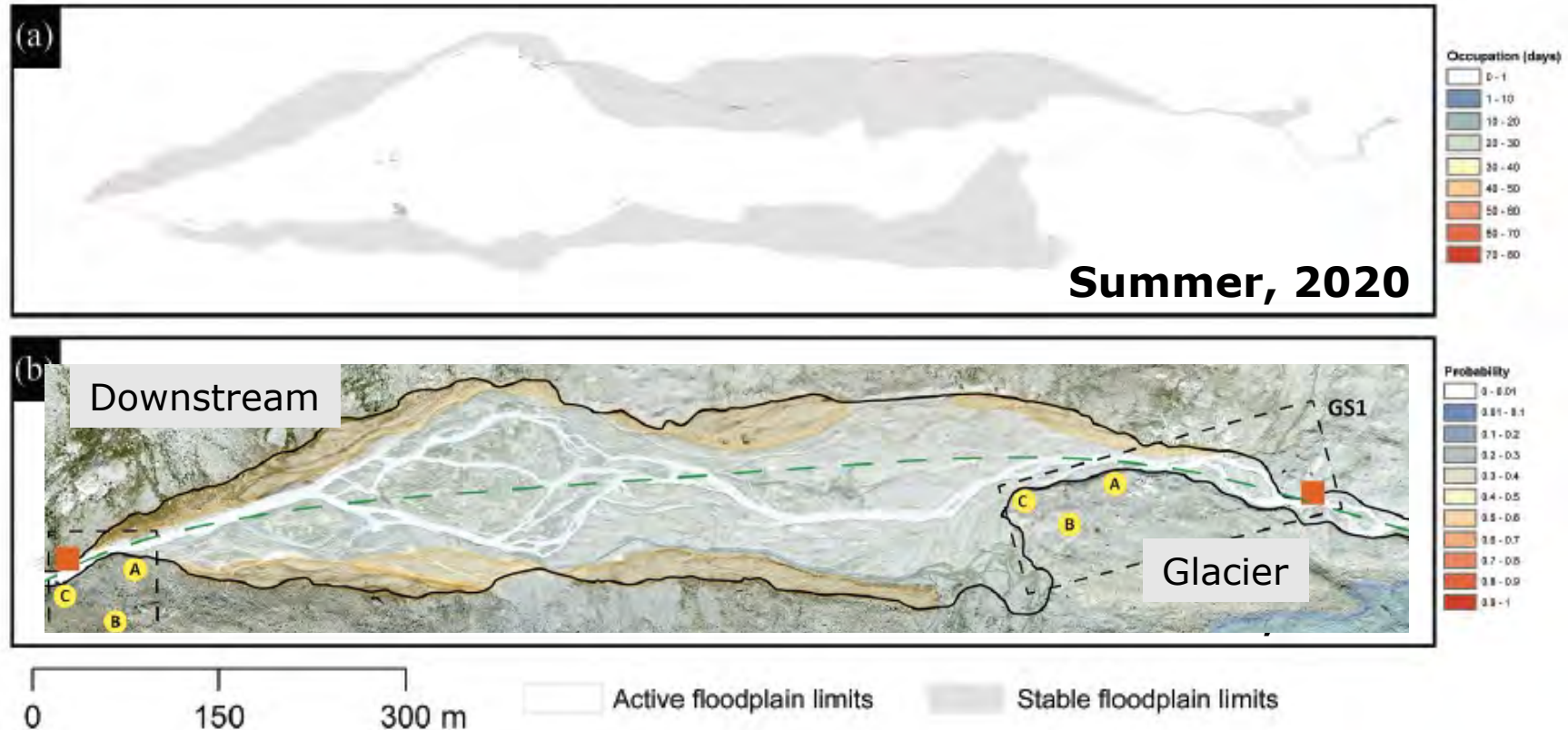


2009
with post little ice
age recession rates

1983



Where do we find life appearing on the floodplain ?



INTERNATIONAL JOURNAL OF REMOTE SENSING
<https://doi.org/10.1080/01431161.2022.2079963>



OPEN ACCESS Check for updates

Centimeter-scale mapping of phototrophic biofilms in glacial forefields using visible band ratios and UAV imagery

Matteo Roncoroni ^a, Davide Mancini ^a, Tyler J. Kohler ^b, Floreana Miesen^a, Mattia Gianini^a, Tom J. Battin^b and Stuart N. Lane ^a

PhD Matteo Roncoroni, 2018-2022
Supervised with Tom Battin, EPFL

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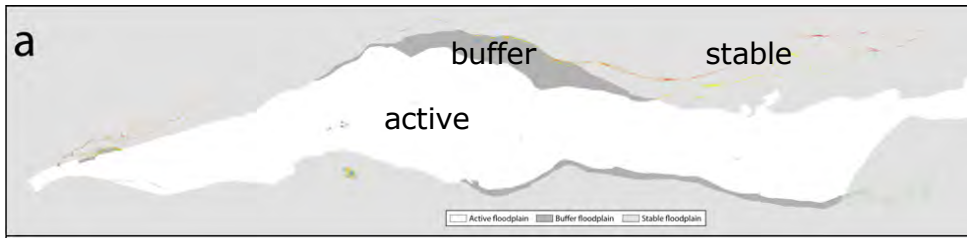
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SSGL-SSHL, 21.03.24

Where do we find life appearing on the floodplain ?

Science of the Total Environment 867 (2023) 161374



Contents lists available at ScienceDirect

Science of the Total Environment

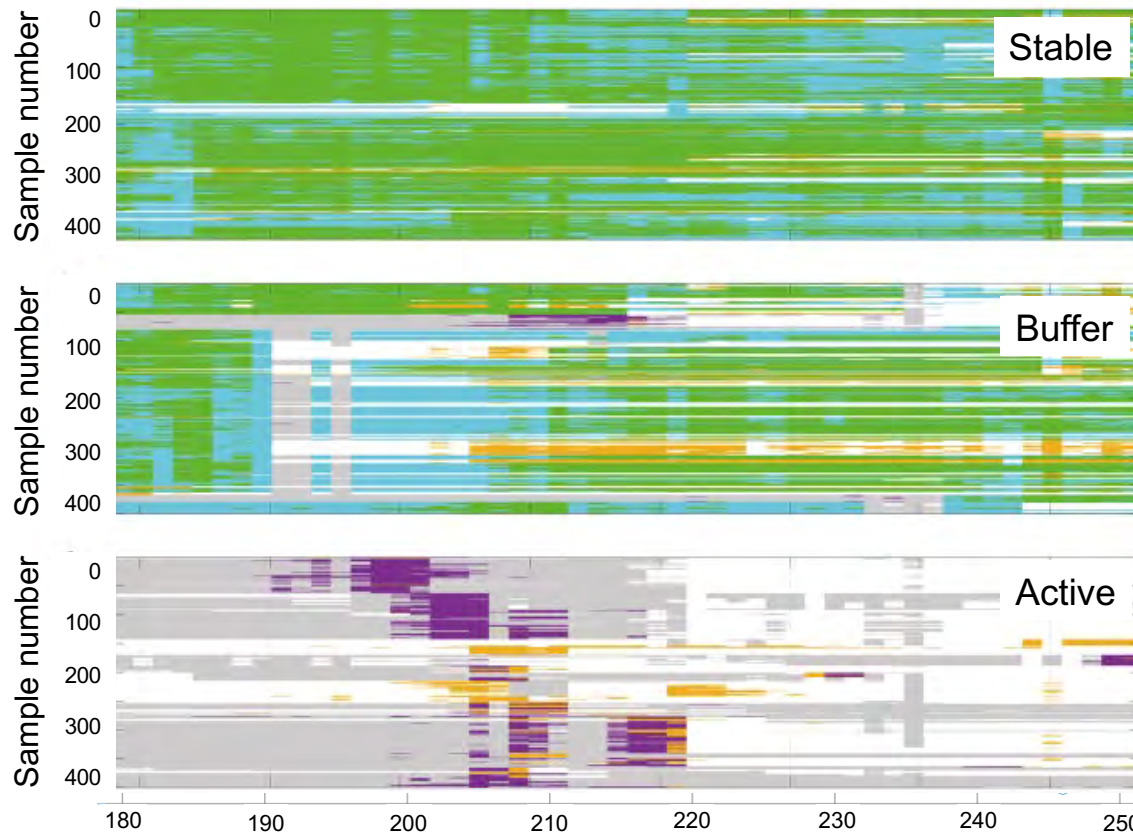
journal homepage: www.elsevier.com/locate/scitotenv



Decrypting the stream periphyton physical habitat of recently deglaciated floodplains



Matteo Roncoroni ^{a,*}, Davide Mancini ^a, Floreana Miesen ^a, Tom Müller ^a, Mattia Gianini ^a, Boris Ouvry ^c, Mélanie Cléménçon ^a, Frédéric Lardet ^a, Tom J. Battin ^b, Stuart N. Lane ^a

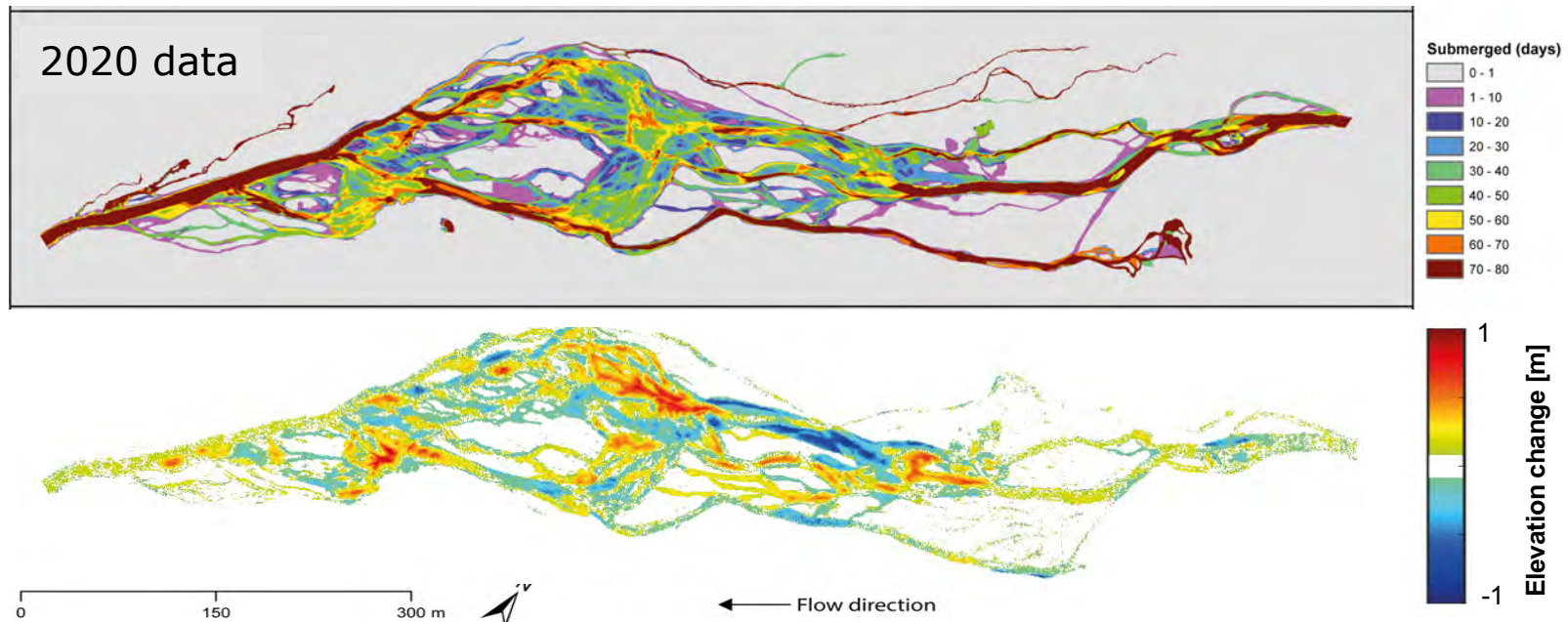
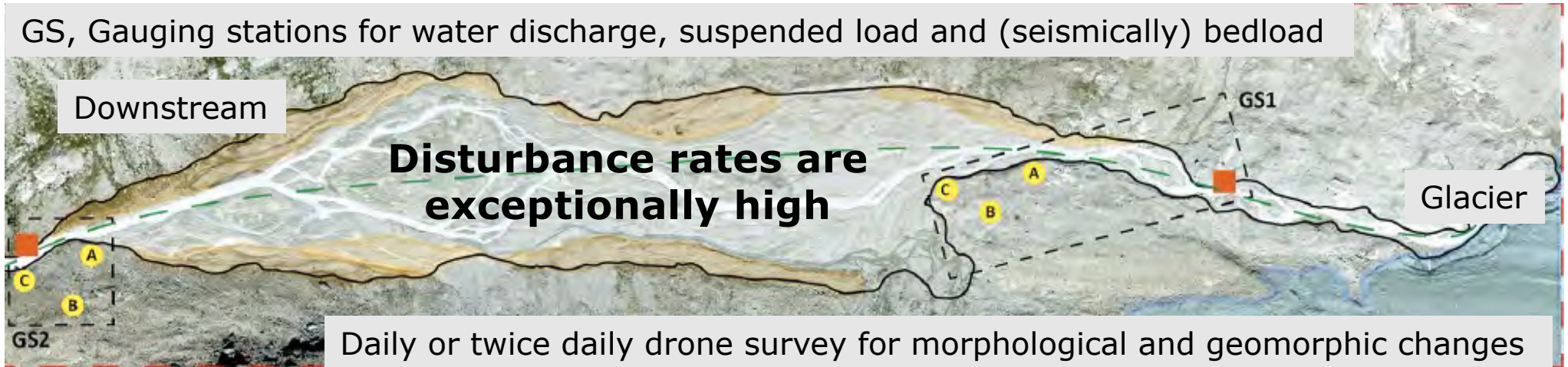


PhD Matteo Roncoroni, 2018-2022
Supervised with Tom Battin, EPFL

Days since 1
January 2020

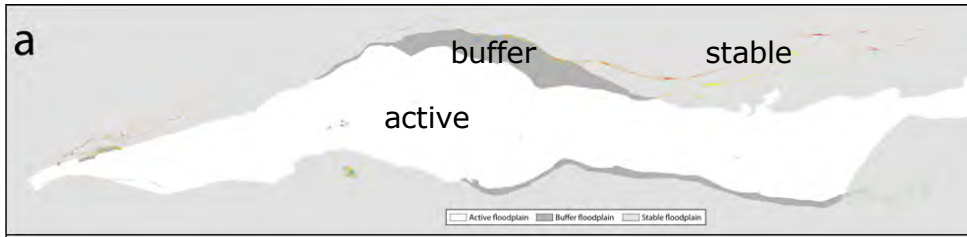
Why is life not developing ? 2 reasons

GS, Gauging stations for water discharge, suspended load and (seismically) bedload



Where do we find life appearing on the floodplain ?

Science of the Total Environment 867 (2023) 161374



Contents lists available at ScienceDirect

Science of the Total Environment

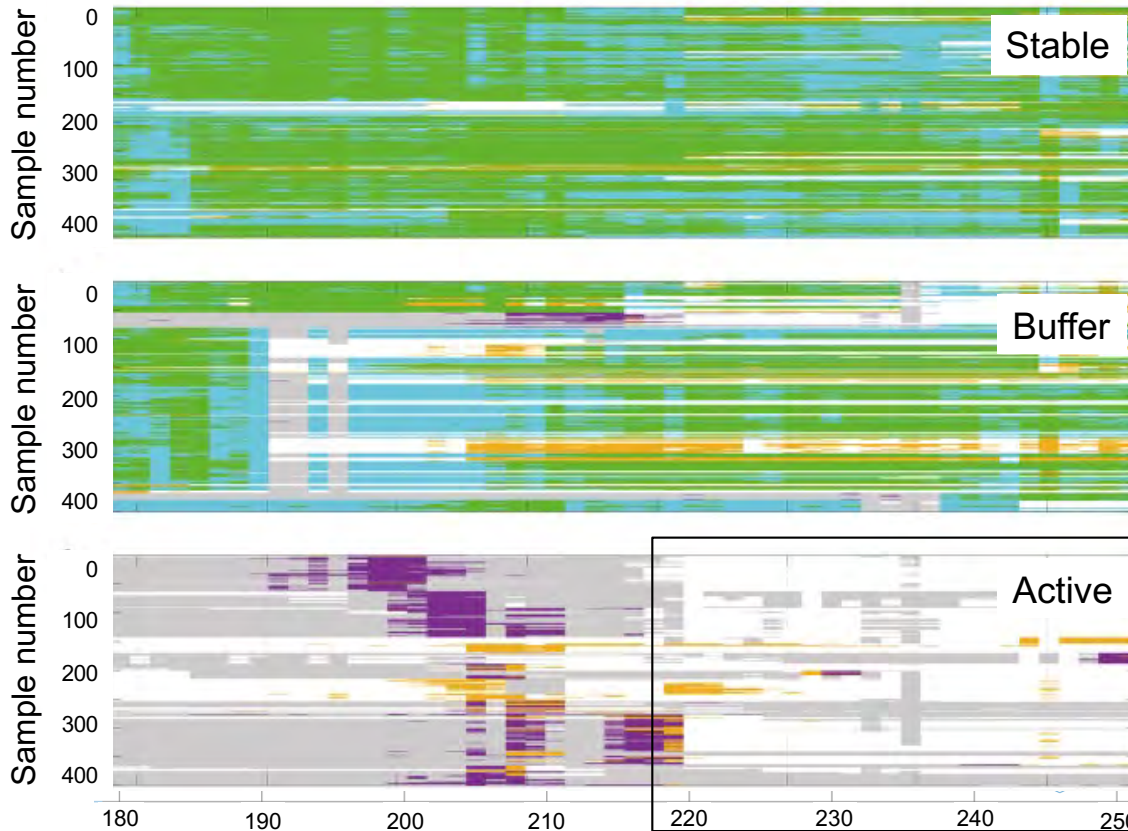
journal homepage: www.elsevier.com/locate/scitotenv



Decrypting the stream periphyton physical habitat of recently deglaciated floodplains



Matteo Roncoroni ^{a,*}, Davide Mancini ^a, Floreana Miesen ^a, Tom Müller ^a, Mattia Gianini ^a, Boris Ouvry ^c, Mélanie Cléménçon ^a, Frédéric Lardet ^a, Tom J. Battin ^b, Stuart N. Lane ^a

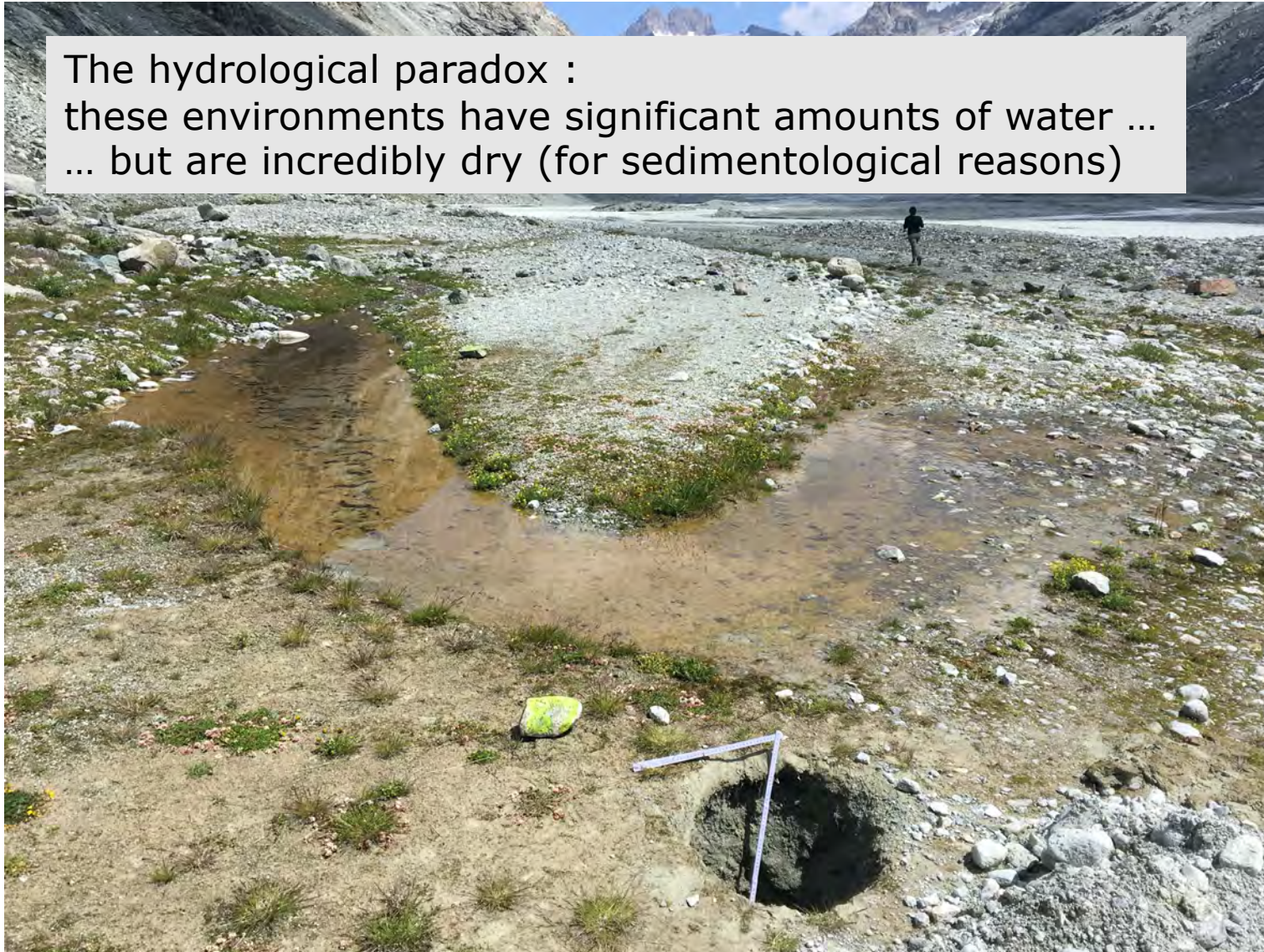


Undisturbed zones are high and dry

**PhD Matteo Roncoroni, 2018-2022
Supervised with Tom Battin, EPFL**

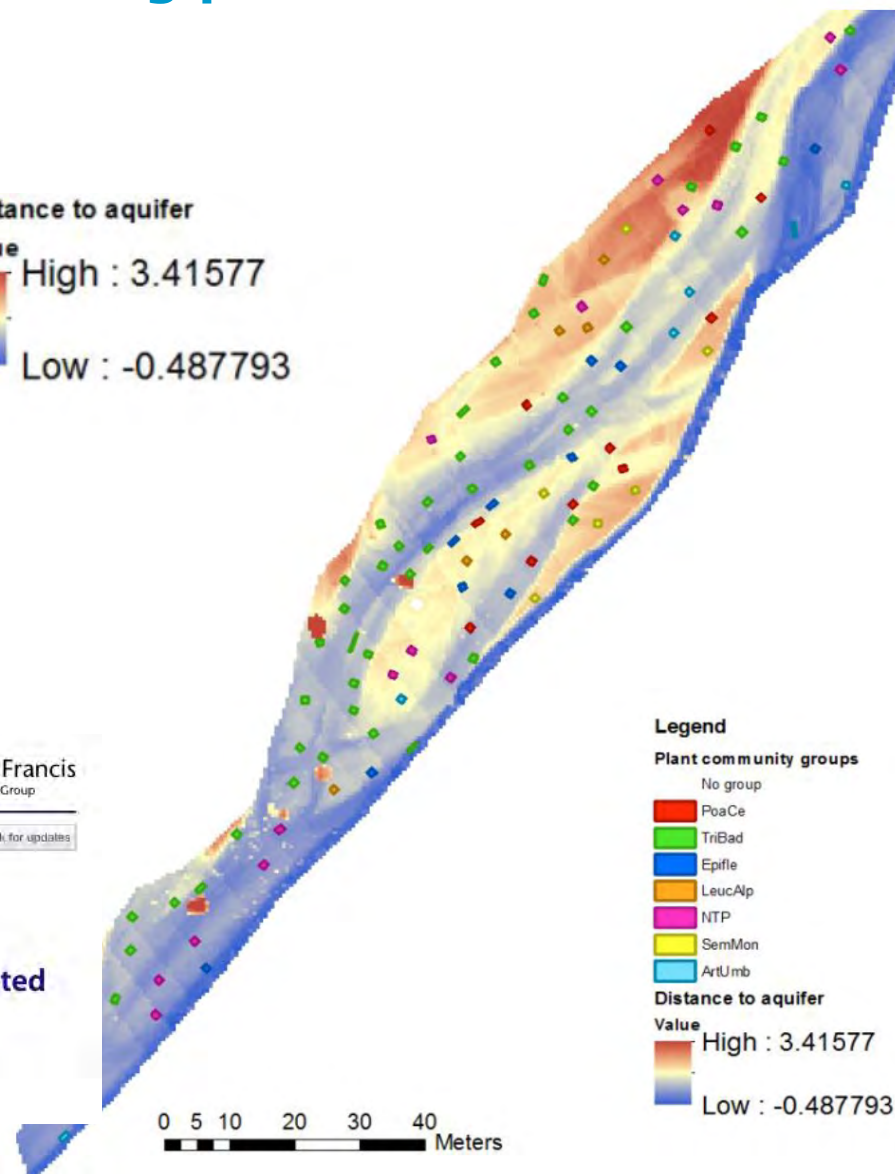
Days since 1
January 2020

The hydrological paradox :
these environments have significant amounts of water ...
... but are incredibly dry (for sedimentological reasons)



Undisturbed zones are high and dry

This is reflected in the pioneering plant communities



ARCTIC, ANTARCTIC, AND ALPINE RESEARCH
2023, VOL. 55, NO. 1, 2259677
<https://doi.org/10.1080/15230430.2023.2259677>

Taylor & Francis
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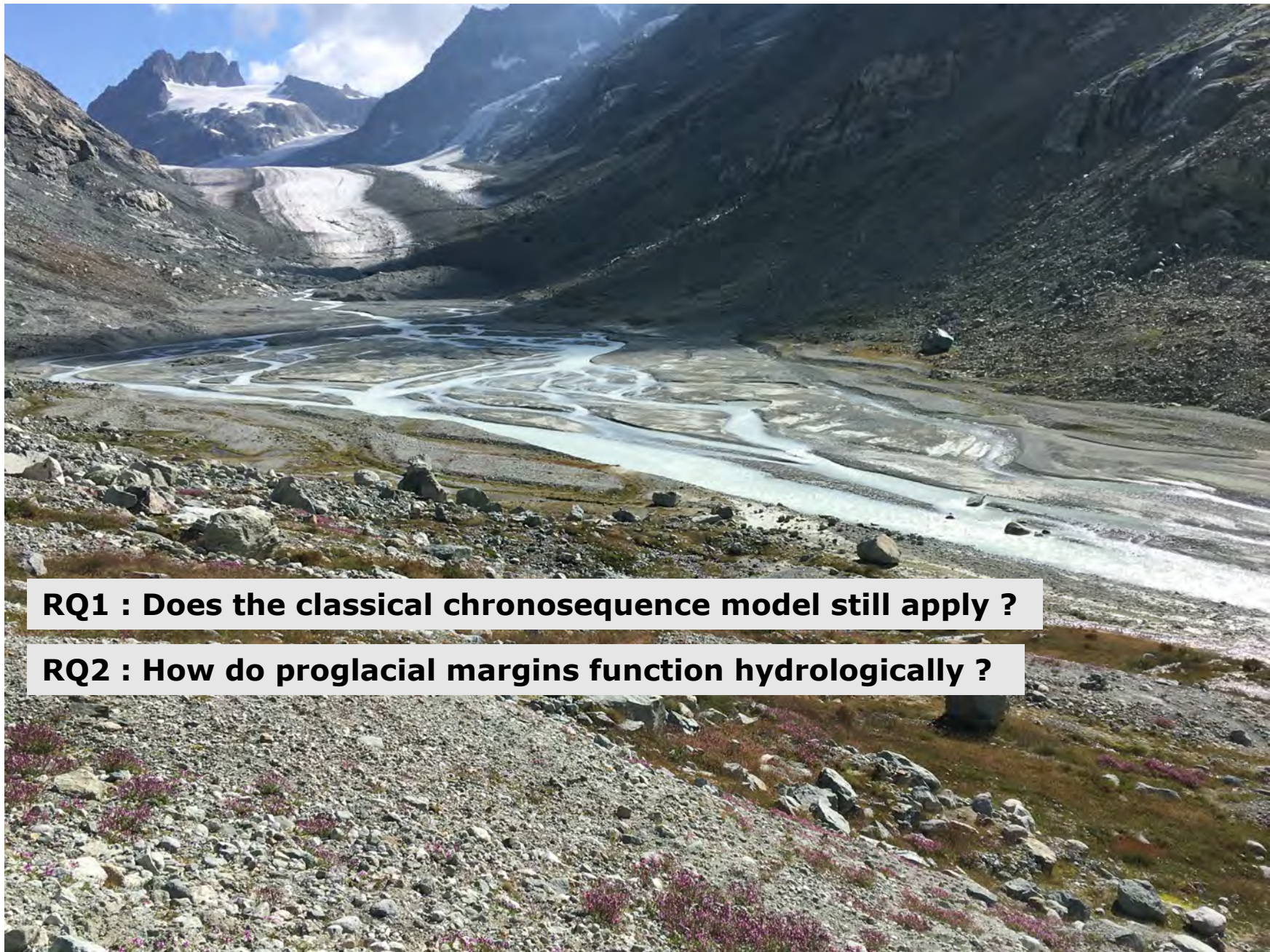
OPEN ACCESS [Check for updates](#)



Hydrological heterogeneity and the plant colonization of recently deglaciated terrain

Lila Siegfried , Pascal Vittoz , and Stuart N. Lane

Institute of Earth Surface Dynamics, Faculty of Geosciences and Environment, University of Lausanne, Lausanne, Switzerland

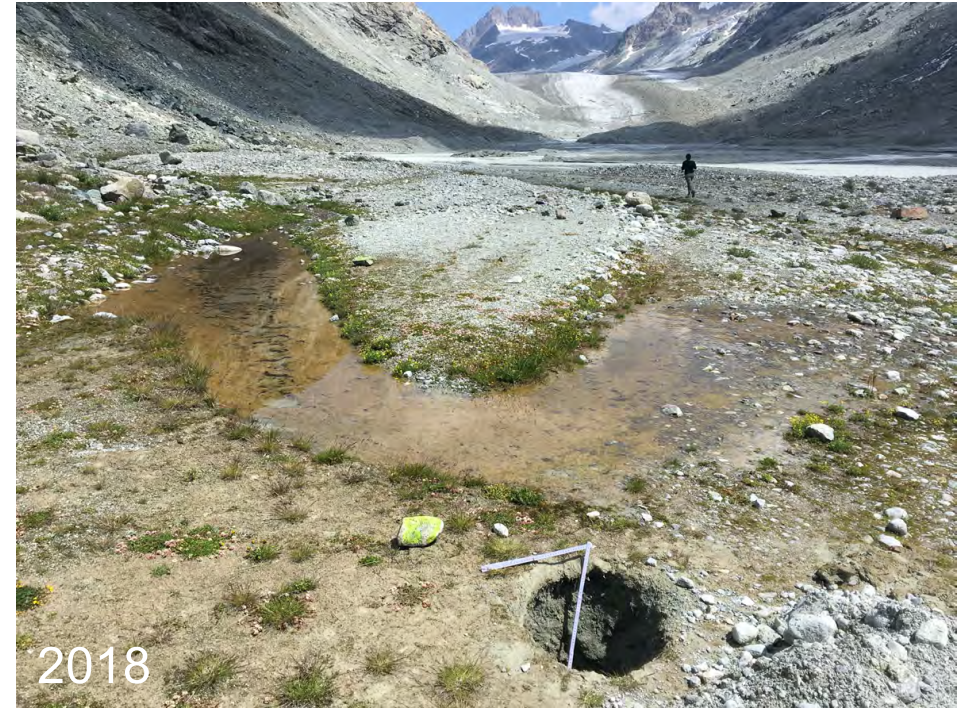


RQ1 : Does the classical chronosequence model still apply ?

RQ2 : How do proglacial margins function hydrologically ?

How do proglacial margins function hydrologically ?

OIKOS 69: 373–386. Copenhagen 1994



Organisms as ecosystem engineers

Clive G. Jones, John H. Lawton and Moshe Shachak

Jones, C. G., Lawton, J. H. and Shachak, M. 1994. Organisms as ecosystem engineers.
– Oikos 69: 373–386.

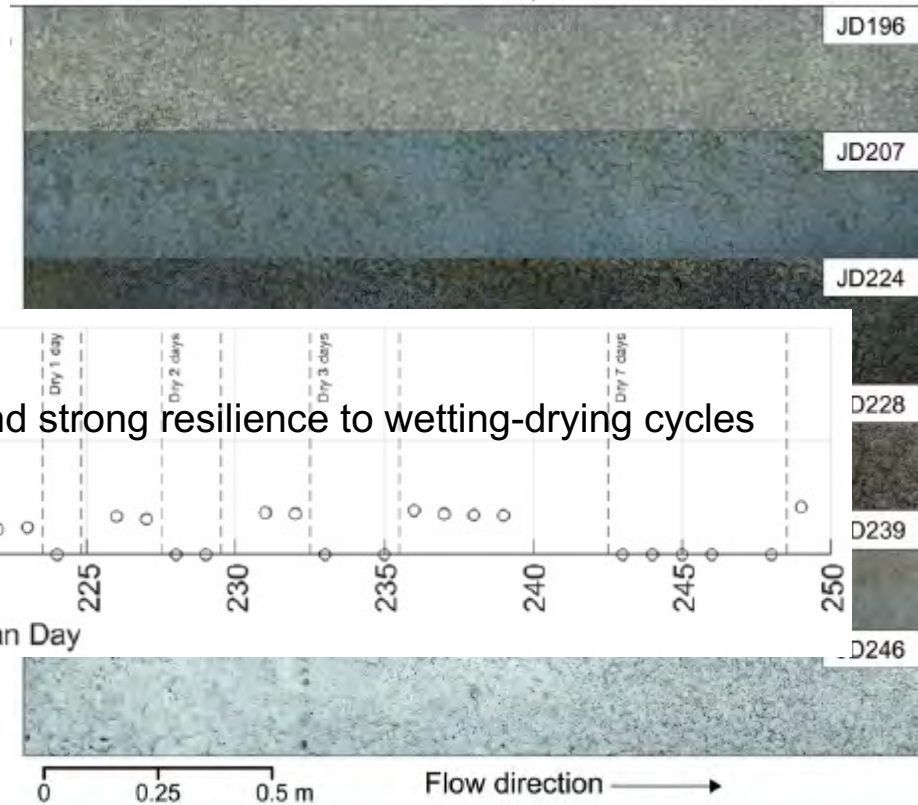
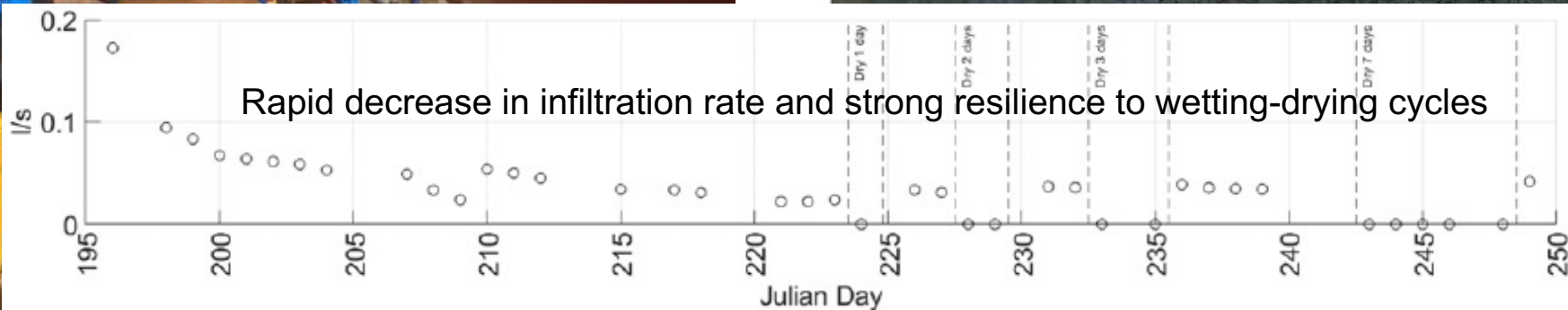
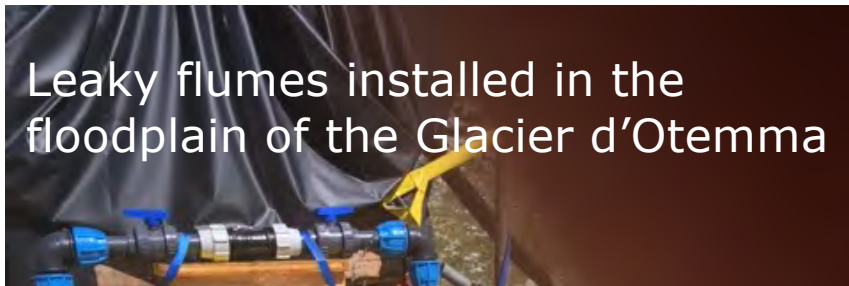
How do proglacial margins function hydrologically ?



PhD Matteo Roncoroni, 2018-2022
Supervised with Tom Battin, EPFL

How do proglacial margins function hydrologically ?

Leaky flumes installed in the floodplain of the Glacier d'Otemma



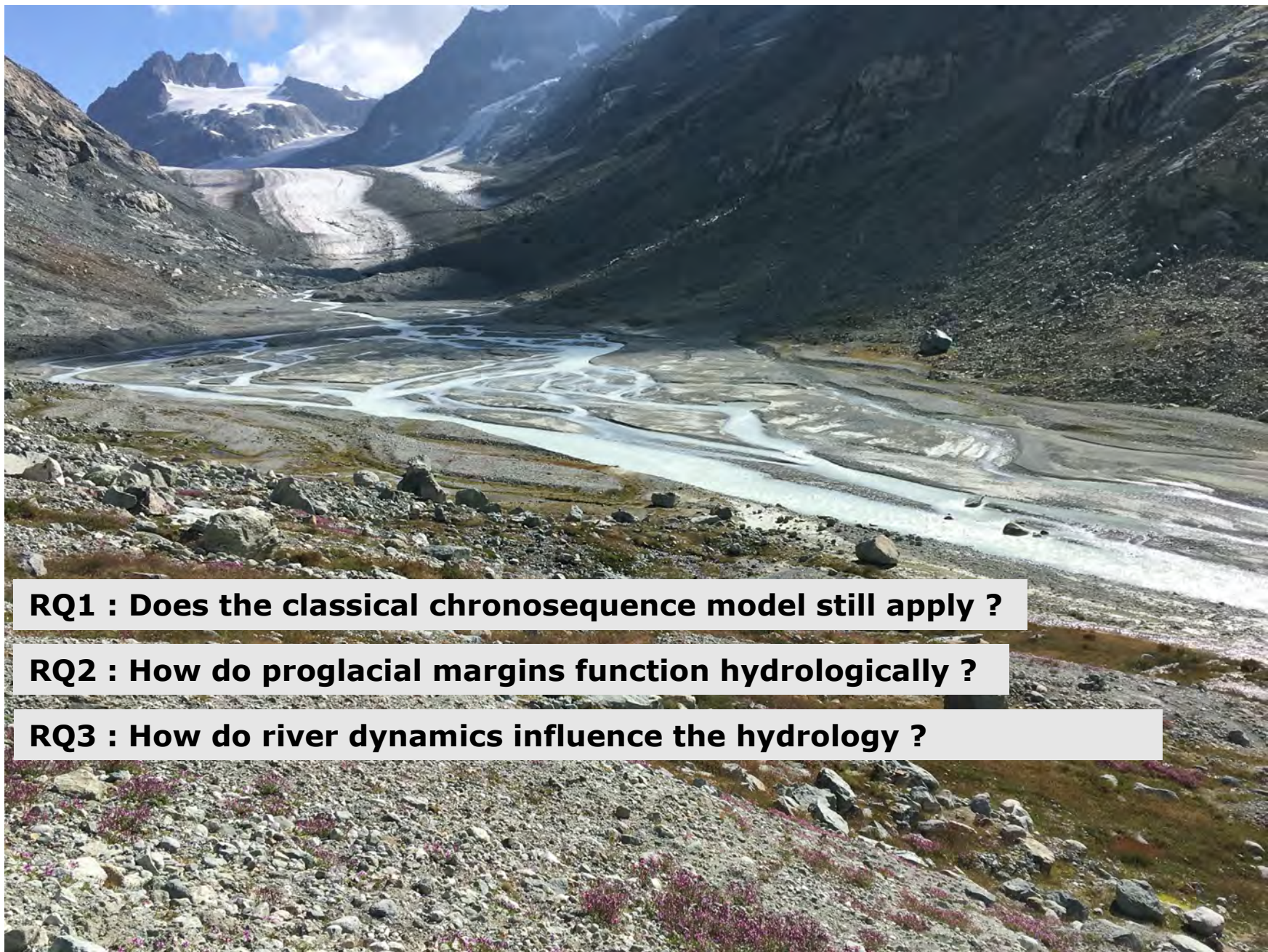
Received: 1 March 2023 | Revised: 18 July 2023 | Accepted: 15 September 2023
DOI: 10.1002/esp.5712

RESEARCH ARTICLE

ESPL WILEY

Ecosystem engineering by periphyton in Alpine proglacial streams

Matteo Roncoroni¹ | Aurélien Ballu¹ | Adrijan Selitaj¹ | Davide Mancini¹ | Floreana Miesen¹ | Marc Aguet¹ | Tom I. Battin² | Stuart N. Lane¹

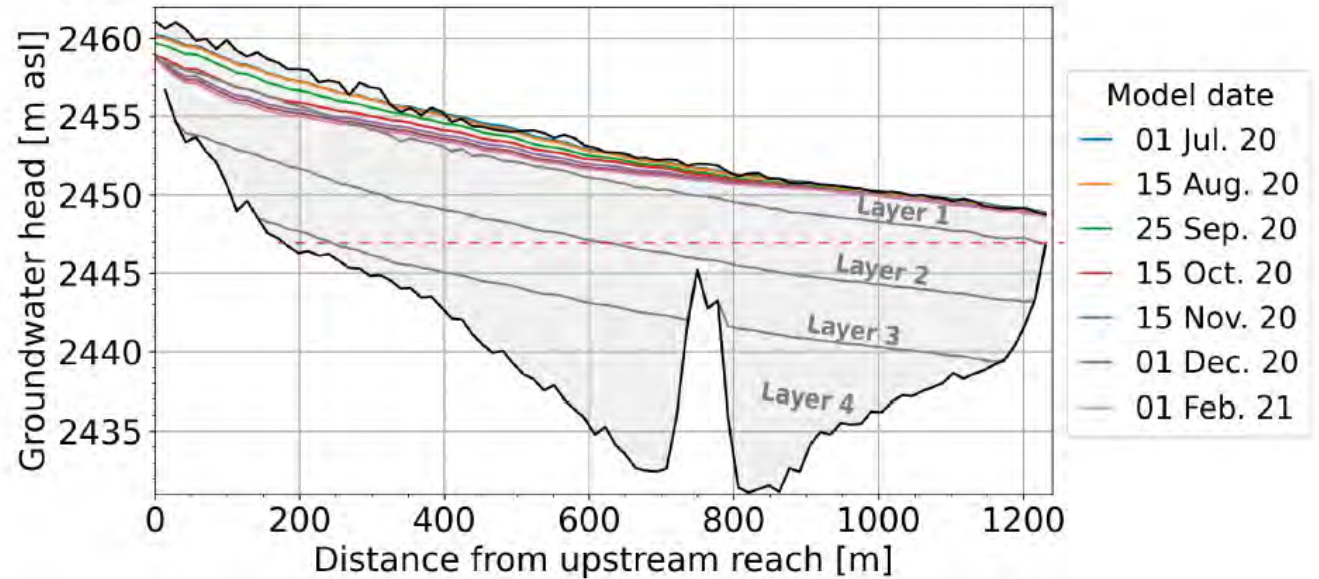
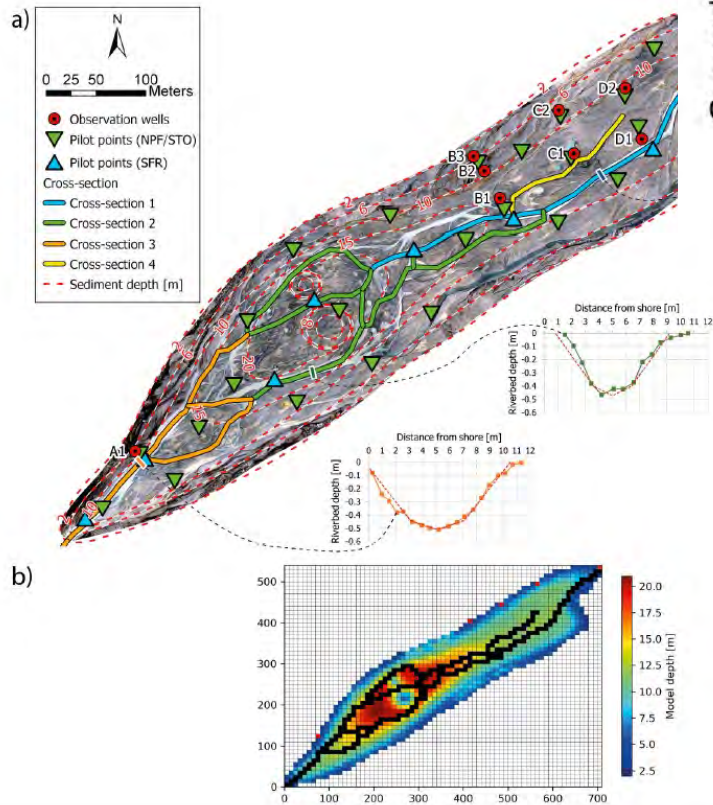


RQ1 : Does the classical chronosequence model still apply ?

RQ2 : How do proglacial margins function hydrologically ?

RQ3 : How do river dynamics influence the hydrology ?

How do proglacial margins function hydrologically ?



Current and future role of meltwater-groundwater dynamics in a proglacial Alpine outwash plain In press, Hydrology and Earth System Science

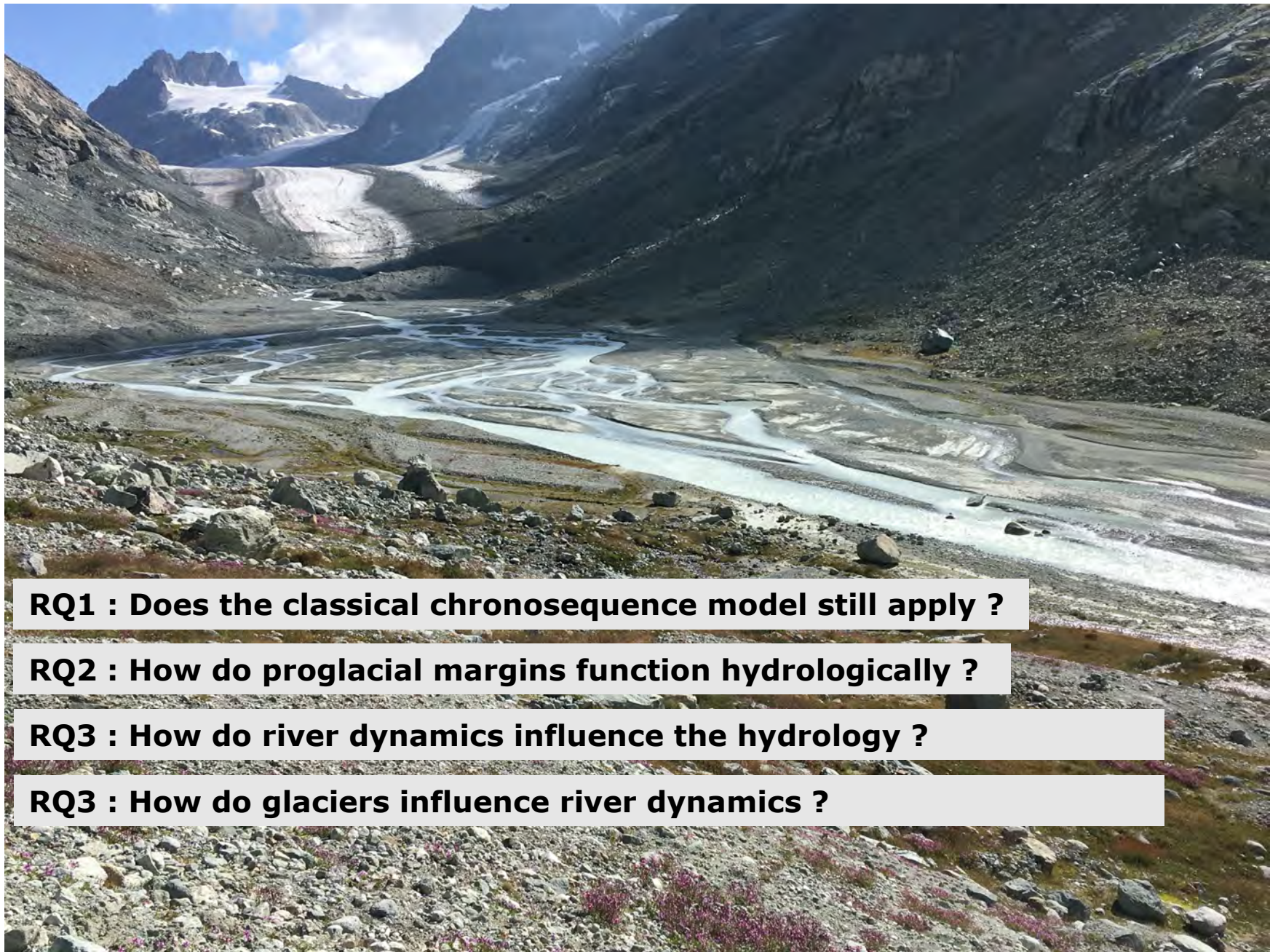
Tom Müller^{1,3}, Matteo Roncoroni¹, Davide Mancini¹, Stuart N. Lane¹, and Bettina Schaeffli^{2,3}

¹Institute of Earth Surface Dynamics, University of Lausanne, 1015 Lausanne, Switzerland

²Oeschger Centre for Climate Change Research (OCCR), University of Bern, 3012 Bern, Switzerland

³Institute of Geography (GIUB), University of Bern, 3012 Bern, Switzerland

**PhD Tom Müller, 2019-2023
Supervised with Bettina Schaeffli, UniBE**



RQ1 : Does the classical chronosequence model still apply ?

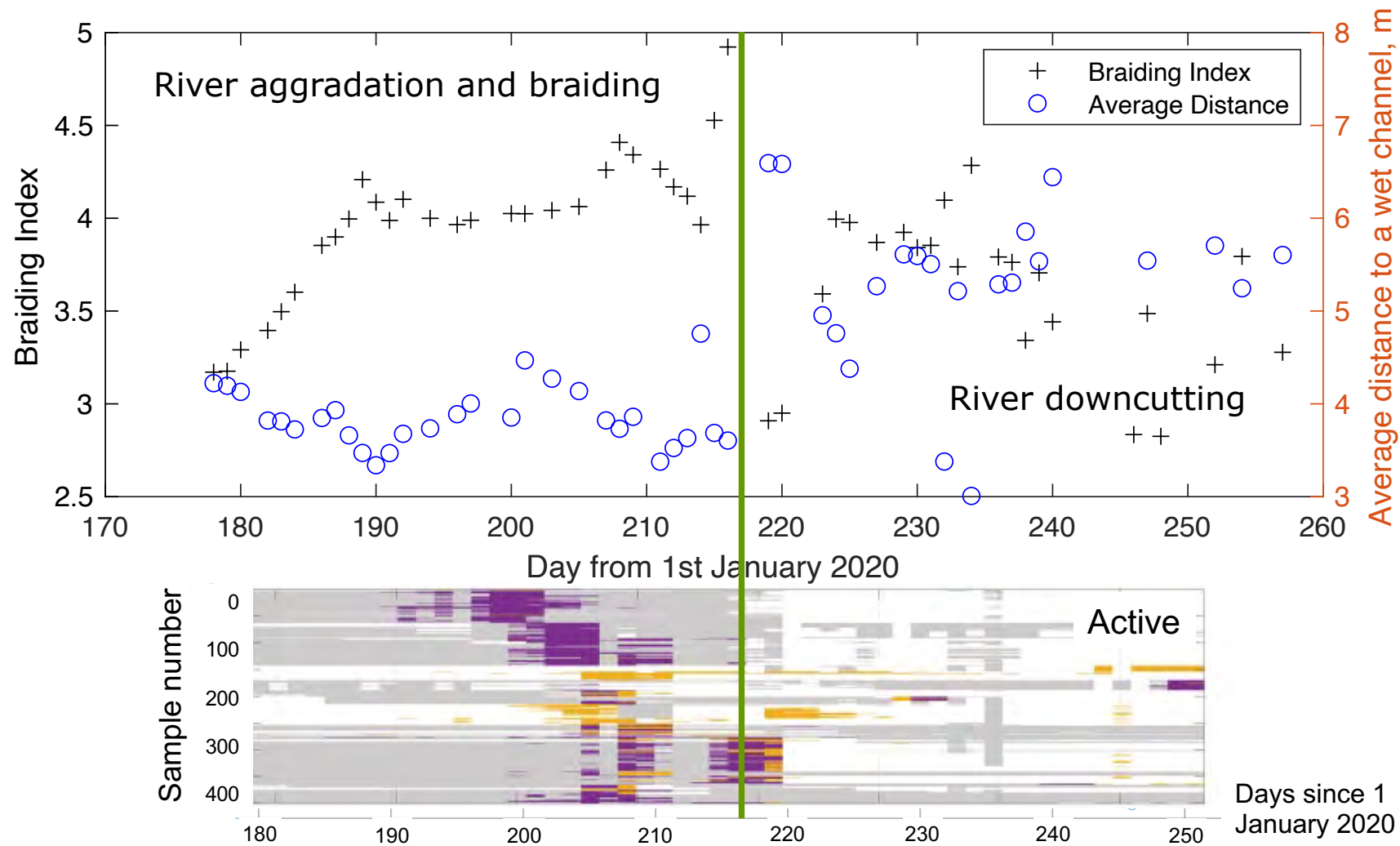
RQ2 : How do proglacial margins function hydrologically ?

RQ3 : How do river dynamics influence the hydrology ?

RQ3 : How do glaciers influence river dynamics ?

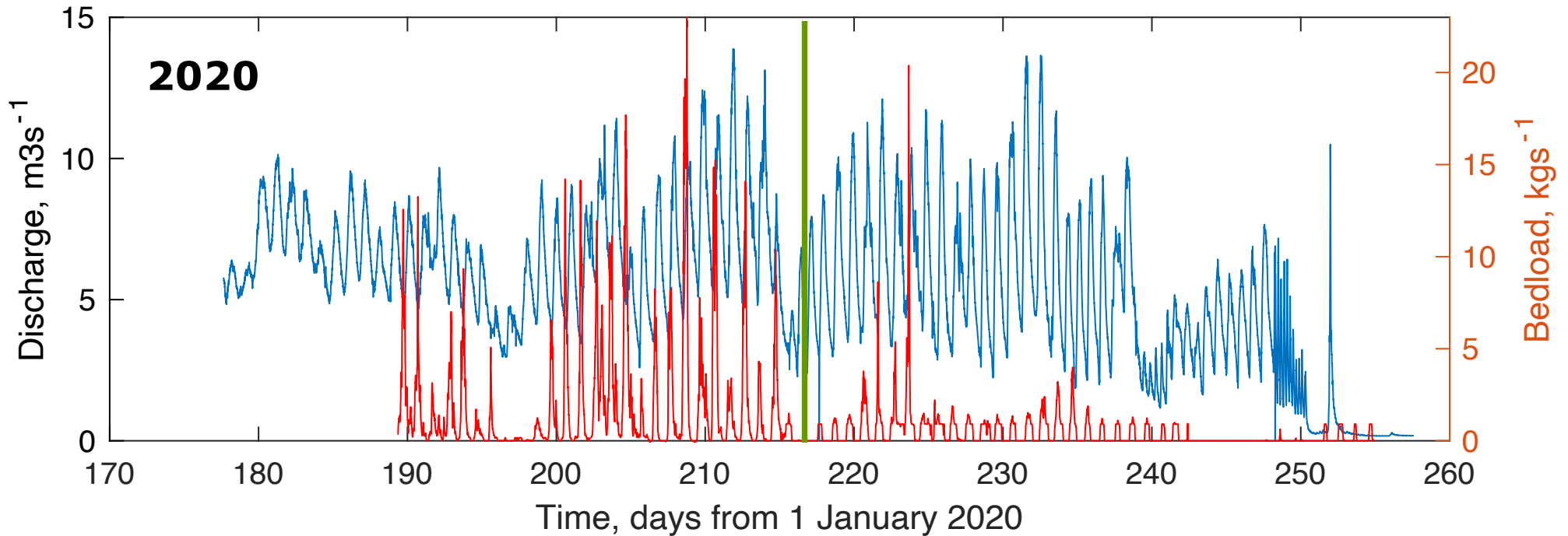
The glacier-river-hydrology-biofilm link

2020



The glacier-river-hydrology-biofilm link

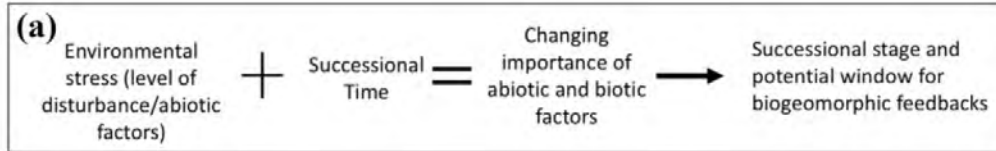
Small changes in the balance between sediment supply and channel capacity can switch the system to erosion, and only small degrees of erosion are needed to draw the water table down to below the surface



Discharge

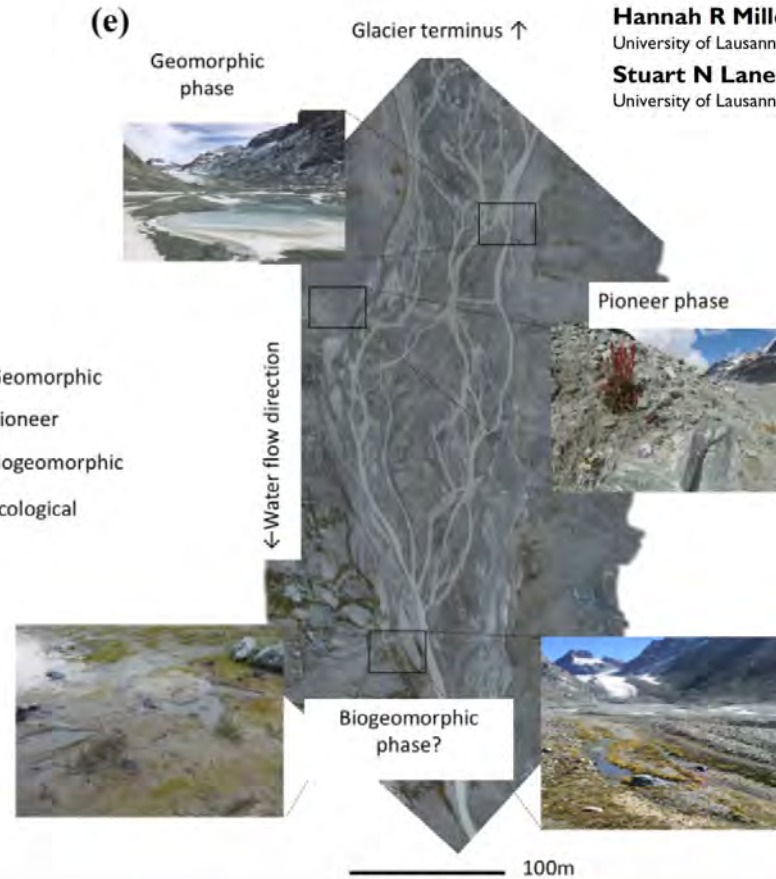
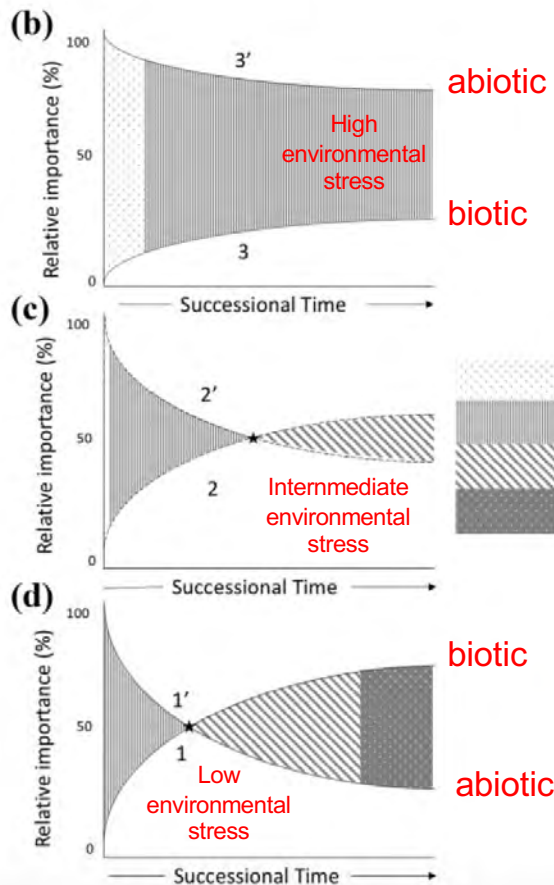
Bedload export by the glacier

Conclusions



Biogeomorphic feedbacks and the ecosystem engineering of recently deglaciated terrain

Progress in Physical Geography
2019, Vol. 43(1) 24–45
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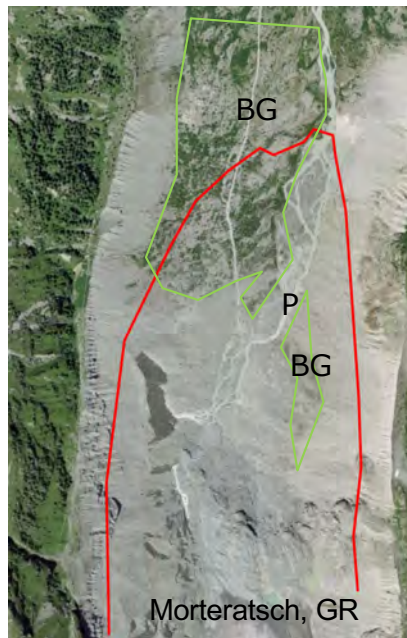
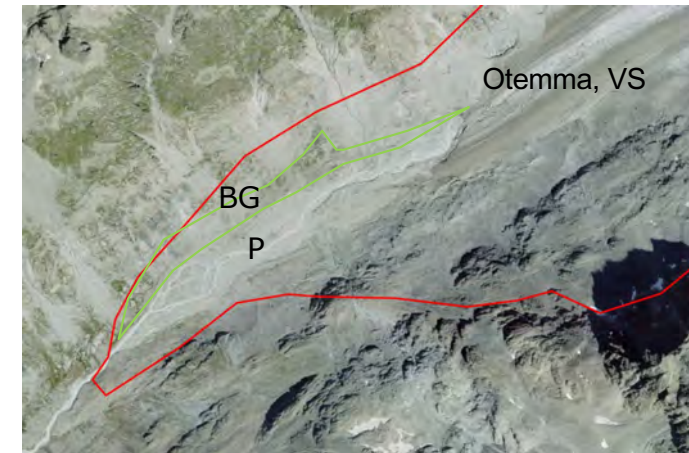
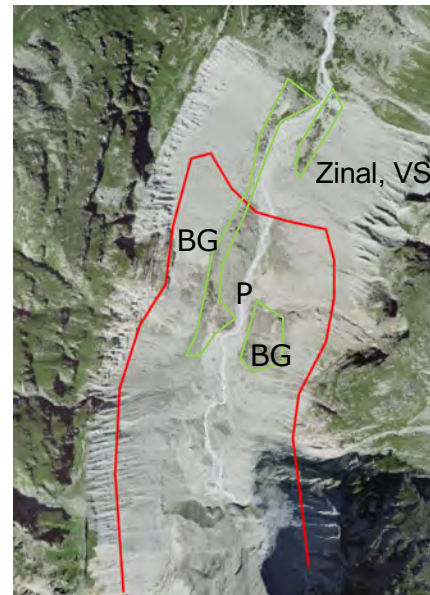
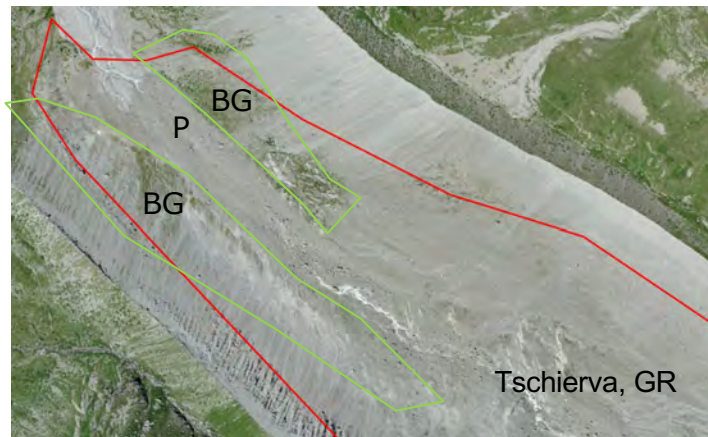
Hannah R Miller
University of Lausanne, Switzerland
Stuart N Lane
University of Lausanne, Switzerland

System maintained in the pioneer phase :

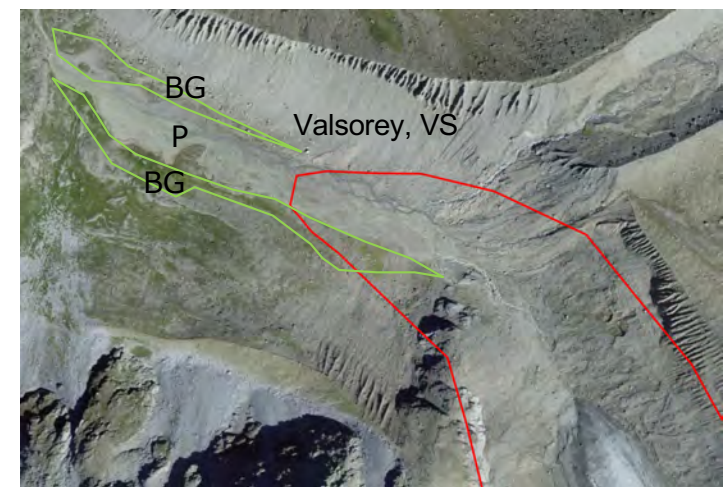
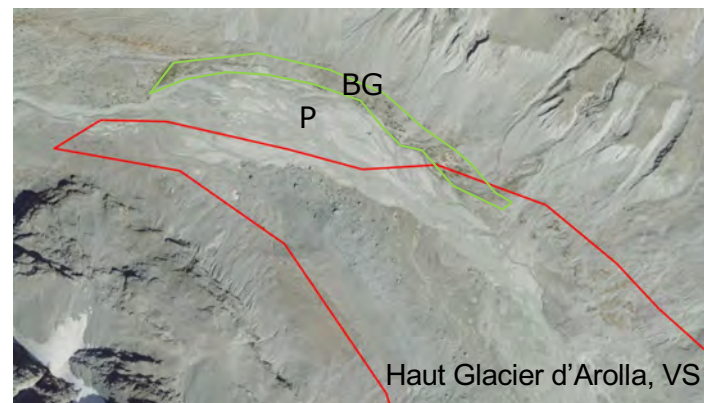
High rates of disturbance

High melt rates but lower sediment delivery

From longitudinal to lateral chronosequences



P Pioneer
BG Biogeomorphic
Glacier margin, 1986



Thank you for listening

