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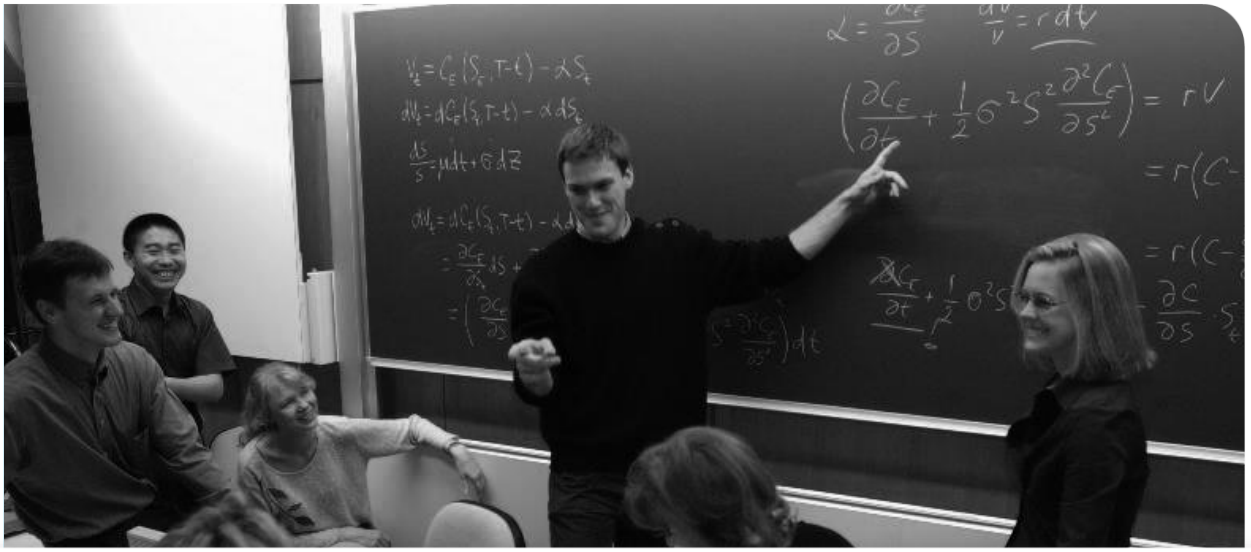

UAV-based cm-scale mapping of biofilms and Chl-a patterns in glacial forefields using visible band ratios

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Fonds National Suisse
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ALPWISE
Alpine Environments: Water, Ice, Sediments and Ecology

Introduction

Biofilms are involved in **multiple ecosystem processes** and claimed to be **potential ecosystem engineers** in glacial floodplains:

- The knowledge of their distributions through time is crucial for understanding **development constraints** and **potential ecosystem engineering hotspots**.

This paper aims to track biofilm distributions (logistically) and chl-a concentrations (linearly) of an alpine glacier forefield over a 5-month period (56 single day datasets) by using visible band ratios derived from UAV-based SfM-MVS orthomosaics at 5 cm resolution.

Floodplain of the Glacier d'Otemma (Valais, Switzerland) - © Roncoroni M.

Methods

UAV-based imagery of the floodplain of the Glacier d'Otemma (VS, Switzerland)
- 56 single day datasets spanning from late June 2020 to early November 2020

Datasets processed through SfM-MVS
- Following rigorous photogrammetric processing of James et al. (2020)
- Fully georeferenced orthomosaics

Relative radiometric normalization of orthomosaics
- Pseudo-Invariant-Feature correction following Schott et al. (1988)

Visible band ratio generation

Name	Acronym	Formula	Source
Chromatic Coordinates of Red	RCC	R/(R+G+B)	Woebbecke *et al.*, 1995
Normalized Green-Red Difference Index	NGRD	(g-r)/(g+r)	Tucker, 1979
Excess Red Vegetation Index	ExR	1.4*r-g	Mao *et al.*, 2003
Excess Green Vegetation Index	ExG	2*g-r-b	Mao *et al.*, 2003
Green Leaf Index	GLI	((G-R)+(G-B))/(G-R-G-B)	Louhaichi *et al.*, 2001
Visible Atmospherically Resistant Index	VARI	(G-R)/(G+R-B)	Gitelson *et al.*, 2002
Kawashima and Nakatani Index	KANA	(R-B)/(R+B)	Kawashima and Nakatani, 1998
Red Green Ratio Index	RGRI	R/G	Saberioon *et al.*, 2014

Two sediment sampling campaigns (July 15 and September 9)
- Sediment Chl-a concentrations of selected sites

Linearly modelled chl-a concentrations from band ratio values
- Calibration (early season samples) and validation (late season samples)

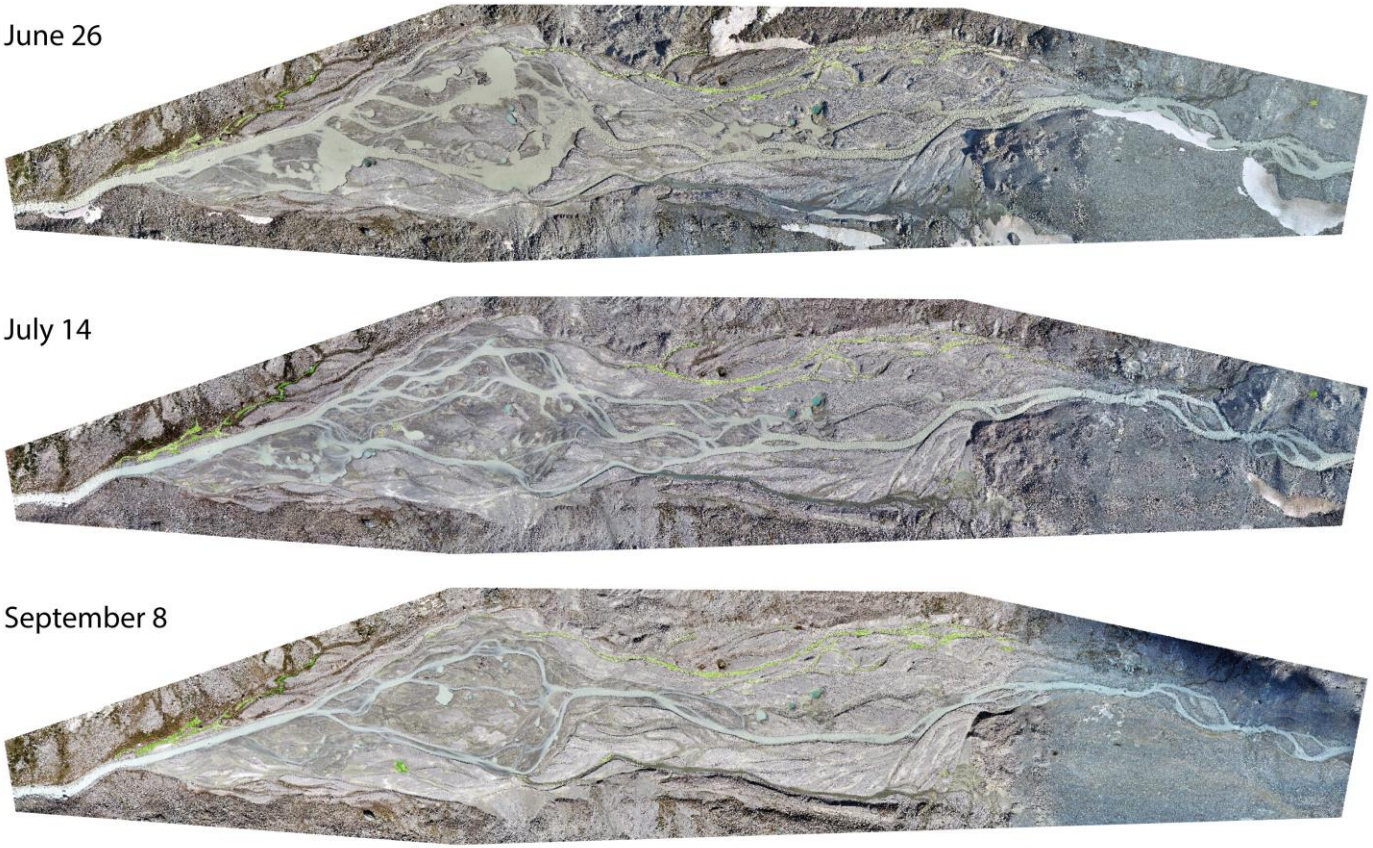
Chl-a concentration maps
- At the whole floodplain scale
- Repeated 56 times

Pixel sampling
- Pure end-members (biofilms and not-biofilms)

Logistically modelled biofilm presence/absence from band ratio values
- Calibration (July 14) and validation (September 9)

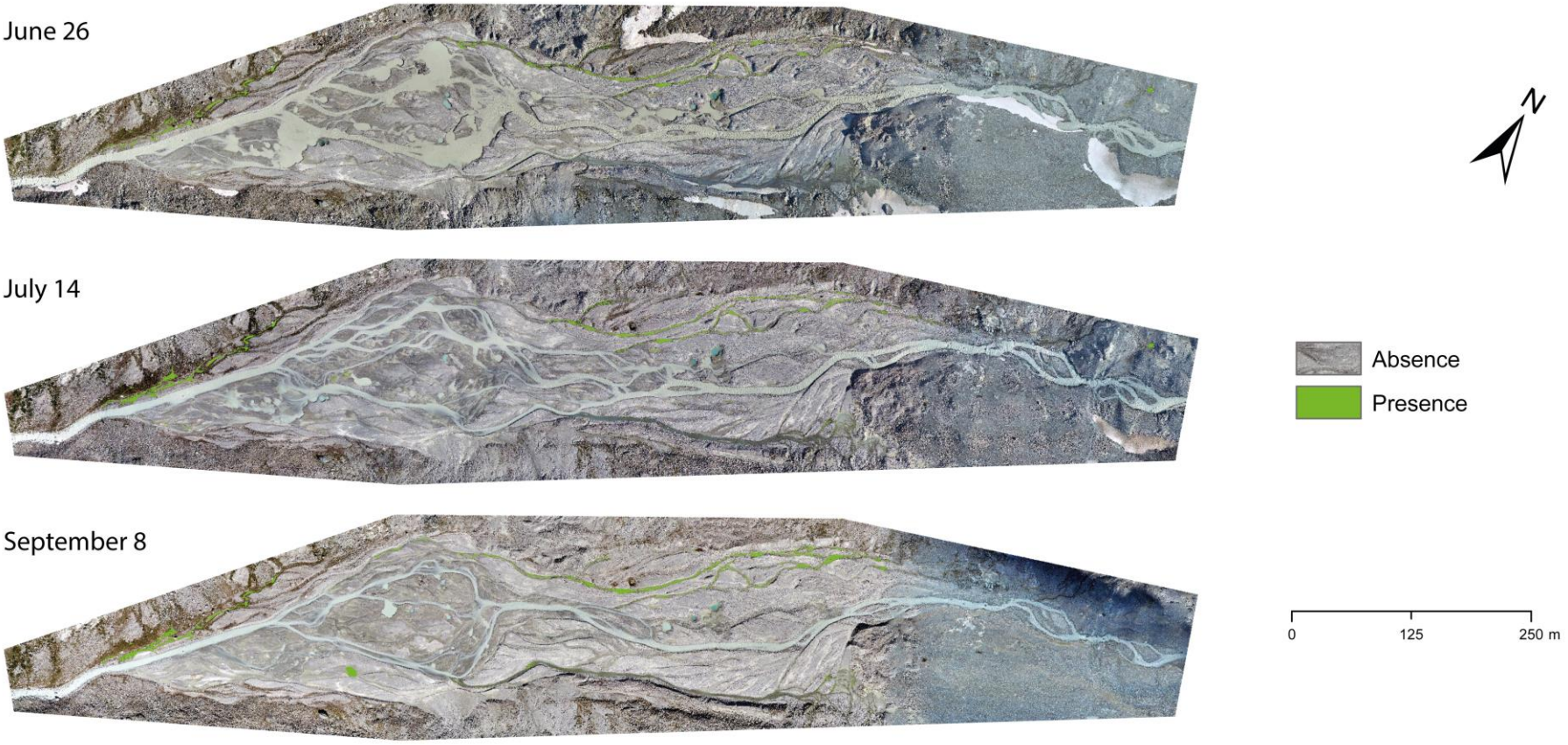
Presence/Absence maps
- At the whole floodplain scale
- Repeated 56 times

Chl-a concentration prediction



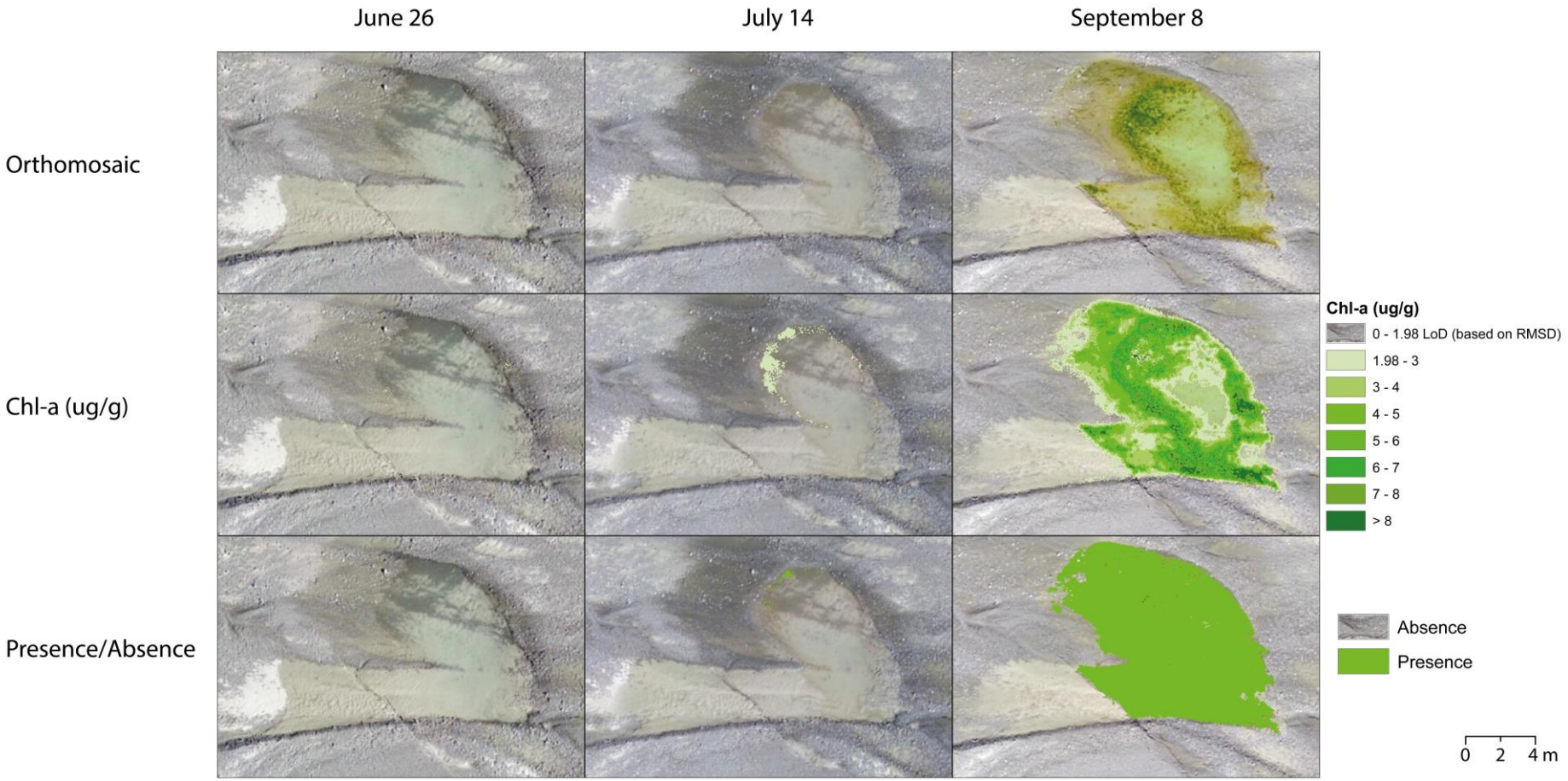
Chl-*a* concentrations (ug/g) based on RCC index

Biofilm absence/presence



Biofilm absence/presence based on KANA-index derived logistic model

A nice comparison



Conclusions

Our results suggest that **visible band ratios** derived from UAV-based RGB imagery processed through SfM-MVS are **a means of mapping biofilm distributions and chl-a concentrations** in shallow clear water channels and **at very high spatial and temporal resolutions**.

The use of low cost UAVs equipped with RGB cameras may be **potential alternatives** to expensive multi- or hyper-spectral cameras, especially in extreme and dangerous environments (e.g., glacier forefields) or when intensively repeated surveys are needed.

The forefield of the Glacier d'Otemma is a deadly place for UAVs - © Roncoroni M.

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