Submitted Abstract

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First Author First Name Last Name	 Joana (1) Llodrà-Llabrés
Submitting Author First Name Last Name	 Joana Llodrà-Llabrés
Correspondence	joanallodra@ugr.es
Co-Authors >> E-Mails will be not listed	Martínez-López, Javier (2); Postma, Thedmer M. (2); Navarro, Carlos (2); Pérez-Martínez, Carmen (1); Alcaraz-Segura, Domingo (3)
Organisations	1: Ecology Department, Faculty of Sciences, University of Granada, Spain 2: Andalusian Institute for Earth System Research IISTA-CEAMA 3: 3Botany Department, Faculty of Sciences, University of Granada, Spain
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Abstract

High-mountain lakes provide crucial ecosystem services (ES) such as non-drinking water resources, biodiversity hosting and maintenance, recreational purposes and aesthetic value, among others. However, these ecosystems are still poorly understood mainly due to their typical difficult access and the large amount of resources needed for their sampling and study making it difficult to maintain a regular monitoring based on field campaigns. These ecosystems are amongst the most vulnerable systems to global change, especially in the Mediterranean region, and have shown to be sentinels of regional global change. Due to their socio-economic, scientific and environmental relevance and their sensitivity to climate change, they require strategies for their optimal management. Hence, the main aims of this study are: a) to assess how chlorophyll-a (chl-a) concentration in shallow (<10 m) small (<1 ha) high-altitude lakes can be monitored through high (Sentinel-2; 10-20 m) and very-high spatial resolution (Worldview-3; 0.3 m) satellite imagery; and b) create a remote monitoring methodology to overcome the accessibility issue of high-mountain ecosystems.

A systematic literature review of chl-a retrieval indexes was first conducted to identify a comprehensive set of relevant indexes for our study area, input parameters and atmospheric corrections. Our study is focused on remote high-mountain lakes of the Sierra Nevada National Park, a biodiversity hotspot located in SE Spain. In a set of several lakes (between 2800 and 3100 m a.s.l.), chl-a concentration was regularly measured in several field campaigns conducted during 2020, 2021 and 2022. Field measurements were used as a response variable to train several linear and machine learning models. Different models were trained for each lake individually and for the whole set. Several co-variables were included and tested for training the models to improve the prediction across lakes, such as water level, turbidity, lake size, temporal window between the field sample and satellite image (a maximum of three to five days was established), etc. We will present some preliminary results, discuss the transferability of this innovative method to monitor relevant ecological attributes of high-altitude lakes, review key methodological challenges and highlight the implications of this methodology to support the study of human and environmental interactions in these endangered ecosystems.

Preliminary analyses reveal that the traditional empirical models that perform best are the ones based on blue and green bands. Current models could improve implementing novel artificial intelligence techniques.

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