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Challenges and opportunities of remote sensing for monitoring biodiversity change

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Biodiversity is rapidly declining and monitoring biodiversity change is thus of key importance to prevent the destabilization of ecosystems and their services. A key component of monitoring biodiversity change is the development of Essential Biodiversity Variables (EBVs) which facilitate the harmonization and standardization of raw data from disparate sources. In this context, consistent and adequate geospatial information needs to be available to ecologists and policymakers around the world, even for countries in which comprehensive in-situ biodiversity measurements cannot be taken on a regular basis. Satellite remote sensing (SRS) currently represents the only tool which allows to acquiree spatially contiguous and temporally replicated observations for monitoring biodiversity over continental or (near-)global spatial extents. Observations from SRS already provide a wealth of information on the distribution, structure and functioning of ecosystems, but user requirements of ecologists and policymakers have not been systematically quantified for allowing the development of roadmaps by SRS experts.

In response, we performed a top-down user requirement analysis combined with a bottom-up technical review to highlight (i) how currently available remote sensing products can contribute to biodiversity monitoring, and (ii) which immature SRS products could be prioritized for further development. We performed a systematic review of the Post2020 goals (for 2050) and biodiversity targets (for 2030) of the Convention on Biological Diversity (CBD) and their corresponding biodiversity indicators. Subsequently we evaluated SRS products according to relevance (to biodiversity indicators), (im)maturity, feasibility, and suitability for provisioning user-adequate spatio-temporal information. We found that currently existing CBD-relevant biodiversity indicators mainly use EBV-related information on ecosystem structure and distribution (e.g. available from remote sensing products of landcover and Leaf Area Index, LAI) or on species populations (predominantly acquired from in-situ biodiversity measurements because current SRS products are too limited in the spatio-temporal resolutions of their sensors). Moreover, only few biodiversity indicators derived from SRS currently focus on species traits or community composition EBVs, as both the identification of individual species and the quantification of species traits such as LAI and foliar nitrogen, phosphorus, kalium and chlorophyll content remain challenging. We outline how further advances in data-science techniques (e.g. merging SRS observations of high spectral and high spatial resolution) provide tremendous opportunities for advancing community composition

and species-focused EBVs for global biodiversity monitoring.