CSQ-54 Summary

Question	Knowledge Advancement Objectives	Geophysical Observables	Measurement Requirements	Tools & Models	Policies / Benefits
How different drivers and threats effect the integrity of ecosystem?	A) Long-term, global land use and land use change monitoring	• Land cover and land use change types including, agricultures, pastures (grazing), urban and its relationship with changes	• Using various optical/SAR time series data available in the long-term (i.e. Landsat, Sentinels)	• Different change detection and time series analysis • AI for inferring land use patterns	• UNCBD • IPBES • Nature-based solutions • Restoration efforts
	B) Monitoring direct exploitation patterns worldwide	• Tracking different extraction, production, and consumption patterns (incl. mining, infrastructures, subsidence)	• using optical time series, very high-resolution data, subsidence/ structural changes (SAR/LIDAR)	• Various EO data analysis methods • AI for integrating different EO data and inferring specific extraction types	
	C) Explore different approaches for monitoring environmental pollution and invasive alien species	• Different environmental pollution processes (i.e. air quality, waste sites etc.) • Tracking of invasive species (although limited EO opportunities	• using optical time series, very high-resolution data, subsidence/ structural changes (SAR/LIDAR)	• Various EO data analysis methods • AI for integrating different EO data and inferring specific extraction types	
	D) Monitoring ecosystem integrity	• “integrity”, also naturalness or intactness to be assessed by quantifying the human pressures (land use, extractions etc.) and/or by quantifying ecosystem properties (structure, function,	• High resolution space-based LIDAR and RADAR measurements	• Various EO data analysis methods • Statistical and AI methods for integrating EO	

		and composition) compared to a “natural” state regionally	• Optical EO time series (i.e. Sentinels) • Quality ground reference networks (i.e. plot networks)	with innovative ground data	

CSQ-54 Narrative

How different drivers and threats effect the integrity of ecosystem?

A recent synthesis of direct drivers of recent global anthropogenic biodiversity loss showed that land/sea use change has been the dominant direct driver, followed by direct exploitation of natural resources, pollution; while climate change and invasive alien species have been significantly less (Jaureguiberry et al., 2022).

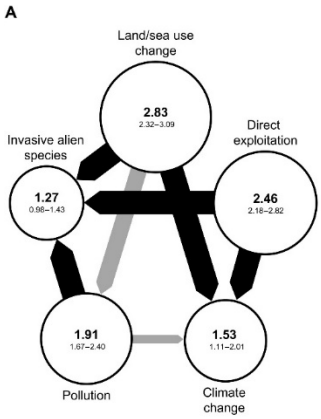

Fig. Dominance hierarchies of the five studied direct drivers of biodiversity loss (N=154, Jaureguiberry et al. 2022)

This study has been based on meta-analysis of different regional studies, while at the same time there is potential for using different EO-approaches to better map and constrain the various drivers and threats, for example:

1. Land use change monitoring (using optical/SAR time series)
2. Direct exploitation incl. extraction, production, consumption (using optical time series, very high-resolution data, subsidence/structural changes [SAR, LIDAR])
3. Climate change (using various ECV data records)
4. Pollution (some opportunities using hyperspectral, SAR, atmospheric monitoring)
5. Invasive alien species (limited remote sensing possibilities)

At least for the first three and most important drivers and threats a new systematic global and regional assessments across multiple drivers and including temporal trends could be advanced and provide consistent information suited for assessing ecosystem impacts and integrity. Considering and comparing with the series of local/regional case studies (that is current scientific base, Jaureguiberry et al., 2022) is important.

Improved spatial and temporal data on drivers can underpin an improved analysis of their impacts on ecosystem integrity. Ecologists associate the term “integrity” with naturalness or intactness and that can be assessed by quantifying the human pressures (land use, extractions etc.) and by quantifying ecosystem properties (structure, function, and composition) compared to a “natural” state regionally (Hansen et al., 2021). This assessment can benefit from improved EO-based mapping of ecosystem structure and composition when analyzed together with the new data on drivers. This approach is a practical way forward since the full complexity of Ecosystem and Biodiversity characteristics cannot be fully capture by observational methods, but tracking the key changes and using the concept of Ecosystem Integrity allows to quantify the most important patterns and trends.

References:

Hansen et al., 2021. Toward monitoring forest ecosystem integrity within the post-2020 Global Biodiversity Framework, Conservation Letters, 14,: 4, DOI: (10.1111/conl.12822)

IPBES (2019): Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. E. S.

Hollings, T. M. Burgman, M. van Andel, M. Gilbert, T. Robinson, A. Robinson (2018). How do you find the Green Sheep? A critical review of the use of remotely sensed imagery to detect and count animals, Methods in Ecology and Evolution, https://doi.org/10.1111/2041-210X.12973

Brondizio, J. Settele, S. Díaz, and H. T. Ngo (editors). IPBES secretariat, Bonn, Germany. 1148 pages. https://doi.org/10.5281/zenodo.3831673

Jaureguiberry et al. (2022) The direct drivers of recent global anthropogenic biodiversity loss, Science Advances, 8, eabm9982

Junker et al., (2023). List and specifications of EBVs and EESVs for a European wide biodiversity observation network, https://doi.org/10.3897/arphapreprints.e102530

Moersberger et al., (2023). Europa Biodiversity Observation Network: User and Policy Needs Assessment, https://doi.org/10.3897/arphapreprints.e84517

Senf C. (2022). Seeing the System from Above: The Use and Potential of Remote Sensing for Studying Ecosystem Dynamics, Ecosystems 25: 1719–1737, https://doi.org/10.1007/s10021-022-00777-2

Skidmore, A. et al., (2021). Priority list of biodiversity metrics to observe from space, Nature Eco Evo, 5, 896–906, https://doi.org/10.1038/s41559-021-01451-x

Ustin & Middleton (2021). Current and near-term advances in Earth observation for ecological applications, Ecological processes 10:1, https://doi.org/10.1186/s13717-020-00255-4

Verbesselt J. et al. (2016). Remotely sensed resilience of tropical forests. Nature Climate Change 6:1028–1031.

Xue, Y, Wang, Y., & A. Skidmore (2017) Automatic Counting of Large Mammals from Very High Resolution Panchromatic Satellite Imagery, Remote Sens. 2017, 9(9), 878; https://doi.org/10.3390/rs9090878