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A vegetation model based indicator measuring the risk for ecosystem destabilization (EcoRisk)

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A stable Earth system requires a healthy biosphere, but many ecosystems are being pushed beyond safe limits due to human activities such as land-use, resource extraction and climatic changes.

We map the “risk for ecosystem destabilization” (EcoRisk) due climate and land-use pressures based on simulations with the dynamic global vegetation model LPJmL. EcoRisk quantifies ecosystem dissimilarity relative to a preindustrial reference on a scale ranging from no change (0) to very strong change (1). It captures shifts in the vegetation structure (e.g., transition from forest to savanna), as well as relative (relevant for the local scale) and absolute shifts (relevant for the global scale) in soil and vegetation carbon stocks and fluxes, nitrogen stocks and fluxes, and changes in the water cycle [Stenzel et al. 2024].

Currently, almost 30% of the Earth’s global land area show severe changes (EcoRisk exceeds 0.55, a threshold derived from 10 independent indicators of biosphere integrity). These transgressions have steadily increased since 1600 and accelerated after 1925 [Stenzel et al. 2025]. A preliminary assessment of the future status according to simulations from ISIMIP3b scenarios indicates that EcoRisk continues to rise under SSP3-7.0, whereas under SSP1-2.6 it might plateau after mid-century, depending on the land-use scenario.

EcoRisk however is not only useful as a biosphere integrity indicator, but can also be used for model evaluation, because it can be computed separately for vegetation structure, water, carbon or nitrogen. It thus provides a diagnostic tool for model evaluation, benchmarking, and isolating the sources of change after major code revisions.

Data availability: https://biointegrity.pik-potsdam.de

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