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Refining geodiversity variables for monitoring global mining

Harry Seijmonsbergen, Joe McMeekin, Eline Rentier, Emma Polman, and Kenneth Rijdsdijk

University of Amsterdam, Institute for Biodiversity and Ecosystem Dynamics, Biogeography and Macroecology, Amsterdam, Netherlands (a.c.seijmonsbergen@uva.nl)

Within a few hundred years, mining has changed from a traditional, low impact, local and regional extraction activity to a global industry that is responsible for the conversion of most natural landscapes into man-made (agri)cultural/urban landscapes. The irreversible extraction of specific geological and geomorphological resources has immensely impacted global scale geodiversity and ecosystem functioning. Although geodiversity is vitally important for global sustainability, this is not reflected in international policy, conservation and management, possibly due to a lack of harmonized, transparent and easy to measure science-based geodiversity indicators. We use two case studies on sand and phosphate mining to identify their drivers, pressures, state and impact on the environment to demonstrate how geodiversity variables can be used to raise awareness and to respond adequately. Sand provides society with important benefits, specifically through the provisioning of raw materials for use in construction, although extraction volumes are largely unknown. Phosphate has essential value for global food security as modern agriculture heavily depends upon phosphate fertilizers, but concerns have been raised suggesting potential depletion of rock phosphate in the near future. Sand and phosphate mining are in high demand, have associated scarcity concerns, are unevenly distributed on a global scale, and their extraction has numerous (unexpected) environmental and societal impacts. These examples demonstrate the need for monitoring and management of mining activities on global scales, in order to adequately respond to the effects of extraction of these resources. We provide refinements to the existing geodiversity variables related to geology and geomorphology and present opportunities to monitor their global geodiversity dynamics using remote sensing technology. Such data can support the improvement of global datasets on mining, and provide a pathway towards international recognition of geodiversity variables.