Uncertainty Beyond Data: Assessing the Stability of LUCC-Driven Knowledge

Abstract:

Land-use and land-cover change (LUCC) is widely used as a core driving factor in environmental assessment and policy-relevant research. However, LUCC data are subject to substantial uncertainty stemming from differences among data products, temporal instability, and classification inconsistencies. While these uncertainties are increasingly acknowledged at the data level, their implications for the stability of scientific conclusions and the reliability of policy-relevant knowledge remain poorly understood. In particular, it is unclear whether regions characterized by high LUCC uncertainty also exhibit greater inconsistency in LUCC-dependent research findings.

This study develops an integrated analytical perspective to examine the relationship between LUCC data uncertainty and the stability of research conclusions across regions and thematic domains. Drawing on a large body of LUCC-related studies, we synthesize reported findings and assess the consistency of evidence in terms of effect direction, statistical significance, and the relative role of LUCC among multiple driving factors. Rather than focusing on pooled effect sizes, the analysis emphasizes patterns of agreement and disagreement in reported conclusions as an indicator of knowledge stability.

By linking spatial patterns of LUCC uncertainty with patterns of knowledge instability, this work provides new insights into how data limitations may affect scientific evidence and policy interpretation. The proposed framework contributes to ongoing discussions on uncertainty in environmental research and highlights regions where LUCC-based evidence may require more cautious use in decision-making.

Keywords: Land use and land cover change (LUCC); Data uncertainty; Knowledge instability; Meta-analysis; Policy risk