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T4 Mapping and modeling ecosystem services: Comparing methods

Ecosystem service tradeoffs and ecological–economic production possibilities frontier: A case study in Costa Rica

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Understanding interactions between ecosystem services (ES) is a high priority in ES research. Two types of interaction are commonly defined: (1) tradeoffs, in which one service increases while another one decreases in time or space; (2) synergies, in which both services either increase or decrease. Most studies on ES use statistical analysis and descriptive methods to assess ES spatial or temporal correlation. Recently, a new framework for ES interactions based on ecological–economic production possibilities frontier (EPPF) has been developed, which relies on the production theory branch of microeconomics. Applied to natural capital, this framework considers different levels of ES produced across a broad range of management actions and landscape configurations and describes graphically the nature and intensity of ES interactions by determining the production frontier (i.e. the set of Pareto–optimal values for pairs of ES). This study aims to estimate empirically EPPF using multiple ES maps and to compare the EPPF framework with statistical approaches. InVEST software was used to model and map ES production in the upper part of the Reventazón watershed (Costa Rica) for carbon storage (C), water yield, sediment retention, nitrogen retention (n) and phosphorus retention (p). Agricultural production (pa) was represented by its economic value. Spatial concordance and temporal covariation between ES were analyzed using statistical correlations for four observed land–uses (LU) over time. EPPF curves were constructed using a set of 32 contrasting LU scenarios generated considering slope and altitude constraints for some LU and assuming different LU proportions and distributions (either random or clustered). The nature and intensity of interactions between ES varied widely according to the methodologies used for evaluating tradeoffs. In comparison with the analysis of spatial and temporal ES correlations, EPPF curves brought supplementary information related to tradeoff intensity and identification of optimal LU scenarios.

Keywords: Ecosystem Services mapping; Tradeoff; Modeling; Production possibilities frontier