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The effects of switching spatial scales on soil-based ecosystem services levels and patterns: a case study at the patch scale

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The ecosystem service (ES) framework can be a useful tool to support sustainable land management and policy-making through mapping and assessment tasks. Quantifying the effect of the spatial precision of input data mobilised for ES assessment and mapping is a relatively new but fundamental issue, particularly with soil data that are often unavailable or available only at very coarse resolutions. However, no studies deal with the impact of the precision of input soil data on soil related-ES assessment and mapping

This study focus on a French territory of 100 km^2 and it examines the effect of increasing the spatial precision of soil data – at the 1:1,000,000, 1:250,000 and 1:50,000 scales – on the levels and the spatial patterns of four soil-related ES: the provision of biomass, the provision of water, the regulation of global climate and the regulation of water quality. The delivery of these services is finally analyzed according to multiple operational spatial units of aggregation such as municipal administrative boundaries, landforms and finally land-use and cover.

The precision of input soil data has limited impact on ES levels averaged over the whole 100 km^2 territory. More precisely, the soil maps at 1: 1,000,000 and 1:250,000 scales provide accurate ES levels for areas larger than 100 and 10 km^2. However, soil-supported ES are not equally sensitive to scale effects. Increasing the precision of soil data has indeed almost no impact on the water provisioning, slight impacts (around 10 %) on the regulation of water quality but impacts around 20% on the provision of biomass and the regulation of climate.

The three maps have contrastingly a strong impact on the location of the considered services with scaling effects locally reaching or even exceeding 100%. Switching spatial scales has almost no impacts on ES levels in cultivated lands localized on flat plateau positions. On the contrary, they reach around 50, 70 and 80% for the regulation of water quality, the production of biomass and the regulation of climate respectively in forested and natural lands localized on plateau edges, sloping lands and valley bottom that appear more particularly sensitive to switching scales. Forested and sloping lands indeed concentrate marginal soils showing very specific ES signatures.

Identifying the optimal representation of soil diversity to obtain a reliable representation of ES spatial distribution is not straightforward. The ES sensitivity to scale effect is indeed highly variable among individual ES, landforms, or land-uses and not directly linked with the soil diversity represented in soil maps.