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Scale dependency of biocapacity and the fallacy of unsustainable development

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Since the concept of sustainable development was put forward (WCED, 1987), it has become an ideal development mode and a common policy goal, and many indicators have been developed to assess the status of sustainable development. However, among these large numbers of indicators of sustainable development, the EF methodology has gain popularity due to its compatibility with the data format commonly derived from economic and social surveys. To date, area-based information obtained from remote sensing and aerial photography is often used in studies on ecological footprint and sustainability, especially in calculating biocapacity. Given the importance of the modifiable areal unit problem (MAUP; i.e. the scale dependency of area-based information), a comprehensive understanding of how the changes of biocapacity across scales (i.e. the resolution of data) is pivotal for regional sustainable development. To this end, based on the Monte Carlo simulation and the GIS technology, we chose two typical river basins in Northwest China (Jinghe River Watershed and Shiyang River Basin) and calculated the biocapacity at different spatial scales based on remote sensing data, with a nominal resolution of 30m at the scale of 1:100,000. The analysis demonstrated that the area sizes of major land covers and subsequently biocapacity showed strong signals of scale dependency, with minor land covers in the region shrinking while major land covers expanding when using large-grain (low resolution) data. The relationship between land cover sizes and their change ratio across scales was shown to follow a logarithm function. The biocapacity estimated at 10×10 km resolution is 10% lower than the one estimated at 1×1 km resolution, casting doubts on many regional and global studies which often rely on coarse scale datasets. Our results not only suggest that fine-scale biocapacity estimates can be extrapolated from coarse-scale ones according to the specific scale-dependent patterns of land covers, but also serve as a reminder that conclusions of regional and global un-sustainability derived from low-resolution datasets could be a fallacy due to the MAUP. On the other hand, the application of GIS and remote sensing data in the EF methodology is to address the requirement for a spatially explicit assessment of regional sustainability. It is therefore important to have a comprehensive understanding of how the area-based land use/cover sizes and BC are affected by the resolution of data. It is only by fully appreciating and utilizing the scale dependencies of land covers and biocapacities that we can have a robust picture of the regional ecological budget and sustainability.