Improved data for integrated modeling of global environmental change

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The assessment of global environmental changes, their impact on human societies, and possible management options requires large-scale, integrated modeling efforts. These models have to link biophysical with socio-economic processes, and they have to take spatial heterogeneity of environmental conditions into account. Land use change and freshwater use are two key research areas where spatial aggregation and the use of regional average numbers may lead to biased results. Useful insights can only be obtained if processes like economic globalization can be consistently linked to local environmental conditions and resource constraints (Lambin and Meyfroidt 2011).

Spatially explicit modeling of environmental changes at the global scale has a long tradition in the natural sciences (Woodward et al 1995, Alcamo et al 1996, Leemans et al 1996). Socio-economic models with comparable spatial detail, e.g. on grid-based land use change, are much less common (Heistermann et al 2006), but are increasingly being developed (Popp et al 2011, Schneider et al 2011).

Spatially explicit models require spatially explicit input data, which often constrains their development and application at the global scale. The amount and quality of available data on environmental conditions is growing fast—primarily due to improved earth observation methods. Moreover, systematic efforts for collecting and linking these data across sectors are on the way (www.earthobservations.org). This has, among others, also helped to provide consistent databases on different land cover and land use types (Erb et al 2007).

However, spatially explicit data on specific anthropogenic driving forces of global environmental change are still scarce—also because these cannot be collected with satellites or other devices. The basic data on socio-economic driving forces, i.e. population density and wealth (measured as gross domestic product per capita), have been prepared for spatially explicit analyses (CIESIN, IFPRI and WRI 2000, Nordhaus 2006) and there is also some information on road networks and the travel time to the nearest cities (Nelson 2008). However, this information has not so far been integrated to facilitate analyses of market access and market influence, which has hampered many socio-economic analyses to date.

The analysis by Verburg et al (2011) provides an important improvement in this respect. They developed a consistent global dataset on various market accessibility indicators on a 1 km² spatial resolution. Their analysis shows that market access is distinctly different from population patterns in some regions, which may help us to understand the prevalence of current economic conditions there. These are mostly areas with high population density, but little access to markets and, hence, a large share of subsistence farming and local economic activities.

Measures of market access and market influence can improve our understanding about the drivers of environmental change, as they link regional and global economic activity to local environmental conditions. They can also help to assess, design and implement targeted measures to reduce environmental pressure and improve ecosystem services. The analysis and dataset provided by Verburg et al demonstrates the kind of valuable insights that can be generated by
an integration of earth observation data, local case studies and modeling efforts at different spatial scales. This integration can improve monitoring, modeling and management of various global environmental changes, which will contribute to more sustainable economic development (Lotze-Campen et al. 2008).

Moreover, local market access is an important factor for economic development, poverty and food security. Aggregate, national figures, such as the human development index, do not provide sufficient detail. In many developing countries, certain rural areas lack market access and related options for development, as shown by Verburg et al. for e.g. Nigeria and Ethiopia. Together with data from household studies, the new dataset could provide the basis for improved assessments of targeted infrastructure investment, which could help to reduce environmental degradation, promote economic development and alleviate poverty.

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