How to sustain the terrestrial biosphere in the Anthropocene? A thermodynamic Earth system perspective

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Many aspects of anthropogenic global change, such as land cover change, biodiversity loss, and the intensification of agricultural production, threaten the natural biosphere. Implications of these specific aspects of environmental conditions are not immediately obvious, so it is hard to obtain a bigger picture of what these changes imply and distinguish beneficial from detrimental human impacts. Here I describe a holistic approach that provides a bigger picture and use it to understand how the terrestrial biosphere can be sustained in the presence of increased human activities. This approach focuses on the free energy generated by photosynthesis, the energy needed to sustain both the dissipative metabolic activity of ecosystems and human activities, with the generation rate being set by the physical constraints of the environment. One can then distinguish two kinds of human impacts on the biosphere: detrimental effects caused by enhanced human consumption of this free energy, and empowering effects that allow for more photosynthetic activity and, therefore, more dissipative activity of the biosphere. I use examples from the terrestrial biosphere to illustrate this view and global datasets to show how this can be estimated. I then discuss how certain aspects of modern technology can enhance the free energy generation of the terrestrial biosphere, which can then safeguard its sustenance even as human activity increasingly shapes the functioning of the Earth system.

Note: Presentation is based on this manuscript (https://arxiv.org/abs/2210.09164), accepted for publication in the INSEE journal.