

The social metabolism in the Anthropocene: modes of subsistence, population size, and human impact on Earth.

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Abstract

The discussion on the Anthropocene is in search for a valid and quantifiable description of how and when humans acquire the ability to dominate major features of the Earth system. While common approaches seek to quantify the human impact upon the carbon cycle by identifying the area of land cleared by humans, we base our estimate on the social metabolism of the human population. As a starting point, we use Ehrlich's classical IPAT formula, and give it a specific interpretation: human impact on Earth equals population size times affluence (interpreted as energy available per person) times technology – differentiated by mode of subsistence. We qualitatively describe the functional characteristics of hunter gatherers, agrarian and industrial modes of subsistence such as population dynamics, energy regime and the technologies by which they interact with their environment. In a 'toy' model, we translate these considerations into global numbers for the past millennia: we estimate the respective population sizes and affluence (energy), and finally also technology concerning its impact on the carbon cycle. We see a major historical dividing line around AD 1500: up to then, human population growth and metabolic rates carry about equal weight in increasing human pressure on the environment approximately fivefold from the year AD 1 onwards. Then fossil fuel use gradually raises the socially disposable energy to unprecedented levels and introduces a take off in population and technology. From then on, the overall pressure of humanity upon Earth increases by one order of magnitude; energy intensity contributes to this rise by roughly tripling the impact of population growth. Technology, because it is based upon a shift from biomass to fossil fuels (and other "modern" energy carriers), does not moderate this impact, but enhances it by a factor of 1.5.

Biographical notes

Marina Fischer-Kowalski is professor at the Alpen-Adria University and founded the Vienna based Institute of Social Ecology. Her background is in sociology (Ph.D. at Vienna University). She has taught at Griffith (Australia), Roskilde (Denmark), Yale University (USA) and the Universidad Federal de Rio de Janeiro (Brazil). Currently, she is President of the International Society for Ecological Economics. As expert member of UNEP's International Resource Panel, she became lead author to its publication, "*Decoupling resource use and environmental impacts from economic growth*" (2011). She is interested in social metabolism across history, on global, national and local scales, and investigates how it relates to social dynamics (quality of life, equity, division and quality of labour, time use) and to environmental change. She works on transitions in complex systems and engages in transdisciplinary sustainability research. She has published about 300 articles, and her most recent book (2014) is on *Ester Boserup's Legacy for Sustainability Research*. Springer.

Fridolin Krausmann is Professor of Sustainable Resource Use at Alpen Adria University Klagenfurt and Deputy head of the Vienna based Institute of Social Ecology. His background is in natural sciences (Ph.D. at Vienna University). He is involved in interdisciplinary teaching and research linking socio-economic and ecological approaches in sustainability science since 20 years. In his research he focuses on socio-ecological transition processes and has intensively studied changes in socio-economic use of energy, materials and land during the last centuries in local rural and urban systems, national economies and at the global scale.

Irene Pallua has a background is in communication science and political science (MA at Vienna University) and holds a Master in social ecology (Alpen- Adria- University Klagenfurt). Her research interests include socio-ecological transitions and societal energy use through history.