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Modelling socio-metabolic transitions: The historical take-off, the acceleration of fossil fuel use, and the 1970s oil price shock – the first trigger of a future decline?

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By talking about socio-metabolic transitions, we talk about changes in the energy base of socio-economic systems, leading to fundamental changes in social and environmental relations. This refers to the historical shift from a biomass-based (agrarian) economy to a fossil fuel based (industrial) economy just as much as to a future shift from fossil fuels to renewable energy carriers.

In our presentation,

• We will first show that this pattern of transition can be identified for most high income industrial countries: the later the transition started, the faster it proceeded, and the turning point to stabilization of metabolic rates in all of them happened in the early 1970ies. Due to the inherent non-linearity of this process, two approaches will be aplied to estimate parameters for the starting point, transition speed and saturation level: firstly a combination of an expontential and a generalized logistic function and secondly a Gompertz function. For both an iterative test procedure is applied to find the global minimum of the residual error for the whole function and all its parameters. This theory-based approach allows us to apply a robust methodology across all cases, thereby yielding results which can be generalized.

• Next, we will show that this was not just a "historical" socio-ecological transition, however. Currently, a substantial number of countries comprising more than half of the world's population are following a similar transitional pathway at an ever accelerating pace. Based on empirical data on physical resource use and the above sketched methodology, we can show that these so-called emerging economies are currently in the take-off or acceleration phase of the very same transition.

• Apart from these "endogenous" processes of socio-metabolic transition, we will investigate the effect of external shocks and their impact on the dynamics of energy and materials use. The first such shock we will explore is the oil crisis of 1972 that possibly triggered the end of rapid physical growth in high income countries. This could contribute to understanding the potential effect of other such shocks such as the rise in energy prices preceding the recent crisis, or future shocks related to the risks of nuclear energy or unconventional fossil fuels.