Socio-ecological transitions in human history and present, and their impact upon biodiversity

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In the model of **Socio-ecological systems** culture and nature interfere in **society's biophysical structure**. This structure, which has an exchange with nature (the material world) through **metabolism** and with culture (the human society) through **live communications**, is in focus of the research presented.

Socioecological regimes are dynamic equilibria of socio-ecological systems, that is a certain range of social organisation coupled to a certain natural system on which they depend, and which they colonize and exploit in specific ways. Thereby not humans as a species are in focus but society with its specific way of living according to its history. **Attributes** of socioecological regimes are the metabolic profile (energy use, material use), infrastructure, range of technologies, economic and governance structures, demographic reproduction, environmental impact and regulatory positive and negative feedbacks between the socio-economic system and the natural environment.
Changes within a socioecological regime normally happen gradually, steadily and a certain path dependency prevails until for example:

- the path is interrupted from outside
- the system collapses and possibly falls into an earlier stage of social development.

Transitions between socioecological regimes mark as well a change of the social development of the society. In contrast to changes within regimes transitions can be chaotic, exhibit jumps and can be non-linear. Societies are expected to face major transitions from time to time, an example from history is, e.g., the transition from the hunters society to the agricultural society.

The models of **material social metabolism** and **energy social metabolism** describe the flows into and out of a nation or nations. The material input in the EU15 nowadays consists, e.g., out of 2/3 construction materials, ¼ fossil fuels, ¼ boimass and 1/16 industrial minerals. The waste emissions of the EU15 mainly consist of CO_2. An important figure is the **domestic material consumption** (**DMC**), which denotes the domestic material input, such as imports and immigrants, minus the exports. The metabolic profiles of socioecological regimes in history differ remarkably. The per capita use of energy in agrarian societies for example is with 40-70 giga joules 4-6 times lesser than the per capita use of energy in industrial societies. The metabolic transistion from the agrarian regime to the industrial regime was an explosion in terms of energy use, material use and population density (*discussion: does the change of life expectancy alter the figures? Not qualitatively*). Therefore the changes per area are even more dramatically than per capita. In the European countries this transition took place from 1600 or 1700 to 2000. Energy use was not only intensified, but society switched from biomass dominated to fossil fuel dominated. Furthermore agricultural yields were raised and the fraction of urban population grew. These indicators may be used to determine the time point of transition of yet still agrarian societies.

To **colonize** a natural system the social system has to invest work and energy. The colonized natural system permanently tries to get back in the uncolonized state, therefore work and energy has to be invested steadily to keep the natural system colonized. In return human society can benefit from the primary production of the natural system: NPP = HANPP + NPPC. In the colonized natural system remains only a part of the net primary product (NPPC) of the natural system (NPP). The other part is the **human appropriation of net primary production** (**HANPP**). The HANPP is divided into primary production, which is needed to colonize the natural system and into primary production, which can be harvested by human society. The HANPP may be used to compare societies.

If the world's nations are divided into four clusters, namely industrial – high population density,

industrial – low population density, developping country – high population density and developping country – low population density, and these clusters are compared regarding their share of population, energy use, material use, GPD and territory, it gets apparent that we have an unequal distribution of energy and material use per area, carbon emissions per capita and ecological footprint per capita between these clusters. A solution has to be found for this unequal distribution. Furthermore a lot of developping countries are near the transition from agrarian to industrial societies, e.g. China or India. It is a challenge to make these transitions smooth and without big problems. The global increase of material and energy use is a global problem as well, regarding the limited resources. The aim to stop the increase of energy use by being more efficient may be only partly successful. We already had a decrease in energy intensity (giga joule primary energy use/gross domestic product) since 1830 and nevertheless had to face an enormous global increase of energy use.

Social metabolism may influence **biodiversity** in several ways:

- other species may be outcompeted,
- environmental media may be polluted, and
- new opportunities and niches may be created, e.g. plant and animal pets.

Furthermore the human colonization strategy may, e.g., intervent into ecosystems (biotops), organisms, populations or the evolution.
There may be a relation between the HANPP and biodiversity.

Discussion/Conclusions:

- In case a society is able to get new energy stocks, changes of population are triggered, e.g. another base of society. How can we get to a transition towards a sustainable energy use? We could use former transitions to learn.
- We need a new type of transition from the agrarian to the industrial society, otherwise we will face international chaos: The developping countries will have enormous social conflics due to an increase of energy prices. If not, the large pollution and according effects will cause trouble. Therefore all countries of the world, especially the industrial countries, must provide infrastructures and (new) technologies to create this new type of transition for the developping countries. It is a race with time and the developing countries can't cope on their own.

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