

## SOE 15: Physics of Sustainability and Human-Nature Interactions I (joint with DY, jDPG, BP, AKE) - session accompanying the symposium SYPS

Time: Wednesday 16:45–18:30

Location: MA 001

**Topical Talk** SOE 15.1 Wed 16:45 MA 001  
**The Industrial Society's natural Sustainability** — ●HANS G. DANIELMEYER and THOMAS MARTINETZ — Institut für Neuro- und Bioinformatik, Uni Lübeck

Human nature and industrial engineering form a predictable macro-system with six S-functional variables and biologically stabilized parameters [1]. S-functions display storing lifetimes with time shifts like Sinus functions with phase shifts. Since 18th century UK the real GDP per capita increased 100-fold; only a factor of 2.7 yields for the G7 the biologic limit of 118 years for the life expectancy.

This is orders of magnitude below all earlier predictions. The industrial society will be materially sustainable. But the present financial system is unsustainable because saturating growth and interest rates dry out saving, life insurances, and pension funds. This caused the Great Depression and the crash of 2008, not neoclassical excuses [2]. The only cure is bringing finance in line with human biology: return to the sustainable income distribution between World War II and 1980; increase retirement age; continue innovation; and defend the G7 position globally. Believing in the Neoclassical Paradigm of exponential growth is already Chinas problem because it wastes resources with unsustainable investments.

[1] H. G. Danielmeyer and T. Martinetz, An exact theory of the industrial evolution and national recovery, [www.inb.uni-luebeck.de](http://www.inb.uni-luebeck.de), 2009 pdf. [2] C. Teuling and R. Baldwin, Secular Stagnation: Facts, Causes and Cures, CEPR London 2014, [www.voxeu.org/sites/default/files/Vox\\_secular\\_stagnation.pdf](http://www.voxeu.org/sites/default/files/Vox_secular_stagnation.pdf)

SOE 15.2 Wed 17:15 MA 001  
**The decoupling of CO2 emissions and human development** — KAI KORNUBER<sup>1</sup>, DOMINIK REUSSER<sup>1</sup>, ●LUIS COSTA<sup>1</sup>, JÜRGEN KROPP<sup>1,2</sup>, RYBSKI DIEGO<sup>1</sup>, and SCHELLNHUBER JOACHIM<sup>1,3</sup> — <sup>1</sup>Potsdam Institute for Climate Impact Research, Potsdam, Germany — <sup>2</sup>University of Potsdam, Potsdam, Germany — <sup>3</sup>Santa Fè Institute

Evidence of a decoupling between greenhouse gas emission and socioeconomic development would benefit international climate negotiations in two ways. First, it would communicate to emerging countries that socioeconomic progress is not strictly connected with ever-growing emissions. Secondly, it informs developed economies on reduction targets that do not jeopardize progress. Using the Environmental Kuznets Curve as background and country-panel data between 1990 and 2013, a model was established to test postulated relationships between socioeconomic progress (measured using the Human Development Index (HDI)) and CO2 emissions from fossil fuels. An inverted U-curve with a time-dependent maximum moving towards higher HDI and lower per capita CO2 mission was established as the relationship delivering the lower fitting error. Extrapolating the global decoupling trend until 2050 returns global cumulative emissions of CO2 that are incompatible with meaningful with long-term climate protection targets. Individual countries presented remarkable differences in their decoupling dynamics. Further insights and implications of the analysis will be discussed, as well as future research needs.

SOE 15.3 Wed 17:30 MA 001  
**The size distribution, scaling properties and spatial organization of urban clusters: a global and regional perspective** — ●TILL FLUSCHNIK, STEFFEN KRIEWALD, ANSELMO GARCÍA CANTÚ ROS, BIN ZHOU, DOMINIK REUSSER, JÜRGEN PETER KROPP, and DIEGO RYBSKI — Potsdam Institute for Climate Impact Research (PIK)

Human development has far-reaching impacts on the surface of the globe. The transformation of natural land cover occurs in different forms and urban growth is one of the most eminent transformative processes. We analyze global land cover data and extract cities as defined by maximally connected urban clusters. The analysis of the city size distribution for all cities on the globe confirms Zipf's law. Moreover, by investigating the percolation properties of the clustering of urban areas we assess the closeness to criticality. We study the Zipf-exponents as a function of the closeness to percolation and find a systematic decrease with increasing scale, which could be the reason for deviating exponents reported in literature.

SOE 15.4 Wed 17:45 MA 001  
**Limits and opportunities of a regionalized food production for cities: A global analysis** — ●STEFFEN KRIEWALD, ANSELMO GARCÍA CANTÚ ROS, TILL STERZEL, PRAJAL PRADHAN, and JÜRGEN P. KROPP — Potsdam Institute for Climate Impact Research, Potsdam, Germany

The massive ongoing urbanisation in the 21st century is a major challenge for societies and therefore crucial developments towards a sustainable future will take place in cities. Together with many other issues a proper food supply is essential. Today, the necessary transport of food, especially the increasing transport by plane due to the global food supply chain, leads to a significant amount of greenhouse gas emissions. A reorganisation of cities in terms of their food allocation could save a considerable amount of emissions. We provide a global overview of the potential of peri-urban agriculture based on land-use, population, yield and dietary datasets. Our analysis indicates that up to 2 billion city dwellers can be fed by local grown products. However, Climate Change will drastically decrease the possibility of a local food supply for many regions.

SOE 15.5 Wed 18:00 MA 001  
**Food demand and supply under global change: need for sustainable agricultural intensification** — ●PRAJAL PRADHAN<sup>1</sup>, DOMINIK REUSSER<sup>1</sup>, MATTHIAS LÜDEKE<sup>1</sup>, and JÜRGEN KROPP<sup>1,2</sup> — <sup>1</sup>Potsdam Institute for Climate Impact Research, Potsdam — <sup>2</sup>University of Potsdam, Dept. of Geo- and Environmental Sciences, Potsdam

Global food demand is expected to increase by 60–110% between 2005 and 2050. Meeting growing food demand along with reducing agricultural environmental impacts is a global sustainability challenge. We investigated diet shifts, emissions, livestock feed, local food, and yield gaps to address this challenge. Globally, we identified sixteen dietary patterns. Diets common in developed world, exhibit higher emissions. Currently, 40% of global crops is fed to livestock. Two billions people are self-sufficient within 5' grid, while 1 billion Asians and Africans require inter-continental trade. However, they can become self-sufficient by closing yield gaps. By 2050, the global agricultural emissions will approach 7–20 Gt CO<sub>2eq</sub>/yr and feed demand may increase up to 1.3 times. The number of trade dependent people will range 1.5–6 billion which may be further increased by 4–16% due to climate change. In future, diet shifts will significantly increase crop demand, emissions, and trade. These can be reduced by technological change, consuming local food, and closing yield gaps. Sustainability of inputs and management required to close yield gaps depends on how options are chosen and implemented. Hence, a combination of sustainable intensification, expansion, trade and diet shifts is required to feed growing population.

SOE 15.6 Wed 18:15 MA 001  
**Sustainability for a Warming Planet** — ●HUMBERTO LLAVADOR<sup>1,2</sup>, JOHN ROEMER<sup>3</sup>, and JOAQUIM SILVESTRE<sup>4</sup> — <sup>1</sup>Universitat Pompeu Fabra (Barcelona) — <sup>2</sup>Barcelona GSE — <sup>3</sup>Yale University — <sup>4</sup>University of California, Davis

A clean biosphere is a resource in jeopardy due to man-made GHG emissions. What is the fair way to share this scarce global resource across present and future generations, and across regions of the world? This study proposes that the guiding ethics should be sustainability and egalitarianism. Sustainability is interpreted as a pattern of economic activity over time that sustains a given rate of growth of human welfare indefinitely; in doing so, the atmospheric concentration of carbon must be capped at some level not much higher than exists today.

Human welfare depends not only upon consumption, but also upon education, knowledge, and a clean biosphere. The analysis shows that we should be investing more in education and substantially more in knowledge creation than is currently the case.

International cooperation is vital in capping global greenhouse gas emissions at a sufficiently low level. We propose that solving the bargaining problem between developing and developed nations requires recognizing the relationship between economic growth and the climate problem. We propose that the dates at which developing countries converge in living standards to those of developed countries should

not be altered by the agreement. This principle, along with sustainability, suffices to determine how emissions should be allocated across regions and time.