SYPS 1: Physics of Sustainability and Human-Nature Interactions

Time: Wednesday 9:30–12:15 Location: H 0105

Invited Talk SYPS 1.1 Wed 9:30 H 0105

Anticipating and avoiding tipping points — •Timothy M. Lenton — University of Exeter, Exeter, UK

A 'tipping point' occurs when a small change in forcing triggers a strongly non-linear response in the internal dynamics of a system, qualitatively changing its future state. Large-scale 'tipping elements' have been identified in the Earth's climate system that may pass a tipping point under human-induced global change this century. At the smaller scale of ecosystems, some tipping points have already been observed, and more are anticipated in future. Our capacity to forecast such abrupt, non-linear changes has historically been poor. However, much excitement has recently been generated by the theory that some approaching tipping points carry generic early warning signals. I will critically examine the prospects for gaining early warning of approaching tipping points. Promising methods are based on detecting 'critical slowing down' in the rate a system recovers from small perturbations, and on accompanying changes in the statistical distribution of its behaviour. I will show examples of early warning signals in paleo-data approaching past abrupt climate changes, and in models being gradually forced past tipping points. I will also consider the conditions under which the methods fail. Finally, I will discuss how we might respond to early warning to try and avoid tipping points, especially in the climate system.

Invited Talk SYPS 1.2 Wed 10:00 H 0105

Climate investment under uncertainty: the two degree target and the desire for dynamic consistency — •Hermann Held and Delf Neubersch — Center of Earth System Research and Sustainability, University of Hamburg, Grindelberg 5, 20144 Hamburg

During the climate Conferences of the Parties 2009-2011 the global community developed a formal consensus to limit the anthropogenically induced increase of global mean temperature to 2K ("two-degree targe" or "2°-target"). While the latest IPCC (Intergovernmental Panel on Climate Change) report (2014) summarizes cost estimates that can be interpreted as rather low, suggesting some potential political feasibility of the 2°-target, some authors start to question the conceptual validity of the 2°-target: it might be too late to still comply with it, given the slow pace of mitigation policy. Moreover, it is pointed out that a strictly interpreted temperature target does not have a straightforward generalization when uncertainty is internalized in decision-making under anticipated future learning.

Here we present a generalization of the 2°-target that addresses both of these problematic aspects and that respects dynamic consistency under anticipated future learning. Consequences for climate policy are highlighted. We find that previous climate economic analyses of the 2K-target in terms of low cost for transforming the energy system are still valid, when being re-interpreted. Moreover, mitigation costs could be reduced by up to 1/3 if the climate response to greenhouse gas forcing were known with certainty, pointing to the expected economic value of geo-scientific information.

Invited Talk SYPS 1.3 Wed 10:30 H 0105

What are the resources required to fulfil human needs? — •Julia Steinberger — Sustainability Research Institute, University of Leeds, UK

All human societies require environmental resources, in the form of energy and materials, to survive and flourish. However, the exact level of resource requirements may be difficult to estimate, since it can depend on many factors. These factors include: local biophysical conditions, such as climate or available crops for food; technological options and efficiencies for delivering key services; but also socio-economic parameters, including consumption levels and inequality in distribution. This talk will present recent advances in the international study of energy requirements for human needs. These results demonstrate that high levels of human wellbeing are attainable at moderate as well as very high energy use, and that the average level of energy use required to achieve high human wellbeing is declining over time. Moreover, it can be shown that energy itself does not play a dominant role in explaining the considerable advances in human wellbeing over the past half century. An agenda for analysing the resource requirements to fulfil universal basic human needs will then be presented. This agenda must take into account socio-economic as well as technological choices, since fulfilling human needs at low levels of resource use most likely requires a re-organisation and re-orientation of many socio-economic activities.

15 min. break

Invited Talk SYPS 1.4 Wed 11:15 H 0105

Design of Sustainable Supply Chains for Sustainable Cities — •Anna Nagurney — Isenberg School of Management, University of Massachusetts Amherst

Supply chains provide the critical infrastructure for the production and distribution of goods and services in our Network Economy and serve as the conduits for the manufacturing, transportation, and consumption of products ranging from food, clothing, automobiles, and high technology products, to even healthcare products. Cities as major population centers serve not only as the principal demand points but also as the locations of many of the distribution and storage facilities, transportation providers, and even manufacturers. The sustainability of supply chains is, hence, a precursor to the sustainability of our cities.

In this presentation, we discuss a plethora of relevant supply chain networks for cities from food to energy ones. We provide the foundations of the methodologies in terms of variational inequality theory and projected dynamical systems theory and describe both an optimization model for sustainable supply chain network design as well as a game theory one with multiple decision-makers and frequencies of the network economic activities.

Invited Talk SYPS 1.5 Wed 11:45 H 0105

Ecological econophysics for degrowth — •Salvador Pueyo — Dept. d'Ecologia, Universitat de Barcelona, Barcelona, Catalonia, Spain — Research & Degrowth, Barcelona, Catalonia, Spain

Climate change, resource scarcity and ecosystem degradation suggest that we have already overshot the sustainable level of economic throughput. One of the greatest challenges of our time is to move from a growth-based economy to a socially benign degrowth. The obstacles ahead are not only political and cultural but also technical: How to transform the economic system in depth without undesired emergent properties or loss of its basic functionality? How to shrink the economy without triggering uncontrolled recessions? How to effectively increase equality to compensate for a decreasing average consumption? Several of the involved features are best expressed as frequency distributions (of recession sizes, of individual income or resource consumption), thus demanding the kind of approach used in statistical physics, which links distributions to mechanisms. This econophysical approach should be combined with that of ecological economics, which treats the economy as a subsystem of the biosphere instead of an autonomous system. Researchers in econophysics or complexity economics are in a unique position to move beyond more mundane goals and apply their knowledge to help changing the system in favor of sustainability, equality and democracy while we still have the opportunity.