SOE 8: Climate Impact and Human-Economy-Nature Interactions (accompanying the symposium SYCE)

Time: Wednesday 12:15–13:00 Location: HSZ 02

Topical Talk SOE 8.1 Wed 12:15 HSZ 02

A physics of governance networks: critical transitions in contagion dynamics on multilayer adaptive networks with application to the sustainable use of renewable resources — •Jonathan F. Donges[1,2], Fabian Geier[1], Wolfram Barfuss[1,3], and Marc Wiedermann[1,3] — [1]Potsdam Institute for Climate Impact Research, Potsdam, Germany — [2]Stockholm Resilience Centre, Stockholm University, Stockholm, Sweden — [3]Department of Physics, Humboldt University, Berlin, Germany

Adaptive network models are promising tools to analyze complex interactions in coupled human-economy-nature systems in the context of climate change mitigation and sustainability transformations. Here, we focus on a three-layer adaptive network model, where a polycentric governance network interacts with a social network of resource users which in turn interacts with an ecological network of renewable resources. We uncover that sustainability is favored for slow interaction timescales, large homophilic network adaptation rate (as long it is below the fragmentation threshold) and high taxation rates. We also observe a trade-off between an eco-dictatorship and the polycentric governance network of multiple actors. In the latter setup, sustainability is enhanced for low but hindered for high tax rates compared to the eco-dictatorship case. These results highlight mechanisms generating emergent critical transitions in contagion dynamics on multilayer adaptive networks and show how these can be understood and approximated analytically, relevant for understanding complex adaptive systems from various disciplines ranging from physics to epidemiology.

SOE 8.2 Wed 12:45 HSZ 02

Dynamic emergence of domino effects in systems of interacting tipping elements in ecology and climate — •Ann Kristin Klose[1,2], Volker Karle[1,3], Ricarda Winkelmann[1,4], and Jonathan Donges[1,5] — [1]Earth System Analysis, Potsdam Institute for Climate Impact Research, Potsdam, Germany — [2]Carl von Ossietzky University Oldenburg, Oldenburg, Germany — [3]Institute of Science and Technology Austria, Klosterneuburg, Austria — [4]Department of Physics and Astronomy, University of Potsdam, Potsdam, Germany — [5]Stockholm Resilience Centre, Stockholm University, Stockholm, Sweden

In ecology, climate and other fields, systems have been identified that can transition into a qualitatively different state when a critical threshold in a driving process is crossed. An understanding of those tipping elements is of great interest given the increasing influence of humans on the biophysical Earth system. Tipping elements are not independent from each other as there exist complex interactions. Based on earlier work on such coupled nonlinear systems, we systematically assessed the qualitative asymptotic behavior of interacting tipping elements. We developed an understanding of the consequences of interactions on the tipping behavior allowing for domino effects to emerge under certain conditions. The application of these qualitative results to real-world examples of interacting tipping elements shows that domino effects with profound consequences can occur and calls for the development of a unified theory of interacting tipping elements and the quantitative analysis of interacting real-world tipping elements.