Modelling resilience of agro-ecosystems: the co-evolution of regimes

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Understanding how natural resources co-evolve with management practices is fundamental to all questions concerning their sustainable management. In the search for new pathways of sustainable development we seek to understand how comparable initial conditions in agro-ecosystems lead to fundamentally different resource conditions. Agro-ecosystems are characterized by a high diversity, path dependence, self organization, cross-scale interactions and non-linear feedbacks. The resilience perspective claims it offers insight in these complex systems attributes. For exploring these dynamics we used a summary model approach. A summary model approach aggregates processes based on detailed knowledge, while allowing for integration of multiple scales and the identification of thresholds.

We analysed an area characterised by dairy farming in the Netherlands, within which two different farming systems can be found. One system is characterised by the modernisation paradigm with benefits of scale, intensification and specialisation, while the other system is characterised by low external input and less intensive farming. For a long time it was thought that the latter, alternative, system represented the laggards of the adoption rate of innovations. Scientific attention to the development of this region was attracted by the persistence of the alternative farming system, the increasingly valued effect on the landscape by these farms, and their mismatch with "modern" environmental regulations.

We developed a summary model that integrates the soil, feed, and animal compartments of the farming system. The model enables us to simulate the effects of farm management decisions on the key natural resources soil carbon and nitrogen. When characteristic farm management of both the intensive and the alternative farming systems are used as model input, the systems evolve to different regimes. I.e., the different management systems lead to natural resources that respond differently to external drivers.

The two management systems evolved to different natural resource regimes and traverses to the other regime are slow, highly non-linear and involve large costs. Policies aiming at social-ecological regime change are currently not aware of these dynamics. We are now discussing with farmers strategies for regime change employing the non-linear dynamics in their system. With researches in the area we are formulating new hypothesis on system functioning. Meanwhile at the governance level we show how the environmental regulations, although initially successful, will actually drive the systems to an unwanted regime.