Elementary models for a sustainable economy
: Summary of Presentations, Prof. Bert J M de Vries

21-24 January 2010 in Utrecht

The presentations. More than a dozen presentations have been given; there was a core group of about 10 participants plus another dozen people who participated one or two days. I give here a very brief summary; see the pdf's on the website for more details. On the first day, four presentations (Lindgren, Weisbuch, Brede and Van den Bergh) dealt with the various ways in which (human) agent behaviour can be modelled. *Lindgren* presented work in which competition and cooperation are explored in an evolutionary game context. Memory, interpretation and errors can lead to large fluctuations in strategy space – an outcome which suggests that a system of interacting agents choosing from a set of behavioural strategies (i.e. an economy) is probably unpredictable although there may be periods of relative stability.

Guided by KISS (Keep It Simple Stupid), *Weisbuch* introduced a simple analytical model of consumers with heterogeneous preferences (bell-shaped Willingness To Pay distribution) for a more expensive 'green' product. Such a model can exhibit hysteresis as a result of multiple attractors – this may imply large shifts for small parameter changes. It suggests that phenomena like market transitions can also be described without explicit agents (cf. KISS). The model has also been applied on a social net.

Brede presented investigations on the physics of coupled oscillators and their relevance for economic cycles and social interactions. Assume a network of oscillators with a 'native' frequency and synchronizing couplings between them – for instance, a network in space or an opinion network. How is system dynamics and final state determined by the network characteristics? Brede shows that this strongly depends on the strength of the original 'native' states and the strength and nature of the couplings.

Van den Bergh gave a comprehensive overview of evolutionary concepts and their applications and relevance in evolutionary economics and for sustainability related issues. He used the replicator dynamics equation in a Common Pool Resource (CPR) problem and the Sugarscape model to explore the question: are local interactions relevant? He also discusses the insights from evolutionary modeling in understanding the co-evolution of demand and supply, including lock-in phenomena; the role of power, conflicts and coalitions; and possible trade-offs between efficiency and diversity.

On the second day, the focus was the ecology-economy interface. The opening talk was given by *Mylius*, who introduced the basic equations in evolutionary dynamics. In particular the quasi-species equation in replicator dynamics and the canonical equation in adaptive dynamics. Kernel of the evolutionary approach is the feedback upon process dynamics though the environment, using evolutionary optimization with fitness measures and changing fitness alndscapes. The talk provided for a continuation of the discussion about what evolution [theory] really is about and can/should be used in economics. Ecology tends to focus more on persistence than sustainability, was one observation.

Hein then reflected on PhD.research on the implications for economic models of the, relatively recent, discovery of non-linear change in ecosystems (catastrophic, regime shift) and how the notion of ecosystem services might complement prevailing (optimal) management strategies. He dealt in some detail with case-studies of a forest, a wetland and a rangeland ecosystem. There are distinct ecological and institutional scales at which the two interact – this is an important consideration in choosing the level of interaction between agent and ecosystem.

De Zeeuw built upon this with an analysis of [optimal] [common pool] resource management in the face of thresholds and tipping points in the ecosystems. The mistake of many resource –economic models is their focus on species – it should be on ecosystems. Only then one understands the importance of 'managing for resilience'. Resource management now is about understanding (eco)system slow and fast variables and (in)stabilities, and explore how to avoid shifts to 'bad states'.

Hasselmann presented the methodology and some outputs of the latest version of The Multi-Actor Dynamic Integrated Assessment Model System (MADIAMS), in particular in relation to the IPCC/Stern evaluation of the cost of mitigation. He advocates the construction of a hierarchical family of (simple) models which translate the verbal models of (real-world) economists into visual models (qualitative→quantitative). He also showed simple models on supply-demand dynamics and on the socio-political dynamics behind climate policy.

Magnuszewski gave an overview of various approaches to consumer choice and interaction processes. One key notion is the threshold fraction of surrounding agents above which an individual's choice switches. Combined with individual preferences and random factors, one get a generalized utility function which can exhibit multiple equilibria. The social psychology oriented approaches suggest decision rules which are a function of impact which is a combination of persuaviness and supportiveness. Magnuszewski showed the equivalence of the utility and the impact function approach and presented a generalized model.

The last lecture was given by *Safarzynska*, who presented PhD research on an agent-based model of supply-demand coevolution where firms experience positive returns by learning, economies of scale and innovating, while network, snob and advertisement effects cause positive feedbacks among consumers. The probability of lock-in is explored in 500 monte-Carlo simulations, with 100 consumers divided in two classes and with three network types representing interactions. She also presented some evolutionary approaches to (parts of) the energy transition, in order to explore diversity-efficiency and short-long-term trade-offs and introduce specific sectors and actors in modeling system transitions.

The objective of the saturday session was to get informed about existing interactive simulation models/games in the 'sustainable economy' arena and identify some of the basic models in CSS which might be suitable for such an approach. *Anderson* presented some of his work on cellular automata and network approaches in urban modeling. It is a conceptually simple model which uses network and cellular automata theory to

implement the idea that (land) value is fundamentally related to trade. In this way empirical data on land value can be reproduced fairly well from a multiplicative and additive growth process.

Lindgren introduced briefly the GETonline model. This is an interactive version of the dynamic optimization Global Energy Transition (GET) model, which has been developed as part of the GSD-project. There is some experience with its use during the Copenhagen COP-meeting.

Magnuszewski presented the experiences of him and his colleagues in organizing role-playing simulations about the maintenance of a drainage system in the Oder river (Poland). The AgroGame has an underlying simple crop-income model (in Vensim) and a set of role descriptions. The results of the game sessions are being used to validate some of the functionals and parameters in agent-based models.

Bots then shared his experiences in the use of models and games in real-world policy processes, in particular in (restructuring) Dutch neighbourhoods (DuBes). In an elaborate process, actors (stakeholders) and their preferences (goals) are identified; themes and decision areas are prioritized; options relate via impacts to variables through equation sets. Given actors, preferences and policy frames and instruments, the model is used in a simulation gaming context – in an iterative validation process. He also briefly presents elements of the ComMod methodology developed at INRA-CIRAD in Montpellier (*Ferrand*).

Finally, *De Vries* gives a quick overview of interactive models and games he has used in the past for teaching purposes (Stratagem and Fish Banks Ltd., by Meadows; powerPlan; SusClime) and the CLIMEX internet-based risk-perception game developed within the GSD-project. The latter is a simple game, in which players (one or in the multi-user version more) are asked to contribute to a Climate Fund in order to reduce the probability that they will loss their accumulated income in the future due to climate change.