What can artificial life offer the development of methodologies in the field of socio-ecological sustainability?

Alexandra Penn

Science and Engineering of Natural Systems group, School of Electronics and Computer Science,
University of Southampton
asp@ecs.soton.ac.uk

Issues of sustainability involve the dynamics and interactions of multiple complex adaptive systems at a variety of scales: climatic; ecological; economic; technological; political and social. Some of the most pressing challenges for society are inherently concerned with gaining a better ability to understand and manage the interacting systems upon which we rely. While there is widespread acknowledgement that the science of complex adaptive systems can provide key tools to address these challenges, there is little consensus on how to develop and apply these tools effectively. New approaches are therefore needed before effective policy-making can be informed by well-founded scientific modelling. Concepts and terminology such as complexity, complex adaptive systems, whole systems thinking, non-linear dynamics, co-evolution, autopoeisis, and self-organisation enjoy common currency in movements such as resilience thinking, sustainable systems approaches and permaculture (amongst others), which share a common ancestry with A-Life in systems theory. The use of such ideas as metaphors to guide thinking is valuable up to a point. For example, the concept of non-linear response to change, including at the extreme system tipping points, is an important understanding which must certainly guide policy in areas such as climate change. A large array of complex systems metaphors are also used as sources for design and management heuristics. However, there are presently enormous methodological leaps to be made before their full potential usefulness can be realised, and the availability of clear quantitative or qualitative measures and methodologies connecting theory with practice is extremely limited. A clear opportunity exists for the field of Artificial Life to contribute in this domain at this key time. In this talk I will give an overview of the current use of complex and dynamical systems concepts within the sustainability movement and associated challenges. I will detail practical tools being developed to measure the qualitative or quantitative behaviour (or health) of dynamical systems such as ecosystems, and discuss how we can move from a metaphorical understanding of such systems as complex, dynamical or adaptive, towards strategic intervention in or interaction with them with the goal of sustainability in mind.

I will focus on what I consider to be three key areas in which A-Life methodology can contribute: 1) The use of modelling to predict the gross behaviour of systems, with a particular emphasis on the incorporation of evolutionary processes, network dynamics, and agent-based modelling into current resilience approaches; 2) The development of quantitative indicators of systems' "health" with regard to their ability to self-maintain; 3) The development of tools for management or steering of complex systems undergoing rapid change, including the potential for "engineering" or "programming" self-organisation of complex adaptive systems for increased resilience, robustness and "sustainability".

The aim of this talk is to initiate dialogue between theoreticians and practitioners towards practical use of A-Life methodologies in frontline sustainability.