

Computational Ecology

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CEES

The Computational Ecology and Environmental Science Group (CEES) aims to develop the new concepts, methods, and software tools that are needed to produce useful **predictive models of ecological systems**. Without such predictive models, humanity cannot hope to develop solutions to the crucial global challenges that it is currently facing, including **climate change, the loss and degradation of ecosystems, food security, and global pandemics**. With a very few exceptions, the science of ecology has not been able to make predictions. CEES aims to change that, by helping to develop a new kind of computational ecology that will one day underlie a more rational approach to managing the world's ecosystems, whether natural, semi-natural, or artificial.

Who we are

Although CEES sits within one of Europe's leading Computer Science research labs, all CEES members are active research ecologists with **PhDs in Ecology, and a proven track record of publishing in top ecology journals**. Our specialisms include food-webs; vegetation, forests and climate change; animal behaviour; biogeography; and disease dynamics. But we are very different from other ecology research groups in several important respects: we sit within a **corporate research lab**; we focus on **computational ecology**, an emerging discipline that CEES is helping to define; we develop and distribute novel **software tools** to enable ourselves, and also our academic colleagues in the scientific community, to carry out computational ecology; and we attempt to integrate different aspects of ecological theory into **global-scale models**. We collaborate actively with a wide variety of academic colleagues, and co-supervise PhD students in several top universities.

Joined up Ecology

We have developed a philosophy and approach characterized by:

Joining up ecological sub-disciplines, and ecology and other areas of natural science, economics, sociology and engineering.

Joining up ecological theory, with data, via statistics, to produce useful predictive models of ecosystems.

Joining up ecological science with policy, to help develop workable solutions to key global challenges.

CEES is less than five years old, but in this time we have published over 50 research papers in journals including Science, PNAS, Proc Roy Soc B and PLoS Biology. CEES is becoming increasingly recognized as a world-leading group in computational ecology. For example, we currently have many more requests for collaboration from academic colleagues than we can possibly deal with!

CEES: Two Global Modelling Projects

Climate change is arguably the greatest single global challenge of the 21st century and beyond. To develop policies to reduce the degree of climate change and to mitigate its effects, we need models that can forecast future climates associated with different policy scenarios, ranging from 'business as usual', to the total decarbonization of the global energy network. Currently, one of the largest single source of uncertainty in global climate models is the future of carbon stored in vegetation*. In recent years vegetation (mostly forests) has soaked up 25% of human CO₂ emissions, but models disagree drastically about the future of this 'carbon sink': will vegetation soak up ever larger amounts of carbon, acting as an ever-stronger brake on climate change? Or will vegetation become a significant carbon source, accelerating climate change? which in turn would demand much more radical policy action to reduce CO₂ emissions now...

To help answer this question, CEES is simulating the global carbon cycle using a 'balanced complexity' approach to modelling complex systems. The result will be the first global carbon cycle model that gives equal weight to all important components and scales of the system, and which is fully constrained against published data sources using Bayesian statistical techniques. This CEES project can be expected to deliver more accurate projections of future CO₂ concentration and hence climate change; a better understanding of the global carbon cycle; and a new set of priorities for data-gathering and basic research.

But climate change is far from the only global challenge. An expanding population, with expanding resource use per capita, is resulting in an alarming loss and degradation of ecosystems, the economic consequences of which could potentially dwarf those of the recent worldwide economic crisis**. In order to balance the need for increased food, timber and textiles production, with industrial use of natural resources, and the healthy functioning of natural, semi-natural and artificial ecosystems, we require predictive, global models of the response of ecosystems to various human activities.

CEES is working with the United Nations Environment Programme***, to develop such a model. By combining different strands of ecological theory – from the behaviour of individual animals and plants, through communities and foodwebs, to ecosystem function and biogeochemistry – with a large number of heterogeneous global data sets made available by governments, NGOs and universities, we aim to produce a novel model that is useful both for guiding policy in the near term, and for guiding environmental research in the longer term. Moreover, we aim to provide others with the software tools needed to build such models. In this way, we hope to trigger the development of a number of (healthily) competing models of global ecosystem function.

* IPCC synthesis report 2007: http://www.ipcc.ch/publications_and_data/ar4/syr/en/spms3.html

** TEEB interim report, box 3.5 page 34: <http://www.teebweb.org/LinkClick.aspx?fileticket=u2fMSQoWJf0%3d&tabid=1278&language=en-US>

*** UNEP-World Conservation Monitoring Centre: <http://www.unep-wcmc.org/>