

Stream A - Workshops

A1: Issues Surrounding the Combined Use of Indicators and Models in Decision Making

Organizers: Lescot, Leccia.

At present, policy decisions relating to environmental and social-ecological systems tend to be made based on indicators (i.e. reduction of pressure) as opposed to models, which can simulate achievement of environmental targets in the long term.

It would seem advantageous to combine these indicators and models into a more efficient decision-making approach. However, to achieve this, some issues need to be examined in more detail.

The key questions would appear to be the following:

- What type of validation is necessary for models and indicators to be used in parallel?
- How can different temporal and spatial scales be made compatible with both methods?
- How can changes of scale and the resulting aggregation be defined when associated with questions of sensitivity and uncertainty?

The aim of our proposed contribution to the workshop is to tackle the questions that need addressing when researchers are called upon to help stakeholders make decisions about managing environmental systems.

A2: Integrated Socio-Ecological Modelling for Ecosystem Services And Beyond

Organizers: Stefano Balbi, Ferdinando Villa.

The ecosystem services framework has gained much attention in the last years. New conceptual models and computational methodologies are improving the accounting of environmental values and addressing an increasingly interdisciplinary research field. Still, traditional socio-economic thinking, which greatly influences policy making, has only been marginally affected by these developments. Key environmental resources continue being over-consumed around the world, while socio-ecological systems at different scales remain far from following sustainable development. By neglecting interactions among human agents, ecosystem services research alone cannot explain the reasons of this failure. An approach that can better integrate social and economic dynamics is needed to explain why most human societies remain unsustainable in this phase of human history (descriptive research). Hopefully this new research line could then stem into a better science for policy making (normative research).

A3: Long –Term Analysis of Socio-Ecosystems Under Climate Change: New Avenues for Integrated Modelling of Adaptation Processes

Organizers: Carlo Giupponi, Paola Mercogliano.

The workshop will focus on modelling and techniques (RS & GIS) for monitoring and assessing the interactions between exogenous drivers (climate change in particular) and the evolution of socio-ecosystems. A specific interest is for land cover/use change as a manifestation of the effects of climatic changes and their interlinkages with ecosystems and human activities.

The main aim of the workshop is exploring methodological avenues and technological solutions to go beyond state of the art to analyze the vulnerability of socio-ecosystems to global change over the long term.

We expect contributions covering topics ranging from climatic modelling, to natural disaster mapping, RS for land cover and land use change analysis, economic modelling of impacts. The workshop will contribute to develop new ideas about which opportunities are there for innovative approaches and how they could be integrated in studies like for example climate change adaptation analysis and strategy development.

A4: The Miracle Prototype: A Hands-On Demo of a New Tool for Visualization, Analysis, and Workflow Management for Agent-Based Models of Socioeconomic Systems

Organizers: Dawn Parker, J. Gary Polhill.

This session follows up on the 2014 IEMSS workshop “Analyzing and synthesizing results from complex socio-ecosystem models with high-dimensional input, parameter and output spaces,” and a related ESSA metadata workshop, whose input contributed to the development of the Digging into Data MIRACLE software prototype, which will be demoed in the workshop. MIRACLE allows users to upload, analyze, and share output data from complex simulation models in a cloud-based community environment. Rather than uploading and executing code, output data, output analysis scripts, and model and provenance metadata are uploaded. Users (project participants, external researchers, or even students) can query data, examine existing visualizations and analyses, and run new queries using novel parameter combinations, sharing and commenting on queries. The tool is designed to facilitate efficient sharing of model output and analysis and thereby improve communication and reduce barriers to entry for modelers.

A5: Scalable Environmental Modeling with Containerization and Restful API Endpoints

Organizers: Tom Purucker, Jon Flaishans.

Environmental models may require the ability to scale their implementation. This may be in response to a need to execute more complex, detailed applications and/or be responsive to multiple users in a distributed modeling setting. Regardless, such implementations may require a combination of significant core computing capacity and concurrency control that is difficult to achieve in a desktop environment. Scaling these models can present challenges, but may be necessary for Monte Carlo simulation, for higher spatial resolution and/or geographical scale, long time series modeling, and/or to account for multiple simultaneous users.

This hands-on workshop will allow users to deploy a combination of modern technologies that can address these issues. Participants will quickly build a running instance on their laptop of the leading containerization technology, Docker, in order to deploy a set of environmental models. Container-based technologies separate the application from the underlying infrastructure, just like virtual machines separate the host operating system from the underlying hardware. These technologies allow for the ability to build and configure an environmental model once, and then deploy and run the model anywhere. The core services consist of a daemon that is installed on a machine and a client that interacts with the daemon. A typical workflow then consists of a containerized image that is layered to contain the host operating system, environmental model(s), and all dependencies. Images are used to create containers that can be started, stopped, moved or deleted. This technology is supported by a registry system that allows for public or private access to repositories that store images as well as a system for automating building images. This lightweight approach is portable and scalable, with the ability to launch and shut down additional machines as needed.

To fully leverage this technology, the models in the containerization image will be in the form of

application programming interface (API) representation state transfer (RESTful) web services. We will address approaches for accessing these endpoints and leveraging their deployment within cloud environments, providing Models-as-a-Service. RESTful endpoints opens up a number of possibilities for scaling computations and allow for model interoperability possibilities at both the computational/ algorithmic level and from a user interface (mobile, desktop or web) development standpoint.

A6: Integrated Assessments and Sustainability Indicators for Africa

Organizers: Ann van Griensven, Youssef Filali-Meknassi, Liu Junguo, Stefan Uhlenbrook.

In the workshop we aim at presenting and discussing new developments and applications of:

- (1) Integrated Assessment tool developments and applications for sustainable use of natural resources in Africa
- (2) Inter-disciplinary inter-model comparisons in Africa (eg within ISI-MIP initiative)
- (3) Mapping of indicators of sustainability for Africa;
- (4) Mapping of ecosystem services, water accounting and water productivity scores for Africa (5) water-food-energy nexus in Africa

Stream B - Workshops

B1: 2016 Agricultural Modelling Hackathon

Organizers: Ioannis Athanasiadis, Marcello Donatelli, Gianni Bellocchi, Sander Janssen, Dean Holzworth.

This crop modelling hacking event aims to focus on the code of different crop models and to investigate (a) how similar model implementations are (or not), and (b) how to enable multi-model runs. No presentations are involved, and model developers are invited to attend possibly bringing UML models of the architecture they use. The intention is to analyze the invasiveness of the modelling frameworks using common metrics and a methodological framework, and discussing its impact on biophysical modellers practice. The approach of the BioMA framework and its developments in the project MODEXTREME will be discussed as one of the possible cases. The workshop is expected to generate interesting results for a future joint publication on crop model implementations.

B2: Identifying an Appropriate Model: Working with A Flexible Hydrological Modelling Framework

Organizers: Jiri Nossent, Mahyar Shafiei, Thorsten Wagener.

Mathematical models play a crucial role in supporting our understanding and predictions of the response of environmental systems, given the existence of uncertainties (in data, parameters and model structure). One of modelers' most important tasks is the identification of an appropriate model (i.e. combination of a proper model structure and its corresponding parametrization). In hydrological modelling, conceptual rainfall runoff (CRR) models have been extensively used to predict watersheds' behavior. The conceptual nature of these models, combined with the existing uncertainties, results in the fact that different structural conceptualizations might yield equally good results when taking a number of goodness-of-fit metrics into consideration. It is argued that the identification of the most suitable model structure

must be conducted on the basis of multiple hydrologic quantities and processes, rather than a limited set of statistical metrics. This workshop provides guidance to system analysis techniques for quantifying the watershed's response in terms of different hydrological signatures, and using them to identify the most hydrologically consistent model structure and parameters.

The workshop starts with a short introduction on standard sensitivity analysis and optimization of a CRR model. Additionally, the concept of hydrological signatures and their application to a process-based model identification procedure will be introduced. Next, attendees will use a flexible hydrological modeling framework, in which they can change conceptual model configurations to obtain a range of simple to complex model structures. In this way, they have the opportunity to practice their skills to adjust model structure and parameters to the extent that hydrological signatures (reflecting the watershed behavior from different perspectives) are acceptably captured.

The workshop is targeted at researchers (PhD students, post-doctoral fellows and senior researchers) who are interested in going beyond statistical analysis of their data, and fit a mathematical model to the signatures observed in environmental/hydrological systems. The workshop consists of short introductory lectures covering the underlying theory, combined with practice group exercises and discussions. The attendees can bring their own data sets to work on their own watersheds, but sample data sets will be provided in the workshop as well. Basic knowledge in model calibration and MATLAB is required.

B3: Geovisualization of Model Outputs with Mapwindow

Organizers: Georgii Alexandrov, Dan Ames.

Environmental models that deal with large objects such as ecosystems, biomes, or the Earth System produce geospatial outputs. This workshop is organized to discuss the use of MapWindow, www.mapwindow.org, a free open-source geospatial data viewer, for visualization of such outputs. Organizers of this workshop call for papers reporting the cases of MapWindow use for visualizing outputs of environmental models. An ideal paper may include a template for visualizing a specific category of geospatial data, information about availability of developed MapWindow project for sharing and re-use, and suggestions for improving MapWindow functionality.

B4: Convergence or Divergence in Crop Models (from a Framework Point of View)

Organizers: Sander Janssen, Dean Holzworth, Ioannis N Athanasiadis.

This crop modelling hacking event aims to focus on the code of different crop models and investigate how similar model implementations are. No PowerPoints or presentations are involved, and model developers will be invited to attend. The intention is to analyze the invasiveness of the modelling frameworks using common metrics, and a methodological framework. Hopefully this will conclude to some interesting results for a future publication on crop model implementations.

Stream C - Workshops

C1: DMTES Workshop

Organizers: Karina Gibert, Joaquin Izquierdo, Miquel Sànchez-Marrè, Ignasi Rodríguez-Roda, Serena Hamilton, Geoff Holmes, Ioannis Athanasiadis, Antonio Ciampi, Joaquim Comas.

This workshop (W-DMTES-2016) aims to provide a global perspective of the complete and complex process of transforming raw data into really useful decisional knowledge in environmental domains. Data Mining processes transforms the data into relevant information, and permits to induce decisional knowledge from it, even taking into account the doctrinal corpus in the target domain, when available. This knowledge can be used to provide rational support to the complex decision making process in front of high levels of uncertainty, multifactor influences and, eventually, different experts opinions, providing highly powerful tools for better knowledge of environmental systems as well as better control and management. This workshop is in close connection with S-DMTES-2016 session, and pretends to promote the interaction among the Environmental Sciences, the Data Mining and Data Science, and related areas, like Big Data, or Intelligent Decision Support Systems, as well as to make data mining techniques and related more accessible to environmental modelers and to give data miners and knowledge engineers a better idea of the needs and desires of the environmental community. As a main discussion topic, this year the connections between Big Data, Data Science, Data Mining and Environmental Sciences will be addressed. Participants in S-DMTES'2016 and/or session IEDSS in iEMSs'2014 are specially invited to take active participation in this workshop

C2: Land Use Change Science: Lessons Learned from Applications of Using the Land Transformation Model

Organizers: Amin Tayyebi

Over three decades of model development have gone into the land change science across the world. The objectives of this workshop are to: (1) review the depth of land change issues that are being addressed by the land change science community to better understand environmental issues; (2) using a land change model to simulate land use transition; (3) show recent advancement for forecasting and back-casting big data at continental scale and link the forecasted and back-casted land use change scenarios to climate, hydrologic or biological models to examine how what-if land use change scenarios impact the environment; (4) reconfigure land change models for urban growth boundary simulation to protect to conserve environmentally sensitive areas and (5) show the ways that the land change models should be interpreted given errors that occur in simulations.

C3: From Environmental Information Systems to Big Data

Organizers: Ioannis Athanasiadis, Argyris Samourkasidis.

In the past years, with the decreasing cost of sensory equipment we experienced the democratization of environmental sensing via crowd-sourced platforms, along with major investments from the public for installing long-term monitoring networks. At the same time, the dig data movement brought forward algorithms and tools for efficiently processing massive amounts of different kinds of information to unlock the value that was previously unattainable. In this workshop we will discuss the challenges and the prospects for environmental information management for the years to come. Issues of data modelling, archival, and interoperability will be considered and experiences from different environmental disciplines (i.e. hydrology,

agronomy, forestry, ecology, air quality etc.) will pave the way for identifying common problems and universal solutions.

Workshop organizers and attendees will share their experiences, preview next steps and outline a research agenda for the near future.

C4: New Technologies to Aid the Parsing, Management, and Use of Sensed or Observed Data to Inform Environmental Modelling and Decision-Making

Organizers: Ioannis N. Athanasiadis, Suzanne A. Pierce.

Advanced computing applications for environmental systems are developing at rapid rates. Innovative applications are improving the technology applications range across many forms and formats from crowdsourced data and real time global sensing, to 3D printed tangibles for educational and interactive management and implementation of information hubs for rapid response to hazards or monitoring for environmental systems.

This workshop aims to foster interactions among peers around the conceptualization, design and use cyber-enabled sensing and observation to connect the real world with computing environments. Applications and case studies that highlight tools that can be used to develop connections between the tangible and the digital world. The goal of the workshop will be to explore unified perspectives on the use of advanced computing and interactive platforms for data fusion, modelling and decision support.

C5: Efficient Exchange of Citizen Science Data: Data Models, Standards, and Governance

Organizer: Ingo Simonis, Lars Bernard.

Citizen science generally refers to the general public engagement in scientific research activities. Currently, it is established as a factor to be reckoned with in the context of environmental data collection and processing. Starting to be part of administrative decision processes, the requirements on citizen science data in terms of description, reliability, and applicability have grown. In principle, two different approaches need to be distinguished. The first one provides data to citizens (often in the form of images) and requests processing of this material, for example classification of asteroids or land cover. The second approach requests citizens to observe their environment and to report or verify observations, e.g. bird or butterfly spotting, occurrence of invasive plants, flooding areas, or air pollution. Here, we focus on this latter approach and address the question on how to make data obtained by citizens available in an optimal way.

Data collected by citizens contains a number of uncertainties that need to be assessed and documented throughout all processing steps; and eventually be made available as metadata. If used outside of the original purpose, metadata describing the collection process, used sensors and assets, experiences of the citizens, applied processing steps and other elements become essential parts of all versions of citizen science data from raw to heavily processed. The goal of this workshop is to explore data models and data exchange models that allow efficient exchange of citizen science data. Given the variety and heterogeneity of citizen science data, particular interest is on the role of standards in order to minimize integration efforts and to maximize reusability of existing material. The following questions shall be addressed:

- How do data models look like that support reusability of citizen science data even in other than the original context?

- How much information needs to be preserved and documented throughout citizen science data processing chains?
- How can citizen science data be shared efficiently?
- What level of semantics is required to ensure correct usage of citizen science data and how can it be realized?
- What standards need to be considered in order to maximize reusability of citizen science data?
- How can citizen science data be integrated with external data sets?
- How do citizen science data quality assurance processes look like and how can they be documented?
- How can citizen science data be made persistent and available (even beyond the lifetime of the original research project)?

Stream D

D1: Tools and Methods of Participatory Modeling

Organizers: Nagesh Kolagani, Steven Gray, Alexey Voinov.

The popularity of participatory modeling (PM) has grown considerably in recent years with the acknowledgement that the inclusion of stakeholders and a variety of scientific perspectives are required to improve our understanding of social-ecological systems and current environmental problems. The proposed session (and the linked workshop) will focus on tools, methods, approaches and interfaces that can be used in participatory modeling and stakeholder interaction. We seek to bring together academic experts, action researchers and practitioners to explore recent developments in modelling with stakeholders, and invite papers on such efforts and on visualization, interaction, documentation, recording, conceptualizing, etc. technologies that can help in these efforts. By bringing together diverse perspectives we hope to assess current trends in the field and define new questions that characterize future directions in PM.

D2: The Challenges of Implementing Human Decision Making in Agent-Based Models of Natural Resource Use

Organizers: Gunnar Dressler, Jule Schulze.

Models of natural resource use often lack an adequate representation of human decision making, assuming a rational actor or making ad-hoc assumptions, neglecting the wide field of existing behavioral theories. This workshop will address the challenges of selecting and specifying the elements of the decision process and implementing these decision models adequately and efficiently. We will discuss first which standard models for decision making are being so far and how they can be expanded along dimensions such as interaction and learning, social norms, habitual behavior or collective decision making. We will elaborate how this expansion can be structured, e.g. by following a framework to guide this process that makes these dimensions explicit. In a second part we will discuss the possibility of developing prototype decision making models that can enable a faster coding, enhance the comparability of models and reduce unnecessary model reproduction as well as the use of ad-hoc models.

D3: Teaching the Next Generation: Core Practices for Problem Framing and Formulation of Environmental Models

Organizers: Sondoss El Sawah, Tony Jakeman, Suzanne Pierce.

Successful models for socio-environmental issues help integrate various sources of data, perspectives and knowledge, facilitate stakeholder participation, and support decision making. Such success depends on the use of effective practices throughout the model development lifecycle. But these practices are often captured and evaluated from a single field or disciplinary viewpoint and ignore what stakeholders think and need. This workshop is organized as part of a National Socio-Environmental Synthesis Center (SESYNC) project. It aims to provide a venue to share and evaluate core modelling practices including products and methods that are accessible and relevant to different disciplinary and stakeholder perspectives.

D4: Defining Future Research Agenda for Interactive Online Tools Aimed at Environmental Challenges

Organizer: Evelina Trutnevyte

Recent years have seen a rapid increase in interactive online tools that focus on environmental, energy and climate challenges. Prominent examples are the US Surging Seas Risk Finder (<http://sealevel.climatecentral.org>), UK Department of Energy and Climate Change Calculator 2050 (<http://2050-calculator-tool.decc.gov.uk>) and many others. While interactive interfaces are in principle not new to environmental modeling, such online tools reach vast audiences beyond a specific situation of decision support. To date such tools have been used for outreach (i.e. explanation of complex environmental issues to lay audience and awareness raising), decision support (i.e. enabling tailored access to the information tool users need for decisions), and research (i.e. understanding tool users' decision making processes or decision preferences). Although new, several existing tools already demonstrate their added value, when various audiences have engaged with complex environmental issues or when such tools have lead to novel research findings.

The workshop aims at reviewing this trend of interactive online tools and defining the future research agenda for Environmental Modelling and Software community. The workshop will start with a short presentation on results of a review activity that has been conducted at ETH Zurich about existing interactive online tools, their scope, usage, strengths and limitations. Roundtable format will then be adopted to critically reflect on the current progress with such tools and discuss ideas, opportunities and challenges for future research. As a result, the workshop will provide a brief written statement with a proposed research agenda for the development and use of interactive online tools aimed at environmental challenges.

D5: Bridging Qualitative Approaches and Quantitative Models in Scenario Analysis for Decision Making: Recent Advances and Remaining Issues

Organizers: Tony Jakeman, Dale Rothman.

Scenario analysis and modeling recognizes that the future is inherently uncertain but not totally out of policy control. Therefore rather than attempting to predict the state of the future, it involves exploring and comparing different plausible scenarios and the pathways to their alternative futures. By exploring the implications of alternative futures across the possibility space, scenarios are intended to expand our thinking and understanding under uncertainty by: promoting an informed discussion among stakeholders about the future; analyzing various sources of vulnerabilities and opportunities for possible scenarios; focusing on formulating policies that are robust under different scenarios; challenging our assumptions; raising awareness and public education about the need for proactivity and foresight in dealing with our environmental challenges. Whilst scenario analysis now has a long history, over the last few decades the urgency for resolving environmental problems has added to this rich history, putting more emphasis on linking scenarios to decisions and inducing learning. Approaches enabling this link include normative scenarios and back casting, robust decision making, links across multiple geographical and time scales, and stakeholder and public engagement in co-development of scenarios.

Scenario analysis and modelling has a promising role to play in evaluating and designing change around complex and strategic issues, such as climate change, water-energy nexus issues, and other grand challenge problems. However the current use of scenario modelling in that context barely scratches the surface. Socioeconomic changes, such as population demographics, economic development, political change and technological innovation, are important in shaping future resource practices and resource demand. At the same time, these socioeconomic processes may be contingent on biophysical and ecological processes in the natural system. Therefore it is highly appropriate that scenario modeling integrates the future and changing state of socioeconomic, climatic and environmental conditions. For this integration, the handling and management of uncertainty will remain a crucial activity. The aim of this workshop is to share recent research developments and discuss the potential for an enhanced role of scenario analysis and modeling to support decision making and learning amongst decision makers and interest groups ('what is' versus 'what can be done').