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I. SESSION DESCRIPTION

SESSION DESCRIPTION

ID: T5b

Addressing ecosystem services modelling bottlenecks through simple to complex models: The ARIES approach

Hosts:

	Title	Name	Organisation	
Host	Prof.	Ferdinando Villa	Basque Centre for Climate Change	
			(BC3)	
Host:	Dr.	Zuzana Harmackova	Stockholm Resilience Centre	
Co-host:	Dr.	Stefano Balbi	Basque Centre for Climate Change	
			(BC3) (Spain)	
Others	Dr.	Marta Pascual	Basque Centre for Climate Change	
involved:			(BC3) (Spain)	
	Dr.	Ken Bagstad	Geosciences & Environmental	
			Change Science Center. U.S.	
	Dr.	Javier Martínez	Geological Survey (US),	
			Basque Centre for Climate change	
			School of Environment, Natural	
	Dr.	Simon Willcock	Resources and Geography. University	
			of Bangor (UK)	

Abstract:

Recent research has identified the robustness, relevance and transparency of ecosystem services mapping as key features to enhance its information value for decision-making processes. Nevertheless, multiple bottlenecks (challenges) remain to be resolved within current ecosystem-service modelling practice, such as implementing a tiered approach to

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address multiple users' needs, operationalizing large pools of open-access and citizenscience data, and connecting and taking advantage of the plethora of existing scientific models and datasets. To date, most ecosystem services modelling approaches have struggled to adequately address these challenges.

This session aims to address how some of these key ecosystem-service modelling bottlenecks can be resolved through the integrated approach of semantic modelling. Building on the ARIES modelling environment (ARtificial Intelligence for Ecosystem Services), the session illustrates how integrated semantic modelling covers a broad range of modelling approaches from simple to complex, efficiently reuses scientific and stakeholder knowledge and shares it with the larger ecosystem services community, and represents a versatile tool to address different modelling needs of researchers and practitioners. In addition, the session focuses on how integrated semantic modelling can contribute to the current needs of large-scale science-policy processes such as the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) and System of Environmental-Economic Accounting – Experimental Ecosystem Accounting (SEEA-EEA). Individual contributions will illustrate existing approaches to deal with today's bottlenecks, while participants and presenters will have the opportunity for open dialogue to discuss potential solutions to remaining challenges.

The session strives to provide space for participants' active involvement in discussions and a practical demonstration. The session consists of two parts: (1) a theoretical presentation and Q&A part, focusing on ecosystem-service modelling bottlenecks and their potential solutions through integrated modelling approaches, and (2) a practical real-time demonstration of the ARIES modelling environment as well as selected simple and complex ecosystem services models.

The session is further accompanied by an ARIES booth at the conference project marketplace, where conference participants are welcome to further familiarize with the ARIES modelling environment, raise practical questions and engage in one-to-one discussion with a member of the ARIES development team.

Goals and objectives of the session:

- 1. To present the ARIES approach to integrated semantic modelling:
 - a. What is the ARIES modelling environment?
 - b. How can the ARIES approach contribute to address current ecosystem services modelling bottlenecks?
 - c. How can ARIES be useful for current ecosystem services decision-making processes?



- 2. To discuss the ecosystem service assessment bottlenecks that integrated semantic modelling can overcome, and which remaining challenges may require other novel approaches.
- 3. To demonstrate how interested users can apply ARIES and what are the current developments and applications of the ARIES modelling environment.

These goals will be reached through a block of presentations, an inclusive discussion and a real-time demonstration.

Planned output / Deliverables:

- 1. Following the session, the participants will be asked to fill in a short online survey focused on the capabilities of currently available ecosystem services modelling tools to address ecosystem services mapping bottlenecks.
- 2. Journal paper: A discussion paper on current advances towards addressing the bottlenecks in ecosystem services mapping
 - a. Based on the issues raised during the presentations and discussion at the session
 - b. Open for contribution by session participants
 - c. Incorporating the input from the survey among session participants.

Related to ESP Working Group/National Network:

Thematic Working Groups: TWG 5 - Modeling ES

II. SESSION PROGRAM

Date of session: Wednesday, 17 October 2018 Time of session: 8:45 - 10:15

Timetable speakers

Time	First name	Surname	Organization	Title of presentation
8:45-9:00	Benjamin Ignacio	Burkhard Palomo	Leibniz Universität Hannover BC3	ldentifying and solving bottlenecks in ecosystem services mapping and modelling
9:00-9:10	Stefano Marta Zuzana	Balbi Pascual Harmackova	BC3 BC3 Stockholm	A decade of ARIES: Adapting ecosystem service models to decision making needs

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Time	First name	Surname	Organization	Title of presentation
			Resilience Centre	
9:10-9:20	Kiichiro	Hayashi	Nagoya University	Case study 1: Ecosystem service mapping: The case of Japan
9:20-9:30	Odirilwe	Selomane	Stockholm Resilience Centre	Case study 2: Predicting human dependence on nature in a fast urbanising African metropolitan region
9:30-9:40	Michele	Zen	Ca' Foscari University of Venice	Case study 3: Scenario analysis within the framework of SSPs: a semantic meta-modelling approach
9:40-10:00	Ferdinando	Villa	BC3	ARIES demonstration
10:00-10:15				Discussion

III. ABSTRACTS

The abstracts appear in alphabetic order based on the last name of the first author. The first author is the presenting author unless indicated otherwise.

Invited speaker abstract

T. Thematic Working Group sessions: T5b – Addressing ecosystem services modelling bottlenecks through simple to complex models: The ARIES approach

From simple to complex ecosystem services models

First author: Kenneth Bagstad, Stefano Balbi *Affiliation*: USGS, BC3 Spain

Decision makers using ecosystem service (ES) models face tradeoffs between simplistic approaches that are easily implemented but scarcely customizable, and complex, data- and time-intensive approaches that may produce more accurate results but are difficult to apply

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broadly. The ARtificial Intelligence for Ecosystem Services (ARIES) modelling platform aims to navigate this range of model complexity, making models more accessible to a broad range of users. Three key innovations of ARIES include models that are (1) paradigm-agnostic, (2) context-aware, and (3) community developed. First, an integrated modeling system would ideally be able to choose between, link, and reuse models from multiple paradigms (e.g., agent-based models, Bayesian networks, machine learning, process models, lookup tables, multicriteria analysis). The use of semantics - a consistent system to label and match data and models - allows different datasets to be consistently linked and reused in different model types. Second, context awareness allows a user, assisted by the computer system, to pick the most appropriate models and data for their spatiotemporal context and scale of analysis. The underlying artificial intelligence offers the means to specify when and where data and models are most appropriately used, building context awareness into ES assessment. Third, ARIES aspires to be community developed, with users contributing and reusing data and models to take full advantage of the blossoming open data and science movement. We have recently released a series of globally applicable ES that use global data, but are easily customized using local data and knowledge. By engaging with the ES modelling community to further develop these and more complex models, and to provide knowledge to account for important local differences in ES provision and use, we aim to cover the full arc from simple and quick to sophisticated assessments, minimizing additional costs to the user when increased complexity and accuracy are needed.

Keywords: ARIES, complexity-oriented, global model

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Identifying and solving bottlenecks in ecosystem services mapping and modelling

First author: Benjamin Burkhard, Ignacio Palomo *Other author(s):* Vytautas Narusevicius, C. Sylvie Campagne, Kremena Burkhard, Chloe Bellamy, Evangelia G. Drakou, Louise Willemen, Solen Le Clec'h *Affiliation*: Leibniz Universität Hannover, Basque Centre for Climate Change Germany

Ecosystem services (ES) maps need to be robust, evidence-based, understandable and applicable for potential end-users and to be produced in a transparent and reproducible manner. To fulfil these demands, a large amount of approaches and methods from biophysical, social-cultural, economic, geographic and - last but not least - cartographic sciences have been used and integrated in order to compile ES maps. The creation of ES maps is, however, not at all trivial and several bottlenecks are usually encountered during the mapping process, from the conceptualization to the communication and the application of the map. In order to support the selection of the most appropriate mapping techniques and methods, tiered and integrated approaches have been developed that consider the purpose of the map, available capacities regarding data, methods and technical know-how as well as potential end-user needs. Besides methods selection, other bottlenecks have been identified, related to: map-maker and map-user communication, skills and background, ES nomenclature and ontologies, and data availability (Palomo et al., 2018). The mapping process itself can also contain several technical difficulties and shortcomings and aspects of generalization and over-simplification may hamper a proper representation of socialecological systems with complex and dynamic ES flows. In this presentation, these key bottlenecks will be illustrated with examples from selected case studies, providing the base for further discussion and improvements of ES mapping processes, as well as ES maps and models.

Keywords: ecosystem services, mapping techniques, communication, tools, tiered approach



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Ecosystem service mapping in the case of Japan

First author: Kiichiro Hayashi, *Other author(s):* Hiroaki Takagi, Wataru Kobayashi, Satoru Sugita *Affiliation*: Nagoya University, Japan

In Japan, because of the development activities, a lot of natural lands including forest have been degrading and also these lead to the degradation of ecosystem services provided from the nature. Biodiversity conservation is one of the important topics of the environmental policy in the central government of Japan. Currently, biodiversity and/ or ecosystem service mappings were got paid attention in the academic research study. Most of these were limited in the scope of area covered. Or others covered the wide area of Japan with a limited resolution scale. Also the items of the assessment were limited in a certain ecosystem services. The author has been conducting ecosystem service mappings in different resolution scales, especially focusing on Aichi region, Japan. In this study, ecosystem service supply potential mappings which covered most of the Japanese land area were conducted based on a Japanese 10-m grid scale land-cover map which was provided by Japan Aerospace Exploration Agency (JAXA). Several ecosystem services were evaluated by a proxy and other methods. Some of the proxies were developed based on a forest field survey. K.Lab was used for modeling each ecosystem service assessment. Finally, integrated assessment of ecosystem services were conducted averaging the value of each ecosystem services. Also the serval centimeter scale mappings developed by using the images of an unmanned aerial vehicle (UAV) were presented as a test study. In this presentation, the application of ecosystem service assessment focused on Japanese situation will be presented through K.Lab system.

Keywords: ecosystem service, ARIES, Japan, K.Lab

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A decade of ARIES: adapting ecosystem service models to decision making needs.

First author: Marta Pascual, Zuzana Harmáčková

Other author(s): Javier Martínez–López1, Stefano Balbi1, Ainhoa Magrach1, Kenneth J. Bagstad3, Brian Voigt4, Ioannis Athanasiadis5, Simon Willcock6, Ferdinando Villa1, 7 *Affiliation*: 1 – BC3–Basque Centre for Climate Change, 2 – Stockholm Resilience Centre, Stockholm University, Sweden, 3 – U.S. Geological Survey, Geosciences & Environmental Change Science Center, 4 – University of Vermont, Gund Institute for the Environment, 5 – Information Technology Group, Wageningen University, The Netherlands, 6 – School of Environment, Natural Resources and Geography, Bangor University, United Kingdom, 7 – IKERBASQUE, Basque Foundation for Science, Bilbao, Spain.

The need for ecosystem services (ES) modelling to deliver timely and informative results for decision-makers has been widely recognised. However, the actual impact of ES assessments on decision making has been limited so far. Novel modelling paradigms and interfaces may help ensure a broader impact of ES science in decision making. This contribution illustrates how the ARtificial Intelligence for Ecosystem Services (ARIES) modelling platform, after a decade of developments, provides results customized to the spatial and temporal scales of interest, making it suitable to address the needs of decision-makers on local, regional and global levels. We show how the holistic conceptualisation of ES flows within the ARIES modelling platform addresses the challenges faced within emerging ES related discourses, such as ES accounting and ES co-production by ecosystems and human society, including the assessment of ES provision sustainability, ES trade-off analysis and scenario planning.. At the same time, we demonstrate the added value of ARIES as a freely available online platform, based on open data- and model-sharing principles and encouraging the engagement of the communities of ES modellers, researchers and practitioners. We illustrate how these communities can benefit from and contribute to the shared ecosystem of data and models that supports the ARIES platform, and how community efforts can help bridge some of the most limiting bottlenecks in ES modelling. This contribution provides an overview of how the ARIES platform can inform next-generation ES modelling by providing more current, accessible, transparent, accurate, and rapid results to decision makers.

Keywords: ARIES; ecosystem services; decision making; semantic modelling; integrated modelling

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Predicting human dependence on nature in a fast urbanising African metropolitan region

First author: Odirilwe Selomane, Stefano Balbi

Other author(s): Ryan Blacnahrd, Nadia Sltas, Ilse Kotzee, Ferdinando Villa, Patrick O'Farell *Affiliation*: Stockholm Resilience Centre and Council for Scientific and Industrial Research, Basque Centre for Climate Change Sweden

Determining the dependence on natural resources in social groups is often hindered by the lack of clear understanding of the different profiles of beneficiaries of these resources. An often-cited reason for this is the lack of data on who uses and depends on local natural resources. We use national survey data, openly accessible from Statistics South Africa, to develop a metric of overall dependence on natural resources in the eThekwini Municipality, comprising the city of Durban. In the survey, households were asked about their main sources of water, energy, building materials and food we focus on sources directly connected to the local environment. We then use machine learning techniques, in particular Bayesian learning, to model observed patterns of dependence using demographic variables including: gender of household head, household size, income, house ownership, informality of settlement, population density, and in-migration rate to the area. We show that few predictors - including population density and informality of settlements - can explain most of the observed variation, and discuss how these could be supplied through remote sensing data, providing opportunities to replicate our model in data poor areas. Additionally, we discuss the complementary use of open access and volunteered data. With data availability generally being a limiting factor in most sustainability modelling and monitoring workflows, accessing inexpensive, up-to-date and collectively harvested data can significantly improve research outcomes. The Sustainable Development Goals are one example that calls for monitoring frameworks that depend less on primary data collection, as data for more than half of the indicators needed to monitor progress are hard to obtain or unavailable.

Keywords: ecosystem services, sustainable development, urban transition, machine learning



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Scenario analysis within the framework of SSPs: a semantic meta-modelling approach

First author: Michele Zen *Other author(s):* Stefano Balbi, Carlo Giupponi *Affiliation*: Ca' Foscari University of Venice, Italy

Over time, ecosystem services (ES) have been frequently quantified through static spatial analysis based on primary data or proxies, representing the spatial variability of phenomena to be assessed. The inherent complexity of spatial dynamics, where natural and social processes are built one upon the others in a dynamic and evolving system, make us pose some doubts on the validity of existing static models as methods to quantify natural capital. Modelling socio-ecological systems is a complex task that is addressed by the Integrated Modelling Partnership through the ARIES integrating technology. Their mission is to help scientists overcoming non-dynamic ES accounting, to exploit the full potential of ES modelling in the perspective of achieving a dynamic, interoperable spatial resource planning. The landcover is an example of a spatial variable that is not stable over time and its pattern is often rather clustered over space. Several ecosystem services are assessed through methodologies based on landcover maps. Our objective is that of exploring the spatial distribution and the magnitude of the land use change (LUC) phenomenon, within the case study area of Local Action Group Alto Bellunese - South Eastern Alps - to understand whether it significantly affects the ES provision over a set of scenarios. We use a semantic meta-modelling approach i.e. conceptualize models and data to enable interoperability with existing ES models developed within the ARIES framework. We assess LUC both on existing historical series of landcover maps and land use scenarios. Procedural raster generation methodologies are explored to simulate evolving landscape patterns towards Shared Socioeconomic Pathways (SSPs). Spatial inter-dependencies are considered, so as to constrain temporal changes to clusters rather than each individual land unit.

Keywords: ES, landcover, LUC, SSPs, procedural