BOOK OF ABSTRACT

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I.   **SESSION DESCRIPTION**

ID: T5

Integrated ecosystem services models – advancing modelling science and application

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Abstract:

With the rapid advancement in modelling of potential and current ecosystem service stocks and flows, there is a growing need for more integrated modelling approaches that address the consequences of multiple changes in drivers, pressures and biodiversity on multiple ecosystem services in space and time. Furthermore, decision makers are becoming ever more interested in integrating ecosystem services in policy and practice. The complex nature of ecosystem services and related decision contexts necessitates integration of a variety of dimensions (e.g. models, data, scales, contexts, actors) to develop models that can appropriately inform planning and decision-making. In addition, there is a need for versatile integrated modelling tools that allow for data and model sharing, reuse, and integration, in order to address enduser requirements and support research across variable conditions in different contexts. Integrated models build links between sectoral models, e.g. agriculture, forestry, biodiversity and water, and scenarios of drivers of change, including climate change and socio-economic change. Such models are capable of quantitatively assessing future changes in socio-ecological systems through accounting for the non-linear, interconnected nature of their multiple components. Integrated ecosystem service models aim to provide a more realistic assessment of the impact of changes in drivers and pressures on biodiversity and ecosystem services than studies that focus on individual system components or single drivers, as they represent the complex interdependencies within human and environmental systems. Such approaches can help guide planning and decision-making by highlighting

critical interdependencies and potential synergies and trade-offs between ecosystem services under different future scenarios.

Different types of integrated models have been developed to assess trade-offs and synergies between ecosystem services, such as coupled component models, agent-based models, system dynamics models, Bayesian belief networks, semantically driven integrated models and knowledge-based approaches. Nevertheless, the majority of ecosystem service assessments still rely on single component models. Building integrated models is a complex and often time and resource intensive process. Hence, it is important to learn from each other on how this process can be undertaken in a manner that supports the sharing of data and models in transparent, reliable, and efficient ways. The concept of interoperability has been emerging in this respect to facilitate the access, processing and integration of data and models from multiple sources to help create more holistic and contextual ecosystem services assessments that support decision-making, accountability and transparency purposes. Finally, further advances are needed to involve key issues into integrated ecosystem service models, including involvement of stakeholders, handling uncertainty, integrating space and time perspectives (incl. future scenarios), impacts of multiple drivers and pressures, and implications for biodiversity and human well-being. In this session we will extensively address integration in modelling from a broad range of perspectives, and highlight several angles in sub-sessions.

First, we present and discuss the state-of-the-art of integrated ecosystem service modelling based on a model review that is being carried out in the Thematic Working Group 5 – Modelling ES. Second, a sub-session around integration and interoperability will be held, based on the ARIES (ARtificial Intelligence for Ecosystem Services) modelling framework. Third, a sub-session with a special focus on participatory socio-ecological systems modelling will be held. Finally, in an open sub-session, a variety of integrated model applications will be presented.

1. The Thematic Working Group sub-session will discuss the recent advancements in integrated modelling within the ESP community, and facilitate an open discussion on aspects of integration and future challenges, ultimately leading to a research agenda to improve integrated modelling approaches.
2. The interoperability sub-session will illustrate how the ARIES modelling framework implements integration and interoperability approaches through semantic web modelling and how this approach can overcome some of the common challenges of data and model integration, providing a broad range of collaborative models from simple to complex, while efficiently reusing scientific and stakeholder knowledge and sharing it with the larger ecosystem services community.
3. In the sub-session on Social-Ecological Watershed Systems we address and discuss the participatory and methodological approaches to develop a socialecological conceptual model for supporting resilience and decision-making in watersheds, using cases in Mexico, Colombia

and France. The sub-session aims at fostering an open discussion on the participatory and methodological choices – i.e. underlying theoretical choices – in the process of Social-Ecological Watershed Systems formalization and operationalization.

4. For the open sub-session on integrated models we invite speakers to present the following key issues regarding integration in ecosystem service models: (1) space and time representativeness, (2) trade-offs and synergies of ecosystem services, (3) inclusiveness of biodiversity, (4) sensitivity to multiple pressures and drivers of change, (5) comprehensiveness and promptitude to promote assessments for robust policy-making on ecosystem services and sustainable development, and (6) approaches for overcoming technical and conceptual challenges in ecosystem service model integration.

Goals and objectives of the session:

This session is organized by the ESP Thematic Working Group on Modelling ES and has the following goals:

- To present and discuss the results of the working group paper that was initiated in San Sebastian, Spain (ESP Europe 2018);
- To showcase recent advancements and developments in applications of integrated models by the global ES community;
- To demonstrate how interested users can apply selected integrated modelling tools (e.g. ARIES), why semantics are needed to make the integration process cleaner and faster, what are their current developments and applications across contexts and geographies;
- To initiate a discussion on a research agenda for integrated ecosystem service models;
- To discuss the remaining challenges for collaborative integration of models towards interoperability.

Planned output / Deliverables:

This session will be used to further develop collaboration and a research agenda within the Thematic Working Group on Modelling ES. The output will be summarized in a science-policy brief, and likely be integrated in the proposed working group paper. Following the session, the participants will be asked to fill in a short online survey focused on the possibilities of collaborative integration of ecosystem services data and models.

Related to ESP Working Group/National Network:

Thematic Working Group: TWG 5 – Modelling ES

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II.   SESSION PROGRAM

Date of session: Tuesday, 22 October 2019
Time of session: 10:30 – 18:00

Timetable speakers

Part 1: 10:30 – 12:00
Integrated ecosystem service models – advancing modelling science and application

Time	First name	Surname	Organization	Title of presentation
10:30–10:45	Roy	Remme	Natural Capital Project, Stanford University	Integrated ecosystem service models – advancing modelling science and application: session introduction and working group research
10:45–11:00	Silvia	Rova	Ca' Foscari University of Venice	Contribution of multiple ecosystem services modelling to environmental management: an application to the Venice lagoon, Italy
11:00–11:15	Edna	Cabecinha	University of Tras-os-Montes and Alto Douro	ALICE Project: Linking terrestrial and riverine models to improve biodiversity and ecosystem services in Atlantic Landscapes
11:15–11:30	Clara	Veerkamp	PBL Netherlands Environmental Assessment Agency	Future projections of biodiversity and ecosystem services in Europe with two integrated assessment models
11:30–11:45	Paula	Harrison	Centre for Ecology & Hydrology	Quantifying the benefits of regional integrated modelling for ecosystem service assessment: moving beyond a sectoral world
11:45–12:00	Ana	Stritih	ETH Zürich	An online Bayesian Network tool for ecosystem services modelling

Part 2: 13:30 – 15:00
The ARIES modelling approach: Integration and interoperability for ecosystem services science, policy and practice

Time	First name	Surname	Organization	Title of presentation
13:30–13:45	Marta	Pascual	Basque Centre for Climate Change (BC3)	The ARIES modelling approach: Integration and interoperability for ecosystem services science, policy and practice
	Zuzana V.	Harmáčková	CzechGlobe/ SRC	

Time	First name	Surname	Organization	Title of presentation
13:45–14:00	Stefano	Balbi	Basque Centre for Climate Change (BC3)	Philosophy of Globally Customizable ARIES models
14:00–14:15	Kiichiro	Hayashi	Nagoya University	ARIES customized modelling application for ecosystem service assessment and renewable energy potential
14:15–14:35	Ferdinando	Villa	Basque Centre for Climate Change (BC3)	ARIES in practice: putting science in the hands of decision makers (Live demonstration)
14:35–15:00				Discussion: Interoperability and integration issues in ecosystem services modelling and application

Part 3: 16:30 – 18:00
Social-ecological systems modelling

Time	First name	Surname	Organization	Title of presentation
16:30–16:45	Linda Ivette	Berrio Giraldo	Universidad Nacional de Colombia	Dynamic modelling of socio-ecological systems. Analysis of dynamics in land cover change in strategic basins
16:45–17:00	Clara	Villegas-Palacio	Universidad Nacional de Colombia	Can the right policy instrument to protect strategic ecosystem services stand up, please? A multi-criteria analysis approach
17:00–17:15	Lina Maria	Berrouet Cadavid	Universidad de Antioquia	Vulnerability of social systems to the modification of ecosystem services
17:15–17:30	Maria	Perevochtchikova	El Colegio de México A.C.	Conceptualization and operationalization of socio-ecological system framework for Mexico City periphery study case
17:30–18:00				Discussion

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.

1. Type of submission: **Abstract**

T. Thematic Working Group session: T5 Integrated ecosystem services models – advancing modeling science and applications

Philosophy of Globally Customizable ARIES models

First author: Stefano Balbi

Other author(s): Ferdinando Villa, Marta Pascual, Zuzana Harmáčková, Kii Hayashi, Ken Bagstad

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Scientists and decision makers face trade-offs between adopting simple or complex approaches when modeling ecosystem services (ES). Complex approaches may be time- and data-intensive, making them more challenging to implement and difficult to scale, but can produce more accurate and locally specific results. In contrast, simple approaches allow for faster and more comparable assessments. However, current technological innovation driven by semantics applied to interoperability of data and models allows for automatic integration of simple and complex approaches according to modelling objective and target system boundaries (and spatio-temporal resolution). The Artificial Intelligence for Ecosystem Services (ARIES) modeling platform provides a spectrum of simple to complex ES-related components, which are also self-contained and self-consistent: so that they can be used individually or assembled into more complex computational workflows. These components are readily accessible in the ARIES semantic web and power a modular modelling architecture which allows respond to queries from a broad range of users. ES-related user queries can be entered in the ARIES Explorer as English sentences, or keywords. Keywords call on logical statements that are resolved with the data and algorithms available in the network. Default ES components do not require user input, but use publicly available global- and continental-scale data, while offering the option to easily customize models with context-specific data and parameters. This approach enables rapid ES quantification, as computational workflows are automatically adapted to the application context. Other components in development are largely data-driven and built with machine learning techniques. Further the ARIES' spatial multicriteria analysis

module, enables spatial assessment of ES for different beneficiary groups. Users can modify data input requirements, model parameters or entire model structures to capitalize on high-resolution data and context-specific model formulations. Data and methods contributed by the research community become part of a growing knowledge base, enabling faster and better ES assessments worldwide.

Keywords: simple models, complexity, model integration, MCA, Machine Learning

2. *Type of submission:* **Abstract**

T. Thematic Working Group sessions: T5 Integrated ecosystem services models – advancing modeling science and application

Dynamic modelling of socio-ecological systems. Analysis of dynamics in land cover change in strategic basins.

First author: Linda Ivette Berrio Giraldo
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The accelerated transformation of ecological systems by human beings, together with the variability of natural processes due to the effects of climate change, translates into degradation in the provision of ecosystem services with their impact on the well-being of human communities. Sustainable development objectives make a universal call for the adoption of measures for the fulfillment of diverse goals. Some of these are related to the integrated and sustainable management of terrestrial ecosystems to improve the capacity to provide essential benefits for sustainable development. To design adequate management policies, a holistic understanding of natural and social systems is necessary. However, these have been studied separately and, therefore, the models that have been developed have not taken into account the feedback mechanisms that result from the interactions between the systems. This fact can generate biased or erroneous results that can lead to non-optimal policy decision making. This research developed a model in systems dynamics to understand the dynamics of the transition of coverage and land use in a socio-ecological system and its incidence in the provision of ecosystem services. This model includes the feedback mechanisms that result from the interactions between the natural and the social systems. The

generated model represents an input for the process of evaluating different policies for the sustainable management of natural resources.

Keywords: Socio-ecological Systems, systems dynamics, ecosystem services, feedback

3. *Type of submission:* **Abstract**

Vulnerability of social systems to the modification of ecosystem services

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The understanding of socio-ecological vulnerability allows to establish the capacity of the systems (social and ecological) to face threats such as environmental change. In this work, a conceptual and methodological framework for the evaluation of the vulnerability of the social system (Vss) in the context of environmental change was developed. This Vss is defined as the capacity of a social system (SS) to maintain its level of benefits under scenarios of change in the level of provision of an ecosystem service (ES). For this a composite index constituted by two parameters, dependence and adaptation, for assessing the Vss at the local level was designed. The first parameter is determined by two variables change in the level of benefits and the category of the satisfied need associated with the ES, on other side the adaptation is determined according to the capacity of the substitution of the ES with natural sources and the adaptive capacity of each beneficiary. This index, validated through a study case in Rio Grande and Chico basin (Antioquia, Colombia), allows to capture the changes in the levels of Vss, under different scenarios of change in the level of ES (water provision for different uses human and for livestock production, mainly). Although some refinements of the index are still necessary, it has the potential, together with other indicators, to provide information related to the sustainability of the SES under different trajectories of change. The Vss can indicate under which trajectories the SS is not affected by the change in the level of provision of an ES (Vss <0 with values very close to -1), it begins to lose capacity to maintain the benefits (Vss

<0 with values very close to zero) or finally, it moves to different levels of vulnerability (Vss> 0, being high with values close to 1).

Keywords: Social System Vulnerability, Socio ecological systems, composite index

4. *Type of submission:* **Abstract**

ALICE Project: Linking terrestrial and riverine models to improve biodiversity and ecosystem services in Atlantic Landscapes

First author: João Santos

Other author(s): Andre Fonseca, João Cabral, José Aranha, Martinho Lourenço, Rui Cortes, Mario Santos, Simone Varandas, Sandra M. Monteiro, Vanessa Queirós, Luis F. Fernandes, Fernando Pacheco, João Paulo Moura, Domingos Lopes, Diane Burgess, Cendrine Mony, Thomas Houe, Stefano Balbi, Ferdinando Villa, Mariana Milagaia, Marco Magalhães, Pedro Ferreira, Denis Bailly, Johanna Beganton, Stephen Hynes, Jose Alvarez-Martinez, Pepe Barquín, Edna Cabecinha

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The ALICE project - Improving the management of Atlantic Landscapes: aCcounting for bIodiversity and eCosystem sErvices - will develop a comprehensive package of new methodologies to identify barriers to the delivery of benefits from Blue and Green Infrastructures (BGI) implementation and to improve the characterization of biodiversity and the valuation of ecosystem services (ES) across four Atlantic case studies (CS; Portugal, Spain, France and UK-Ireland). Here we will focus on the Portuguese CS. One of the key objectives of ALICE is developing a full-package of new methods, tools and procedures to assist with riverine and inland landscape management, based on participative learning and modelling by incorporating socioeconomic and climate change scenarios.

Therefore, biophysical models are being develop to link terrestrial and riverine environs and test scenarios to assess impacts on target ecosystem components. A fully harmonised

biomonitoring spatial database was created on ALICE's platform. Water runoff, sediment transport and water quality models are being developed and will be linked through a simulation platform. For each CS a geospatial riverine landscape unit coupling a digital elevation model and synthetic hydrography is being developed for analyses of landforms, processes, and human interactions. Linked with this a Stochastic Dynamic Methodology (StDM) and a cellular automata model will be used to assess how different catchment configurations and scenarios affect the catchment.

This project is an integrative technological approach by identifying the ES benefits delivered by BGI and explore the economic and social barriers to the delivery of ES. This is supported by an intensive participative process accounting for stakeholders' interests.

This innovative ALICE approach complement other programs by integrating social, economic and environmental analytical tools and models at the basin scale.

Keywords: Modelling, Climate change, Ecosystem services, Blue and Green infrastructures, Participatory process

5. *Type of submission:* **Abstract**

T. Thematic Working Group sessions: T5 Integrated ecosystem services models – advancing modeling science and application

ARIES in practice: putting science in the hands of decision makers

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A live demonstration of ARIES from the perspective of the user, demonstrating both simple and complex ecosystem services assessments. This demonstration will showcase the ARIES web application (k.Explorer) and illustrate its most important functionalities. Complementing other presentations of the ARIES approach and its applications, the demonstration will offer a

preview of how sophisticated science can be put at the fingertips of decision-makers without compromising on rigor, transparency and detail.

Keywords: ARIES, ecosystem services, integrated modelling, semantic modelling, interoperability

6. *Type of submission:* **Abstract**

The ARIES modelling approach: Integration and interoperability for ecosystem services science, policy and practice

First author: Marta Pascual
Other author(s): Zuzana V.Harmáčková, Stefano Balbi, Kenneth Bagstad, Kiichiro Hayashi, Ferdinando Villa
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While the sustainability challenges faced by society are growing, ecosystem services science strives to provide timely, robust and holistic knowledge to support practice and policy-making across local, regional and global levels. The speed and efficiency of such efforts can be substantially increased by flexible and transparent sharing, reusing and combining available data and models. To this end, artificial intelligence has proved to be a promising solution to overcome some of the common challenges of data and model integration and interoperability. In this contribution, we present how data and model integration and interoperability are approached by the ARIES modelling platform (ARtificial Intelligence for Ecosystem Services) and how this can be beneficial for multiple parts of the ecosystem services community, including end-users, ecosystem services model and data developers, and other actors. Data findability, accessibility, interoperability, and reusability (FAIR data principles) are central to the ARIES philosophy which aims to connect data and models based on their meaning (through semantic annotation), and subsequently combine and reuse them through machine reasoning algorithms. This approach largely overcomes technical and conceptual challenges in

ecosystem-service model integration and allows to combine models based on entirely different modelling paradigms, as well as to make the integration process cleaner and faster. Furthermore, it helps overcome data shortages in data-poor areas, as well as save substantial time and resource capacities. Finally, we present several applications of this approach to integrated modelling from local scale ecosystem service modelling using simple and complex models to natural capital accounting applications.

Keywords: ARIES, ecosystem services, integrated modelling, semantic modelling, interoperability

7. *Type of submission:* **Abstract**

T. Thematic Working Group sessions: T5 Integrated ecosystem services models – advancing modeling science and application

Quantifying the benefits of regional integrated modelling for ecosystem service assessment: moving beyond a sectoral world

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It is increasingly recognised that an integrated approach is needed to address environmental problems, which moves away from a sectoral (or silo) view of impacts to recognising the importance of cross-sectoral interactions and trade-offs between ecosystem services. Despite the increasing recognition of the importance of integrated modelling approaches, many impact assessments often apply models of individual sectors without considering interactions between these sectors. The IMPRESSIONS Integrated Assessment Platform (IAP2) addressed these issues by linking together a series of sectoral models, in which data were passed down a model chain representing cross-sectoral interactions. In order to provide an exploratory model with rapid interactively for the user, the run times of the sectoral models were reduced through a meta-modelling approach, whereby computationally-efficient models that emulate the performance of more complex models were developed. The extensive cross-sectoral linkages facilitated by this meta-modelling approach enables stakeholders to explore and

understand the interactions and trade-offs between different ecosystem services, rather than viewing their own policy area in isolation.

In this presentation, we describe the participatory process that was used to develop the IAP2, as well as the scenarios of multiple climate and socio-economic drivers. In addition, we compare differences in land use and ecosystem service indicators when derived from single sector impact models vs integrated modelling frameworks. This highlights that single sector studies misrepresent the spatial pattern, direction and magnitude of most impacts because they omit the complex interdependencies within human and environmental systems. Such discrepancies are particularly pronounced for indicators such as food production, which are highly influenced by other sectors through changes in land suitability and resource competition. Finally, we summarise several uncertainty analyses of the IAP2, including a model intercomparison exercise, a Monte Carlo-based assessment of scenario uncertainty, and an assessment of error propagation across the linked model chain.

Keywords: Integrated model, multiple drivers, cross-sectoral interactions, stakeholders, uncertainty

8. *Type of submission:* **Abstract**

T. Thematic Working Group sessions: T5 Integrated ecosystem services models – advancing modeling science and application

ARIES customized modelling application for ecosystem service assessment and renewable energy potential

First author: Kiichiro Hayashi
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Under the ARIES project, three are two types of interfaces in k.LAB products. One is the k.Explorer and the other is the k.Modeler. The k.Explorer is easy handling for everyone, The k.Modeler is for a specialist for modelling. The k.Modeler has been developed as a powerful tool for customizing ecosystem service modellings in addition to using the global proxy model

of the k.Explorer, which have equipped with several ecosystem service models, such as carbon storage model, pollination model, flood regulation model, outdoor recreation model and sediment model. By utilizing the k.Modeler, carbon stock model, forest volume model, air regulation model etc. have developed for using 10m-grid digital elevation model (DEM) and landuse data in Japan. Also the k.Modeler can be utilized for a variety of ways that are related to spatial assessment, such as site selection and environmental assessment. In this presentation, several application examples of the k.Modeler will be presented focusing on Japanese ecosystem service assessment. Also, micro-hydro power potential site selection Japan model will be presented for a renewable energy potential selection. In this, by using 10m-gid DEM, after extracting river, the potential micro-hydro sites are selected for overlying disaster and environmental risk factors. Then the demand of electricity consumption around the potential sites will be compared with the potential electricity supply. The conclusion includes that the k.Modeler is one of the good tool for integrated modelling for customizing a variety of models.

Keywords: integrated modelling, ARIES, Renewable energy, Japan

9. *Type of submission:* **Abstract**

T. Thematic Working Group sessions: T5 Integrated ecosystem services models – advancing modeling science and application

Conceptualization and operationalization of socio-ecological system framework for Mexico City periphery study case

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One way to make explicit the relationships of coupled systems in space-time is from the analysis of territorial dynamics at the regional level, under the assumption of the result of this escalation is derived from the dynamic expression of human activities at local scales. In order to implement territorial management strategies, there is a need for models that integrate the state, structure and function of the spatial configuration, as well as the relationships of the social and ecological contexts that coexist in the landscape and the condition of the suppliers

and defendants. The analysis of the vegetation, the change of land use and vegetation and its associated drivers, the biophysical modeling of ecosystem services and the climate change scenarios can be integrated into the prospective models resulting in an operable tool for decision making, both for a medium and long-term vision in the articulation of socio-economic and environmental objectives, the identification of performance measures and the deliberation of alternative actions, and the generation of information and knowledge about the costs, benefits, compensations and synergies of alternative investments in the provision of Ecosystem Services. This under the assumption that they provide information for territorial strategic planning, the analysis of internal and external factors in the spatio-temporal dynamics and provide an ideal framework for the development of more resilient conservation policies.

Keywords: socio-ecological system, operationalization, Mexico City, methodological proposal

10. Type of submission: **Abstract**

T. Thematic Working Group sessions: T5 Integrated ecosystem services models – advancing modeling science and application

Contribution of multiple ecosystem services modeling to environmental management: an application to the Venice lagoon, Italy

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Modeling the dynamics of multiple ecosystem services (ES) is a crucial research frontier. Here we present a modeling application in which the dynamic simulation of multiple ES is used to explore the sustainability of ES provision in the Venice lagoon (Italy). The model, based on the Petri Net modeling framework, jointly represents a set of 13 ES and has been implemented separately for 11 lagoon sub-basins. The model is capable to simulate the ES dynamics in each sub-basin, under two different scenarios, business as usual and climate change (CC). The modeled trends are the result of the both the external pressures included in the scenarios and the synergies/trade-offs occurring between multiple ES, and provide an indication

whether the current ES provision is sustainable (non-declining ES trends) or unsustainable (declining ES trends) in the different areas of the lagoon. The trends have been analyzed jointly with the results of the assessment of the current ES provision, carried out at the same spatial scale. The results show that, under the business as usual scenario, the trends in the different sub-basins are related to the composition of the patterns of multiple ES, in particular, being sustainable where the patterns are dominated by regulating ES, and being instead unsustainable where patterns are dominated by ES mediated by human activities. However, the situation changes under the CC scenario, with most of the sub-basins showing a declining ES trend, suggesting that CC induced pressures turn unsustainable also the situations in which the interactions between ES patterns are not critical. These results provide an example of how an integrated modeling application that includes the interactions among multiple ES can provide new insights for the management of complex social-ecological systems.

Keywords: integrated modeling, multiple ecosystem services, sustainability, coastal ecosystems, climate change

11. Type of submission: **Abstract**

T. Thematic Working Group sessions: T5 Integrated ecosystem services models – advancing modeling science and application

An online Bayesian Network tool for ecosystem services modelling

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Mapping and modelling ESs requires integrating different types of information about socio-ecological systems, including Earth Observation and in-situ data, empirical or process based models, socio-economic data, and expert or stakeholder knowledge. Bayesian Networks (BNs) are a powerful tool for ES modelling, since they can incorporate qualitative knowledge and existing models, as well as learning directly from data. In addition, the probabilistic structure of the BNs explicitly takes into account uncertainties, which are often high in ES assessments, while their graphic representation facilitates communication and collaborative modelling.

Although the spatial and temporal dimensions are often crucial in socio-ecological systems, there is a lack of openly available and easy-to-use tools to run BNs with spatial data over time. Therefore, we have developed gBay (gbay.ethz.ch), an online platform for BNs with geo-data, which aims to facilitate ES modelling. Users can upload their BN models (developed in Netica or a similar software), add spatial data (vector or raster), and run the network over each pixel or object. The BNs can be run iteratively, over multiple time steps, to incorporate temporal dynamics or feedback loops. In addition, geo-processing calculations can be added by uploading Python scripts, e.g. to account for neighbourhood effects or to apply policy-related boundary conditions. The gBay platform supports users with its simple graphical interface and a wiki page with guidelines on how to develop BN models, instructions, examples, and detailed descriptions of case studies. As such, it provides a step towards more accessible, transparent, and flexible modelling of ecosystem services.

Keywords: Bayesian Networks, mapping, integrative modelling, online tool

12. *Type of submission:* **Abstract**

T. Thematic Working Group sessions: T5 Integrated ecosystem services models – advancing modeling science and application

Future projections of biodiversity and ecosystem services in Europe with two integrated assessment models

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Projections of future changes in biodiversity and Ecosystem Services (BES) are of increasing importance to inform policy and decision-making on options for conservation and sustainable use of biodiversity. Scenario-based modelling is a powerful tool to assess these future changes. This study assesses the consequences for BES in Europe of four different socio-environmental scenarios (i.e. OpenNESS scenarios). We evaluated these scenarios using two integrated assessment models (IMAGE-GLOBIO and CLIMSAVE IAP).

Despite differences in projections due to different modelling approaches, our results revealed similar trends of future BES consistent with the scenarios: projections indicate that i) climate and land use change will continue to pose significant threats to biodiversity and some ES, ii) none of the four scenarios achieved and overall preservation of BES in Europe, iii) targeted policies and societal behavior can reduce the extent of BES changes.

In this presentation, we will discuss these trends and conclusions drawn. Thereby, we will concentrate on the drivers behind BES changes by comparing the results between the scenarios and the two models. Moreover, we will reflect on the lessons learnt from the multi-modelling approach including the discussion on model uncertainties.

Keywords: integrated assessment modelling, IMAGE-GLOBIO, CLIMSAVE IAP, scenario analysis, inter-model comparison

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Can the right policy instrument to protect strategic ecosystem services stand up, please? A multi-criteria analysis approach

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Since some decades ago it has been pointed out the relationship between natural and social systems. Natural systems determine life possibilities and welfare of the social system through the supply of different goods and services. Social systems use and make decisions that impact – at different scales- the functionality of the natural system. Despite the above-mentioned dependence, there is an alarming rate of degradation of natural systems. To stop such degradation, different kind policy instruments have been designed and implemented around the world: command and control policies, economic instruments, voluntary instruments, and instruments based on information. However, many times the selection and design of the polity instrument to implement in each case does not consider the multiplicity of natural, social,

governance and institutional characteristics of the territory in which it will operate. Such features condition the probability of success of different policy instruments. Not considering natural, social and institutional features of the context in which the policy instrument will be implemented may lead to what is known as perverse effects or adverse consequences to the objective initially proposed. The selection of the policy instrument to use in each case must follow a decision process with multiple criteria. To the best of our knowledge, there is not a decision tool to help the decision of the policy instrument to select considering the abovementioned factors. This research presents a multi-criteria analysis tool using an Analytical Hierarchical Process (AHP) for selecting policy instruments to regulate ecosystem conservation attending social, natural, institutional characteristics of the context. The tool is applied and validated in different case studies in strategic ecosystems in Colombian Andes