BOOK OF ABSTRACTS

SESSION DESCRIPTION

Session ID:
T7

Title of session:
Use of ES in trade–off assessment tools and other DSS

Hosts:

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<th>Title</th>
<th>Name</th>
<th>Organisation</th>
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<tbody>
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Abstract:

Over the past decade, much effort has been placed on mapping and assessing of ecosystem services (ES) to articulate and sustain the societal benefits derived from ecosystem processes. Several new and promising methods have been developed, providing researchers the ability to estimate and map multiple ES simultaneously. High–profile international and state efforts have recently called for integrating ecosystem service values into land–use decision making (Global Land Project, IPBES) as management decisions and policies can lead to possible trade–offs between provisioning, regulating and cultural ES. Trade–offs occur
when one ecosystem service is enhanced at the expense of another. If trade-offs are not acknowledged and identified within a thorough analysis, the effectiveness of any response policy for their management can be potentially impaired. Therefore, impact assessment and trade-off analysis among various types of ecosystem services present a cornerstone of sustainable landscape planning and decision-making. Detailed and spatially explicit information is often required by decision makers to facilitate sustainable landscape management and governance on all scales. Indicators can play a fundamental role as well. Recently, an array of modelling and assessment tools focused on various types of ecosystem services and their trade-offs have been developed within both research and business communities. These tools substantially differ in their aim and focus, with variation of features such as scope, spatial scale and resolution, indicators and the extent of stakeholder involvement.

Subsession 1: The aim of this session is to present novel approaches to assess ecosystem service trade-offs, especially by coupling ecosystem services with land use change models, to introduce newly developed tools and to address user needs and requests regarding the further course of trade-off assessment tools development.

Subsession 2: this second part of the session aims at reviewing the specific application of the ES framework and linked indicators within different decision support systems, from planning, impact assessment, project implementation and policy making.

**Planned output:**
Preparation of a database of available trade-off assessment tools with factsheets on their users, data needs, output and examples.

Special issue of “Ecosystem Services”

**Voluntary contributions accepted:**
Yes, we do accept voluntary contributions on challenges within trade-off analysis, on trade-off tools and case studies where these tools were successfully used.

**SPEAKERS**

**Invited speakers (if applicable)**

**Subsession 1**

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<td>Verburg</td>
<td>VU University Amsterdam</td>
<td>Trade-offs in time and space: how land use change affects the trade-offs between ES</td>
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<td>Darius</td>
<td>Semmens</td>
<td>U.S. Geological Survey</td>
<td>Exploring the effects of land-use change on the social values of cultural ecosystem services</td>
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<td>Inostroza</td>
<td>Global Change Research Centre AS CR</td>
<td>Indicators for cultural ecosystem services in urban contexts: a critical review for urban planning</td>
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<td>Hannes</td>
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<td>Integrating Ecosystem Services into sustainability assessment: the case of German Biosphere Reserves</td>
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<td>Xie</td>
<td>Gaodi</td>
<td>Institute of Geographic Sciences and Natural Resources Research</td>
<td>The dynamic changes of ecosystem service value in China</td>
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<tr>
<td>Lin</td>
<td>Zhen</td>
<td>Institute of Geographic Science and Natural Resources Research, Chinese Academy of Sciences</td>
<td>Holistic assessment and comparison of wetland ecosystem services and driving forces in China and Bangladesh</td>
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<td>Rolf</td>
<td>Baur</td>
<td>University of Namibia</td>
<td>Assessment of technical infrastructure in protected areas</td>
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<td>Zuzana</td>
<td>Harmáčková</td>
<td>Global Change Research Centre AS CR</td>
<td>Modelling Ecosystem Service Trade-offs under Future Management Scenarios in UNESCO Biosphere Reserves</td>
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<td>Brian</td>
<td>Pickard</td>
<td>North Carolina State University</td>
<td>Understanding ecosystem service tradeoffs from scenarios of urban configuration in the Appalachian Mountains, North Carolina, USA.</td>
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<td>Benoit</td>
<td>Othoniel</td>
<td>Luxembourg Institute of Science and Technology</td>
<td>Dynamic integrated valuation of trade-offs between crop provision and pollination services</td>
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<td>Megan</td>
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<td>Stefano</td>
<td>Balbi</td>
<td>BC3 – Basque Centre for Climate Change</td>
<td>Integrating models of ecosystem services to estimate trade-offs in agro-forestry</td>
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<td>Wouter</td>
<td>Van Reeth</td>
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<td>Thomas</td>
<td>Palo</td>
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<td>Yan</td>
<td>Huimin</td>
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<td>Sustainable land use ability of inner Mongolia grassland: From ecosystem consumption and supply perspective</td>
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<td>Ryan</td>
<td>Blanchard</td>
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<td>Linking biodiversity and ecosystem services: Can the difference in functional traits of introduced plants be used to estimate potential changes to ecosystem services?</td>
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<td>Zhejiang University</td>
<td>Land–use change and ecosystem services evaluation in the islands city, based on remote sensing: a case studies in Zhoushan, China</td>
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<td>Steven</td>
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<td>Planning for green infrastructure in cities with the “Nature Value Explorer for Cities’ tool: Comparing scenarios</td>
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**Type of submission:** Voluntary contribution

**T7 Use of ES in Trade-off assessment tools and other DSS**

**Integrating models of ecosystem services to estimate trade-offs in agro-forestry**

*Presenting author:* Stefano Balbi  
*Other authors:* Ferdinando Villa, Simon Willcock  
*Affiliation:* BC3 – Basque Centre for Climate Change, Spain  
*Contact:* stefano.balbi@bc3research.org

Agro-forestry systems and ecosystem services (ES) are intrinsically related; constituting a source of provisioning, regulating, and cultural services, whilst at the same time being highly dependent on them in order to successfully function for their intended use.

The delivery of ES by agricultural and forest ecosystems becomes increasingly important as the demand for more food brings new areas of land under agriculture and the attempts to raise crop yield intensify; contributing to a significant decline in the state of ecosystems and the services they provide. To reduce the negative trade-offs and identify potential synergies, our understanding of the relationships between various ES must greatly improve.

Our modelling framework was developed to capture some main ES trade-offs in a generic agro-forestry landscape, analysing the effects of both managing practices and local environmental conditions on several ES:

1. Crop production (crop yield);
2. Forestry (biomass production);
3. Climate regulation (carbon sequestration and storage);
4. Water quantity and quality (water balance and quality indicators);
5. Flood regulation (flood prevention);
6. Air quality (mitigation of ammonia pollution).

We used a semantically-driven technology that enables flexible integration of models to overcome the service-by-service modeling approach applied traditionally in ES assessment. In our implementation, each ES is represented as one stand-alone module of the main model, however all the modules share one or more of the input variables between them. Further the effect that certain ES have on other ES is reflected through input and output interaction at the pixel level.
With this technology we are able to integrate models of different scale and nature. Modules can be developed deterministically (through equations and look up tables derived from the literature), or probabilistically (through Bayesian networks calibrated on empirical data) and be either static or dynamic. Results are produced as raster layers and as aggregated key indicators.

*Keywords:* Agricultural systems, forestry, ecosystem services, trade-offs, model integration
Ecosystems provide services for society, and it is important to investigate the ways how to measure and to indicate those. Ecosystem services can be reduced and compromised by the infrastructure that becomes necessary to access the services. However, little attention so far is paid on the technical and engineering infrastructure that becomes necessary for mining those; and moreover, the potential negative impacts that can be caused by poor design and operation of it. Design of technical infrastructure typically is based on guidelines and regulations formulated for the urban context, which do not necessarily account for specific requirements in sensitive areas.

In the study presented, performance indicators are developed and analysed for the technical infrastructure in facilities of Etosha National park in Namibia, with a particular focus on infrastructure for transportation, water and waste water, solid waste and energy. The potential impacts of the infrastructure are evaluated against the requirements of the ecosystem service they shall serve.

Keywords: Technical infrastructure, protected areas, performance indicators
Assessment of ecosystem services trade–offs resulting from land management choices with Bayesian belief networks

Presenting author: Elina Bennetsen
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Affiliation: Ghent University, Belgium
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Ecosystem services trade–offs are the result of decisions related to landscape management. Many tools are now already available to assess multiple ecosystem services. Some tools have shown their value for trade–off analysis, but there is room for improvement. A big issue still remains the lack of quantitative data for the complete chain of ecosystem service delivery. Also, many ecosystem services have limited possibilities for the evaluation of specific land management options. Often the focus remains on the effect of changing land use on ecosystem services. In recent years Bayesian Belief Networks have gained importance in ecosystem services modelling because of their ability to handle diverse types of data and uncertain or incomplete information. In this study, we have developed a Bayesian Belief Network that allows the direct evaluation of changing land management on multiple ecosystem services in Flanders. To include the effect of changing land management in the model, we have classified these management options using 4 criteria: field of application, spatial scale of application, goal of the management option and type of management option. This gives insight into how these management options can be integrated into a Bayesian Belief Network and allows a clear inventarisation of available information on the effect of these management options on ecosystem services. The resulting model can be used for trade–off analyses and so–called what–if analyses, which can support scenario development for changing land management.

Keywords: Trade–off analysis, Bayesian modelling
Modelling Ecosystem Service Trade-offs under Future Management Scenarios in UNESCO Biosphere Reserves

Presenting author: Zuzana Harmáčková
Other author: David Vačkář
Affiliation: Global Change Research Centre AS CR, Czech Republic
Contact: harmackova.z@czechglobe.cz

The capacity of ecosystems to concurrently provide different types of ecosystem services is inherently limited. Furthermore, the resulting trade-offs between ecosystem services can be exacerbated by different preferences of stakeholders regarding the prioritized types of services provided by specific areas. Therefore, it is vital to provide decision-makers with relevant assessments of potential trade-offs between ecosystem services in order to sustain well-being of local communities and preserve valuable natural assets. The aim of this contribution is to present a modelling approach to assess the trade-offs between regulating, provisioning and cultural ecosystem services, illustrated by two case studies carried out in UNESCO Biosphere Reserves in the Czech Republic. Both of the selected case study areas are characterized by high levels of natural and cultural assets and challenges regarding future landscape management. In this study, we first analysed the social-ecological dynamics within the study areas by creating participative scenarios through collaboration with local stakeholders, eliciting their preferences regarding future landscape development to 2050. Second, we assessed the impact of the scenarios on trade-offs between ecosystem services using various spatially explicit models and modelling approaches (InVEST, ARIES, etc.). The results indicate that while scenarios promoting economic development caused substantial trade-offs among ecosystem services, conservational scenarios provided higher levels of ecosystem services with lower trade-offs. This study illustrates that while a large proportion of stakeholders prefer managing ecosystems for short-term economic revenues, incorporating the provision of ecosystem services and their trade-offs shows that environmentally focused scenarios provide higher long-term benefits. We conclude with emphasizing the importance of assessing ecosystem services trade-offs for sustainable landscape management and well informed spatial planning and decision-making. At the same time, this study aims to contribute to the development of long-term socio-ecological research in the Czech Republic.

Keywords: Šumava Mountains, Třeboň Basin, LTSER
Indicators for cultural ecosystem services in urban contexts: a critical review for urban planning

Presenting author: Luis Inostroza
Other authors: Daniele La Rosa, Marcin Spyra
Affiliation: TU Dresden, Germany
Contact: inostroza@technotope.org

Urban systems, like any other ecosystem, provide specific services to their inhabitants and communities and they are benefited by surrounding ecosystems as well. Among the different categories, typical ES categories such as food production and erosion control usually have a lesser importance within urban contexts. On the contrary, the very diverse range of land uses in urban contexts provide specific cultural ES including recreational, cultural and educational values. However, up to date, a limited attention has been given to the provision of cultural ES, especially considering the relevant benefits that communities and urban planning processes can get from them. Assessing the value of culture in terms of benefits or services is a complex and sometimes even controversial issue, as it makes necessary a mix of qualitative and quantitative approaches. Finding a proper way of assessing these services can provide essential insights for urban planning and management of different urban systems, especially for specific urban contexts where history, location and other features play a central role for the social identity and cohesion. In this manuscript, we review the existing approaches for the assessment of Cultural Urban Ecosystem Services (CUES), and provide a critical overview of how indicators are used to assess and measure CUES, looking at its applicability in urban planning. By querying to some academic database, the review records the state of art of scientific literature about indicators used for CUES in urban contexts. Our results shows that existing CES indicators have limited usability for urban planning and management. Moreover a lack of appropriate data use is a significant obstacle for proper CUES assessment. This impacts the potential for sustainable decision-making concerning CES in urban contexts. These issues, together with fact that most identified indicators are proxy ones, identify an urgent need to develop proper assessment indicators for CUES

Keywords: Cultural urban ecosystem services, urban planning, review
**Integrating Ecosystem Services into sustainability assessment: the case of German Biosphere Reserves**

**Presenting author:** Hannes König  
**Other authors:** Claudia Bethwell, Sarah Diem, Katharina Helming, Ulrich Stachow, Thomas Kaiser  
**Affiliation:** ZALF, Germany  
**Contact:** hkoenig@zalf.de

UNESCO biosphere reserves are considered model regions for sustainable development. They consist of three complementary zones: the core area, the buffer zone, and the transition (or cooperation) zone. While the core areas are dedicated to nature conservation, the buffer zone act as intermediate areas; the aim of the transition zone is to promote sustainable development through adequate land use. This means that economic development, socio-cultural considerations and environmental protection should be harmonized in a balanced way. We looked at the main land use sectors in the transition zones including agriculture, forestry and water management. Our objective was to assess alternative options for land management that result from regional policy programs, laws and stakeholder initiatives. In a first step, we developed a sustainability assessment framework that integrates multiple Ecosystem Services with land management services, such as the provision of: natural resources, industry and services, infrastructure & transport (economic); work, health and recreation, cultural identity (social); abiotic and biotic resources, the maintenance of ecosystem processes (environmental). In a second step, we conducted a survey, in which all German biosphere reserve administrations have been asked to specify and prioritize the proposed Ecosystem Services from a regional perspective. Results show that, in general, there are different regional priorities for Ecosystem Services among the biosphere reserves. We identified that agriculture and regional policies were perceived to bear most challenges but also potentials towards sustainable development. We discuss the potential of an integrated Ecosystem Services framework to assess sustainable development at the level of biosphere reserves. Thereby, we strengthened the communication between science and biosphere reserve administrations to support decision making and to promote sustainable development.

**Keywords:** Land use, ecosystem service values, science–stakeholder dialogue, decision support
Interactions among multiple ecosystem services and their social-ecological drivers: a case study from the Norrström drainage basin, Sweden

Presenting author: Megan Meacham
Other authors: Cibele Queiroz, Albert Norström, Garry Peterson
Affiliation: Stockholm University, Sweden
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Ecosystem services is a concept that has recently been integrated into national and regional policy in Sweden. Our research aims to develop practical ways of assessing ecosystem services that can support local decision making. Sweden and our research takes a strongly social–ecological approach to ecosystem services, in which ecosystem services are viewed as being co-produced by both people and ecosystems. We aim to simplify the management of multiple ecosystem services by identifying patterns of interaction and clustering among ecosystem services across the landscape, and how these patterns are shaped by social, geographic, and ecological drivers. Understanding the relationships among services helps to harness the synergistic qualities between services to enhance the impact of interventions and to avoid the perverse outcomes that can result from ignoring their interconnected nature.

Using the Norrström drainage basin that surrounds Stockholm, Sweden as a case study, we have mapped the spatial distribution of 16 ecosystem services and used cluster analyses to identify bundles of services that can be viewed as representing different types of social–ecological systems. The Norrström basin is highly multifunctional, and compared to research in Canada we found weaker bundling of ecosystem services. To explore what drives observed patterns of ecosystem service use, we tested models based on cross-disciplinary theories of land use change to predict individual ecosystem services and bundles of ecosystem services. We found that services closely related to land use are predicted by land cover, but other models work better for other services. Ecosystem service bundles are predicted worse than individual ecosystem service models, but provide a clear picture of change in multiple ecosystem services based on limited information. In future work, we are interested in better incorporating resilience in the assessment of ecosystem services.

Keywords: Trade-offs, synergies, bundles, spatial
Dynamic integrated valuation of trade-offs between crop provision and pollination services

Presenting author: Benoit Othoniel
Other authors: Benedetto Rugani, Marco Beyer, Pim Post, Reinout Heijungs
Affiliation: Luxembourg Institute of Science and Technology, Luxembourg
Contact: benoit.othoniel@list.lu

The expansion and intensification of agricultural production as well as the growth of cities and infrastructures, particularly in developed countries, endanger ecosystems and their capacity to supply services (e.g. soil fertility, water availability, pollination). By relying on existing modelling frameworks to assess ecosystem services, it is possible to evaluate the trade-offs and synergies between the necessary supply of biomass (for different purposes), and the preservation of the ecological processes that support it. Such information seems primordial to design more efficient and sustainable land use strategies.

A spatialized land use-based integrated model is developed and illustrated here to assess the pollination intermediate service with regard to its contribution to crop provision, considered as a final service. Through a modification and adaptation of the InVEST crop pollination model to the Luxembourgish context (taken as a case study), our model enables to spatialize the impact of land use changes on the production of pollination–dependent cultures. The InVEST model is improved according to its implementation within an existing integrated dynamic framework (i.e. MIMES; Boumans et al. 2015, Ecosystem Services 12:30–41), allowing to assess over time the trade-offs between the crop provision and pollination services underlying different agricultural land use scenarios for Luxembourg. Moreover, the contribution of managed honey bees is considered in parallel to wild pollinators, providing a broader outlook on the crop pollination process. Modelling results show overall a significant variability in the impact on crop yields of land use changes depending on their location.

Aggregated at the municipality scale, these results a priori seem useful in a land management decision context. The definition and modelling of clear cause–effect chains and the management and coupling of multi-scalar data and models are key aspects of our approach.

Keywords: Pollination service, integrated modelling, land use changes, trade-offs, agricultural scenarios
**Type of submission:** Voluntary contribution

**T7 Use of ES in Trade-off assessment tools and other DSS**

**The integration of concepts in municipality planning in relation to research interests, environmental concerns and policy decision tools.**

*Presenting author:* Thomas Palo  
*Other authors:* Karen Lagerkrantz, Torleif Bramryd, Ingemar Jönsson, Christine Wamsler, Thomas Beery, Nils Ekelund  
*Affiliation:* Swedish University of Agricultural Sciences, Sweden  
*Contact:* thomas.r.palo@slu.se

In times of rapid urbanization and technology evolution, we realize our dependence on nature for wellbeing, culture, society and livelihood. Several pressing issues face municipality planners under increased land use and climate change. Environmental Impact Assessment is one tool that has been developed for planning of society for management of natural resources. In addition, in Sweden, the environmental goals are set targets for planning and action at all levels of the society. New concepts such as ecosystem services are introduced from policy and governmental level and need to be implemented at the local and regional scale. This may require collaboration between science and policy. The focus is on research needs and for identification of important areas of concern that may be of interest for such collaborations. The present study gives an overview and an analysis of how key concepts related to ecosystem services are used in planning documents and among servants in municipalities in region of Skåne, Sweden. It is concluded that there is a growing interest from municipalities to have exchange with academia with involvements in research projects, tools developments, knowledge sharing and exchange of ideas, but that the municipalities differ in their priorities of the most pressing issues to be solved with support from academy. The differences are based on their local conditions. The municipalities ask for a system perspective and see integration of several areas as important for future planning. Ecosystem services are regarded as a promising concept but are only mentioned in a few recent planning documents. Many aspects of Ecosystem Services such as ecological indicators are already covered in environmental impact assessments and this is reflected in planning documents. The general planning documents present concepts at a policy level and rarely provide a more detailed plan of action compatible with the Ecosystem Services approach.

*Keywords:* Ecosystem services, municipalities, planning, tools, EIA
Understanding ecosystem service tradeoffs from scenarios of urban configuration in the Appalachian Mountains, North Carolina, USA.

Presenting author: Brian Pickard  
Other authors: Derek Van Berkel, Ross Meentemeyer  
Affiliation: North Carolina State University, United States of America  
Contact: b.r.pickard@gmail.com

Urbanization is likely to be a major driver of change for the delivery of ecosystem services in the coming decades with various trade-offs. Present understanding of how spatial configurations of urbanizing areas will impact ecosystem services remains a challenge. Simulations of urbanization can be useful in this regard, providing likely approximations of future urban growth patterns. Studies have shown that increasing urbanization results in ecosystem service tradeoffs that are dependent on the specific spatial pattern of urbanization. Yet, many models simulating urbanization often do not capture disjointed urban configurations typical of southeastern USA, which are important for ecosystem process and the delivery of ecosystem services. We loosely couple a suite of ecosystem service models with a land change model, the FUTure Urban–Regional Environment Simulation (FUTURES) to investigate tradeoffs. FUTURES accurately simulates urban growth patterns typical of urbanization in the US. Coupling this model with a suite of ecosystem service models allows for the examination of how spatial configurations of urban growth will impact ecosystem services for a nineteen county region in North Carolina, USA. Applying a range of urbanization scenarios, from high infill densification to low density sprawl, we highlight tradeoffs among ecosystem services as a direct result of specific urban configurations. Understanding how patterns of urbanization may impact ecosystem services and the tradeoffs among them is critical as southeastern USA populations continue to expand. Our results demonstrates urban configurations that may limit future impacts to ecosystems and provides a framework to understand ecosystem service tradeoffs associated with each urban growth configuration.

Keywords: Urbanization, tradeoff analysis, ecosystem services, land change
Exploring the effects of land-use change on the social values of cultural ecosystem services

Presenting author: Darius Semmens
Other authors: Benson Sherrouse, Zachary Ancona, Nicole Brunner
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As regional population growth results in continued increases in the use of public lands across the Southern Rocky Mountains, it is more necessary than ever to consider the full range of economic, ecological, and social values when assessing potential trade-offs among the broad array of ecosystem services that these landscapes provide. Until recently, social values have received little attention relative to their economic and ecological counterparts. Additionally, cultural ecosystem services, with which social values share a particularly close association, have not always been well represented in ecosystem service assessments. To address these deficiencies, Social Values for Ecosystem Services (SoLVES; solves.cr.usgs.gov), a geographic information system tool, was developed. SoLVES offers capabilities to assess, map, and quantify perceived, nonmarket values that the public ascribes to cultural ecosystem services such as aesthetics and recreation. The spatially explicit information SoLVES provides takes into account public values and preferences as well as characteristics of the underlying environment. To date, this information has been presented as a snapshot in time. The current study attempts to expand upon the capabilities of SoLVES to investigate the impact of future population growth on the intensity and spatial distribution of social values associated with cultural ecosystem services in four national forests extending more than 600 kilometers along the western flank of the Front Range Urban Corridor of Colorado and Wyoming. Scenarios were developed based on various alternative population projections and the resulting observable impacts on the landscape related to increased visitation and congestion. The goal is to assist decision makers with the sustainable management of public lands by explicitly accounting for plausible, potential changes in the spatial distribution of cultural ecosystem service values over time in association with population growth. With such information available, some future ecosystem service trade-offs may be better anticipated and managed towards a more sustainable course.

Keywords: Cultural ecosystem services, valuation, population growth, scenario development, geographic information system
Type of submission: Voluntary contribution

T7 Use of ES in Trade-off assessment tools and other DSS

Investigating Trade-offs Between Water Quality and Agricultural Productivity
Using LUCI – a New Zealand Application

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There is global concern over the impact of rural land management on ecosystem services, especially with regards to water quality. Due to its fine spatial scale and focus on the rural environment, the Land Utilisation & Capability Indicator (LUCI) is well placed to help both farm and catchment managers quantify and explore spatially explicit solutions to this issue.

LUCI, an extension of the Polyscape framework described in Jackson et al. (2013), is a GIS framework that considers impacts of land use on multiple ecosystem services in a holistic and spatially explicit manner. A number of ecosystem services are supported within the framework, including emissions to water of N and P and agricultural productivity. Ecosystem service tools can be run for individual ecosystem service analysis and to analyse interrelationships between ecosystem services, identifying trade-offs and synergies between them. LUCI has been applied in a number of countries, but most extensively in the UK.

A collaboration between LUCI developers and a New Zealand farmer owned co-operative has recently commenced. The aim is to develop a bespoke version of LUCI for the co-operative that will assist New Zealand farmers and other land managers with decision making around ecosystem services, with a particular focus on water quality.

This paper presents results from an application of LUCI water quality and agricultural productivity models in a catchment in Bay of Plenty, New Zealand. N and P sources and sinks are discussed, trade-offs and synergies between water quality and agricultural productivity investigated, and implications for land managers, catchment managers and policy makers explored.

The authors thank Ravensdown and Bay of Plenty Regional Council for data and funding support for this project.

Keywords: LUCI, water quality, agricultural productivity
Making ecosystem services (ES) trade-off analysis ‘actionable’ in concrete planning and governance contexts

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In the scientific literature, ES trade-offs (or synergies) are mostly assessed based on spatial or temporal co-occurrence of ES. We argue that these should be considered as ‘ES bundles’, and that ‘real’ trade-offs need to reflect actual causal relationships between ES. Consequently, trade-offs can only be determined if the underlying mechanisms are explained. As these mechanisms are highly context-dependent, generalized models do not fully capture these mechanisms, and the involvement of local knowledge/experts and stakeholders is often more efficient to identify and explain ES trade-offs reliably.

In our Belgian case studies, we observe that in concrete planning contexts, landscape planners and regional managers usually have more interest in ES trade-offs (and synergies), than for individual ES assessment, valuations or maps. This can be explained by the need for multifunctional landscape use in a highly populated country, but also by the concern that land-use conflicts can impact stakeholder cooperation.

To make ES trade-offs useful for practical planning, we propose a typology that considers ‘actual ES use’ as entry point. In this typology ES trade-offs are the result of either competing activities (spatial competition, activity incompatibility, activity side-effects), or of the misuse of ES (overuse, overharvesting, depletion supporting ES). These trade-offs can be further analysed based on respective ES demand and supply in relation to its spatial and temporal scales. For each trade-off type a problem-solving strategy is proposed. Such trade-off assessments are geared towards the scale and context of landscape planners, and provide ‘actionable’ information instead of theoretically elegant graphics. This typology of trade-offs is tested within OpenNESS (FP7) case studies, and typical examples of ES-trade-offs will be provided in the paper.

Keywords: Ecosystem services, trade-off, synergies, causal relationship, landscape planning
Economic valuation of land use change: farming and forestry in Flanders

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When faced with the choice to allocate open space to farming or sustainable forestry, private landowners try to maximize their private benefits of marketed ecosystem services. In this trade-off the opportunity cost of forest expansion is often considered too high. As a result it has turned out to be impossible for the Flemish Government to achieve its spatial and environmental policy targets to achieve 10,000 hectare of forest expansion on farmland. The objective of our study is to investigate for the densely populated and urbanized region of Flanders to what extent the inclusion of non-marketed ecosystem services could, in theory, alter the land use decisions by private landowners in favour of sustainable forestry. This study is part of the Flanders Regional Ecosystem Assessment (Flanders REA) that was presented in February 2015 (www.inbo.be/en/flanders-regional-ecosystem-assessment-state-and-trends-synthesis-report).

We compare the capacity for ecosystem services and their economic value for two alternative land uses, current professional farming and a hypothetical, sustainably managed mature broadleaf forest. The study includes two marketed ecosystem services, food and timber production, and two non-marketed services, global climate regulation and recreation. The study takes spatial data into account with regard to soil characteristics, land cover, land use regulations, demography and other socio-economic parameters as well as policy measures like agri-environment schemes and other farm subsidies.

The aggregated valuation maps indicate where and to what extent the net social benefits of sustainable forestry outweigh those of current agricultural land use. The paper illustrates how, in theory, regional value based maps allow to delineate areas in which afforestation of farmland is likely to generate more social benefits than in others. For the maps to serve this purpose, the quantification and valuation still need to be improved and the number of assessed ecosystem services increased. Regional valuation maps could help to select areas for participatory local valuation studies. These local studies could also include sustainable agricultural land uses, adapted to local needs.
Keywords: Ecosystem services, economic valuation, value based mapping, land use trade-offs
Trade-offs in time and space: how land use change affects the trade-offs between ES

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Trade-offs are inherent to land use and land management. Changes in land use will affect the trade-offs, both at the location of change as well as at the level of the landscape as a whole. Land use change reconstructions and scenarios can provide insight in how both individual as well as the trade-offs between services change with time and space. Most land use scenarios for Europe indicate a polarization of land uses with a separation of intensive and extensive productions systems within the landscape. Such developments lead to a shift of multifunctionality from the parcel level to the level of the region, causing tradeoffs for the production of individual services and the benefits by the users of the services.

In this talk we will provide examples of how land use scenarios, ES mapping and trade-off analysis can be combined to shed insights into the functioning of landscapes in the future.

Keywords: Trade-offs, land use change, scenarios, scale, multifunctionality
The dynamic changes of ecosystem service value in China

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The ecosystem services with extremely high economic value impact the human well-being significantly. The practices of ecological system asset management, ecological compensation and paid use of ecological system asset are urging to fully evaluate ecosystem service value. In this paper, the economic values of 11 types of ecosystem services are accounted based on the expansion of the labor value theory and mainly using the method of equivalent value factor per unit ecosystem area. The research results show that: (1) the total value of ecosystem services in China is ¥42.36×10^{12}, of it, forest ecosystem services value accounting for 41.4%, followed by aquatorium and grass ecosystem service value respectively accounting for 29.3% and 17.7%; (2) In terms of the economic value derived from different types of ecosystem services, the support services account for 68.5%, regulation services account for 17.01%, provision services account for 4.71% and the cultural services account for 3.41%; (3) the value of ecosystem services vary seasonally during a year, the value of ecosystem services during May to September is higher, during October to April the value of ecosystem services is relatively low; (4) the ecosystem per unit area in the South and Northeast China supply higher ecosystem services value, the overall trend of spatial distribution of ecosystem services value per unit of ecosystem area gradually reduce from the southeast to the northwest; (5) with comparison between the per capita ecosystem service value and the per capita GDP in different regions of China in year 2010, the per capita ecosystem service value in China is ¥3.2×10^4, closely near to per capita GDP, which fully demonstrates the relative scarcity of China's ecosystem services, especially in the economically developed and densely populated areas of China.

Keywords: Ecological system service value, value assessment, dynamic method
Hollistic assessment and comparison of wetland ecosystem services and driving forces in China and Bangladesh

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Wetland ecosystem in Asia plays a key role in providing necessary goods and services for humans and wild animals, but land management decisions can maintain or deplete ecosystem services (ES). This research attempts to investigate the impacts of land-use change on ES in two wetlands of international importance in China and Bangladesh. Methods for the assessment include Participatory Rural Appraisal (PRA), household questionnaire survey and Shannon–Wiener Index (SWI) to identify ES change and driving forces of the wetland ecosystem. It was found from the study that substantial changes had been occurred in food supply and biodiversity of the two developing countries' wetlands. Rice supply decreased significantly in the two wetlands over the past 15 years, major drivers include ecological restoration project in Poyanghu wetland, and the frequent floods in Tanguar Haor wetland. Fish production decreased as a result of population growth, economic development, sandpit and water contamination in Poyanghu, and population is the most important factor affecting over exploration of fish in Tanguar Haor wetland. On the other hand, SWI of migratory bird in Poyanghu increased by 10.0% during the past decade owing to the increase of habitat area and quality, but it decreased by 7.0% in Tanguar Haor due to shrinkage of waterbodies and shortage of food and shelter because of over consumption of natural resource by human beings. Tree species increased in the typical villages in Poyanghu Lake wetland because of implementation of ecological projects, however, SWI of trees in Tanguar Haor wetland reduced by 24.2% during 2000–2010, population growth and over consumption of forest resources is the main reason for such changes.

Keywords: Food supply, biodiversity protection, PRA, Poyanghu of China, Tanguar Haor of Bangladesh
Linking biodiversity and ecosystem services: Can the difference in functional traits of introduced plants be used to estimate potential changes to ecosystem services?

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Better understanding the relationships between biodiversity and ecosystem services will provide key insights into the impacts of changing species communities at a landscape scale. Little is known about the processes by which introduced species affect the delivery of ecosystem services, and the degree to which they do. Given that ecosystem processes are largely governed by the combinations of species traits within communities, impacts may be better understood by the relationship between the traits of native and non-native species. In this study, we aimed to understand the impact of introduced plants, used for commercial purposes, on ecosystem functioning using plant functional traits. We used three leaf traits (leaf dry matter content, leaf nitrogen content and leaf phosphorous content) to characterise the functional composition of natural communities to determine functional diversity within an ecosystem service hotspot in Eastern Cape, South Africa. These were used to compare changes in species composition across four different land-use types. Using some of the newest approaches to link functional traits with ecosystem services we provide a test case using data from our study. The results indicate that understanding the per capita effect of individual species is important to determine overall contributions to ecosystem service provision. We discuss the merits and challenges of these approaches and provide a key insight into the methods available to researchers. Furthermore, we highlight the potential to assist decision makers by assessing potential tradeoffs in ecosystem service provision.

*Keywords:* Plant functional traits, land-use, invasive alien plants, biofuels,
Type of submission: Poster

T7 Use of ES in Trade-off assessment tools and other DSS

Sustainable land use ability of inner Mongolia grassland: From ecosystem consumption and supply perspective

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High intensity of resource utilization and increasing food, fiber, energy, material requirements are leading to the growing strength of consumption of limited natural resources of the earth's surface, if the existing socio-economic development model continues, the ecological system may be further reduced and degraded, threatening socio-economic sustainable development. How to construct scientific and reasonable model to match supply and consumption of ecosystem services is a new challenge for slowing down or even curbing the degradation of ecosystems, and this need to develop the evaluation system and the simulation method of the reasonable consumption of ecosystem services, which found the junctions between the supply of natural ecosystem services and the human consumption and appropriate indicators is the key. Ecosystem net primary productivity (NPP) consumption reflects the human use intensity on the supply of ecosystem services. This study constructed a conceptual framework for ecological service reasonable consumption evaluation, developed a calculation method with consumed-NPP as a main indicator. The developed method was used at three case study regions in Inner Mongolia grassland transect, and three regions have apparent gradient within ecological consumption model and intensity. Reasonable ecosystem NPP consumption was defined as the human consumed NPP for their livelihood did not produce excessive pressure to the ecosystem and can satisfy the basic human subsistence life need. The largest NPP consumption on which ecosystem could carry is the actual supply NPP of ecosystem, and the basic living consumption refers to the directly or indirectly consumed NPP used for obtaining the necessary food (including food, vegetable, meat, milk, etc.). Reasonable consumption evaluation system is divided into three levels. The first level determined the current ecological consumption pressure on the ecosystem. The second level evaluated the living satisfaction of the farmers and herdsmen. The third level examined the households’ diet rationality in contrast with national diet standard. This paper described the data selecting principles and methods for the ecosystem productivity supply services and reasonable consumption in the evaluation process, and also detailed ecological consumption and calculation steps and basis of reasonable threshold.
The method was designed based on attributive characters of the ecosystem services consumption agents, and the algorithms provided methodological basis for development of reasonable ecosystem consumption simulation platform based on multi-agent technology. This study also is an attempt on developing comprehensive evaluation methods for reasonable consumption taking into account a variety of ecosystem services (e.g. water regulation, soil formation and retention, species diversity maintenance) and consumptions.

*Keywords: Ecosystem services, ecosystem consumption, ecosystem pressure, NPP, reasonable consumption*
Planning for green infrastructure in cities with the “Nature Value Explorer for Cities” tool: comparing scenarios

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Nature based solutions can assist urban planners to meet the different challenges (health and wellbeing, biodiversity, climate change, air quality…) of today. Where to develop and preserve which type of green to establish solutions for many problems simultaneously is however not straightforward. The online Nature Value Explorer tool (www.natuurwaardeverkenner.be) is originally aimed to value the impact of nature development projects on ecosystem services, but is currently being extended with an urban version. Its aim is to support cities, administrations and planners in providing the right urban green on the right place in urban environments, paying attention to the quality and the functions of the green infrastructure and the trade-offs between different ecosystem services/indicators. Cities can also estimate the effects of the existing and planned green infrastructure on reaching different sustainability ambitions. The rural version estimates the value for different provisioning, regulating and cultural services. The urban version builds on a specific typology of urban green and requires other valuation methodologies specifically suited for urban environments. Ecosystem services which can be valued include urban farming, air quality, urban heat islands, carbon sequestration, water retention and health and wellbeing.

The presentation will outline the user requirements for such a system, the valuation methodologies and demonstrate results for a case. It will also discuss challenges that arise when developing such tools. A large challenge for practical tools is that they need to simplify complex things, be user-friendly, transparent and flexible to address future questions and include new insights. On the other hand, they also require a high accuracy and scientific reliability.

Keywords: Trade-offs, valuation, rural, urban, ecosystem services
Land–use change and ecosystem services evaluation in the islands city, based on remote sensing: a case studies in Zhoushan, China

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Ecosystem services are the conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfill human life. They are the cornerstone of human survival and sustainable development of society. Islands owning special location are considerably fragile and highly sensitive to human activities. Zhoushan is the only city of Zhejiang Province consisting solely of islands and also the first state–level new area of marine in China. It consists of a number of islands and has a long coastline. Recently, owing to new urbanization strategy and the rapid development of marine economy, Zhoushan is in a hurry to exploit the urban and reclaim new land, resulting in a serious of significant changes in land structure and ecosystem services and potentially posed threats into island environment. Combining multi–date remote sensing images and data of topography, soil, meteorology and social economy, in this research we analyzed spatial–temporal dynamic of land–use changes trigged by rapid urbanization and rampant reclamation. We further evaluated the trajectory of ecosystem services change including biodiversity, soil conservation, hydrology regulation, carbon storage and production supplement. This study finally revealed the potential role of ecosystem in supporting the ecological safety and social development and the dynamic interaction between human activities and ecosystem. Main conclusions are as follows:

(1) Owing to rampant reclamation, the monitoring area of Zhoushan city increased significantly from 1271.82 km$^2$ in 2000 to 1376.23 km$^2$ in 2010. Among the extended areas by reclamation, 47.58 % of them were used for urban construction, and 23.67 % turned into water bodies for aquaculture.

(2) The main type of land use was forest, followed by farmland and urban land. From 2000 to 2010, forest and farmland area decreased, while urban area increased dramatically. And the area which transferred from farmland and forest to urban land accounted for 80.27 % and 50.58 % of respective transfer area.
(3) Product supplement was found as the most prominent ecosystem service of Zhoushan, followed by soil conservation, carbon storage, biodiversity, and hydrological regulation was the weakest. During 2000–2010, product supplement service improved significantly; soil conservation service and carbon storage service increased slightly. Hydrological regulation service remained stable; biodiversity service declined slightly.

(4) Carbon storage, hydrological regulation and soil conservation service correlated significantly indicating obvious synergies. However, biodiversity negatively correlated with them which resulted from the radiation distribution of land use in “Forest – Farm – Urban” type.

(5) The impacts of forest and farmland on ecosystem services were serious, especially forest. They were in significant positive correlation with carbon storage, hydrological regulation, and soil conservation.

Keywords: Land use change, ecosystem services, InVEST model, islands city, Zhoushan