



BOOK OF ABSTRACT

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I. SESSION DESCRIPTION

ID: T14c

Ecosystem services and drivers of change

	Title	Name	Organisation	E-mail
Host:		Lukas Egarter-Vigl	Institute for Alpine Environment, Eurac Research	lukas.egarter@eurac.edu
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Abstract:

A major challenge to support environmental management and planning is the development of theoretical and operational models capable to assess the effects of environmental and anthropogenic drivers on ecosystem structures/processes that as a consequence affect ecosystem services delivery and societal well-being and health. Global and local drivers of climate change, intensifying land and sea urbanization, demographic trends, human-induced movement of organisms (e.g. invasive species) or food production practices (e.g. fertilizer use) are a major threat to ecosystems and to the ecosystem services they deliver to society. It is fundamental that decision-makers and planners obtain a combined understanding of single and cumulative effects of drivers on ecosystem conditions and their interrelation to ecosystem services delivery. In order to better design environmental protection measures, prevention and mitigation strategies, planners need decision support instruments that are capable to represent the spatial and temporal behavior of stressors and their influence on mid and long term ecosystem services delivery. The session aims at presenting current conceptual and methodological advancements in analyzing the effects of environmental and socio-economic



drivers of change on ecosystem services delivery, share experience on the compatibility of the approach for environmental planning, management and regulations and discuss most important opportunities, challenges and gaps in addressing effects of drivers to ecosystem services delivery and societal well-being.

Goals and objectives of the session:

The session aims (1) to present current theoretical and methodological developments in the integration of anthropogenic and environmental drivers of change into ecosystem services assessment and mapping by addressing stressor effects on ecosystem conditions and as consequence on ecosystem services provision to society; (2) to present cases of integration of ecosystem services into risk and impact assessment from drivers of change; (3) to address the compatibility of the approaches to environmental policies, planning and regulations in their study domain and (4) to share knowledge among experts of different fields on the challenges, opportunities and gaps of drivers-oriented ecosystem services assessment. Particular attention will be given to case studies addressing drivers of change related to climate change, urbanization of land and sea, demographic trends, food production practices and human-driven organisms movement (e.g. invasive species) and their interrelation to ecosystem condition and services to societal wellbeing. Case studies differing from the drivers above can be considered as well. Contributions are welcome from any biome (terrestrial, urban, freshwater and marine) and any geographical scale (global to local).

Planned output / Deliverables:

Review paper (involving all session presenters) on current trends of ecosystem services assessment linked to stressor and drivers of change analysis. This includes a review of most relevant drivers addressed in the session, ecosystem services assessed and current methodological advancements and gaps.

Related to ESP Working Group/National Network:

[Thematic working group: TWG 14 – Application of ES in Planning & Management](#)

II. SESSION PROGRAM

Date of session: Thursday, 24 October 2019

Time of session: 10:30 – 18:00

Timetable speakers

Time	First name	Surname	Organization	Title of presentation
10:30–10:45	Lukas	Egarter Vigl	Institute for Alpine Environment, Eurac Research, Bolzano, IT	Multi-stressor effect analysis on ecosystem services in mountain areas
10:45–11:00	Thomas	Marsoner	Eurac Research	Analysing the status and change of protection forest across Europe
11:00–11:15	Janina	Kleeman	Martin-Luther-University Halle-Wittenberg	Impacts of changes in climate, population and agricultural area on food provision – an example from northern Ghana
11:15–11:30	Jarot Mulyo	Semedi	University of Twente	The impact of geothermal development on ecosystem service supply in Mount Patuha, West Java-Indonesia
11:30–11:45	José Pedro	Ramião	CBMA – Centre of Molecular and Environmental Biology, Department of Biology, University of Minho, Braga, Portugal	Modelling hydrological ecosystem services for improved watershed management under climate change scenarios
11:45–12:00	Joachim H.	Spangenberg	SERI Germany	Sustainable Consumption (SC) for Biodiversity and Ecosystem Services (ESS)
13:30–13:45	Paula	Rendon	Leibniz University of Hannover, Germany	Application of an operational framework for the integrated mapping and assessment of agroecosystems' condition and services at different spatial scales
13:45–14:00	Ksenija	Hanacek	The Institute of Environmental Science and Technology (ICTA), Autonomous University of Barcelona (UAB)	Impacts of land-use changes on the perceived importance for cultural ecosystem services in rural Bulgaria
14:00–14:15	Sebastian	Candiago	Ca' Foscari University of Venice	A system dynamics approach to assess ecosystem service supply in

				viticulture in the context of global change
14:15–14:30	Andre	Fonseca	University of Trás-os-Montes and Alto Douro, Portugal	High-resolution river catchment simulation to protect and promote ecosystem services: the ALICE project
14:30–14:45	Anna	Schlattmann	Leibniz University Hannover, Germany	Sustainability assessment of agricultural water use in the Danube Basin: First steps towards a global monitoring tool
14:45–15:00	Ieva	Misiune	Vilnius University, Lithuania	Analyzing anthropogenic threats to marine ecosystem services in small sea areas assessments: the case of the crowded coastal areas in the Italian Adriatic Sea
16:30–16:45	Aija	Nieminen	Parks & Wildlife Finland	Ecosystem services provision in year 2020 and in 2120: a case study analysis in the Kvarken Archipelago
16:45–17:00	Matthias	Schröter	UFZ – Helmholtz Centre for Environmental Research	Modelling global coproduction of agricultural crops to distinguish anthropogenic and natural effects on yields
17:00–17:15	Nuket Ipek	Cetin	Gebze Technical University, Turkey	Spatiotemporal dynamics of ecosystem services (ES) change in urban catchments: Istanbul case
17:15–17:30	Betül	Uygur Erdoğan	Istanbul University–Cerrahpaşa, Faculty of Forestry, Watershed Management Department	Watershed prioritizing for hydrological ecosystem services in the context of conservation management
17:30–18:00				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.

1. Type of submission: **Abstract**

T. Thematic Working Group sessions: T14c Ecosystem services and drivers of change

A system dynamics approach to assess ecosystem service supply in viticulture in the context of global change

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Vineyard landscapes (VL) provide multiple benefits to people, such as food, regulating functions and appealing landscapes. However, they are also exposed to several growing threats such as climate/land use change and increased pressure from globalized markets, that influence the multiple interdependences between the agro-ecological and socio-economic components at their basis. Due to its flexible nature, the ecosystem services (ES) approach offers a promising framework to address these influences, taking in consideration the consequences of the major drivers of change (MDC) on the benefits provided by VL.

This study aims at analyzing the possible effects of MDC on ES bundles in viticultural areas using a system dynamics approach. We present a causal loop diagram that consider the most important components of the VL system (vines, viticultural landscapes, management choices, climate) and connects them with the relevant exogenous (e.g. market demand, climate change) and endogenous (e.g. resilience, adaptive capacity) variables that can influence ES supply. The analysis of these variables is carried out by focusing on their possible positive and negative feedbacks, that can reinforce or reduce the supply of ES. This allows to assess the possible effects of the MDC on VL, by developing a framework that specifically addresses the dynamics of these changes. The in-depth study of these dynamics may provide insights on possible strategies that can increase the potential of VL for ES supply in the face of the impacts of the MDC. This can include the adoption of measures such as land-use change regulations that preserve the agrarian landscape or climate change adaptations measures based on sustainable



soil management, that will help to give new impulses for the long-term preservation and sustainable development of VL.

Keywords: Viticulture, Global Change, Agro-ecological Systems, Socio-Economic Systems, System dynamics

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

T. Thematic Working Group sessions: T14c Ecosystem services and drivers of change

Spatiotemporal dynamics of ecosystem services (ES) change in urban catchments: Istanbul case

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Unplanned urbanization is characterized by deteriorating human intervention on urban ecosystems threatening the variety, quantity, quality and spatial distribution of ecosystem services (ES). Herein, assessing the changes in land use and land cover (LULCC) contributes to a better understanding of dynamic relationships between ES provision and anthropogenic activities. As a convenient decision-support tool, LULCC monitoring defines, quantifies and evaluates the spatial pattern of changes in urbanizing landscapes and it helps to produce tangible outputs for the variations in ES provision. From this point of view, the research focuses on the spatio-temporal dynamics of ES change in two important catchments of Istanbul in terms of urban planning practices. The case study areas –Omerli and Buyukcekmece Catchments– are among the most critical drinking water suppliers for the city and declared as ‘Important Bird Area (IBA) and Important Plant Area (IPA)’ due to their biodiversity abundance. However, both catchments are under the increasing pressure of rapid urbanization and population growth since 1980’s, which have resulted in significant changes in catchments’ ES provision capacity. Therefore, the research aims to analyze the interactions between spatio-temporal changes in LULC and total ES provision in each catchment through Normalized Difference Vegetation Index (NDVI)-based trend analysis between 1990–2017. Total ES provision of each case year is determined with an expert scoring based on the ES potentials of each LULC. The results of trend analysis are interpreted from the perspective of urban planning policy to clarify the positive and negative consequences of spatial decisions on ES supply



capacity. Understanding these interactions contribute to the conservation of vulnerable landscapes in urban catchments and provide significant insights for planners and policy makers to sustain the ES provision and quality of life in Istanbul Metropolitan Area.

Keywords: Spatio-temporal change, NDVI, ES change, Urban planning policy, Istanbul

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

T. Thematic Working Group sessions: T14c Ecosystem services and drivers of change

Analyzing anthropogenic threats to marine ecosystem services in small sea areas

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The Lithuanian sea space is an ecosystem services rich area, supporting human well-being and maritime activities in multiple ways. Small sea areas can be particularly threatened from anthropogenic activities due to their restricted sea space and limited ecological resources allocation. In this research we present a geospatial methodology for the analysis of biotic and abiotic marine ecosystem services richness in one of Europe's smallest sea areas, namely the Lithuania Sea located in the South Eastern Baltic Sea. The area is particularly subjected to anthropogenic activities, such as shipping, coastal and maritime tourism and offshore wind energy development that may exert multiple threats to ecosystem services. Results of the analysis were presented using existing marine zoning definitions in the study area, namely the Lithuanian coastal stripe, the Territorial Waters and the EEZ. Results show that the Lithuanian Mainland Coast is the richest area in supporting ecosystem services and cultural ecosystem services (tourism, landscape aesthetics and natural and cultural heritage). Threat exposure illustrate that cultural ecosystem services in proximity of Klaipėda Port can be particularly affected by marine litter accumulation phenomena, while transboundary effects of potential oil spills from D6-Platform (Kaliningrad Region) can affect valuable fish provisioning areas and coastal cultural values in the Curonian Spit. Results were discussed for the relevance



in MES assessment for marine planning in small sea areas and the methodological application potentials within this region of the Baltic Sea.

Keywords: Marine ecosystem services, anthropogenic threats, Marine Spatial Planning, Lithuania, Baltic Sea

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

T. Thematic Working Group sessions: T14c Ecosystem services and drivers of change

Multi-stressor effect analysis on ecosystem services in mountain areas

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Increasing anthropogenic stressors such as noise, light pollution, soil ceiling or invasive species can cause multiple impacts to ecosystems and the goods and services they provide. In order to address the potential effects on ecosystem services providing units we propose a geospatial framework for cumulative effects identification and analysis on terrestrial and freshwater ecosystem services. The framework proposes an impact chain analysis based on geospatial dataset of anthropogenic activities, stressor propagation and a set of terrestrial and freshwater ecosystem services, including habitat provision, recreation and forest protection. Results were presented for the Alpine space, a highly transboundary area including eight countries illustrating the cumulative effects, pressure intensity maps and ecosystem service rich areas. Results were discussed for their importance in protected areas in mountain landscapes and for the need of strategies for reducing to multi-stressor occurrences in transboundary ecological areas.

Keywords: anthropogenic stressors, Ecosystem Services, protected areas, impact chain, European Alps



5. *Type of submission: Abstract*

T. Thematic Working Group sessions: T14c Ecosystem services and drivers of change

High-resolution river catchment simulation to protect and promote ecosystem services: the ALICE project

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The ALICE Project contributes to the implementation of Blue and Green Infrastructures (BGINs) as a measure to mitigate impacts resultant from climate and land use/cover change, at regional and local level, and to improve ecosystem services. An overview of this study focusing on water hydrology is presented herein. New very high resolution gridded datasets (~1 km) of daily minimum, maximum and mean air temperatures and of daily precipitation over Portugal were used as meteorological input in a hydrological model. The grid has a regular 0.01° horizontal resolution and spans the period 1950–2015. The Hydrological Simulation Program FORTRAN (HSPF) model was used to assess daily flowrates in the Paiva River catchment. The HSPF is an integrated part of the environmental analysis system: Better Assessment Science Integrating Point and Non-point Sources (BASINS), which is designed to perform water quantity and quality based studies. The verification of the model performance was undertaken by three statistical metrics: Deviation Runoff (Dv), Nash–Sutcliffe efficiency coefficient (E) and the Coefficient of Determination (R²). The results clearly hint at a satisfactory model performance. Daily hydrographs for the entire period were analysed, showing acceptable agreements between observed and simulated flowrates at all hydrometric stations, as confirmed by the daily values of the statistical criteria. The spatial-temporal changes of meteorological and hydrological variables and the linkage between surface runoff and precipitation/temperature over the Paiva River catchment were addressed for two RCP scenarios (4.5 and 8.5). Overall, the results suggest that, under the current climate change scenarios, in the future, the resources will be under strong pressure to meet water security in the region. Therefore, this study provides important information on where to prioritise the implementation of BGINs in the catchment and improve Ecosystem Services.



Keywords: Hydrological ecosystem services, Watershed prioritizing, Land use, Indicators of change

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

T. *Thematic Working Group sessions:* T14c Ecosystem services and drivers of change

Impacts of land–use changes on the perceived importance for cultural ecosystem services in rural Bulgaria

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Coupled social–ecological farming systems provide multiple cultural ecosystem services such as rural identity, belonging, connectedness to nature, and memories. Yet, the links cultural ecosystem services create between farmers and their environment are becoming increasingly loose due to accelerating land–use changes, including intensified agriculture, urbanization, and land abandonment. This study aims for a better understanding of the impacts of land–use changes on the perceived importance of cultural ecosystem services. Focusing on eleven rural communities in four regions in Bulgaria, the study is based on a workshop conducted with different stakeholder groups, followed by a survey conducted with farmers and local residents. Results show a strong social awareness of cultural ecosystem services and their accelerated loss, especially in the form of traditional agricultural practices and knowledge associated with farming activities. The losses can primarily be attributed to increased land abandonment, urbanization processes, and natural resource degradation or overuse. The investigation furthermore reveals a strong perceived importance of rural identity by local people when the most prominent land–use changes occur, such as mining activities and intensification processes. Thus, the perception of the cultural ecosystem services' importance appears to rise with the intensity of land–use changes, as people strongly value these services when they start to disappear. The study provides insights for more holistic land–use policies that consider the critical importance of cultural ecosystem services for rural livelihoods.



Keywords: Social-ecological farming system, Cultural ecosystem services, Land-use change, Value, Policy

7. *Type of submission: Abstract*

T. Thematic Working Group sessions: T14c Ecosystem services and drivers of change

Impacts of changes in climate, population and agricultural area on food provision – an example from northern Ghana

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Climate variability, population growth and agriculture belong to the main driving forces of land degradation. Especially in low-income countries, people are more directly dependent on natural resources and, consequently, changes in ecosystem service have fundamental impacts on livelihoods. In a study in northern Ghana, we assessed with an expert-based Bayesian Belief Network the likelihood of food provision under changes in climate, population and agricultural area. In addition, seasonality determines the demand and provision of food. Different measures against food insecurity were tested. For example, the model showed that under “business as usual” conditions there is a 75% probability that the food demand during the dry season can be covered by food produced during the previous rainy season. In contrast, there is only a 37% probability that food from crops will be sufficient in the following rainy season before the harvest because less is produced during the dry season. Among the measures for food security, improving income was most promising. The Bayesian Belief Network could potentially be used to forecast food shortage under specific climatic and anthropogenic parameters.

Keywords: Food security, probability, land use change, experts, Africa



8. *Type of submission: Abstract*

T. Thematic Working Group sessions: T14c Ecosystem services and drivers of change

Analysing the status and change of protection forest across Europe

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In many European countries there is an increasing awareness of the protective functions and environmental services provided by forests, and the importance of these services for sustainable forest management and human well-being. The ways in which forest ecosystems protect people and the environment are manifold: they offer protection against gravitative mass movements, preserve soil and water resources, and have a mitigating effect on the climate and extreme weather events (e.g. flooding). However, there still exist knowledge gaps on the actual protective effect of many forest areas, due to a missing transnational, harmonized assessment approach in research and management. In our study, we aim at bridging these gaps by proposing an ecosystem service based approach for assessing the protective function of forests across Europe using regional geospatial models and high-resolution topographic data. In a second step, the development of the ES was examined over a 30-year land use trajectory, covering a good part of the socio-ecological transformations such as recent climate and land use changes (e.g. farmland abandonment, forest line changes and urban sprawl). Results indicate a general increase of forests with a protective function over the last decades on a European level, while on a local and regional scale the spatial patterns of protective forest are much more diverse and dependent on differences in local land management strategies and spatial development. We conclude that a harmonized approach to assess protection forest as an ES is a necessary first step to strengthen a multifunctional forest management in the European Union, supporting the priority areas of the EU forest strategy by strengthening the knowledge of forests and fostering transnational management practices.

Keywords: protection forest, large-scale assessment, risk mitigation, land-use change



9. *Type of submission: Abstract*

T. Thematic Working Group sessions: T14c Ecosystem services and drivers of change

Ecosystem services provision in year 2020 and in 2120: a case study analysis in the Kvarken Archipelago

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Maritime spatial planning advances sustainable development and growth. Plans are made for decades further but what will the future look like in 100 years? The Gulf of Bothnia (GoB) in the Baltic Sea is an area of special interest because its underwater nature will be the most affected by climate change. Many species are already on the verge of their existence due to low salinities which will further decline due to climate change. Bladder wrack (*Fucus vesiculosus*) and blue mussel (*Mytilus edulis*) are vanishing keystone species providing regulating and maintenance ecosystem services (ES). Cultural services will also change e.g. due to loss of sea ice caused by warmer winters. To ensure sustainable maritime development a clearer vision of future ES needs to be assessed.

The case study area is situated in the Kvarken Archipelago, GoB. The area is defined by the WFD Water Body Typology, an accepted division of water bodies. We apply a recently developed methodological approach and tool called the Marine Ecosystem Services Assessment Tool (MESAT) to address changes in ES provision over time. MESAT includes 31 CICES ES and 54 indicators assess the services. We address changes in ES provision over time by defining two statuses (year 2020 vs. 2120), applying future climate scenarios for our case study area. By comparing the changes between the indicators, we get the changes in services provision.

The results of the upcoming assessment suggest which services will strengthen and which weaken in year 2120, but also if new services occur. The results indicate changes in the water body of the case study area and support decision makers in their work. If the tool is proven reliable the assessment will be applied for an area of 160 water bodies in the region. Results are made available for the public on a GIS-platform.



Keywords: Maritime Spatial Planning, Climate Change, Baltic Sea, Ecosystem Service, Future Scenario

10. Type of submission: **Abstract**

T. Thematic Working Group sessions: T14c Ecosystem services and drivers of change

Modelling hydrological ecosystem services for improved watershed management under climate change scenarios

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Climate change can increase the pressure on freshwater ecosystem and threaten the sustainable supply of ecosystem services. In this study, we examined the impacts of climate change on the provision of a hydrological ecosystem service, namely water supply, in the Alto Cávado river basin (NW Portugal) using SWAT (Soil and Water Assessment Tool). We further examined the sensitivity of the SWAT model to precipitation input data using local gauge-based and reanalysis data (E-OBS). SWAT was calibrated against 5 reservoir volumes and inflows, with a good agreement between simulated and observed values. Future climate projections were based on four realizations of the SMHI-RCA4 regional climate model driven by four global climate models under the scenarios RCP 4.5 and 8.5 for 2020–2050, compared to 1971–2000. Results revealed that an increase in temperature and a decrease in precipitation with marked uneven seasonal distribution will affect reservoir water volume and river discharge, with consequences for hydropower production and drinking water supply. We also demonstrate that model output is affected by precipitation input data, and that further uncertainty of climate projections may influence results in a transition climatic zone Atlantic-Mediterranean, as in the case of our study area. This study emphasizes the value of predictive models to facilitate decision-making in environmental management by anticipating the impact of climate change on hydrological ecosystem services, and underlines the need to account for uncertainty associated with the model input data.



Keywords: Hydrological ecosystem services; SWAT model; Climate change

11. Type of submission: Abstract

[T. Thematic Working Group sessions: T14c Ecosystem services and drivers of change](#)

Application of an operational framework for the integrated mapping and assessment of agroecosystems' condition and services at different spatial scales

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Agroecosystems play a significant role in the support of various human needs by supplying foremost different provisioning, but also cultural and regulating ecosystem services (ES). The purpose of this research is to analyse the condition of agroecosystems and their capacity to supply ES. It is presumed that an ecosystem in good condition ensures the long-term, high-quality and sustainable delivery of multiple ES. However, changes in ecosystem condition caused by drivers and pressures such as climate change, land use change, pollution and biodiversity loss can impair the ability of ecosystems to deliver these services in sufficient quantity and quality. In order to identify the relationships between ecosystem condition and service supply, we apply the operational framework for integrated mapping and assessment of ecosystems and their services proposed by Burkhard et al (2018). In addition, we test a series of indicators proposed by the working group on Mapping and Assessment of Ecosystems and their Services (MAES) from the European Union (EU), for the assessment of ecosystem condition.

The study applies the operational framework for integrated mapping and assessment of agroecosystems at different spatial scales (EU and Northern Germany), with a focus on the regulating ES control of erosion rates. For this purpose, we follow a step-wise approach, including: the identification of the policy objective “healthy soils” as a theme to be assessed; the identification and mapping of agroecosystems; the selection, quantification and mapping of indicators of agroecosystem condition and the ecosystem service control of erosion rates;



the integration of results to identify interactions between condition and ecosystem services supply; and the identification of pressures and management practices that affect the condition of agroecosystems and the regulation of soil erosion rates. This study also identifies some gaps specifically related to the application of the framework and the indicators at different spatial scales.

Keywords: ecosystem condition, integrated assessment, ecosystem services, control of erosion rates

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

T. [Thematic Working Group sessions: T14c Ecosystem services and drivers of change](#)

Sustainability assessment of agricultural water use in the Danube Basin: First steps towards a global monitoring tool

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Managing the allocation of freshwater resources for human uses and the environment is a major challenge. In particular, high water withdrawals for agriculture can impair water-related ecosystems and their services. Knowledge about water use and its sustainability is therefore crucial to support decision-making in the area of conflict between nature conservation and food provision.

The transdisciplinary research project Virtual Water Values (ViWA) aims to address these challenges in developing a global, remote sensing based management and monitoring system for the efficiency and sustainability of water use in competing sectors. Part of this project is the sustainability evaluation of agricultural water use.

The water related 'Sustainable Development Goals' (SDGs) of the United Nations serve as the main reference for the developed method, focusing on agricultural water use and its' impacts on ecosystems. It is mainly based on existing concepts like the water footprint with the focus on distinct criteria for adaptation purposes. A spatially explicit biodiversity component is



added to enhance understanding of expected impacts on water dependent habitats and river flows given the observed agricultural practices. The evaluation criteria are classified according to their degree of legitimacy on global level. This allows building a tiered approach that can be adapted to evaluate different levels of sustainability. Using data that is provided by project partners, amended with globally available data, a first application in the Danube basin allows identification of potentially affected habitats, hot spots of unsustainable water use, and cold spots of sustainable water use. Assessment results can give insights that help in prioritizing the protection of areas sensitive to changes in the water regime and incentives for change of water use in areas where unsustainable water uses have been identified.

Keywords: SDGs, fresh water dependent ecosystems, remote sensing, monitoring, decision support

*13. Type of submission: **Abstract***

[T. Thematic Working Group sessions: T14c Ecosystem services and drivers of change](#)

Modelling global coproduction of agricultural crops to distinguish anthropogenic and natural effects on yields

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Food production is a crucial ecosystem service which results from coproduction, i.e. a combination of natural and anthropogenic contributions that together lead to an output. Coproduction of ecosystem services is so far little understood. Production of agricultural crops depends on ecological processes leading to soil fertility and on anthropogenic factors such as the application of fertilizers or the use of machinery. The aim of this study is to model yield with a set of explanatory variables to test the effect of different anthropogenic coproduction factors (fertilizer, capital stock in agriculture, i.e. machinery, market influence) and natural coproduction factors (agricultural suitability including soil fertility, topography and climate).

We collected global data for a selected group of 15 major crops for four time steps over the period 2000–2014. The selected crops comprise barley, cassava, groundnut, maize, millet, oil



palm, potato, rapeseed/canola, rice, rye, sorghum, soybean, sugarcane, sunflower, and wheat. We used model selection and averaging for multiple linear regression models predicting yield as a function of different anthropogenic and natural coproduction factors and included interaction effects of different factors in the model. We find that – as expected – fertilizer application, capital stock in agriculture and agricultural suitability have a positive effect on crop yield globally. Results indicate that the relative strength of natural agricultural suitability decreases over time. Interaction effects show that both higher application of fertilizer per hectare and a higher amount of capital stock per hectare decrease the positive effect of natural agricultural suitability on yield, which potentially indicates substitution effects among coproduction factors.

Keywords: Coproduction, multiple linear regression model, food production, yield

14. Type of submission: Abstract

[T. Thematic Working Group sessions: T14c Ecosystem services and drivers of change](#)

The impact of geothermal development on ecosystem service supply in Mount Patuha, West Java–Indonesia

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The increasing need for renewable energy is driving the development of geothermal facilities in West Java, which holds the largest geothermal energy potential in Indonesia. In geothermal energy power plants, energy is generated using Earth heat. In West Java, these are located in volcanic mountainous areas and with many protected areas. Here, the development of geothermal infrastructures can impact forest conservation objectives and ecosystem service supply to people. This study aims to quantify the relation between geothermal development activities and changes in ecosystem services supply from 1990 through 2018 in Mount Patuha, West Java Indonesia. For this period we map each geothermal development activity, including road development, well drilling, pipe installation, and the construction of a power plant. The ecosystem services examined in this study are wood provision, water provision, food



provision, carbon sequestration, landslide protection, and geothermal tourism (crater lakes and hot springs). We use Landsat satellite imageries to map land use/land cover change as an indicator of ecosystem services supply change. Field surveys and social media photo posts are used to validate the ecosystem service mapping process. Next, we examine the statistical relations between ecosystem services supply and geothermal development activities. Road access is one of the main drivers of ecosystem service supply change. This study shows that nexus approaches, which integrate management and governance across sectors and scales, is also key for renewable energy development.

Keywords: Geothermal development, Land use/land cover change, remote sensing, impact assessment

15. Type of submission: **Abstract**

T. Thematic Working Group sessions: T14c Ecosystem services and drivers of change

Sustainable Consumption (SC) for Biodiversity and Ecosystem Services (ESS)

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According to the IPBES Global Assessment, consumption is a prominent Indirect Driver of biodiversity loss. Patterns of consumption comprise both the level of consumption and its composition. Economic affluence is a dominant influencing factor, with more affluence correlated to higher impacts. Inequality of income, wealth distribution, and access to public goods tends to enhance the consumption levels of the upper strata and thus the impacts on nature and nature's contributions to people.

In biodiversity research four important indirect pressures have been identified leading to biodiversity loss:

- Land use changes,
- Biological pollution (invasive species, GMOs);
- Climate Change (importance increasing);
- Pollution (chemicals etc.)



SC Responses to land use changes might include, a.o., buying at farmers' markets, reducing human appropriation of NPP by buying organic, consuming only labelled seafood, eating meat only from free ranging animals, buying or renting no single house, or using as biofuel only certified wood. Regarding biological pollution, SC responses might include, a.o., not buying tropical timber for one's house, not using exotic non-food animals for aquaculture, aquarium and fishing bait, not having exotic pets and ornamental plants, minimising food miles, including for tropical plants and animals, and boycotting GMOs for food, feed and fibres. SC Responses to Chemical pollution can also be addressed by SC; steps might include, a.o., buying reused electronic devices, stop using disinfectants in-house, boycotting nanoparticle containing cosmetics etc., not throw household chemicals, in particular medicine, into the sink, toilet or other outlets ending in the waste water and later in streams and rivers.

These examples illustrate that many, but by far not all of the direct and primary indirect drivers can be (and even less are) addressed by SC. Others refer to the institutional setting and policy priorities in different policy domains making them a citizen, not a consumer issue.

Keywords: Consumption patterns, consumption levels, biodiversity, ecosystem services, institutions

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Watershed prioritizing for hydrological ecosystem services in the context of conservation management

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Identifying and valuing ecosystem services have an important role in the process of developing management strategies. However, valuing hydrological ecosystem services (HES) can be changed regionally depending on attributes of watersheds. In addition to this, watersheds as the complex units should be evaluated due to economic (ecn), ecological (ecl) and socio-



economic (s-ecn) indicators in terms of determining the drivers of change on services. In other words, assessing the consequences of these indicators on land use, soil and hydrological properties can be related with the changes of ecosystem services in a watershed. In this perspective, defining the interactions between drivers and ecosystem services becomes more crucial in the concept of prioritizing watersheds through conservation management. So that, in this study it was aimed to prioritize a watershed for providing water quality regulation service with a high capacity due to main drivers in the watershed. Kağıthane watershed which is located on the European side of Istanbul was selected as the study site. Therefore, the values (ecn, ecl, s-ecn) of indicators and main drivers of change on ecosystem services were calculated by Analytic Hierarchy Process (AHP) method. On the other hand, 12 sub-watersheds of Kağıthane were used in a scoring method based on field data for identifying the providing capacity of HES. When the results of AHP method were analyzed, the order of indicator importance was ecological, socio-economic and economic respectively where the main driver of changes was land use in the context of providing services with a high capacity. Additionally, that was consistent with the results of scoring method which indicated that the providing capacity of HES depends on landuse of watershed. So, the results of both methods revealed that a watershed can has high capacity of providing ecosystem services according to ecological attributes but that can be effected adversely by the land use of watershed because of social perceptions and pressure.