BOOK OF ABSTRACTS

I. SESSION DESCRIPTION

ID: S1e

Operationalizing Ecosystem Services for agroecosystem One Health: data-driven insights, limits and interdisciplinary prospects

Hosts:

	Name	Organisation	E-mail
Host:	Dimitris Bormpoudakis	Beyond Centre of EO Research & Satellite Remote Sensing, National Observatory of Athens	dim.borb@noa.gr
Co-host(s):	Nikos Stathopoulos	Beyond Centre of EO Research & Satellite Remote Sensing, National Observatory of Athens	n.stathopoulos@noa.gr
	Dora Aifantopoulou	EDGE In Earth Observation Scien	dora@eo-edge.com

Abstract:

The sustainability of agroecosystems is deeply implicated with One Health principles (Durso and Cook 2019; Mission Board for Soil Health and Food 2020). Ecosystem Services as an interdisciplinary, holistic framework, is uniquely positioned to help operationalize the nexus of soil, plant, animal, microbial, ecosystem and human health that comprises the One Health provocation. Taking this is a starting point, we seek to present and critically evaluate data-driven methodologies for data collection, integration, and analysis for using Ecosystem Services to operationalize One Health for agroecosystems. We are interested in papers on data collection (e.g. audio sensors, social media Big Data, Earth Observation, microbiomics), data integration (e.g. Linked Open Data, Federated Data, ontologies), and modelling and prediction (e.g. causal

inference, bioinformatics, spatial statistics, Machine/ Deep Learning) frameworks and methods that can serve as building blocks for monitoring, understanding and predicting One Health in agroecosystems. We would particularly welcome papers on:

- Data-driven One Health assessments of sustainable agricultural systems and practices (e.g. cover crops, integrated pest management, rotational diversity, regenerative agriculture) using Ecosystem Services
- How do we link the various aspects of One Health (soil, animal, plant, ecosystem, microbial, human) through Ecosystem Services
- Limits of the Ecosystem Services framework in relation to the One Health provocation
- New ontologies for linking the Ecosystem Services and One Health frameworks; can we integrate the relational aspects of Ecosystem Services - One Health ontologies?
- Data integration and modelling methods for cross-scale data in the context of One Health (e.g. molecular microbial diversity and Earth Observation data)
- Conceptual frameworks and theoretical papers on the limits of data-driven One Health perspectives (e.g. Big Data ethics, social studies of algorithms and modelling), especially considering the environmental justice aspects of One Health (Murray et al. 2022)
- Future prospects and challenges

References

Durso, L. M., & Cook, K. L. (2019). One health and antibiotic resistance in agroecosystems. EcoHealth, 16, 414-419.

Mission Board for Soil Health and Food (2020) Caring for soil is caring for life. https://www.novamont.com/public/modello-novamont/Mission%20Soil%20Health%20and%20Food%20-%20report%20EN.pdf

Murray, M. H., Buckley, J., Byers, K. A., Fake, K., Lehrer, E. W., Magle, S. B., ... & Schell, C. J. (2022). One health for all: advancing human and ecosystem health in cities by integrating an environmental justice lens. Annual Review of Ecology, Evolution, and Systematics, 53, 403-426.

Goals and objectives of the session:

In this session, through a careful combination of 7 invited and submitted presentation and a final summarizing plenary presentation, we aim to unify and integrate the Ecosystem Services and One Health perspectives for agroecosystems in a single operational framework. Emphasis will be placed on the operational aspects of this integration, and the data collection, integration, and analysis methods that will be required for monitoring, understanding, and predicting One Health

outcomes in real agroecosystems. The interdisciplinary aspects of One Health will be highlighted, and critically explored through a combination of empirical and theoretical presentations.

Planned output / Deliverables:

Depending on the quality, quantity and coherence of the invited and submitted papers, we have a two-fold aim for planned outputs:

- At a minimum, we envisage a perspective paper co-authored by session organizers and participants that reviews the literature and presents the case for linking Ecosystem Services, One Health, and Environmental Justice perspectives for operational, data-driven agroecosystem management.
- If the presentations are of high quality and coherence, and the participants agree, we would organize a SI for a suitable venue that would include the paper outlined above, but with key empirical / theoretical studies backing it up.

Session format:

The proposed format is a quasi-typical conference presentation panel. As mentioned above, we envisage 7+1 presentations, with roughly 15 minutes allocated to each.

II. SESSION PROGRAM

Room: Expert Street 5

Date of session: 21st of November 2024
Time of session: 11:00 – 12:30

Timetable speakers

Time	First name	Surname	Organization	Title of presentation
11:00 11:5	Dimitrios	Bormpoudakis	National Observatory of Athens	Advancing agroecosystem resilience holistically: advancing a critical framework that links One Health, data-driven ecosystem science, and multispecies justice
11:10 11:20	Simone	Martino	The James Hutton Institute	The use of wellbeing and natural capital indicators as a foundational step towards a “One Health” approach in farming
11:25 11:35	Dimitrios	Sainidis	National Observatory of Athens	From trapping mosquitos to ecosystem disservices estimation: High-resolution, AI-based mapping of mosquito-related

Time	First name	Surname	Organization	Title of presentation
				epidemiological and entomological risk in agroecosystems and rural ecosystems
11:40 11:50	Jonathan	Madeira Rocha	Federal University of Rio Grande do Sul	Multispecies health and digital agribusiness in the southern Brazil landscapes
12:55 12:05	Dora	Aifantopoulou	EDGE in Earth Observation Sciences	Mapping agroclimatic extremes and their impact on ecosystem services across the Mediterranean using climate reanalysis, climate projection and Earth Observation data
12:10 12:20	Helle	Hestbjerg	Danish Technological Institute	The impact of soil management and climate stressors on soil biodiversity and multifunctionality

III.ABSTRACTS

The first author is the presenting author unless indicated otherwise.

1. Mapping agroclimatic extremes and their impact on ecosystem services across the Mediterranean using climate reanalysis, climate projection and Earth Observation data

First authors(s): Dora Aifantopoulou
Other author(s): Alexia Tsouni, Dimitrios Bormpoudakis
Affiliation: EDGE in Earth Observation Sciences
Contact: dim.borb@noa.gr

In the face of climate change, resilient agroecosystems are crucial for sustaining multiple ecosystem services, including among others productivity, soil moisture, soil carbon content, crop health, and human health. Our research focuses on understanding the relationship between climate extremes and these services within the One Health framework. Utilizing ERA-5 land reanalysis and regional EURO-CORDEX climate projections, we map past and future climate extremes across the Mediterranean region. We leverage Earth Observation (EO) indices as proxies for ecosystem services data. We model the relationship between climate extremes and

ecosystem services using a multifunctionality index derived from EO indices and historical ERA-5 land reanalysis data. This multifunctionality index is then projected under future climate scenarios using EURO-CORDEX projections. Our study encompasses a broad Mediterranean approach and includes five regional/local case studies: southern France and Italy, eastern Spain, and northern Algeria and Egypt. These case studies allow us to investigate the spatial variability in the impact of climate extremes on ecosystem multifunctionality at both regional and local scales. Our approach is designed to be inclusive, utilizing only open/free data and software, thereby ensuring accessibility for lower-income countries. The findings reveal that climate extremes significantly reduce the resilience and capacity of ecosystems to provide multiple services. However, the impact of these extremes is not uniform; it varies spatially even within sub-national contexts. This highlights the necessity for integrated, locally meaningful management strategies that enhance ecosystem resilience and adaptability to climate variability.

Keywords: Resilient agroecosystems, climate projections, multifunctionality, One Health

2. The impact of soil management and climate stressors on soil biodiversity and multifunctionality

First authors(s): Helle Hestbjerg
Other author(s): Markus Gorfer, Salva Lladó, Crisina Yacoub, Martin Hartmann, Tania Galindo, Santiago Soliveres
Affiliation: Danish Technological Institute
Contact: helh@teknologisk.dk

Plant production systems constitute the foundation for a wide range of ecosystems services (ES) related to economic, social and environmental wellbeing. Soil biodiversity provides multiple ES and is crucial for supporting plant production in the agro-ecosystem.

The SOILGUARD project aims at boosting the sustainable use of soil biodiversity for ES. The project focuses on the influence of agricultural management practices and climate stressors as two main drivers of land degradation and thereby loss of soil health and biodiversity. To investigate the impact, multiple activities have been carried out within SOILGUARD. A cross-biome network of 234 sites in 10 countries has been established and soil samples herefrom have been analyzed for a range of physical, chemical, bio-chemical and biological parameters, the latter ranging from microscopy to PFLA, enzymes and eDNA. The included biomes are

arable fields, grasslands and forests, managed conventionally or with an alternative practice. Sites span three soil degradation levels.

Another activity simulated drought periods and heatwaves at 14 sites in seven European countries using open shelters and heaters. Soil as well as rhizosphere samples were analyzed.

The total data sets comprise more than 80 parameters. The large amounts of data are analyzed with the aim of describing community compositions and revealing connections and patterns between different groups of organisms, e.g. bacteria, fungi, archaea, nematodes, and collembola in relation to management practice and land degradation. This data-driven approach leverages advanced analytical methods, to provide insights into the complex interactions within soil ecosystems.

The outline of the SOILGUARD project and selected results will be presented. Emphasis will be on results from the drought experiment in Denmark in 2022 and the impact on the rhizosphere.

These results will be viewed in a holistic context, connecting soil biodiversity to the health and wellbeing of nature and humanity.

Keywords: Soil biodiversity, soil degradation, biogeographical regions, soil food web, soil management

3. The use of wellbeing and natural capital indicators as a foundational step towards a “One Health” approach in farming

First authors(s): Simone Martino
Other author(s): Rachel, Nichols; Niamh, McHugh; Ellie, Ness; Jayna, Connelly, Claudio, Petucco, Clare, Buckerfield, Alastair, Simmons, Trinity, Ndlovu; Graham, Begg
Affiliation: The James Hutton Institute
Contact: simone.martino@hutton.ac.uk

This research, carried out as part of the H2020 FRAMEwork project, shows how to combine social, economic, and environmental indicators to assess the health and wellbeing of a farming system at the landscape scale through Farmer Clusters i.e. groups of neighbouring farmers working together to deliver landscape-scale environmental benefits. The environmental

indicators were selected, guided by our internally produced Natural Asset Profiling approach (NAP), to assess the impacts and dependencies of farming on natural capital. The NAP was formulated by merging considerations from the Natural Capital Accounting for business (Natural Capital Protocol) and the System of Environmental Accounting–Ecosystem Accounts framework (SEEA–EEA).

In this study we carry out the health analysis of the Cranborne Chase (UK) Farmer Cluster using indicators referring to natural, social, and human domains (or capitals). Dependencies and impacts of different enterprises (arable, livestock, etc.) on natural capital are proposed and compared against a benchmark to understand what aspects of the farming system could be improved to increase farming sustainability. Using linear correlations and analysis of variance we identified key variables related to Farmer Clusters management that drive positive changes in biodiversity and other aspects of their natural capital.

The NAP can be considered a foundational step towards the formulation of the One Health approach that can be reached by including indicators referring to soil and animal health. We will show how to expand the framework to provide evidence of these indicators by collecting and analysing qualitative and quantitative proxies. These proxies do not require specialized skills but utilize local knowledge of the farming context, making them accessible and practical for broader application.

Keywords: biodiversity, natural capital, farmer cluster, accounting, One-Health

4. Multispecies health and digital agribusiness in the southern Brazil landscapes

First authors(s): Jonathan Madeira Rocha
Affiliation: Federal University of Rio Grande do Sul
Contact: jonathanderocha@gmail.com

The Pampa biome is more than a geographic shared space between Argentina, Brazil and Uruguay. It's also a cultural area (Leal, 1997; 2021). The Pampa has always been related to a specific relation between man (the gaúchos), animals (cattle and horse) and landscape. Fostering a local imaginary that remains nowadays, it highlights a certain multispecies Pampa. However, since the 2000's, the advancement of soybeans in these areas has been increasingly modifying it. It's attributed to the economic advantages of this activity in relation to other temporary crops and extensive livestock farming (Painel do Agronegócio do RS, 2022). This

article discusses how agribusiness initiatives, specially based on new technologies, are shaping the landscape and local cultures in southern Brazil areas. Known for its rich green plains, where cattle, men and horses coliving, the Pampa is increasingly being occupied by large enterprises linked to the cultivation of genetically modified soy (Leguizamon, 2022). Despite all the proven environmental damage, agribusiness is largely accepted in this region and described as a necessary activity for the Brazilian economy and food system. In the first part of this article, we highlighted how a new imaginary about agribusiness has been promoted since the 1990s, specially through agricultural trade fairs, and how this has intensified due to the recent entry of new technologies. We argue that digitalizing agriculture promotes the idea of sustainability as it introduces digital devices and cloud computation to managing and controlling agriculture activities. Then, as a part of an ongoing research that took place on agricultural trade fairs and farms in the Pampa region, we discuss, through an ethnographic approach, how agribusiness leaders, farmers and local population experiences this transformation. We expect to collaborate with the discussions on how technological innovations on agrosystems affect multispecies lives in local contexts.

Keywords: Multispecies health; Pampa biome; Sustainability; ethnography; agribusiness

5. From trapping mosquitos to ecosystem disservices estimation: High-resolution, AI-based mapping of mosquito-related epidemiological and entomological risk in agroecosystems and rural ecosystems

First authors(s): Dimitrios Sainidis

Other author(s): Argyro Tsantalidou, Konstantinos Tsaprailis, Nikolaos Stathopoulos, Charalampos Kontoes

Affiliation: National Observatory of Athens

Contact: dimitris.sainidis@gmail.com

Mosquitos carry and transmit Mosquito-Borne Diseases (MBDs), a key ecosystem disservice, affecting approximately 700 million people and are responsible for around a million deaths annually worldwide. Without vaccines or treatments, the best countermeasures against MBDs are accurate mosquito population and epidemiological risk maps serving as Early Warning Systems for health and other related authorities. Furthermore, mosquitoes impact One Health by transmitting diseases to animals and humans, influencing ecosystem health through their role in the food web, and being affected by agricultural practices like irrigation and pesticide use. Climate change and socioeconomic factors also play a role in ecosystem change and thus mosquito prevalence and disease outbreaks. Furthermore, land and soil degradation often leads

to increased mosquito breeding sites (e.g., through the formation of stagnant water bodies, changes in water quality, or altered vegetation cover). Effective surveillance and integrated control measures are essential for maintaining the health of humans, animals, and the environment in these systems. However, the distribution of vector-borne diseases is influenced by complex environmental features, such as soil moisture, vegetation type, ground morphology, weather conditions, etc., alongside demographic and social factors such as global travel or trade, making them hard to predict with absolute certainty. In this work, dynamic big Earth Observation data are fused with in-situ mosquito abundance, infected human population, and site-specific morphological and ecosystem features to train a neural network and produce monthly mosquito population 2x2 km gridded maps in several rural areas in Greece. The output of the mosquito abundance model is subsequently used, in combination with the previous data and demographic data, to produce a disease susceptibility map for MBDs in the same 2x2 km grid. We discuss the potential of this type of model in advancing One Health perspectives in agroecosystems toward effective operationalization by policymakers and practitioners.

Keywords: Vector-borne diseases, mosquito abundance, artificial intelligence, agroecosystems, ecosystem disservices

6. Advancing agroecosystem resilience holistically: advancing a critical framework that links One Health, data-driven ecosystem science, and multispecies justice

First authors(s): Dimitrios Bormpoudakis
Other author(s): Nikos Stathopoulos, Charalampos Kontoes
Affiliation: National Observatory of Athens
Contact: dim.borb@noa.gr

In the context of climate change and its profound impacts on agriculture, advancing agroecosystem resilience holistically is crucial. This paper presents a framework that operationalizes the nexus of soil, plant, animal, microbial, ecosystem, and human health within the One Health paradigm, drawing critically from the interdisciplinary scholarship on Ecosystem Services, nature's contributions to people and multispecies justice. We present a practical framework that systematically integrates various methodologies and perspectives and focuses on agroecosystems. By integrating One Health we ensure that One Health components are considered and managed synergistically, leading to more sustainable and effective health outcomes. Data-driven ecosystem services science exploits advances in Earth Observation, data handling and fusion technologies, and causal inference to ensure that decisions are based on

robust, transparent empirical evidence. Diverging from past approaches, our framework also centres multispecies justice, i.e., an ethical dimension of agroecosystem management, ensuring that the interests and well-being of all species within the ecosystem are considered. We explore the implications of this framework in the Mediterranean, and consider how the framework can advance how we monitor, assess, implement, and live-with sustainable agricultural practices. By focusing on the Mediterranean, we acknowledge the unique environmental, cultural, and socio-economic conditions of the region, thereby the framework becomes more relevant and effective, addressing the particular challenges and opportunities of Mediterranean agroecosystems.

Keywords: Holistic management, political ecology, multispecies, environmental justice, agroecology