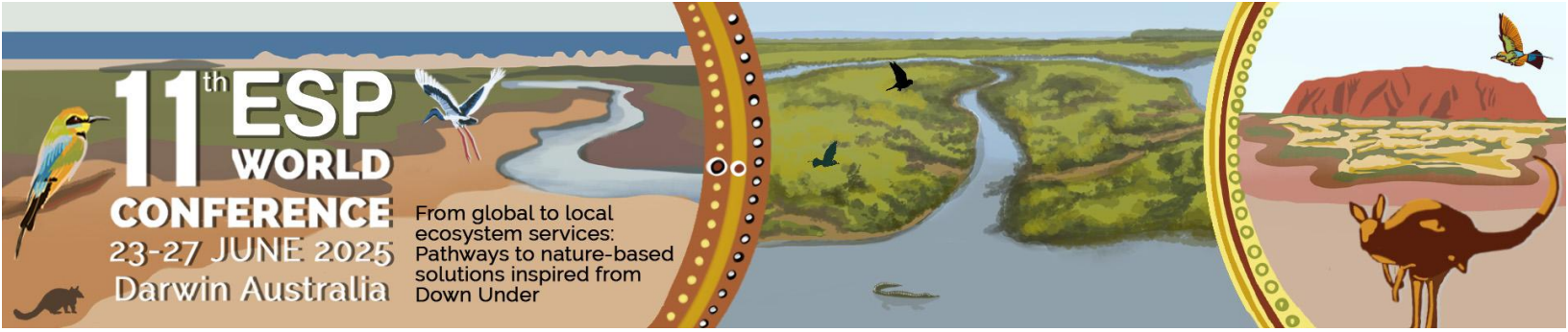

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I. SESSION DESCRIPTION

ID: O5

Ecosystem Services and NbS – From Local Wisdom towards Global Sustainability through Artificial Intelligence and Machine Learning

	Name	Organisation	E-mail
Host:	Jan Haas	Karlstad university	jan.haas@kau.se
Co-host(s):	Vince van 't Hoff	Ecosystem Services Valuation Database (ESVD)	vince.vanthoff@fsd.nl
	Mieke Siebers	Ecosystem Services Valuation Database (ESVD)	mieke.siebers@fsd.nl
	Pedro da Costa Brito Cabral	Nanjing University of Information Science & Technology (NUIST)	100123@nuist.edu.cn

Abstract:

Artificial Intelligence (AI) is revolutionizing how we understand, monitor, and manage ecosystems, offering innovative pathways to integrate Indigenous and local community knowledge with advanced analytical methods. By bridging ecosystem services science on a local and global scale and cutting-edge technologies such as deep learning, GeoAI and Large Language Models (LLMs), this session explores how AI can enhance our understanding of ecosystem services, their underlying functions and Nature-based Solutions (NbS) to shape inclusive pathways towards a more sustainable Earth.

This session emphasizes the synergy between AI innovations and value systems across various spatial scales in designing equitable NbS. By incorporating diverse knowledge systems, AI can support the assessment of ecosystem service distribution, quality, supply, demand, flow and design of NbS while respecting local cultural and ecological nuances. The session aims at showcasing how AI applications within the fields of remote sensing, (big) geodata processing and natural language processing, enable better mapping, monitoring, and decision-

making while addressing local and global challenges related to biodiversity conservation, climate adaptation, and achieving Sustainable Development Goals (SDGs).

Key topics include:

- Successful models of AI-powered NbS from local to global scales, emphasizing adaptability and scalability.
- Innovative methods to integrate AI into ecosystem assessments to promote nature-positive outcomes, harmonizing "people's obligations to nature" with "nature's contributions to people."
- Ethical considerations and strategies for ensuring AI tools amplify, rather than overshadow, Indigenous and local perspectives in decision-making processes.
- Best practices for linking ecosystem services science with policymakers, practitioners, and multi-sector stakeholders.
- A future outlook which highlights and discusses the role of AI in the field of ES, NbS and plural valuation from a local to a global scale.

By fostering interdisciplinary collaboration and leveraging the potential of AI, this session aims at sharing our experiences and results at any spatial scale, inspire actionable insights that connect research to practice and local insights to global goals. Attendees will explore opportunities to co-develop innovative frameworks, bridging technology and traditional knowledge for a sustainable, equitable, and resilient future.

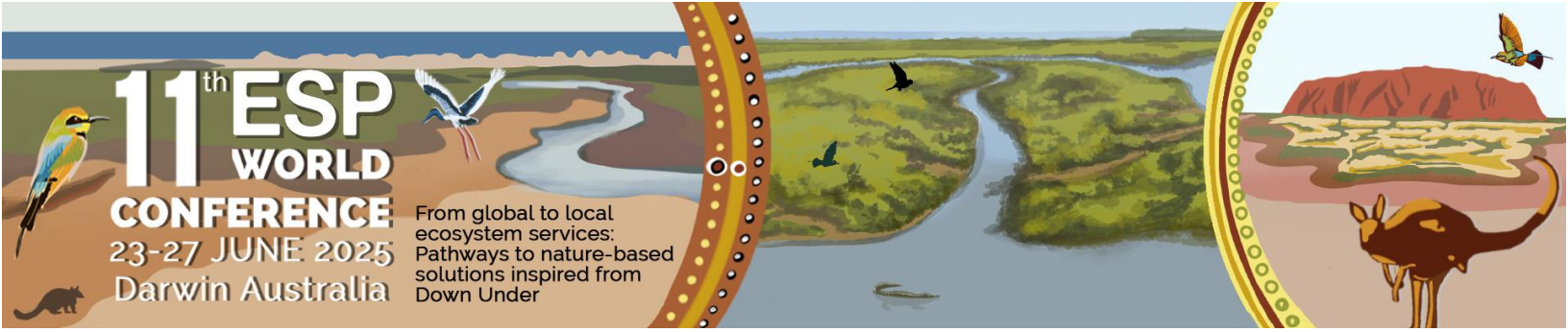
We cordially invite you to contribute to our session with an abstract related to a broad range of perspectives regarding the potential of AI for Ecosystem Services and NbS. Not limited to and including best practices and ethical, methodological, applicational considerations of AI in mapping and assessing ES.

Goals and objectives of the session:

Explore Recent Advancements: To showcase and discuss the latest advancements in AI technologies and methodologies relevant to ecosystem services and NbS research, including data extraction, analysis, and interpretation.

Promote Collaboration: To foster interdisciplinary collaboration and knowledge exchange among researchers, practitioners, policymakers, and other stakeholders interested in leveraging AI for ecosystem services and NbS assessments and management.

Share Best Practices: To identify and share best practices for integrating AI technologies into existing research methodologies and workflows.



Address Ethical Considerations: To raise awareness and facilitate discussions around ethical considerations, potential biases, and limitations associated with AI-driven approaches in ecosystem services and NbS research, and to explore strategies for mitigating risks and ensuring responsible use of AI technologies.

Inspire Innovation: To inspire innovation and creativity in the application of AI technologies to address pressing environmental challenges and promote sustainable management of ecosystems and their services.

Identify Opportunities: To identify opportunities for future research, collaboration, and capacity building in the intersection of AI and ecosystem services, with the aim of advancing scientific understanding, informing policy decisions, and enhancing conservation efforts.

Planned output / Deliverables:

Possibly a special issue/a paper based on discussions during the day.

Post-conference inception of AI-related Thematic Working Group.

II. SESSION PROGRAM

Room: Damibila 1

Date of session: 23 June, Monday

Time of session: 16:00 – 17:30

Timetable speakers:

Time	First name	Surname	Organization	Title of presentation
16:00 – 16:20	Robert	Costanza	Institute for Global Prosperity (IGP) at University College London (UCL)	Keynote
16:20 – 16:35	Xiaoqian	Liu	Beijing Union University	Urban Dust-Proof Nets Covering Extraction and its Indications to Urban Regeneration Spatial Pattern in Beijing based on Multi-source Data.
16:35 – 16:50	Andrea	Ghermandi	Natural Resources and Environmental Research Center, University of Haifa, Israel	Digital insights for nature park management: Integrating multiple social media platforms and AI analytics

Time	First name	Surname	Organization	Title of presentation
16:50 – 17:05	Zih-Hong	Lin	School of Biological Earth and Environmental Science, University of New South Wales	Evaluating the Efficiency of Nature-Based Solutions: A Data Envelopment Analysis – Machine Learning Approach
17:05 – 17:30	Vince	van't Hoff	Ecosystem Services Valuation Database (ESVD)	A Community Perspective on AI in ES Science and Practice

III. LIST OF ABSTRACTS

The first author is the presenting author unless indicated otherwise.

1. Urban Dust-Proof Nets Covering Extraction and its Indications to Urban Regeneration Spatial Pattern in Beijing based on Multi-source Data

First authors(s): Xiaoqian Liu

Other author(s): No

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Keywords: Urban renewal,Dust-proof nets (GRPC),Remote sensing,

Rapid urbanization has entered a fast regeneration stage, generating significant construction waste and dust pollution, particularly in expanding urban areas. Green plastic covering dust-proof nets (GRPC) are widely used in China to mitigate these environmental impacts. Their increasing deployment in redevelopment projects provides a valuable indicator for monitoring urban transformation.

Urban renewal, now a dominant form of urbanization, is highly fragmented and concealed within dispersed redevelopment projects. Conventional spatial identification methods—such as monitoring impervious surfaces and land use types—are often inadequate. High-resolution

remote sensing offers a novel approach to tracking urban renewal. This study employs Earth observation techniques, including Landsat-8 OLI and Sentinel-2 MSI, to extract and monitor GRPC distribution in Beijing, assessing spatial patterns, driving factors, and temporal dynamics of new construction. However, GRPC-covered areas lack fixed geometries, making field surveys inefficient for large-scale assessments. To address this, advanced remote sensing techniques, such as deep learning models, have been applied for accurate identification.

GRPC analysis provides a new method for delineating urban renewal zones, particularly in central urban areas where land redevelopment is fragmented. Research shows urban renewal types vary along the urban-rural gradient, from inner-city infill to peri-urban expansion and suburban leapfrog development. This study integrates machine learning with multi-source remote sensing to classify urban renewal patterns and assess renewal rates based on GRPC dynamics. The findings provide novel spatial indicators for urban planning and governance, supporting sustainable urban development. By leveraging innovative remote sensing techniques, this research enhances the understanding of urban renewal processes and offers critical data for managing urban expansion and ecological restoration.

2. Digital insights for nature park management: Integrating multiple social media platforms and AI analytics

First authors(s): Andrea Ghermandi

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Keywords: cultural ecosystem services, digital footprints, passive crowdsourcing, user-generated content, visitor experience

While social media data offer significant promise in delivering actionable insights to nature park managers, current research often lacks in analytical depth and relies on limited data sources,

raising concerns about representation biases. This study conducted a comprehensive analysis of user-generated content across 13 social media platforms, using Ramat Hanadiv nature park in Israel as a case study. We leveraged artificial intelligence (AI) tools, including OpenAI ChatGPT through Atlas.ti and Google Cloud Vision, to analyse both textual and visual content. The research examined platform-specific socio-demographic characteristics (visitor provenance, gender, language) and evaluated differences in content shared across platforms. For textual data, we investigated visitors' emotions based on Plutchik's wheel, while photograph analysis revealed visitors' interests according to socio-demographic variables. Results were cross-validated against on-site survey data to assess whether multi-platform integration reduced biases. Our findings revealed substantial variability across platforms, with textual content analysis offering closer alignment with survey responses than visual content alone. While data integration yielded more balanced demographic representation, combined content did not uniformly improve alignment with survey data. Throughout the research, we collaborated iteratively with park managers, who found demographic data and expressed emotions particularly valuable. Negative feedback, though less common, provided especially actionable insights. The park management team confirmed the significant potential of AI-enhanced social media analysis to support evidence-based decision-making. The combined approach demonstrates the potential of AI-driven social media analysis to provide valuable data for environmental management and conservation planning, emphasizing the importance of park manager input in refining and interpreting results, and of accounting for cross-platform differences in user demographics and content-sharing norms.

3. Evaluating the Efficiency of Nature-Based Solutions: A Data Envelopment Analysis - Machine Learning Approach

First authors(s): Zih-Hong Lin

Other author(s): Shawn Laffan, Graciela Metternicht

First author affiliation: University of New South Wales

Contact: zihhong.lin@unsw.edu.au

Keywords: Nature-Based Solutions, DEA-ML, Explainable AI, Non-stationary effect, Efficiency

Nature-based Solutions (NbS) play a critical role in enhancing urban resilience and mitigating climate change. Data Envelopment Analysis (DEA) is considered a suitable approach for evaluating NbS environmental efficiency; however, due to DEA's limitations, the evaluation results may be inconsistent when new NbS are assessed. To address this gap, this study presents an innovative framework that integrates DEA with machine learning (ML) to evaluate and predict the efficiency of NbS. This approach offers decision-makers a scalable and adaptable tool to enhance multiple ecosystem services in a cost-effective manner. This study uses potential NbS locations in the Taipei River Basin as a case study. Various tree-based boosting classification algorithms were tested to build the models, and XGBoost showed the best performance, achieving an ROC-AUC Score of 0.85. This indicates its strong capability to distinguish between efficient and inefficient NbS. We further applied explainable AI to interpret the DEA-ML model and understand the impact of inputs on efficiency at both universal and individual levels. The non-stationary effects between each input and efficiency were explored, and the possible thresholds to improve efficiency were identified accordingly. By bridging AI-driven modelling with ecosystem services science, this framework offers a replicable and transparent approach to NbS efficiency evaluation, contributing to multiple sustainable development goals. It assists decision-makers in evaluating the performance of future NbS, suggesting guidelines for improving efficiency and facilitating the creation of strategic plans aimed at effectively enhancing urban resilience.

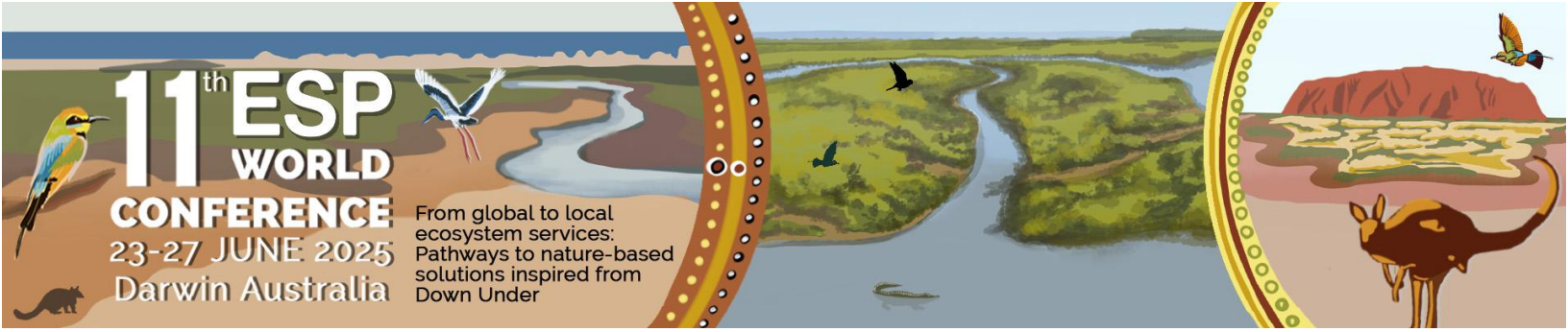
4. A Community Perspective on AI in ES Science and Practice

First author: Vince van 't Hoff

First author affiliation: Ecosystem Services Valuation Database (ESVD)

Contact: vince.vanthoff@fsd.nl

Keywords: Artificial Intelligence (AI), Ecosystem Service Science (ESS), AI-ESS integration



Artificial Intelligence (AI) has been adopted in many fields, including Ecosystem Service Science (ESS). This process is beneficial, but it also presents challenges that must be addressed to ensure the full preservation of the Ecosystem Services (ES) delivered to society. To address this necessary AI-ESS integration, we collected the opinions of ES practitioners and experts during the first AI workshop held at the 5th Ecosystem Services Partnership (ESP) Conference in Wageningen, the Netherlands, in November 2024. The results, calling for the effective integration of AI with ESS, were translated into an evolvable four-dimensional framework that identifies and discusses the main challenges, ethics, data and models, and opportunities to jointly advance AI and ESS disciplines in a synergetic way; AI4ESS. As future development, we propose the development of an AI-ESS working group within ESP focusing on guiding and progressing AI developments to advance the science and uptake of ES. This WG will be developed in line with the discourse within the ESS community with the possibility to leverage interdisciplinary and transdisciplinary collaboration. What are perspectives and comments of the ESP World participants on this white paper and the direction of AI & ES.