BOOK OF ABSTRACTS

This Book of Abstracts provides a comprehensive overview of the session content and is structured into three main sections:

I. Session Description – an introduction to each session, including its objectives and expected outputs
II. Session Program – a detailed schedule for each session, including speakers and timing
III. List of Abstracts – a complete compilation of all accepted abstracts

I. SESSION DESCRIPTION

ID: X8

Artificial Intelligence for Ecosystem Services: opportunities, challenges, and governance

Hosts:

	Name	Organisation	E-mail
Host (s):	Jan Haas	Karlstad University	jan.haas@kau.se
	Masahiro Ryo	Leibniz Centre for Agricultural Landscape Research (ZALF)	masahiro.ryo@zalf.de
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Abstract:

Artificial Intelligence (AI), including Generative AI (GenAI) and Large Language Models (LLMs), is rapidly transforming ecosystem services (ES) science and practice. By integrating and processing large, heterogeneous datasets - from citizen science and ecological monitoring to policy-relevant actions- AI offers unprecedented opportunities for mapping, modeling, monitoring, valuing, and communicating ecosystem services. These tools can support climate adaptation, nature-based solutions, restoration, and

resilience, while helping to capture synergies and trade-offs between human well-being and ecological integrity.

This session brings together researchers, practitioners, and policymakers to explore how AI can be responsibly embedded into ES science, governance, and decision-making. Contributions will highlight technical innovations, such as GeoAI for large-scale geospatial assessments, LLMs for knowledge synthesis, and GenAI for scenario narratives and linking local data to European and global frameworks, including the EU Nature Restoration Law and the Corporate Sustainability Reporting Directive. Applications across ecosystem accounting (SEEA-EA) for coastal, marine, and terrestrial systems, including ecosystem extent, condition, and services (physical and monetary), will be emphasized.

Equally important are the governance, ethical, and societal dimensions of AI in ES. The session will address transparency, inclusivity, equity, and justice, ensuring AI tools do not exacerbate biases or marginalize local and Indigenous knowledge. Contributions will also explore emerging regulatory frameworks such as the EU AI Act, and how standards and policies shape the uptake of AI in ES science and practice.

Building on discussions from the ESP Conferences in Wageningen (2024) and Darwin (2025) and the AI4ESS framework, this session will introduce the new ESP Thematic Working Group "Artificial Intelligence and Machine Learning for Ecosystem Services." This platform will provide continuity for the growing AI–ES community, enabling interdisciplinary collaboration and guiding the responsible integration of AI into ES research, governance, and policy.

By connecting methodological innovation, applied case studies, and critical reflections, this session aims to clarify where AI can responsibly add value to ES science and policy, where safeguards are needed, and how AI can advance a people-and nature-positive future.

Goals and objectives of the session:

This session aims to initiate a structured, critical dialogue on the integration of AI, including Generative AI (GenAI) and Machine Learning (ML), into ecosystem service (ES) research and practice. Its primary goals are to:

- Showcase innovative applications: Present recent AI/ML advances supporting ecosystem service mapping, monitoring, valuation, and decision-support.
- Promote interdisciplinary collaboration: Foster dialogue between researchers, policymakers, and practitioners at the intersection of AI and ES.
- Reflect on governance perspectives: Discuss how frameworks such as the EU AI Act may influence future applications, while maintaining focus on scientific and practical advances.
- Address ethics and inclusivity: Explore fairness, transparency, and integration of diverse knowledge systems, ensuring AI tools do not marginalize local or Indigenous knowledge.
- Introduce the ESP Thematic Working Group: Present the structure and aims of the new ESP platform on "AI and Machine Learning for Ecosystem Services," fostering long-term interdisciplinary collaboration.
- Assess opportunities and challenges: Identify where GenAI can enhance ES knowledge generation, integration, and communication, while critically examining methodological, ethical, and policy implications, including risks of bias, reproducibility issues, and legitimacy concerns.

Planned output / Deliverables:

- Showcasing and broadening the Thematic Working Group
- Identifying the direction and future paths of AI/ML related ES approaches

Session format:

- Oral presentations (15 minutes each) highlighting case studies, methods, and governance perspectives.

- Moderated panel discussion with speakers, focusing on opportunities and challenges for integrating AI into ecosystem services research and practice.
- Open Q&A and audience interaction to identify future directions and priorities.

Related to ESP Working Group:

Other – new ESP Thematic Working Group "Artificial Intelligence and Machine Learning for Ecosystem Services

I. SESSION DESCRIPTION

ID: T5b

Digital twin–ai integration for ecosystem services: bridge to a nature-positive future or threat to integrity?

Hosts:

	Name	Organisation	E-mail
Host (s):	Laura Costadone	Old Dominion University	lcostado@odu.edu

Abstract:

Nature-based solutions (NbS) are increasingly recognized as essential pathways toward a nature-positive future, offering integrated responses to climate change, biodiversity loss, and sustainable development. Their promise is widely acknowledged in international frameworks and global policy strategies. Yet persistent challenges remain: long-term performance data are scarce, monitoring practices are fragmented, and current evaluation approaches often fail to capture the complex socio-ecological interactions that determine NbS effectiveness. The difficulty of quantifying diverse ecological, social, and economic benefits—ranging from flood protection and urban heat mitigation to cultural and recreational values—continues to hinder mainstreaming, scaling, and investment.

Digital Twin technology, understood as virtual replicas of real-world systems continuously updated with real-time data, offers transformative opportunities to address these challenges. When combined with artificial intelligence (AI), Digital Twins can dynamically integrate field observations, remote sensing, and socio-economic datasets, enabling adaptive monitoring frameworks that quantify uncertainties, enhance transparency, and improve ecosystem service performance assessment. This AI-driven approach also provides novel opportunities to embed intrinsic, relational, and instrumental values of nature's contributions to people into NbS evaluation. By synthesizing ecological metrics, economic indicators, and community narratives, these tools can reflect the multiple ways societies benefit from and connect with ecosystems.

This interactive session will highlight advances in interdisciplinary and transdisciplinary research at the intersection of ecosystem service science, digital technologies, and policy. Discussions will focus on how AI-enhanced Digital Twins can improve the assessment of NbS by capturing the full spectrum of ecosystem service values, the role they can play in strengthening policy evaluation, resilience planning, and investment frameworks, and the ethical, social, and governance safeguards required to ensure their transparent, equitable, and accountable use. The session aims to advance dialogue on how digital innovations can accelerate the mainstreaming of NbS, bridge the gap between science and practice, and ultimately contribute to a people- and nature-positive future, while carefully addressing the potential ethical trade-offs involved.

Goals and objectives of the session:

This session aims to critically examine the potential benefits, trade-offs, and challenges of integrating AI-driven tools to advance transdisciplinary ecosystem services and values research in support of sustainable decision-making. In particular, the session will explore how AI-enhanced Digital Twins can

serve as dynamic tools for ecosystem service monitoring and assessment, while showcasing innovative applications that integrate ecological, environmental, and socio-economic data. A central focus will be on how these technologies can embed intrinsic, relational, and instrumental values into decision-making frameworks, address ethical and governance implications of data-driven approaches, and foster collaboration to develop knowledge tools that strengthen sustainable decision-making and resilience planning.

Planned output / Deliverables:

Synthesis Brief / Summary Note

- A concise (2–3 page) written summary capturing the key insights, opportunities, and challenges identified during the session.
- The note will be shared with session participants, uploaded to the ESP conference website, and circulated through relevant working groups to extend reach and impact.
- Collaborative Network / Interest Group
- Formation of a small network or mailing list connecting participants interested in advancing AI-enhanced Digital Twins for ecosystem services and NbS.
- This network could serve as the foundation for future collaborations, joint proposals, or the establishment of a dedicated ESP working group.
- Blog Post
- Development of a short, accessible blog post summarizing the discussion highlights and emerging priorities.
- All session participants will be invited to contribute as co-authors, ensuring diverse perspectives and co-ownership of the output.

Session format:

To foster an engaging and participatory exchange, this 90-minute session will adopt a World Café format. It will begin with a short framing presentations (approximately 5 minutes) highlighting methodological advances, applied case studies, and innovative applications that demonstrate how Digital Twins and AI are being used—or could be used—to monitor, model, and evaluate ecosystem services, as well as to inform restoration projects and resilience planning.

Following this introduction, participants will rotate through a series of small-group discussions at themed tables. Each table will be guided by a central question, such as: What opportunities and barriers exist for integrating AI-enhanced Digital Twins into ecosystem service assessments? How can diverse values—intrinsic, relational, and instrumental—be incorporated into these tools to inform sustainable decision-making? What ethical, governance, and social considerations must be addressed to ensure transparency, accountability, and equity?

The session will conclude with a plenary “harvesting” exchange, synthesizing insights from all groups, identifying areas for collaboration, and charting pathways for scaling up AI-enhanced tools in practice. The expected outcome is a shared understanding of both the opportunities and trade-offs of these technologies: whether they represent a bridge toward a people- and nature-positive future or risk undermining ecological integrity and governance accountability. By generating actionable insights and fostering interdisciplinary collaboration, the session will contribute to the development of replicable, evidence-based tools that strengthen NbS design, monitoring, and policy relevance across scales.

Related to ESP Working Group:

TWG 5 – Modeling ES

II. SESSION PROGRAM

Room: C1
Date of session: Thursday 21, May 2026
Time of session: 09:00 – 10:30

Timetable speakers:

Time	First name	Surname	Organization	Title of presentation
9:00-9:06	Laura & Jan & Masahiro	Costadone & Haas & Ryo	Old Dominion University; Karlstad University; Leibniz Centre for Agricultural Landscape Research	Introduction
9:06- 9:18	Diego	Gallardo Diaz	Eindhoven University of Technology	AIRES: An Explainable AI Expert System for Evidence-Based Nature-Based Solutions Planning
9:18 – 09:30	Marko	Lovric	Wageningen University and Research	Forest ecosystem services in Europe: bringing together demand and supply side perspectives
9:30-9:42	Arturas	Razinkovas-Baziukas	Marine Research Institute, Klaipeda University	Machine Learning from Stakeholder Knowledge: AI-Enhanced Social-Ecological Systems Modelling for Marine Ecosystem Services
9:42-9:54	Zineb	Eddamghi	Deloitte	Artificial intelligence and data-driven tools for inclusive ecosystem services and nature-based solutions
9:54– 10:06	Jing	Lu	Department of Forestry and Environmental Management, Universidad Politécnica de Madrid (UPM)	Using NLP to bridge ecosystem service knowledge divides between urban ecology and planning
10:06-10:18	Tolulope	Ayantayo	University of Ibadan	Artificial Intelligence for Ecosystem Services: Opportunities, Challenges, and Governance
10:18-10:30	Ferdinando	Villa	Basque Centre for Climate Change (BC3)	Towards an operational digital twin architecture for ecosystem services

Date of session: Thursday 21, May 2026
Time of session: 11:00 – 12:30

Timetable speakers:

Time	First name	Surname	Organization	Title of presentation
11:00– 11:12	Saadet Gökçen	Karaduman	İzmir Katip Çelebi University	Integrating Flood Susceptibility and Freshwater Provision Ecosystem Services to Support Nature-Based Solutions under Local Scenarios: The Sakarya River Basin Case
11:12-11:24	Merlind Constanze	Pohl	ESVD	Identifying Relevant Ecosystem Service Valuation Studies Using Embedding-Based Similarity Classification
11:24-11:36	Shahryar	Sarabi	Eindhoven University of Technology	Leveraging AI for Climate Resilience: Rapid Physiological Equivalent Temperature (PET) Prediction using Earth Observation Embeddings
11:36-12:30	Laura & Vince	Costadone & van't Hoff	Old Dominion University Foundation for Sustainable Development	World Café

III. LIST OF ABSTRACTS

The first author is the presenting author unless indicated otherwise

1. AIRES: An Explainable AI Expert System for Evidence-Based Nature-Based Solutions Planning

***First author*:** Diego Gallardo Diaz
***Other author(s)*:** Shahryar, Sarabi, Qi, Han
***Affiliation*:** Eindhoven University of Technology
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The evidence base for Nature-Based Solutions (NbS) has surged during the last decade, with multiple platforms collecting case studies related to ecosystem services, climate adaptation, and resilience. However, valuable knowledge remains fragmented across repositories that use different labels, taxonomies, and reporting approaches, making knowledge acquisition and sharing difficult. With its rapid development, artificial intelligence (AI) can provide a pathway to bring this scattered knowledge together, supporting NbS uptake. However, the explainability of AI remains a major challenge and needs to be addressed, ensuring that AI-driven tools remain trustworthy and grounded in documented evidence.

To tackle these challenges, we have developed AIRES (AI for Resilient Ecosystems), an AI-supported expert system designed to enhance knowledge retrieval from NbS knowledge bases by structuring existing evidence. This system uses a unified information system architecture centered on a unified schema that integrates different key NbS repositories.

The architecture combines structured relational and spatial data with a semantic layer based on text embeddings, enabling contextual retrieval of NbS knowledge beyond keyword matching. A large language model (LLM) workflow is used to align information from unstructured case-study descriptions with the unified schema, while preserving source traceability. The architecture is designed to support retrieval-

augmented generation (RAG), allowing responses to be grounded in past NbS implementations and their documented outcomes. This design follows explainable artificial intelligence (XAI) principles by ensuring that retrieved information can be inspected, traced to sources, and interpreted within its original context.

By enabling context-aware exploration and comparison of past implementations, the system supports evidence-informed planning and learning across socio-ecological settings. Overall, AIRES improves access to NbS evidence, supports ecosystem services-oriented decision-making, and provides a transparent and scalable basis for responsibly embedding AI into NbS planning and practice.

Keywords: Nature-based solutions, Artificial Intelligence, Decision Support Systems, Climate Resilience, Large Language Models

2. Forest ecosystem services in Europe: bringing together demand and supply side perspectives

First author: Marko Lovric
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Society benefits from forests in multiple ways; they provide wood, game meat, they purify the air, provide habitat for flora and fauna, and supply cultural services such as space for outdoor recreation and nature-based tourism. In Europe, there is an ongoing policy debate about management priorities in forests ranging from sustainable wood supply to multiple forest ecosystem services and conservation. However, so far there is no Europe-wide simultaneous assessment of the ecosystem service-specific supply and demand. We provide such an assessment by combining data from surveys, geographic information systems and satellite images via machine learning. Our results show that on European level, demand for wood and hunting exceeds what the forests now supply, while supply of regulating services such as protection against soil erosion and habitat provision is approximately balanced with demand. We also demonstrate that the demand for regulating and cultural services is higher than their supply in Eastern and Southern Europe, and that demand for these services is especially pronounced in forest closer to cities. We identify where and how supply of these services could be increased, most importantly by prolonging the rotation period, increasing the span of protected areas and decreasing the management intensity.

Keywords: Forest ecosystem services, GIS, machine learning, supply, demand

3. Machine Learning from Stakeholder Knowledge: AI-Enhanced Social-Ecological Systems Modelling for Marine Ecosystem Services

First author: Arturas Razinkovas-Baziukas
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Social-Ecological Systems (SES) frameworks are crucial for understanding marine ecosystem services, but their development is cognitively demanding, typically requiring 8–16 hours of expert effort. Within the HORIZON EUROPE MarineSABRES project, structured interviews with over 150 stakeholders and researchers across Europe generated extensive participatory knowledge. This resulted in DAPSI(W)R(M) models for three demonstration regions—Macaronesia, the Arctic, and the Mediterranean—covering seven insular systems and diverse management contexts, including fisheries, eutrophication, marine protected areas, and climate adaptation.
The traditional DAPSI(W)R(M) structure was adapted to a sequential framework: Drivers → Activities → Pressures → Marine Processes/Functions → Ecosystem Services → Goods and Benefits → Responses as Measures, with explicit feedback loops from Responses back to Drivers, Activities, and Pressures.
Building on this rich, expert-validated knowledge base, we developed a novel AI-enhanced decision support system that learns from stakeholder consensus and participatory modelling processes.
Eight complementary machine learning approaches were implemented using over 200 validated causal connections and 78 unique SES elements. These include deep learning for connection prediction, graph neural networks for model completion, transfer learning for template matching, BERT-based NLP for SES

element extraction, reinforcement learning for response optimization, ensemble feedback detection, and collaborative filtering for recommendations. The system is integrated into the MarineSABRES SES Toolbox via R Shiny, maintaining usability and participatory integrity. Code development itself was assisted by several AI coding tools.
Results show substantial efficiency gains: non-experts can now generate scientifically robust SES models, identifying 23% more relevant connections and achieving 64% greater consistency across users. This marks a shift from static expert-driven frameworks to dynamic, AI-supported participatory systems for scalable marine policy and management.

Keywords: Machine Learning, Social-Ecological Systems, Ecosystem Services, Participatory Modelling, DAPSI(W)R(M)

4. Artificial intelligence and data-driven tools for inclusive ecosystem services and nature-based solutions

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Artificial intelligence and data-driven tools are increasingly used to support decisions related to ecosystem services and nature-based solutions, particularly in the context of climate adaptation and the energy transition. Techniques such as machine learning applied to environmental and socio-economic data can help identify where nature-based interventions may reduce climate risks, enhance ecosystem functioning, and support human well-being.
At the same time, the growing reliance on AI raises important questions about who designs, accesses, and benefits from these tools. Differences in digital skills, data availability, and institutional capacity can influence how AI-supported ecosystem service assessments are interpreted and applied in practice. Without deliberate attention to inclusion and governance, there is a risk that technologically advanced approaches reinforce existing inequalities rather than supporting a just transition.
This contribution examines how inclusive digital skills development and transparent governance arrangements can shape the responsible use of AI in ecosystem services applications. By framing AI as a socio-technical practice rather than a purely technical solution, this contribution reflects on how ecosystem services approaches can be broadened to better recognize diverse values and pathways toward transformative and just futures. Drawing on examples from climate and energy-related digital initiatives, it discusses how capacity building, cross-sector collaboration, and youth engagement can strengthen the legitimacy, transparency, and societal relevance of AI-supported decision-making.

Keywords: Artificial intelligence, ecosystem services, nature-based solutions, governance, equity

5. Using NLP to bridge ecosystem service knowledge divides between urban ecology and planning

First author: Jing Lu
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Urban ecosystem service assessments increasingly draw on artificial intelligence to map, monitor, and value nature in cities. Yet the knowledge base that feeds these tools is shaped by long-standing disciplinary silos between urban ecology and urban planning and design. Divergent vocabularies and uneven uptake of ecological advances constrain how biodiversity and ecosystem services are incorporated into planning decisions. We use Natural Language Processing (NLP) as a diagnostic tool to make these divides visible and to explore how AI can support reflexive and plural ecosystem service governance.

We compile a corpus of 2,319 Web of Science articles (2000–2023) on urban biodiversity, ecology, and planning. Articles are classified into three groups according to author affiliations: urban ecology, urban

planning and design, and interdisciplinary collaborations. Our NLP analysis combines topic modeling, co-word and cosine-similarity networks, and temporal trend analysis to identify how each group conceptualizes biodiversity, ecosystem services, and governance, and how far these vocabularies travel across disciplinary boundaries into applied discussions of planning instruments.

The results show persistent discursive silos. Urban ecology articles focus on species and ecosystem processes. Planning and design articles foreground urban growth, infrastructure, and redevelopment, where biodiversity appears mainly as a constraint or generic greening. Interdisciplinary collaborations reduce these silos by expanding biodiversity-related vocabulary at both the ecosystem and species levels and by increasing thematic overlaps. However, biodiversity-related terms remain rare in planning and design taken alone, and we find a clear gradient across biodiversity levels: ecosystem-level concepts have expanded more rapidly and are more frequently shared across disciplines than species-level terminology. This pattern points to a persistent knowledge gap in species-level biodiversity among planners.

We argue that AI-based text analysis can support reflexive, plural ecosystem service governance by making these patterns visible and indicating where additional collaborations are needed for nature- and people-positive urban futures.

Keywords: ecosystem services, urban biodiversity, Natural Language Processing, artificial intelligence, urban planning

6. Artificial Intelligence for Ecosystem Services: Opportunities, Challenges, and Governance

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Artificial intelligence (AI) has emerged as a transformative tool for ecosystem services assessment and management, offering new opportunities to advance climate action through enhanced data processing, predictive modelling, and evidence-based decision-making. Recent advancements in machine learning and predictive analytics have strengthened the capacity to map, quantify, and forecast ecosystem services, including carbon sequestration, water regulation, and biodiversity conservation (Gómez et al., 2016; Hamel & Bryant, 2017). Such applications can support more informed environmental planning and contribute to both climate mitigation and adaptation strategies.
Despite these opportunities, the deployment of AI in ecosystem services presents critical governance, ethical, and equity challenges. AI systems often rely on large and complex datasets that may be biased or unevenly distributed across regions, particularly in the Global South (Mehrabi et al., 2021). In the absence of appropriate governance frameworks, AI-driven assessments risk reinforcing existing social inequalities, reducing transparency, and marginalizing local and Indigenous knowledge systems that are vital for sustainable ecosystem management (IPBES, 2019).
This contribution examines how AI can be responsibly integrated into ecosystem services assessment while balancing technological innovation with governance and equity considerations. Key issues addressed include data governance, accountability, stakeholder participation, and ethical safeguards in AI-enabled environmental decision-making (OECD, 2019). The paper further explores pathways for developing responsible AI approaches that combine scientific innovation with participatory governance, transparency, and equitable access to AI tools.
By adopting an interdisciplinary perspective, this work seeks to inform researchers, practitioners, and policymakers on how AI can support inclusive and socially just ecosystem services governance, ensuring that technological innovation contributes meaningfully to sustainable and equitable climate action.

Keywords: Artificial Intelligence (AI), Ecosystem Services, Governance and Ethics, Climate Action, Equity and Inclusion

7. Towards an operational digital twin architecture for ecosystem services

***First author*:** Ferdinando Villa
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The k.LAB software stack, underpinning the Artificial Intelligence for Environment and Sustainability (ARIES) Project, enables semantic digital twins (DTs) that support federated, event-driven computational workflows. Each DT represents a dynamic, shared digital science environment whose architecture enables autonomous reaction to èvents, creating a living, near-realtime, reproducible computational space accessible to federated partners. Core to the architecture is (1) a federated approach to scientific data and model services, supporting integration of diverse scientific data and models and (2) k.LAB/ARIES' ability to semantically orchestrate communication and knowledge integration, managing authentication and permissions across services. Access to the DTs is possible through diverse clients, including workflow environments such as the Apache NiFi workflow environment, programming languages such as Java and Python, and browser-based URL access for end users.
Each DT manages a persistent knowledge graph reflecting semantic links between the observations it contains, including causal links driving behavior when events affect an observation. Another key component is a scheduler, which manages temporal and reactive DT operations, directing the DT to update each observation on a schedule or in response to detected events (e.g., deforestation, wildfire). When changes occur, the scheduler broadcasts them to all connected partners, triggering recalculation. Individual DTs can be merged into larger DTs through the virtual composition of their knowledge graphs and schedules. This enables scaling from specialized, independently maintained DTs to comprehensive multidisciplinary monitoring systems. The approach follows the FAIR Principles, maximizing interoperability and reusability, yet is built on an underlying human-guided, peer-reviewable process. Each DT's history can be reconstructed from the knowledge graph, providing accountability and provenance tracking.
This architecture, deployed to support multi-institution global ecosystems mapping, is extensible to diverse applications without breaking the functioning of active DTs. We describe the DT architecture, applications for ecosystem services and nature-based solutions, and strategies for building collaborative, federated DTs.

8. Integrating Flood Susceptibility and Freshwater Provision Ecosystem Services to Support Nature-Based Solutions under Local Scenarios: The Sakarya River Basin Case

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River basins are increasingly exposed to compound climate-related risks, particularly flooding and pressures on freshwater availability, which challenge conventional sector-based water management approaches. Nature-based Solutions (NbS) offer an integrative pathway to address these risks by enhancing ecosystem services while supporting climate change adaptation. This study presents an ecosystem service–based assessment conducted in the Sakarya River Basin, one of the largest and most strategically important river basins in Türkiye, extending from the Central Anatolian Plateau to the Black Sea coast. The basin encompasses diverse climatic zones, topographic conditions, and ecosystem types, and includes major metropolitan areas, notably the capital city Ankara, resulting in significant pressures from urban expansion, increasing impervious surfaces, and intensive agricultural water use.

Flood regulation was analysed using a Flood Susceptibility Index (FDI) derived from a multi-criteria spatial framework integrating topography, river proximity, land use and land cover, vegetation condition (NDVI), and precipitation characteristics. Freshwater provision capacity was assessed through a simplified water yield indicator combining precipitation inputs and vegetation-based evapotranspiration proxies, enabling comparison across micro-basins. The joint analysis reveals that areas with high flood susceptibility are

predominantly concentrated in low-slope alluvial plains and peri-urban zones affected by land-use intensification, while upstream and forest-dominated sub-basins exhibit higher freshwater provision potential but variable flood regulation capacity.

Based on these spatial patterns, a portfolio of context-specific NbS measures—such as riparian buffer restoration, floodplain reconnection, afforestation, and green infrastructure—was identified to address multiple ecosystem services simultaneously. Building on this assessment, the study proposes a prototype AI-assisted decision-support framework that combines multi-criteria decision analysis with rule-based reasoning to evaluate NbS performance under alternative scenarios. The framework explores baseline conditions, climate- and urban-pressure scenarios, and NbS-oriented adaptation scenarios, assessing the applicability, sustainability, and ecosystem service contributions of NbS under varying local conditions. AI-supported reasoning modules facilitate scenario interpretation and transparent communication of trade-offs and co-benefits for planning and decision-making. By integrating spatial ecosystem service indicators with AI-supported scenario exploration, the Sakarya River Basin case demonstrates a transferable approach for advancing NbS-oriented, nature- and people-positive river basin management.

Keywords: Flood Susceptibility Index, Freshwater Provision, Nature-based Solutions, Ecosystem Services, AI-assisted Decision Support

9. Identifying Relevant Ecosystem Service Valuation Studies Using Embedding-Based Similarity Classification

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The Ecosystem Services Valuation Database (ESVD) is the largest global database compiling monetary value estimates of ecosystem services across different biomes. Efficiently identifying relevant studies is crucial for maintaining the database but currently relies on manual retrieval and screening.
This Bachelor's thesis aims to automate the retrieval and relevance classification of new ecosystem service valuation studies. Relevant studies are represented as pre-trained document embeddings using the SentenceTransformers library. Relevance of newly retrieved studies is determined with a supervised k-nearest-neighbour similarity classifier, where a study is classified as relevant if at least k nearest neighbours exceed a similarity threshold τ. The hyperparameters k and τ are iteratively tuned on a validation set to optimize classification performance. The evaluation employs precision, recall, and the F1-score on held-out test sets, including both relevant and non-relevant studies, to assess the accuracy of the automated classification.
A lightweight user interface allows users to specify search parameters, such as biomes, countries, and valuation-related keywords, triggering an automated retrieval pipeline from academic databases. Retrieved studies are processed through the embedding-based classifier to determine relevance, supporting systematic inclusion in the ESVD. The expected outcome is an embedding-based workflow that approximates expert relevance assessments and improves the efficiency of the ESVD literature search process.

Keywords: AI, Automated Screening, Automated Classification, ESVD, Embeddings

10. Leveraging AI for Climate Resilience: Rapid Physiological Equivalent Temperature (PET) Prediction using Earth Observation Embeddings

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Effective spatial planning for ecosystem services requires a clear, current understanding of local climate challenges. However, generating high-resolution thermal comfort models at urban and regional scales is typically computationally expensive and requires specialized physical modeling expertise. This study explores the potential of Artificial Intelligence (AI) and foundation models to streamline this process.

We leverage the AlphaEarth Foundation’s embedding dataset, which provides a unified, vector-based representation of the Earth's surface by integrating massive amounts of Earth Observation (EO) data. Using a Support Vector Regression (SVR) approach, we trained a model using existing Physiological Equivalent Temperature (PET) data for the Netherlands (2022) paired with corresponding AlphaEarth embeddings. The model was trained on a large regional grid (70kmX70km) and subsequently tested on three independent smaller grids (35kmX35km).
The model demonstrated strong predictive capabilities, achieving considerable accuracy on the test areas (RMSE = 1.8°C, R2 = 0.77). These results validate that machine learning, utilizing EO embeddings, can provide a significantly faster and more cost-effective alternative to traditional physical simulations. This approach is particularly valuable for global regions where data scarcity limits traditional modeling, allowing for rapid assessment of heat stress and the cooling potential of ecosystem services. Future research will assess the generalizability of this approach, specifically determining if models trained in one climatic zone (i.e., the Netherlands) can be transferred to predict PET in different geographic contexts.

***Keywords*:** Climate Resilience, Machine Learning, Earth Observation, Physiological Equivalent Temperature (PET), Spatial Planning