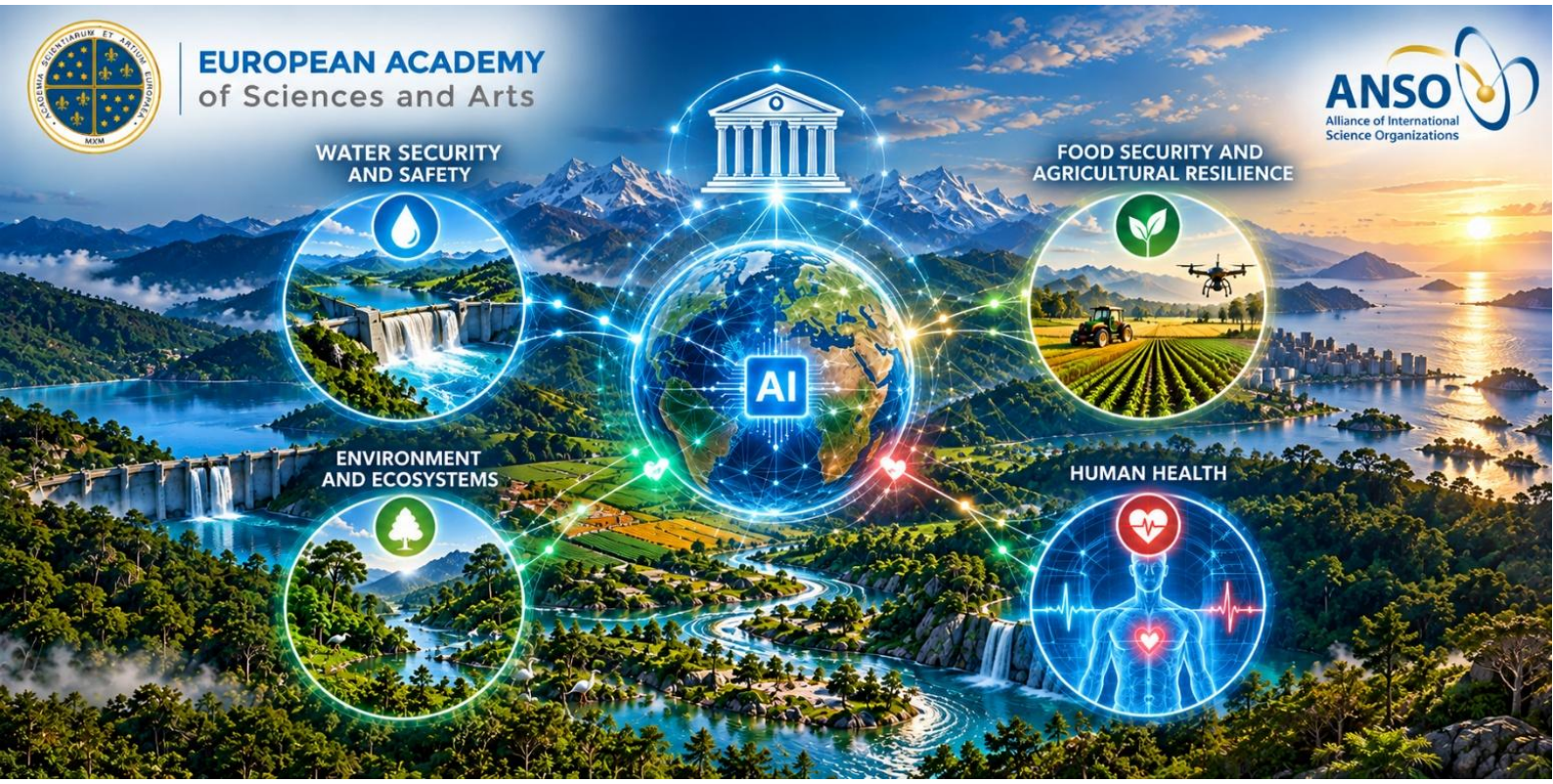


CAS-ANSO funded Conference

APPLIED AI and COMPLEX SYSTEMS

Water Security and Safety • Food Security and Agricultural Resilience • Environment and Ecosystems • Human Health

EUROPEAN ACADEMY of Sciences and Arts

European Academy of Sciences and Arts (Host)

In collaboration with

Serbian Academy of Sciences and Arts (member of ANSO)
Alma Mater Europaea (AMEU)
University of Zagreb (member of ANSO)
South China University of Technology (SCUT)

CONTENT

I. ABOUT THE CONFERENCE

II. PROGRAM

III. ABSTRACTS CONTRIBUTIONS

Overview

The European Academy of Sciences and Arts (EASA), in cooperation with international academic partners and ANSO member institutions, is pleased to announce the international conference:

Applied AI and Complex Systems

The conference will explore how Artificial Intelligence and Complex Systems Science can contribute to addressing some of the most pressing global challenges, including:

- Water security and safety
- Food security and agricultural resilience
- Environmental and ecosystem sustainability
- Human health
- Integrated AI-driven solutions for sustainable development

The meeting will bring together internationally recognized scholars and experts from Europe, Asia, and North America to discuss innovative approaches that combine artificial intelligence, mathematical modeling, systems thinking, and sustainability science.
The conference aligns with several United Nations Sustainable Development Goals and promotes interdisciplinary collaboration and international scientific exchange.

Organizers

European Academy of Sciences and Arts (EASA)

Conference Chairs

- Prof. Dr. Ioannis Liritzis, Vice President, EASA
- Prof. Dr. Klaus Mainzer, President, EASA

Co-Hosting Institutions

- Serbian Academy of Sciences and Arts (member of ANSO)
- University of Zagreb (member of ANSO)
- Alma Mater Europaea (AMEU)
- South China University of Technology (SCUT)

Main Themes

Artificial Intelligence and Complex Systems for:

- Water security and resilience
- Agricultural sustainability and food security
- Environmental monitoring and ecosystems
- Human health and well-being
- Climate intelligence and digital twins
- Risk assessment and decision support systems
- AI ethics and responsible innovation
- Cross-sectoral sustainability solutions

ANSO–EASA International Conference

Date	13 November 2026
Time	9:00 am – 6:00 pm
Venue	Bibliotheksaula (Library Hall), University of Salzburg, Austria, Hofstallgasse 2-4.
Participation	By Invitation Only

Speakers

Time	Speaker	Title / Topic
09:00 – 09:30	**Prof. Dr. DDr.h.c. Klaus Mainzer,** President of EASA **Prof. Dr. Ioannis Liritzis,** Vice President of EASA	**Introduction**
09:30 - 09:45	**Prof. Dr. DDr.h.c. Klaus Mainzer**, President of EASA, TUM-Emeritus of Excellence, Munich	*“Complex Systems and AI: From Foundation to Innovation”*
09:45 -10:00	**Prof. Dr. Ioannis Liritzis,** Vice President EASA, Fellow of World Academy of Art and Science (WAAS), Distinguished Professor (Hon.) at Chuzhou University, China	*“Learning from Civilizations: Archaeological Evidence, Complex Systems and AI for Sustainable Futures”*
10:00 -10:15	**Prof. Dr. Stavros Stavrinides**, Physics Department at Democritus University of Thrace, Greece Ordinary Member of EASA, Class IV - Natural Sciences	*“Reservoir Computing: Complexity’s Contribution to AI”*
10:15 -10:30	**Prof. Dr. Aleksander Zidanšek**, Prof. at the Institute "Jožef Stefan", Slovenia Ordinary Member of EASA, Class IV - Natural Sciences	*“Opportunities of AI in Education for Sustainability”*
10:30 -10:45	**Prof. Dr. Wolfram Mauser**, Department of Geography, Chair em. for Remote Sensing, LMU, Munich, Germany, Ordinary Member of EASA Class IV - Natural Sciences	*“Enhancing the Resilience of the Water-Food-Energy Nexus - the role of real and artificial intelligence”*
10:45 – 11:00	**Prof. Dr. Tanja Cirkovic Velickovic**, Prof. at the University of Belgrade, Faculty of Chemistry, Serbian Academy of Sciences and Arts	*“Towards AI-supported Integrative Risk Assessment of Micro- and Nanoplastics in Allergy and Asthma”*
11:00-11:30 | *Coffee break*		

11:30 -11:45	**Dr. Christian Diem**, KOF Swiss Economic Institute, ETH Zurich	*"Stress-testing systemic risk in food supply networks"*
11:45 - 12:00	**Andrea Francesco Castelletti**, Politecnico di Milano, Director Euro-Mediterranean Center on Climate Change, Division Director Technologies for Climate Transition, European Institute on Economics and the Environment	*“Climate Intelligence: Toward an AI-Based Epistemology of Weather and Climate Extremes”*
12:00 - 12:15	**Dr. Stefan Piel**, AI Product Management, UBS Switzerland AG, Zurich	*“Off Is Not a Switch. Responsible AI Adoption in Regulated Environments"*
12:15 -12:30	**Prof. Ioannis Athanasiadis**, Chair of Artificial Intelligence at Wageningen University & Research (WUR), Netherlands	*“Artificial Intelligence for agricultural sciences - Challenges and opportunities”*
12:30 - 12:45	**Assoc. Prof. Nikolaos Tziolas**, Department of Soil, Water, and Ecosystem Sciences, Institute of Food and Agricultural Sciences, UF/IFAS Florida University, USA	*“Conversational AI for Earth Observation in Support of Farmer-Centric Decision-Making.”*
12:45-13:45 | *extended coffee break*		
13:45 -14:00	**Prof Em. Yannis Phillis**, Technical University of Crete, Greece; Ordinary Member of EASA, Class VI - Technical and Environmental Sciences	*“Aggregation of complex systems indicators and sustainability"*
14:00 - 14:15	**Prof. Monica Riva**, Politecnico di Milano (POLIMI), Italy, Department of Civil and Environmental Engineering; Dean Class IV, EASA	*“The use of AI for the reconstruction and analysis of aquifers”*
14:15 - 14:30	**Prof. Ronald Corstanje**, Cranfield University (UK), Cranfield Environment Centre	*“Advanced data analytics on complex systems; generating insights from nature to solutions to our current challenges”*
14:30 - 14:45	**Thomas Cherico Wanger Guerrero**, Sustainable Agricultural Systems & Engineering Laboratory, School of Engineering, Westlake University, China	*“Transforming Food Systems - Opportunities from Environmental Monitoring"*
14:45-15:15 | *Coffee break*		

CONFERENCE „APPLIED AI and COMPLEX SYSTEMS“

15:15 -15:30	**Prof. Dr. Gabriel M. Lentner**, University of Continuing Education Krems	*“Law, AI, and the Interpretive Community: Recovering Democratic Authority in Legal Meaning-Making”*
15:30 – 15:45	**Prof. Dr. Vladan Devedzic, Miodrag Mihaljevic, Mirjana Ivanovic**, Serbian Academy of Sciences and Arts (SASA)	*“Quo vadis, education, in the AI era?”*
15:45 -16:00	**Dr. rer. nat. Matevž Vremec**, Department of Artificial Intelligence and Digital Technologies, Alma Mater Europaea, University, Maribor, Slovenia; Department of Earth Sciences, University of Graz, Austria.	*“From Reactive to Proactive Groundwater Management: AI-Driven Monitoring and Forecasting”*
16:00-16:15	**Dr. Elma Dervic**, Postdoctoral Fellow, Complexity Science Hub Vienna, Medical University of Vienna, Austria	*“AI and Complex Network Approaches to Mapping Human Disease Trajectories Across the Lifespan”*
16:15-16:30	**Teodoro Criscione**, Postdoctoral Fellow, Complexity Science Hub, Vienna, Austria	*“Complexity, Networks, and Food Security: Measuring Cyclicity in a Kenyan Community Currency”*
16:30-16:45	**Prof. Youshan Zhang**, Professor at the School of Artificial Intelligence, Chuzhou University, China	*“Robust Stem-Cutting-Point Localization for Embodied Intelligence Grape Harvesting Robots”*
16:45-17:00	**Prof. Hongmin Cai**, South China University of Technology, Future Technology Institute, China	*“Modeling Multi-Modal Brain Connectomes for Brain Disorder Diagnosis via Graph Diffusion Optimal Transport Network”*
17:00-17:15	**Prof Wang Zhen**, NPU, Xian, Ordinary Member of EASA, Class IV - Natural Sciences	*“In view of game theory: how humans make decisions with humans vs machines?”*
17:15-18:00	**Prof. Dr. Ioannis Liritzis,** Vice President of EASA **Prof. Dr. Klaus Mainzer,** President of EASA	**Final remarks** Discussion
CONFERENCE DINNER (8 pm)		

ABSTRACTS CONTRIBUTIONS

Complex Systems and AI: From Foundation to Innovation

Prof. Dr.DDr.h.c. Klaus Mainzer, *President of EASA, TUM Senior Excellence Faculty, Technical University of Munich, Carl Friedrich von Weizsäcker Center, University of Tübingen*

Huge and permanently increasing sets of data (Big Data) in nature and society can only be handled by algorithms of artificial intelligence, which require the innovation of more efficient computer technologies. The recent race in machine learning highlights this requirement. Even Millennium Problems of mathematics have recently been proclaimed to be solved by machine learning in High Tech companies. At the same time, the living conditions and the limits of resources on this planet must be taken into account. Therefore, a platform is needed for innovative research and critical discussions that bridge theoretical frameworks with practical AI applications across diverse fields. For decades, my research has been dedicated to the foundations, methodologies, and implications of complex systems and AI algorithms. It aims to foster a dialogue between scientific, technological, and philosophical perspectives, emphasizing how emerging innovations shape and are shaped by societal, ethical, and philosophical contexts.

But human intelligence is more than machine learning with Big Data and statistical correlations. What we need in science and engineering is causal thinking and learning represented by causal laws. Therefore, physical AI (or Physics-Informed AI) combines statistical machine learning with physical laws and equations. Sustainable and reliable engineering for better infrastructure (urban systems, traffic, bridges, robotics, factories et al.) needs physical knowledge combined with AI. In short: Running statistical machine learning must be extended by fundamental physical knowledge, represented mathematically by partial differential equations (PDE) and their initial and boundary conditions, in order to get more precise and better results of AI application in engineering. However, digitalisation requires a huge amount of energy, which is different for different computer technologies. As with the energy issue, digitalisation must not be based on a single solution, but rather the entire technological potential must be bundled in an innovation portfolio. Therefore, classic digitalisation and artificial intelligence are examined together with future technologies such as neuromorphic computing (based on the energy-saving mode of natural brains with analog computing) as well as quantum computers, quantum communication and quantum technology.

References:

K. Mainzer, Thinking in Complexity, Springer: New York 5th edition 2007 (1st edition 1994); K. Mainzer, Artificial Intelligence. When will Machines take over? Springer: Berlin 3rd edition 2026; K. Mainzer/R. Kahle, Limits of AI – theoretical, practical, ethical, Springer: Berlin 2023 (dt. 2022); K. Mainzer (ed.), Philosophisches Handbuch der Künstlichen Intelligenz, Springer: Wiesbaden 2024; K. Mainzer (ed.), Complex Systems, AI, and Emerging Technologies, World Scientific Singapore, book series since 2025.

Learning from Civilizations: Archaeological Evidence, Complex Systems and AI for Sustainable Futures

Prof. Dr. Ioannis Liritzis, *Vice President, European Academy of Sciences and Arts (EASA), Salzburg, Austria, Fellow, World Academy of Art and Science (WAAS), Distinguished Professor (Hon.), Chuzhou University, China*

Archaeology and archaeometry provide long-term evidence of interactions among societies, environments, technologies and institutions, extending the temporal perspective of contemporary complex-systems research. This contribution examines how historical experience

can inform four interconnected challenges: water security and safety, food security and agricultural resilience, environmental and ecosystem sustainability, and human health.

Mesopotamian irrigation, Mycenaean hydraulic engineering and Late Bronze Age Mediterranean transformations illustrate how environmental stress, infrastructure, governance and exchange networks interacted through feedback mechanisms. Water quality, food availability, sanitation, nutrition and exposure to environmental hazards also shaped human well-being, although their historical relationships require careful evaluation of archaeological and bioarchaeological evidence. Building upon the author's previously developed and continuing Nonlinear Theory of Civilizations, the analysis considers three dynamically coupled domains: internal societal organization (A), external interactions and networks (B), and environmental conditions (C). Their interactions offer a conceptual framework for investigating resilience, thresholds, cascading disturbances and societal transformation. Human health is understood both as an outcome of these interactions and as a factor influencing demographic and institutional dynamics. Artificial intelligence can support the integration of archaeological, environmental, agricultural and health-related evidence, identify patterns, compare competing explanations and explore scenarios relevant to contemporary sustainability. However, AI-based inference must remain grounded in reliable chronology, validated measurements, causal reasoning and explicit uncertainty. Historical societies do not provide ready-made solutions or deterministic forecasts; rather, their varied experiences expand the evidence base for critically examining coupled human–environment systems and informing responsible decisions about future resilience.

Reservoir Computing: Complexity’s Contribution to AI

Prof. Stavros Stavrinides, *EASA, Class V, Democritus University of Thrace, Greece*

Artificial intelligence continues to advance through statistical models, yet surpassing the limits posed by statistics and variations of neural networks is demanded. On the other hand, understanding physical processing requires exploring unconventional computing paradigms. This presentation explores Reservoir Computing (RC), a non-Von Neumann framework expanding the framework of recurrent neural networks that transforms complex time-series data through high-dimensional nonlinear mapping rather than static function evaluation. The talk describes the main theoretical model, namely the Echo State Networks alongside physical realizations across memristors, photonics, spintronics, and quantum circuits. To demonstrate practical efficacy, a proposed 3D reservoir architecture consisting of randomly distributed spatial charges, operating as nodes, is presented. Successful, out-of-sample forecasting of a real-world, nonlinear time series is demonstrated. Finally, the talk examines frontier questions in complex systems, asking whether dynamic physical systems can surpass traditional Turing computability limits, and the philosophical question “what is intelligence across the universe?” is posed and discussed.

Artificial Intelligence and Systems Thinking in Education for Sustainability: From Knowledge to Action

Prof. Aleksander Zidanšek, *EASA, Class IV, Institute "Jožef Stefan", Slovenia*

- Technology shifts education toward personalised systems
- Complex systems can be learned via explorable, interactive learning
- AI can democratise high-quality education for sustainable development

Education is changing rapidly with the advent of new technologies like artificial intelligence (AI). This poses grave threats to contemporary learning environments, but also huge opportunities to improve education and support the sustainable development of humanity.

While traditional teaching approaches often struggle to personalise learning, advances in artificial intelligence now offer concrete opportunities to shift education toward personalised systems that adapt to individual learners, their knowledge, context and pace. This way, difficult topics and complex systems become explorable through interactive simulations and scenario tools. Examples from a series of case studies from graduate education will be presented to examine how artificial intelligence can transform education into a strategic instrument for sustainability by developing systems thinking, interdisciplinary competencies, and evidence-based decision-making, enabling individuals and institutions to understand and address interconnected challenges involving water, food, ecosystems, and human health. These case studies illustrate competency gaps, learning preferences, and the practical conditions under which AI supports sustainability education. AI can help us understand complex sustainability challenges, and education determines whether societies acquire the knowledge, judgment and responsibility to act upon that understanding. Further development of AI and AI-related technologies promises to tailor education across languages, regions, and resource levels, making it democratised and easily accessible. This shift is moving education from traditional ex cathedra teaching to custom-made, personalised learning as an essential mechanism for translating scientific innovation into societal action.

Enhancing the Resilience of the Water-Food-Energy Nexus: The Role of Real and Artificial Intelligence

Prof. Dr.Wolfram Mauser, *EASA, Class IV, Department of Geography, Chair em. for Remote Sensing, LMU University Munich, Germany*

The agricultural sector, functioning as the primary open-sky component of the global Water-Food-Energy nexus, faces critical vulnerabilities driven by climate change, extreme meteorological events, and geopolitical shocks. Building systemic resilience requires adaptive, human-led management. However, actionable decision-making is severely constrained by extreme data scarcity: an average farmer experiences only 35 to 40 harvests in a career, resulting in a distinct lack of empirical trials to navigate multi-variable environmental shifts.

This training data deficit equally paralyzes pure, brute-force Artificial Intelligence (AI) approaches. Lacking robust causal data connecting physiological plant growth to unpredictable environmental stressors, standalone AI models risk violating physical laws or generating inaccurate hallucinations. Modern agricultural machinery yields high-frequency data streams to optimize short-term mechanics, but current AI-driven satellite approaches rarely support complex, long-term strategic resilience planning. Conversely, "Real Intelligence" process simulation frameworks, such as the PROMET Digital Twin, utilize biophysical laws and remote sensing to model highly realistic crop dynamics. Yet, these mechanistic twins are computationally expensive and too slow to deliver interactive, multi-scenario exploration for real-time stakeholder decision-making.

To bridge this gap, this paper proposes a paradigm shift toward **Science-Informed Artificial Intelligence (SIAI)**. By leveraging process-based Digital Twins to simulate millions of synthetic management variations under climate extremes, we can generate a physically consistent, highly parameterized training dataset. This SIAI framework effectively combines the scientific rigor of biophysical principles with the rapid execution speeds of neural networks, delivering scalable, high-speed decision support to systematically optimize global food security.

Towards AI-supported Integrative Risk Assessment of Micro- and Nanoplastics in Allergy and Asthma

Prof. Dr. Tanja Cirkovic Velickovic, *University of Belgrade - Faculty of Chemistry, & Serbian Academy of Sciences and Arts*

Micro- and nanoplastics (MNPs) are emerging environmental contaminants with complex physicochemical properties, diverse exposure pathways, and potentially important implications for human health. Their contribution to allergic diseases, including food allergy and asthma, remains insufficiently understood, particularly in the context of combined exposures to allergens and environmental contaminants. Conventional risk assessment approaches face substantial challenges arising from the heterogeneity of MNPs, limited exposure data, and the complexity of biological responses.

We addressed these challenges through an interdisciplinary approach integrating advanced analytical characterization, molecular interaction studies, in vitro and in vivo toxicology, clinical investigations, and artificial intelligence. Using well-characterized polyethylene terephthalate (PET) and polypropylene (PP) particles, we investigated their interactions with food allergens, biological macromolecules, and epithelial and immune systems. Experimental models revealed particle-dependent immunomodulatory effects and differences in nanoparticle distribution and clearance under allergic conditions.

These mechanistic findings were complemented by clinical investigations involving school-aged children in Croatia, integrating environmental and dietary exposure indicators, microplastic occurrence in biological samples, and allergic health outcomes. Machine-learning models were applied to explore complex, potentially nonlinear relationships between environmental exposures, lifestyle factors, and allergic sensitization.

Together, our findings illustrate the potential of AI-supported integrative approaches to connect MNP exposure, molecular mechanisms, immunological responses, and epidemiological observations. Future risk assessment frameworks should incorporate particle-specific properties, biological transformations, combined exposures, and mechanistic evidence alongside interpretable predictive models. Such integration could support more informative hazard identification, improved exposure–response assessment, and the development of evidence-based strategies for evaluating the potential contribution of MNPs to allergy and asthma.

Keywords: Micro- and nanoplastics; Allergy and asthma; Integrative risk assessment; Explainable artificial intelligence; Protein corona; Immunotoxicity; Environmental exposure.

Stress-testing systemic risk in food supply networks

Dr. Christian Diem, *KOF Swiss Economic Institute, ETH Zurich*

Recent events have highlighted the fragility of national and international supply networks, leading to significant shortages of essential goods such as food and medicines. Severe disruptions can propagate through complex supply networks and expose entire regions or countries to supply risks. Yet a lack of granular data and quantitative methods has made it difficult to assess these vulnerabilities empirically.

We introduce **supply network stress-testing (SNST)**, a data-driven methodology for quantifying product-level supply losses resulting from cascading disruptions between establishments. We demonstrate the approach using a large fraction of the Austrian food supply network, combining the pork production network from farms to meat processors with the distribution networks of major food retailers. The resulting network contains 23,001 establishments, 44,730 supply links, and covers 116 administrative districts.

Using SNST, we quantify the systemic criticality of individual establishments for population-level food supply. We identify 28 facilities whose failure could cause severe supply shortages

affecting up to 20% of the population. The approach provides a quantitative framework for identifying critical nodes and vulnerabilities in national supply networks and for assessing measures aimed at increasing their resilience to future disruptions.

Euro-Mediterranean Center on Climate Change (CMCC) and Politecnico di Milano

Andrea Francesco Castelletti, *Politecnico di Milano, Director Euro-Mediterranean Center on Climate Change, Division Director Technologies for Climate Transition, European Institute on Economics and the Environment*

The summer of 2026 set new heat records across Western Europe, and heat-related losses and deaths keep rising. Adaptation and early-warning decisions depend on forecasts of events we have rarely, or never, observed. At the same time, AI has moved from research papers to operations in three years. GraphCast and GenCast outperform leading physics-based ensembles on most verification targets, ECMWF's AIFS runs operationally, and a DeepMind cyclone model delivered the best guidance of the 2025 hurricane season. Machine-learning articles on climate tripled between 2020 and 2023. This talk follows AI along the chain of climate science, from problems with data (scarcity, bias, missing values) to detection, attribution, forecasting and emulation. At each stage it shows how AI helps: generative models sample extremes, networks learn their spatial signature, and surrogates emulate costly simulations. At each stage the same question returns. Can a model trained on the climate we have seen say anything reliable about the extremes we have not? Can it invent an unseen extreme, hold in a climate it never saw, or extrapolate beyond its training data?

I frame these questions within Climate Intelligence, a bottom-up framework in which AI enhances climate science and climate services. I argue that the epistemology of extremes, meaning what we can know about events at the edge of the record, is where the value and the limits of AI are decided.

Keywords: climate extremes, artificial intelligence, weather forecasting, extrapolation, climate services

Off Is Not a Switch. Responsible AI Adoption in Regulated Environments

Dr. Stefan Piel, *AI Product Management, UBS Switzerland AG, Zurich*

Financial services were the first regulated environment to deploy generative AI at scale. UBS has publicly reported that its in-house AI assistant is available to more than 85,000 employees and that over 300 AI use cases are live. An institution of that kind with tens of thousands of people, a statistical model that never gives the same answer twice, a corpus that changes daily, and clients on the other side of many interactions is not just a piece of software. It is a complex adaptive system. Supervisors have understood this faster than most technologists. In October 2026, Reuters reported that US banking regulators are asking banks how they would shut down autonomous AI systems, the European Central Bank required action plans against AI-enabled cyber threats by 31 October, and the Bank of England called for "bare metal" recovery capabilities. The talk argues that for an adaptive, data-driven system embedded in a living institution, "off" is not a switch. It is a property that must be designed in.

Drawing on ten years of AI delivery in Swiss Wealth Management, the talk organizes responsible adoption around the three questions a supervisor asks, referencing illustrations from the industry. 1. Scope: what is the system allowed to do? Use cases are tiered by the harm they can cause, and a clear line separates assistants, which propose, from actors, which execute. 2.

Evidence: how do you know your AI works? Grounding, evaluation gates, monitoring, inventories and independent verification show that accountability is a measurement problem before it is a rules problem. Regulated AI needs its archaeometry, a provenance, an error bar, a date. 3. Control: can you stop it and recover? Per-use-case kill switches, practiced fallbacks, staged rollout and rehearsed provider exit, set against the regulatory warning on model concentration. The same three questions transfer to the conference's domains: the US FDA's predetermined change control plans for learning medical devices, the aviation EASA's assurance levels for machine learning, and the EU AI Act's high-risk classification of safety components in water and energy supply. The talk closes with three open problems for complex-systems research: 1. certifying statistical systems whose object is a distribution rather than a device; 2. uncertainty quantification that a supervisor would accept; 3. the behavioral science of human oversight.

Keywords: responsible AI · regulated environments · complex adaptive systems · AI governance · certification · financial supervision

Artificial Intelligence for agricultural sciences - Challenges and opportunities

Prof. Ioannis Athanasiadis, *Chair of Artificial Intelligence at Wageningen University & Research (WUR), Netherlands*

Artificial intelligence (AI), driven by advanced machine learning methods and the integration of large-scale, multimodal, and multidisciplinary datasets, offers a transformative pathway for data-driven discoveries in agricultural sciences. In this talk, we identify key challenges inherent to AI research in agriculture and advocate for a paradigm shift toward more adaptable, scalable AI architectures to accelerate innovation. We argue that developing robust, generalized AI frameworks can overcome the traditional limitations of narrow, single-purpose models, providing the scalability and flexibility needed to address complex ecological and agricultural systems. By reflecting on core agricultural challenges, data structures, and domain theory, we identify strategic pathways for AI model development and evaluation. Ultimately, we demonstrate how agricultural researchers can transition toward shared, generalizable AI architectures that can be fine-tuned for diverse applications and locations, moving away from the inefficient practice of training new models from scratch for every unique scenario.

Conversational AI for Earth Observation in Support of Farmer-Centric Decision-Making

Assoc. Prof. Nikolaos Tziolas, *Department of Soil, Water, and Ecosystem Sciences, Institute of Food and Agricultural Sciences — UF/IFAS University of Florida, USA*

Growers face increasingly complex decisions as extreme weather events and soil degradation threaten agricultural productivity. The challenge is no longer simply data availability. Earth Observation (EO) delivers unprecedented observations of agricultural landscapes, yet the tools to translate these data into accessible, farmer-centric decisions remain fragmented and technically demanding. This talk explores how geospatial and conversational artificial intelligence can bridge this gap. Drawing on our research in AI-driven soil mapping, we illustrate how multimodal satellite observations and AI can map soil organic carbon and other key soil properties, assess soil health, and identify areas vulnerable to degradation. By translating these observations into soil health and degradation indicators, we highlight their relevance to sustainable land management. Federated learning further offers complementary approaches to addressing data limitations and enabling collaborative soil intelligence. To bring these capabilities directly into growers' hands, we introduce GAIA, an agentic geospatial AI framework that orchestrates specialized AI agents, analytical tools, and scientific knowledge

through natural-language interaction. Combining large language models with retrieval-augmented generation, GAIA integrates scientific publications and domain-specific knowledge with geospatial analyses to deliver context-aware responses. Applications in Florida demonstrate GAIA's potential for pre- and post-hurricane preparedness through crop assessment and flood susceptibility mapping, as well as its role in agricultural management. Looking ahead, the next challenge is to integrate and interpret EO and environmental data alongside farmers' local knowledge, moving beyond isolated analyses toward better-informed, context-specific decisions.

Aggregation of complex systems indicators and sustainability

Prof Em. Yannis Phillis, *EASA, Class VI, Technical University of Crete, Greece*

The attributes of large-scale complex systems are frequently evaluated using sets of indicators. For instance, the flexibility of a manufacturing system, the climate vulnerability of a society, or the sustainability of entities like nations, cities, and corporations are all effectively captured through indicators and data series. However, for these representations to be practically useful, we must establish aggregation methods that yield hierarchical performance measures alongside decision-making frameworks to drive improvement.

This talk presents a mathematical aggregation theory founded on intuitive postulates. These postulates establish the mathematical foundations for a general theory which culminates in a practical model that utilizes shifted geometric means to aggregate basic indicators into a comprehensive composite index. Shifted geometric means offer several desirable properties, generalizing the more simplistic, commonly used weighted arithmetic and weighted geometric means. This model is further enhanced by a sensitivity analysis that identifies the specific indicators with the greatest potential for performance improvement, offering decision-makers a robust tool for policy design. Finally, the framework is applied to evaluate the sustainability of 161 countries using data up to 2024. The resulting rankings and sensitivity analyses reveal compelling insights, including unexpectedly low rankings for some highly developed countries, demonstrating that development does not always rest on robust foundations.

The use of AI for the reconstruction and analysis of aquifers

Prof. Monica Riva, *EASA, Dean of Class IV, Politecnico di Milano (POLIMI), Italy, Department of Civil and Environmental Engineering*

Groundwater is a strategic component of the water cycle. It is critically relevant for sustaining water supply, agriculture, energy production, and freshwater ecosystems. Despite its importance, its largely invisible nature makes its characterization and quantitative assessment particularly challenging. These challenges are amplified at regional and supra-regional scales, where information on subsurface properties is inevitably incomplete, observations are sparse and unevenly distributed, and computational demands associated with physically-based models can still become prohibitive. At the same time, tackling climate variability, growing water demand, and environmental pressures requires reliable tools and approaches capable of anticipating responses of groundwater systems and supporting informed decision-making in the presence of a variety of sources of uncertainty. Recent advances in numerical modeling, probabilistic methods, and artificial intelligence (AI) are opening new opportunities to address these challenges. This contribution explores ways in which these approaches can be integrated to characterize dynamic behavior of complex groundwater systems, combining data-driven pattern recognition with geological knowledge and process-based simulation. The work focuses on two complementary elements. These comprise: (i) the reconstruction of complex three-dimensional geological architectures from sparse, heterogeneous observations, which is a key step in representing subsurface structure and its influence on groundwater flow; and (ii) the assessment of the discharge of natural springs, which is an observable manifestation of

groundwater dynamics and groundwater-surface-water interactions reflecting the response of the subsurface environment to recharge and hydrological variability. Selected showcase scenarios illustrate opportunities and limitations of these integrated strategies. They illustrate how AI can support interpretation of incomplete datasets and representation of complex subsurface settings, while probabilistic approaches characterize predictive uncertainty and physically based models relate geological structure to system behavior. This synergistic approach can improve subsurface reconstruction and robustness of predictions (including quantification of associated uncertainty) of groundwater dynamics and spring discharge. The contribution also discusses conditions for providing useful information for water resources management, including data quality, geological constraints, model evaluation, and transparent uncertainty assessment. The overall aim is to stimulate discussion about concrete avenues to advance reliable groundwater assessment under variable climatic and human pressures.

Advanced data analytics on complex systems; generating insights from nature to solutions to our current challenges

Prof. Ronald Corstanje, *Cranfield University (UK), Cranfield Environment Centre*

Climate extremes, and the lack of resilience of the systems exposed to them, are among the most persistent environmental challenges of this century, and the interaction between the two may amplify the consequences of each. The frequency of droughts, wet extremes and the rapid transitions between them is rising, and the extent to which successive extremes produce compounding effects that cascade through environmental systems remains uncertain. Where such effects accumulate, systems may approach tipping points beyond which loss of key functions is difficult to reverse, thus affecting food and water security. Resilience is widely invoked in ecological restoration and climate adaptation policy (e.g. nature-based solutions), yet it is rarely determined directly and is difficult to measure. Resilience is an emergent property of complex systems, and systems with deteriorating resilience exhibit early-warning signals, including rising variance and autocorrelation and slower recovery. Detecting these signals requires resolving them at the timescales of the ecological processes that generate them, since indicators across the whole signal can give false positives, miss transitions and mistake a settled new state for robustness. Moreover, observations are often sparse, noisy and influenced by many drivers. Here we show that signal processing and artificial intelligence can extract the ecological signal at these timescales across a number of ecological systems. Next we illustrate and visualise resilience using stability landscapes, visualising where a system sits relative to its stable states, and so allowing its resilience to be assessed qualitatively and its trajectory followed through time. Case examples from earth and coastal systems show how this approach distinguishes systems approaching a threshold from those that are maintained or have settled in a new state. Where uncertainty is quantified, knowing where a system sits in terms of its stability can support risk assessment and decision making, such as whether management is sustaining resilience, and contribute to climate intelligence for food, water and ecosystem management.

Transforming Food Systems - Opportunities from Environmental Monitoring

Thomas Cherico Wanger Guerrero, *Sustainable Agricultural Systems & Engineering Laboratory, School of Engineering, Westlake University, China*

The “Green Revolution” was one of the 20th century's great successes, boosting global cereal production to feed billions of people. Yet these gains came at an increasing environmental cost, while the efficiency of the inputs behind them steadily declined. Today, food systems are a major driver of global change, accounting for roughly 30% of greenhouse-gas emissions and

an estimated USD 15 trillion in hidden annual costs, while remaining essential to human health and livelihoods. This raises the question of how we can transform food systems to be both profitable and sustainable at scale. In this talk, I argue that the solution lies at the intersection of complex agricultural systems, environmental monitoring technology, and people, with agricultural diversification at its core. Recent global syntheses spanning up to 120 years of data show that diversification benefits increase by up to 200% compared with conventional agricultural systems across decades. I then show how environmental monitoring technology — embedded AI cameras, passive acoustic monitoring, and plant phenotyping deployed through large research networks — can optimise these benefits and close critical data gaps, from cocoa pollination in China to wheat performance in Switzerland. Finally, I show how farmer surveys, industry knowledge, and policy engagement turn this science into practice.

Law, AI, and the Interpretive Community: Recovering Democratic Authority in Legal Meaning-Making

Prof. Dr. Gabriel M. Lentner, *University of Continuing Education Krems*

This contribution addresses a central development in contemporary AI-and-Law research: the increasing use of artificial intelligence to model, predict, and operationalize legal interpretation. It argues that the meaning of legal norms does not arise directly from their textual representation enacted by the legislator but is constituted through the interpretive community of judges, lawyers, and academics. This practice of meaning-making adds a democratic element to the law in action.

Current AI-and-Law research, however, is dominated by data-driven approaches that rely on past judicial and administrative decisions to simulate or predict legal outcomes. Such systems risk reproducing the normative biases, politicizations, and democratic deficits embedded in existing judicial and administrative practice. Moreover, they leave unresolved the question of whose understanding of law is epistemically privileged and whose is marginalized. It therefore risks eliminating an important democratic element in legal meaning-making.

To address these challenges, the contribution proposes ‘legislative AI’, where the legislator would not only enact legal rules but simultaneously authorize norm-specific AI systems trained on statutory text, legislative intent, systematic context, constitutional principles and values. The proposal connects with research in legal knowledge representation and argumentation-based AI, offering an alternative paradigm in which AI supports legal interpretation as a normatively structured practice of democratic meaning-making instead of a purely statistical exercise in prediction.

Quo vadis, education, in the AI era?

Prof. Dr.Vladan Devedzic, Miodrag Mihaljevic, Mirjana Ivanovic, *Serbian Academy of Sciences and Arts (SASA)*

This presentation addresses the transformative, yet unpredictable impact of Generative AI on higher education. While GenAI offers unprecedented capabilities – spanning automated assignment grading, gamified lesson creation, virtual teaching, and administrative support – the rapid evolution of AI technologies raises fundamental questions about the future trajectory of educational frameworks.

Current trends indicate a landscape in flux. Although the initial hype around AI is gradually settling and giving way to AI fatigue, advancements in large language models (LLMs) continue to accelerate. Capable of performing complex tasks faster than humans, AI systems and autonomous agents are reshaping higher-education course design and practices. Consequently, traditional pedagogical paradigms are forced to adapt. Higher education is shifting from knowledge-acquisition to skills-based instruction, where practical execution takes precedence

over foundational knowledge, and personalized AI-assisted schooling challenges standard classroom structures.
Despite these opportunities, profound uncertainty looms over what institutions should teach, how curricula should be structured, and how quickly these changes must occur. Educators face non-trivial educational, ethical, legal, financial, and societal challenges. Questions persist regarding how to update core required courses, integrate elective tools like retrieval-augmented generation (RAG) and prompt engineering, and reimagine classic subjects like programming in an era dominated by automated coding. Illustrated through multiple examples from the presenter's teaching practice, the presentation discusses a growing need for continuous adaptation to an ever-evolving technological ecosystem powered by rapid developments in AI.

From Reactive to Proactive Groundwater Management: AI-Driven Monitoring and Forecasting

Dr. rer. nat. Matevž Vremec, *Department of Artificial Intelligence and Digital Technologies, Alma Mater Europaea University, Maribor, Slovenia; Department of Earth Sciences, University of Graz, Austria*

Groundwater is the main source of drinking water in many European countries, and irrigation increasingly adds to the pressure on these resources. Recent droughts have shown how widespread low groundwater levels can become: in September 2026, almost 90 % of Austrian groundwater monitoring stations showed low to very low levels (BMLUK, 2026). However, groundwater management remains largely reactive: restrictions are often introduced only after critical levels have been reached. Groundwater responds to rainfall, river levels and pumping with delays and sometimes nonlinear changes. Levels also reflect conditions from months or years earlier, while pumping and recharge decisions change the system being forecast.
AI and data-driven models can support more preventive management across three decision horizons. Operational forecasts of up to 15 days use recent observations, ensemble weather forecasts and planned pumping to warn of possible threshold crossings. In managed aquifer recharge systems, these forecasts can help operators adjust pumping and recharge while considering operating costs. Seasonal outlooks start from current groundwater levels and replay historical weather to examine possible low-water conditions over the coming months, including severe drought cases. Long-term climate scenarios can indicate which aquifers and wells may become more vulnerable or important for water supply over coming decades. Monitoring data also need to be reliable: anomaly-detection methods flag spikes, sensor drift and logger faults.
Several of these approaches are being developed and tested in the Interreg Slovenia–Austria project GW-CARE (2026–2028) at two pilot sites: the managed aquifer recharge system at Vrbanski plato supplying Maribor, and about 180 groundwater monitoring wells in Styria. At Vrbanski plato, pumping, recharge and river levels interact and affect groundwater flow towards the drinking-water wells. In Styria, automatically flagged anomalies are checked against field inspections. The tools are co-designed with water utilities and authorities in both countries. The talk presents the approach and its practical challenges, in particular quality control of monitoring data and communicating forecast uncertainty to operators.
Acknowledgement: GW-CARE is co-funded by the European Union through the Interreg VI-A Slovenia–Austria programme.
Keywords: Groundwater management; Artificial intelligence; Groundwater forecasting; Drought; Anomaly detection; Decision support

AI and Complex Network Approaches to Mapping Human Disease Trajectories Across the Lifespan

Dr Elma Dervic, *Postdoctoral Fellow, Complexity Science Hub Vienna, Medical University of Vienna, Austria*

We analysed 44 million Austrian inpatient records (2003–2014) to study comorbidity networks, gender differences, and disease trajectories — conceptualising aging as a **complex process in which chronic conditions accumulate and interact over time**, giving rise to **patterns of multimorbidity** that can be mapped using **network approaches**. We mapped disease paths in a **multilayer network**, with diagnoses as nodes across ten-year age groups. Significant diagnosis correlations ($p < 0.001$, relative risk > 1.5) formed inter-layer links; intra-layer links showed cross-age ties. **Unsupervised machine-learning clustering** revealed overlapping trajectories and key divergence points, where early diagnoses split into different late-life outcomes. We found 1,260 trajectories (618 female, 642 male), averaging 9 diagnoses over 23 years, and 70 diverging pairs. This **AI-driven, data-intensive framework** pinpoints risk factors that predict diagnoses decades in advance, supporting **personalised, data-driven clinical decisions**. We extended this framework by integrating disease–gene associations from eight major resources into the human protein–protein interaction network — a **complex molecular network**. This produced molecular profiles for 766 ICD-10 disease codes (11,378 genes), showing that diseases within the same ICD chapters share high molecular similarity matching their clinical closeness. **Network centrality** of disease-associated proteins predicts progression, distinguishing favourable and adverse trajectories. Integrating drug–target data identified trajectory-specific therapeutic opportunities supported by literature and **AI predictions**. All results are available in an interactive web app for exploring the **molecular atlas of disease trajectories**: https://vis.csh.ac.at/disease-trajectories/

Keywords: Disease trajectories; Multimorbidity; Complex networks; Artificial intelligence; Machine learning; Network medicine; Aging; Precision medicine

Complexity, Networks, and Food Security: Measuring Cyclicity in a Kenyan Community Currency

Teodoro Criscione, *Postdoctoral Fellow, Complexity Science Hub, Vienna, Austria*

Aid paid in a community currency is meant to keep circulating among the households and vendors supplying a community's food, water and services. We test whether it does in Sarafu, a Kenyan community currency observed under four designs between 2018 and 2025: community tokens, the currency of a COVID-19 cash-transfer programme with the Kenyan Red Cross, group vouchers, and commitment pools. Treating payments as a complex network, we measure maximal circularity (maxC), the largest share of value that can travel in loops, and count loops of three to five accounts, each against 500 randomised networks that keep every account's number of partners and those partners' need class (food, water, health and others). Circulation peaked during the emergency programme (maxC 0.86), and longer loops thinned once cash-out ended. Food sits at the centre of the loops in every design; during the emergency, food vendors held 37% of loop positions where the randomised networks give 29% (z +22), while clinics held 4% against 8% (z −19). Under the pools, the most recurrent loop links three planting-voucher accounts, and water vouchers are over-represented (z +13). In 704 household financial diaries from a 2022 voucher pilot in drought-hit Kitui, voucher spending on food reached maxC 0.17 against 0.05 for cash, and on water 0.09 against 0.04, while cash spent on clinics and school fees never returned in a loop. Computed from the ledger alone, without surveys or trained models, these measures can show in data-scarce settings whether aid keeps food and water trade local.

This work was supported by the Austrian Science Fund (FWF) as part of the funding project 10.55776/EFP5, REMASS — Resilience and Malleability of Social Metabolism.