The 2025 Euro-CASE Annual Conference Summary

The 2025 Euro-CASE Annual Conference, entitled *"Complex Systems, Shaping the Future for a Resilient Society"*, took place in Vienna on 29 September 2025, hosted in the beautiful premises of the Austrian Academy of Sciences. Under the chairmanship of Günter Blöschl, the conference brought together leading thinkers from the fields of health, energy and environment to examine how resilience can be cultivated in the face of today's interconnected global challenges. A consistent message emerged: resilience is not achieved through optimizing for efficiency alone. Instead, it requires embracing complexity, incorporating redundancy, valuing diversity, and embedding justice as foundational principles.

At the center of the discussions stood the concept of complex systems. These are systems where numerous components interact in non-linear ways, where small changes can cascade into large and sometimes unexpected consequences, and where outcomes often cannot be understood by examining the parts in isolation. The program was structured around three thematic sessions, each featuring four complementary perspectives: one from the technical sciences, one from the natural sciences, one from the social sciences, and one from law or philosophy. This format reflected the conviction that understanding and managing complexity requires dialogue across domains, with each discipline illuminating dimensions the others might overlook.

In the health session, speakers highlighted the potential of network approaches to predict diseases and manage comorbidities more effectively. They also emphasized that redundancy, often criticized as inefficiency, is essential for resilience in health systems. Calls were made to rethink causality, with attention to context, diversity, and path dependence as central factors shaping outcomes. In terms of policy, participants stressed that wicked problems cannot be definitively solved but must instead be managed adaptively. Here, the metaphor of gardening proved useful: policymaking as a continuous, flexible, and long-term process of care rather than a one-time engineering fix.

The energy session underscored the unexpected complexities of transitioning to low-carbon systems. Large land requirements, paradoxical emissions, and the environmental costs of sourcing battery materials highlighted the need for policies that recognize systemic interdependencies rather than treating challenges in isolation. Participants advocated for a mix of solutions - including storage through both electrons and molecular fuels - and called for legal frameworks capable of rebuilding trust, strengthening collective bonds, and embedding principles of justice across health, energy, and climate policy alike.

Environmental discussions brought both warnings and opportunities. Scientists pointed to the importance of making uncertainty explicit in climate and water cycle models and drew attention to tipping points such as the potential dieback of the Amazon rainforest, with cascading effects across continents. At the same time, case studies such as swidden agriculture showed how traditional knowledge, when combined with agent-based modeling, can reveal emergent patterns and inform planning processes. International environmental diplomacy was also examined, with a growing emphasis on translating goals into measurable

indicators - such as biodiversity metrics - and an acknowledgment that negotiations are becoming increasingly diverse in both participants and perspectives.

Across the sessions, several cross-cutting themes emerged. Complex challenges cannot be addressed within disciplinary silos; systems thinking and collaboration are essential. Efficiency, while valuable in some contexts, cannot be the sole objective, as it often undermines resilience by removing the buffers needed to absorb shocks. Redundancy, diversity, and adaptability were consistently recognized as critical to resilient design. Equally, justice and trust were highlighted as central to building systems that are not only technically robust but also socially and politically sustainable. Finally, metaphors such as networks and gardening were shown to be effective in reshaping how resilience is understood - encouraging approaches that are adaptive, context-sensitive, decentralized, and open to change.

The overall conclusion of the conference was clear: resilience must be treated as a guiding design principle across health, energy, environment, and governance. Without a systemic perspective, solutions risk being fragile or even harmful in the long term. Engineers, scientists, policymakers, and social scientists alike are called upon to adopt a broader view that reflects the interwoven nature of real-world systems. In doing so, societies can move beyond reactive crisis management and begin to cultivate the conditions required to thrive in an uncertain and rapidly changing future.

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