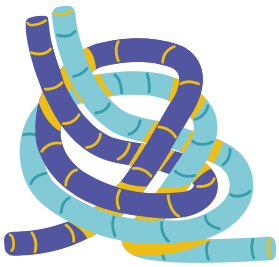
Complexity Science and Integration Methodologies

In NEXOGENESIS, we explored how complexity science can be used to improve decision-making and integrate different methodologies in various scientific fields. Complexity science focuses on understanding systems that are dynamic, interconnected, and influenced by multiple factors. We examined how these principles can be applied to solve real-world problems by integrating diverse scientific approaches.

Managing complexity in research

The main objective of this work was to provide a structured way to address complexity in scientific research. Modern challenges often involve dynamic, interdependent variables that traditional methods struggle to handle. Complexity science enables researchers to better analyse these relationships and develop more effective strategies for dealing with uncertainty and change. In our report, we also discussed methodologies that allow different disciplines to work together, ensuring that findings from one field can inform and enhance others.



Scientific models and tools

After evaluating five complexity science methodologies, System Dynamics Modelling (SDM) was selected as the core method for NEXOGENESIS. It was chosen for its visual clarity, ability to handle cross-sectoral variables, and integration capacity. The STELLA Architect environment was adopted for model building. Other methods reviewed included Agent-Based Modelling, Fuzzy Cognitive Maps, Material Flow Analysis, and Cellular Automata. This approach helped researchers in NEXOGENESIS to simulate real-world scenarios and predict potential outcomes. The study also emphasised the importance of data integration, where information from different sources is combined to create a clearer picture of complex phenomena. By applying these techniques, scientists can develop more accurate models and make better-informed decisions.

Understanding uncertainty

Complexity science provides tools for analysing uncertainty, which is vital for unpredictable real-world systems like climate change, economic markets, and biophysical ecosystems. Traditional methods often oversimplify these interactions, leading to incomplete or inaccurate conclusions. SDMs, on the other hand, embrace and incorporate uncertainty through feedback loops and scenario testing, offering ways to manage it effectively.

The role of integration methodologies

NEXOGENESIS emphasized the value of integrating diverse scientific disciplines. Integration enables communication across silos and improves holistic decision-making. Examples from the project include the joint use of climate, socio-economic, and ecological data streams in a single model framework. This integration improves problem-solving and leads to more robust conclusions.

Challenges and future directions

The report also highlights challenges in applying complexity science. One challenge is the need for better tools and computational resources to analyse large amounts of data. Another challenge is the difficulty in translating complex models into practical applications that policymakers and industry leaders can use. Addressing these challenges requires further research and collaboration between scientists, engineers, and decision-makers.

Conclusion

Complexity science and integration methodologies provide valuable tools for understanding and managing complex systems. By using these approaches, researchers can improve their ability to analyse uncertainty, integrate diverse scientific perspectives, and develop innovative solutions to global challenges. The study emphasises the need for continued investment in this field to enhance scientific understanding and decision-making processes in an increasingly complex world.

To learn more about the NEXOGENESIS complexity science and integration methodologies, read our corresponding deliverable: Here.

More about the project: https://nexogenesis.eu/

And stay tuned to learn more about the results on our social media accounts:

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The NEXOGENESIS consortium

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