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The Dawn of Dynamic Hypergraph Modelling in Ecology

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A recommendation of: **A single changing hypernetwork to represent (social-)ecological dynamics**

Cedric Gaucherel, Maximilien Cosme, Camille Nous, Franck Pommereau(2023), *bioRxiv*, ver.3, peer-reviewed and recommended by PCI Network Science <https://doi.org/10.1101/2023.10.30.564699>

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Recommendation

The study of Gaucherel et al. (2024) represents a groundbreaking shift in the field of ecosystem representation and management (DeFries and Nagendra 2017), offering a comprehensive and innovative approach that emphasises the importance of dynamic and complex models to accurately understand and preserve our ecosystems.

At the heart of this pioneering work is the introduction of advanced representational methods such as interaction networks and hypergraphs (Bretto 2013; Golubski et al. 2016), which mark a significant departure from traditional static models. These novel representations are adept at capturing the intricate, multi-component interactions within ecosystems, thereby providing a much more nuanced and interconnected view of ecological systems.

This approach is particularly innovative as it moves beyond the simplicity of previous models, offering a dynamic, fluid, and interconnected perspective of ecological dynamics that is more reflective of the real-world complexity of these systems. Furthermore, the study proposes the integration of social networks with ecological ones (Sosa et al. 2021; Sueur 2023), acknowledging the profound impact that human activities have on natural systems (Afana 2021; Elmqvist et al. 2021; Pelé et al. 2021). This interdisciplinary approach is pioneering in its attempt to bridge the gap between social and ecological studies, underscoring the interconnectedness of natural and human systems and highlighting the need for a holistic approach to ecosystem management (Stokols et al. 2013; Stone-Jovicich 2015).

The significance of the study lies not only in its methodological innovations but also in the implications it holds for the field of ecology and environmental management. By employing these advanced methodologies, the study provides a more thorough understanding of ecosystems. By considering a wide range of components and their interactions, these models offer insights into the complex dynamics of ecosystems, which are crucial for developing effective conservation and management strategies. This comprehensive approach is particularly important in an era where ecosystems are increasingly threatened by a variety of factors, including climate change, habitat destruction, and pollution (Mantyka-pringle et al. 2012; Trathan et al. 2015).

Additionally, the dynamic nature of the proposed models, especially the use of hypergraphs, facilitates the adaptive management of ecosystems. By accurately representing the changing interactions and components within these systems, these models enable managers and policymakers to respond more effectively to ecological changes, ensuring that conservation efforts are both effective and timely (Ascough li et al. 2008; Fischer et al. 2009; McKinley et al. 2017). Moreover, the

advanced modelling techniques proposed by the study have the potential to significantly improve predictive capabilities regarding ecosystem dynamics. Understanding the complex interactions and the long-term dynamics of ecosystems allows for better anticipation of future changes and challenges, a crucial aspect in a rapidly changing world where ecosystems are under constant threat.

In conclusion, this study marks a significant advancement in the field of ecological representation and management. Its innovative approach in utilising complex models like hypergraphs and integrating social and ecological networks provides a more comprehensive, dynamic, and nuanced understanding of ecosystems. Such innovations are crucial in an era of rapid environmental change and increasing anthropogenic pressures.

By enhancing our ability to understand, predict, and manage ecosystem dynamics, this study lays the groundwork for more effective conservation strategies and ecosystem management practices. It underscores the need for a holistic approach to understanding and preserving our natural world, recognising the intricate and interconnected nature of ecosystems and the pivotal role humans play within them.

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Conflict of interest:

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