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EDITORIAL

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Confronting complexity

The analysis of flood risks gives us an overview of the flood hazards, the elements at risk, and their vulnerability within a certain region, namely in floodplains. In these landscape elements, the determinants of risk—hazard, exposure, and vulnerability—overlap spatially. Flood risk analysis synthesises the risk factors and thus provides an important basis for decision-making in managing risks. In many cases, today's decisions set the framework for future flood risks for quite a long time, at least for the lifetime of flood protection measures. At the same time, many of our problems in flood risk management result from unintended consequences of past solutions. These legacy effects sometimes narrow the degree of freedom for today's problem-solving. Environmental and societal conditions that had shaped decisions in the past markedly changed since then, and will do so in the future. Thus, flood risks are far away from being static but are dynamically evolving with the changing determinants of flood risks.

Flood hazards might be altered by the effects of climatic changes, by the effects of environmental changes on catchment runoffs, or by changes in the river morphology. River systems and their floodplains adapt to their environmental boundary conditions and can thus be considered as complex adaptive systems (Thoms & Sheldon, 2019). Complexity increases further if we take human behaviour and adaptation into account. Exposure to flood hazards will follow future economic growth, and vulnerability will evolve along with changes in societal values, risk awareness, and technology. The processes and forces that shape the evolution of flood risks thus are numerous, diverse, and work at different scales. They are interdependent, influence each other, coevolve, balance each other out, or amplify each other. Feedback processes can self-reinforce or dampen the effects of climatic changes on flood risks. Out of these interactions, sometimes new patterns or a change in the system behaviour may emerge at a higher order level or at another scale (Neal et al., 2011). Flood events sometimes foster a paradigm shift in flood risk management practice (Johnson et al., 2005).

Complexity is also encountered in flood risk management practice. Professionals involved in participatory planning processes know about the diversity and the multiplicity of perspectives of stakeholders on flood risks. Decision-making in flood risk management is embedded in or touches a large set of policies, strategies, and measures of other disciplines. Managing flood risks therefore requires intervening at multiple scales, from the problem at the local scale to matching and shaping the funding and legislation frameworks at regional, national, or international scales such as the EU Floods Directive (EC, 2007) or international agreements on transnational basins (e.g., Danube, Rhine, or Mekong). Multiple perspectives often can complicate project management but more often they lead to the emergence of robust and resilient solutions out from seemingly irresolvable conflicts of interest and objectives. Therefore, a variety of different perspectives on a project increases the ability to understand and confront complexity in flood risk management.

Looking at the dynamics of flood risks, that is, looking at how flood risks evolve in space and time, adds a further dimension to flood risk analysis. In addition to quantifying the current flood risk in a river system, a dynamic perspective on flood risks points at the trajectory of flood risk evolution along with the continuous process of flood risk management (Schanze, 2006). This gives information on how flood risk might change in the near future and which factors are influencing flood risks the most. Consequently, interventions for risk reduction and risk governance can focus on those factors. However, for analysing the dynamics of flood risk evolution, research and management have to confront complexity arising from the interactions between the changing determinants of risk. To be able to predict the future evolution of flood risks, we must predict all relevant drivers of change as well as the feedback between some of these drivers. We must consider time lags, non-linear sensitivities to change, emergence, path dependence, hierarchy, and the adaptation of the human systems to changes in the environmental systems.

In this issue, examples of such features of complexity in flood risk analysis are shown. Addison-Atkinson et al. (2022) review microbial risks due to sewer flooding, an often neglected indirect flood impact. Azimi et al. (2022) show

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how flood vulnerability is amplified by socio-economical and environmental changes. A key of risk management is to understand social and institutional vulnerabilities (Alves et al., 2022). Yang et al. (2022) show how floods influence the behaviour of companies and how this cascades through supply chain disruptions. Van Woerkom et al. (2022) show an example of the legacy effect of past flood risk management practice and how it influences today's risks.

It is now time for confronting complexity in flood risk management instead of reducing it to manageable small topics. In addition to a dynamic perspective on flood risks, a complexity perspective on flood risks helps to understand the dynamics of flood risk change and to approach several wicked problems in a multi-disciplinary framework. The *Journal of Flood Risk Management* covers the full breadth and depth of the topic of flood mitigation in an era of evolving flood risks. It covers both the whole chain of processes, from precipitation through flood impacts, their management, and the in-depth research on specific features of complexity. Continued effort is needed to develop methods for considering complexity in flood risk research and flood risk management practice.

By the time this editorial is published. Professor Burrell Motz will have retired from the Editorial Board of the Journal. The Editorial Board would like to thank Burrell for her considerable contribution over many years of service and we welcome Dr Brian Cook of the University of Melbourne as a member of the Editorial Board.

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REFERENCES

Addison-Atkinson, W., Chen, A. S., Memon, F. A., & Chang, T.-J. (2022). Modelling urban sewer flooding and quantitative microbial risk assessment: A critical review. *Journal of Flood Risk Management*, e12844. https://doi.org/10.1111/jfr3.12844

Alves, P. B. R., Djordjević, S., & Javadi, A. A. (2022). Addressing social and institutional vulnerabilities in the context of flood risk mitigation. *Journal of Flood Risk Management*, e12839. https://doi.org/10.1111/jfr3.12839

Azimi, M., Sharifian, A., Riazinia, V., Arzani, H., & Abbaspour, K. C. (2022). Pastoral community's vulnerability under extreme floodings accelerated by rangeland degradation among Turkmen transhumant, northern Iran. *Journal of Flood Risk Management*, e12842. https://doi.org/10.1111/jfr3.12842

EC (2007): Directive 2007/60/EC on the assessment and management of flood risks. Brussels (Official Journal of the European Union, L 288/27).

Johnson, C. L., Tunstall, S. M., & Penning-Rowsell, E. C. (2005). Floods as catalysts for policy change. Historical lessons from England and Wales. *International Journal of Water Resources Development*, *21*(4), 561–575. https://doi.org/10.1080/07900620500258133

Neal, R., Bell, S., & Wilby, J. (2011). Emergent disaster response during the June 2007 floods in Kingston upon Hull, UK. *Journal of Flood Risk Management*, *4*(3), 260–269. https://doi.org/10.1111/j.1753-318X.2011.01110.x

Schanze, J. (2006). Flood risk management ? A basic framework. In J. Schanze, E. Zeman, & J. Marsalek (Eds.), *Flood risk management. Hazards, vulnerability and mitigation measures (NATO science series. Series IV, Earth and Environmental Sciences)* (Vol. 67, pp. 1–20). Springer.

Thoms, M., & Sheldon, F. (2019). Large rivers as complex adaptive ecosystems. *River Research and Applications*, *35*(5), 451–458. https://doi.org/10.1002/rra.3448

van Woerkom, T., van Beek, R., Middelkoop, H., & Bierkens, M. F. P. (2022). Assessing lithological uncertainty in dikes: Simulating construction history and its implications for flood safety assessment. *Journal of Flood Risk Management*, e12848. https://doi.org/10.1111/jfr3.12848

Yang, S., Ogawa, Y., Ikeuchi, K., Shibasaki, R., & Okuma, Y. (2022). Modelling the behaviour of corporations during the flood damage recovery process using multi-agent deep reinforcement learning. *Journal of Flood Risk Management*, e12845. https://doi.org/10.1111/jfr3.12845

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