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Climate Extremes and Systemic Risks for Sustainable Development Pathways – Artificial Intelligence for Risk Mitigation?

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Climate change is increasingly leading to severe and frequent extreme events, ranging from forest fires to heatwaves, droughts, and floods. These events are likely not only intensifying as our climate continues to warm but also interlink across various environmental and social systems. For example, a heatwave can trigger forest fires, which in turn lead to air pollution impacting public health. Droughts can disrupt agricultural production, causing market fluctuations and exacerbating socio-economic inequalities, potentially leading to social unrest. Despite the growing systemic risks posed by these extreme climate events, they are often inadequately addressed in national strategies for achieving the United Nations Sustainable Development Goals (SDGs).
The core challenge in tackling these risks stems from their roots in the dynamic boundary conditions of global warming, such as rising temperatures and altered precipitation patterns. Conventional risk models designed for assessing discrete, non-climate-related hazards or based on past climate are becoming increasingly invalid in this non-stationary scenario. In addition, process-based models are challenged by high-resolution complex-systems forecasting tasks. This is due to both epistemic limitations in understanding climate-ecosystem-society interactions and computational constraints. We discuss howArtificial Intelligence (AI) can serve as a complementary and effective tool in understanding, managing, and communicating these systemic risks, given its ability to process vast datasets and uncover patterns within complex systems. The vision is an AI enabled Early warning system of complex risk, operating on several time-scales (hours to decadal).

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