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Comprehensive Flood Early Warning Systems: From Modelling to Policy Making Perspectives

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Todays, early warning systems are widely applied in real-time flood forecasting operations as valuable non-structural tools for mitigating the impacts of floods [1]. Although many research works have perfectly could review recent advances in this era, current review papers tend to focus narrowly on specific perspectives, such as water quantity or quality [2]. Therefore, there is a pressing need for a more comprehensive and multi-disciplinary approach that not only explores various potential aspects of flood early warning system applications but also reveals the interconnections between these aspects [3]. This paper aims to bridge this gap by mapping out diverse applications and presenting significant trends, past initiatives, and future directions across a wide range of domains. By adopting such an approach, our goal is to provide a more holistic understanding of flood early warning systems and pave the way for further exploration in this critical field.

This papers, as state-of-art, suggests that a comprehensive framework may include all these aspects to meet all desired task and also ensure that all aspect of sustainability, reliability, resiliency, and accuracy have been fulfilled: (1) using recent input data extracted from both well known resources such as ground station and satellite stations, and novel but local resources i.e. IoT-based remote sensing, drones, USV and even social media and qualitative data; (2) Advance modelling with focusing on hybrid deep learning and physics-informed neural networks for different type of flood i.e. fluvial, pluvial or surface run-off. Also, application of data mining for data screening still have required more attention; (3) Adding concept of water quality as target and outputs of EWS especially with focusing on emerging pollutants, biological pollutants and micro-plastics; (4) Interconnection of EWS with optimisation techniques, decision support systems, and

multi criteria decision making processes; (5) Appropriate sensitivity/uncertainty analysis especially due to requirement for developing dynamic retrainable or self-trainable EWS; (6) Application of post modelling tools including virtual/augmented/mixed reality or digital twin to including stakeholder engagement.

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