Stormwater calculations using AI to predict and prevent flooding along railway lines. Case study: Meråkerbanen

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ABSTRACT

The management of stormwater runoff is critical for maintaining the safety and sustainability of infrastructure and urban environments (EPA, 2021). Stormwater calculations are integrated for designing systems that can effectively handle the volume of water generated during rainfall events (ASCE, 2016). Recently, automated stormwater calculations have gained traction following significant increases in processing efficiency and accuracy (Liu et al., 2019).

Automated stormwater calculations involve the integration of multiple data sources and the utilization of advanced processing techniques to perform complex calculations quickly and accurately (Chen et al., 2018). This approach has been successfully implemented in multiple stages of a collaborative project between Bane Nor and the 7 Analytics (7A), focusing on the Meråkerbanen railway line in Mid-Norway. The project aims to demonstrate how automated stormwater calculations can be applied in the context of railway design and maintenance, to avoid water to disturb railway operations.

Furthermore, the field of natural hazard prediction is constantly advancing, with the development of increasingly sophisticated models and continuous improvements in data processing hardware and software for the deployment and updating of these models (Kreibich et al., 2019). This includes the incorporation of novel data sources, state-of-the-art modelling algorithms, and strategies for empirical model adaptation beyond traditional single-catchment calibration (Blöschl et al., 2020).

As an extension, 7A are prototyping a forecasting and warning system employing real-time data and predictive models to deliver timely and accurate warnings of forecasted events. The system is designed to offer advanced notice of potential hazards, allowing for appropriate actions to be taken to minimize the impact of extreme events. To be effective, a real-time forecasting and warning system must exhibit high accuracy and reliability, with minimal false alarms or unwarned events. Additionally, the system must operate in real-time, with rapid data processing and dissemination capabilities, to provide prompt warnings and alerts to relevant stakeholders (Wagner et al., 2014).

The developed model can be enriched with data from various external sources, including precipitation and flow sensors. In this pilot study the automated stormwater model is integrated with historical weather data and forecasts from the Norwegian Meteorological Institute, as well as flow data from a Pipelife sensor in one culvert along the Meråkerbanen railway line. All the data is processed using sophisticated algorithms and predictive models to identify patterns and trends that may signal an extreme event (Huang et al., 2018).

By designing and developing the tools independently, they can operate as stand-alone tools solving specific problems. Furthermore, it is possible to connect modules, hence adopting a more holistic

approach to strengthen the understanding of interactions between natural processes, environment, and climate change.

Finally, the adoption of automated stormwater calculations can be a game changer for the stormwater management as we can develop an even more efficient and accurate software for designing, monitoring, and maintaining stormwater infrastructure. Likewise, advancements in natural hazard prediction modelling will play a critical role to ensure the safety and resilience of our communities in the face of climate change and related natural hazards (Kreibich et al., 2019).

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