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Urban flood return period assessment through rainfall-flood response modelling

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Intense rainfall can often cause severe floods, especially in urbanized areas, where population density or large impermeable areas are found. In this context, floods can generate a direct impact in a social-environmental-economic viewpoint. Traditionally, in design of Urban Drainage Systems (UDS), correlation between return period (RP) of a given rainfall and RP of its consequent flood has been assumed to be linear (e.g. DS/EN752 (2008)). However, this is not always the case. Complex UDS, where diverse hydraulic infrastructures are often found, increase the heterogeneity of system response, which may cause an alteration of the mentioned correlation. Consequently, reliability on future urban planning, design and resilience against floods may be also affected by this misassumption.

In this study, an assessment of surface flood RP across rainfall RP has been carried out at Lystrup, a urbanized catchment area of ∼440ha and ∼10.400inhab. located in Jutland (Denmark), which has received the impact of several pluvial flooding in the last recent years.

A historical rainfall dataset from the last 35 years from two different rain gauges located at 2 and 10 km from the study area has been provided by the Danish Wastewater Pollution Committee and the Danish Meteorological Institute (DMI). The most extreme 25 rainfall events have been selected through a two-step multi-criteria procedure, ensuring an adequate variability of rainfall, from extreme high peak storms with a short duration to moderate rainfall with longer duration. In addition, a coupled 1D/2D surface and network UDS model of the catchment area developed in an integrated MIKE URBAN and MIKE Flood model (DHI 2014), considering both permeable and impermeable areas, in combination with a DTM (2x2m res.) has been used to study and assess in detail flood RP.

Results show an ambiguous relation between rainfall RP and flood response. Local flood levels, flood area and volume RP estimates should therefore not be neglected in order to guarantee quality of the assessment, especially in design of complex UDS, where features as the main slope, hydraulic capacity, permeability, etc. can play an important role. In addition, a novel approach has been applied to map the response time (Tc) of the flood prone areas of the system under study. Together with the flood area and volume RP estimates this provides valuable knowledge suggesting to consider the different subareas of the UDS for design purposes and to establish a robust database that allows urban areas to be resilient against the severe impact of rainfall.

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References

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