Regionalised design rainfall estimation: An appraisal of inundation mapping for flood management under data scarce situations

Hydrological studies in regions with sparse rain gauge networks are limited by the availability of rainfall data. Hence, a regionalisation approach becomes critical in modeling extreme events such as floods. A comprehensive framework is put forward for generating regionalised design rainfall time series, which can serve as a vital tool for data-scarce catchments prone to flood disasters. To demonstrate the framework, Jagatsinghpur district, a highly flood prone region in Odisha (India) is selected.
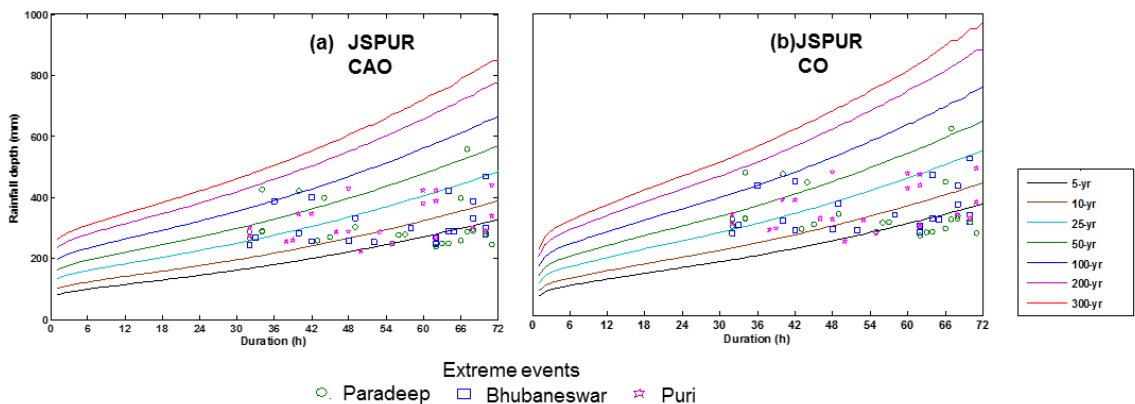

Fig.1: Regionalised DDF curves for Jagatsinghpur district (JSPUR) using (a) Complete averaging optimisation and (b) Complete optimisation
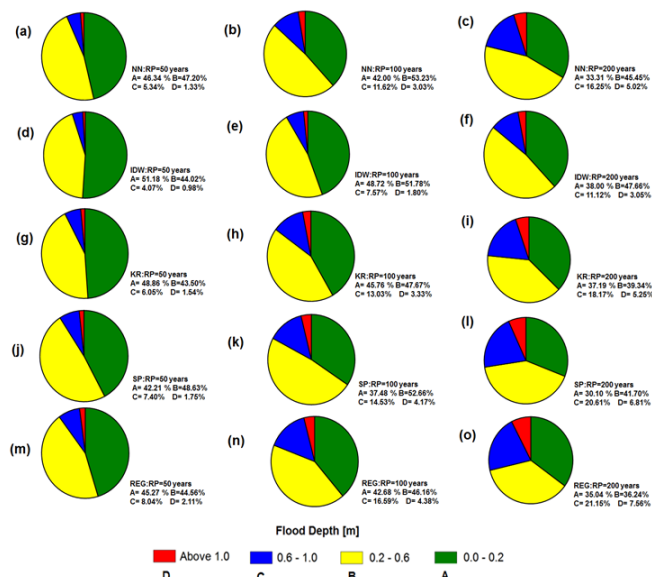

Fig. 2: Flood depth distribution for Jagatsinghpur District using interpolation techniques: NN, IDW, KR, SP, and a regionalisation method (REG) for return periods of 50-yr, 100-yr and 200-yr

Flood depth [m]

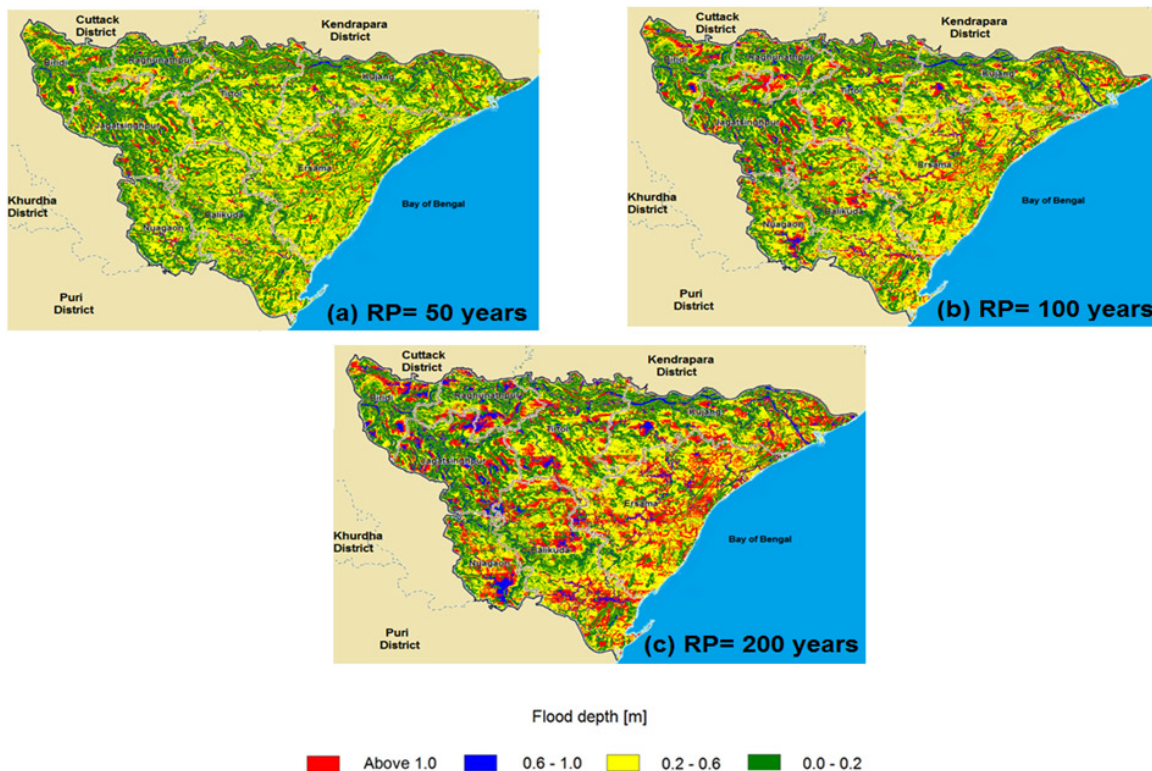| | Above 1.0 | | 0.6 - 1.0 | | 0.2 - 0.6 | | 0.0 - 0.2 |

Fig. 3: Comparison of flood inundation depth obtained using regionalised design rainfall for return periods of: (a) 50-yr (b) 100-yr and (c) 200-yr using MIKE 21 model

An extensive number of parametric and non-parametric families of distribution are used to perform multivariate rainfall frequency analysis. To obtain the regionalised design rainfall (RDR) time series, two optimisation based approaches are proposed. The RDR time series were used as one of the inputs to 2-D MIKE 21 flood model and its performance was assessed by comparing the inundation statistics with those derived by using rainfall from different spatial interpolation techniques. Although a high degree of comparison was noticed with kriging and spline interpolation techniques, the regionalisation method proved to be more dependable and conservative approach.

The proposed framework can help in better estimation of rainfall data, especially for ungauged / partially gauged catchments in developing and underdeveloped countries. In this study, we showed that the framework can be used for extreme events arising due to floods that can support in improved flood management leading to reduction in flood losses. In future, the concept of regionalisation can be incorporated into flood simulation tools along with other existing set of interpolation techniques.

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