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Regional Flood Frequency Analysis using Dimensionless Index Flood Method

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Abstract

Hydrologic designs require accurate estimation of quartiles of extreme floods. But in many developing regions, records of flood data are seldom available. A model framework using the dimensionless index flood for the transfer of Flood Frequency Curve (FFC) among stream gauging sites in a hydrologically homogeneous region is proposed. Key elements of the model framework include: (1) confirmation of the homogeneity of the region; (2) estimation of index flood-basin area relation; (3) derivation of the regional flood frequency curve (RFFC) and deduction of FFC of an ungauged catchment as a product of index flood and dimensionless RFFC. As an application, 1983 to 2004 annual extreme flood from six selected gauging sites located in Anambra-Imo River basin of southeast Nigeria, were used to demonstrate that the developed index flood model: $Q_m = 0.495A^{0.6676}$, overestimated flood quartiles in an ungauged site of the basin. It is recommended that, for wider application, the model results can be improved by the availability and use of over 100 years length of flood data spatially distributed at critical locations of the watershed.

Keywords: Analysis; Estimates; Index Flood; Regional; Southeast Nigeria.

1. Introduction

The estimation of extreme flood probabilities has been a long-standing problem in hydrology because of insufficiently long flood records needed to estimate the annual exceedence probabilities (AEPs) at the site of interest [1]. Yet estimates of extreme floods and AEPs are needed for hydrologic engineering designs. Robson and Reed [2] recognized the practical value of this problem and suggested the analysis of flood frequency. According to Robson and Reed [2], the fitting of a defined probability distribution to historical annual maximum or partial discharge time series in order to determine the magnitude of a flood event at set AEP or return period is called flood frequency analysis (FFA).

Historical discharge time series required to estimate AEPs and peak floods are furnished from installed stream gauging stations [3]. However, in developing countries like Nigeria, spatial coverage of stream gauges is limited by logistics and functional challenges [3]. Even where gauging stations exists, intense flooding, poor planning and technological limitations lead to insufficient length of flood data due to faulty and dysfunctional gauging equipment [4]. The estimated flood quartiles of these sites are therefore based on large degree of extrapolation by simulation with associated high level of uncertainties [5]. In such cases, the widely used at-site flood frequency analysis is most preferred as historical flood records are drawn from a single site of interest. In at-site flood frequency analysis,

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