COMPARISON OF REGIONAL FLOOD ESTIMATION MODELS OVER SOME CATCHMENTS IN KENYA

BY

PAUL NG'ALA OLOO
Department of Meteorology
University of Nairobi
P.O. Box 30197
Nairobi

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DECLARATION

This thesis is my original work and has not been presented for a degree in any other university.

Signature ..... Date 3/8/2001

PAUL N. OLOO

This thesis has been submitted for examination with our approval as University Supervisors.

Signature ..... Date 31/8/2001

DR. FRANCIS M. MUTUA
Department of Meteorology
University of Nairobi .

Signature ..... Date 31/8/01

PROF. LABAN J. OGALLO
Department of Meteorology
University of Nairobi.

ABSTRACT

Each year floods occur, resulting in damages to property and loss of life. Good knowledge of the magnitude and frequency of occurrence of floods, on a river system can greatly reduce such adverse effects. Flood frequency analysis provides information for the design of hydraulic structures and for the risk assessment in flood plain use and insurance.

Flood frequency analyses require a large number of records of annual floods at a gauging station. If a large record of peak flows were available the design event and its risk could be derived directly from the sample. However, the record length of most river gauging stations, generally, is much less than the return period, and this can result in very large errors for the design flood. Flood populations, from short records are very variable in nature having high values of coefficients of variation and skewness. Such short records further contain outlying values, which makes flood estimates to be highly uncertain. The short period data, can also lead to different cumulative distribution functions to be fitted to streamflow data of neighbouring gauges with the same hydrological characteristics. The single station analysis applies only to the exact location at which the original observations were made. But, it is always necessary to estimate design floods at sites where no observations have been taken.

These flood frequency problems can be minimized by adopting regional flood estimation methods. In such procedures, site-specific hydrologic information is augmented with regional information. This reduces parameter uncertainty or equivalently increases the total information over using each source separately. This can improve or stabilize site-specific estimates based on limited site data. Regional information can also be used to estimate design flood at unmonitored river basin sites, by using models which can transfer regional information into specific site information.

In this study, comparison of regional flood estimation models was undertaken, over the Lake Victoria, the Tana river and the Athi river basins in Kenya. The data consisted of the annual maximum flood series for sixty one gauging stations, with areas varying from a few to several thousands square kilometres for the period 1960 - 1994 inclusive.

Regional models require the identification of homogeneous regions. This involves grouping gauging stations with similar flow characteristics. This was done using the Cluster analysis, the Discriminant analysis and the Principal Component Analysis.

The regional estimation methods were then applied to the specific homogeneous regions. They included the Index flood method, the Two component extreme value method and the empirical Bayes method. The best regional estimation model was obtained using the Kolmogorov-Smirnov test, the Chi-square test and the Akaike Information Criterion. Simulation was further used to examine if the best regional model could provide skilful estimates of floods over these homogeneous regions.

Results from the regional homogeneous zoning showed that the three drainage basins could be grouped into nine homogeneous flood regions with three regions in the Lake Victoria basin, four regions in the Tana river basin and two regions in the Athi river basin. The nine groups formed the base for the development of the regional flood frequency estimation methods.

The results from the regional models based on the Index flood method indicated that, the extreme value type 2 was identified as the regional distribution that could best fit annual flow records in all the drainage basins. The two component extreme value method was found to be inappropriate for modelling annual floods, since the extraordinary flood events were very few in comparison to the ordinary flood events. The General extreme value distribution was the best fitting regional model It was thus used in the simulation study. Simulation results indicated that the General extreme value distribution could provide skilful estimates for the flows in all the nine regions.

It may be concluded that reliable estimates of design flood, can be obtained both for gauged and ungauged river basins by regional models. The Index flood method was the best regional flood frequency estimation model. The results from this study can be used for the general planning and management of most hydrological systems in Kenya.