

FLOOD RISK MANAGEMENT INCORPORATING STAKEHOLDER PARTICIPATION AND CLIMATIC VARIABILITY

BY

Hemalie Kalpalatha Nandalal

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Research Supervised

By

Dr. U.R. Ratnayake

DEPARTMENT OF CIVIL ENGINEERING
UNIVERSITY OF PERADENIYA
PERADENIYA
SRI LANKA
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653399

ABSTRACT

Impacts of floods are enormous all around the world and recent events confirm their catastrophic potential. Mitigation of damage due to floods is undoubtedly important and diverse measures have been adopted for that purpose. At present the use of non-structural measures to reduce flood damage that complements traditional structural measures receives wide attention globally.

Kalu-Ganga river basin in Sri Lanka experiences floods very often. This thesis presents a methodology to develop a Decision Support System (DSS) for the management of flood risk in the Kalu-Ganga river basin in a varying climatic condition incorporating views of stakeholders.

Quality and quantity of data available is a major set back for flood studies carried out in developing countries. The study commenced with an extensive investigation of geospatial data available for flood modelling of the Kalu-Ganga river basin and adjusting them as required. Subsequently, necessary screening tests were carried out for hydrological data to investigate their suitability. A technique was proposed and applied to identify trend of extreme rainfall in the basin based on Gumbel parameters estimated for 30 year long periods, which indicated an increasing trend. Rainfall for 100 year return period was determined using the proposed methodology for the next 30 year periods.

Software HEC-GeoHMS and HEC-GeoRAS, as tools of ArcMAP, were used to develop geospatial data for use with HEC-HMS rainfall-runoff model and HEC-RAS flood inundation model, respectively. The HEC-HMS based model was calibrated and verified for the river basin and subsequently used to determine runoff due to the 100 year rainfall. Afterwards, the HEC-RAS based model was applied to establish flood extents and depths in the basin due to that rainfall.

Risk is a combination of hazard and vulnerability. In the study, flood depth and inundation area were considered to be hazard factors while population density and dependency ratio were taken as vulnerability factors. These factors were determined at the lowest administrative division level, Grama Niladhari Divisions (GNDs), in taking decisions on flood relief work by the government. Based on these hazard and vulnerability factors, risks were estimated for the entire flood affected GNDs in the river basin initially using the conventional risk assessment approach. Then a novel methodology was developed and applied to assess the risk assuming the above factors as fuzzy variables, which takes their uncertainty into account explicitly. Suitable fuzzy membership functions were proposed and used to represent the hazard and vulnerability factors. Comparison of the results obtained from the two approaches with flood relief expenses incurred at GND level due to a recent flood event indicated that the proposed fuzzy based method, which takes uncertainty in the determination of hazard, vulnerability and risk levels into account, as providing more realistic results.

An investigation was carried out to identify the major stakeholders involved in the management of flood risk in the Kalu-Ganga river basin. After identifying the flood affected people as the most important stakeholder, a questionnaire survey was carried out to find the best possible adaptation approach for flood impact mitigation. A model was developed to decide the best way to invest funds to achieve the optimum adaptability of the flood affected people.

Finally, a DSS was developed based on all the information and results. The developed DSS is a prototype web site that provides information for decision makers at different administrative levels including the general public.