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A Review on Evaluation and Development of Effective Flood Forecasting, Warning and Response System

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Abstract: *To provide flood warning to the community involves significant uncertainty. Historically all the uncertaintyrelatedto the data and models used. Also flood plain management is applied method at the river engineering and essential for the purpose of managing river training practices. It is necessary to simulate complicated hydraulic behavior of the river in a more simple way. The technology to bring in a number of objective techniques to estimate uncertainty in hydrologic modelling is slowly gaining acceptance both nationally and internationally. This review paper discusses how these technologies can be used within a flood forecasting environment and explore ways on how this uncertainty can be communicated to the public.*
Keywords: *flood forecasting, hydraulic simulation, flood management, flood frequency*

I. Introduction

Flood can occur anywhere after heavy rain. All flood plains are vulnerable and heavy storms can cause flash flooding in any part. Flash floods can also occur after a period of drought when heavy rain falls onto a heavy, dry, hard ground that the water cannotpenetrate. Floods come in all sorts of forms from small flash flood to sheet of water covering huge area of land. Dam break and sudden regulatory operation can also cause catastrophic flooding. Flood threaten human life and property worldwide. It is the exponentially increasing impact of flooding that has raised the profile of the practice of flood forecasting and warning.

Flooding is a chronic natural hazard with potentially devastating consequences giving rise to all losses due to natural events. Extreme weather events over the last decade have fuelled the perception that weather due to anthropogenic global warming or otherwise, flooding is becoming more extreme, more widespread and more frequent. The control and harnessing of floods is often beyond effective human intervention and complete protection from flooding is rarely viable goal. Different inputs and physical factors and their combinations act as a driving force to produce high flow in natural surface water channels giving rise.

The purpose of flood forecasting and warning system is to provide as much advance notice as possible of an impending flood to the authorities and the general public. The main components of flood forecasting are as follows

1. Collection of real time data for the prediction of flood severity including time of onset and extent and magnitude of flooding.
2. Preparation of forecast information and warning messages giving clear statement on what is happening.
3. Communication and dissemination of such a message which can also include what action should be taken.
4. Interpretation of the forecast and flood observation in order to provide situation update to determine possible impacts on communities and infrastructure.
5. Response to the warning by the agencies and communities involved.

II. Literature Review

Several researches attempted to develop flood forecasting model to forecast flood in particular area. Some of the models have taken review in literature.

"Real Time Flood Forecasting – Indian Experiences" by R D Singh by National Institute of Hydrology (2012), Roorkeeexpressed that the real time flood forecasting is one of the most effective nonstructural measure for flood management. For formulating the flood forecast in the real time the observedmeteorological and flow data are transmitted to the forecasting station through the different means of data communications. There is a need for significant improvement of the real time flood forecasting system. Efficient automatic communication system are required to be established for transmitting data in real time. The forecasting techniques such as

deterministic model, stochastic models, ANN, and Fuzzy logic techniques, etc are required to be studied. And suitable method may be recommended for field applications based on performance evaluation criteria.

"Impact of Precipitation Forecast Uncertainties and Initial Soil Moisture Conditions on a Probabilistic Flood Forecasting Chain" by Francesco Silvestro,CIMA Research foundation, Italy published in "Journal of Hydrology" 519(2014) considered thatdifficulties of flood forecasters are faced evaluating how errors and uncertainties in forecasted precipitation propagate into stream flow forecast. These errors must be combined with the effects of different initial soil moisture conditions that generally have significant impact on the final result of flood forecast. Finally it conclude that forecasting must always exercise caution when interpreting the flood forecast system result their variability is not constant but depends on various factors such as the type and characteristics of the event and soil moisture initial condition .

"Artificial Neural Network (ANNs) for flood forecasting at Dongola Station in the river Nile (2014)Sudan", by Sulafa Hag Elsafi, Faculty of Arts , Dept. of Geography, Saudi Arabia included that heavy seasonal rain cause the river Nile in Sudan to overflow and flood the surrounding areas. The flood destroy houses, crops, roads, and basic infrastructure resulting in the displacement of people The study aim to focus to forecast the river Nile flow using an ANN as a modeling tool and validated the accuracy of the model against actual flow. The ANN model was formulated to simulate flow at a certain location in the river reach. Based on flow at upstream location. Different procedure was applied to predict the flooding by the ANN.This method is advantageous because only one variable is required.This study facilities the production of rapid and repeated analytical testing. ANN has the advantage of simplicity when compared to other more sophisticatedmodels. Therefore in situation where information is lacking or difficult to obtain the ANN method provide the most viable for flood forecasting.

"One Dimensional Hydrodynamic Modeling of Flooding and Stage Hydrograph in the lower Tapi River in India" by P.V.Timbadiya,P.L.Patel, and P.D.Porey from Department of civil Engineering ,S.V.National Institute of Technology Surat published in current science vol.106 (2014) included that the simulation of floods for the years 2003 and 2006 and the development of stage discharge relationship along the lower Tapi River in India. The river network and cross sections for this study were extracted from the field survey contour of the Tapi River. The calibrated model was validated using low and high flood data of the years 2003 and 2006 respectively. The simulation result based on the hydrodynamic modeling can be improved by using two dimensional model particularly in the plain area. The result of the model can be further improved by giving due consideration to sediment transport in the river during flood.

"Prediction of Flood for Lower Tapi River using HEC-RAS"(2015) by DarshanMehta,Dr. S.M.Yadav,Mrs. SahitaWaikhom from SVNIT Suratincluded that the flood prediction using HEC RAS.This will be useful in the preparation of flood mitigation plan as a curative major for the control of flood. In this paper they focused to analyze the stability of a segment of TapiRiver by evaluating its capacity in response to discharge and slopes.

III. Objective

Floods the most devastating natural disasters, striking numerous regions in the world each year. During the last decades the trend in flood damages has been growing exponentially. This is a consequence of the increasing frequency of heavy rain, changes in upstream land-use and a continuously increasing concentration of population and assets in flood prone areas. In general, less developed countries are the most vulnerable to floods, causing damages that significantly affect the national GDP. At country and community levels important initiatives have and are being devoted to implement appropriate countermeasures, both structural and non-structural, aiming to alleviate the persistent threats of water-related disasters. Flood Forecasting forms an important tool in reducing vulnerabilities and flood risk and form an important ingredient of the strategy to "live with floods", thereby contributing to national sustainable development.

IV. Research Methodology

The expectation for flood forecast in terms of magnitude and timing have grown with the recognition of the importance of flood warning as a contribution to flood management. This means that past methods of simple extrapolation of forecast from gauges sites may no longer while the heart of any flood forecasting system is a hydrological model. The catchment modeling is just one of the crucial element on which the effectiveness and efficiency of an integrated flood forecasting and warning system (FFWS) depends. A hydrological forecast is an estimate of the future state of some hydrological phenomena such as flow rate, cumulative volume, stage level, area of inundation, or mean flow velocity at a particular geographical location .the lead time of such a forecast is the period from the time of making the forecast to the future point in time for which the forecast apply.

Rainfall and runoff models are designed to produce the required flood forecast from meteorological and other data. There are still significant problems to be overcome in using weather radar in combination with rain gauge.
The technique available for real time flood forecasting may be broadly classified in a four group
1. Deterministic Modeling
2. Stochastic Modeling
3. Statistical Modeling
4. Computational Technique. Like Artificial Neural Network (ANN) and Fuzzy Logic.

The deterministic models are based on either index catchment models or conceptual catchment model. Such a model tends to simulate the basin response to hydrological event and do not fully utilize information collecting during event. Furtheretheredeterministic model were originally developed fordesign studies and their formulation has not been influenced by the need to incorporate hydrological information. In real time as a consequence these model cannot readily be updated and may prove difficult to reinitialize following telemetry or computer breakdown. The statistical model involve the development of relationship correlating the flood characteristics of forecasting station and upstream gauging station considering the various other factor influencing the flood. The ANN And fuzzy logic based models which have the potential for the real time flood forecasting are capable of considering the inherent nonlinear ties in the rainfall runoff process is to be going to use for this project. Depending on the availability of hydrological and hydro-meteorological data, basin characteristics, computational facilities availability at forecast station.

There are different flood forecasting technique used which include 1. Simple relation developed correlating the stage discharge data.2. Co axial correlation diagram developed correlating the stage discharge and rainfall data etc.3.Eventbased hydrological system model for small to moderate size catchment.4. Network model consisting of the sub basin and sub reaches for the large size catchment 5. Hydrologic model, the stochastic model have been mostly applied but research and academician for real time flood forecasting, however their application are restricted only a few places. The application of the computing technique such as ANN and fuzzy logic are currently in the development stage and being mostly used by the academician and researchers.

Thus mostly statistical approach is used to formulate the real time flood forecast, Event based network model and multi parameter hydrological model are applied for some of the project some sort of flood warning arrangement had existed in a few state of country.

V. Data Requirement

The precise details of data requirement will depend on the particular nature of a flood warning system and its objective. A real time data collection subsystem for receiving and processing the relevant information. This will include meteorological information, the discharge data at appropriate gauged section in rivers from impoundment and also soil moisture measurement if required. This may involve manual or automatic recording gauges terrestrial data collection platform, ground based radar, satellite, or borne sensors, and extensive use of GIS.

5.1 Hydrological

DataThis data essentially relate to measurement of river flow and level and the monitoring instruments should be able to record accurately. A flood forecasting system will require a network of stream gauges ranging from simple staff gauge to Doppler or ultra-sonic sensing devices measuring level or flow.

5.2 Meteorological Data

Rainfall intensity and duration, precipitation forecast and past data for calibration of rainfall-runoff models are all necessary prerequisite to develop and operate a successful flood forecasting and warning system.Meterological data and forecast are required in real time to maximize the lead time for flood forecast and warning. The principal item for meteorological data used is rainfall and this is required from a network of rain gauge or radarcoverage. These data will provide a best estimate of a rainfall over the area modeled.

5.3 Topographic Data

Topographic data are increasingly required for the development of flood forecasting systems as more demands are made for models to produce realistic estimate of spatial flooding. Topographic information which can be obtained from maps and used to delineate catchment areas and more detail information now available from terrain or digital elevation model (DEM) data.

Other useful information may include population and demographic data to indicate settlement at risk, inventories of properties, reservoir and flood protection infrastructure control rules, and systematic post flood damage assessment.

VI. Result

The result or output for flood forecasting depends on the choice of appropriate method and models used for flood forecasting. Model calibration is the process of adjusting model parameter values until model results match historical data. The process can be completed using engineering judgment by repeatedly adjusting parameters and computing and inspecting the goodness-of-fit between the computed and observed hydrograph. After computing the exact value of the unknown variable during the calibration process the calibrated model parameters are tested for another set of observations to estimate the model accuracy. In this process if the calibrated parameters do not fit the data of validation, the required parameters have to be calibrated again. Through investigation is needed to identify the parameters to be calibrated again. The developed model is validated thoroughly with several observed flood event. Comparing hydrograph provides a qualitative evaluation of the simulation skill as the graphical representation permit a quick comparison between simulated and observed levels within a time frame. The accurate representation of flood volume is also important to demonstrate how effective the model is relating the rainfall and run off response.

VII. Conclusion

At Present the performance of many flood forecasting system in an operational context is sub optimal and often below expectation .The information they designed to provide fail to reach much of the target audience. Existing flood warning systems even with their manifest deficiencies can be effective in the mitigation of flood damage. It is very likely that if they are recast in terms of completeness, carefully planned and kept alive, their effectiveness can be augmented considerably. In India most of the techniques for formulating the real time flood forecast are based on statistical approach. For some project network model and multi parameter hydrological model are used. Conventionalsystems of communication are normally used for transmitting the data in real time. Flash floods are usually experienced. As such there is no system for formulating the flash flood forecast. It results in heavy losses of lives and properties.

There is a need for improvement of the real time flood forecasting system in India. Efficient automatic communication systems are required to be established for transmitting the data in real time. The forecasting technique such as deterministic models, stochasticmodels, ANN and Fuzzy Logic techniques etc. are required to be studied and a suitable method may be recommended for field applications based on the performance evaluation criteria and considering the data availability. The information about the flood have to be disseminated well in advance to the people likely to be affected so that an emergency evacuation plan may be developed for the river basin.

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