ISSN 2250-3153

Implementation of Neural Networks in Flood Forecasting

Radhika Subramanian

Symbiosis Institute of Computer Studies And Research, Pune

Abstract- This paper focuses on the implementation of Soft-Computing Technique (Artificial Neural Network) on Flood Management System. This paper presents an alternate approach that uses artificial neural network to simulate the critical level dynamics in heavy rain. The algorithm was developed in a decision support system environment in order to enable users to process the data. The decision support system is found to be useful due to its interactive nature, flexibility in approach and evolving graphical feature and can be adopted for any similar situation to predict the critical level. The potential benefit of a flash flood forecast depends on three main factors. Firstly its accuracy, which in turn depends on the accuracy of the forecast data, the observational data and the numerical weather modeling and updating procedures. Secondly the magnitude of the lead time it provides before critical levels are reached which can be improved by using quantitative precipitation forecasts from meteorological satellite cloud image, weather radar and numerical weather prediction models. Thirdly, the benefits depend on the effective use of the forecast information, for flood monitoring, flood warning, the operation of flood protection structures and the evacuation of people and livestock. This requires appropriate decision information in a timely manner to those who need it, where they need it, in a manner that is easy to understand. Finally, use of Artificial neural network may serve as a tool for real-time flood monitoring and process control.

Index Terms- Decision Support System; Neural Network; Automatics weather station; Flood level; Numerical Weather Prediction (NWP)

I. INTRODUCTION

Hydroinformatics is a branch of informatics which concen-trates on the application of information and communications technologies (ICTs) in addressing the increasingly serious problems of the equitable and efficient use of water for many different purposes. Growing out of the earlier discipline of computational hydraulics, the numerical simulation of water flows and related processes remains a mainstay of hydroinfor-matics, which encourages a focus not only on the technology but on its application in a social context. On the technical side, in addition to computational hydraulics, hydroinformatics has a strong interest in the use of techniques originating in the so-called artificial intelligence community, such as artificial neural networks or recently support vector machines and genetic programming. These might be used with large collections of observed data for the purpose of data mining for knowledge discovery, or with data generated from an existing, physically based model in order to generate a computationally efficient emulator of that model for some purpose. Hydroinformatics draws on and integrates hydraulics, hydrology, environmental engineering and many other disciplines. It sees application at all points in the water cycle from atmosphere to ocean, and in artificial interventions in that cycle such as urban drainage and water supply systems. It provides support for decision making at all levels from governance and policy through management to operations.

A. Flood Management

A Flood (natural calamity is an overflow of water that submerges land. Floods are caused by many factors: heavy rainfall, highly accelerated snowmelt, severe winds over water, unusual high tides, tsunamis, or failure of dams, levees, retention ponds, or other structures that retained the water. Flooding can be exacerbated by increased amounts of imper- vious surface or by other natural hazards such as wildfires, which reduce the supply of vegetation that can absorb rainfall. Flood management evolves taking appropriate measures for flood control such as predicting floods and warnings etc.

B. Study Area: Mumbai Floods

The 2005 monsoon proved to be extremely erratic for Maharashtra. In the beginning, a serious deficiency of rainfall, particularly in the western Vidarbha and Marathwada, created a drought-like situation with shortage of drinking water and fodder. The situation changed dramatically in the course of a week from July 21, when unusually heavy rains lashed the coastal areas of Konkan and Western Ghats. It caused extensive flooding in Raigad and Ratnagiri districts, with many towns and villages under waters. On July 26,when the highest ever rainfall recorded in the last 100 years in the country battered the sub-urban Mumbai and Thane, Maharashtra experienced one of the worst floods in its history. For the first time ever, Mumbai's domestic and international airports (including Chatrapati Shivaji International Airport, Sahar and Juhu aerodrome) were shut for more than 30 hours due to heavy flooding of the runways, submerged Instrument Landing System equipment and extremely poor visibility. The Mumbai-Pune Expressway, which witnessed a number of landslides, was closed the first time ever in its history, for 24 hours.

C. Artificial Neural Network

An Artificial Neural Network (ANN), usually called neural network (NN), is a mathematical model or computational model that is inspired by the structure and/or functional aspects of biological neural networks. A neural network consists of an interconnected group of artificial neurons, and it processes information using a connectionist approach to computation. The word network in the term 'artificial neural network' refers to the

Fig 1: Study Area

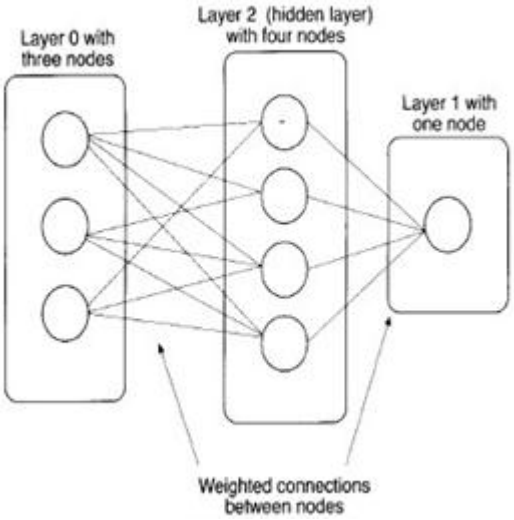

Fig 2: Artificial Neural Network

interconnections between the neurons in the different layers of each system. An example system has three layers. The first layer has input neurons, which send data via synapses to the second layer of neurons, and then via more synapses to the third layer of output neurons. More complex systems will have more layers of neurons with some having increased layers of input neurons and output neurons. The synapses store parameters called "weights" that manipulate the data in the calculations.

II. IMPLEMENTATION OF NEURAL NETWORKS IN FORECASTING

A. Neural Networks

The ANN nodes in neighbouring layers are linked via weighted connections. The values of those weights can be adaptively modified during the process of training the network. Shortly the Multi-Layer Perceptron network (see Figure 2) operates in the following way: signals Si (i=1,..N) from the input nodes (e.g. values of input variables normalized to 0-1 interval) are multiplied by proper weights wji (j =1,...K), connecting the neuron from which signal has been dispatched and a suitable neuron in the second layer. In the second layer the weighted sum of all the inputs are computed and then transformed by logistic function giving the output value of a neuron in the second layer. Afterwards the weighted signals zj (multiplied by proper weights vj), are transferred to the neuron of the third layer. In the neuron of the third layer the new weighted sum is computed and after de-normalization of the output, the sought (forecasted) value may be determined. This is a feed-forward network, which means that there is only one direction of the flow of information, from the input to the output layer.

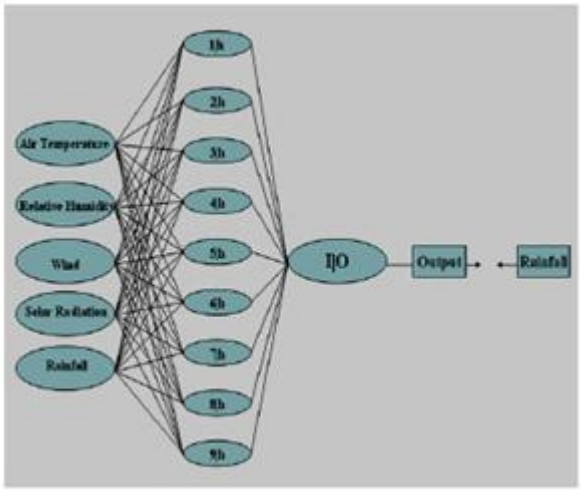

Fig 3: Estimation with ANN

B. Automatic Weather Stations

An automatic weather station (AWS) is an automated version of the traditional weather station, either to save human labour or to enable measurements from remote areas. An AWS will typically consist of a weather-proof enclosure containing the data logger, rechargeable battery, telemetry (optional) and the meteorological sensors with an attached solar panel or wind turbine and mounted upon a mast. The specific configuration may vary due to the purpose of the system. The system may report in near real time via the Argos System and the Global Telecommunications System, or save the data for later recovery. In the past, automatic weather stations were often placed where electricity and communication lines were available. According to the article published on 30th June 2012, "An erratic monsoon coupled with not so accurate Met Department predictions has spurred the Maharashtra Government to accelerate the proposed installation of over 2,000 private Automatic Weather Stations (AWS) in the state."

C. Working

The purpose of this network consisting of AWSs (3 stations) is monitoring the amount of rainfall. Part of these Stations are equipped with meteorological sensors as temperature, relative humidity, windspeed /direction, solar radiation and this information is useful for making meteorological forecast that are

part of the material that is going to be employ in the warning alert system. The network works fully automatically or by including observer information. Also monitoring and administration of the stations, data communication, store data, alarm handling and process of the measurements are discussed, as the system is part of the national warning alert system a brief explanation of the inter institutional system is treated. The main target of the research is to design, verify and integrate the Automatic Weather Stations (AWS), remote sensing such as meteorological satellite image and Numerical Weather Prediction (NWP) product such as relative vorticity. The all data from everything as above to the server was analyzed by using decision support system program and the process of real- time reporting situation by the network system was monitored and adjusted.

D. Decision Support System

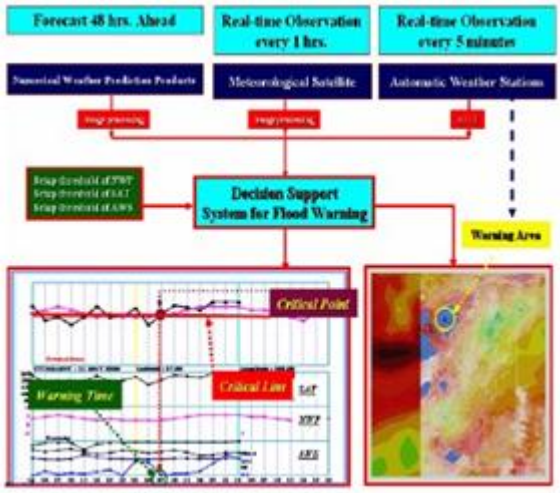

Fig 4: DSS

E. Warning

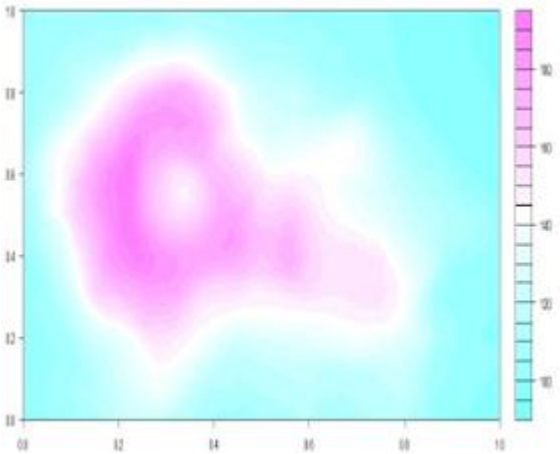

Fig 5: Warning Area

F. Conclusion

The principal conclusion from this research is that the new AWS network is an excellent Technology that permits a quantitative and qualitative improvement of the measurement of meteorological parameters.The introduction of this system is giving to risk area protection more information In type and detail to be an effective tool in providing advance notice of potential flooding So orderly evacuations can take place prior to the onset of flooding will require a strong effort to assure the long term sustainability of the system. Integrating human knowledge with modeling tools, an intelligent decision support system (DSS) is developed to assist decision makers during different phases of flood management. The DSS is able to assist in: selecting suitable flood damage reduction options (using an expert system approach); forecasting floods (using artificial neural networks approach); modeling the operation of flood control structures; and describing the impacts (area flooded and damage) of floods in time and space.

REFERENCES

[1] Decision Support System for Flash Flood Warning Man-agement using Artificial Neural Network-Wattana Kan-bua, Charn Khetchaturat.

[2] Flood Early Warning System Develop at Garang River Semarang using Information Technology base on SMS and Web Joko Windarto Engineering Faculty, Diponegoro University Semarang Indonesia. Hydroinformatics Support to Flood Forecasting and

[3] Flood Management-ADRI VERWEY Maharashtra Floods 2005 Relief and Rehabilitation-

[4] Report made by Government of Maharashtra

AUTHORS

Radhika Subramanian, Symbiosis Institute Of Computer Studies And Research, Pune