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# Forecasting Flood Due to Unplanned Discharge of Dams in Western Maharashtra Using Artificial Neural Network and Real Time Monitoring by Internet of Things

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**ABSTRACT:**Floods are the most common natural disasters, and cause significant damage to life, agriculture and economy. Research has moved on from mathematical modelling or physical parameter-based flood forecasting schemes, to methodologies focused around algorithmic approaches. By last few years the western Maharashtra, which has ample irrigation systems; get affected by heavy rainfall and unplanned flood conditions. The present work is carried out in the downstream area of Dhom dam, under Satara Irrigation division of Maharashtra, India. The Internet of Things is a field of applied electronics and computer science where a system of devices collects data in real time and transfers it through a Wireless Sensor Network to the computing device for analysis. IoT generally combines embedded system hardware techniques along with data science or machine learning models. In this work, an IoT and machine learning based embedded system is proposed to predict the probability of floods in a river basin. The existing flood forecasting is for upstream catchment, forecasting the HFL of dam. Data regarding rainfall, Highest Flood Level, inflow, outflow data has been used for forecasting flood levels using ANN. A real time monitoring has been suggested using IoT and CDMA. The existing infrastructure was recommended to setup monitoring devices to avoid life and property loss.

**KEYWORDS:**Early warning systems, Flood Monitoring, Internet of Things, Unplanned Discharge.

## I. INTRODUCTION

The flood estimation process is somehow found uncertain due to nonlinear correlation of different metrological parameters like rainfall, evaporation, seepage, etc. Estimation of flood levels in real time manner is a significant necessity in flood management operations. A risk of peak outflow or discharge through dams may result loss of properties and livestock. In case of the downstream or backwater dam sites, due to topography or limited mechanical control real time monitoring of flood situations will be most recommended. Such an automated systems may provide effective flood management and control. Earlier various models have been developed using physical, empirical and soft computing approaches. In recent years it has been observed that many parts of western Maharashtra are getting affected largely by sudden flood conditions. Sometimes unexpected massive rainfall also caused severe flood conditions. This geographic part of Maharashtra contains large number of dams constructed in series. These dams are across major rivers like Koyana, Panchaganga, Krishna, etc. In case of massive rainfall, the discharge becomes mandatory causing crucial flood conditions. Few recent episodes can be stated 2 in July 2021, May 2020, October 2020, etc. These flood episodes not only affected properties but developed insecure lifestyles as well. The present experimentation consists, estimation of flood levels using ANN and developing a communication system to alert civilians to reduce further losses. The application of IoT, conveniences some ordinary activities, improves the way people interact with the surroundings, and enlarges our social communications with other people and objects. IoT refers to network technology that transfers information between sensors – receiving devices and output. In addition, this technology supports various features like adaptability, real-time monitoring, traceability, etc. A sensor operated flood level detection mechanism has been proposed and experimented on lab scale model. An Arduino operated real time monitoring will provide changing flood levels and communication will followed using CDMA tool.

## II. RELATED WORK

Forecasting flood includes estimation of rainfall or precipitation and stormwater generated for specified duration may be per day or per hours. (Thirumalaiah and Deo 1998; Jain et al. 2018; Karl and Lohani 2010).[1].Flood forecasting is an important component of flood management(Li et al. 2016; Campolo, Soldati, and Andreussi 2003).[2].The real time monitoring of flood helps to get early warning of severe conditions, prevention of desire, deciding control points, mitigation strategies and ultimately reduction and property losses. (Lindenschmidt et al. 2019).[3].The real time monitoring of flood helps to get early warning of severe conditions, prevention of desire, deciding control points, mitigation strategies and ultimately reduction and property losses. (Lindenschmidt et al. 2019).[3].ANN acquires large collection of units that are interconnected in some pattern to allow communications between units. These units, also referred to as nodes or neurons, are simple processors which operate in parallel. Every neuron is connected with other neuron through a connection link. Each connection link is associated with a weight having the information about the input signal. This is the most useful information for neurons to solve a particular problem because the weight usually inhibits the signal that is being communicated (Anaokar, Khambete, and Christian 2021)(Gadekar and Ahammed 2016).[4].

## III. METHODOLOGY

The proposed work has to be planned for the flood affected area near Dhom dam, Satara District; MS, India. The location of dam and flood affected area is highlighted in Fig. 1.



Figure 1 Study area with catchment and flood affected zone.

In the first stage of development of model using Artificial Neural Network (ANN); four input parameters viz. rainfall, evaporation, Inflow and outflow are considered as input parameter and highest flood level as output.

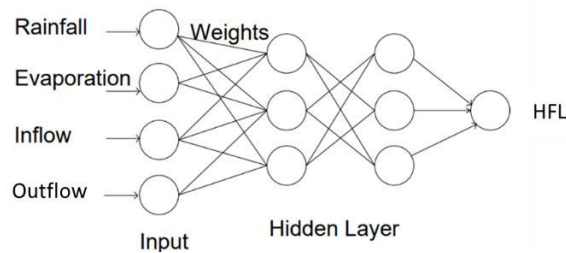


Figure 2 ANN network

The feedforward type neural network was adopted, as shown in Fig. 2, as that has the facility that any continuous function to be approximated.

The data was collected from officio of dam regulation authority, of Dhom Dam – Satara Irrigation Department MS. A five-year data with reference to rainfall, inflow, outflow, evaporation and highest flood level recorded was considered in the development of ANN model. Records for 366 days for all five parameters were considered. The minimum and maximum values are tabulated in table 1 below.



Table 1 Minimum, Maximum and average values of Input and Output Parameters

Name	Minimum Value	Maximum Value	Average Value
Rainfall	13	114	63.5
Evaporation Losses	0.0058	0.310	0.1579
Inflow	0.0001	16.6347	8.3174
Outflow	0.0229	19.688	9.8554
HFL	748.295	749.440	748.867

Laboratory scale setup was developed to validate the model. The schematic diagram is as shown in Fig. 3 below.

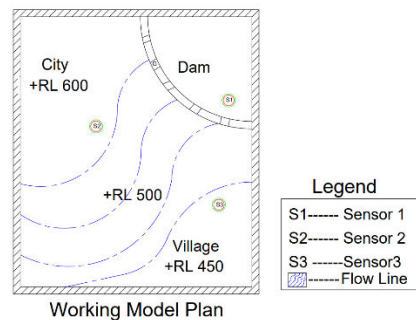


Figure 3 Schematic diagram of Proposed lab scale model

In case of lab scale model, three sensors were fitted to sense water level in the reservoir, backwater level and downstream level. The sensor used were as shown Fig. 4, below.



Figure 4 Floating Sensor installed for water level monitoring

The sensor being adopted are with specifications as Contact Rating 10W, Switching Voltage: 220V, Switching Current: 0.5A, Breakdown Voltage: 220VDC, Carry Current: 1A, Contact resistance: 100mΩ. The Arduino Uno can be programmed with the Arduino software. The Arduino Uno has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. LCD1602 Parallel LCD Display was provided which is a simple and cost-effective mode of display for real time monitoring.

#### IV. EXPERIMENTAL RESULTS

The ANN network was trained with the help of 366 training patterns using Feed forward backpropagation type network with transfer function as Tan – Sigmoidal and training approach Levenberg Marquardt algorithms. 70% data was used for training, rest 30% data was used for validation and testing equally. The number of hidden layers were provided using thumb rule. Figure 5, indicates the output found after 49 iterations with best epoch at 64.

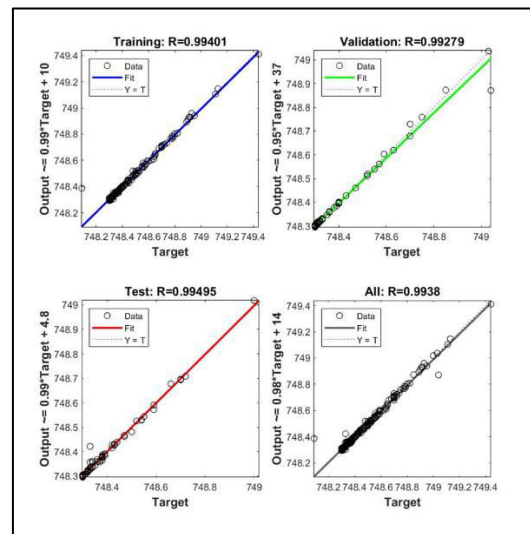


Figure 5 ANN output plot

When the plot was generated within observed HFL and predicted HFL it was found precise with R square value 0.96. Figure 6, shows the same.

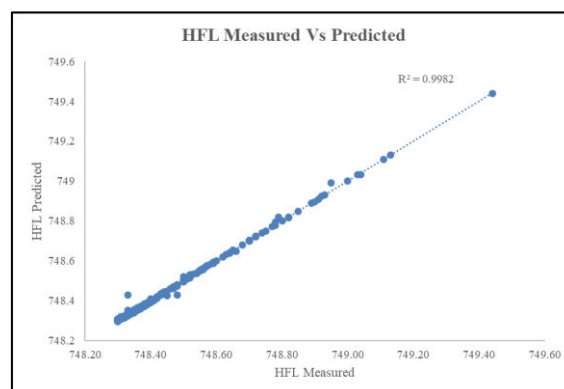


Figure 6 Graph showing HFL measured Vs Predicted by ANN

This predicted HFL can be interpreted with authorities to arrange necessary remedial actions. At the same time, the sensor-based mechanism will provide real time monitored data through floatable sensor. The HFL shall be communicated with population through SMS. 500.

## V. CONCLUSION

The prediction of flood level is very important step to reduce the losses in case of unplanned dam discharge. Many times, in western Maharashtra, a continues heavy rainfall makes officials unavoidable to start discharge with massive outflow. In such unavoidable circumstances this approach will be more helpful to reduce lives and property losses as well.

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