FLOOD DISASTER MANAGEMENT FOR CULTIVATION AND POWER GENERATION – A REVIEW

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ABSTRACT

This study was conducted in Department of Computer Science, G. C. University, Lahore, Pakistan during the year 2012. It presents the review work of Flood Disaster Management and proposes a new arrangement to overcome the disasters in flooded areas of Punjab, Pakistan. This arrangement is proposed to be designed at ArcGIS by mapping boundaries of Tehsils, Districts and water bodies (rivers, canals and branches) of whole Punjab. This work suggests three arrangements at Mianwali, Jhang and Bahawalpur to control the flood water and manage it for useful cultivation and electricity generation through various reservoirs. These three arrangements are required to be established at various roots. The autonomous control, Adaptive Control System, is based on fuzzy logic to control whole arrangement according to the need.

KEYWORDS: Flood control; crops cultivation; power generation; adaptive control system; Pakistan.

INTRODUCTION

Over the last few decades a rapid disaster management is in progress to divert this disaster for useful cultivation and power generation. Many researchers have worked on flood control using different techniques and tools. Previously work done by Chuntian (2) is about to make a model by using fuzzy for controlling flood in selected river. Similarly flood forecasting and flood management system has been reported by Todini (8). A technology based work called as counter propagation by using fuzzy-neural network is reported by Chang *et al.* (1). Karaboga *et al*. (4) have worked on controlling the spillway gates of dams by using a technology named as optimum rule number. Similar work for controlling the reservoir water level has been done by Li *et al.* (6). Then assessing the flood risks and solutions on affording the

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risks is reported by Lind *et al*. (5). They have suggested better design to reduce risks from making the best out of social and economic benefits. This design also influences the financing details. It is important to recheck the typical design of reservoir to increase the capacity of soil water. A model for two dimensional water flow between parallel drainages with rising water level is designed by Wiskow *et el.* (9). Sanders *et al.* (7) have described that diversion of water flow towards an off-line reservoir is evaluated to control problem of an interference between waves that can be reduced at peak of the flood. These workers applied three strategies including controlling of passive, controlling of weir and controlling of gate. They found that controlling of gate is the process in which dam failure is optimized into an off-line reservoir, to complete 2–3 times to reduce the flood depth of passive. If the gate would not be opened on time by any failure or error then controlling of gate becomes less effective than passive controlling. A reservoir flood model is presented by Chuntian and Chau (3) that is based upon three-person multi-objective conflict decision model. In this model an ideal bargaining solution is sorted by passing through two stages; first is programming stage and the second stage is to chose the best decision using fuzzy pattern recognition to obtain group decision.

ANALYSIS AND DISCUSSION

In fuzzy optimal model (2), the author described how to control the flood in Yangtze river; for this purpose Three- Gorges Reservoir is made to be used for whole basin and downstream types of floods. Three types of sub-system are used in making this whole system workable. Sub-system I has four reservoirs at upper side; sub-system II has four downstream reservoirs. Then the reservoir named as Geheyan Reservoir on upper Qiangjiang falls into sub-system III. Main aim of sub-system I is to reduce inflow of flood to Three Gorges Reservoir specially in case of downstream floods. Sub-system II has played an important role in Three-Gorges Project. Sub-system III has the functionality of reducing reservoir from discharging and during the procedure of regulating the Jingjiang and Chenglinji to diversion regions. It also provides compensation criteria. Out of above three sub-systems, sub-system II will help achieve the general flood control objectives of the system.

In an operational decision support system for flood risk mapping, forecasting and management, a tool is developed for making plans and management and for that high performance computers are available, to detect risky areas. This system first forecasts floods by analyzing the present meteorological data and forecasts available at different time and space scales. Then process of evaluation starts which checks the effects of decisions aimed at reducing social, economical and environmental damages. Then it allows continuous training of staff and lastly three groups work in this system i.e. meteorologists/hydrologists, operational managers and civil response managers (Fig. 1).

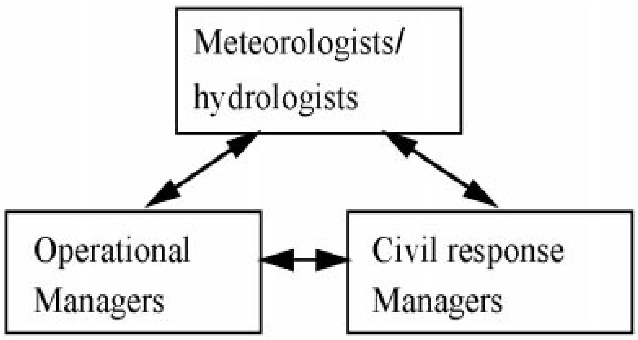

Fig. 1. Three groups participating in the system

The system first forecasts precipitation through Satellite, RADAR and Telemetering Gauges and with the help of this forecast the system makes rainfall run-off model. This model forecasts flood which help this system define its controlling strategies and hydraulic models. These hydraulic models and control strategies are used to make inundation maps for analyzing flood effects. Then this system defines flood impact and uses multi-criteria analysis and quantitative impact analysis for generating flood risks maps.

In control spillway gates of dams, by using fuzzy logic controller with optimum rule number, the operation of reservoir dams during flood events is compound, non-stationary controlled process and is strongly influenced by the conditions of hydrology, non-predictable in advance. The gates for reservoirs during floods are based on fuzzy logic control (FLC). Taboo searching algorithm that is a contemporary famous heuristic algorithm, is used for fuzzy logic controller. Simulation results show that Taboo produces better results because it provides efficient solution. A basic FLC is broken down into four basic elements viz. fuzzification unit - knowledge base (rule base and database), decision-making unit (inference mechanism) and defuzzification unit. Fuzzification module converts the measurements (net) of data in vague terms. Knowledge base consists of a rule base and database. The rule base contains fuzzy control rules obtained from the natural system and the database includes all definitions used for functions for members and stakeholders. The decision making process (conclusion) module determines which way the system will make conclusions using the rules of fuzzy in rule base in the grant of input. Lastly, defuzzification unit combines results of all rules for a given input to generate an abrupt value as an output. The performance of an FLC depends on the rules, the inference mechanism and method of defuzzification.

According to Counterpropagation fuzzy-neural networks (CFNN), a case study is taken as a flood in a city, solved by a high control system nonlinear control problems and the complex melodies strongly transformation of human intelligence logic function system. CFNN simulates human-intelligence strategies for the operation in a flood control system in form of fuzzy rules. For this system two areas are used as a case study. Historical records are also collected that contained the raw facts and figures for volume of rainfall, internal level of water and pumping operating conditions and torrential rain events. Classification on the base of input is done according to the similarities that are mapped into the hidden layer to form earlier rules, and weights are adjusted at the output layer to get the best output function. The results show that the presented computerized network has a basic structure to build effective ability to learn like a man who has guts to make strategies. It also has the ability to automate the operations of flood control system.

According to Chinese law for Flood Control Act, no tank water level exceeds the limited level of flood water (FLWL). The system provides sufficient capacity for storage of flood water. Dynamic control of ELWL for the operation of reservoir by considering inflow uncertainty, consists of a model with dynamic input, which includes the flood water uncertainty and error in input. The literature model is composed of three sections: the first section is a first release of unit, to calculate the flood forecasting with the help of upper limit of dynamic control bound. An operating unit replacement is the second section which is used to maintain recession of flood and the third section is a unit of risk analysis, to fix the flood damages. All these sections are committed FLWL calculated by using simulation Monte Carlo. The selected case study for this method is three Gorges dam of China (TGR). A model is predicted for the flow of TGR and that model uses multiple-input, single-output and future inflows from the records evaluated by assuming that inflow prediction error is normally distributed.

SUGGESTED MODEL

Every country has made its research in flood management by changing the direction of flood water or by storing the flood water to make the country progressive, safe and prosperous. All the above research is based upon their own circumstances and their own land capabilities and suitability. Suggested solution is specifically meant for the land of Pakistan. Research areas of Punjab province were recently badly affected by the flood of 2010 (Fig 2).

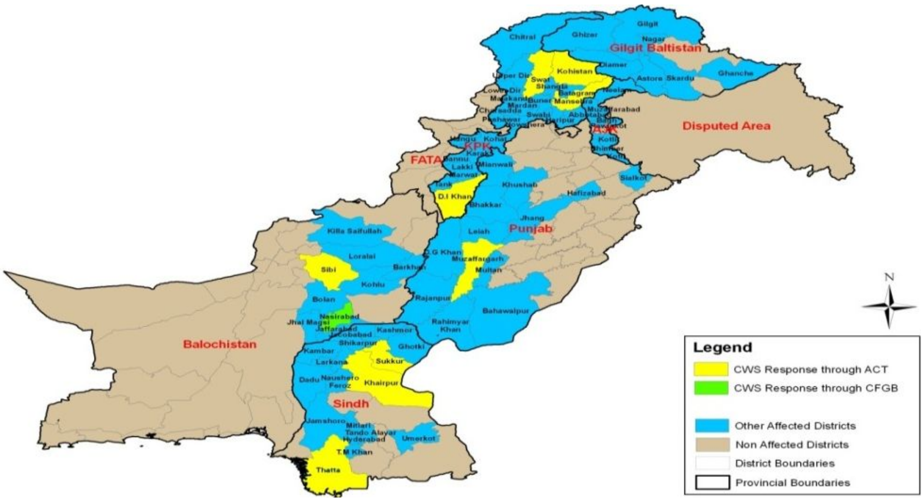

Fig. 2. Flood affected areas of Pakistan

For this purpose three areas of Punjab are chosen in which no such preventive measures are taken to save from flood water. Map of the whole arrangements is shown in Fig. 6.

First arrangement is at Mianwali and starts from Indus river to Jehlum river, named as Arrangement-A (Fig 3). It takes flood water from Chenab river through pipes and these pipes give direction to flow of water with the help of openings. Openings will send water to reservoirs and if the reservoir is filled, openings will not open and direct the water to other reservoirs.

Second arrangement is at Jhang and at Chenab river, called as Arrangement-B (Fig. 4). Third arrangement is at Bahawalpur and at Satluj river named as Arrangement-C (Fig. 5).

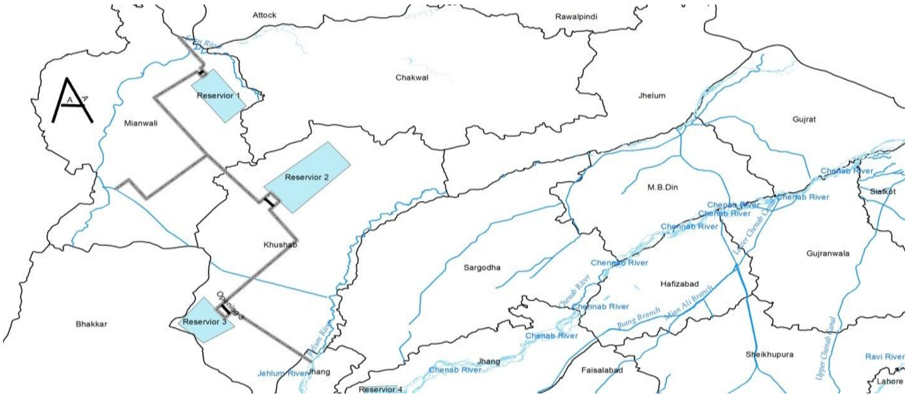

Fig. 3. Arrangement-A

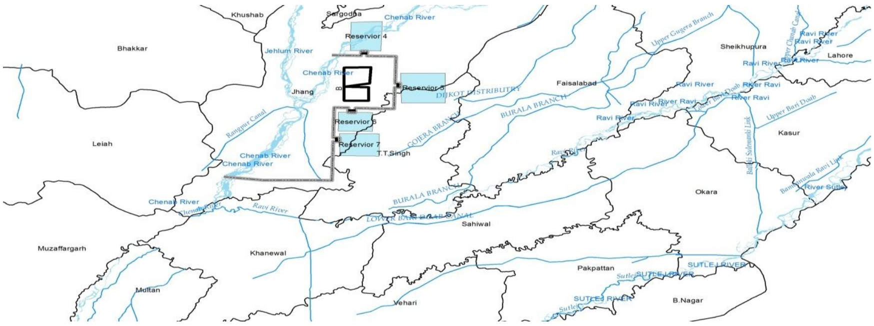

Fig. 4. Arrangement-B.

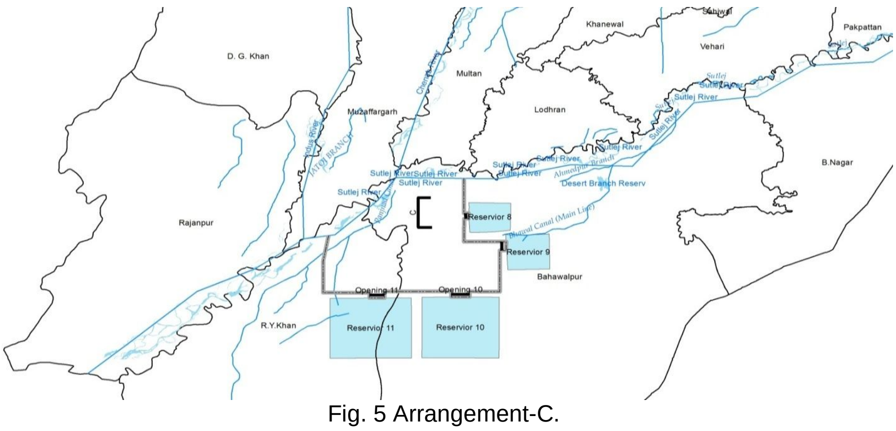

Fig. 5 Arrangement-C.

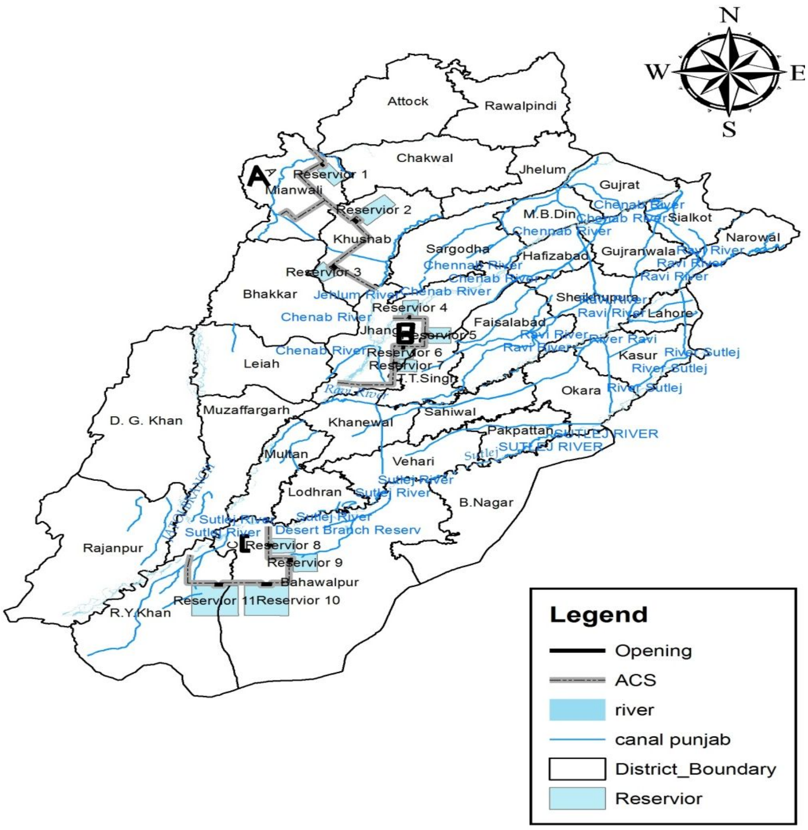

Fig. 6 Map of water bodies of Punjab and proposed arrangements

Cascading Control System

A control system is designed to implement the above mentioned arrangements. This system consists of two fuzzy sets. The diagrammatical presentation of the system is shown in Fig. 7.

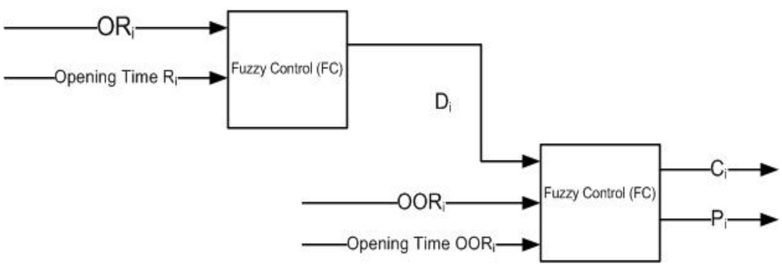

Fig. 7. Cascading Control System.

OR_i is opening gate of respective reservoir.
Opening time OR_i is the opening time of that respective reservoir which shows the duration for which the gate of reservoir remained open.
D_i is depth of the respective reservoir. Larger the depth, maximum would be the opening time of the gates.
OOR_i (output opening reservoir) shows output from the reservoir.
Opening time OOR_i is the opening time of respective output reservoir.
C_i is the cultivation storage from respective reservoir.
P_i is the power storage from respective reservoir, where *i* is total number of reservoirs and it ranges from 1,2,3,4,…11.

Fuzzy control set consists of Fuzzifier, Defuzzifier and rule based inference. Opening of any reservoir and its opening time is given as input to first fuzzy control set. This set generates output in the form of depth of reservoir and this depth will become the input of second fuzzy set with help of output opening reservoir and this time of opening as an input for cultivation and generating power for the respective reservoir.

CONCLUSION

This research and review work suggests a state of the art control system for flood water management for useful cultivation and power generation. The control system based on fuzzy logic is suggested to be implemented. The control system may further also be improved using FPGAs based microelectronic system. These types of protected management systems may also be extended elsewhere according to the need of flooded area.

REFERENCES

1. Chang, F. J., K.Y. Chang and L. C. Chang. 2008. Counter propagation Fuzzy-Neural Network for city flood control system. J. Hydrology. 358(1): 24-34.
2. Chuntian, C. 1999. Fuzzy optimal model for the flood control system of the upper and middle reaches of the Yangtze River. Hydrological Sciences. 44(4): 573-582.
3. Chuntian, C. and K.W. Chau. 2002. Three-person multi-objective conflict decision in reservoir flood control. European Journal of Operational Research. 142(1): 625–631.

4. Karaboga, D., A. Bagis and T Haktanir. 2008. Controlling spillway gates of dams by using Fuzzy Logic Controller with optimum rule number. Applied Soft Computing. 8(1): 232-238.
5. Lind, N., M. Pandey and J. Nathwani. 2009. Assessing and affording the control of flood risk. Structural Safety. 31(1): 143-147.
6. Li, X., S. Guo, P Liu, and G. Chen. 2010. Dynamic control of flood limited water level for reservoir operation by considering inflow uncertainty. J. Hydrology. 391(1): 124-132.
7. Sanders, B. F., J.C. Pau and D. A. Jaffe. 2006. Passive and active control of diversions to an off-line reservoir for flood stage reduction. Advances in Water Resources. 29(1): 861-871.
8. Todini, E. 1999. An operational decision support system for flood risk mapping, forecasting and management, Urban Water. 1(1): 131-143.
9. Wiskow, E., R. Rienk and van der Ploeg. 2003. Calculation of drain spacing for optimal rainstorm flood control. J. Hydrology. 272(1): 163-174.