**2.n Flood Disaster Indicator of Water Level Monitoring System**

The early warning systems for flood management have been developed rapidly with the growth of technologies. These systems help to alert people early with the used of Short Message Service (SMS) via Global System for Mobile Communications (GSM). This paper presents a simple, portable and low cost of early warning system using Arduino board, which is used to control the whole system and GSM shields to send the data. System has been designed and implemented based on two components which is hardware and software. The model determines the water level using float switch sensors, then it analyzes the collected data and determine the type of danger present. The detected level is translated into an alert message and sent to the user. The GSM network is used to connect the overall system units via SMS. (Wan Haszerila Wan Hassan, Aiman Zakwan Jidin, Siti Asma Che Aziz, Norain Rahim 2018)

# 2.n Flood Early Warning Systems Using Machine Learning Techniques: The Case of the Tomebamba Catchment at the Southern Andes of Ecuador

Worldwide, machine learning (ML) is increasingly being used for developing ﬂood early warning systems (FEWSs). However, previous studies have not focused on establishing a methodology for determining the most efﬁcient ML technique. We assessed FEWSs with three river states, No-alert,Pre-alert and Alert for ﬂooding, for lead times between 1 to 12 h using the most common ML techniques, such as multi-layer perceptron (MLP), logistic regression (LR), K-nearest neighbors (KNN), naive Bayes (NB), and random forest (RF). The Tomebamba catchment in the tropical Andes of Ecuador was selected as a case study. For all lead times, MLP models achieve the highest performance followed by LR, with f1-macro (log-loss) scores of 0.82 (0.09) and 0.46 (0.20) for the 1 h and 12 h cases, respectively. The ranking was highly variable for the remaining ML techniques. According to the g-mean, LR models correctly forecast and show more stability at all states, while the MLP models perform better in the Pre-alert and Alert states. The proposed methodology for selecting the optimal ML technique for a FEWS can be extrapolated to other case studies. Future efforts are recommended to enhance the input data representation and develop communication applications to boost the awareness of society of ﬂoods. (Hydrology 2021)

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