An INTERESTING System

Typhoon Damage Cost Estimation through Artificial Neural Network

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*Abstract* — The Integral Emergency Response Tool for Identifying Natural disaster Gravity is a system used to estimate the cost of damages brought about by typhoons that sweep the Philippines each year. This program is implemented using artificial neural network where data regarding the characteristics of typhoons, the characteristics of the area to be affected, and cost of damages are used to compute the cost of damages to the said area for better disaster mitigation and emergency response.

Keywords—artificial neural network; typhoon; cost estimation; disaster mitigation; emergency response; machine learning

# INTRODUCTION

Annually, the Philippine archipelago is affected by an average of 19 to 20 tropical cyclone systems. Of these, nine to ten make landfall, bringing damage to landlocked provinces as well as battering the coastal towns with strong winds, heavy rains, and storm surges. [1]

The country is prone to such natural disasters due to its location on the equator. The Pacific Ocean waters near the archipelago are exposed more to the sun due to the axial tilt of the Earth and therefore have higher temperatures that are favorable to the formation of typhoons. The ideal water temperature for typhoons to form is 28°C and the temperature of the water around the Philippine archipelago is normally above that temperature [2].

The Philippines is also prone to experience disastrous effects of these typhoons due to the topography of the country. According to World Bank estimates, more than 60 percent of the population lives along coastal regions in the country [2]. The low coastlines provide little protection against the strong winds and storm surges that may occur when the high tide coincides with such strong winds that the water is pushed further into the coast. Additionally, due to poverty in the country, most houses are made of light materials [3] like thin wood boards, galvanized iron roof and even cardboard and scrap. These light material houses provide no shelter against the effects of typhoons. Deforestation also contributes to the gravity of natural disasters. The reduction of the number of trees and plants in the mountains is directly proportional to an increased in severity of floods and landslides due to the lack of roots that would hold down the soil and absorb excess water brought about by the typhoon.

In light of these disastrous effects, it is important that the Philippines increase its disaster mitigation and response system. After experiencing crisis after crisis brought about by typhoons, the Philippines has been steadily improving its disaster mitigation and response action that a zero casualty figure is an achievable goal even if it involves a strong typhoon.

Human lives are not the only ones that are affected when calamity strikes a populated area. The physical infrastructure that is the backbone of civilization is also being damaged by strong winds and heavy rain caused by typhoons. The destruction of such asset prolongs the suffering of the people affected since they could not easily resume their normal lives after the storm has passed.

It is necessary to estimate the cost of damages before a typhoon strikes a locality so that necessary preparations may be easily organized and observed deficiencies may be eliminated or minimized so that at the event when the typhoon strikes the actual cost of damages may be lessened to the point that it is possible to recover in a small amount of time.

This paper seeks to solve this need for a damage cost estimation tool to aid the Filipino people in their annual struggle against typhoons by determining the cost that would be needed to rebuild the lives of the people affected by the typhoon.

# CONCEPT THEORY

Artificial neural network is an information processing system modeled after the biological neural network present in living organisms such as humans and animals. Interconnected elements act like the neuron cells that compose the brain and the nervous system where data from one element to the other as the system solves a specific problem.

Artificial neural networks learn through example. The user feeds training data to the system for it to learn the process that the user needs it to do. Once the system acquires the skills necessary for it to operate, validation data is fed to it to determine the deviations between the desired and actual output. Once the errors are detected, the system is fine tuned to reduce these deviations to a minimum. Finally, the system is tested in real world applications through the use of test data.

# METHODOLOGY

The artificial neural network is trained by the researchers to estimate the cost of damages an incoming typhoon will inflict on a locality. Two of the most destructive typhoon characteristics, wind speed and amount of rainfall, and the partition of the area according to use are the input data that is fed to the system. The inputs then pass through the network, where it will gain weights after passing through different connections between neurons. The output of this network will be the cost of damage in the typhoon will cause in the locality.

Eighty percent of the data would be devoted to train the system while ten percent will be used for verification. The last ten percent will be used for testing. This process is called cross-validation.

# DATASET

The Philippine Atmospheric, Geophysical, and Astronomical Services Administration is the government agency that is tasked to monitor the weather condition throughout the country and therefore keeps track of the typhoons that enter the Philippine Area of Responsibility. They also log the characteristics of the typhoon as they monitor it.

This paper deals about the other casualties that are difficult to evacuate and these are the residential and industrial structures that people utilize everyday such as houses, business establishments, offices, and farms. The data regarding the utilization of areas for agricultural, industrial, residential purposes comes from the National Statistics Office where the utilization of the area is detailed.

Data regarding the cost of damages caused by typhoons come from the reports compiled by the National Disaster Risk Reduction and Management Council.

Since there are many factors that contribute to the gravity of the post-calamity situation, the researchers do not expect to achieve a very high accuracy rate.

Parameters:

* X1 – The first parameter is the wind speed of the typhoon at the time of impact in kilometers per hour.
* X2 – The second parameter is the amount of rainfall of the typhoon at the time of impact in millimeters.
* X3 – The area of the locality dedicated to residential purposes in meter squared.
* X4 – The area of the locality dedicated to residential purposes in meter squared.
* X5 – The area of the locality dedicated to industrial purposes in meter squared.
* X6 – The area of the locality dedicated to agricultural purposes in meter squared.
* Y – The estimated cost of damages the typhoon will bring to the locality when it hits in Philippine peso.

# ANALYSIS OF RESULTS

# CONCLUSION AND RECOMMENDATIONS

The Integral Emergency Response Tool for Identifying Natural disaster Gravity system is a tool designed to assist in typhoon disaster mitigation and response by estimating the cost of damages a typhoon would bring to a populated area given the characteristics of both the typhoon and the affected area. The needed parameters were fed to an artificial neural network and the estimated cost of damages was obtained as an output.

Data from previous typhoons obtained from the various government agencies responsible were used as training data, validation data, and testing data.

The researchers would like to recommend increasing the capability of this system through the use of more parameters such as the strength of the structures in the area concerned and the parameters of the surrounding waters so that the actual estimated cost of damages would be as close as possible to reality. Also, this system is adaptable to other calamities such as earthquakes, volcanic eruptions, and tsunamis with only minimal modification required. Also, the researchers would like to recommend the increase of the scope of this system to also accommodate natural disasters that may occur in unison with a typhoon so that this system can truly live up to its name as a system to estimate the cost of damages of natural disasters in general and not only of typhoons.

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