ATSARNINGS (AUTOMATIC TSUNAMI EARLY WARNING SYSTEM) TO MITIGATE THE SOUTH MEGATHRUST ZONE OF JAVA

Extended Abstract

This Paper was Designed as a Requirement to Join the Competition of

E-NNOVATE International Invention & Innovation Show 2021

Category: Safety/Security/Protection

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INDONESIA

2021

ATSARNINGS (AUTOMATIC TSUNAMI EARLY WARNING SYSTEM) TO MITIGATE THE SOUTH MEGATHRUST ZONE OF JAVA

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Abstract
The Java Island, as an island close to the subduction zone of the Eurasian and Indo-Australian plates, is often shaken by earthquakes that can sometimes bring tsunamis. In addition, Java Island also has a high population so that it will be very at risk of disasters. This condition is not yet supported by adequate means of disaster mitigation and a tsunami early warning system. The objective of this study was to create an ATSARNINGS to be conveyed through loudspeakers in places of worship which area will be affected by the tsunami. This study used the Research and Development (RnD) method with the ADDIE (Analyze, Design, Development, Implementation and Evaluate) procedure. This study developed a tsunami early warning system that works effectively with a fast average response time of 13.48 seconds to download tsunami potential information on the BMKG (Indonesian Agency for Meteorological, Climatological and Geophysics) website and proceed it to trigger the loudspeaker at places of worship.
Keyword: tsunami, dissemination, automatic

Introduction

The Java Island, as an island close to the subduction zone of the Eurasian and Indo-Australian plates, is often shaken by earthquakes that can sometimes bring tsunamis. In addition, Java Island also has a high population so that it will be very at risk of disasters. In the book Sources and Earthquake Hazards Maps for Indonesia in 2017, in the South Indian Ocean, there are 3 megathrust segments, namely the East Java Segment, the Central Java-West Java Segment, and the Banten-Sunda Strait Segment. The area of 3 earthquake gaps in the subduction zone of Java has the potential to become a source of a large earthquake or called megathrust with a magnitude of 8.8 and can cause a tsunami that can damage the southern coast of Java in the future (Sudibyo, 2015).

With this risk, researchers created ATSARNINGS as a solution to strengthen disaster mitigation systems to minimize casualties, especially along the southern coast of Java.

Research Method

This ATSARNINGS was developed with the Research and Development (RnD) method that uses the ADDIE procedure adopted from Robert Maribe Branch (2009).

2.1 Analysis Stage

The concept prepared based on data obtained from field observations in several related agencies such as Yogyakarta Geophysics Station, BPBD Bantul, PUSDALOPS Bantul, BPBD Kulonprogo and PUSDALOPS Kulonprogo which analyze the weaknesses of the existing tsunami early warning system.

The result show that Indonesia uses tsunami early warning systems called InaTEWS (Indonesia Tsunami Early Warning System), but it is only 52 units in total throughout Indonesia. BPBD Bantul and Kulomprogo have BISS (Bantul Integrated Siren System) and EWS (Early Warning System) which have a collaboration system and the chain process from BMKG. BPBD broadcasts using radio waves such as Handy Talky at a frequency of 140-450 MHz thus it requires large transmitter power, has a weakness against the weather, and transmits data that were vulnerable to other nearby radio signal interventions.

2.2 Design Stage

Based on the results of the analysis, the ATSARNINGS was designed. It was generally divided into two main parts, server and client, as shown in Figure 2. The server will be located in the centre of the city that has an internet network to take the earthquake and tsunami data from the BMKG server using the Raspberry Pi 3 mini-PC and process it into the required information then send it to the location of the potentially tsunami-affected client via SMS. The client receives information sent from the server using the GSM SIM 900SA module to trigger the loudspeaker at the places of worship to produce sound automatically. If an earthquake occurs but it is not potential to cause a tsunami, it will be informed in the form of a voice instructing the public to remain calm and displaying running text on the dot matrix that informs the magnitude and depth of the epicentre.

Whereas if there is a potential for a tsunami, then the voice will inform the community to immediately evacuate to a higher and safer place and then be followed by a long siren. The dot matrix will display a running text that displays potential tsunami hazards and instructs the community to immediately evacuate.

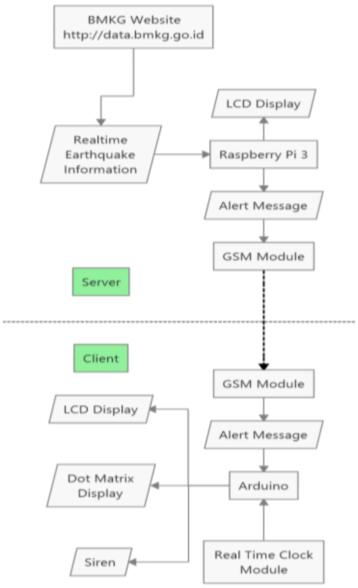

Figure 1. System Block Diagram

2.3 Development Stage

At this stage, the ATSARNINGS was developed according to the results of the previous draft.

Figure 2. Server-Side

Figure 3. Client-Side

The limitation of the problem in this study was in testing the system to broadcast tsunami warning sirens. It was determined for a limited area of Parangtritis coastal area, Yogyakarta.

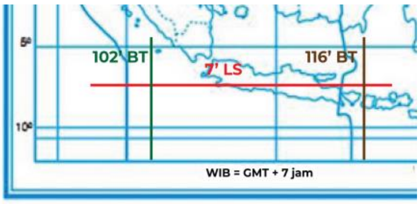

Figure 4. Regional Experiment Mapping

The method used for this problem is to determine the coordinates of the location where the earthquake occurred. If an earthquake that has tsunami potential is between the coordinates of 102o BT to 116o BT and more than 7o LS, it will send a tsunami warning message to the Parangtritis coastal area, Yogyakarta. In the other side, if the earthquake location is outside the determined coordinates, the server will not send a tsunami warning message. This also applies if there is an earthquake that does not have the potential for a tsunami. If an earthquake arrives at the location specified above, the system will only send information messages that the earthquake has no tsunami potential. Table 1 presents the test results.

Table 1. Regional Mapping

No	Location	System Reaction
1.	8^{o} LS 99^{o} BT	It didn't send SMS
2.	2^{o} LU110^{o} BT	It didn't send SMS
3.	9^{o} LS 120^{o} BT	It didn't send SMS
4.	9^{o} LS 117^{o} BT	It didn't send SMS
5.	6^{o} LS 115^{o} BT	It didn't send SMS
6.	8^{o} LS 110^{o} BT	It sent the SMS
7.	8^{o} LS 103^{o} BT	It sent the SMS
8.	9^{o} LS 112^{o} BT	It sent the SMS
9.	10^{o}LS115^{o}BT	It sent the SMS
10.	10^{o}LS115^{o}BT	It sent the SMS

2.4 Implementation Stage

After the system is completed and operates as expected, the next step is to implement it in Assalam mosque, Parangtritis, Bantul, Yogyakarta.

Figure 5. Implementation at Assalam Mosque

2.5 Evaluation Stage

The next stage is to evaluate based on the performance, by testing the system at the Yogyakarta Geophysics station and obtaining some input for evaluation and improvement.

Results and Discussion

The results of the ATSARNINGS development showed that on the server-side located in the center of the city with adequate internet access, the system can retrieve data from the official BMKG website using Raspberry Pi as a server computer and process it to be sent to the clientside. This data collection is carried out every 10 seconds to ensure the system gets the latest information from the BMKG, so that if an earthquake occurs, a potential tsunami warning can be sent faster. The client-side has been able to receive messages sent by the server using the SIM 900A Module and process them using the Arduino Nano microcontroller as the main controller in activating the siren and display earthquake and tsunami information in the form of running text on the dot matrix display to be able to distinguish whether the warning sirens are turned on tsunami or just an information viewer on the LCD screen and dot-matrix.

ATSARNINGS has been tested at the Assalam mosque, located in the coastal area of Parangtritis, Bantul, DIY and has been tested at the Yogyakarta Geophysical Station to analyze its performance and to identify its weaknesses for evaluation and improvement. The testing method was to simulate a post-earthquake tsunami, by creating a dummy website from the official BMKG website because it is not possible to wait for a tsunami in real-time for the trials. The data contained in the website page can be changed according to the need for the trials in the form of magnitude, coordinates and the potential for a tsunami to trigger the server computer to send tsunami information immediately to the client-side.

The trials were designed to examine the level of accuracy of the server computer and information transmission to the predicted locations which are affected and not affected by the tsunami. This is the test result:

Table 2. Test Results

Experiment	Response Time (second)
I	13.8
II	12.2
III	14.5
IV	13.4
V	13.5
Average	**13.48**

From the test results, it was obtained the average response time of 13.48 seconds.

Conclusion

The developed ATSARNINGS is divided into two main parts, namely the server and the client. The server is a data reader program of earthquakes which have tsunami potential from the BMKG website, the information processor and the information sender section to the location of the tsunami. Whereas the client is a recipient program sending information from the server and the driver section that turns on the loudspeaker automatically. The developed ATSARNINGS showed high performance and can work effectively as expected. Based on the test results, it was obtained the average response time of 13.48 to proceed the tsunami information on the BMKG website to trigger loudspeakers at places of worship.

The main advantages of this ATSARNINGS consist of low production cost, direct synchronization with the official BMKG website, efficient energy use with only a 12 Volt DC power source, fast and precise with an average response time of 13.48 seconds and easy maintenance.

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