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Real-Time and Automated Flood Detection &Early Warning Systems for the Municipality of San Leonardo, Nueva Ecija: A Case Study

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Abstract: *In whatever part of the country we are in, the chances are that sooner or later, a natural or human-induced disaster may strike our community due to Climate Change. When this happens, it causes un-estimated destruction of properties, infrastructure, agricultural damages, and loss of lives. Nevertheless, one of the most fundamental limitations of disaster management among agencies is preparedness and response coordination. Disaster management literature highlights the need for vulnerable agencies to collaborate with other stakeholders in disaster management to enhance their capacity to respond with more incredible speed, effectiveness, and efficiency. With this regard, the researchers wish to identify and find out the significance of real-time and automated flood detection and early warning systems versus conventional flood monitoring and information dissemination, its effects on the general public, its pros and cons to the community, and the responding unit. The researchers used the descriptive method type of quantitative design; thus, a questionnaire comprised three (3) main parts subdivided into different questions related to the participant's awareness regarding Real-Time and Automated Flood Detection and Early Warning Systems in the community. It was developed by having critical questions adapted from related studies and specific questions created and validated by the researchers. The researchers further evaluated the data gathered from the respondents to gain valuable and relevant information. At the end of this study, a conclusion was drawn based on the acquired and tabulated data, which resulted in numerous suggestions from the researchers that would undoubtedly benefit thecommunity, LDRRM Office, its staff and rescuers, Local Government Unit of San Leonardo, the entire country, the stakeholders, the researchers themselves, and the future researchers.*

Key Words—*Automated Early Warning Systems, Disaster Risk Reduction and Management,Local Government Unit, Residents of San Leonardo, Responding unit*

I. INTRODUCTION

An Early warning system is an adaptive measure for climate change, using integrated communication systems to help communities prepare for hazardous climate-related events. A successful EWS saves lives and jobs, land, and infrastructures and supports long-term sustainability. Early warning systems will assist public officials and administrators in planning, saving money in the long run, and protecting economies. [1]

Due to the geographical location of the Philippines, an average of 20 Tropical storms hit the country every year. Its local communities are vulnerable to disaster and other climate-related calamities and illnesses by which marginalized sectors are commonly affected, such as the poor, women, children, senior citizen, farmers, and others.

Under the National Government framework and the vision of the Local Government Unit of San Leonardo, the Local Government Unit of San Leonardo advocates sustainable development to fulfill human needs while maintaining the quality of life and natural environment for current and future generations. The Local Government Unit of San Leonardo shall design and prioritize its policies, plans, programs, and projects upon firm environmental considerations - adaptation to Climate Change and the principle of sustainable development without sacrificing the environment.

Since climate change and disaster risk reduction are interrelated, the Local Government Unit of San Leonardo shall consider its integration into the plans to address the problem of the people. The dangerous consequences of climate change include increased frequency of droughts, floods, typhoons, fires, earthquakes, climate-related illnesses and diseases, damage to the ecosystem, biodiversity loss that affects the environment, culture, population, properties, and economy. Consequently, adaptation measures on public works and infrastructure projects will consider such concerns to protect lives and properties while enhancing economic growth and accessibility.

Furthermore, the geographical location of San Leonardo is vulnerable to the typhoon. At the same time, eight barangays along the Pampanga and Peñaranda River are susceptible to flooding, resulting in loss of lives, agricultural products, and public and private properties. It was also a phenomenon that the typhoons gradually intensify up to signal no. 5 due to climate change that causes severe damage to public and private infrastructure, crops, and livestock and leads to loss of lives. So, it is a serious matter to take into consideration.

The LDRRMC, in cooperation with NGAs and NGOs, aims to formulate necessary measures in preparedness and mitigation for the occurrence of typhoons, floods, fires, earthquakes, epidemic diseases, and other related disturbances that the community may experience.

The LGU will allocate resources and seek the assistance of NGOs, NGAs, and other private institutions to fund programs and projects of the LGU on the disaster. Conducting training/exercises and drills will enhance the capacity of the LDRRMC and its Technical Working Group. And these can be cascaded to the barangay level.

Due to the contagious spread of the virus during the Covid-19 pandemic, preparation for the typhoon can be dangerous. The limited human interaction can weaken the capacity of the members of the LDRRMC in playing their roles and responsibilities at the onset of calamity. Their traditional process of monitoring of river water level, collecting and interpreting data, translating and disseminating them to the community uses the human resources workforce to play this duty.

In line with this, this study aims to determine the effectiveness of automated early warning systems in flood detection and disseminating them to the community versus the traditional process of playing the duties and responsibilities of the LDRRMC of the Municipality of San Leonardo.

II. REVIEW OF RELATED LITERATURE

Frequent and catastrophic disasters have increased the role of the public sector in managing disasters and emergencies (Kapucu and Van Wart, 2006). We assume that all disasters are local and that the major responsibility of managing disasters and emergencies, including informing and alerting the public, belong to local government (MacManus and Caruson, 2006). Early warning is an important strategy to save lives. However, the magnitude of the task of designing, implementing, and sustaining early warning systems in communities is enormous. An effective system requires that early warning and risk reduction be mainstreamed into a policy process and that governmental agencies have the capacity to be able to design and implement effective policy. An effective early warning system policy process also requires local community participation to ensure that the public at risk is adequately informed and alerted. Early warning systems protect the public by combining scientific monitoring and detection systems with social design factors and components to notify the at risk public. Early warning systems can be seen as having scientific, managerial, technological, and social components that are integrated with communication processes (Sorensen, 1993).[2]

Current research suggests that technologies play a significant role in the efficient management of disasters around the world. Drawing from Collins and Kapucu (2008), emerging technologies have positively impacted how people prepare, respond, and recover from the occurrence of man-made or natural disasters. The availability of specialized tools helps save lives, time and secure property from the destruction and sustenance of daily teaching, research, and public service activities in universities worldwide.

In Uganda, where 64 percent of the population relies on agriculture for subsistence, most weather stations fell into disrepair following the civil war, changes in Government, and poor maintenance. The Strengthening Climate Information and Early Warning Systems (SCIEWS) project has replaced outdated and inadequate meteorological stations with updated systems, improving disaster risk reduction with more effective means of generating and disseminating information.[1]

In Southeast Asia, long coastlines and low-lying countries make the region particularly vulnerable to increasing extreme weather conditions. In Cambodia, for example, more than 1.7 million people in 2013 were affected by floods with a loss of $365 million; by 2016, the number of people affected by floods rose to more than 2.5 million people, indicative of an increase in climate-related flooding. UNDP implemented a four-year program with the Government and other partners entailed installing and re-activating existing Automatic Weather and Agrometeorological Stations and Automatic Hydrological Stations. Farmers can now access climate bulletins for detailed and substantial planning to avoid costly consequences, both in money and life.[1]

UNEP's Climwarn project, a partnership with entities in Burkina Faso, Ghana, and Kenya, has replaced rudimentary meteorological methods with a more sophisticated system using modern technology that alerts communities of potential floods and other risks. Then, this is then communicated to rural regions through SMS and email, aiding them in better preserving their crops and livelihoods.[1]

UN entities also provide support as implementing partners for the Climate Risk and Early Warning Systems (CREWS) initiative, launched at the UN Climate Change Conference in Paris in 2015. CREWS boosts the capacity of Multi-Hazard Early Warning Systems and operates in 19 countries in Africa and the Pacific, including Least Developed Countries (LDCs) and Small Island Developing States (SIDS), the most prone to tropical cyclones and floods. In June 2018, CREWS announced that they could roll this out in the Democratic Republic of Congo, Burkina Faso, Mali, and Niger. CREWS Steering Committee continues to identify new countries in Africa and Asia where they can finance the programs in disaster prevention.[1]

In the United States, the U.S. Geological Survey and the National Weather Service — part of the National Oceanic and Atmospheric Administration — work together to maintain flood warning systems. Specifically, the USGS acts as the principal source of surface and groundwater data and operates more than 85 percent of stream gaging stations in the U.S. The NWS uses those data and data from other sources to issue river forecasts and flood alerts.[3]

Generally speaking, the NWS issues flood alerts either on a county or for particular rivers and streams. Those alerts are divided into several basic categories:

i. **Flood watches** are issued when conditions suggest a possibility of flooding or if flooding is anticipated within 12-48 hours.
ii. **Flood warnings** are more severe and are issued if widespread flooding is expected across a large region or if flooding is imminent or actively taking place.
iii. **Flash flood watches and warnings** follow the same protocol but indicate a potential for rapid flooding, usually from heavy rain or dam failure.
iv. **Flood statements** are issued when flooding is expected along significant streams where people and property are not threatened. They may also be given as an update to previous warnings and watch alerts.

In the U.S., these alerts are distributed in Specific Area Message Encoding through the Emergency Alert System and the NOAA Weather Radio network.[3]

In communities that lack a flood warning program but are interested in developing their own, the NWS can provide further guidance, technical support, outreach, and education to involved parties and community leadership. A flood warning system need not be expensive or overly complicated, and the benefits — protecting lives and property — far outweigh any potential complications or inconveniences.[3]

The Concept of Early Warning Systems:

1. Public Warning Systems

An Early Warning System (EWS) represents the set of capacities needed to generate and disseminate timely and meaningful warning information that enables at-risk individuals, communities, and organizations to prepare and act appropriately and in an adequate time to reduce harm or loss [UNI 09]. Based on this definition, the International Federation of Red Cross and Red Crescent Societies have identified the four core components of an EWS [INT 12], namely:

- risk knowledge to build the baseline understanding about the risk;
- monitoring to identify how risks evolve through time;
- response capability; and
- warning communication packages the monitoring information into actionable messages understood by those that need, and are prepared, to hear them

This public warning system includes, on the one hand, the gathering, processing, and presentation of information in a consistent and meaningful manner to allow the generation of alert messages and, on the other hand, the generating and transmission of alert messages to the citizens at risk through warning communication. Therefore, from an operational perspective, Public Warning Systems (PWSs) can be divided into two main functional modules: an information aggregator, which provides risk knowledge and monitoring functionalities, and an alert dispatcher, which makes use of the available response capability and warning communication to reach the citizens at risk [PÁR 16]. Taking the interaction between Public Warning Systems (PWSs) and public warning actors defined in [PÁR 16] as the starting point, a simplified version focusing on the communication between PWS and alert message recipients (citizens at risk) can be seen in Fig. 1. It shows the alert (message) recipient functionalities and the applications. This message can be used at the recipient side to efficiently receive, decode (ifneeded), and present alert messages to alert recipients and allow them to understand the situation and put it into practice, if required, the recommended protective actions.

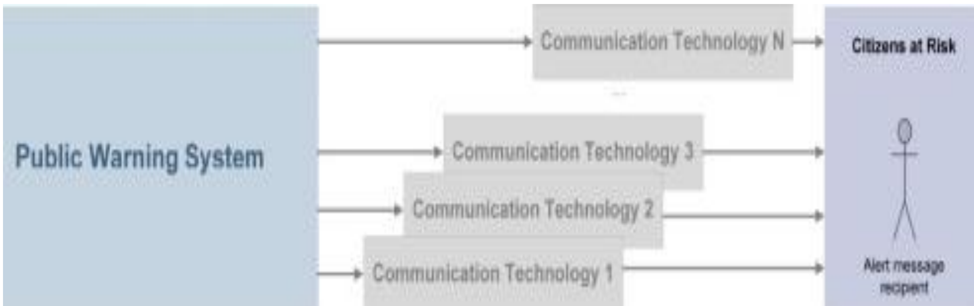

Figure 1. Interaction between PWS and alert message recipients

As it can be seen in Fig. 1, there is a wide range of communication technologies that can be used to disseminate alert messages towards the population at risk. Each communication technology used for that purpose provides a different set of features with respect to others and, at the same time, influences the efficiency of the dissemination of alerts [MUL 14]. Additionally, different communication technologies require alert recipients to have or to access dedicated receiver devices for the reception of alert messages over the available bearer services. A summary of communication technologies and the related receiver devices, if needed, is described in Table 1.

Table 1. Communication technologies and receiver devices

Communication technology/bearer service	Receiver device
Sirens	Not needed
Tannoy	Not needed
Information billboards	Not needed
SMS	Cell phone/smartphone
Cell broadcast	Cell phone/smartphone
Internet access (either provided through terrestrial, mobile wireless, or satellite data networks) using dedicated applications	Cellphone/smartphone Portable and fixed devices (desktop computer, tablet PCs, laptops, etc.)
Pager	Pager
TV broadcast (either satellite, terrestrial, or cable TV)	Television receiver
Hybrid Broadband Broadcast TV (HbbTV)	HbbTV-enabled receiver
Radio Data Service (RDS)	RDS-enabled radio receiver
Satellite-Based Augmentation Systems (SBAS)/Global Navigation Satellite System (GNSS)	SBAS/GNSS receiver (navigation device/smartphone
Building notification system	Not needed
Evacuation systems	Not needed

The efficiency of the transmitted alert message is affected by both the communication technology used and the corresponding receiver device. Regarding receiver devices, a first classification can be done between communication technologies that require citizens to have a dedicated receiver device and the ones that do not.

Firstly, communication technologies that allow the reception of alert messages without a dedicated receiver device can have a higher penetration since the alert message recipient does not need to take any action to receive the news. Still, on the other hand, the penetration of alert messages depends strongly on the location of alert distributors (sirens, evacuation systems, building notification systems, tannoys, electronic billboards, etc.). Therefore, this type of solution is very effective and widely used in specific risk locations, such as highways, chemical plants, or power plants, but is not efficient for distributing alert messages in more expansive areas. Secondly, in cases where a specific receiver device is needed, the portability of the device and current behavioral trends play an essential role in the effectiveness of alert message distribution. In this regard, two main categories of devices can be identified: portable and non-portable devices [MUL 14].

The first category of receiver devices includes a wide range of personal communication devices (smartphones, cell phones, tablet PCs, pagers, etc.). This allows the reception of alert messages through various communication technologies, such as wireless mobile networks, terrestrial networks, and navigation satellites (SBAS/GNSS). The computational power provided by current devices and the available storage capacity they can provide allows the transmission of efficiently encoded alert messages and the presentation of alert messages to citizens at risk in different languages and modes. For instance, text or voice, thus addressing citizens with special cognitive needs. This type of device allows end-to-end transmission of alert messages from the alert message issuer to the alert message recipient.[5]

The second category includes devices that have traditionally been available in households to be used by the entire community, like television and radio receivers (although portable TVs and radio receivers are open in the market). The effectiveness of alert messages received using these devices is affected by technical and behavioral aspects. On the one hand, alert messages distributed through TV or radio are generally received by the TV or radio broadcaster. Then further process the message and transmit it to the alert message recipient (typically embedded in the TV or radio news or using subtitles in the TV case). In recent years, this limitation has been overcome by using so-called "smart TVs," allowing commercial TVs to receive alert messages via an Internet connection. Similarly, the use of the Hybrid Broadband Broadcast TV (HbbTV) would allow the reception of alert messages either in the data carousel of the TV signal or using the Internet connection provided. Decoding and presentation of the received alert messages could be done in both cases, thanks to dedicated applications available in receiver devices [PFE 13]. On the other hand, from a non-technical perspective, the penetration of alert messages using this category of devices is limited because alert message recipients must be using receiver devices when the message is received.[4]

2. Core Early Warning System

An Early Warning System (EWS) allows harm and loss reduction by getting and disseminating warning information about hazards and vulnerabilities in a group of people who are at risk. Each word has a significant meaning. For example, a community involves a network of social interaction. Early refers to the prevention of any disaster or reduction of potential harm or damage. A warning means a message that announces danger, and the system puts it all together. Therefore, a CEWS has four key elements [INT 12, ELL 12]:

1) risk knowledge;
2) monitoring;
3) response capability; and
4) warning communication.

With this bit of introduction to a CEWS, it is crucial to consider when a city becomes smart. A city is smart when it uses an infrastructure composed of communication technology, sensor, and control devices, which collect data of what happens in the city and list all in an intelligent way, allowing for better resource utilization. The activities performed by their citizens are therefore faster and more effective.

With this knowledge about smart cities and CEWS, we can now analyze how these two ideas can be put together to obtain an effective CEWS based on smart city technology.

1. <u>Risk knowledge</u>

A warning system reduces the possibility of injury, death, damage, and property loss from individuals and communities by immediately responding to the hazards. Therefore, it is important to understand the role that a smart city plays in disaster mitigation and decision-making for acquiring risk knowledge.

The smart city plays a role in this scenario with a specific application; it can provide necessary information to know where the hazards and vulnerabilities are by collecting information about historical risk (sensors). With proper research, community planning could be better in different scenarios such as transportation, security, disasters, health, etc. [DEL 01]

2. <u>Monitoring</u>

A sensor is a device that transforms environmental measurements into signals that can be understood and interpreted by a system; these measurements can be monitored, processed, and stored by an application. Therefore, monitoring, as a component of EWS, should be considered as a key element, because it involves all of the information gatherings.

Smart cities have many applications, for example water distribution systems, electricity distribution systems, smart buildings and homes, environmental monitoring, surveillance, health care, and crowdsourcing. An important application with smart cities and their smart buildings in a CEWS context is an evacuation. For example, in a conventional evacuation scenario as for an earthquake, the system assumes that people inside know the building's exit routes and an alarm triggers when an emergency occurs.

The best way to get this, in any field, is to achieve the best early warning time. The anticipation of an "impact" allows better decision-making in a matter of seconds, such as shutting down industrial machinery, stopping a train, and exiting a burning building.

3. Response capability

Nowadays, the fast-growing urbanization continues exerting influence on substantial issues such as urban mobility and capacity to respond to disasters, among others, which lead to the need to cope with these challenges that include topics such as the impact of the environment or the ability to anticipate and react quickly to any disaster in cities.

That is why, on having realized the development of an EWS, it is necessary to keep in mind that, in a society, there are diverse groups, and during a natural disaster present different vulnerabilities like culture, disabilities and age, amongst others that play an important role when actively coping with a disaster, to prepare and to be able to have a correct answer to it.

Thanks to the relationship between systems, information and communication technologies play a very important role in bringing the biggest profit to this "network" controlled by citizens. Therefore, a smart city uses technology that allows us to perform the transformation of the basic systems and their optimization, spurring them to innovation, and being a key factor for competitiveness and economic growth.

4. Warning communication

When a natural disaster occurs, the authorities responsible for carrying out an emergency plan should start by answering several questions, for example, how will the alerts be given to the people who are in danger? Or, does the population have the ability to know and understand the warning that is given to them at a critical moment?

It is in this way that the authorities displayed the communication of a warning, as a fundamental part when deciding on EWS. This decision is directly related to the information obtained from monitoring conducted in the most affected areas. To realize that the message is retrieved of a form that is clear and efficient, there are three main actors [MER 10]:

- ✓ **Author**: responsible for establishing and setting up the message that will be subsequently broadcast;
- ✓ **Mediator**: the first receiver of the message that must maintain the message original or can be modified in case of being necessary for an effective broadcasting;
- ✓ **Receiver**: a population that is responsible for understanding the message of warning delivered.

Taking the aforementioned parameters into account, we emphasize Information and Communication Technologies (ICT) because they allow us to have an efficient and effective way to obtain various data to prevent as is, in this case, a possible natural disaster. By using the ICTs, it is possible to integrate an EWS into any technical service, such as transportation, meteorology, seismology, and health, which can generate information in the first moments of traffic jams, car crashes, floods [JUN 15], earthquakes or volcanic eruptions. These natural disasters can be prevented using several tools, such as:

1) system monitoring: to monitor first affected areas or future disaster areas;
2) the sensor of flood for the urban area;
3) the sensor of opening and closing of river gates;
4) monitoring of transit;
5) monitoring of landslide;
6) the collapse of river bed alarm.

To alert the population about potential natural disasters instantly, an intelligent alert system can be developed by bringing together a set of sensor networks, alarms, and monitoring devices, which complements a smart city [FUR 10].[5]

Per the mode of operation adopted, we can have [XIN 15]:

Technological advances have improved the quality and response time of warnings of dangers achieving informed technologies of surveillance and early warning. In Table 3, some technologies are observed:[4]

Table 2. Operation modesTable 3. Technological advances

Modality	Community EWS	EWS centralized or instrumental	EWS mixed
Characteristic	Active participation of the population in the monitoring, using handmade instruments	Is characterized by using the automated monitoring	They use automated instruments and local monitoring
Advantage	It involves an active participation of the population The instruments used are of lower cost The trend is to lower use of this modality	A high technological component which will be effective The trend is greater use of this modality	It allows to be provided with technological advances, and too with the local monitoring The tendency is little use of this form
Disadvantage	The instruments used may not be accurate in critical moments	The technology used is of greater cost Demand for a good level of capacity of the operators	The union of these two modalities involves higher costs

Technology	Characteristics
Forecasting and modeling	They used data from monitoring including values of temperature, precipitation and climate models equipped with modern technology
Remote sensing and geographical information system	Allows us to give early warnings on food security before the end of the season
Satellite communication	Help reduce the time between the collection of data and the alert
Mobile technology	Used to communicate the alert and coordinate the activities of preparation, especially SMS alerts for mass mailings
ICT for multiple sources	Were extensively used in the Haiti earthquake 2010, thereby acknowledging that it could help in activities prior to the disaster by identifying potential risks
Cartographers crisis	They can provide information in real time about the impending crisis in times of uncertainty and confusion

III. OBJECTIVE

The general objective of this study is to analyze the effectiveness of an Automated Early Warning System versus the traditional process to help communities prepare better for hazardous-related events, thus promoting a safer and disaster-resilient community in the municipality. The researchers wish to address the following objectives:

1. To identifythe effects of automated early warning systems on the lives of the community in times of climate-related hazard events;
2. To determine the advantages and disadvantages of automated early warning systems to the lives of the responding unit; and
3. To measure its effects to the general population of the municipality of San Leonardo

IV. METHODOLOGY

Conceptual Framework

In this chapter, the research design, area of study, population, sample of the population, sampling technique, instrument for data collection, validation of the questionnaire, administration of the instrument, and method of data analysis are discussed. Fig.2 illustrates the study's conceptual framework.

The study was conducted in the municipality of San Leonardo, Province of Nueva Ecija (Philippines). This place was selected knowing its geographical location is vulnerable to typhoons and suspectable for flooding, which will result in loss of lives, agricultural products, and public and private properties.

The researchers used the Descriptive Method type of quantitative design. A questionnaire was used in gathering the data. The questionnaire is a Likert scale question type of survey. They were given electronically via google forms which the respondents can access using their emails. The researchers used this to ensure the confidentiality and integrity of the survey collection process; thus, it is purely for research purposes only

The survey comprised three (3) main parts subdivided into different questions related to the participant's awareness regarding Real-Time and Automated Flood Detection and Early Warning Systems in the community.The data were collected between the first and third week of October 2021.

The researcher gathered, summarized, analyzed, and evaluated the data for interpretation according to the frequency of items checked by the participants. After collecting and evaluating all the data, researchers generate results, conclusions, and suggestions.

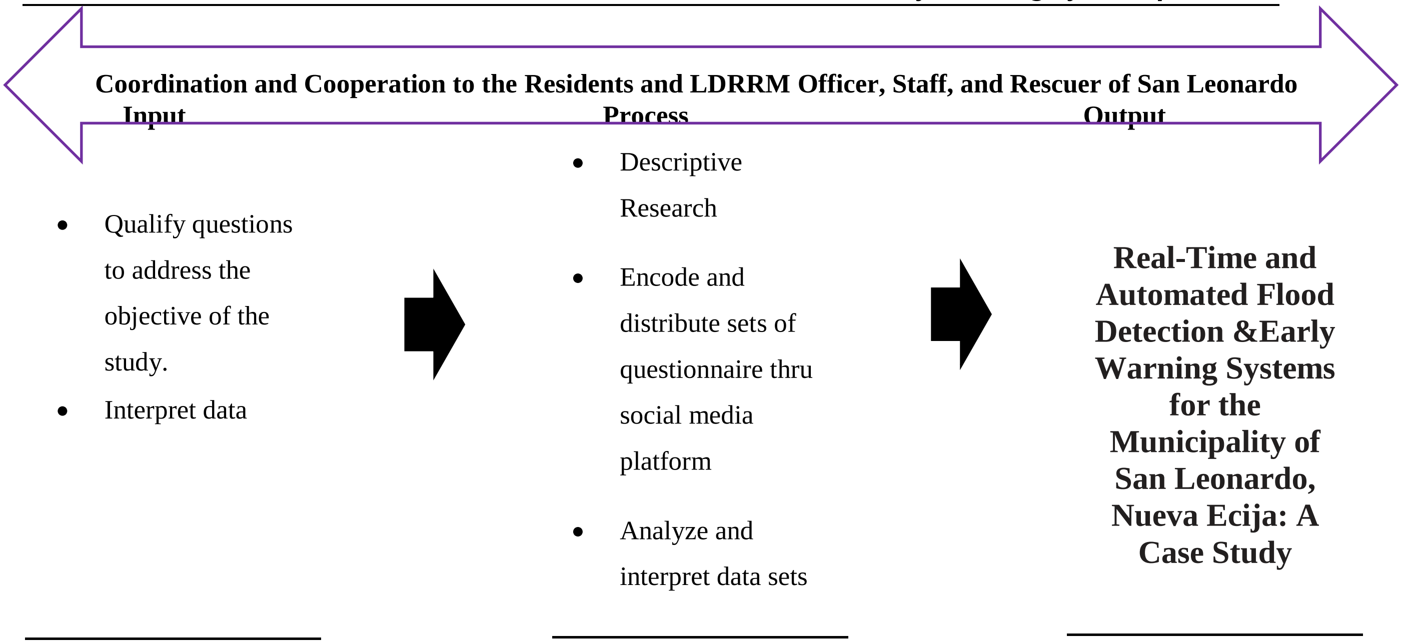

Figure 2. Conceptual Framework of the Study

Sample

The researchers conducted a survey from the LDRRM officers, staff, rescuers, and residents of San Leonardo, Nueva Ecija. Additionally, these respondents have lived in this community for an extended period, indicating an extensive understanding of the issue.

Questionnaire Survey

The survey is divided into three sections. The first section is the demographic and personal information of the respondents. The second section is allotted from the residents of San Leonardo, and the third section is allotted from LDRRM officers, staff, and rescuers.

The survey questions aim to identify the following:

1. Measures the effects of automation in flood detection and information dissemination to the general public.
2. Measures the pros and cons of the change in responding to disasters of the responsible unit and officials.
3. Identifies and summarizes the effects of this innovation on the community of San Leonardo.

For this purpose, we employ survey data collected from questionnaires distributed and limited to 25 residents of San Leonardo and 25 participants from the Local Disaster Risk Reduction and Management Office. The researchers used Table 4 below to interpret the data collected.

Table 4. Four-point Likert Scale Interpretation

Likert Scale	Interval	Difference	Description
1	1.00-1.75	0.75	Strongly Disagree
2	1.76-2.51	0.75	Disagree
3	2.52-3.27	0.75	Agree
4	3.28-4.00	0.72	Strongly Agree

V. RESULTS AND DISCUSSION

Results

Evaluating the data presented in this work leads tothe conclusion and recommendations this study aims to achieve. Furthermore, the interpretation of the results obtained from the data collection is shown below.

Table 5. Interpretation of results of data collected from the Residents of San Leonardo

	Mean	Interpretation
R1	3.20	Agree
R2	3.20	Agree
R3	2.96	Agree
R4	2.92	Agree
R5	2.76	Agree
R6	2.88	Agree
R7	2.88	Agree
R8	2.88	Agree
R9	3.04	Agree
R10	2.96	Agree
Satisfactory Average	**2.97**	**Agree**

The interpretation of the responses in the conducted questionnaire survey for the residents of San Leonardo is shown in Table 5. The ratings in all the 10 items and the overall average fall under the interval for "agree". This suggests that most respondents think they are satisfied with the conventional services, such as personal monitoring of stream water level, and announce it to the community through bandillos.

Table 6. Interpretation of results of data collected from the LDRRM Officer, Staff, and Rescuers of San Leonardo

	Mean	Interpretation
L1	3.04	Agree
L2	2.68	Agree
L3	2.28	Disagree
L4	3.08	Agree
L5	2.80	Agree
L6	3.24	Agree
L7	3.36	Strongly Agree
L8	3.32	Strongly Agree
L9	3.32	Strongly Agree
L10	3.44	Strongly Agree
L11	3.40	Strongly Agree
L12	3.36	Strongly Agree
L13	3.16	Agree
L14	3.12	Agree
Satisfactory Average	**3.12**	**Agree**

The interpretation of the responses in the questionnaire survey for the LDRRM Officer, Staff, and Rescuers are shown in Table 6. The ratings in seven (7) items fall under the interval of "agree", six (6) items fall under the interval of "strongly agree". At the same time, there is 1 item that falls under the range of "disagree". Moreover, the overall average falls under the interval for "agree". This suggests that most respondents think they are satisfied with the automated early warning systems than the conventional way of monitoring the flood and disseminating warnings and information.

Discussion

This result is consistent with what has been found in previous studies by Sorensen (2017), that an effective system requires that early warning and risk reduction be mainstreamed into a policy process and that government agencies have the capacity to be able to design and implement effective policy. An effective early warning system policy process also requires local community participation to ensure that the public at risk is adequately informed and alerted. Early warning systems protect the public by combining scientific monitoring and detection systems with social design factors and components to notify the at-risk public. The result highlights that little is known for the residents of San Leonardo about the automated early warning systems. Likewise, another promising finding was that although automation means getting the job done more manageable, the disadvantage of this automation is that the association of personnel or authorized officials to disseminate warnings and information makes their constituents trust and rely on them more.

In line with this, some residents are included in the vulnerable sectors: PWDs, children, and senior citizens. These sectors need special consideration in planning, preparation, and receiving helpful and relevant information, especially in times of calamity.

Furthermore, in this Covid-19 pandemic, LDRRM Officers, Staff, and Rescuers, as part of the minimum safety protocol, think that an automated early warning system in monitoring stream water level will be of better help than the association of personnel to visit the site for monitoring personally. Thus, so in disseminating warnings and information.

VI. CONCLUSION AND RECOMMENDATION

The technology nowadays is vast and quickly developing. Traditional methods of manual detections through personal observations are already proven to be part of the reactive approach. Along with this reason, the adverse effect of climate change and severe weather conditions bringing about continuous and heavy rains has become more or less constantly present in the country.

From the short review above, the researchers conclude that:

1. The need to have a localized and automated early warning system is critical in disaster preparation.
2. Through this system, automated and localized monitoring of the water level is feasible and should, as a result of this, be established in the municipality of San Leonardo. This system, in particular, also gives a localized interpretation of the threshold values for the water level in a more precise and more accurate measurement, which makes it easier for the Local Government Units to understand. In addition, the said automated system also serves as a proactive approach to determining the possibilities of floods. Moreover, as the system will send updates to the water level and rain, the local authorities will have enough time for decision-making, such as early evacuation to prevent damages to properties and loss of lives brought by flooding.
3. There will be swift information dissemination, resulting in more extended preparation periods for the community and households. This system saves time as it saves the lives and properties of the people of San Leonardo.

Therefore, the automated early flood warning system for San Leonardo is an excellent means for a safer and quicker response to the risks of flooding. The only challenge of this system that the researchers eyed in its application will be knowledge and awareness. The community awareness of this advancement is equally essential to help the residents understand the advantages of automation in this critical disaster monitoring. It is vital to keep in mind that change is inevitable in achieving excellence in services. Thus, the researchers highly recommend the following that aims to answer the objectives of this study:

1. It is conducting information, education, and communications campaigns on the accessibility and existence of such a system to increase the residents' awareness of the advantages of switching the conventional flood warning system into automated early detection and warning systems.
2. The municipality of San Leonardo, especially its responding unit or the LDRRM Office, should adapt to change that includes embracing technological advancements in its disaster monitoring and risk mitigation activities. Likewise, the automated early flood detection and warning system perfectly fits and is adequate to become more efficient in serving the community.
3. "You are the help before the help arrives". This quotation means that one's proper knowledge and awareness of something, like disaster prevention and preparedness, can help one's safety and efficiency. The responding units

should conduct seminars to the community or residents of San Leonardo regarding the proper planning and preparation when the real help does not arrive yet when a disaster happens.

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