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FRiMap: Development of Web-GIS Flood Risk Index Mapping Platform for Disaster Risk Reduction

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Abstract— **Floods seriously threaten economies, infrastructure, and communities, making them one of the most common and destructive natural events in the world. Practical flood management strategies and risk assessment are essential to mitigate these risks. This study aimed to design and develop a Web-GIS FRiMap Platform intending to establish a spatial database for assessing the barangays in flood-prone areas in Sagay. It also provided accessible and user-friendly tools for flood risk assessment and mapping. A Rapid Application Development (RAD) model was employed in the system's development, prioritizing excellent results and a rapid design cycle. The five evaluation criteria utilized were derived from ISO 25010:2011 software quality standards which included functional suitability, performance efficiency, usability, security, maintainability, and portability. The statistical tool Jeffrey's Amazing Statistics Program (JASP) was also employed to calculate the grand Mean. The results showed that the developed platform received high effectiveness ratings from IT specialists, achieving a grand mean score of 4.40, which was interpreted as excellent, and from end-users, achieving a grand mean score of 4.53, which was also interpreted as excellent, indicating that the newly developed system offers a notably satisfactory quality. Furthermore, FRiMap empowers decision-makers, planners, and communities to proactively address the challenges of flood hazards and promote sustainable development. The Disaster Risk Reduction Management Office (DRRMO) recommended integrating a device for monitoring water levels, triggering alarms, and sending Short Messaging Service (SMS) notifications to responders during flooding events.**

Keywords— **Flood risk index mapping; geographical information system; disaster risk reduction management.**

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I. INTRODUCTION

Floods are among the most destructive disasters since they are severe hazards to human life and can cause extensive property damage globally. It is a notable natural catastrophe that affects people, results in fatalities, and causes significant losses[1], [2], [3]. In the Philippines, coastal communities in the country are particularly vulnerable to storm surges and flash floods due to their archipelagic geology. Floods are considered a persistent threat in the Philippines, aggravated by increasing urbanization, deforestation, and severe storms, worsened by inadequate drainage infrastructure and climate change [4], [5]. Sotto [6] emphasizes the significance of structural and non-structural flood control techniques to reduce the impact of hydrometeorological risks, such as flooding. Since flooding has become more frequent and severe recently, implementing effective disaster risk reduction techniques, flood risk assessment and preparedness is even more critical [7]. Several studies have been conducted recently that support the development of maps depicting flood susceptibility to support effective flood risk management [8], [9], [10], [11], [12], [13]. According to Antzoulatos et al. [14], flood susceptibility is the potential incidence of flooding that an area might experience based on its physical-geographical factors. Implementing appropriate mitigation measures, assessing, responding and conducting thorough monitoring to identify locations that are susceptible to flooding are considered essential to reducing the risks [6], [15], [16]. Building social capacities, early warning systems, and disaster literacy are among the initiatives to improve flood resilience are the essential elements for efficient flood management [17].

In the area of Sagay City in Negros Occidental, residents, livelihood, and infrastructure suffer from devasting monsoonal flooding frequently, which includes Barangay Paraiso and Fabrica. They were identified as vulnerable to frequent floods, which substantially negatively influence the lives and means of subsistence of the local population. For instance, residents of Purok Sto. Niño of Barangay Paraiso and Purok Riverhillside of Barangay Fabrica in Sagay City face recurrent flooding, with water infiltrating their homes during heavy rains and storms. The situation is exacerbated by the proximity of the residents to the river and inadequate infrastructure to protect them from rising water levels. Due to financial limitations and proximity to their workplaces such as the adjacent sugar company, many residents are still unwilling to relocate despite the ongoing threats and challenges. In response to these challenges, the researcher has collaborated with DRRMO to develop a web-GIS Flood Risk Index Mapping.

In discussing the digital transformation for disaster risk reduction, as stated in [18] gave emphasis on service design and participatory of GIS, both of which are in line with the creation of the Web-GIS FRiMap Platform. Furthermore, the creation of GIS-based web applications supports planning and decision-making processes, and it is crucial to incorporate near-real-time information components into the system [19]. As stated in [20] emphasized that a GIS-based flood risk assessment providing geographical flood risk information for planning and decision-making helps reduce the chance of disaster. Therefore, the maps can be used for various operations, including identifying properties that need flood prevention measures installed, regulating buildings in flood-prone areas, and informing the public about the risk of flooding in particular areas [21]. The spatiotemporal dynamics of flood threats can be mapped and understood with the help of Geographic Information System (GIS), which helps to organize and evaluate data from many resources. GIS technologies like Quantum Geographic Information System (QGIS) offer tremendous mapping, modeling, and visualization capabilities in the Philippines, where geographical information is crucial for disaster management. It is impossible to overestimate the significance of flood risk maps in the country. These maps are vital resources for communities, urban planners, and decision-makers to identify flood-prone locations, evaluate vulnerability, and rank mitigating options. In addition, there is a great deal of potential for improving disaster risk reduction initiatives in flood-prone places like the Philippines by creating a web-GIS platform for mapping flood risk indices.

Through GIS technology, thorough risk assessments, and astute solution implementation, communities may enhance flood resilience and protect lives and livelihoods from unforeseen calamities. For disaster risk reduction, developing a web-GIS Flood Risk Index Mapping is essential [22], [23]. These platforms combine observations, multicriteria decision-making techniques, and hydrodynamic modeling tools to evaluate flood-prone locations and facilitate several phases of flood risk management, such as operational response and emergency readiness [22]. These platforms serve various stakeholders by streamlining data analysis, simulation operations, and flood forecasting with Geographic Information Systems (GIS) and Web technologies [24], [25]. These platforms facilitate the process of mapping flood susceptibility by integrating physical aspects of the surrounding environment.

It helps with early warning systems, mitigation strategies, and land use planning. Furthermore, crisis responders can better prioritize response operations by augmenting flood vulnerability maps with non-traditional data sources like social media. According to Kumar et al. [26] a web-GIS can be created to help policymakers with flood appraisal and mitigation operations using AHP and GIS methodologies. The researchers of this paper integrated GIS and Analytical Hierarchy Process (AHP) methods to provide an empirical method of mapping flood risk.

Creating a Flood Risk Index Mapping in Sagay City can assist the government and the local public in developing effective long-term methods of reducing flood-related damage in the region. Therefore, this study designed and developed a Web-GIS Flood Risk Index Mapping (FRiMap) Platform for Disaster Risk Reduction. The primary objectives included designing the FRiMap Platform, establishing a spatial database to assess the Flood Risk Index for areas susceptible to flooding during severe circumstances, generating Flood Hazard Area Maps utilizing Geographical Information System (GIS) technology, and evaluating the system using ISO 25010:2011 criteria in terms of functional suitability, performance efficiency, usability, security, maintainability, and portability.

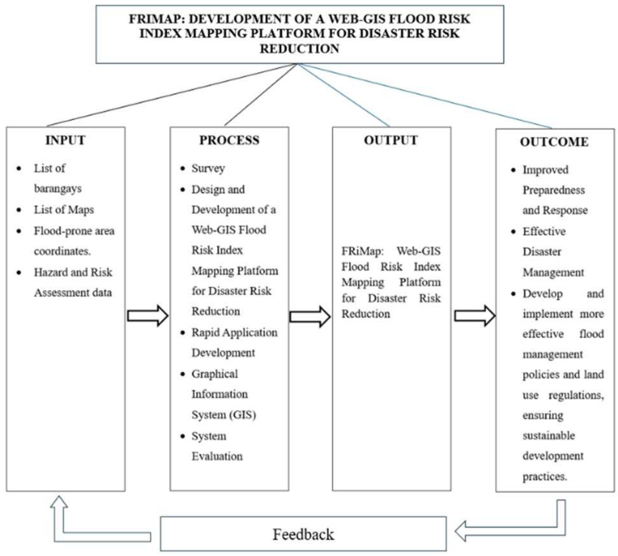

Fig. 1 Flood Risk Index Mapping (FRiMap) Conceptual Framework

This conceptual framework presents an integration of several data-driven and technological innovations to establish a systematic method of solving flood-related challenges. The Process involves several methodological processes. First is the Data Basement, which involves an analysis of various information that includes barangay lists, maps, coordinates of flood-prone areas, and the statistics of the hazard and risk. This plan is crucial in ensuring that people are making the right decision in the strategic direction.

To ensure that the subsequent stages are reality-based for the affected communities, surveys and interviews are critical techniques for exploring local needs and acquiring local information. Second, to facilitate the process, the design and development of a Web-GIS Flood Risk Index Mapping Platform for Disaster Risk Reduction begins. The Rapid Application Development (RAD) approaches are applied in the project. By applying Graphical Information System technologies (GIS), flood risk data becomes visualized and investigated to offer a better understanding of the driving forces behind it. Based on system evaluation, the final platform will satisfy the desired reliability and efficacy levels.

In addition, the product of this architecture is FRiMap, it is a Web-GIS platform that provides virtually limitless capabilities for mapping flood risks to all stakeholders. Using the platform, decision-makers can proactively assess and mitigate flood risks, thereby saving lives and livelihoods.

Furthermore, the Outcome significantly enhances flood preparedness and response by enabling efficient resource allocation and increased community awareness. It contributes to more effective disaster management through coordinated incident command systems and improved training for emergency response teams. Additionally, the framework aids in developing and implementing more effective flood management policies and land use regulations by informing zoning laws and building codes thereby incentivizing mitigation measures. Moreover, it promotes sustainable development practices by protecting natural flood buffers, facilitating resilient infrastructure planning, and ensuring long-term development strategies that consider future flood risks. Generally, the framework makes it easier to modify input for policy development in the direction of clever flood resilience solutions, advancing evidence-based decision-making and revolutionary change at the local and policy levels [27].

II. Materials and Method

A. Research Design

This study utilized descriptive development research. A descriptive approach was employed when designing the platform to collect hazard and risk assessment data and coordinates of flood-prone areas as inputs. Developmental research was used to develop a Web-GIS FRiMap Platform.

B. B. Study Area

The city of Sagay located in the province of Negros Occidental is the study area. It was purposively selected as the pilot site for this study. Sagay City, positioned in the northeastern part of Negros Island, takes its place as the 68th city in the Philippines as declared by Republic Act 8192. Resembling an "ice cream cone" in its shape, Sagay Marine Reserve was recognized as the largest marine reserve in the country [28]. Higher rainfall and typically colder temperatures are experienced by Sagay's uplands, particularly during the northeast monsoon. It is politically divided into 25 barangays (Fig 2) and is approximately 84 kilometers from Bacolod City, the capital of Negos Occidental. Each barangay consists of purok some have sitios. According to the DRRM Office, the barangays in Sagay City that experience flooding are Barangay Old Sagay, Paraiso, Poblacion 2, Fabrica, Bulanon, and Himoga-an Baybay. Sagay City is located at 10.8783° North Latitude and 123.4082° East Longitude on the island of Negros.

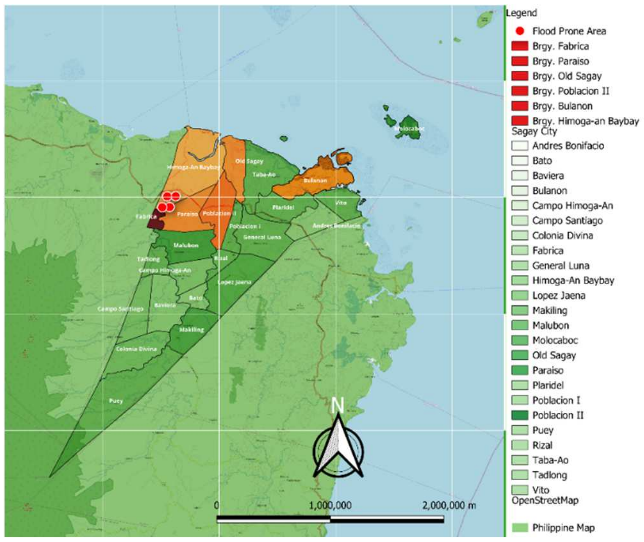

Fig. 2 Study Area (Sagay City)

C. Software Development Method

In this study, the researcher used the Rapid Application Development (RAD) model for the systems development, as illustrated in Figure 3. It is a software development methodology that emphasizes rapid development and provides a high-quality result that meets end users' requirements [29].

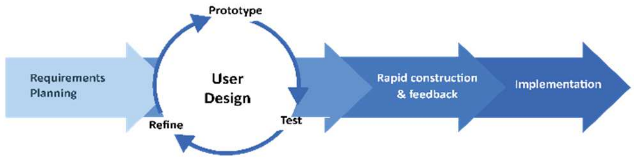

Fig. 3 Rapid Application Development

1) *Requirements Planning*: The researcher sent a request letter to the DRRM Office to conduct an interview and survey. A DRRM Officer was interviewed about their current situation and issues with the current system in monitoring and preparing emergency responses during calamities. The researcher identified and gathered relevant geospatial data sources for disaster risk reduction, including the Hazard Assessment and Risk Analysis datasets and flood-prone areas in Sagay City.

2) *User Design:* In the user design phase, the researcher designed and developed a user-friendly GIS platform that incorporates resource mapping data and is easy for users to access, view, and evaluate.

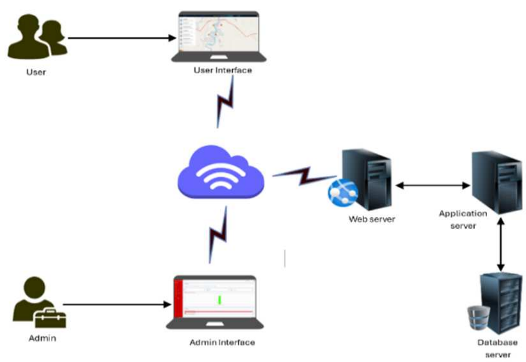

Fig. 4 Web-GIS Flood Risk Index Mapping Platform Architecture

In this architecture, the FRiMap system presents two user interfaces, including the pages for administrators and users. While the user's page was optimized for mobile and laptop devices, providing access to limited features, the administrator page was also intended for viewing on these devices, with full permission to navigate all system functions. One of the system's key components was the database server. This device included all the relevant information to be retrieved. A web server serves as both a database server and a server for HTTP requests received from clients (web browsers) and provides them with HTTP responses and optional data contents. It is developed to serve as an intermediate and determine if the query originates from a mobile device or the web using an application server. Furthermore, it will retrieve the information from the database server and forward the request to a mobile device in a mobile application format and the web in a web format.

In the system development of the Web-GIS Flood Risk Index Mapping Platform, the researcher preprocesses the collected data, including data cleaning, standardization, and conversion to a suitable format for GIS analysis. Integrating the various datasets into a single GIS database also ensures compatibility and consistency. The researcher determined which programming language, web server, and other essential software were necessary to develop an efficient system.

TABLE I
COMPONENTS UTILIZED FOR WEB-GIS FRIMAP

Components	Modules
Web browser	Google Chrome, Microsoft edge, etc.
Scripting Languages	HTML 5, PHP 7.1+, JavaScript, CSS
Database server	MySQL
Web server	Apache HTTP
Map server	GeoServer, OpenStreetMap
GIS	QGIS
Spatial data	Flood zone shapefile layer (shp) boundary of the study area (Sagay City)
Geographic Data Formats	geoJSON, KML, GPX
MysqlPHP Extensions	Gettext, zip,curl,gd,imagick,mysqli
Map library	Leaflet.js (HTML, CSS, JavaScript)

Table 1 shows the components and modules used to develop the Web-GIS platform. In this phase, the researcher used scripting languages like HTML, PHP, JavaScript, and JQuery; MysqlPHP extensions include get text, zip, curl, gd, and imagick; while QGIS software was also used for creating a hazard map and spatial data, which include the flood zone layer (shp) boundary of the study area (Sagay City). Furthermore, XAMPP was a web server solution package consisting of an Apache HTTP server, MySQL database, and interpreters for PHP acting language.

3) Testing: The researcher performed an alpha test to improve the system's functionality and remove bugs. Before deployment, this type of Testing helps the software system become more polished. The IT instructors conducted the alpha testing. The system was prepared for assessment after a few errors in design and functional issues were resolved. The assessment survey used was modified from ISO 25010:2011 to assess the functionality and quality of the developed system. The respondents included five (5) IT experts and four (4) DRRM Officers. They tested the system thoroughly by using all its features multiple times and verifying its functionality.

4) Research Instrument: A survey tool was used in this study to assess the functionality of the system produced. The evaluation questionnaire used was based on the ISO 25010:2011 software quality standards, focusing on criteria such as functional suitability, performance efficiency, usability, security, maintainability, and portability. Other criteria were excluded as they were not relevant to the developed system. The research established indicators for each criterion, which were validated by five (5) IT experts at the State University of Northern Negros (SUNN).

In each item, the evaluators were instructed to evaluate the system using a five-point Likert scale, with the mean ranges interpreted as follows: (1) 1 to 1.80: poor, (2) 1.81 to 2.60: Fair, (3) 2.61 to 3.40: Good, (4) 3.41 to 4.20: Very Good, (5) 4.21 to 5.00: Excellent.

5) Validity and Reliability of the Instrument: The instrument was pre-tested among thirty (30) respondents from Sagay City, and five (5) IT experts from the College of Information and Communications Technology and Engineering (CICTE) using a convenient purposive sampling technique. The instrument was validated using Lawshe's Content Validity Ratio (CVR), with a validity index of 0.956, indicating very high validity. Reliability analysis using Jeffrey's Amazing Statistics Program (JASP) application was also used to determine the instrument's reliability. JASP is a free, cross-platform statistical software package that provides an easy-to-use interface for performing a wide range of statistical analyses [30]. A Cronbach's alpha of 0.954 is interpreted as very highly reliable.

6) Data Gathering and Analysis: The researcher directly gave the respondents the survey questionnaires. At their pace, they were given ample time to complete the survey. The completed surveys were then gathered, treated, and analyzed using JASP software. Mean was used to determine the level of effectiveness of the system.

7) Rapid Construction and Feedback Phase: In the Rapid Construction and Feedback phase, all comments and suggestions from IT experts and DRRM Officers who validated the initial version were considered. The researcher specified some additional requirements needed to enhance the initial version. The researcher modified the design according to the first validation result and added new components and modules for extra features.

8) Implementation: In the implementation phase, based on an overall evaluation of the platform, the IT professionals, DRRM Officers, and residents involved in this study found the newly developed system to be "very effective," meaning that it satisfied the ISO 25010:2011 standard's definition of software quality characteristics and is thus advised for implementation because it offers users convenient and high-quality service.

D. Ethical Consideration

The researcher discussed the terms of the questionnaire with the study respondents before answering the survey instrument. Likewise, they were informed that their participation in the study is voluntary and that participating or withdrawing from it while it is in progress will not harm them and the study. The respondents, at their own pace, had ample time to read the information sheet before deciding whether they wanted to be involved in the study. Agreeing to the terms indicates that they fully understood the purpose of the research, the data collection process, and their permission to be part of the study. The study ensured the anonymity and confidentiality of the respondents and their responses by anonymizing their names and identities during the data collection, analysis, and reporting phases.

III. Results and Discussion

A. *Web-GIS FRiMap Platform*

The researcher's primary goal is to create an informative Web GIS that addresses the effects of flooding in Sagay City. The researcher developed this Web GIS using the flood-prone area database from Sagay City, which was created as part of a project initiative. The established system is a robust instrument for comprehending, visualizing, and overseeing flooding within Sagay City. As a result, it helps mitigate risks and safeguard lives. Consequently, it is imperative to continue developing and enhancing it to address the escalating challenges presented by flooding effectively. FRiMap is an excellent OpenStreetMap solution that enables flexible visualization and simple location tagging.

The developed system is highly adaptable, allowing the Disaster Risk Management Officer, in the role of administrator, to modify the system's content and settings completely (Fig. 5). The administrator can see a summary of the map and markers indicating the flood-prone area at the specific location (Fig. 6) as well as the statistics of map usage (Fig. 7).

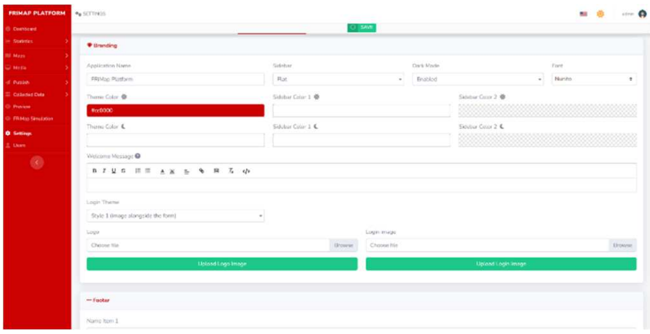

Fig. 5 FRiMap Page Settings

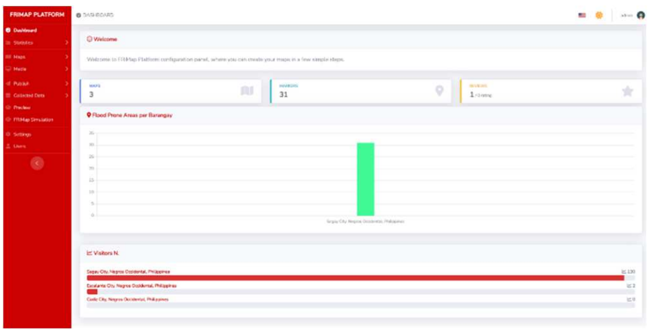

Fig. 6 Flood Risk Index Mapping (FRiMap) Dashboard

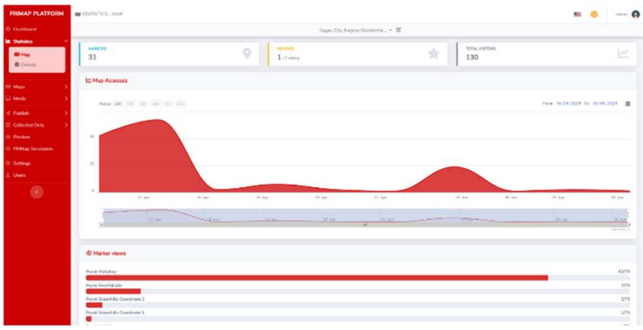

Fig. 7 Map Access Statistics

Fig 8 depicts the interactive map system, offering a range of styles and the ability to add maps for individual cities. Within this functionality, users can utilize options such as adding markers, publishing, duplicating, and deleting. Furthermore, clicking on the map allows for updating information associated with it.

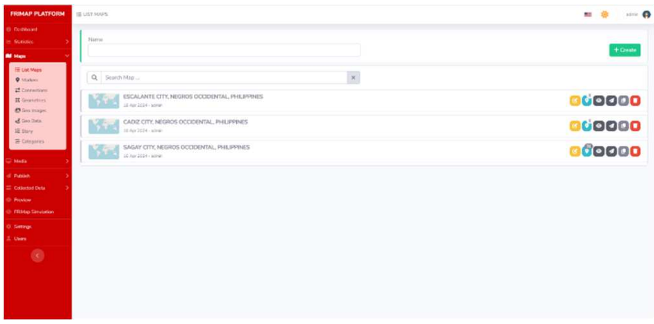

Fig. 8 Map Management

Figure 9 illustrates the system's capacity to incorporate an unrestricted quantity of markers, which can be intelligently organized and personalized with unique icons. Additionally, it provides comprehensive details for each marker, forming images and precise coordinates pinpointing the specific location, particularly identifying flood-prone areas.

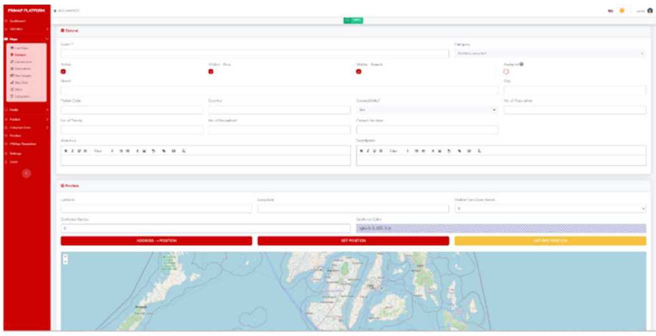

Fig. 9 Add Marker

Figure 10 exhibits risk assessment data and markers within a designated area. This system enables information updates upon clicking the edit button and facilitates deletion.

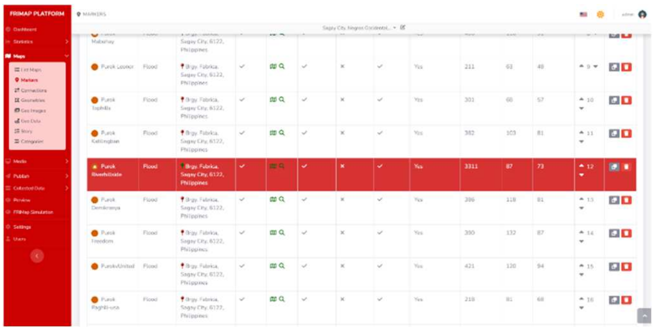

Fig. 10 Marker Lists

Figure 11 illustrates how the system can connect markers and generate connecting lines, as well as its capability to incorporate geometries into markers (Figure 12).

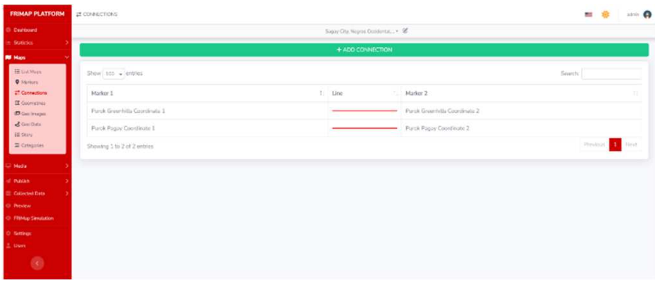

Fig. 11 Marker Connection

Fig. 12 Marker Geometries

Figure 13 depicts the map of Sagay City, one of the areas examined in this study, segmented into 25 barangays. The Disaster Risk Reduction Management (DRRM) office has identified certain barangays prone to flooding, notably Barangay Old Sagay, Paraiso, Poblacion 2, Fabrica, Bulanon, and Himoga-an Baybay. Hovering the mouse over a particular area triggers a pop-up window displaying basic information. The data is essentially the shapefile layer (shp) of the flood-prone areas and the boundary of the study area, which is the city of Sagay.

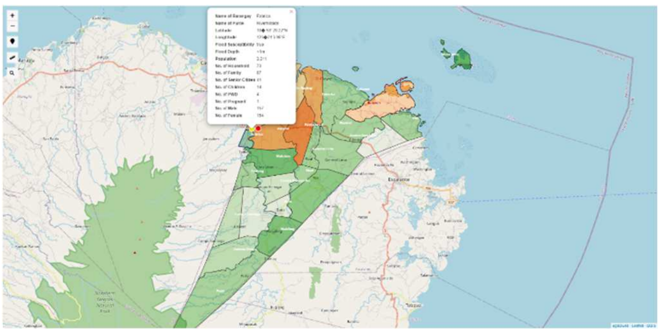

Fig. 13 FRiMap Simulation

Figure 14 illustrates the system's capability to manage user role permissions, including those of administrators who can oversee users and manage maps across all users. Editors are limited to managing maps associated with them, while customers can solely manage their maps.

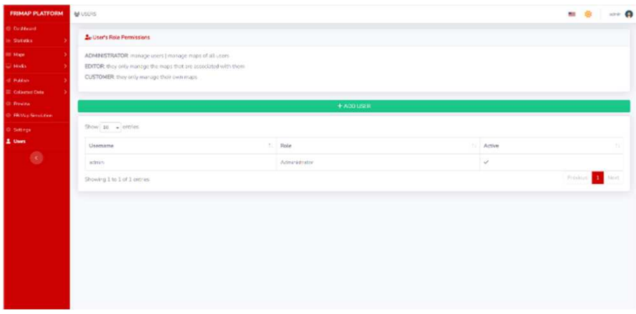

Fig. 14 User Management

Figure 15 demonstrates that users can access the map along with basic information. It offers users options for submitting reviews and ratings and links to routes and Street View.

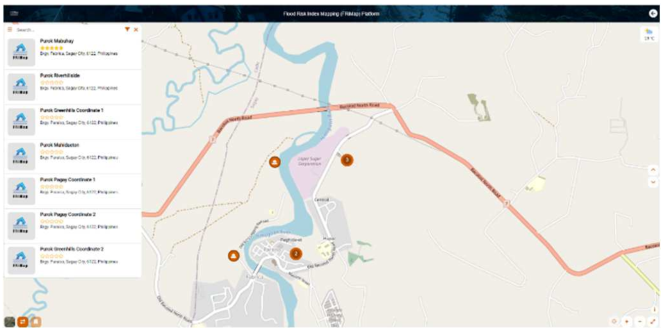

Fig. 15 User Interface

B. *System Evaluation Result*

The system was evaluated using ISO 25010:2011 software quality standards based on its functional suitability, performance efficiency, usability, security, maintainability, and portability. It was evaluated by five (5) IT Experts who are in line with system design and development, and four (4) officials in DRRM who have first-hand contact or access to the system. The scores were calculated using the Mean, and a five-point Likert scale was employed.

TABLE II
EXPERT EVALUATION SUMMARY OF THE SYSTEM USING ISO 25010:2011 SOFTWARE QUALITY STANDARDS

Criteria	IT Experts					Mean	Interpretation
	1	2	3	4	5		
A.Functional Suitability	4.00	5.00	4.67	4.00	5.00	4.53	Excellent
B.Performance Efficiency	4.00	5.00	4.33	4.00	5.00	4.47	Excellent
C. Usability	4.00	5.00	4.67	5.00	5.00	4.73	Excellent
D. Security	4.00	4.00	3.67	4.00	5.00	4.13	Very Good
E. Maintainability	4.00	5.00	4.00	4.00	5.00	4.40	Excellent
F. Portability	4.00	4.00	4.00	4.00	4.67	4.13	Very Good
Grand Mean						**4.40**	**Excellent**

The evaluation results for the Web-GIS FRiMap as evaluated by the IT experts in terms of Functional Suitability, with an average mean of 4.53, interpreted as excellent. Performance efficiency with an average mean of 4.47 (excellent). Usability, with an average of 4.73 (excellent). Security, with an average of 4.13, interpreted as (very good). Maintainability, with an average mean of 4.40, interpreted as excellent. Lastly, Portability with an average mean of 4.13, interpreted as (very good). The table indicates that the expert's evaluation of the system based on ISO 25010:2011 software quality standards criteria was excellent, achieving a grand mean score of 4.40. This demonstrates that the system complies with the software quality characteristics specified by ISO 25010:2011 standards, indicating its high quality and potential to deliver excellent service to its users, particularly within the Office of Disaster Risk Management.

TABLE III
EVALUATION SUMMARY OF THE RESPONDENTS BASED ON THE FEATURES OF THE DEVELOPED SYSTEM

Features of the Developed System	Mean	Verbal Interpretation
A. Functional suitability		
1. The FriMap platform runs according to its expected function.	4.80	Excellent
2. The FRiMap platform works correctly based on user requirements	4.80	Excellent
3. The FRiMap platform provides features that enhance the user's engagement including local communities, policymakers, and emergency responders	4.40	Excellent
Total	**4.67**	**Excellent**
B. Performance efficiency		
1. The FRiMap platform updates the Disaster Risk Reduction Office records in real-time	4.60	Excellent
2. The FRiMap platform loads quickly	4.20	Very Good
3. The FRiMap platform handles a large amount of necessary data including hazard assessment and risk analysis data	4.80	Excellent
Total	**4.53**	**Excellent**
C. Usability		
1. The FRiMap is user-friendly	4.80	Excellent
2. The user interface of the FRiMap is easy to navigate.	4.80	Excellent
3. The FRiMap platform can be easily accessed online with no hassle.	4.80	Excellent
Total	**4.80**	**Excellent**
D. Security		
1.The FRiMap platform does not compromise the personal information of the residents in Sagay City	4.00	Very Good
2.The FRiMap platform provides a mechanism that prevents unauthorized access to data stored on the system.	4.00	Very Good
3.The FRiMap prevents unauthorized modifications to critical data and ensure the integrity and accuracy of information.	4.40	Excellent
Total	**4.13**	**Very Good**
E. Maintainability		
1. The FRiMap is applicable to any area within a city in Negros Occidental.	4.80	Excellent
2. The FRiMap is easy to modify without causing any errors on the other components of the system	4.80	Excellent
3.The FRiMap provides a mechanism which notifies if there is an error in some parts of the system	4.40	Excellent
Total	**4.67**	**Excellent**
F. Portability		
1. The FRiMap platform allows the user to easily install the system.	4.40	Excellent
2.The FRiMap platform allows upgrading of individual components without disrupting the overall functionality.	4.40	Excellent
3.The FRiMap platform has the ability to integrate real-time and historic data from multiple sources.	4.40	Excellent
Total	**4.40**	**Excellent**
Grand Mean	**4.53**	**Excellent**

Table 3 presents the evaluation findings for the Web-GIS FRiMap as evaluated by the end-users in terms of Functional Suitability, with an average mean of 4.67, interpreted as excellent, which means that the system runs according to its expected function and works correctly based on user requirements. Performance efficiency with an average mean of 4.53 (excellent) indicates that the system updates the DRRMO records in real-time and it can handle large amounts of necessary data including hazard assessment and risk analysis data. Usability, with an average of 4.80 (excellent), means that the system is user-friendly and the user of the FRiMap is easy to navigate. Security, with an average of 4.13, interpreted as (very good), indicates that the system does not compromise the personal information of the residents and it provides a mechanism that prevents unauthorized access to data stored on the system. Maintainability, with an average mean of 4.67, interpreted as excellent, indicates that the system is easy to modify without causing any errors on the other components of the system. Lastly, Portability, with an average mean of 4.40, interpreted as excellent, indicates that the system allows users to easily install it and integrate real-time and historical data from multiple sources. The table indicates that the end-user's evaluation of the system based on ISO 25010:2011 software quality standards criteria was excellent, achieving a grand mean score of 4.53.

IV. CONCLUSION

This research introduces a Web GIS platform focusing on flood-prone regions within Sagay City. The development of this platform relies on open-source software. Primarily constructed using scripting languages such as HTML, PHP, JavaScript, JQuery, and CSS, the application utilizes MySQL as the database server and Apache HTTP as the web server. Preprocessing, analysis, and cartographic tasks with spatial data, specifically the Flood shapefile layer (shp) boundary of Sagay City, were conducted using QGIS. Additionally, qgis2web, a QGIS plugin, facilitated data exportation to an OpenLayers/Leaflet web map. This plugin aims to replicate various project elements, including layers, extent, and styles, as well as categorized and graduated representations.

FRiMap platform is a valuable system that fulfills its expected functions, according to the result of the ISO 25010:2011 software quality standards evaluation. The FRiMap platform represents a significant leap forward in flood risk assessment and disaster risk reduction. By harnessing the power of web-based Geographic Information System (GIS) technology, FRiMap offers a sophisticated tool for mapping flood risk indices, enabling a comprehensive understanding of vulnerability across varied landscapes.

Nevertheless, like any tool, the platform comes with its limitations. A system utilizing the Leaflet JavaScript library was developed, but the platform's capacity to handle geospatial data may be limited. Processing maps with multiple layers or extensive datasets can significantly disrupt application speed. Furthermore, the platform confines data visualization to 2D, lacking the capability for 3D cartographic representation [31].

However, to enhance the efficacy of disaster preparedness and response measures, it is recommended that IoT-enabled Water Level Alarm Systems be integrated into the FRiMap platform and that algorithms be incorporated into an early warning system to transform it into a comprehensive platform. These systems provide real-time monitoring of water levels, offering crucial early warnings to communities and authorities and enabling timely evacuation and mitigation efforts. By combining the analytical capabilities of FRiMap with the real-time data provided by IoT-enabled systems, stakeholders can significantly improve their ability to anticipate and respond to flood events. This integration enhances the effectiveness of disaster risk reduction strategies and underscores the importance of embracing innovative technologies in building resilient communities in the face of escalating climate challenges. This tool aids authorities in managing, preventing, and mitigating flood risks within Sagay City. The project's progression entails naming infrastructures like schools and health services in flood-prone zones. Regular updates to the integrated geospatial data are imperative.

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