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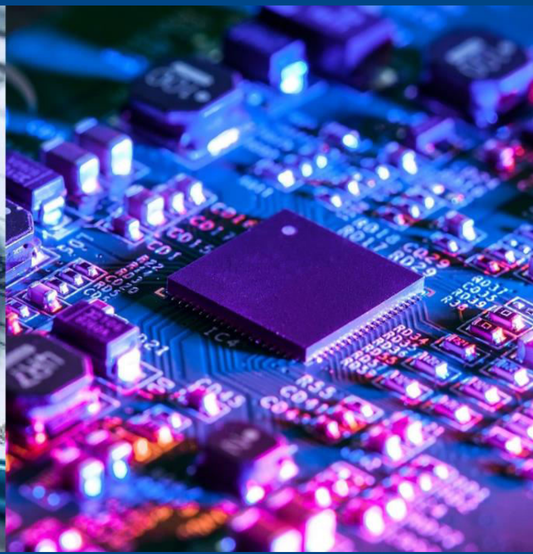

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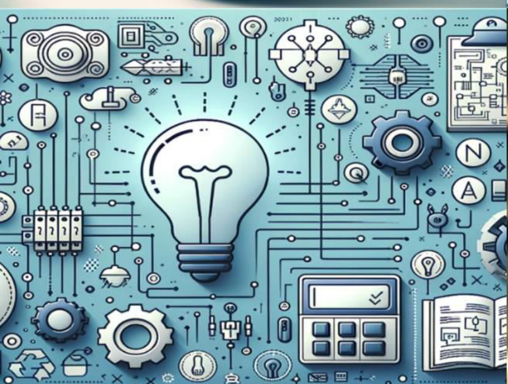

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Unified Modelling Language Use Case Diagram for Flood Mitigation

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ABSTRACT: Effective flood risk management necessitates a combined approach that includes flood risk management and land administration. The aim of the research was to create a use case diagram for flood mitigation in the Etsako Central local government area of Edo State, Nigeria, using Unified Modelling Language (UML) system. This study's data were gathered through field observations and questionnaire administrations. The number of respondents was defined by administering the questionnaires randomly at all villages and focusing on communities that are prone to flooding, land administration agencies, and flood risk management agencies. The research revealed that the current land administration system is inadequate, and it is not integrated into flood risk management; hence, flood risk is high in the study area. The focus is on integrating the concepts of flood risk management and land administration to design a system using Unified Modelling Language for mitigating flooding disaster in the study area. A use case diagram was designed based on the concepts of the inter-relationships that exist amongst flood risk management and land administration. The system was created to give accurate and up-to-date flood risk information, facilitate effective flood risk management, and lessen the effect of floods on communities. As a result, the study suggests that the use case diagram be implemented in the Etsako Central Local Government Area to improve flood risk management and lessen flooding's impact on communities. It also proposes that stakeholders, such as local government officials, community leaders, and citizens, be trained to ensure the system's efficient implementation and sustainability.

KEYWORDS: Flood risk management, Land administration, Unified modelling language, Use case diagram, Etsako central local government area

I. INTRODUCTION

A Unified Modelling Language (UML) use case diagram is a graphical representation of a system's interactions with its users, displaying the relationships between its users (actors), the system, and other functions or services the system offers (use cases) (OMG, 2017). Use case diagrams describe the system's capabilities and how actors interact with it in relation to certain use cases. Actors, use cases, system boundaries, and relationships are all components of a use case diagram, while the various forms of relationships include association, generalisation, inclusion, and extend (Booch et al., 2005). A UML use case diagram is a visual representation within the Unified Modelling Language (UML) that depicts how different actors (users and external systems) interact with a system, demonstrating the operations and behaviours a system can perform from the user's perspective, and essentially outlining the system's key features and how users will interact with them. It provides a high-level overview of the system's requirements and user interactions.

Flood mitigation refers to the steps taken to mitigate the impact of floods on communities, infrastructure, and the environment (UN, 2015). To prevent or limit flood damage, a variety of methods are used, including structural and non-structural approaches (EU, 2007). Flood mitigation strategies include structural, non-structural, natural, and nature-based approaches. Flood mitigation is the process of managing and controlling floodwater movement caused by a rainfall event. To minimise floods, first determine floodplain locations and then design flood frequencies. Flood risk management is a major worry in today's society due to the regular flooding that occurs each year, resulting in considerable economic, social, and environmental damages. Flooding is one of the most devastating, frequent, and pervasive environmental dangers, with a variety of kinds and magnitudes (Wizor and Week, 2014; Nwankwoala and

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Jibril, 2019). Flooding is an unavoidable natural occurrence that occurs on occasion in all rivers and natural drainage systems, causing damage to life, natural resources, and the environment (Thilagavathi, 2011). Floods are defined as a huge amount of water covering dry ground and are a naturally occurring phenomenon that is determined not just by rainfall levels but also by the area's topography and antecedent moisture conditions (Smiths et al., 2020).

Land administration is defined as "the process of determining, recording, and disseminating information about the tenure, value, and use of land when implementing land management policies," according to UNECE, 1996; 2005. Flood risk management refers to the systematic process of identifying, assessing, and mitigating the risks associated with flooding to minimise the impact on communities, properties, and the environment. Land administration and flood risk management are two vital components for sustainable development in any region. The effective management of land and its resources and the implementation of appropriate flood risk reduction measures can significantly contribute to reducing the impact of flood risk in any society. The UML use case system design is a comprehensive framework that utilises the Unified Modelling Language (UML) and integrates the concepts of land administration and flood risk management for flood mitigation. Despite historical evidence of flood interventions, the absence of an integrated flood risk management (FRM) approach results in the adoption of suboptimal solutions, often leading to the creation of new problems.

An effective land administration system is critical for decreasing flood risk because it ensures that land use practices, development patterns, and infrastructure planning are consistent with flood risk reduction measures. However, the impact of land administration on flood risk management in the Etsako Central Local Government Area is not well understood. This study focusses on two concepts, flood risk management and land administration, to reduce floods in the study area. The methodology is a non-structural method that entails creating an integrated UML use case system to mitigate flooding disasters in the Etsako Central Local Government Area of Edo State, Nigeria.

II. METHODOLOGY

2.1 Study area

The study area is Etsako Central Local Government Area in Edo State, It lies on latitude of 07° 08’ 59’’N to 07° 09’ 05’’N and longitude 06° 20’ 39’’E to 06° 40’ 17.28’’N. It shares boundaries with Etsako East L.G.A in the North, Etsako West L.G.A in the West, Esan South L.G.A in the South Fig (1.6a). It’s elevation ranges from 21m to 506m. Etsako Central L.G.A has an area of 660km2 and population of 94,575 according to 2006 census. The region is referred to as Afemai and the most practice religions are Islamic and Christianity. Sixty percent (60%) of the population are farmers, hunters and fisherman. Most crops grown are yams, cassava and maize. The major River in Etsako Central which take it source from River Niger are River Edion and River Aika (see Fig.1c). There are wetlands in the area. The predominant occupation in the region are irrigation farming and fishing due to the presence of rivers in the area. Agriculture is a major economic activity in Etsako Central Local Government Area. The fertile soil and favorable weather condition in the area make it suitable for farming. The people engage in crop farming, livestock rearing, and fishing.

2.2 Unified Modelling Language (UML) Concept

Unified Modelling Language (UML) is a standardised visual modelling language used in software engineering to describe, visualise, and document software systems (Grady, 2014). It was created in the mid-1990s as a collaborative effort by Booch, Rumbaugh, and Jacobson. Three software engineers had developed their own individual methodologies for designing and documenting software systems, and they decided to combine their efforts to create a unified language (Booch et al., 2005). UML was designed to provide a common notation and semantics for software modelling, which would help bridge the gap between different software development methodologies and tools. The goal was to create a visual language that could be understood by both technical and non-technical stakeholders involved in software development. UML was first introduced in the mid-1990s and has undergone several versions and revisions. The most notable versions include UML 1.0, UML 1.1, UML 1.2, UML 2.0, UML 2.1, UML 2.2, UML 2.3, UML 2.4, UML 2.5, and UML 2.5.1. Each version introduced new features, refinements, and improvements to the language. Accurate land information, such as land type and location, can significantly influence the assessment of flood risks. For instance, a land parcel located in a floodplain has a higher risk of flooding. By integrating these domains, it

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becomes possible to proactively manage flood risks, notify landowners of potential threats, and take proactive and preventive measures.

The process began by defining the objectives of the research. Thereafter, stakeholders (LA and FRM) involved and/or impacted by the assessment were identified, and their concepts and policies served as the data required. The respondents include landowners, notaries, government officials, non-governmental organisations (NGOs), individuals, and academicians. The number of respondents was defined by administering the questionnaires randomly at all villages and focusing on communities that are prone to flooding.

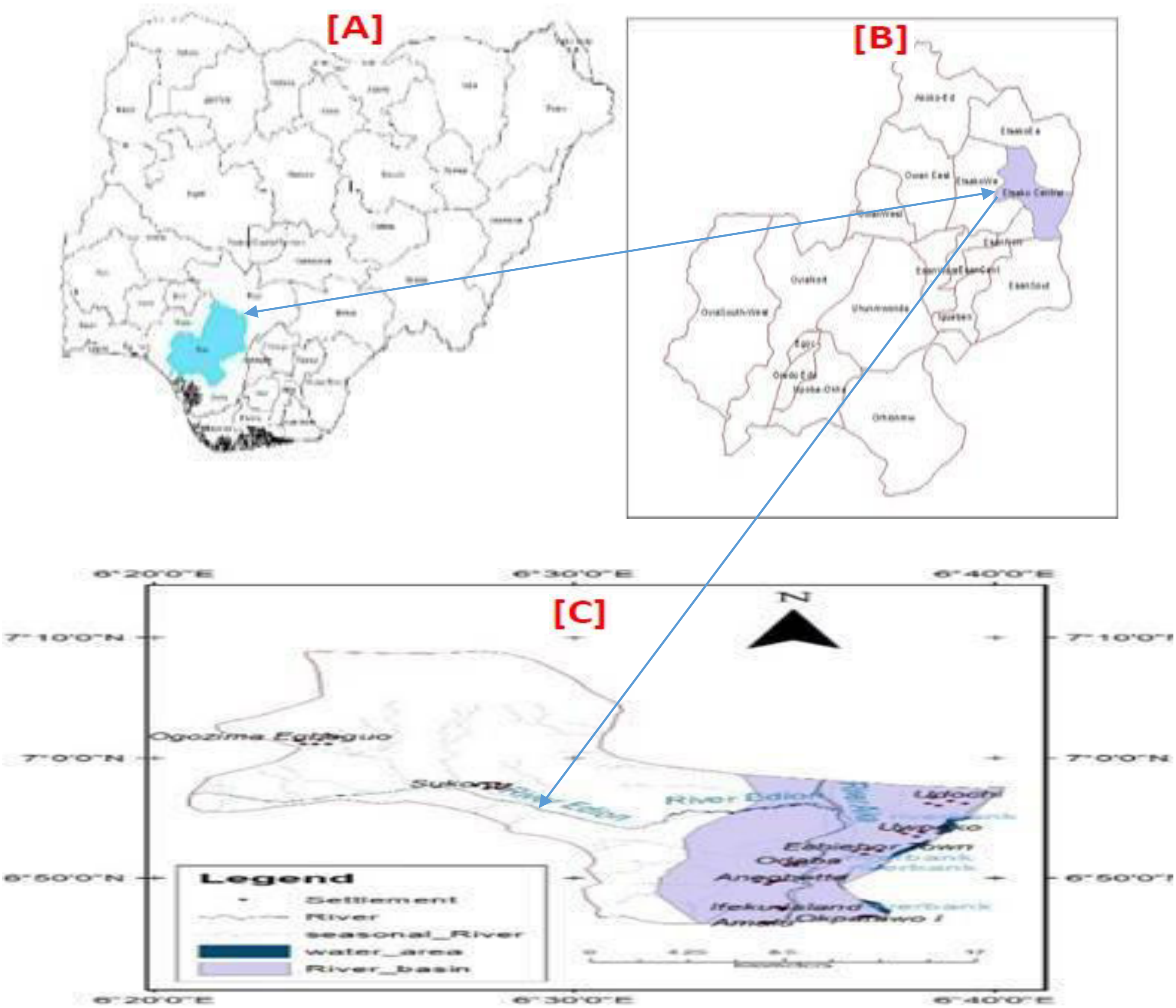

Fig. 1a: Map of Nigeria Showing Edo State.
Fig. 1b: Map of Edo State
Fig. 1c: Map of Etsako Central L.G.A

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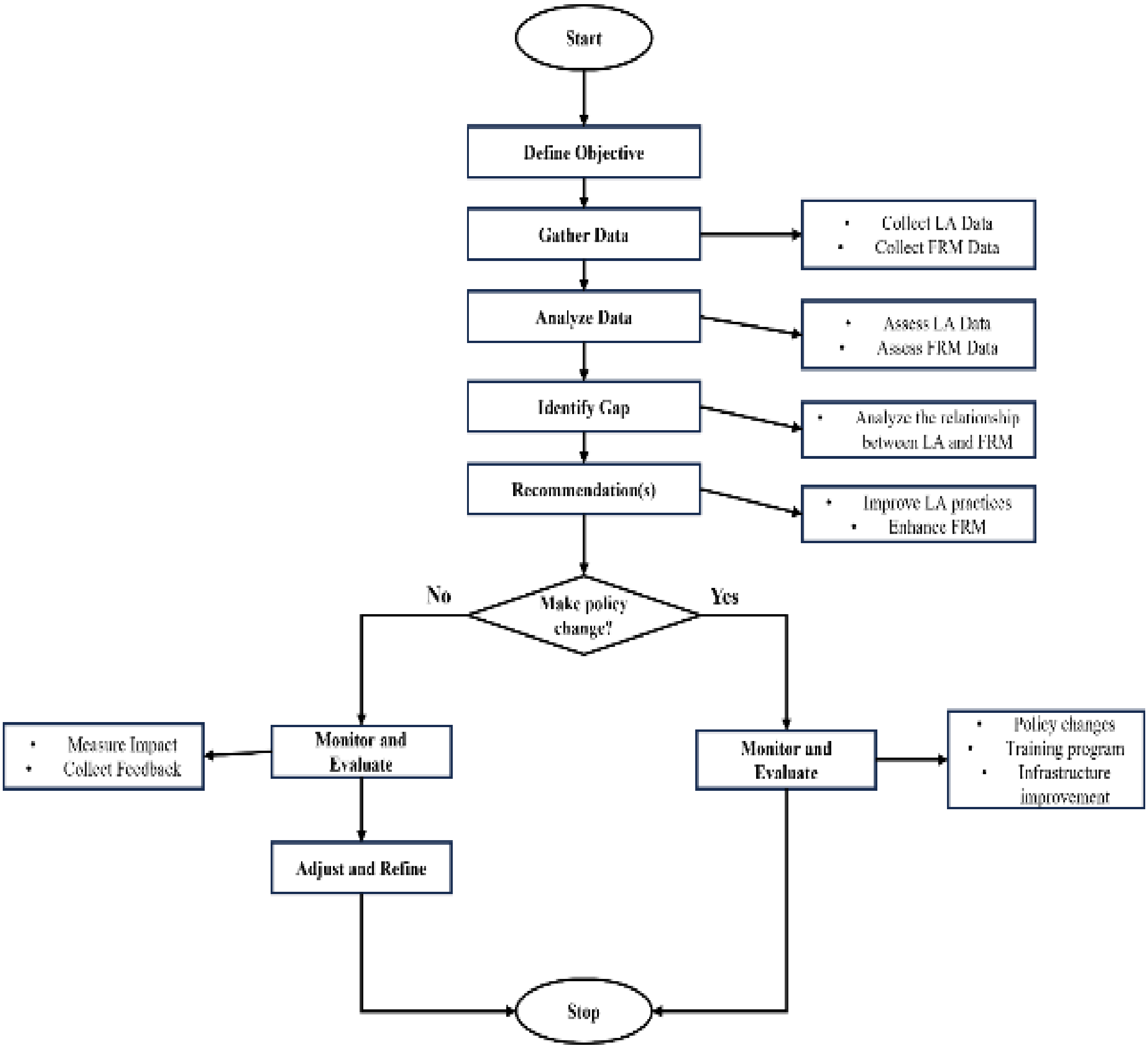

Figure 2: Flowchart for Designing the Integrated Model

Analysis of the data to identify the relationship between LA and FRM was conducted. The procedures of FRM were enhanced by improving LA practices through changing of policy, training programs, and infrastructure improvements. The impacts of flooding in the study area affirmed proffering solutions by creating resilience to flooding through interconnection, relationships, and coordination between LA and FRM concepts and policies of the study area.

2.3 Data Acquisition

The model was based on a use case system designed using the UML technique. The design was based on the actors in land administration and flood risk management. The links between LA and FRM actors and the system being simulated were considered. The categories include land parcels, landowners, flood disasters, government agencies (LA), and flood risk management (FRM) authority, and the actors are landowners, government agencies (LA), flood risk management authorities (FRM), and the general public.

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2.3.1 Data Processing of the System Design

The Unified Modelling Language (UML) was used in the designing of the integrated model. It is a standardised modelling language that provides a way to visualise system architectural blueprints in a diagram. UML is a powerful tool used to represent the interactions, entities, and processes involved in integrating the domains of Land Administration (LA) and Flood Risk Management (FRM). The Lucidchart UML software was employed in the system design. The research focused on the actors such as **the Landowner,** Government Agency (LA), Flood Risk Management Authority (FRM), and General Public. The data processing of the integrated model for land administration (LA) and flood risk management (FRM) involves creating a systematic approach that enables the collection, storage, processing, and analysis of data within the integrated system, ensuring that it supports both land administration and flood risk management functionalities. Figure 4 gives a pictorial representation of the framework integration phase.

2.3.2 Data Collection and Sources

The first step in the data processing involves gathering relevant data from different systems, policies, and agencies associated with LA and FRM, including:

1. **Land Administration Data:** Collected from land registries, surveys, and land use planning systems. Data on land parcels (parcel ID, owner, land type, location) and information related to ownership and land use were collected.
2. **Flood Risk Management Data:** Gathered from flood disaster records, risk assessment models, early warning systems, and disaster notification systems. Data on flood disasters (disasterID, type, severity, affected areas) were included.

The Actors: Landowners, Government Agencies (LA), FRM Authorities, and the General Public.

2.3.3 Data Transformation and Modelling

At this stage, the collected data is processed and transformed into a usable form that supports the functionality of the integrated model.

1. **Land Parcel Data:** Processed to ensure accurate mapping of land use, ownership, and types of land.
2. **Flood Risk Data:** Transformed into risk maps and categorized based on severity, allowing FRM authorities to provide real-time risk assessments and notifications to landowners.

2.3.4 Notification and Decision-Making

The processed data is used to make decisions, such as issuing flood warnings or updating land records. The system automatically:

1. Notifies landowners when flood risks are identified.
2. Updates government databases with the latest land and flood risk information.
3. Provides access to the general public to view flood risk information related to specific land parcels.

2.3.5. Relationships:

Land parcels are owned by landowners.
Flood disasters affect land parcels, prompting government and FRM authorities to take action.

2.4 Data Presentation

Data presentation of the integrated system using the UML approach involved creating diagrams and systems that visually represent the different components, relationships, and interactions within the land administration and flood risk management systems.

2.4.1 Data Storage and Management

The system stores all the integrated data in a centralized database, ensuring secure, efficient retrieval, and updates. This includes:

1. Land Records: Including information on land ownership, type, location, and legal documents (e.g., Certificates of Occupancy).
2. Flood Risk Data: Historical and current flood events, risk assessments, and response plans.

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III. RESULTS AND DISCUSSION

3.1 User Interaction and Data visualization

The processed data is visualised using UML tools. Lucidchart software was employed to represent the system's architecture visually, showing how the land administration and flood risk management systems interact.

Public Interaction: The general public can access flood risk information and participate in community awareness programs through interactive interfaces provided by the system.

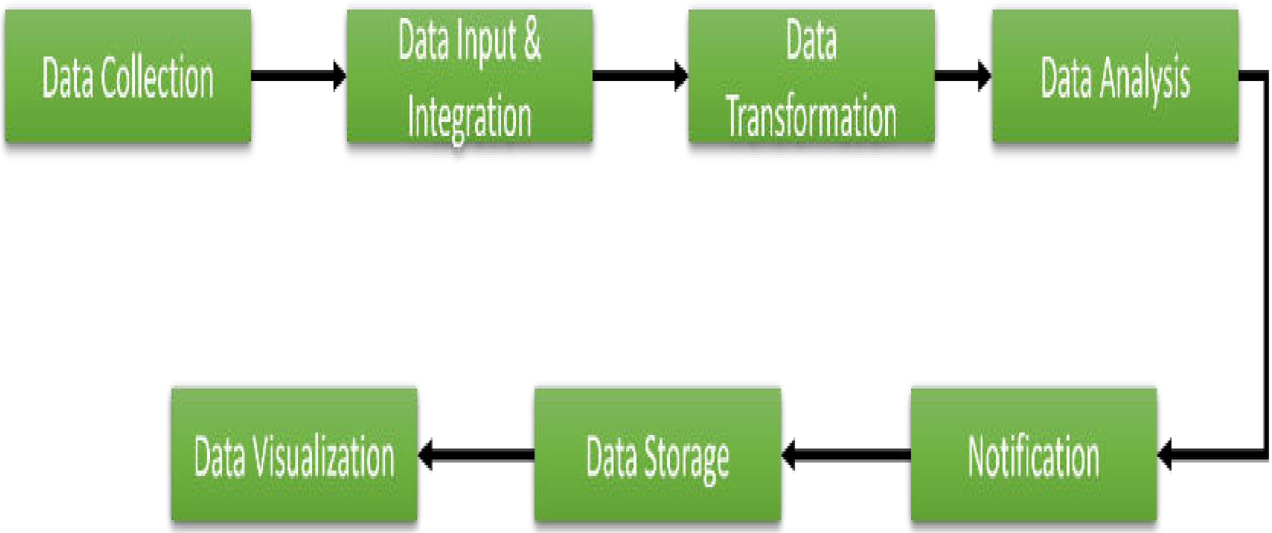
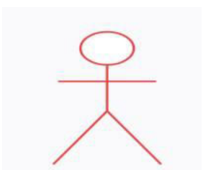


Figure 3**:** Framework for the Data Processing of the System Design

3.2 Data Presentation of the System Design

The section provides a detailed explanation of the various objects, relationships, and notations used in the use case diagram for integrating the Land Administration (LA) and Flood Risk Management (FRM) systems. Table 1 below explains further symbols, names, and descriptions used in the system design (Rumpe, 2016).

Table1: Use Case Objects and its Representation

SYMBOL	NAME	DESCRIPTION
	Actor	Any entity that fulfills a function in a particular system is an actor in a use case diagram. This is typically depicted as the skeleton below and might represent a person, group, or external system.
	Use Case	A use case is a representation of a system action or function. It is named after its function and depicted as an oval.

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	System	The system is represented as a rectangle and is used to specify the use case's parameters. Although optional, this component is helpful when illustrating complex systems. To specify the scope of your project, for instance, you can utilize the system object after
		creating all of the use cases. It can also be used to display the many topics that have been covered in various releases.
	Package	Another optional component that is quite helpful in intricate diagrams is the package. Packages are used to group use cases together, much like class diagrams. They are depicted as shown in the diagram.

The research focused on the following in the designing of the model:
Use case diagram was used to represent the interactions between the different actors and the system. In the context of land administration and flood risk management, the use cases are:

a) Land Register**:** Landowners interact with the LA system to register their land.
b) Land Information**:** Landowners or the government agency can update land information, such as ownership or land use type.
c) Assessment of Flood Risk**:** The FRM authority assesses the risk of flooding on specific land parcels.
d) Notification of Landowners**:** In case of imminent disaster threats, the FRM authority notifies the affected landowners.
e) Public Awareness**:** The general public can assess the flood risk information related to different land parcels.

3.3 Use Case Diagram of Land Administration (LA) and Flood Risk Management (FRM)

The Use Case Diagram outlines the primary interactions between the different actors and the system, highlighting the essential functionalities of the system. The key actors include landowners, the government agency responsible for land administration, the Flood Risk Management Authority, and the general public. Each actor interacts with the system to fulfil distinct roles. Landowners primarily engage with the system to register land and update land information. This ensures that all land-related data, such as ownership and land type, are up-todate in the Land Administration System. The government agency interacts with the system to manage land data, ensuring that all legal and administrative updates are reflected in the system. On the other hand, the Flood Risk Management Authority is responsible for assessing the flood risk associated with particular land parcels. When a significant risk is detected, the authority sends notifications to landowners about potential flood threats. Additionally, the general public can access public awareness information, particularly regarding flood risks in their locality. This interaction with the system enhances community preparedness and disaster mitigation efforts.

The use case relationships are further enhanced by the inclusion of critical use case extensions and inclusions. For instance, the Land Registration use case includes a Validate Ownership step, which ensures that the legitimacy of the land being registered is confirmed. Similarly, the Flood Risk Assessment use case includes the verification of land data before the risk is assessed, ensuring that the data being used for flood risk analysis is accurate. The Notify Landowners

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use case extends the Flood Risk Assessment, occurring only when flood risk exceeds certain thresholds, triggering the need for warnings to be sent out. Figure 4 shows the use case diagram for the system.

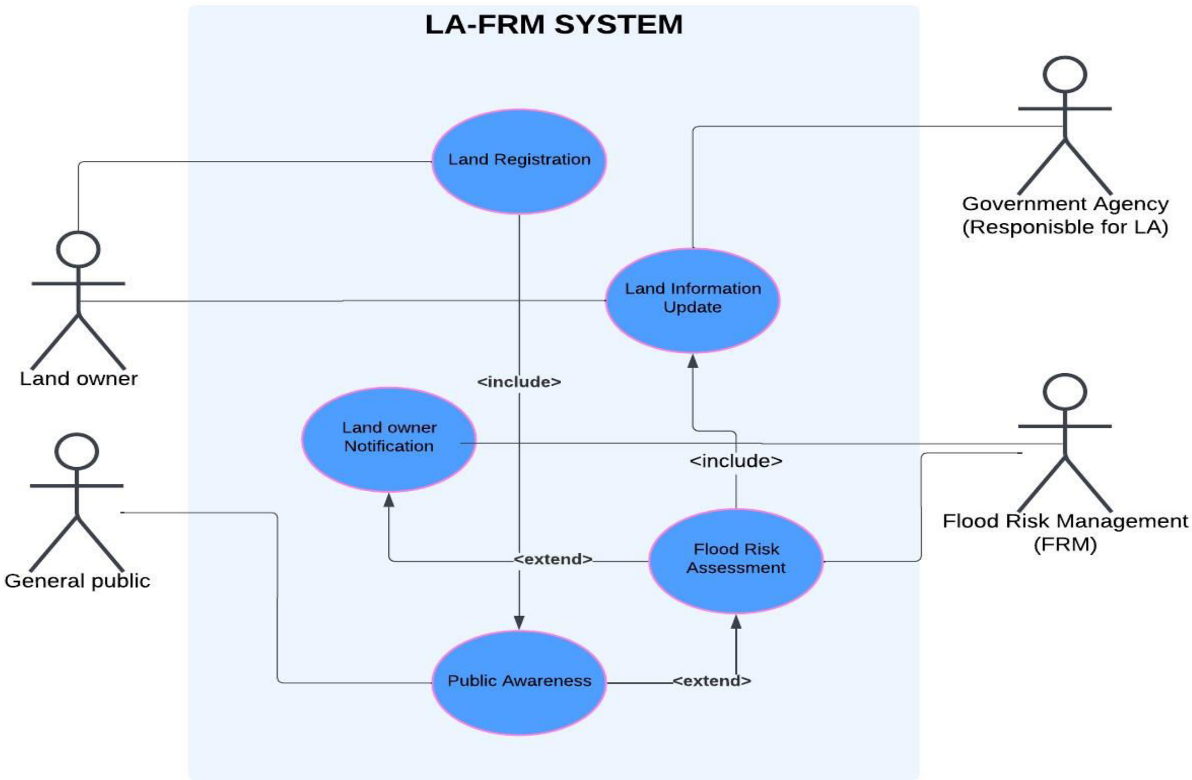

Figure 4: UML Use Case System Design

IV. CONCLUSION

The UML Use Case system is developed to integrate land administration and flood risk management methods to decrease the impacts of floods in the Etsako Central local government region. The system comprises of administration of land and property information, including ownership, boundaries, and land use, while the flood risk management component involves detection, assessment, and mitigation of flood threats. The system provides information on land updates, land registration, and land use planning, as well as zoning and building codes. It gives communities and officials with early warnings about oncoming floods. Flood control structures, wetland restoration, and floodplain management will all contribute to the system's effectiveness in flood reduction.

V. RECOMMENDATIONS

It is therefore recommended that:

1. There is a need for a land use plan to be developed to take into account flood risk zones and ensure that development is guided by flood risk management principles.
2. A land administration system should be established to integrate land information, including ownership, boundaries, and land use.
3. Personnel should be trained in flood risk management and land administration to ensure effective implementation of the UML use case system design.

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4. Flood-resilient infrastructure should be developed, including flood-control structures, bridges, and roads, to reduce the impact of flooding.
5. Develop a public awareness program to educate residents on flood risk management and the importance of flood mitigation measures.
6. Partnerships should be created with stakeholders, local communities, NGOs, and private sector organisations to support the implementation of the system.

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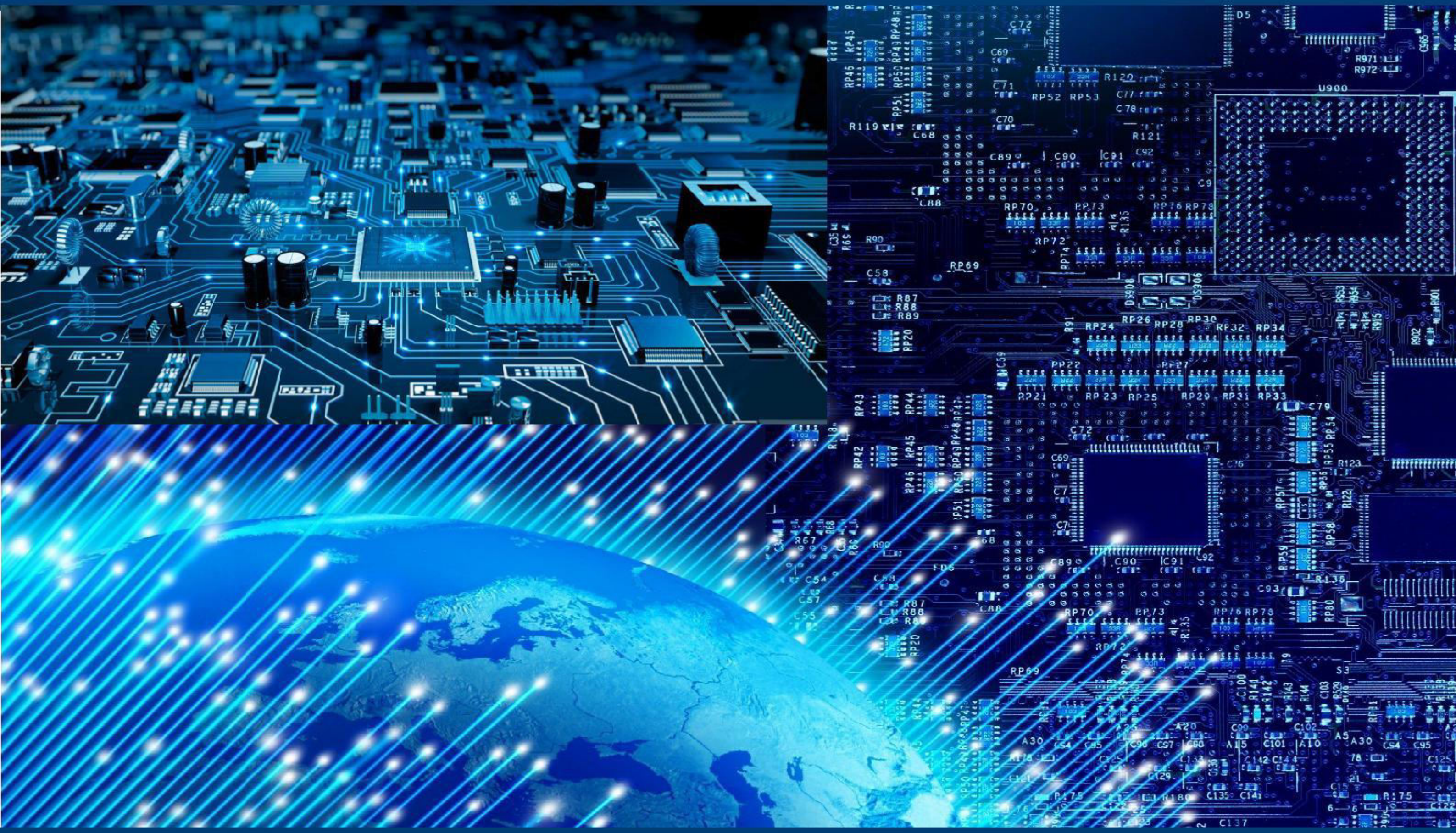

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