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Development Geographic Information System for Forest Mapping in Kutai Kartanegara Regency

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Abstract— The agricultural, plantation, and forestry industries that are the main choice of the population to meet household food needs and boost the community's economy are very much in line with the geographical contours of the Regency Kutai Kartanegara. A geographic information system that can provide information on position, location coordinates, forest areas, forest information in Kutai Kartanegara Regency, and paths to find the location of forest areas. A web-based Geographic Information System (GIS) is required to determine the current position and location of the forest. The waterfall method is used to build this GIS framework, which involves stages such as analysis, design, code generation, testing, and maintenance. MySQL is a database management system. PHP, JavaScript, and HTML are used to create programming languages. Bootstrap user interface implementation. Black box testing is used to verify the software. The test results show that the GIS created meets the requirements and can resolve system issues.

Keywords— Geographic Information Systems, Forestry, Waterfall, Blackbox Testing

I. Introduction

Forests have the potential for human life, both economic and the continuity of life for living things (Kurniawan, 2020). In addition, forests have an important role in long-term environmental protection (Kurniawan, 2020; Kardika, et al, 2022; Schweizer & Cisneros, 2017). The increase in the number of inhabitants leads to an increased need for new farms, houses and jobs, as well as disrupting the balance of the environment (Kaufer, 2023; Wikstrom, 2023). Meanwhile, outside the agricultural industry, other factors point to a lack of transparency in the field of work: diminishing land area (Hoogesteger, 2022), decreased land quality and environmental carrying capacity (McFadden, et al, 2022; Gulati & Juneja, 2022; Greenwood, 2022), and often encountered essential lands (Al Mamun, et al, 2022). Communities are highly reliable on the forest environment, as demonstrated by their dedication to introducing sustainable forest conservation and efforts to gain international recognition as a result of forest areas (Katila, et al, 2019; Delabre, et al, 2020; Afni & Rianita, 2023; Mahmoudi, et al, 2022). In Kutai Kartanegara Regency, there are nine leading forest areas in nine sub-districts, each of which has considerable potential both in terms of the number and scale of forest areas. How to build a website structure that can identify the distribution of forest areas in Kutai Kartanegara Regency to support the data collection of existing forest areas in Kutai Kartanegara Regency (Chao, et al, 2013; Chao, et al, 2012; Gezelius & Torstensson, 2015).

WebGIS is useful as a tool because the data is denser because it is digital (Von Schwerin, et al, 2016), spatial processing is easier (Abdalla & Esmail, 2018; Fu & Sun, 2011), and different types of analysis can be created, and users can more precisely, faster, and manipulate the data as needed (Von Schwerin, et al, 2016; Abdalla & Esmail, 2018; Fu & Sun, 2011; Li & Li, 2020). Parameters. The use of GIS (Geographical Information System) technology is one of the basic approaches that can help in the planning of forest mapping programs (GIS) (Li & Li, 2020; Burrough, at el, 2015). Geographic information systems that generate computer data that can provide information about an environment and show the potential of forest areas (Fu & Sun, 2011; Goodchild & Quattrochi, 2023; Yossa, et al, 2023; Nelson, et al, 2022). It can be used to assist in forest mapping planning focused on designation as a potential productive forest and protected debt area, as well as tracking its sustainable growth (Nelson, et al, 2022). The advantages of GIS technology are able to provide data or information to answer spatial questions appropriately (Li & Li, 2020).

Geographic Information System (GIS) is a system created by a computer that allows an algorithm to function to identify an area on the earth's surface (Goodchild & Quattrochi, 2023). So WebGIS as a framework that contains software and hardware that can handle data in the form of map views that will be used as knowledge and information. Furthermore, Geographic Information Systems (GIS) provide spatial and non-spatial data on natural earth surface events, vector data that provides information on the existence of a position (Yossa, et al, 2023; Nelson, et al, 2022; Li, et al, 2022; Unrau & Kray, 2021).

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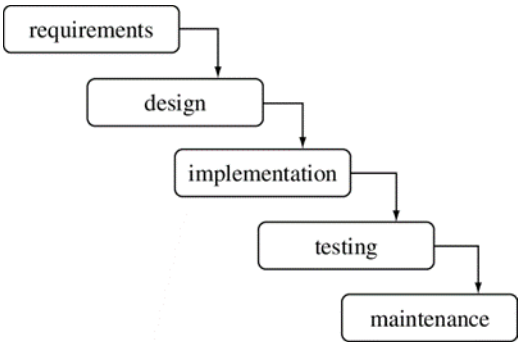
II. Research Methods

A. System Development Life Cycle (SDLC)

System Development Life Cycle (SDLC) with a waterfall method of process or phase that follows the installation of a framework, including models that require needs analysis, design, programming, testing and maintenance. This approach is very useful for building and developing systems, as it involves planning and maintenance (Ruparelia, 2010; Hoti, et al, 2023). Can be seen in Picture 1 structure Waterfall model



Picture 1. Waterfall Model

UML (Unified Modeling Language) plays an important role in displaying and clarifying the flow of a system to be built where diagrams are used to display and notify the flow of a system, one of which is the use of use case diagrams and sequence diagram sequences to describe the interactions between actors involved in forestry geographic information systems (Elyasaf & Sturm, 2023). Black Box testing as a test stage that uses the results of selected inputs to represent the output so that debugging will detect inconsistencies or vulnerabilities and errors that occur in the built system (Troya, et al, 2022) Research methods on the design of a geographic information system for forest mapping in Kutai Kartanegara regency. By using the waterfall method which will perform step by step in the completion of the design of the built system

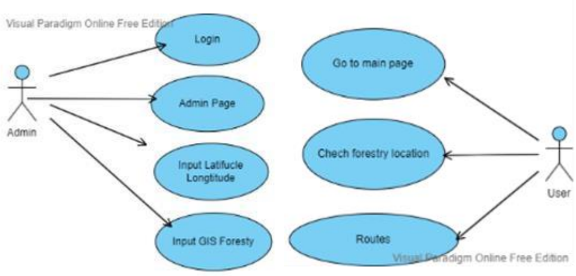
B. Requirements

The process is carried out to meet the needs of users at the Balitbang office (Research & Development Department) in Kutai Kartanegara regency by conducting observations and interviews directly

C. Design

1. Use Case Diagrams

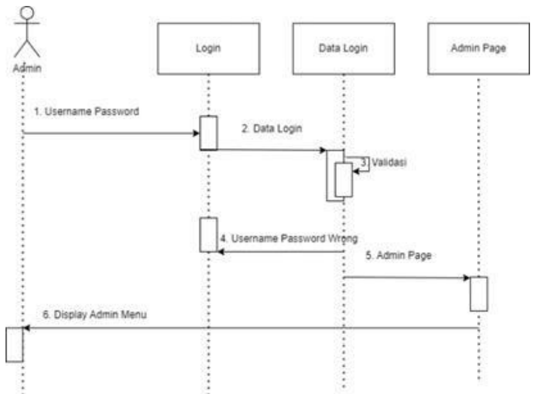
   Design a geographic information system for forest mapping in Kutai Kartanegara Regency. use case diagram consisting of two actors, namely the administrator responsible for entering, modifying and deleting forest area data and users who access the forest area map by selecting forestry coordinate points and accessing the route of the forest area to find out its location (Elyasaf & Sturm, 2023). Can be seen in Picture 2



Picture 2. Use Case GIS Forestry, there are two actors and some use case symbols

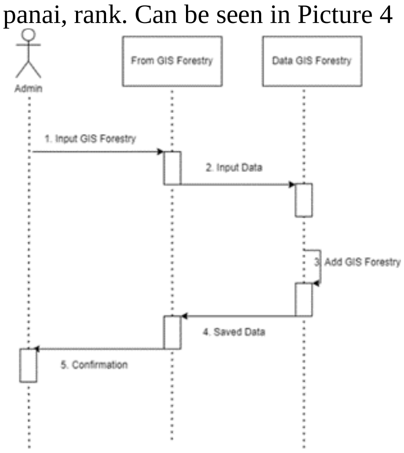
2. Sequence Diagram

   In the sequence diagram image below, the admin is in charge of displaying the login menu, with filling in steps and password. If the username and password are wrong, it will return to the login menu. If the password and username are correct, it will go to the admin page. Can be seen in Picture 3



Picture 3. Sequence Diagram Login Admin

In the sequence diagram below, the admin is tasked with adding forestry GIS data to each sub-district in Kutai Kartanegara along with its latitude and longitude. The forestry data inputted are, upstream blade, west blade, north branch, downstream blade, south branch, upstream panai, downstream panai, middle panai, rank. Can be seen in Picture 4



Picture 4. Enter forest data

In the sequence diagram below, the user actor selects the forestry GIS and then the map of the forestry GIS

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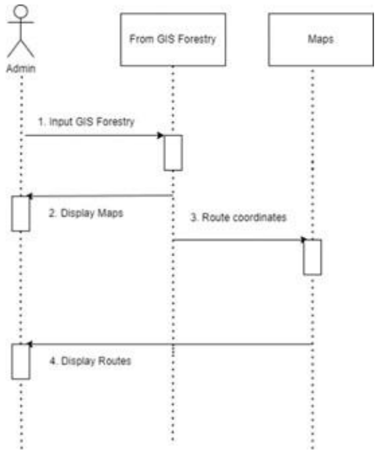
that will appear along with the coordinates and travel routes. When the user actor chooses a route, it will be directed to the travel route to the forestry GIS location. Can be seen in Picture 5



Picture 5. Sequence Diagram User

D. Implementation

After conducting further research and design, the system is built into logic and programming that will form the features of the forest mapping information system according to the needs of the development of the system being built.

E. Testing

Through this stage, the system to be built needs to be tested so that the function of the system can be known whether it is in accordance with what is expected by the user.

F. Maintenance

As the last stage in the development of a waterfall system that has been built on this system and run by users, it is necessary to maintain the system in the form of back-up data so that it runs well and can be used.

IV. Results And Discussion

Based on the results of data collection that has been obtained by conducting observations and interviews directly at the Central Statistics Agency (BPS) in Kutai Kartanegara Regency, there are 8 sub-districts in Kutai Kartanegara regency that have a number of protected and production forests as shown in the following table 1.

Table 1. Forestry Data

#	District	Protected Forest	Production Forest
1.	Anggana	691,03	-
2	Beard Flower	6 037.61	-
3	Notability	-	-
4	City Build	808,96	-
5	Java estuary	2 596.85	-
6	Loa Kulu	-	-
7	Sanga-sanga	5 476.15	14 573.00
8	Tabang	2 372.40	-

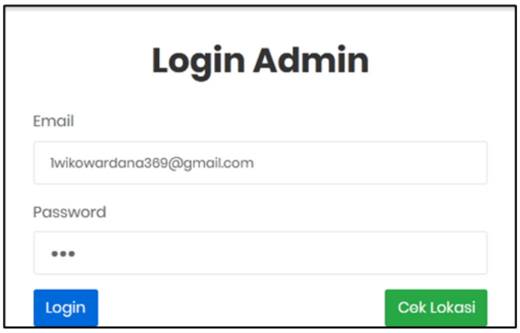
1. Website Pages

   This page is the main display when the user (community) accesses the Web-based forestry GIS design. On this page there are several menus that will later be processed, namely home, categories, and about. Can be seen in Picture 6

Picture 6. Forestry GIS Main Page

2. Login Pages

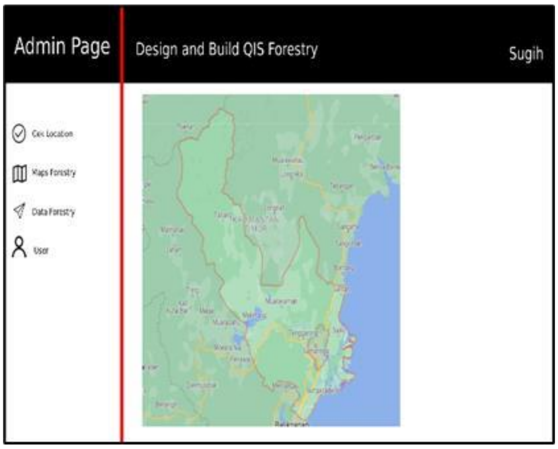
   Though, the admin must enter an email and pass. Can be seen in Picture 7



Picture 7. Forestry GIS Main Page

3. Admin Page

   When the login process is successful, it will enter on the admin page, on this page there are 5 menus that support the running of this system, namely: check location, forestry maps, forestry data, icon, and user. Can be seen in Picture 8



Picture 8. Admin Page

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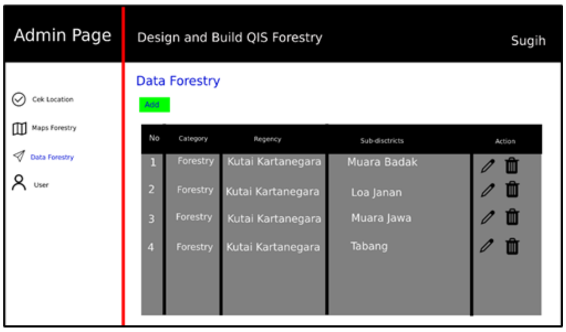
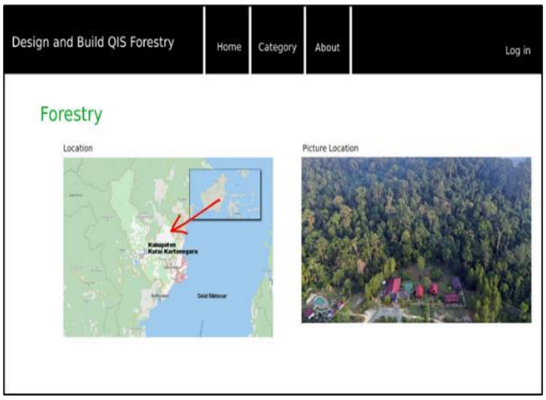
4. Forestry Data
   On the forestry data page, this serves to see the overall data on the forestry GIS design system. Can be seen in Picture 9



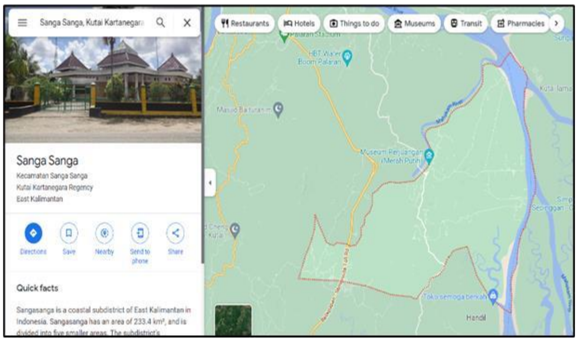
Picture 9. Forestry Data

5. Detail Pages
   This page displays the location results and images of the forestry data you want to go to, namely in the upstream bar district. Can be seen in Picture 10



Picture 10. Forest Data Detail View

6. Route Page
   Displaying forestry data travel routes in upstream bar districts. Can be seen in Picture 11



Picture 11. Forest Location View

7. Testing Phase
   In the final stage of this study we used black box testing. Black-box testing is a method of software testing that examines the functionality of an application without peering into its internal structures or workings. This method of test can be applied virtually to every level of software testing: unit, integration, system and acceptance. Table 2 shows, the results of black box testing.

Table.2 Testing On Black Box Testing

Tested Parts	Testing On The System	Model Testin g	Testing Results
Login Menu	Verify password and email	Black Box	Valid
Check Location	Forestry Data	Black Box	Valid
Data Forestry	District Upstream Bar	Black Box	Valid
Location Details	Location Forest	Black Box	Valid

V. CONCLUSION

The conclusions obtained in the design and construction of the geographic information system for mapping forests in the Kutai Kartanegara regency were carried out in accordance with the waterfall method and the design of the system was built with UML. forest data in Kutai Kartanegara regency was taken from each sub-district. WebGis is useful for helping residents or users who need information needs. with the system built, you can see the location of the existing forest area, see the position of the map and the route of the forest location map needed. Users will zoom in and direct to get the details they want based on the location and position of the coordination. Forest Mapping Website in Kutai Kartanegara Regency has zoom and path capabilities. The system is web-based and uses PHP and HTML programming languages to display mappings. To access the location using the KEY API from Google maps in each forest area that is recorded into this information system.

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