Vol. 6 No. 2, 2025, pp. 146-153 **Jurnal Pepadun**


# Geographic Information System for Mapping the Distribution of Lampung Medicinal Plants

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***Abstract*** *- Medicinal plants are one of the potential natural resources that grow in Indonesia. Data on the location of medicinal plants is currently still scattered in several places. This research goals to develop and apply Geographic Information Systems (GIS) as an innovative tool in the conservation and utilization of medicinal plants. By combining Geographic Information System technology and empirical data on the location of medicinal plants, this research presents a platform that allows researchers, health practitioners, and the general public to access information related to the geographic distribution and properties of medicinal plants. This research utilizes the CodeIgniter framework as the basis for system development and is assisted by several libraries, such as GeoJSON and LeafletJS, for several parts of the system. The result of this research is a basic web-based system about medicinal plant mapping that can be further developed into further research. The research has successfully produced a system that can display the mapping of medicinal plants in several regions in Lampung province. The main difficulty experienced is the precision of the location of medicinal plants. The weakness of the system is that the markers look like they merge when seen from a specific altitude. Future research will develop a search engine for medicinal plant information that is integrated with the location mapping that has been produced from this research. Thus, when people want to search for a medicinal plant, they will get the information easily*

***Keywords*****:** *Plant; Medicine; GIS; Geographic; Coordinates.*

## 1. INTRODUCTION

Geographic Information System (GIS) technology has revolutionized the way we collect, store, analyze, and present geographic data [1]. GIS enables the integration of data from multiple sources for mapping and spatial analysis, providing new insights in areas such as urban planning, natural resource management, environmental conservation, and climate change studies. In recent years, the development and application of GIS technology have experienced exponential growth, driven by advances in computing technology, the availability of large geospatial data, and increased awareness of the benefits of spatial analysis. These technologies have become integral to strategic decision-making in both the public and private sectors. GIS technology offers more efficient and effective solutions to complex problems facing modern society [2]. The evolution of GIS from a simple mapping tool to a complex geospatial analysis system marks a turning point in geographic data management. The use of GIS now extends to a wide range of disciplines, facilitating research and decision-making in ways never imagined before [3][4]. In health, for example, GIS is used to map the spread of disease, understand transmission patterns, and plan health services. In disaster management, the technology helps in risk mapping, evacuation planning, and emergency response coordination. In agriculture, GIS is used for soil analysis, mapping rainfall patterns, and water resource management, providing insights essential for sustainable food production.

Medicinal plants are an important component in the history of human medicine [5]. Humans have identified, used, and depended on medicinal plants to treat various diseases and maintain health. More than 80% of the world's population still rely on traditional medicine as part of their primary health care, especially in developing countries [6]. The importance of medicinal plants cannot be ignored. Scientific recognition of the benefits of medicinal plants, with many studies demonstrating their potential in the treatment as well as prevention of various health conditions.

 | doi: 10.23960/pepadun.v6i3.290

The use of medicinal plants is rooted in traditions and empirical observations that have been passed down from generation to generation [7][8]. In many cases, this knowledge has been the basis for the development of modern medicines. For example, aspirin, which is derived from willow bark, and quinine, which is used to treat malaria and is derived from the bark of the quinine tree, are examples of how medicinal plants have contributed to modern medicine. The use of medicinal plants is not only limited to traditional medicine but has also been integrated into conventional health systems [9], with research constantly exploring and confirming their efficacy and mechanisms of action.

The benefits of medicinal plants are diverse, ranging from the treatment of acute and chronic diseases to disease prevention and general health maintenance. They provide an alternative source for treatment that is often more affordable, more accessible and in some cases, has fewer side effects compared to synthetic drugs. Medicinal plants also play an important role in pharmaceutical research, as a source of natural materials for the development of new drugs [10]. In addition, the holistic approach to treatment offered by medicinal plants, which focuses not only on treating symptoms but also on maintaining balance and overall health, is gaining increasing recognition and appreciation [11] [12]. The benefits of medicinal plants are indisputable, but there is a need for standardization of quality, product safety and sustainability, and data collection on the existence or position of medicinal plants. This research will develop a system that can be used for mapping and data collection of medicinal plants in districts in Lampung Province.

## 2. RESEARCH METHODOLOGY

This research steps starts from problem identification, literature review, design and requirement analysis, system development, system testing, and deployment.

### 2. 1 Problem Identification

Limited access to information on the location and types of medicinal plants available in an area is an obstacle for researchers to conduct further research on medicinal plants. This occurs because of the gap in information about medicinal plants between regions and the scattered and unintegrated data on medicinal plants. In addition, the accuracy of geographical data and information on medicinal plants is also a major obstacle. Another challenge is the preservation of rare or endemic medicinal plant species for which information is limited.

### 2. 2 Literature Review

Spatial data, often referred to as geospatial data, refers to information that is explicitly or implicitly related to a location or area on the Earth's surface. This data can take the form of geographic coordinates [13], administrative boundaries, addresses, or even more complex data such as elevation or depth. In the context of Geographic Information Systems (GIS), spatial data plays a crucial role as it provides a framework for collecting, storing, analyzing, and visualizing geographic information [14]. Geographic Information Systems (GIS) are systems designed to capture, store, manipulate, analyze, manage, and visualize all types of geographic and spatial data [15][16]. GIS integrates operations on spatial data with related databases to solve complex problems of mapping, spatial analysis, and geographic decision making. GIS is used in various fields such as urban planning, environment, natural resources, transportation, and many more, allowing for in-depth geospatial analysis and a better understanding of spatial patterns and relationships. GIS consists of five main components: hardware, software, data, methods, people and networks [17].

Medicinal plants have played an important role in traditional and modern medicine for thousands of years. They are a major source for the development of pharmaceutical drugs and are also widely used in traditional medicine practices around the world [18]. With the increasing interest in holistic and natural medicine approaches, medicinal plants are again gaining attention as alternatives or complements to conventional

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therapies. Recent research has revealed the potential of medicinal plants in treating and preventing various diseases [19], while highlighting the importance of conservation and sustainable use of these natural resources.

A literature review on the development of geographic information systems (GIS) for medicinal plants reveals the importance of integration between traditional knowledge and modern technology in the preservation and utilization of medicinal plants. The basic concepts and applications of GIS have been described in the context of natural resource conservation, with a particular focus on medicinal plants. This includes the use of GIS for mapping, inventory and spatial analysis aimed at supporting conservation efforts. Technologies and methodologies used in previous studies, such as remote sensing, field surveys, and sampling techniques, have provided a solid foundation for data collection and analysis. However, challenges such as data gaps, inaccuracies in geographic information and technological limitations still need to be overcome. Opportunities for the development of more innovative GIS systems were also identified for more in-depth and accurate analysis. The literature study conducted underscores the importance of addressing research gaps and capitalizing on new technological opportunities for the development of more effective medicinal plant GIS systems. These include improved accuracy of data collection, integration of data from multiple sources, and utilization of advanced data analysis technology.

### 2. 3 Design and Requirement Analysis

Design and requirement analysis is a crucial first step in the development of a geographic information system (GIS) for medicinal plants. This step involves an in-depth understanding of the user needs, technical specifications, and objectives of the system to be developed. The following is the draft design and requirement analysis for the study:

2.3.1. End Users: Medicinal plant researchers, policy makers, local communities, and environmental activists.

2.3.2. Functional Requirements:

a. Medicinal Plant Mapping: Ability to map the geographical location of medicinal plants using coordinate data.
b. Search and Filter: A facility to search for plants based on name, location, efficacy, and other criteria.
c. Medicinal Plant Database: Development of a database that includes detailed information on medicinal plants, including scientific names, properties, and geographical distribution.
d. Spatial Analysis: Tools for conducting spatial analysis, such as identification of conservation areas and zoning of medicinal plant habitats.
e. Data Visualization: Visualization of medicinal plant information in the form of interactive maps and graphs.

2.3.3. Non-Functional Requirements:

a. Ease of Use: Intuitive user interface that is easy to use by a wide range of users.
b. Data Security: Strong data protection to maintain the confidentiality and integrity of information.
c. Scalability: A system that is capable of adjusting to significant additions of medicinal plant data.

### 2. 4 Technical Requirements Analysis

2.4.1. Development Technology:

a. Front end: Technologies such as HTML, CSS, and JavaScript for user interface development.
b. Back end: The use of databases such as MySQL for spatial data storage, as well as the use of the Code Igniter framework for web-based system development.
c. GIS Software: Integration with GIS software such as QGIS for analysis and mapping.

2.4.2. Data Collection:

a. Field Survey: For primary data collection on the location and characteristics of medicinal plants.

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b. Existing Database: Use of secondary data from previous research, herbarium, and plant database.

2.4.3. System Analysis and Design:

a. Database Design: An efficient database structure for storage and management of medicinal plant data.
b. Interface Design: UI/UX development that supports ease of use and accessibility.
c. System Workflow: System workflow from data input to visualization and analysis.

This design and needs analysis aim to ensure that the GIS system developed can effectively meet user needs and research objectives. Through a systematic and collaborative approach, the developed system is expected to produce a comprehensive geographic information system of medicinal plants that is useful for various stakeholders.

### 2. 5 System Development

A web development framework is a framework designed to support the development of web applications including web services, web resources, and web APIs [20]. These frameworks aim to automate common tasks involved in the development process, provide reusable code libraries, and make it easy for developers to build efficient, secure, and maintainable applications. Web development frameworks come in a variety of programming languages, with each framework offering certain features and benefits. While the architecture used in this research is Model-View-Control Architecture (MVC). This is a design pattern used in software development to separate applications into three main components: Model, View, and Controller. The main goal of MVC is to separate the representation of information from the user's interaction with that information, thus enabling effective separation of concerns. This helps in organizing the structure of the application, eases the development process, and allows for more organized testing and better code maintenance.

### 2. 6 System Testing

Geographic information system (GIS) testing is a critical process that ensures the system functions according to specifications and user needs. This process includes various types of testing to identify and fix bugs, verify functionality, and ensure the system can be operated effectively in a production environment.

### 2. 7 Deployment

Deployment of a medicinal plant geographic information system (GIS) is the process by which a fully developed and tested system is moved from the development environment to the production environment so that it can be accessed by end users. This deployment process is important to ensure that the system functions properly under actual operational conditions and provides the desired benefits to stakeholders.

## 3. RESULTS AND DISCUSSION

The CodeIgniter framework was chosen as the system development framework. The system will work based on the concept of Model-View-Control. Model is a class that is built to connect the system with the database used, while view is a class that is built to display to the user interface. This view is related to the display that will be accessed by the user. The controller functions to manage circulation from user requests to services provided by the server.

### 3.1 GeoJson

GeoJSON is a JSON (JavaScript Object Notation) based standard format used to represent geographic data. It is designed to be easily read by humans and processed by computers. GeoJSON supports various types of geometry. GeoJson was used to create polygon shapes of 15 districts in Lampung Province. An example of GeoJSON can be seen in Figure 1.

Vol. 6 No. 2, 2025, pp. 146-153
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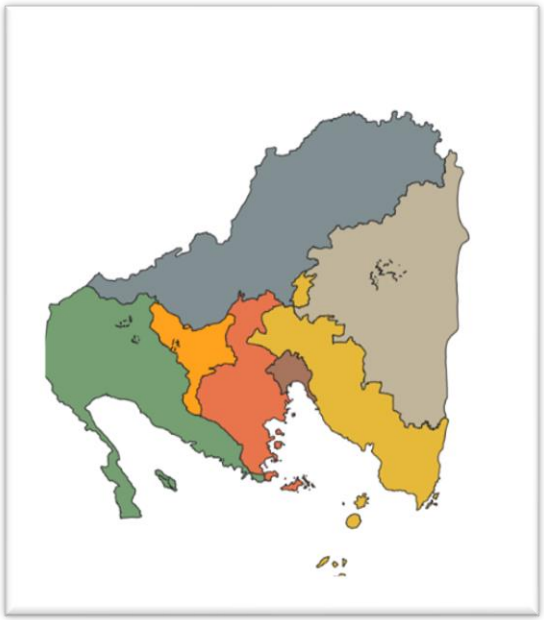

Figure 1. Example Of GeoJSON.

The GeoJSON in Figure 1 contains a set of coordinate points that are connected to each other to form a 2-dimensional field pattern. The GeoJSON can also insert several additional attributes to complement the information needed.

### 3.2 Leaflet

Leaflet is a Java Script library that is used to display GeoJSON data on a web page. Leaflet can also be used to combine polygon data formed by GeoJSON with maps that are commonly used on maps on web pages such as Google Street map or Google Earth. In addition to displaying and combining GeoJSON with maps on the website, leaflets are also used to display markers or markers on the map. A marker is a representation of the coordinates of a location. An example of a location marker can be seen in Figure 2.

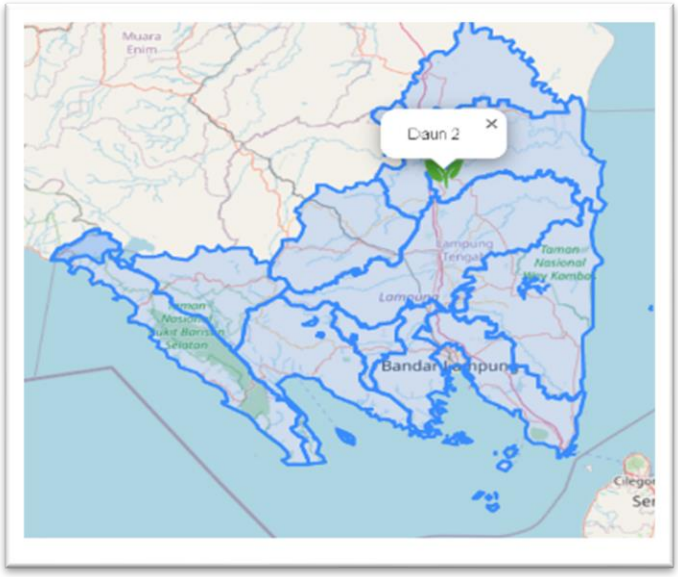


Figure 2. Map Marker.

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Figure 2 is an example of using a single point marker. The marker is obtained from a combination of longitude and latitude of a point in one area. This research produces a system that can be used to see the position or location of medicinal plants in Lampung. The results of the data coordinates that have been obtained are then mapped as shown in Figure 3.

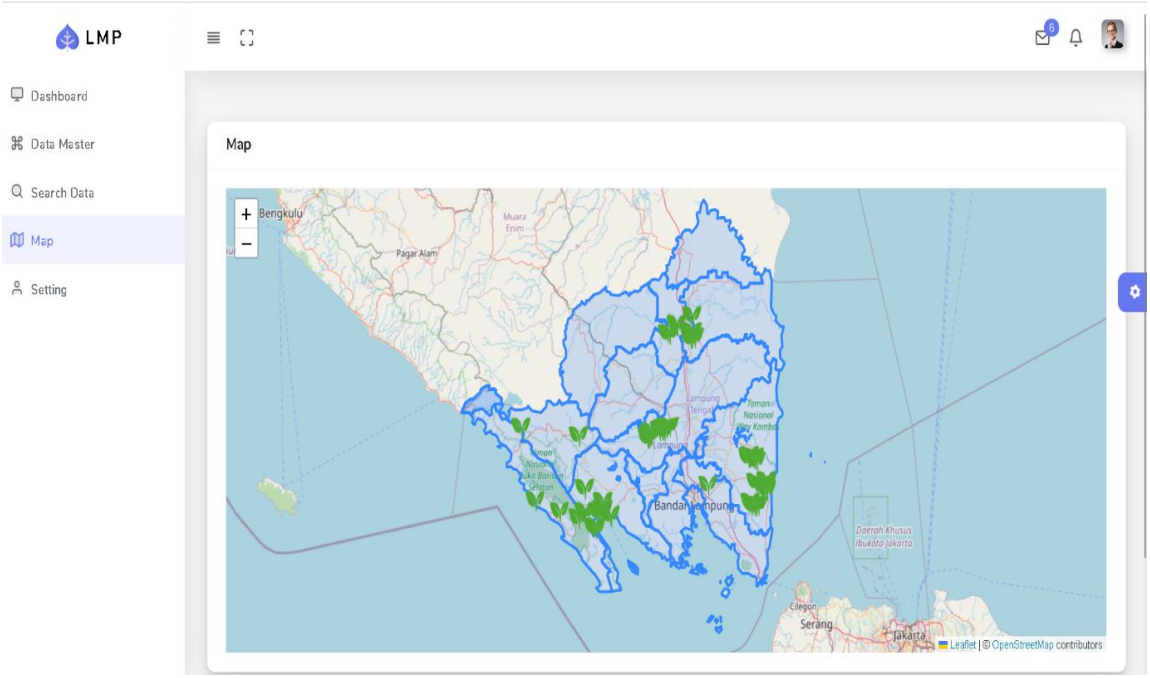


Figure 3. Multi-Point Marker.

In Figure 3, you can see some data represented by markers or plant markers on the map. The model used in this research is a multi-point marker. Multi-markers utilize several coordinates that appear together on a map. The weakness in multi-markers is seen when using a map at a certain height, the marker will appear to merge with other adjacent markers. This problem causes differences in assumptions about the number of locations of medicinal plants.

## 4. CONCLUSIONS

This research successfully developed a basic system that can be used to map the coordinates of medicinal plants in Lampung province. The mapping process is carried out by using several additional tools such as GeoJSON, Leaflet, and Google Street view. The weakness of the system is that the markers look like they merge when seen from a specific altitude. Furthermore, the system can be developed into a medicinal plant portal equipped with information search facilities related to medicinal plants in Lampung province.

## ACKNOWLEDGMENTS

Thanks to LPPM Lampung University for funding support for this research. This research is also supported by the Computational Laboratory Department of Computer Science, Lampung University.

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