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WebGIS Design at the Department of Agriculture and Plantations of Batu Bara Regency

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ABSTRACT

The development of technology today has grown very rapidly, this is marked by the birth of remote sensing technology. In order to maximize data visualization services, the Batu Bara district agriculture and plantation office has successfully implemented the WebGIS application. The data displayed on the WebGIS is data on agricultural tools and machinery, district boundaries, irrigation boundaries, rice field boundaries, farm roads, and district roads. All data can be displayed well on Google Maps-based WebGIS. The data is displayed based on the coordinate points in the database. There are 5 stages in this study, namely, literature study, data collection, data normalization and analysis, visualization, and implementation. The data can be accessed publicly, as a service to the community so that the community can find out and get more transparent information. This is one of the innovations of the Batu Bara district agriculture and plantation office.

Keyword : Geographic Information Systems; WebGIS; Remote Sensing Technology.

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1. INTRODUCTION

The Batu Bara Regency is a regency located in the province of North Sumatra. This regency is a division of Asahan Regency in 2006 with an area of 887.89 Km^2 with coordinates 3.16166 ° N 99.52652 ° E (BPS, 2024). Batu Bara Regency was formed on January 2, 2007 on the basis of Law Number 5 of 2007, with the capital city of Lima Puluh (KEMENDAGRI, 2018).

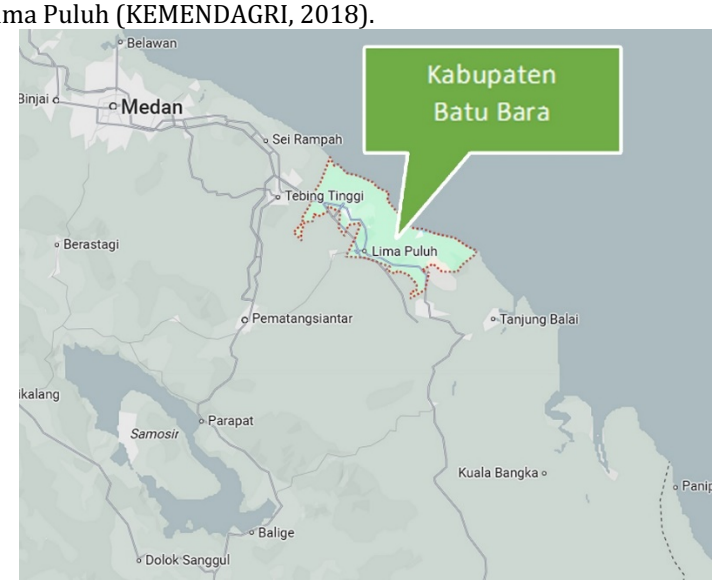

Fig 1. Batu Bara Regency on the Google map

The area of agricultural land for rice fields in Batu Bara Regency covers an area of 12,785.74 hectares (BPS, 2024), thus encouraging the Batu Bara Regency Agriculture and Plantation Service to map the work area. This aims to enable the Batu Bara Regency Agriculture and Plantation Service to monitor the distribution of agricultural tools and machinery, district boundaries, irrigation boundaries, rice field boundaries, farm roads, and district roads. Previously, the Batu Bara Regency Agriculture and Plantation Service could only view distribution data offline. This makes it very difficult to monitor data on location

maps. Especially in data visualization in the form of digital maps that facilitate understanding and analysis (Lü et al., 2019; Watkins, 2001).

Current technological and information developments can answer these problems. The presence of Geographic Information Systems (GIS) based on Website architecture, known as WebGIS, can display map-based data (Howari & Ghrefat, 2021; Merry et al., 2023b; Ruginski et al., 2022; Vinueza-Martinez et al., 2024). Technological developments have led to the integration of metadata, remote sensing, and data visualization, which marks the evolution of increasingly sophisticated technology for geographic management (Bill et al., 2022; Schade et al., 2020; Tavra et al., 2024). So that distribution data can be seen in visual form on the WebGIS architecture (Ruginski et al., 2022; Selvam et al., 2019). WebGIS involves the integration of various components and technologies to enable the creation, management, and visualization of spatial data over the Internet (Merry et al., 2023a; Vinueza-Martinez et al., 2024). It can also help analyze spatial patterns, relationships, and trends in various fields such as agriculture, forestry, urban planning, and others (Cope & Jung, 2009; Ghose, 2018; Howari & Ghrefat, 2021; Jain & Ajmera, 2019; Vinueza-Martinez et al., 2024). In another purpose, the government can integrate various types of location-based data to support decision making (Merry et al., 2023a, 2023b).

In addition, the Batu Bara district agriculture and plantation service can also provide spatial data that can be used in various sectors to improve the effectiveness of business policies and strategies (Gardner & Paul, 1993; Merry et al., 2023a, 2023b). This GIS design can facilitate data visualization in the form of digital maps that are easier to understand (Couclelis, 2010).

2. Research Stages

This research consists of 5 stages, literature study, data collection, data normalization and analysis, visualization and implementation.

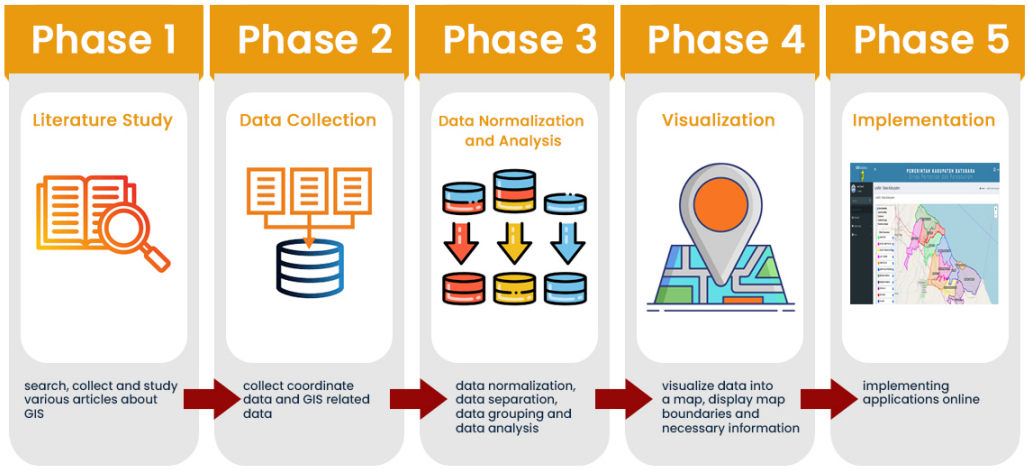

Fig 2. Research stages

2.1 Stage 1 Literature study

This stage will search, select and collect reliable literature related to GIS, and avoid sources that are not credible or less valid. The goal is to understand the development of previous research, identify gaps in previous research, and find a strong theoretical basis. The reference sources used are scientific journals, books, conference proceedings, theses, or other academic sources, using trusted databases such as Google Scholar, Scopus, IEEE Xplore, Springer, ScienceDirect, and ResearchGate. This literature study will prioritize the latest references, namely articles published in the last 5-10 years. This aims to make supporting articles more relevant to current scientific developments.

2.2 Stage 2 Data Collection

The data collected comes from data obtained from the ArcGIS application (Rogers & Staub, 2013). The file extension obtained is with the KMZ (Keyhole Markup-Language Zipped) extension (De Paor et al., 2016; Puttinaovarat & Horkaew, 2020; Theerawasttanasiri et al., 2018). The KMZ file format is a file format used to store geospatial data in a compressed manner (Gupta et al., 2020). This file is a compressed version of the Keyhole Markup Language (KML) file (Rogers et al., 2024). KMZ files contain location data, such as latitude and longitude, as well as other information such as images, place markers, and shapes (Gupta et al., 2020; Hagevik, 2011). KMZ files can be used to store geographic data in Google Earth (Blossom et al., 2011; Demirci et al., 2013). The letter Z in the KMZ file extension indicates that the

file has been compressed (Sidhu et al., 2018). The capacity of KMZ files is smaller than KML files (Hagevik, 2011).

2.3 Stage 3 Data Normalization and Analysis

This stage is useful for separating and grouping data based on existing information. This aims to standardize data into the same group, reduce redundancy or duplication, avoid bias due to differences in scale between features, and improve data quality for more accurate analysis (Naibaho, 2020). The normalized data will be analyzed to obtain the right grouping. Data grouping will be separated into 6 parts, namely agricultural tools and machinery, district boundaries, irrigation boundaries, rice field boundaries, farm roads, and district roads. The data will also be grouped based on village and sub-district coordinates. At this stage, the database and tables in MySQL will also be designed with the help of the Navicat application.

2.4 Stage 4 Visualization

This visualization stage will design the interface, layout, and do programming using the PHP programming language with a source code editor using Sublime and Visual Studio Code.

```
<?php
  $getKoordinat=$db->ObjectBuilder()->get('m_koordinat');
  foreach ($getKoordinat as $row) {
    ?>

    var myStyle<?=$row->id_koordinat?> = {
        "color": "<?=$row->warna_koordinat?>",
        "weight": 1,
        "opacity": 1
    };

    <?php
    $arrayKec[]='{
    name: "'.$row->nm_koordinat.'",
    icon: iconByName("'.$row->warna_koordinat.'"),
    layer: new L.GeoJSON.AJAX(["assets/unggah/geojson/'.$row->geojson_koordinat.'"],{onEachFeature:popUp,style:
      myStyle'.$row->id_koordinat.',pointToLayer: featureToMarker }).addTo(map)
    }';
  }
?>
```

Fig 3. Display data from database to google map based on coordinates

```
function featureToMarker(feature, latlng) {
  return L.marker(latlng, {
    icon: L.divIcon({
      className: 'marker-'+feature.properties.amenity,
      html: iconByName(feature.properties.amenity),
      iconUrl: '../images/markers/'+feature.properties.amenity+'.png',
      iconSize: [25, 41],
      iconAnchor: [12, 41],
      popupAnchor: [1, -34],
      shadowSize: [41, 41]
    })
  });
}
```

Fig 4. Showing the location of agricultural tools and machinery on Google Maps

2.5 Stage 5 Implementation

This stage is the final stage in the implementation of GIS applications online. Before online implementation, the application has been tested on localhost. The localhost used is AppServ 9.3.0 with complete features consisting of Apache 2.4.41, MySQL 8.0.17, PHP 7.3.10, and phpMyAdmin 4.9.1. After everything runs smoothly, the next stage is the installation to the Batu Bara district agriculture and plantation service server so that the WebGIS application can be accessed online.

3. RESULTS AND DISCUSSION

The results that will be displayed in this article are the interface of the WebGIS application that has been successfully installed on the server of the Batu Bara district agriculture and plantation service.

3.1 WebGIS page view

On this home page will display a list of menus on the left panel and map links and data links on the right panel. The left panel contains the home menu, master data, and maps. The master data menu will display sub-menus of sub-district data, village data, agricultural equipment and machinery data, irrigation data, farm roads, and rice field data. The map menu will display sub-menus of search maps, district boundaries, agricultural equipment points, irrigation boundaries, rice field boundaries, farm roads, district roads, and overall maps. The sub-menu of sub-district data on the master data menu will display the area code, sub-district name, postal code, latitude, and longitude. The village data sub-menu will

display the area code, village, and sub-district. The agricultural equipment data sub-menu will display the sub-district, village, group name, chairman's name, type of agricultural equipment, number of units, and year. The irrigation data sub-menu will display the sub-district, village, and irrigation conditions (permanent or non-permanent). In the sub-menu of farm road data, it will display the sub-district, village, condition (permanent or non-permanent), and length. In the sub-menu of rice field data, it will display the sub-district, village, type of land (irrigated rice fields, rain-fed rice fields), farm road, planting index, and area. In this case, there is access for the admin. The admin can edit, add and delete data according to needs.

Fig 5. Menu home

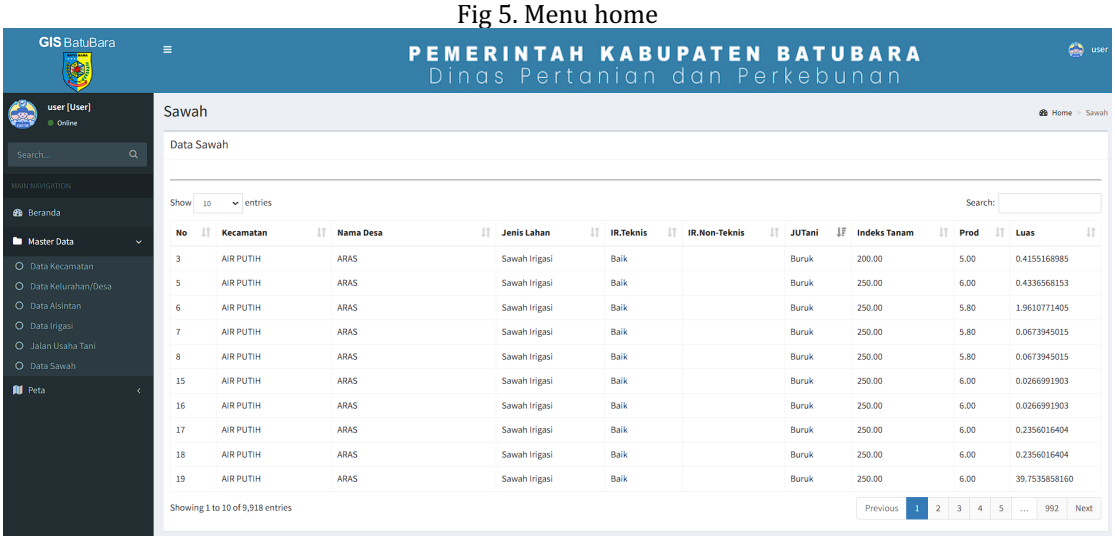

Fig 6. Master data of rice fields

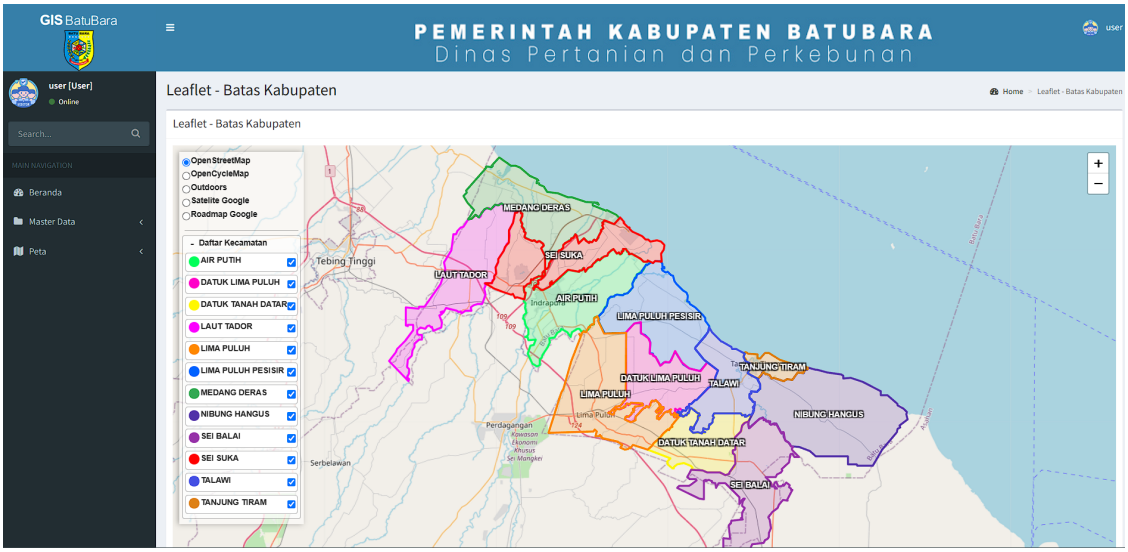

Fig 7. Map of district boundary

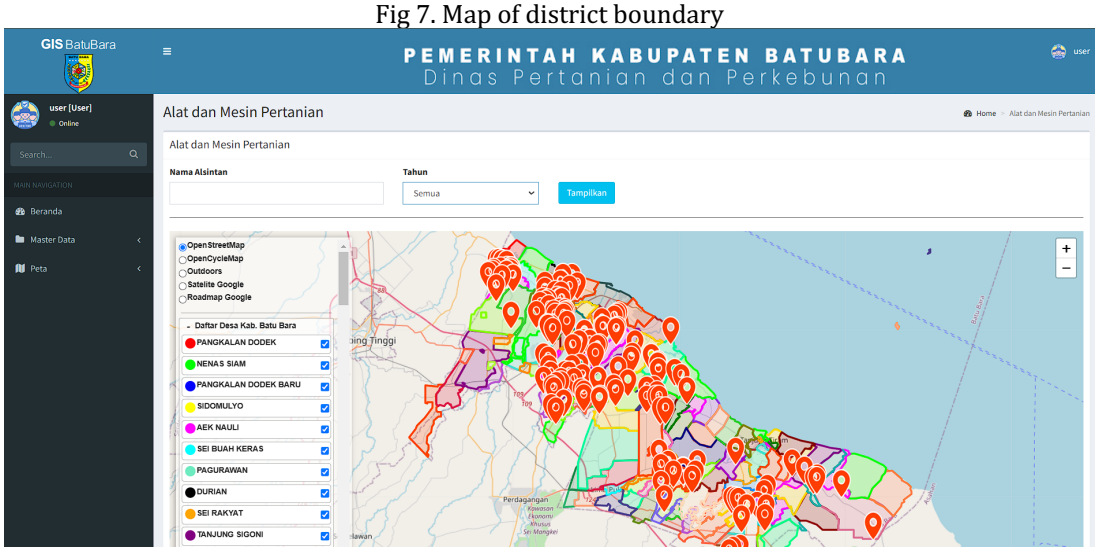

Fig 8. Map of distribution of agricultural tools and machinery

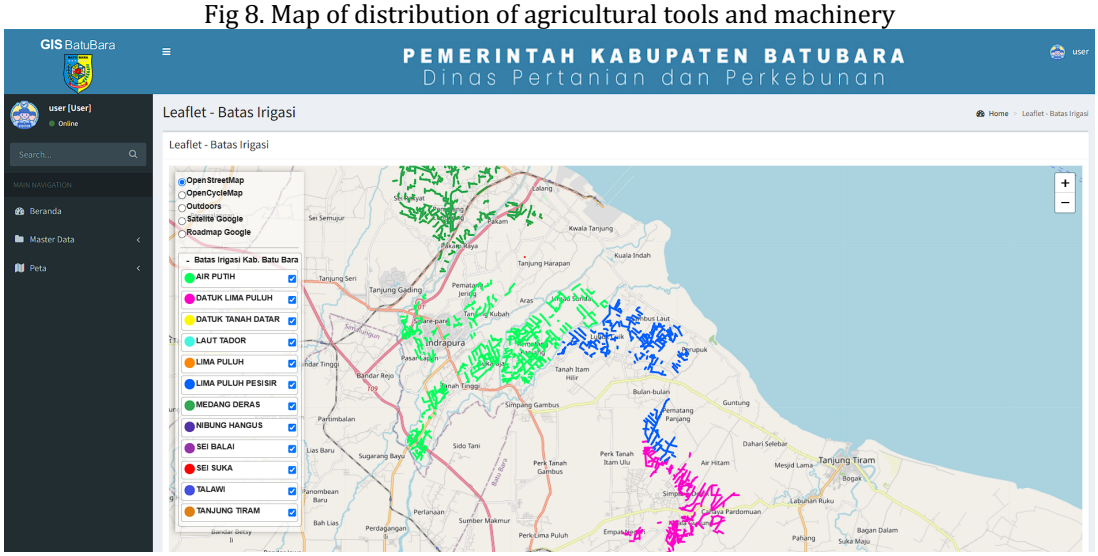

Fig 9. Map of irrigation boundary

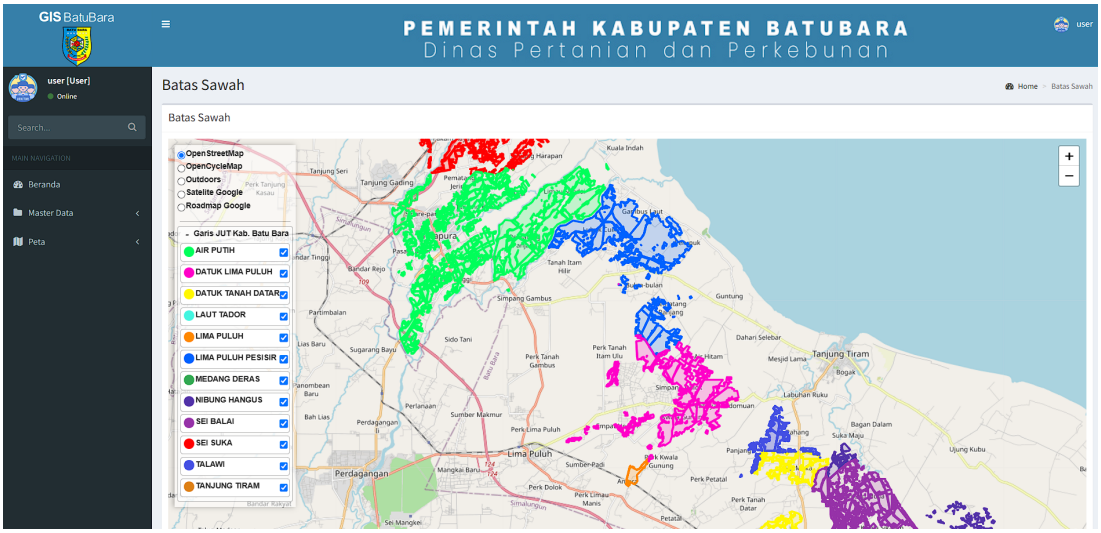

Fig 10. Map of rice field boundaries

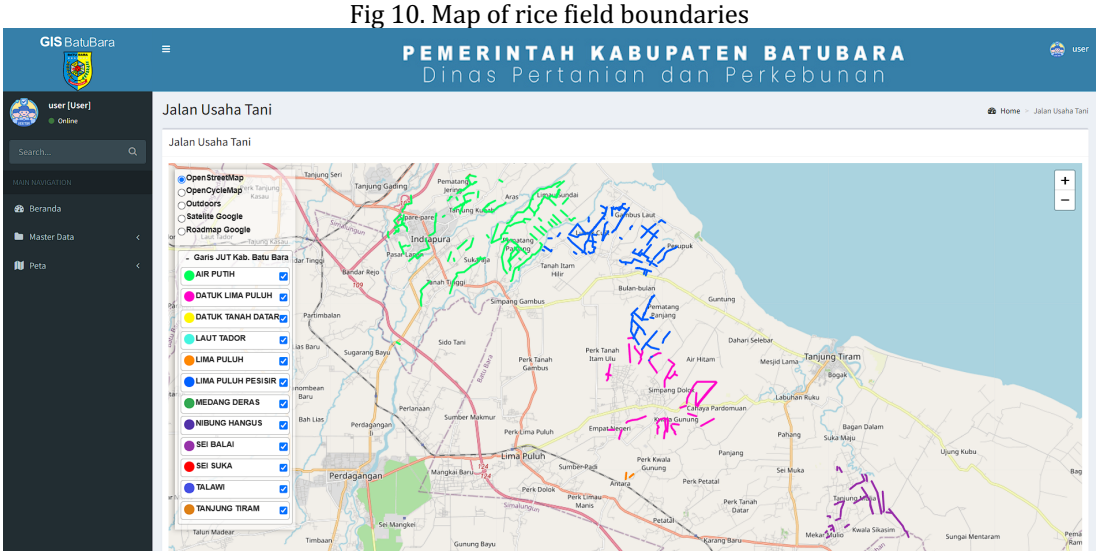

Fig 11. Map of farm roads

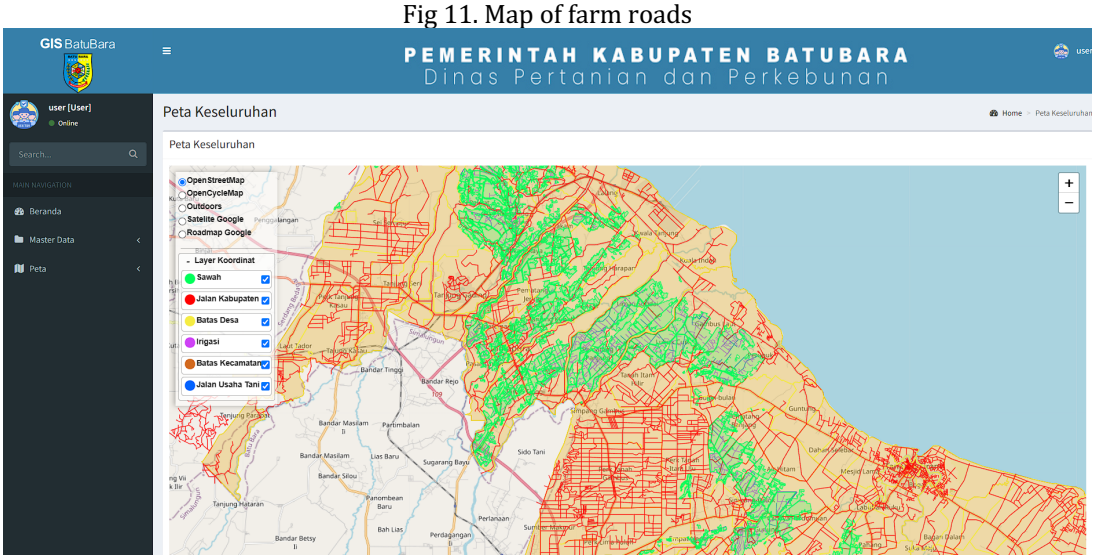

Fig 12. Overall map

4. CONCLUSION

The WebGIS application of the Batu Bara district agriculture and plantation service can run well. The application can display data on agricultural tools and machinery, district boundaries, irrigation boundaries, rice field boundaries, farm roads, and district roads well. The data can also be displayed on a map, according to the coordinates that have been entered into the database. Each color that appears on the map represents each sub-district. This approach is very helpful for the Batu Bara district agriculture and plantation service in monitoring the location of data on the map. This remote sensing is very useful in presenting more interactive data at the Batu Bara district agriculture and plantation service. This WebGIS application can also be accessed publicly, so that the public can find out and get more transparent information. This WebGIS application still has shortcomings, innovation is still needed in deeper data analysis. This is needed so that this WebGIS can be used as the main reference source to obtain the latest information regarding the rice field situation in Batu Bara district. Innovation is also still needed in terms of predicting the amount of harvest and predicting the potential for reducing rice field land due to the expansion of settlements or other factors.

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