

Sawah Baru Landscape Identification for Agroedutourism Agriculture 4.0, A Community-Based Development Project

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Abstract

IPB University has adequate agricultural land facilities and infrastructure for education and research activities. It has the potential to be developed into an agricultural area 4.0 for *agrotourism* activities, one of which is in the landscape of the Babakan Education Garden or *Farm Teaching* Sawah Baru located in Babakan Village, Dramaga District, Bogor Regency. This study aims to identify the character of the Sawah Baru landscape for the development of community-based agricultural agrotourism 4.0. The analysis used in this study used direct observation of the field and the literature study method. The identification of several aspects in the field is carried out using drones to obtain aerial photos, which are then processed using software to produce orthophotos and continue to digitize the boundaries of the research location using spatial analyst tools. The stages of identifying new rice field landscapes for the development of community-based agricultural agrotourism 4.0 include several stages, namely the preparation and inventory stages. The results of the identification of several aspects consisting of landscape sustainability, potential tourist attraction and tourism-supporting potential show that in terms of landscape sustainability, the criteria of each existing aspect are excellent and suitable to be developed into tourist destinations. Regarding potential tourist destinations, the study area presents aspects that have the potential to attract visitors. Finally, regarding tourism-supporting potential, Sawah Baru has tourism-supporting aspects that are quite adequate to meet the needs of tourism activities. However, there is still a need to create additional facilities and utilities that can support user activity on the site.

Keywords: agriculture 4.0, agroedutourism, community-based, Sawah Baru

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1. Introduction

As an agriculture-based higher education institution, Bogor Agricultural University (IPB) has adequate agricultural land and infrastructure to support teaching and research activities. Based on the IPB Rector's Decree No. 90/IT3/LK/2016 concerning the management of educational gardens under the Faculty of Agriculture, Bogor Agricultural University stated that in order to optimize the management of educational gardens managed by the Faculty of Agriculture (Faperta) IPB, the concept of planning and organizing the management of educational gardens is needed. One is the Babakan Education Garden or Teaching Farm Sawah Baru in Babakan Village, Dramaga District, Bogor Regency. Currently, the Faculty of Agriculture IPB plans to develop rice fields 4.0 in the Teaching Farm Sawah Baru area. The location applies technology-based farming practices or agriculture 4.0. Previously, the Faculty of Agriculture IPB had collaborated with the Subang Regency Government, the IPB Subang Alumni Association and CV Sari Bumi Nusantara to build agriculture 4.0 in the IPB innovation village Subang with an area of 115 hectares.

Agriculture 4.0 as the future of agriculture, is the digital transformation of the agricultural sector and the development and utilization of digital technology that focuses on smart agriculture, precision agriculture and digital agriculture (Klerkx *et al.* 2019). The development of Agriculture 4.0 will increase productivity and produce superior, precise, efficient, and sustainable products. The landscape of Sawah Baru has the potential to be developed into an agricultural agroedutourism 4.0 area, looking at the existing conditions of the site and its surroundings. This study aims to identify the character of the Sawah Baru landscape for the development of community-based agricultural agroedutourism 4.0. As for the development plan of a landscape, according to Haaren (2002), it is necessary to conduct a study on the sustainability of land use as well as the environmental capacity and landscape character of the planning

location.

The concept of agroedutourism or agricultural education tourism is a tourist activity for study purposes that provides experience and knowledge about nature and agricultural technology broadly, including agriculture, animal husbandry, fisheries, forestry and indoor and outdoor recreation (Riyani 2010). Through this concept, visitors can gain agricultural experience by directly participating in Sawah Baru's agricultural activities. In addition to academic interests, agricultural education tourism activities can create work for the surrounding community and provide income for internal IPB. With this research, the landscape of Sawah Baru can become a destination area for community-based agricultural agroedutourism 4.0 and optimize the potential of IPB resources.

2. Methodology

The research was conducted in Sawah Baru area located on Jalan Raya Dramaga Babakan Village, Dramaga District, Bogor Regency, West Java. With coordinates $106^{\circ}43'55''$ E - $106^{\circ}44'15''$ E and $6^{\circ}33'30''$ S - $6^{\circ}33'55''$ S. The location of the study can be seen in Figure 1.

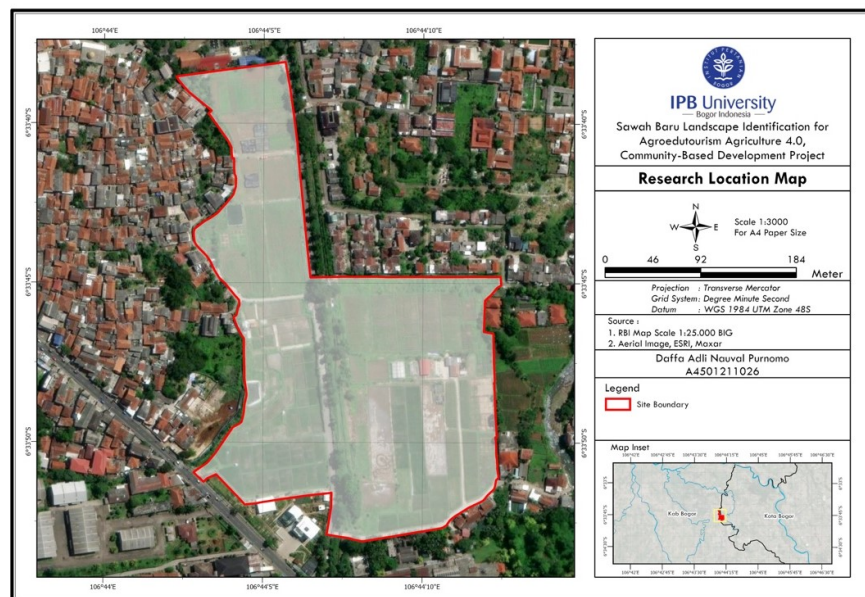


Figure 1. Research location

2.1 Materials

This research uses hardware and software to support research activities, from the preparation stage and inventory to data processing. In addition, base maps and research permits are needed in the data collection process. The details of the tools and materials used in this study are presented in Table 1.

Table 1. Tools and materials used in research

	Tools	Uses
<i>Hardware</i>		
1	Laptop	Processing research data
2	Digital camera	Documentation of conditions on the site
3	Drone DJI Mavic Pro 2	Aerial mapping and documentation
4	GPS	Set the location point of the object
5	Voice recorder	Record interviews
6	Stationery	Record site survey data
<i>Software</i>		
1	Copterus	Creating drone flight routes
2	Pix4D Mapper	Processing aerial photography
3	Global Mapper 21.0	Processing spatial data
4	ArcGIS Pro	Processing spatial data
5	ArcGIS Earth	Spatial information
6	Microsoft Office 365	Processing text data and compiling results
<i>Materials</i>		
1	Base map	
2	Thematic map	Secondary data
3	Administrative map	
4	Soil type map	

2.2 Method

The method used in this research is direct observation of the field and literature study. Direct observation of the field is carried out by visiting the research site directly to identify locations from various aspects and obtain the primary data needed. The identification of several aspects in the field is carried out using drones to obtain aerial photos, which are then processed using the Pix4D application to produce orthophotos, then continued using ArcGIS Pro to digitize the boundaries of research locations and processing identification data in the field. Literature studies are conducted to find additional data needed for research purposes.

2.3 Research Process

The stages of identifying new rice field landscapes for the development of community-based agricultural agroedutourism 4.0 include several stages, namely the preparation and inventory stages.

Preparation

This research begins with a preparatory stage. At this stage, the determination of the location and concept of the research is carried out, the preparation of research proposals and the preparation of administration and licensing of related parties. In addition to administrative preparation, technical preparation is also carried out, including preparing tools, materials, and literature for preliminary studies.

Inventory

The inventory stage is an activity to determine the existing condition of the site and collect data to be examined in the form of primary and secondary data. Primary data is obtained through field surveys, direct observations, and interviews. Secondary data is obtained through literature reviews from books, journals, previous research, and related agencies. The types and forms of data required for the research are listed in Table 2.

Table 2. Data types and shapes

	Data Type	Collection Methods	Data Sources	Data Shapes
I	PHYSICAL/BIOPHYSICAL ASPECTS			
1	Administration	Literature review	Sites	Spatial
2	Topography	Field survey	Sites	Spatial
3	Soil Type	Literature review	IPB	Spatial
4	Climate	Literature review	BMKG	Tabular
5	Hidrology	Field survey	Sites	Spatial
6	Land cover	Field survey	Sites	Spatial
7	Land use	Field survey	Sites	Spatial
II	ASPECTS OF TOURISM POTENTIAL			
1	Tourist objects and attractions	Field survey	Sites	Tabular
2	Infrastructure and facilities	Field survey	Sites	Tabular
3	Availability of clean water	Field survey	Sites	Descriptive
4	Transport and accessibility	Field survey	Sites	Tabular
5	View quality	Field survey	Sites	Descriptive
6	Commodities and agricultural activities	Field survey	Sites	Descriptive
7	Thermal comfort	Field survey	BMKG	Descriptive

Aspects of Landscape Sustainability

Landscape sustainability in Sawah Baru can be identified from several aspects, including slope, soil type, rainfall, and land cover (Table 3). Identification of landscape sustainability determines whether the research site has appropriate slope criteria and can be developed, suitable soil sensitivity to be developed, appropriate rainfall intensity, and appropriate land cover to be developed so that in the future, the research site development plan still meets landscape sustainability principles.

Aspects of Potential Tourist Attraction

The potential tourist attraction of Sawah Baru can be identified from several aspects, including the diversity of natural landscapes, view quality, agricultural commodities, planting patterns, and agricultural activities (Table 4.) Identifying potential tourist attractions aims to determine whether the research location has a diversity of major or minor landscapes, the authenticity and uniqueness of objects and the rate of degradation of visual values at the research site, agricultural commodities and planting patterns at the research location and agricultural activity schedules. The availability of potential aspects of tourist attraction at the research location can be an attraction for visitors.

Aspects of Potential Tourism Support

The potential of tourism supporters in Sawah Baru can be identified from several aspects, including accessibility, tourist facilities, location of the main road, availability of clean water, and thermal comfort (Table 5). Identifying potential tourism supporters aims to determine whether the research location has good accessibility, available tourist facilities, close access from main roads, availability of clean water and the appropriate level of thermal comfort to support tourism activities. The availability of potential tourism-supporting aspects at the research location can provide convenience for users in carrying out tourist activities within the research location.

Table 3. Aspects of landscape sustainability for tourism development

Criteria	Sub-criteria	Description
Slope	<15%	Suitable and expandable
	15%-25%	Quite suitably developed on a limited basis
	>25%	Protected and not suitable for development
Soil sensitivity	a. Alluvial, glei, planosol, gray hidomorf (gleysol), groundwater laterite, latosols	Insensitive – quite sensitive
	b. Cambisol, mediterranean, <i>brown forest, non-calcic brown,</i>	Less sensitive
	c. Lithosol, organosols, rendzina, regosol	Very sensitive
Rainfall intensity	<20,7 mm/day	Low
	20,7 – 27,7 mm/day	Moderate
	>27,7 mm/day	High
Land cover	Farm area	Rice fields, fields, moor, plantations
	Mixed area	Shrubs, grasslands/savannas, mixed gardens, vacant land
	Non-agricultural area	Green open space, blue open space, and settlements

Source: SK Mentan (1980) and Syafazerlinda (2021) with modification

Table 4. Aspects of potential tourist attraction

Criteria	Sub-criteria
Diversity of natural landscapes	a. There are 2 major elements and a diversity of minor elements
	b. There is 1 major element and a diversity of minor elements
	c. There is diversity but only minor elements
	d. There is only one type (homogeneous and flat)
View quality	a. The originality and uniqueness of the object is very interesting, the rate of degradation of visual values is very slow
	b. The originality and uniqueness of the object is quite interesting, the rate of degradation of visual values is quite slow
	c. The originality and uniqueness of the object is less attractive, the rate of degradation of visual values is fast
	d. The originality and uniqueness of the object is not attractive, the rate of degradation of visual values is fast

Source: Adjam (2013) with modification

Table 4. Aspects of potential tourist attraction (continuation)

Agricultural commodities and cropping patterns	<ul style="list-style-type: none"> a. Some types of crop commodities, fish farming, livestock b. Some types of crop commodities, fish farming, without livestock c. Some types of crop commodities d. 1 type of crop commodity
Agricultural activity	<ul style="list-style-type: none"> a. Available, continuous (/day/week) b. Available, continuous (/growing season) c. Available, not continuous d. Not available

Source: Adjam (2013) with modification

Table 5. Aspects of potential tourism support

Criteria	Sub-criteria
Accessibility	<ul style="list-style-type: none"> a. Asphalt road, easy to reach, good condition, there are public transportation b. Cobbled roads, good condition, limited public transportation c. Cobbled road, moderate condition, without public transportation d. No access, no public transportation
Tourist facilities	<ul style="list-style-type: none"> a. Available, complete, good quality and well maintained b. Available, quite well maintained c. Available, poorly maintained d. Not available
Location from the main road	<ul style="list-style-type: none"> a. <1 km b. 1-2 km c. 2-3 km d. >3 km
Availability of clean water	<ul style="list-style-type: none"> a. Distance <500 m b. Distance 500 m – 1 km c. Distance 1 – 2 km d. Distance >2 km
Thermal comfort	<ul style="list-style-type: none"> a. Air temperature 20-22 ° C, humidity 85-90% b. Air temperature 22-24 ° C, humidity 80-85% d. Air temperature 24-26 ° C, humidity 75-80% e. Air temperature 26-28 ° C, humidity 70-75%

Source: Adjam (2013), Yusiana *et al.* (2011) and Kaswanto (2007) with modification

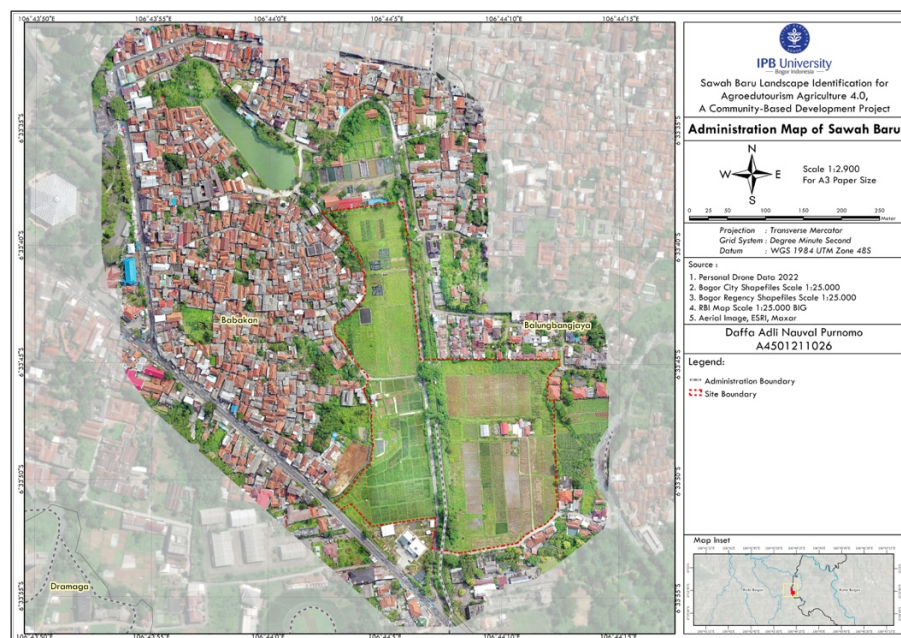


Figure 2. Administration map of Sawah Baru

3. Results and Discussion

3.1 Sawah Baru Area

This research activity was conducted in Sawah Baru, administratively located between Babakan Village, Bogor Regency and Balumbang Jaya Village, Bogor City. Based on the decree of the Rector of IPB No.90/IT3/LK/2016, the Sawah Baru area is designated as an educational garden under the auspices of the Faculty of Agriculture IPB divided into four blocks. Geographically, Sawah Baru is located at coordinates $106^{\circ}44'02''$ E - $106^{\circ}44'13''$ E and $6^{\circ}33'38''$ S - $6^{\circ}33'53''$ S. From the digitization results using processed drone images, it is known that the area of this research site reached 7.38 ha. The administrative map of Sawah Baru is presented in Figure 2.

3.2 Topography

In general, the topography of Sawah Baru is relatively flat because of its designation as an educational garden in the form of rice fields. In the western part of Sawah Baru, there are terraces which are the lowest elevation point of the site, close to the flow of small rivers. Then in the middle of the site lies a high mound from north to south that separates Sawah Baru into two parts. The mound is helpful as a screen to reduce noise and a feature for privacy or security (Figure 3). The slope at the study site was divided into three criteria, namely flat (<15%), gentle (15-25%) and steep (>25%) (Figure 4).

3.3 Soil Type

The soil type at the study site is an association of red latosols with reddish-brown latosols, an old soil type formed from flint undergoing further weathering (Figure 5). The soil at the study site has a pH classified as acidic with a dusty clay soil structure with a relatively low K nutrient content (Budiawan 1995). The latosols soil can be found in areas with choppy to mountainous topography located at 10-1000 m above sea level and overgrown by tropical rain forests with rainfall of 2000-4000 mm/year (Soeprtohardjo 1961).

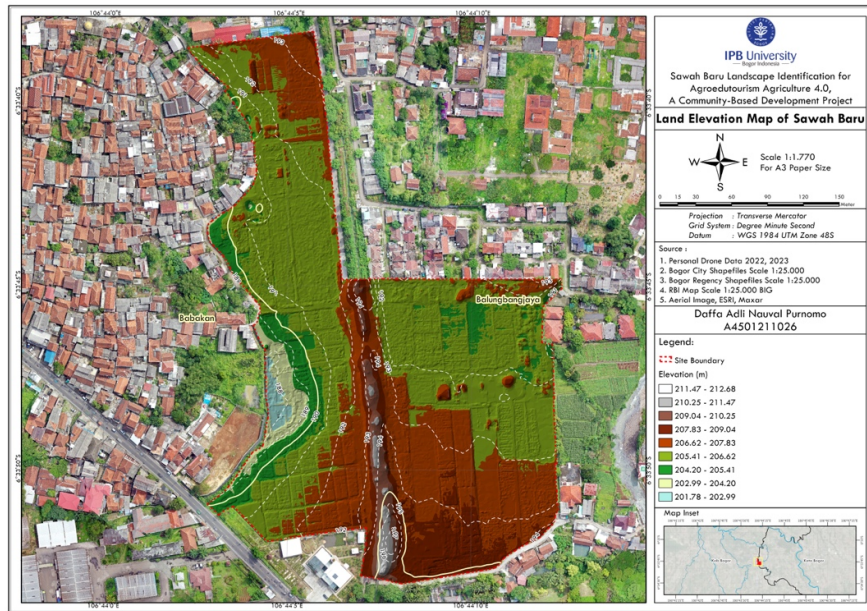


Figure 3. Land elevation map of Sawah Baru

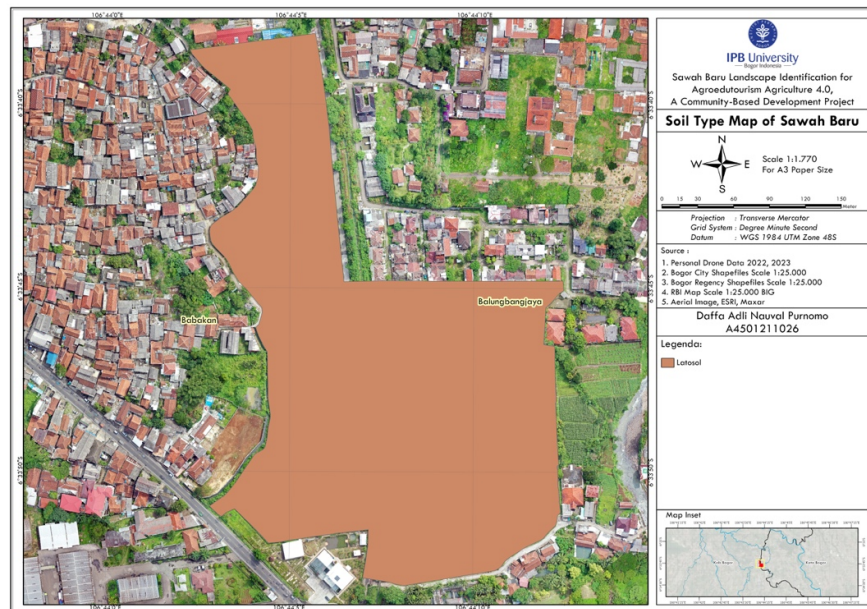


Figure 4. Slope map of Sawah Baru

3.4 Climate

Climate data for Sawah Baru is obtained from the BMKG West Java Climatology Station (2021), which consists of monthly rainfall, number of rainy days, average temperature, average humidity, and average wind speed shown in Table 6. Based on data throughout 2021, it is known that the average air temperature is 26.05 °C. The average minimum temperature was recorded in January with a value of 25.24 °C, while the average range maximum temperature at 26.87 °C occurred in May. The highest rainfall throughout 2021 reached 566.40 mm/month in October, with 24 rainy days, while the lowest rainfall reached 115.60 mm/month in July. The

average rainfall throughout 2021 reached 298.73 mm monthly or 10.95 mm daily. The rainfall map of Sawah Baru can be seen in Figure 6.

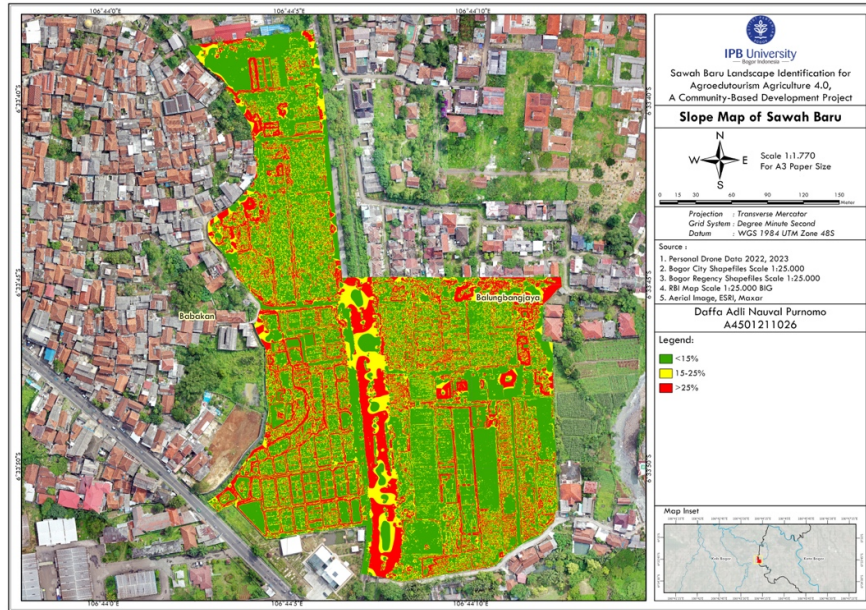


Figure 5. Soil type map of Sawah Baru

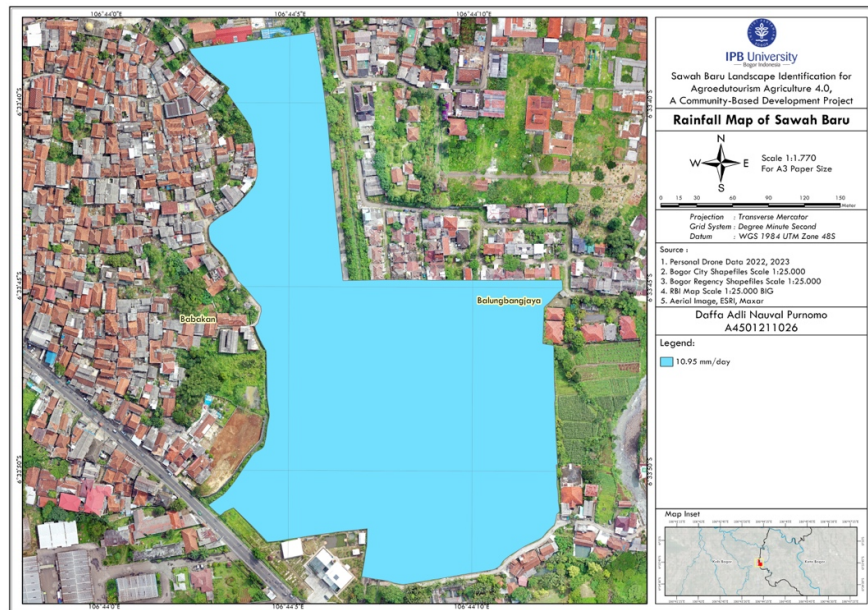


Figure 6. Rainfall map of Sawah Baru

Table 6. Climate data for Sawah Baru in 2021

Month	Rainfall (mm/month)	Rainy days (day)	Average temperature (°C)	Average humidity (%)	Average wind speed (m/s)
January	201.80	22	25.24	87.67	0.96
February	484.80	22	25.46	88.75	1.07
March	233.00	22	25.88	85.25	1.00
April	301.30	24	26.22	84.16	1.10
May	479.10	16	26.87	83.93	1.09
June	281.00	17	25.86	86.10	1.00
July	115.60	10	26.00	79.83	1.06
August	351.20	14	26.01	81.54	1.22
September	317.40	19	26.30	81.16	1.16
October	566.40	24	26.45	82.64	1.16
November	175.90	21	26.40	83.70	1.20
December	279.10	22	26.00	85.84	1.06

Source: BMKG Online

3.5 Land Cover

The results of field surveys and aerial image data processing using drones show that the land cover of Sawah Baru consists of agricultural space, mixed space, and non-agricultural space. The existing agricultural space consists of land use in fields, rice fields, and mixed gardens. Then mixed space consists of land use in the form of shrubs. Then, non-agricultural space consists of land use in the form of settlements and water bodies. The extent of land use in Sawah Baru is presented in Table 7. Rice fields dominate land in Sawah Baru, with an area of 3.69 ha which covers 49.93% of Sawah Baru. This land is a research place for IPB rice and several other commodities. As for land use in the form of a moor in Sawah Baru, the area reaches 1.74 ha; this field is planted with various seasonal crops. The land use map in Sawah Baru can be seen in Figure 7.

Table 7. Land use area in Sawah Baru

	Land Cover Type	Land Use Type	Area (ha)
1	Agriculture space	Fields/mixed garden	1.74
		Rice fields	3.69
2	Mixed space	Shrubs	1.64
3	Non-agriculture space	Settlements	0.23
		Water bodies	0.09

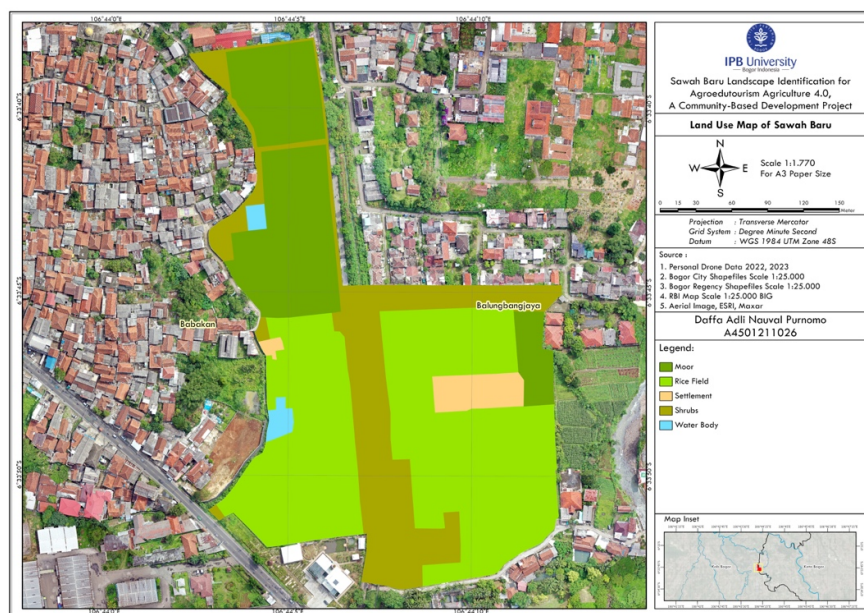


Figure 7. Land use map of Sawah Baru

3.6 Natural Landscape Diversity

Sawah Baru has a variety of natural landscapes consisting of minor landscape elements. According to Wahyuni (2013), landscape elements consist of major and minor elements, with major elements challenging to change, such as rivers, mountains, and beaches. Minor elements can be changed, such as small rivers, small hills, plants, and man-made elements. In the landscape of Sawah Baru, there is a diversity of minor elements in the form of rice fields, gardens, fields, small rivers, and other man-made elements.

3.7 View Quality

The Sawah Baru area presents diverse scenery, including the background in Mount Salak, which is beautiful for visitors to enjoy. Sawah Baru has potential as a tourist spot with small rivers, rice fields and horticultural land whose visual degradation could be faster but has the potential to be disrupted by the construction of multi-storey buildings. The quality of the scenery at the location can be categorized as reasonably exciting scenery with the authenticity and uniqueness of the object; besides that, the land filled with agricultural commodities is also a complementary attraction.

3.8 Agricultural Commodities and Cropping Patterns

From the results of field studies, it is known that Sawah Baru has several types of cultivation: rice fields, corn, taro, kale, spinach, chili, Bogor beans, peanuts, eggplant, cassava, bananas, and papaya. The rice varieties planted consist of IPB 3S, IPB 9G, Inpari 1, Inpari 13, Inpari 24, Inpari 30, Inpari 32, Inpari 33, Inpari 43, IR 64, Batang Piaman, Mentik Wangi and Ciherang. Students and employees carried out the planting of agricultural commodities.

3.9 Agricultural Activities

Agricultural activities in Sawah Baru take place every growing season. Most of Sawah Baru's agricultural activities are focused on paddy rice crops. There are several stages of rice cultivation activities: seeding, spraying, turning the soil, making rice ripen and smoothing the soil texture in rice fields. In addition, there are also horticultural crops planted with quarterly planting patterns according to student practice schedules.

3.10 Accessibility

The location of Sawah Baru is quite strategic and only 12 km from the city centre; besides that, the location is

effortless to access using private vehicles and public transportation. With relatively good road conditions and a connected road network, this makes it easier for visitors to visit the location. However, there is a stagnant water flow on the border road between Bogor City and Bogor Regency, so the asphalt on the road is eroded. This condition causes access in Sawah Baru to be slightly disrupted.

3.11 Tourist Facilities

Sawah Baru has several facilities that can be used to support existing agricultural activities. Nevertheless, Sawah Baru still needs facilities specifically designed to support agroedutourism activities. Today's facilities include rest areas, halls, tractor warehouses and rice storage. The existing utilities in Sawah Baru are in the form of road networks, electricity networks and water networks. In terms of management and service, Sawah Baru is quite good. The existing facilities and utilities are well maintained. However, access to information about the existence of Sawah Baru still needs to be improved.

3.12 Location from The Main Road

The location of Sawah Baru is only 100 m away from the main land transportation route that connects the Bogor City area with Bogor Regency. The status of the site's roads is grouped into collector roads, local roads, and footpaths. A map of the Sawah Baru road network can be seen in Figure 8. The obstacle that often occurs is traffic jams that sometimes occur before the intersection of Jalan Raya Dramaga and Ring Road Jalan Dramaga.

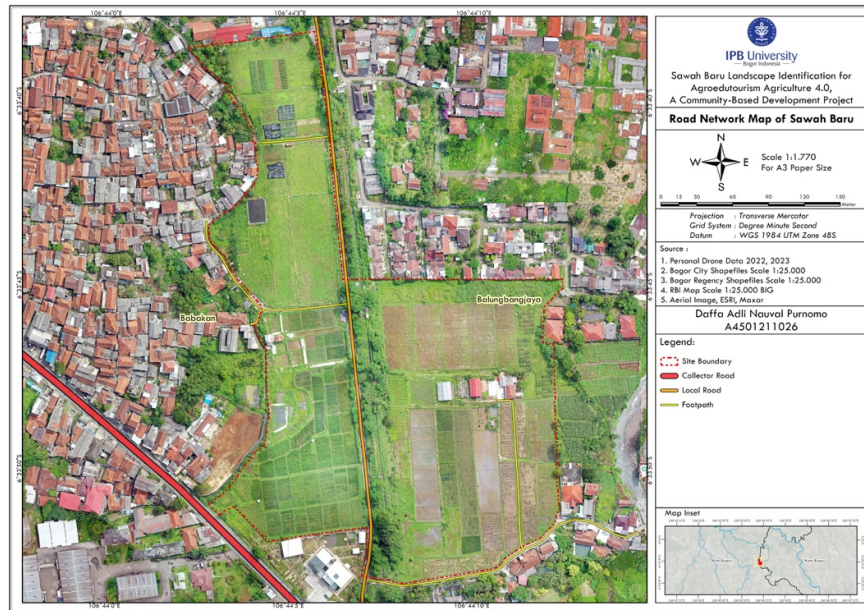


Figure 8. Road network map of Sawah Baru

3.13 Clean Water Availability

Judging from the hydrological conditions in the area, water sources in Sawah Baru come from surface water and groundwater. Shallow groundwater sources in the Sawah Baru area can be used for making wells; reservoirs maintain groundwater quality and water supply. The condition of the existing irrigation system in Sawah Baru is less functional, where at some points, the irrigation is blocked due to wild plants and garbage and sedimentation in the channel so that the flow cannot flow far.

3.14 Thermal Comfort

Based on climate data obtained and then processed, the average Thermal Humidity Index value of Sawah Baru throughout 2021 is 25.37 °C. This value shows that Sawah Baru is considered comfortable for humans in the tropics to carry out activities. The highest THI value occurred in May at 26 °C due to a reasonably high

temperature reaching 26.87 °C, which impacted the effect of being uncomfortable for activities. According to Setyowati (2012), thermal comfort in the environment can be created by providing green space with shade at the edges and windbreaks in certain areas. The highest level of climatic comfort is found in January, with a THI value of 24.61 °C. Thermal Humidity Index (THI) data in the Sawah Baru area throughout 2021 are presented in Table 8.

Table 8. Thermal humidity index data of Sawah Baru in 2021

Month	Average temperature (°C)	Average humidity (%)	Thermal humidity index
January	25.24	87.67	24.61
February	25.46	88.75	24.87
March	25.88	85.25	25.11
April	26.22	84.16	25.38
May	26.87	83.93	26.00
June	25.86	86.10	25.13
July	26.00	79.83	24.95
Augustus	26.01	81.54	25.04
September	26.30	81.16	25.30
October	26.45	82.64	25.53
November	26.40	83.70	25.53
December	26.00	85.84	25.26

Source: BMKG Online

4. Conclusion

The overall topography of Sawah Baru is relatively flat, with a slope percentage of <15% reaching 4.05 ha (54.08%). The type of soil in the area is red latosols to reddish-brown latosols, which is insensitive to somewhat sensitive to erosion, where the influence of soil on erosion is directly proportional to its suitability in the development of the area. The average rainfall in Sawah Baru in 2021 is 10.95 mm/day, included in the low category. For land use, Sawah Baru is divided into several spaces: agricultural space consisting of rice fields and fields, mixed space consisting of shrubs and non-agricultural space consisting of settlements and water bodies.

The landscape of Sawah Baru has a diversity of minor elements in the form of small rivers, rice fields, fields, gardens, and other man-made elements formed from cultural activities and daily life of the surrounding community. Sawah Baru has the potential as a tourist spot with small rivers, rice fields and horticultural land with a view in the form of Mount Salak, which has a relatively slow rate of visual degradation but has the potential to be disturbed in the future there is the construction of high-rise buildings around it. Agricultural commodities in Sawah Baru are rice fields with various varieties, tubers, vegetables, and fruits grown by students and employees. Agricultural activities in Sawah Baru occur every planting season; most agricultural activities in Sawah Baru concentrate on rice crops. In addition, there are also horticultural crops planted with quarterly planting patterns according to the student practicum schedule. Activities such as land preparation, planting agricultural commodities, harvesting agricultural products, and shopping for agricultural products can be tourist attractions so that tourists can visit Sawah Baru.

The location of Sawah Baru is only 100 meters from the main land transportation route in Bogor City and Bogor Regency. This location is easy to reach both using private vehicles and public transportation. The existing road network in Sawah Baru is relatively good, with pavement types in concrete, asphalt, paving blocks, and rocky roads. The existing facilities in Sawah Baru need to be more supportive of agroedutourism activities because the existing facilities are in the form of halls, rest areas, tractor storage areas and rice warehouses that only support existing agricultural activities. Water sources in Sawah Baru come from boreholes, reservoirs, and irrigation. However, the condition of the existing irrigation system in Sawah Baru is less functional, where at some points, there are obstacles due to wild plants and garbage accumulation which causes sedimentation so that the flow of water cannot flow far. Based on processed climate data, it is known that the average THI value of Sawah Baru throughout 2021 is 25.37 °C, which indicates that the area is included in the comfortable category for humans in the tropics to carry out outdoor activities. The comfort level can be increased again by planting

shade plants on the edges of the location and windbreak plants in certain areas.

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