PAPER • OPEN ACCESS

Evaluate land suitability analysis for rice cultivation using a GIS-based AHP multi-criteria decision-making approach: Majalengka Regency, West Java Province

To cite this article: Adrian *et al* 2022 *IOP Conf. Ser.: Earth Environ. Sci.* **1109** 012062

Evaluate land suitability analysis for rice cultivation using a GIS-based AHP multi-criteria decision-making approach: Majalengka Regency, West Java Province

Adrian[1,4], Widiatmaka[2], K Munibah[2], I Firmansyah[3]

[1] Study Program of Natural Resources and Environmental Management, Graduate School, IPB University, Baranangsiang Campus, Indonesia
[2] Department of Soil Science and Land Resources, IPB University, Indonesia
[3] Head of System Dynamics Center, Indonesia
[4] Departement of Education Geography, Islamic University 45 Bekasi

E-mail: ophunkpetrucci@gmail.com

Abstract. This research is motivated by the agricultural sector ranks first and plays a vital role in GRDP income in Majalengka Regency. This study aims to predict areas suitable for land use for sustainable food agriculture (LP2B) and evaluate land suitability for rice. We use the Analytical Hierarchical Process (AHP), and Geography Information System (GIS) approaches to give weight to the suitability of criteria and sub-criteria that influence multi-criteria decisions. Including using parameters; Soil morphology, elevation, rainfall, water cover, land area, disaster risk, erosion, and slope are the criteria identified as requirements for the intended application. The resulting weights to build a suitability map layer using a weighted sum overlay tool on a GIS platform by involving government stakeholders in Majalengka Regency. The results showed that the map of the evaluation of the suitability of rice production in the study area with the land was very suitable, namely 11% (15,038.49 ha) of the total study area, which was very suitable for rice production. The relationship between suitability maps and changes in spatial patterns in 2022 in the study area has also overlapped. The results showed the suitability of the spatial plan with the results of the suitability map of paddy fields.

1. Introduction

Land suitability analysis is essential for planning and sustainable management of land resources and is used to assess the land potential for particular land use [1]. The world population continues to increase. Along with the increase in population, the need for shelter and nutrition has also increased, which has become one of humanity's most critical problems. These pressures severely threaten land resources, such as land degradation. Sustainable use will only be possible through land use following its potential [2]. Increasing rice production can be successful through intensive or extensive agriculture. Intensive farming attempts to maximize the available rice area by increasing the input of rice production. Expansion is an attempt to extend rice fields to other places. This study assesses rice land and needs a reference for decision-making to determine the potential of rice fields [3].

Land suitability evaluation (LSE) for irrigated agriculture involves the interpretation of data relating to soil, topography, vegetation, etc; to match land characteristics with the requirements for plant growth [4,5]. Land evaluation is a process of projecting the potential for land use based on comparing the need for the type of land use with the characteristics of the land. Inappropriate use, not potential, initially results in the degradation of natural resources and then creates social and economic problems (insufficient food supply, production disruption, etc) [6].

This research is motivated that the agricultural sector still an essential role in the economic development and welfare of the people of Majalengka Regency, where the GRDP income of the farming sector is still in the first place and followed by the industrial sector in second place and construction in third place [7]. Geographical conditions and adequate irrigation facilities make this sector the backbone of the Majalengka Regency's development. Still, the leading industry may change over time, considering that the West Java International Airport, CISUMDAWU, and CIPALI Toll Roads have been established and are designated regional areas. Tambourine special economy in Majalengka Regency. Every infrastructure development must have advantages and disadvantages. One of the disadvantages is the reduction in agricultural land so that the farm sector's contribution to Majalengka Regency will gradually decline.

The more rapid conversion of agricultural land into built-up land in the Majalengka Regency will impact decreasing rice production and the contribution of the Majalengka Regency to rice production in West Java Province. The agricultural sector plays a vital role in economic development and the welfare of the people of the Majalengka Regency, where household income from the agricultural sector remains at the top [8]. The Majalengka Regency RTRW Regulation states that the land allocation for sustainable food agriculture has a minimum area of 39,190 ha [9]. Conversion of paddy fields continues. Food resilience will be exposed if the conversion cannot be controlled and stopped [10,11].

Various studies aimed at assessing the suitability of rice land, including an Analysis of the land suitability for paddy fields in Tanzania[12] using a GIS-based analytical hierarchy process key factor for food security and poverty reduction. The study conducted [13] An evaluation of cultivated land protection policies; a case study in Xingning discusses the impact of cultivated land protection policies which are important issues in China's food security and land policy regulations. They assessed land suitability for rainfed paddy rice production in Zambia [14] to expand the potential rice production area. Remote Sensing and Land Suitability Analysis to Establish Local Specific Inputs for Paddy Fields in Subang, using the Geographic Information System [15], the location where the input is required can be in detail. Therefore, it is necessary to conduct a land suitability analysis considering feedback based on a joint decision with stakeholders in Majalengka Regency. The purpose of this study is: (i) to evaluate the suitability of rice fields and (ii) spatial recommendations for land for sustainable food agriculture (LP2B) in the Majalengka Regency.

2. Material and Methods

2.1. Study area

The research locations are Majalengka Regency, West Java Province. Majalengka Regency is geographically located at coordinates between 108°03' - 108°25' East Longitude and 6°36' - 6°58' South Latitude, consisting of 26 Districts. Majalengka Regency in the north is bordered by Indramayu Regency, in the south by Garut Regency, Tasikmalaya Regency, and Ciamis Regency, in the west by Sumedang Regency, and in the east by Cirebon Regency and Kuningan Regency.

This research was conducted in several stages, namely: (i) Identification of research variables obtained from theoretical studies and then concluded based on the understanding of the researchers and adapted to the conditions contained in the research location; (ii) After several variables have been determined, the next step is to confirm these variables to the selected stakeholders (Bappeda, Department of Agriculture, Department of Public Works and Spatial Planning, ATR BPN, Department of Housing Settlement Areas and Land Majalengka, Regional Secretariat) as well as to give a significant score for their influence on the determination of the analysis of land suitability evaluation for lowland rice using the Analytic Hierarchy Process (AHP) Method; (iii) Analysis of suitability and availability of land for rice fields is carried out through an overlay with the amount of weight which will result in a map of recommendations for sustainable food agriculture (LP2B) generated from the AHP process.

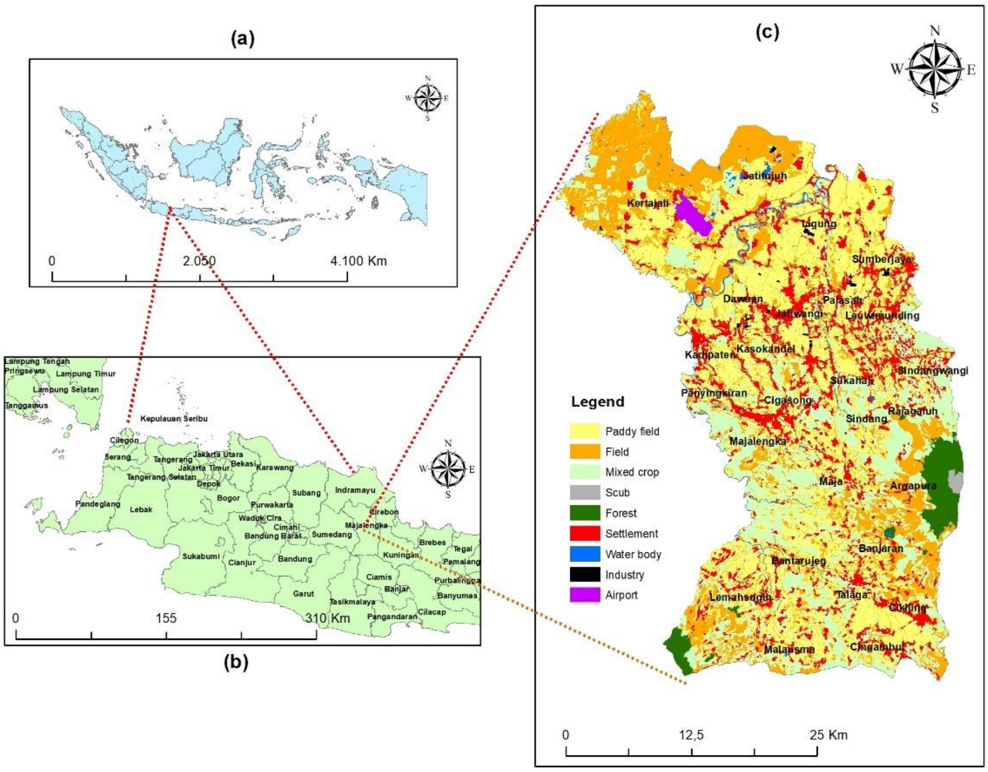

Figure 1. Geographical extent of the study area: (a) Indonesia, (b) West Java Province Area, (c) Majalengka Regency Map, (Land Cover)

2.2. Land use and land cover

Land use land cover (LULC) data is used to assess paddy land, fields, mixed gardens, shrubs/open ground, forests, the body of water, industrial sites, settlements, and airports. According to land use and land cover, most study areas consist of paddy fields, fields, and mixed gardens. LULC was built from the Sentinel-2 dataset at 10m resolution and processed using a random forest-guided classifier with Google Earth Engine Machine.

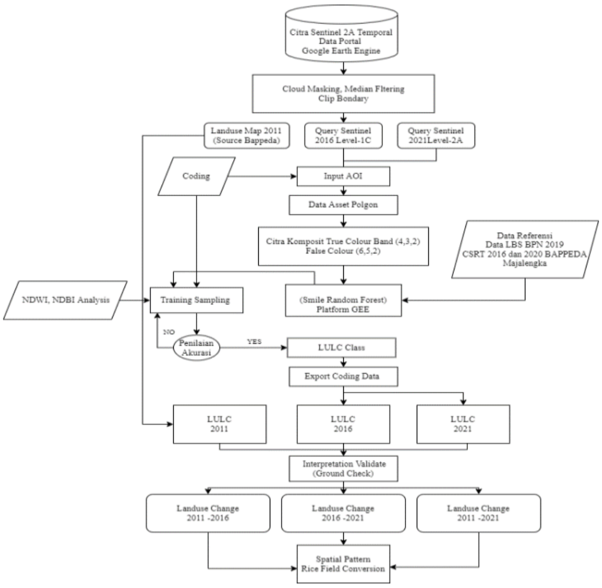

Figure 2. LULC data processing flow chart

2.3. Criteria for suitability analysis
Twelve criteria were considered to determine suitable land for the analysis of land suitability evaluation for rice, including; Paddy Crop Farming Index (IP), Water Coverage, Land Area, Irrigation System, Distance From Road, Drainage, Soil Type, Disaster Risk, Rainfall, Slope and Erosion.

Table 1. List of data sources for the land suitability evaluation of paddy field

Spatial Data	Description	Data Source
Map LULC	10 m resolution	2021, Map classification Sentinel 2
Spatial plan map	Scale 1: 25k	2021, Landuse Plan (RTRW) of Majalengka Regency
Map cultivation intensity	Scale 1: 25k	2021, Department of Agriculture of Majalengka Regency
Map land area	Scale 1: 25k	2021, Landuse Plan (RTRW) of Majalengka Regency
Map of Morphology	Scale 1: 25k	2016, Ministry of Energy and Mineral Resources
Map of soil	Scale 1: 50k	2017, Center for Agricultural Land Resources
Map of elevation	Scale 1: 25k	2021, DEMNAS (Indonesia Geospatial Agency) 2021
Map of precipitation	Scale 1: 25k	2021, Bappeda Majalengka
Map of Slope	Scale 1: 25k	2021, DEMNAS (Indonesia Geospatial Agency) 2021
Map of drainage	Scale 1: 25k	2021, Ministry of agriculture and Bappeda Majalengka
Map of distance of road	Scale 1: 25k	2021, RBI Map and Open Street Map
Map of distance of river	Scale 1: 25k	2021, RBI Map
Location of Paddy Field	GPS Data	2022, Survey

2.3.1. Paddy crop farming index (IP)
Rice productivity describes rice production per unit area of land used in rice farming. Commonly used land area units for productivity in hectares. The increase in the rice planting index describes the number of times farmers plant rice in a year on the same stretch of land. The higher the IP rice, the higher the rice production in an area. In addition to increasing the IP, efforts that can be made to improve the availability of rice in a room are to increase rice productivity. According to [16], to produce high productivity, it is necessary to understand the factors that affect rice productivity, such as seed quality, the number of workers, the type of fertilizer applied, and others.

2.3.2. Water coverage
Irrigation is defined as using water on the soil to supply fluids needed for the growth of plants [17]. However, a more general and included irrigation uses water on the ground for irrigation of every amount [18]. Then the irrigation system is a system that supports the irrigation in this case, divided into three classes: technical irrigation systems, semi-technical irrigation, and simple and rain-fed irrigation systems.

2.3.3. Land area
Expanse area food farm sustainable or agricultural reserve land sustainable food at least 5 ha. Commonly used land area units for productivity are hectares; the data used for the area of rice farming land was grouped into four categories, including those with an area of > 100 ha, 50-100 ha, 10-50 ha, and < 10 ha. This classification aims to obtain the optimal location to produce weights from high to low on the potential for determining sustainable food agricultural land. The expanse of sustainable food agricultural land has at least 10 hectares of rice fields. The goal is to minimize the potential for land conversion. In

the future, developing infrastructures such as technical irrigation networks and access roads to production houses will be more efficient because it covers a reasonably large area. The above calculation determines the minimum size of land per unit stretch of Sustainable Food Agricultural Land in the future.

2.3.4. Irrigation system

The long-distance from the river can also facilitate irrigation; distance data to the river is taken as a polyline vector and then converted to raster data. The conversion of vector to raster data for called rasterization; it analyses using the Euclidean distance to calculate the distance from the river. The study area for distance to the river has been extracted by occlusion followed by reclassification by shortest distance with the highest weight for nearest distance and lowest for furthest distance.

2.3.5. Distance from road

Three types of roads are used in this analysis: highways, district roads, and local roads, including rural and urban roads. Distance from streets was considered because of the need to minimize transportation costs associated with crop distribution using highways, districts, and local roads. The minimum distance between the rice fields and the road makes transporting the collected rice harvest easy. The distance data from the road is taken as a polyline vector and then converted into a raster. Spatial analysis was carried out to measure distance using Euclidean distance. Reclassification of distance from the road is carried out according to [6].

2.3.6. Drainage

Improved drainage is essential to provide adequate aeration in the root zone of rice plants to grow the right crop and increase production. Drainage also prevents surface runoff from limiting the loss of nutrients in the soil and maintaining optimal soil moisture.

2.3.7. Type of soil

Soil type plays a vital role as a medium for growing agricultural land crops; the better the nutrients contained, the better the land for agriculture. In this case, the soil type suitability class is reviewed from the existing literature on what kind of soil is suitable for agricultural land, as well as by examining the soil type map document from the Center for Agricultural Land Resource, which has mapped the distribution of soil types in each sub-district in Majalengka Regency.

2.3.8. Disaster risk

Disaster variables are obtained from the National Disaster Management Agency by accumulating variables by combining the potential for multiple disasters, including floods, landslides, and earthquakes, so that the potential for catastrophe, in general, is obtained. Disaster risk areas determine agricultural land due to the impact of disasters that have the potential to cause crop losses. A review was also carried out on the Regulation of the Ministry of Agriculture of the Republic of Indonesia Number 79 of 2013 concerning Guidelines for Land Suitability for Food Crops Commodities.

2.3.9. Rainfall

Rainfall is obtained from the regional spatial plan of the Majalengka Regency. The precipitation intensity (mm/yr) significantly affects agricultural land, especially rainfed rice fields as a source of irrigation.

2.3.10. Slope

Topography, elevation, and slope are obtained from the image of the DEMNAS Geospatial Information Agency with an accuracy of more than 10 meters. Then processed through GIS to divide by class. The classification of morphology in terms of research conducted [19]. Generally, agricultural land is very suitable in areas with relatively flat surface relief.

2.3.11. Erosion
Soil erosion is obtained from the weighted overlay on the data morphology, slope, rainfall, and soil type. Erosion affects agriculture because of the high rate of soil erosion. The higher it is, the less suitable it is for agriculture.

2.4. Analytical hierarchy process (AHP)
The next step is to determine the weighting of each driving factor in evaluating the suitability of the LP2B land. The AHP method has three basic principles: decomposition, comparative assessment, and priority synthesis. The weighting of each attribute utilizes the calculation results of the AHP method, which involves six government stakeholders in the Majalengka Regency. The weights of each LP2B suitability evaluation variable in Majalengka Regency are as follows: The decision hierarchy model for land suitability evaluation has a structure of factors, criteria, and sub-criteria (Figure 3). The hierarchy of measures considers productivity, infrastructure, and land physique. The sub-criteria attribute (productivity); considers the cropping index, water affordability, and land area, the sub-criteria (infrastructure); considers the irrigation system and distance to roads, and the (physical); sub-criteria considers drainage, soil type, disaster risk, rainfall, slope and erosion hazard. The AHP weighting in this study showed six experts and used Saaty's pairwise comparison.

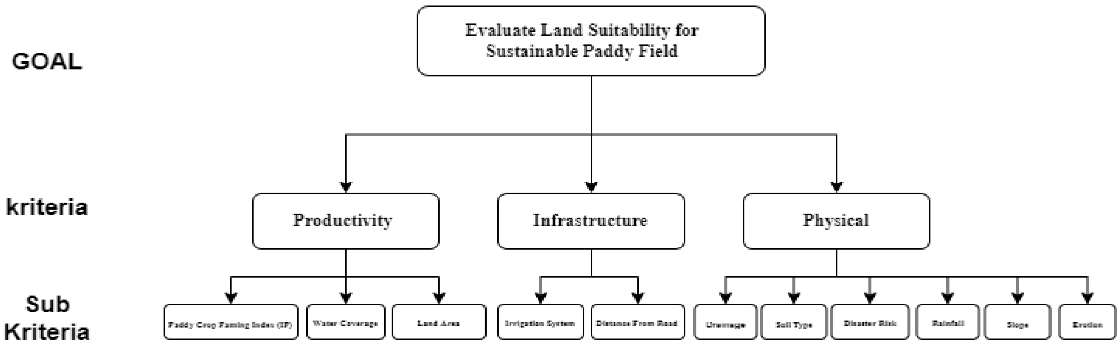

Figure 3. The hierarchical structure of land suitability evaluation decisions for paddy field

2.5. Comparison between land suitability evaluation factors for LP2B
Based on the AHP analysis, the total inconsistency value is 0.012, which means the error rate in this analysis can be received. The physical factor has a weight value (0.312), then the infrastructure factor has a weighted value (0.407), and the last is the productivity factor (0.281). Land suitability evaluation for LP2B determination is highly dependent on the potential of the infrastructure to obtain optimal agricultural land suitability, which considers supporting infrastructures such as irrigation systems and road access for production. Productivity is very low because, based on stakeholder opinion, these factors can no longer be avoided and can be optimized by technological engineering.

2.5.1. Physical parameters
The inconsistency value for physical factors is 0.036, so that acceptable. The results of this variable will later be used as data on the suitability of food agriculture. The weight of the highest suitability variable is soil type (0.323) because it significantly affects the growth of crops. While the lowest weight is the disaster risk area variable (0.103), this is because the condition of the disaster risk area, especially landslides, is an area suitable for agricultural land, so the potential for disasters is not considered.

2.5.2. Infrastructure parameters
The inconsistency value for the primary infrastructure factor is 0.001 because it only consists of 2 variables. The results of this variable will later be used as a value for whether the land has adequate infrastructure. The weight of the irrigation system is very high (0.690) because, based on Permentan No.

7 of 2012, irrigation is very influential on the sustainability of agricultural land. Road access is considered low (0.310) because, on the other hand, road access can cause the conversion of agricultural land; on the other hand, the need for roads to accommodate agricultural products is also needed.

2.5.3. Productivity parameters

The inconsistency value for the primary productivity factor is 0.002, so the error rate is acceptable; the results of this variable will later be used as the most optimal land productivity value. The weight of each variable is the highest water accessibility (0.603), then land area (0.257), and the lowest planting intensity (0.140). Nutrients and from a technological perspective, many chemical fertilizers can affect cropping intensity. The suitability evaluation map was developed using a weighted spatial overlay analysis according to the results of the AHP weights obtained. The weights are received from 7 stakeholders who play a role and have an influence in determining sustainable food agricultural land (LP2B); the overlay analysis process (productivity variable, infrastructure variable, physical variable) is processed according to figure 4.

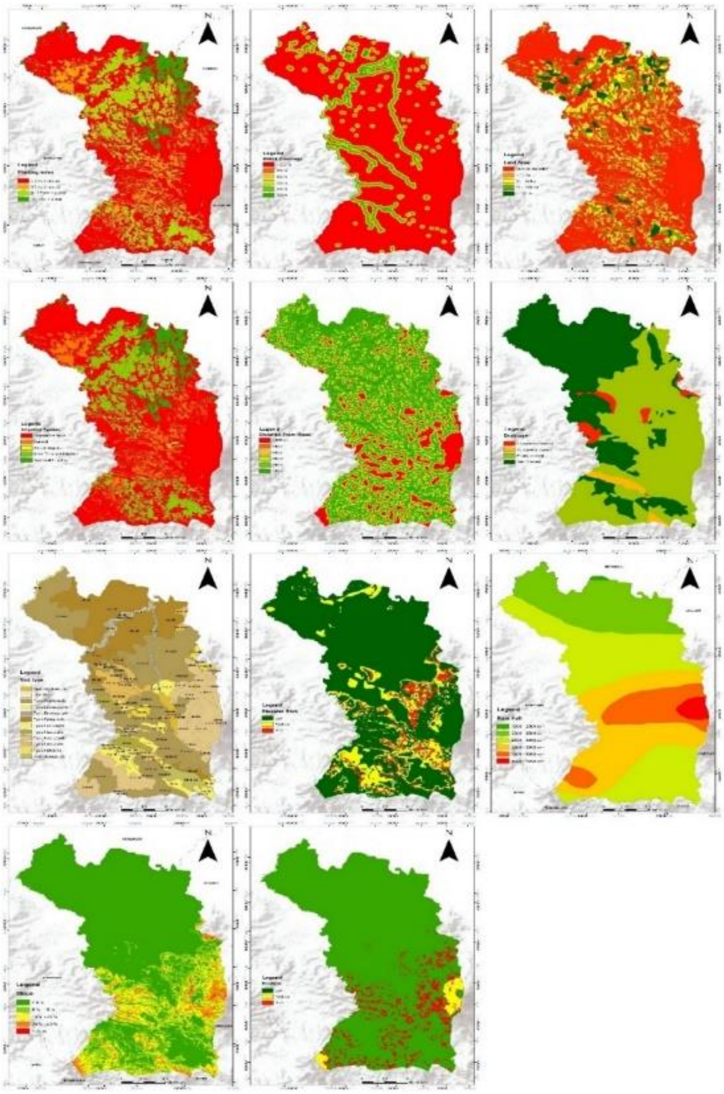

Figure 4. Reclassification of criteria: (a) Paddy Crop Farming Index, (b) Water Coverage, (c) Land Area, (d) Irrigation System, (e) Distance From Road, (f) Drainage, (g) Soil Type, (h) Disaster Risk, (i) Rainfall, (j) Slope and (k) Erosion

3. Result and Discussion

Before the conformity overlay is carried out, it needs to be classified according to the land suitability class of each variable. Classification of Land suitability is assessing and grouping a specific land area concerning use [20]. In this research, agricultural land use is classified based on suitability class FAO land use. Namely class S1 (Highly suitable), S2 Class (Suitable), S3 Class (Marginally suitable), N1 Class (Not suitable). This analysis is used to determine the potential land that aims to be used for sustainable food agriculture based on the values that exist in each variable. The variables used at this stage are physical variables that can be displayed in spatial form. The variables in question are: (productivity) considers the cropping index, water affordability, and land area. Sub-criteria (infrastructure) considers the irrigation system and road distance, and the (physical) sub-criteria consider drainage, soil type, disaster risk, rainfall, slope, and erosion hazard.

3.1. Productivity parameters

The analysis uses the raster calculator method with the (Map algebra) approach. The variables in the question are as follows: (productivity) considers the cropping index, water affordability, and land area. The availability of access to water is used as a source of water other than irrigation networks, including data on the distribution of reservoirs around agricultural areas. Majalengka Regency still has the characteristics of agricultural land by relying on pools to irrigate during the dry season; planting intensity data obtained from the farm office of Majalengka Regency combined with data from the Ministry of Agriculture, with the characteristics of the intensity of 1-3 times agricultural food cropping in a year. The expanse of the expanse is reviewed from the literature study, which generally lands with an area of fewer than 10 ha and will be easily converted.

3.2. Infrastructure parameters

The analysis uses the raster calculator method with the (Map algebra) approach. The variables include the 2017 agricultural irrigation system map from the farm office of the Majalengka Regency combined with data from the Ministry of Agriculture and the 2021 road access buffer map from the Majalengka Regency spatial planning office. Access roads in this study are classified into two types: roads that affect growth in the toll roads and main roads, as well as roads for production accommodation in the condition of local scale roads and roads.

3.3. Physical parameters

This analysis uses the Weight Overlay method, namely, the overlay calculation of each value in each sub-variables multiplied by the weight of each class. The input variables include soil type, disaster risk, rainfall, slope, and erosion hazard. So that the results of the analysis are as follows:

3.4. LP2B potential suitability class in Majalengka Regency

The overlay results of each variable suitability above is a weighted overlay for the suitability of potential LP2B land with the weights and variables that have been analyzed previously. The consequence for environmental; and physical suitability is (0.381); the physical factor has a weight value (0.312), then the infrastructure factor has a weighted value (0.407), and the last is the productivity factor (0.281). From the overlay results. Majalengka Regency has 3 suitability class for potential LP2B. The area allocation for each land suitability class can be seen in the table below:

The suitability class LP2B for S1 (Very suitable) is 15,038.99 (11.31%), while the unsuitable land area of 80,764.05 ha, which is dominated by morphology in the form of mountains and other land uses. The land that is not suitable is because it is in the form of land use other than agriculture and has characteristics that are not following the LP2B potential suitability class that has been formulated. In this case, the land allocation for LP2B Majalengka Regency is 39,190 ha. In contrast, the total land that has suitability starts from S1 – S2 of the total land area of Highly Suitable (S1), covering an area of 15,038.99 ha and Suitable (S2) surrounding an area of 23,745.42 ha. with a total of 38,784.41 ha so that it must be maintained and protected against an appropriate land area in the Majalengka Regency area in the future so that land conversion does not occur in other forms, especially for built-up land.

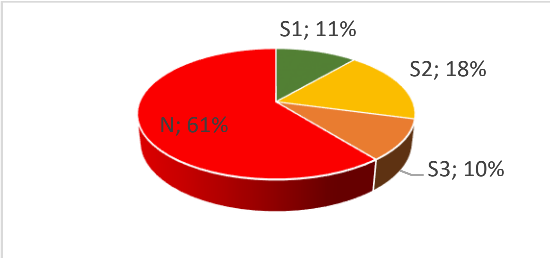

Figure 5. Percentage of land suitability class for L2PB

Previous studies had limitations in obtaining inappropriate validation results due to inadequate field reference information. Validation of the results carried out in this study by physical verification by checking the location of pixels that are suitable for class S1 (Highly suitable), S2 Class (Suitable), and S3 Class (Marginally relevant) identification of GPS distribution locations with a 10 x 5 grid approach to the Majalengka Regency area. In a previous study on the evaluation of tea land suitability, only a few edaphic and climatic parameters use defined regions in different suitability classes [21,22].

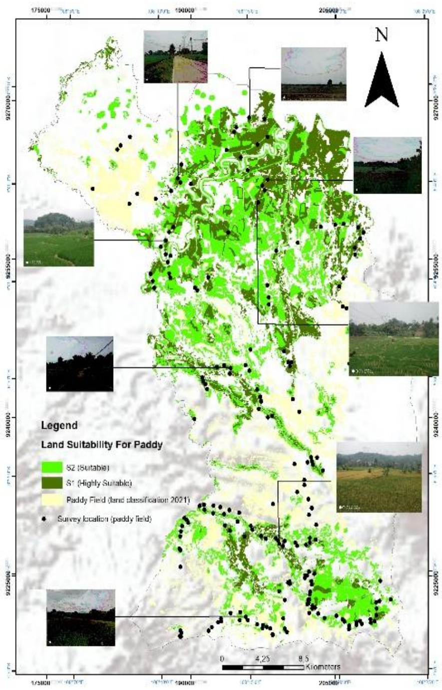

Figure 6. Available land maps (S1) and (S2) for Rice Crops in Majalengka Kabupaten District

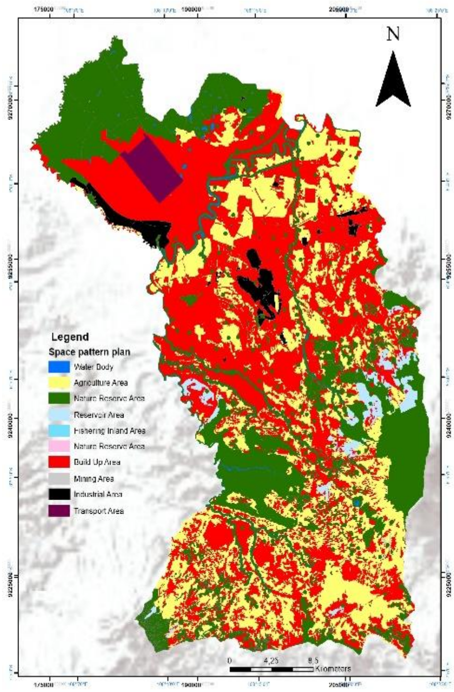

Figure 7. Space pattern plan

The factors that affect land suitability are very complex and diverse, and the aspects of each element are also different; the AHP–MEA model studied in the model has been proven by analyzing land-use suitability for maize and rice cultivation [23]. Quantity, quality, and ecological function of agricultural cultivation land relate and work together. Protection of the cultivated land is a prerequisite for quality protection, which guarantees quantity protection. In addition, the ecological management of cultivated land and protection is an essential basis for quantity and quality protection [13].

4. Conclusion and Suggestion

4.1. Conclusion
The suitability class LP2B for S1 (Very suitable) is 15,038.99 ha (11.31%). In comparison, the unsuitable land area of 80,764.05 ha is dominated by morphology in the form of mountains, and other land uses. The land that is not suitable is because it is in the form of land use other than agriculture and has characteristics that are not following the LP2B potential suitability class that has been formulated. In this case, the land allocation for LP2B Majalengka Regency is 39,190 ha.

4.2. Suggestion
In contrast, the total land that has suitability starts from S1 – S2 of the total land area of Highly Suitable (S1), covering an area of 15,038.99 ha; and Suitable (S2) covering an area of 23,745.42 ha. with a total of 38,784.41 ha so that it must be maintained and protected against an appropriate land area in the Majalengka Regency area in the future so that land conversion does not occur in other forms, especially for built-up land.

Acknowledgement
The authors would like to thank the Regional Government of Majalengka Regency and its stakeholders. They have taken the time and provided input in the discussion in determining decisions in giving weight to the driving factors of this research. Indonesia Endowment Funds for Education (LPDP) funded this research.

References
[1] Jayasinghe S L, Kumar L and Sandamali J 2019 Assessment of potential land suitability for tea (Camellia sinensis (L.) O. Kuntze) in Sri Lanka using a gis-based multi-criteria approach *Agric.* **9** 148
[2] FAO/WHO 1997 *Risk Management and Food Safety* (Rome: FAO/WHO)
[3] Sitorus S R P 2010 Klasifikasi kemampuan lahan untuk evaluasi lahan: Suatu tinjauan *J. Sumberd. Lahan* **4** 69–78
[4] Widiatmaka, Ambarwulan W, Setiawan Y and Walter C 2016 Assessing the suitability and availability of land for agriculture in tuban regency, East Java, Indonesia *Appl. Environ. Soil Sci.* **2016** 1–13
[5] Widiatmaka W, Munibah K, Sitorus S R P, Ambarwulan W and Firmansyah I 2015 Appraisal Keberlanjutan Multidimensi Penggunaan Lahan Untuk Sawah Di Karawang - Jawa Barat *J. Kawistara* **5** 113–31
[6] Pramanik M K 2016 Site suitability analysis for agricultural land use of Darjeeling district using AHP and GIS techniques *Model. Earth Syst. Environ.* **2** p 56
[7] BPS Kabupaten Majalengka 2010 *Kabupaten Majalengka dalam Angka 2010* (Majalengka: Badan Pusat Statistik)
[8] Prayitno G P 2020 Ketahanan Pangan Kabupaten/Kota Provinsi Jawa Barat *Agribus. J.* **14** p 1
[9] [BAPPEDA Majalengka] Badan Perencanaan Pembangunan Daerah 2019 *Rencana Tata Ruang Wilayah Kabupaten Majalengka 2011-2031* (Majalengka: Bapedda Kabupaten Majalengka)
[10] Firmansyah I 2016 *Model Pengendalian Konversi Lahan Sawah* (Bogor: Bogor Agricultural University)
[11] Nazam, Sabiham S, Pramudya B, Widiatmaka W and Rusastra I W 2016 Penetapan luas lahan optimum usahatani padi sawah mendukung kemandirian pangan berkelanjutan di Nusa Tenggara Barat *J. Agro Ekon.* **29** p 113
[12] Al-Hanbali A, Shibuta K, Alsaaideh B and Tawara Y 2022 Analysis of the land suitability for paddy fields in Tanzania using a GIS-based analytical hierarchy process *Geo-Spatial Inf. Sci.* **25** 212–28

[13] Lu X, Zhang Y and Zou Y 2021 Evaluation the effect of cultivated land protection policies based on the cloud model: A case study of Xingning, China *Ecol. Indic.* **131** 108247
[14] Makungwe M, Chabala L M, Van Dijk M, Chishala B H and Lark R M 2021 Assessing land suitability for rainfed paddy rice production in Zambia *Geoderma Reg.* **27** e00438
[15] Widiatmaka W, Ambarwulan W, Firmansyah I, Munibah K, Santoso P B K and Sudarsono S 2014 Land suitability and dynamic system modelling to define priority areas of soybean plantation in paddy fields in Karawang, West Java *Agrivita* **36** 235–48
[16] Ndururu R E, Situmorang M, Tarigan G 2014 Analisis faktor-faktor yang mempengaruhi hasil produksi padi di Kabupaten Deli Serdang *Saintia Mat.* **2** 71–83
[17] Pascale S D, Costa L D, Vallone S, Barbieri G and Maggio A 2011 Increasing water use efficiency in vegetable crop production: From plant to irrigation systems efficiency *Horttechnology* **21** 301–8
[18] Fuadi N A, Purwanto M Y J and Tarigan S D 2016 Kajian Kebutuhan Air dan Produktivitas Air Padi Sawah dengan Sistem Pemberian Air Secara SRI dan Konvensional Menggunakan Irigasi Pipa *J. Irig.* **11** p 23
[19] Subroto G and Susetyo C 2016 Identifikasi Variabel-Variabel yang Mempengaruhi Penentuan Lahan Pertanian Pangan Berkelanjutan di Kabupaten Jombang, Jawa Timur *J. Tek. ITS* **5** C129-33
[20] Fadlalla R and Elsheikh A 2016 Physical land suitability assessment based on FAO framework *IOSR J. Eng* **06** 1–36
[21] Zhai Z, Martínez J F, Beltran V and Martínez N L 2020 Decision support systems for agriculture 4.0: Survey and challenges *Comput. Electron. Agric.* **170** 105256
[22] Speiser J L, Miller M E, Tooze J and Ip E 2019 A comparison of random forest variable selection methods for classification prediction modeling *Expert Syst. Appl.* **134** 93–101
[23] Han C, Chen S, Yu Y, Xu Z, Zhu B, Xu X and Wang Z 2021 Evaluation of agricultural land suitability based on RS, AHP, and MEA: A case study in Jilin province, China *Agric.* **11** 370