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Distribution of Agroclimatic Zones in Aceh Tamiang District Based on Oldeman Climate Classification Results

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Abstract. Climate change will affect agriculture through its impact on the growth, development and production of its crops. Cultivation of short-lived crops such as rice is the agricultural sector most affected by climate change. Estimation of rice productivity in the future is needed to develop strategies for anticipation and adaptation in the agricultural sector so that food security is maintained. Estimation of agricultural production can be done with several approaches, one of which is the approach to changes in climate elements. The purpose of this study was to determine the agroclimate zone, determine the suitability of production and land suitability for rice cultivation based on Oldeman's climate classification. This study uses secondary data analysis, namely rainfall data for 10 years which is then interpolated with the Arc GIS application. The results of the study showed that of the 6 sub-districts analyzed for rainfall, only Rantau Sub-district has a climate zone B1 (suitable for rice cultivation), 1 sub-district (Karang Baru) is in zone C1 and 4 sub-districts (Bendahara, Banda Mulia, Seruway and Karang Baru) are in Zone C2. Rice production must adapt to climate change due to rainfall and shifts in agro-climate zones. Rice production in Aceh Tamiang Regency in sub-districts with decreasing land suitability levels requires monitoring of agro-climate conditions and planning.

1. Introduction

Aceh Tamiang Regency is one of the rice production centers in the eastern coastal area of Aceh Province. In 2021, rice production was 69,164 tons, then decreased to 59,902 tons in 2022 and increased again to 62,428 tons in 2023 [1]. Looking at the data, it can be seen that production is fluctuating. This is partly due to climate change factors which cause many crop failures. Rice crop production is influenced by climate factors and attacks by pests and plant diseases [2]. One of the most important climate elements is rainfall, because rainfall affects the water supply for rice plants [3]. Current climate change has an impact on seasonal shifts, with longer dry seasons causing droughts and shorter rainy seasons with greater rainfall causing flooding [4]. Climate change will affect agriculture through its impact on the growth, development and yield of its crops. Climate variability, increasing temperatures, and increasing CO^2 are three main factors that have a major impact on food crop production [5]. Changes in rainfall patterns associated with climate change can cause significant decreases in crop production. Climate change has a major impact on short-lived crops such as rice [6].

As a climate element that is quite vulnerable to changes due to climate change, rainfall is one of the elements that is widely analyzed in relation to climate change [7]. Rain is the most diverse climate element both in terms of time and place and is a limiting factor for agricultural activities. Therefore, climate classifications for the Indonesian region have been widely developed using rainfall as the main criterion.

The importance of agroclimatic information in facing climate change is very necessary in the agricultural sector as a reference for cropping pattern planning activities. One of the climate classifications used for agriculture is the Oldeman climate classification. This climate classification only uses rainfall elements as the basis for classification. The Oldeman method emphasizes more on agriculture so it is often referred to as agro-climatic classification. Oldeman's climate classification determination is based on the calculation of the average rainfall that occurs. Rainfall > 200 mm in one month is included in the Wet Month (WM). Meanwhile, rainfall < 100 mm in one month is included in the Dry Month (DM) [8]. The results of the Oldeman climate classification method can be used to determine rainfall patterns and describe planting patterns for rice and secondary crops in an area. This research aims to was to determine the agroclimatic zone, determine the suitability of production and land suitability for rice cultivation based on the Oldeman climate classification in Aceh Tamiang Regency.

2. Research Methods

2.1 Location and Times

This research was conducted in 6 Sub District in Aceh Tamiang District, Aceh Province (Figure 1). The research was conducted from July to September 2024.

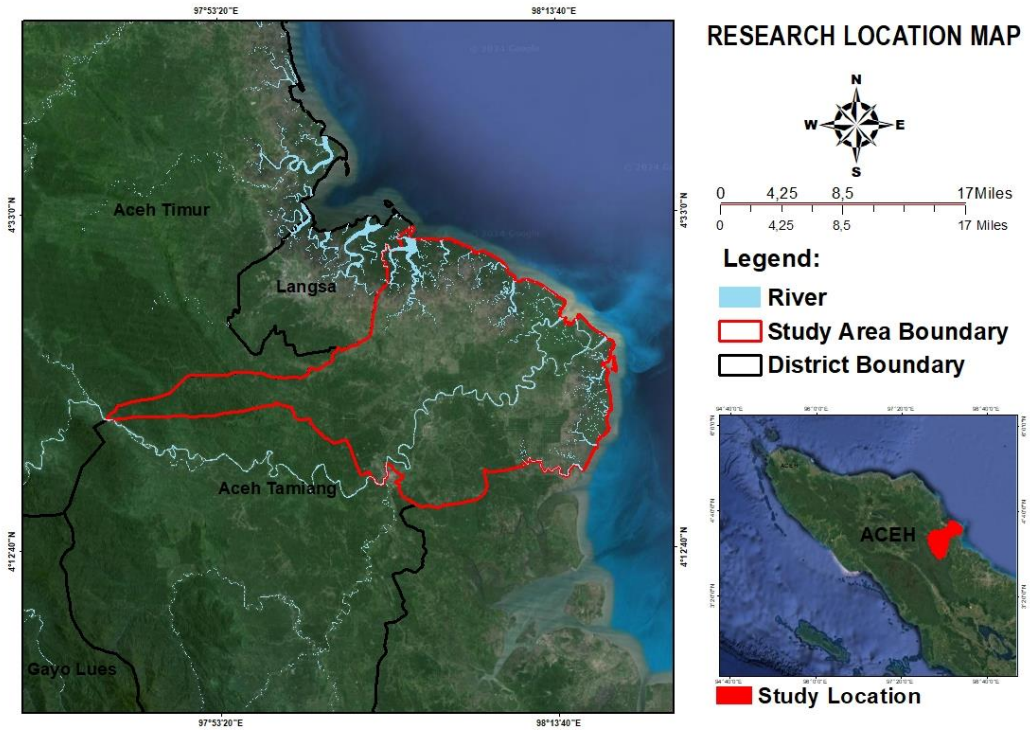

Figure 1. Research location

2.2. Method

Data Preparation

The data used to create an agroclimate zone map based on Oldeman's climate type classification is spatial rainfall data for the period 2014-2023 of Aceh Tamiang District obtained through http://worldclim.org/. In this study, spatial data on the administrative boundaries of Aceh Tamiang District was also prepared.

The administrative boundary data used was obtained through http://tanahair.indonesia.go.id. The administrative boundary data obtained is in the form of complete administrative boundary data starting from the village level, then the data is converted into district-level administrative data using the dissolve tool in ArcGIS.

2.3. Data Analysis

Oldeman Climate Classification

Determination of climate type according to Oldeman's classification is done based on the length of wet or dry months in sequence. The average rainfall for each month is classified into three, namely Wet Months (WMs/ average rainfall above 200 mm), Dry Months (DMs/ average rainfall below 100 mm), and Humid Months (HMs/ average rainfall between 100 and 200 mm). Determination of climate type according to Oldeman's classification is done based on the length of the wet or dry month period in sequence. Climate types in Oldeman's climate classification are divided into five, namely A, B, C, D, and E. then in this climate classification it is divided again into several climate subtypes in the form of numbers from 1 to 4. (Table 1). The description of Oldeman's agroclimate is presented in Table 2.

Table 1. Oldeman's climate type criteria

Zone	Classification	WMs (Mths)	DMs (Mths)
A	A1	10 – 12	0 – 1
	A2	10 – 12	0 – 2
B	B1	7 – 9	0 – 1
	B2	7 – 9	2 – 3
	B3	7 – 9	4 – 5
C	C1	5 – 6	0 – 1
	C2	5 – 6	2 – 3
	C3	5 – 6	4 – 6
	C4	5	7
D	D1	3 – 4	0 – 1
	D2	3 – 4	2 – 3
	D3	3 – 4	4 – 6
	D4	3 – 4	7 – 9
E	E1	0 – 2	0 – 1
	E2	0 – 2	2 – 3
	E3	0 – 2	4 – 6
	E4	0 – 2	7 – 9
	E5	0 – 2	10 – 12

Source : [8]

Table 2 Oldeman's agroclimatic description

Climate Type	Information
A1, A2	The density of solar radiation flux in one year is low so it is suitable for sustainable rice cultivation but the resulting production is low
B1	It is appropriate if rice planting is carried out continuously with proper planting planning. To obtain high production, harvesting must be carried out in the dry season
B2	Rice can be planted twice a year using seeds from short-lived varieties. Secondary crops can be planted during the short dry season
C1	Can plant rice once and secondary crops twice in one year
C2, C3, C4	In one year, rice can be planted once and secondary crops twice. However, when planting the second secondary crop, it should not be done during the dry months
D1	Because the radiation flux density is high, to obtain high production, short-term rice varieties can be planted. The planting time for secondary crops is sufficient
D2, D3, D4	Water supply is a limiting factor, only allowing for planting rice or secondary crops once a year
E	Can only plant secondary crops once a year because they are generally too dry

Source: [8]

The results are then mapped into ArcGIS and converted into raster form using the feature to raster tool.

3. Results and Discussion

Average rainfall data for 10 years (2014 – 2023) per sub-district at the research location was used to determine the Oldeman climate classification (Table 3). This rainfall data can be used to update the agro-climate zone. This data is needed to produce information for the agricultural sector, such as planting patterns, length of planting period, and the wealth of commodities to be cultivated [9].

Table 3. Average monthly rainfall data (mm) for 10 years (2014-2023) in 6 sub-districts in Aceh Tamiang District

District	Monthly Rainfall (mm)											
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Manyak Payed	196	84	103	132	186	163	152	230	210	337	296	408
Banda Mulia	172	72	89	109	194	156	157	220	212	305	295	414
Bendahara	159	62	75	106	195	159	160	223	216	303	298	411
Seruway	169	73	91	109	200	166	158	221	203	306	281	393
Karang Baru	111	69	65	107	209	115	152	192	214	245	211	214
Rantau	102	72	51	158	193	123	144	140	146	164	150	156

The criteria proposed by Oldeman are based on the number of Wet Months (WMs) and Dry Months (DWs). From the calculation results, for planting paddy fields, it is appropriate to have a rainfall of 200 mm/month. While for planting secondary crops, it is appropriate to have a rainfall of 100 mm/month.

The distribution of Oldeman climate types can be seen on the Oldeman climate classification map (Figure 2) which shows the zoning criteria and climate types of each sub-district at the research location.

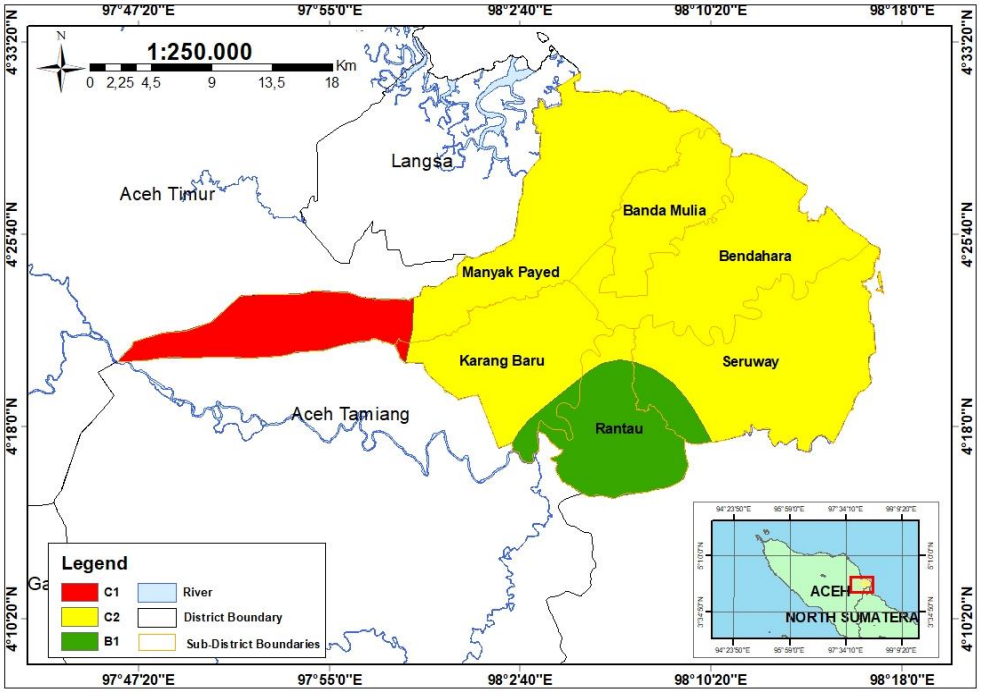

Figure 2. Oldeman's Agroclimate Zone of Aceh Tamiang District for 2014 - 2023

Figure 2 shows that climate types B2 and C1 are found in Rantau District and Karang Baru District. Meanwhile, Climate Type C2 is found in Bendahara, Banda Mulia, Seruway and Manyak Payed Districts which are areas located in the coastal area of Aceh Tamiang Regency.

Based on the results of the reclassification of the Oldeman climate type distribution map, it can be seen that the distribution of climate types in Aceh Tamiang Regency consists of 3 climate types, namely B1, C1 and C2 (Table 4). Land suitability based on climate type obtained the results of 1 type of land, namely very suitable (B1) which was found in Rantau Sub District.

Table 4. Climate types in Oldeman's climate classification at the research location

Sub District	Zona Climate	Climate Tipe	Decription
Rantau	B	B1	It is appropriate if rice planting is carried out continuously with proper planting planning. To obtain high production, harvesting must be carried out in the dry season
Karang Baru	C	C1	Can plant rice once and secondary crops twice in one year
Bendahara, Banda Mulia, Manyak Payed and Seruway	C	C2	In one year, rice can be planted once and secondary crops twice. However, when planting the second secondary crop, it should not be done during the dry months

Based on climate type factors (Table 4), Rantau Sub District is suitable for continuous paddy fields throughout the year with good planning during the planting season and high production during the dry season harvest. Furthermore, for Karang Baru Sub District, rice can be planted once and secondary crops twice a year. While for Manyak Payed, Bendahara, Banda Mulia and Seruway Sub Districts, rice can be planted once and secondary crops should not be planted in the dry season. With this information, it can help farmers in the research location to determine planting patterns in the future.

Planting of secondary crops in Manyak Payed, Bendahara, Banda Mulia and Seruway Districts must be planted carefully, especially when planting during the dry season. There is a need to adjust the crops and varieties planted with the support of other water sources. For example, by using green water, which is part of the precipitation stored in the soil or temporarily in the soil or vegetation during the growing season that can be used by plants for transpiration [10].

Because of the emergence of climate, farmers and their farmer groups are vulnerable, having difficulty maintaining or even increasing their productivity [11]. Rice production is vulnerable to changes in the onset and duration of the rainy season. Changes in the onset and duration of the rainy season have a significant impact on rice crop production. For example, there was an average decrease in rice production of 11% in East Java and Bali Provinces, and 6.5% in West Java and Central Java Provinces due to a 30-day delay in the rainy season [12]. In Kalimantan Island, climate change has caused flooding which has an impact on decreasing rice production, followed by drought and pest attacks which have a significant impact [13].

4. Conclusions

The results of the study showed that of the 6 sub-districts analyzed for rainfall, only Rantau Sub-district has a climate zone B1 (suitable for rice cultivation), 1 sub-district (Karang Baru) is in zone C1 and 4 sub-districts (Karang Baru) are in zone C1 and 4 sub-districts (Karang Baru) of the district (Bendahara, Banda Mulia, Seruway and Manyak Payed) are in Zone C2. The implication of this study is that the Oldeman agro-climate zone map of Aceh Tamiang Regency based on monthly rainfall data for 2014–2023 can be used to support agricultural planning,

especially those related to land suitability for food crop agricultural commodities, especially rice whose productivity depends on rainfall.

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