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Location Analysis of the Best Climate Village in Paser Regency Using Technique for Order Preference by Similarity to Ideal Situation (TOPSIS)

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Abstract

Since the enactment of the National Registration System (SRN) of the Directorate General of Climate Change Control based on the Regulation of the Minister of Environment and Forestry of the Republic of Indonesia Number 71 of 2017 where SRN is a forum to manage and provide web-based data and information in the form of actions and resources in the implementation of climate change adaptation and mitigation actions in Indonesia. Until 2023, there are 16 climate village locations in Paser Regency that have been reported to SRN with various levels of achievement according to the conditions of action that have been carried out by each climate village location. The purpose of this study is to analyze the best location of climate villages as reference locations in efforts to adapt and mitigate climate change in Paser Regency. The method used is TOPSIS, which calculates the highest value to the lowest of the closing results. From the results of the analysis, it was found that the best location of the climate village in Paser Regency that can be recommended as a reference location for ProKlim development is Muser Village, Muara Samu District, Paser Regency.

Keywords: Climate Village, Location Analysis, TOPSIS

Introduction

Very significant changes occur in the climate will have a very drastic impact on human life and other living things. The form of impact that arises is in the form of many natural disasters and various kinds of changes related to vital sectors such as food security, safety and health (Ismiartha et al., 2022). Indonesia is known as an archipelagic country so it is very vulnerable to the phenomenon of climate change. In addition, as a developing country, Indonesia's capacity in implementing climate change adaptation actions is not yet on par with developed countries. So it is feared that the implementation of development can be constrained because of this phenomenon. Those who have a very high vulnerability to the impact of climate change are people who are still classified as poor, and also those who feel the most impact from the constraints on the implementation of national development. So that the implementation of climate change adaptation also includes poverty alleviation programs. From various events, events or phenomena that arise due to climate change that have a negative impact on humans, the government should carry out policy strategies in dealing with and anticipating the impacts of climate change. For this reason, the Ministry of Environment and Forestry (KLHK) of the Republic of Indonesia built a system with a national scope in the form of a program called the Climate Village Program (Proklim). This program has a mission from the government in the form of a desire to involve the community to the most basic site level, starting from the level of Community Harmony or Hamlet to a slightly higher level, namely: Villages to make efforts to raise strength and ability in climate change adaptation and mitigation actions with the intention of being able to improve the welfare of life even though they have to face climate change phenomena that are adjusted to the circumstances of their respective regions (Furqan et al., 2020). The problem is to find a climate village figure that will be used as a real reference and facilitate the location of other

villages in an effort to sensitize residents in anticipation of climate change

The previous research explained the partial climate change adaptation and mitigation efforts as conducted by Gebre (2023) which identified the determinants of success of farmers in Kenya in efforts to select climate change adaptation strategies in the food security sector, Rinaldy, et al (2017) by conducting research on community development in building waste banks in an effort to mitigate climate change. Meanwhile, research related to strengthening and developing community institutional capacity in climate adaptation and change efforts was carried out by Dennevig, et al (2022) which produced findings in the form of developing cooperation from various parties in climate change adaptation and mitigation actions, Bohensky et al (2016) revealed that community participation has a role in climate change adaptation and mitigation action efforts as shown by the participation of the community in responding to the top three challenges in identifying problems that arise in climate change. Furthermore, Afni (2021) found that Tobekgadong Village opened up to the Climate Village Program so that it could provide individual understanding in efforts to control climate change. The expected purpose of this study is to analyze the best locations in carrying out climate change adaptation and mitigation actions through the Climate Village Program which will be used as a reference for other locations in carrying out climate change adaptation and mitigation actions in Paser Regency. The novelty in this study is the location that is the locus of research and the methods used in research related to climate change adaptation and mitigation at the site level specifically and climate change in general.

Materials and Method

The main category of Climate Village is the achievement of adaptation and mitigation actions to climate change if ProKlim's assessment of a location at the village/kelurahan, hamlet or community level has reached a value of 81 or more from that value. It has been mentioned earlier that in Paser Regency there have been 16 locations that have been registered as climate villages which are divided into various criteria. For this third purpose, it is to analyze the location of the best climate village that will be used as a reference for the development of climate villages in Paser Regency more precisely and efficiently. In determining the location of the best climate village as a reference for the development of climate villages in Paser Regency, a decision support system is needed so that the climate village analysis process as a reference can run effectively and efficiently. The researchers used a decision support method, namely the Technique for Order Preference by Similarity to Ideal Situation (TOPSIS) method. The TOPSIS method is a method of assessing decisions for each object where a specific value is evaluated. This method was originally introduced by Hwang and Yoon where there are some simple and efficient criteria in identifying solutions from several groups of alternatives or options. TOPSIS uses the Euclidian distance principle where the best alternative has the closest geometric distance to the positive ideal solution and the farthest geometric distance to the negative ideal solution. The best selection is based on numerical information from the system being evaluated as well as the subjective weight of the existing criteria. So that the purpose of TOPSIS is to evaluate, select and sort the selected alternatives based on the results of the evaluation (Fauzi, 2021).

As for this research, it is hoped that all existing climate villages can achieve the main rank in efforts to adapt and mitigate climate change in Paser Regency and build new climate villages. The method used in this study is to use multicriteria analysis through TOPSIS. Paser Regency has 131 villages, where based on the level of vulnerability to climate change there is only 1 village categorized as not vulnerable, 114 villages are somewhat vulnerable, 12 villages are quite vulnerable, and 4 villages are in very vulnerable conditions (Directorate General of PPI, 2015). So that the location will be analyzed which will be the best choice from several alternative locations for the implementation of the ProKlim national policy in Paser Regency. In this study, 14 alternative locations that have been registered as climate villages will be offered and ranked as Linkov and Moberg models (Fauzi, 2021). All of these alternatives were analyzed by several criteria as presented in Table 1. As for analyzing the best alternative locations as a reference for the implementation of ProKlim in Paser Regency, it can be symbolized as follows:

A1 = Damit Village, Pasir Belengkong District.
A2 = Padangpengrapat Village, Tanah Grogot District.
A3 = Klempang Sari Village, Kuaro District.
A4 = Modang Village, Kuaro District.

Table 1. Criteria, Types and Measurements

Criteria	Description of criteria	Data Type	Measurement	Criteria Direction
C1	Economic Benefits	Qualitative Quali-	Likert scale	Max
C2	Social Benefits	tative	Likert scale	Max
C3	Environmental Benefits	Qualitative Quan-	Likert scale	Max
C4	Climate Change Adaptation	titative	Numerical	Max
C5	Climate Change Mitigation	Quantitative	Numerical Nu-	Max
C6	Institutional Capacity	Quantitative	merical	Max

A5 = Petangis Village, Batu Engau District.
A6 = Padang Jaya Village, Kuaro District.
A7 = Kertabumi Village, Kuaro District.
A8 = Sebakung Makmur Village, Long Kali District.
A9 = Sebakung Taka Village, Long Kali District.
A10 = Kendarom Village, Kuaro District.
A11 = Muser Village, Muara Samu District.
A12 = Laburan Village, Pasir Belengkong District.
A13= Tajur Village, Long Ikis District.
A14 = Sei Terik Village, Batu Sopang District

Table 1 explanation of each measurement for each criterion can be described as follows:

a. For economic benefit criteria (C1), social benefit criteria (C2) and environmental benefits (C3) were obtained by observing the research site by asking whether the economic benefits of implementing ProKlim's national policy using the Likert scale.
b. As for the criteria for climate change adaptation (C4), climate change mitigation (C5) and institutional capacity based on location points that have been obtained based on ProKlim in the National Registration System of the Directorate of Climate Change Control of the Ministry of Environment and Forestry of the Republic of Indonesia.
c. The overall weight of all total criteria is 100% for C1, C2 and C3 each 20% while C4 and C5 are 12% each and C6 are 16 where the calculation is based on the percentage score on Proklim. Next, mathematical calculations will be carried out by following the steps as presented in Figure 1.

After the TOPSIS steps have been carried out properly, the final result will be obtained, namely ranking by sorting the highest value to the lowest value from the closes results as the best choice that will be used in answering the research objectives, namely getting the best alternative location that can be used as a reference

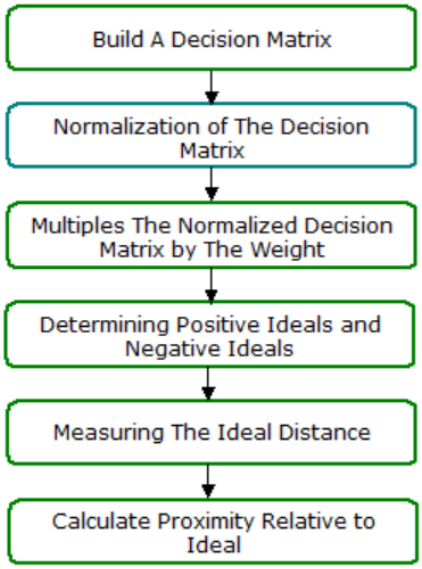

Figure 1. Topsis' steps in analyzing the implementation of ProKLim in Paser Regency

for climate village development as an effort to adapt and mitigate climate change in Paser Regency.

The steps for using the TOPSIS method in this study are as follows:

a. Determine the criteria, types and measurements of the best climate village location analysis that will be used as a reference for ProKlim development in Paser Regency. In this study, 14 (fourteen) locations were selected as alternative locations for reference climate villages and 6 (six) criteria as benchmarks for each alternative location to be selected. The alternative locations chosen are as follows:
   A1 = Damit Village
   A2 = Padang Pengrapat Village
   A3 = Klempang Sari Village
   A4 = Modang Village
   A5 = Petangis Village
   A6 = Padang Jaya Village
   A7 = Kertabumi Village
   A8 = Sebakung Makmur Village
   A9 = Sebakung Taka Village
   A10 = Kendarom Village

A11 = Village Muser
A12 = Laburan Village
A13 = Tajur Village
A14 = Sei Terik Village

While the criteria chosen for each alternative are:

C1 = Economic Benefits
C2 = Social Benefits
C3 = Environmental Benefits
C4 = Climate Change Adaptation Action
C5 = Climate Change Mitigation Action
C6 = Institutional Strengthening

The criteria, types and measurements in the analysis can be seen in table After determining the alternatives and criteria, then build a decision matrix where each criterion is given a weight. In this study, the criteria for social, economic and social benefits were given a weight of 20% each so that the total weight of these three criteria was 60%, while the remaining 40% was divided into the criteria for adaptation actions, mitigation actions and institutions based on the comparison points of the assessment of the three elements in the Climate Village Program (3: 3: 4) so that the weight of the criteria becomes C4 by 12%, C5 by 12% and C6 by 16%. Data collection based on secondary data derived from SRN Climate Change Control.

b. The next step is to normalize the data using the following formula:

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \quad (1)$$

Where $\mathbf{r_{ij}}$ is the normalized value for the i-th criterion and j-th alternative and the Xij value is the initial data value (raw data) I-th and J-th alternative criteria.

c. Multiply the normalized input data by the weights for each criterion that yields the values listed in table of weight normalization.

$$y_{ij} = w_i r_{ij}$$

with i=1,2,3, ... m and j=1,2,3, ... n

d. Determining Positif Ideals and Negatif Ideals.

The positive ideal solution (A+) is calculated based on :

$$A^+ = (y1^+, y2^+, y3^+, \dots , yn^+) \quad (2)$$

The negative ideal solution (A-) is calculated based on :

$$A^- = (y1^-, y2^-, y3^-, \dots , yn^-) \quad (3)$$

e. Measuring The Ideal Distance.

The distance (D_i or S_i) between the alternative Ai and the positive ideal solution is formulated as :

$$D_i^+ = \sqrt{\sum_{j=1}^{n} \left(y_{ij} - y_i^+\right)^2}, \text{ i=1,2,3, ... m} \quad (4)$$

The distance between the alternative Ai and the negative ideal solution is formulated as

$$D_i^- = \sqrt{\sum_{j=1}^{n} \left(y_{ij} - y_i^-\right)^2}, \text{ i=1,2,3, ... m} \quad (5)$$

f. Calculating proximaty relatife (V or C) to ideal.

$$V = \frac{Di^-}{Di^- + Di^+}, \text{ i=1,2,3, ... m} \quad (6)$$

Results and Discussion

The decision matrix built based on data collection can be seen in table 2.

The next step is a modified treatment of the decision matrix in Table 2. That is by subtracting the value of each alternative by the maximum value on the criterion. For example at C1 the maximum value is 100, so the modified value for C1 at A1 is 100-40 = 60; for C1 on A2 it is 100-100=0 and so on for all C values on each A so as to produce the values as in Table 3.

Result of normalize the data using the formula are listed in Table 3. For example, in column C2 and row A2 in table 4. (criterion 2 and alternative 2) are calculated using the equation:

$$R_{2.2} = 0 / (\sqrt{(50^2 + 0^2 + 25^2 + 75^2 + 50^2 + 25^2 + 50^2 + 25^2 + 50^2 + 0^2 + 0^2 + 0^2 + 0^2)}) = 0$$

Similarly for every other cell so as to produce a normalized (standardized) input table as follows: Once the input data has been normalized, the next step is to multiply the normalized input data (Table 4) by the weights for each criterion that yields the values listed in Table 5. In Table 5 also displays ideal and basalt rows which are also the next step in the TOPSIS method. The ideal value

Table 2. Decision Matrix for the Best Climate Village Location in Paser Regency

Alternative	C_1	C_2	C_3	C_4	C_5	C_6
A_1	40.00	50.00	50.00	52.67	40.40	45.83
A_2	100.00	100.00	100.00	77.20	53.56	95.00
A_3	60.00	75.00	75.00	70.00	51.56	87.75
A_4	50.00	25.00	100.00	68.57	41.28	66.75
A_5	40.00	50.00	100.00	58.03	44.00	45.55
A_6	80.00	75.00	100.00	69.50	51.48	93.63
A_7	60.00	50.00	100.00	45.30	49.12	90.75
A_8	60.00	75.00	75.00	39.30	54.24	76.35
A_9	60.00	50.00	50.00	40.43	53.48	80.20
A_{10}	100.00	100.00	100.00	79.10	71.04	99.13
A_{11}	100.00	100.00	100.00	90.33	77.24	97.18
A_{12}	80.00	100.00	100.00	73.83	63.60	67.88
A_{13}	100.00	100.00	100.00	87.67	64.08	94.38
A_{14}	100.00	100.00	100.00	90.90	77.92	93.13
Max Value	100	100	100	90,90	77,92	99,13

Table 3. Decision Matrix for the Best Climate Village Location in Paser Regency

Alternative	C1	C2	C3	C4	C5	C6
A_1	60.00	50.00	50.00	38.23	37.52	53.30
A_2	0.00	0.00	0.00	13.70	24.36	4.13
A_3	40.00	25.00	25.00	20.90	26.36	11.38
A_4	50.00	75.00	0.00	22.33	36.64	32.38
A_5	60.00	50.00	0.00	32.87	33.92	53.58
A_6	20.00	25.00	0.00	21.40	26.44	5.50
A_7	40.00	50.00	0.00	45.60	28.80	8.38
A_8	40.00	25.00	25.00	51.60	23.68	22.78
A_9	40.00	50.00	50.00	50.47	24.44	18.93
A_{10}	0.00	0.00	0.00	11.80	6.88	0.00
A_{11}	0.00	0.00	0.00	0.57	0.68	1.95
A_{12}	20.00	0.00	0.00	17.07	14.32	31.25
A_{13}	0.00	0.00	0.00	3.23	13.84	4.75
A_{14}	0.00	0.00	0.00	0.00	0.00	6.00

Table 4. Topsis Input Data Normalization of the Best Climate Village Location in Paser Regency

Alternative	C1	C2	C3	C4	C5	C6
A_1	0.4615	0.3780	0.6325	0.3512	0.4113	0.5643
A_2	0.0000	0.0000	0.0000	0.1258	0.2671	0.0437
A_3	0.3077	0.1890	0.3162	0.1920	0.2890	0.1204
A_4	0.3846	0.5669	0.0000	0.2051	0.4017	0.3428
A_5	0.4615	0.3780	0.0000	0.3019	0.3719	0.5672
A_6	0.1538	0.1890	0.0000	0.1966	0.2899	0.0582
A_7	0.3077	0.3780	0.0000	0.4188	0.3157	0.0887
A_8	0.3077	0.1890	0.3162	0.4739	0.2596	0.2411
A_9	0.3077	0.3780	0.6325	0.4635	0.2679	0.2004
A_{10}	0.0000	0.0000	0.0000	0.1084	0.0754	0.0000
A_{11}	0.0000	0.0000	0.0000	0.0052	0.0075	0.0206
A_{12}	0.1538	0.0000	0.0000	0.1568	0.1570	0.3308
A_{13}	0.0000	0.0000	0.0000	0.0297	0.1517	0.0503
A_{14}	0.0000	0.0000	0.0000	0.0000	0.0000	0.0635

is the maximum value of each criteria column. For example, in column C3 the highest value is 0.587 so it is the ideal value, and so on for other criteria columns. While the basal value is a negative ideal value which is the minimum value for each criterion. As in table 5. that the minimum value in C2 is 0.0169 and so on for each criterion in each column. The ideal and basal values will then be used to calculate the following steps from the TOPSIS method, namely measuring the positive ideal distance (Si+), negative ideal distance (Si-) and closs-ness (C*) along with alternative ranks or sequences. The Si+ value for alternative 1 (A1) is calculated based on the data in Table 6. with the ideal value as the base (subtractor). So that the value of D+ (Si+) on A1 is obtained at 0.040569 which is obtained based on calculations:

$$Si+(A1) = \sqrt{((0.0923-0.0923)^2+(0.0756-0.1134)^2+(0.1265-0.1265)^2+(0.0421-0.569)^2+(0.0494-0.0494)^2+(0.0903-0.0908)^2)}= 0.040569$$

Table 5. Topsis Input Data Normalization of the Best Climate Village Location in Paser Regency

Alternatif	C1	C2	C3	C4	C5	C6
Bobot	**0.2**	**0.2**	**0.2**	**0.12**	**0.12**	**0.16**
A_1	0.0923	0.0756	0.1265	0.0421	0.0494	0.0903
A_2	0.0000	0.0000	0.0000	0.0151	0.0320	0.0070
A_3	0.0615	0.0378	0.0632	0.0230	0.0347	0.0193
A_4	0.0769	0.1134	0.0000	0.0246	0.0482	0.0548
A_5	0.0923	0.0756	0.0000	0.0362	0.0446	0.0908
A_6	0.0308	0.0378	0.0000	0.0236	0.0348	0.0093
A_7	0.0615	0.0756	0.0000	0.0503	0.0379	0.0142
A_8	0.0615	0.0378	0.0632	0.0569	0.0312	0.0386
A_9	0.0615	0.0756	0.1265	0.0556	0.0322	0.0321
A_{10}	0.0000	0.0000	0.0000	0.0130	0.0091	0.0000
A_{11}	0.0000	0.0000	0.0000	0.0006	0.0009	0.0033
A_{12}	0.0308	0.0000	0.0000	0.0188	0.0188	0.0529
A_{13}	0.0000	0.0000	0.0000	0.0036	0.0182	0.0080
A_{14}	0.0000	0.0000	0.0000	0.0000	0.0000	0.0102
Ideal	**0.0923**	**0.1134**	**0.1265**	**0.0569**	**0.0494**	**0.0908**
Basal	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**

While the value of closness or closeness which is the ratio between Si+ and the total of Si+ and Si-. For example, the closeness value for alternative 2 is:

$$C_2^* = \frac{0{,}215494}{(0{,}215494+0{,}036109)} = 0{,}8565$$

In the same way it is calculated for Si+ and Si- values using MS. Excel for each alternative as presented in Table 6. The final calculation results used as assessment results with TOPSIS analysis are sorting from the highest to lowest values of the closing results. From the results of the analysis, it was found that the best location of the climate village in Paser Regency that can be recommended as a reference location for ProKlim development is the alternative A11 (Muser Village). Figure 2. shows the relationship between the location of climate villages with closeness values and the ranking order of climate villages that can be used as a reference in efforts to improve the ranking of main

Table 6. Penentukan Jarak Ideal, *Closeness* dan *Ranking* Alternatif

Lokasi	Si+	Si-	C*	Ranking
A_1	0.072223	0.017995	0.1995	14
A_2	0.014610	0.078610	0.8433	5
A_3	0.039973	0.047587	0.5435	8
A_4	0.067491	0.034799	0.3402	12
A_5	0.064856	0.034996	0.3505	11
A_6	0.027982	0.060191	0.6826	7
A_7	0.051073	0.043753	0.4614	10
A_8	0.046134	0.043157	0.4833	9
A_9	0.059786	0.029180	0.3280	13
A_{10}	0.006220	0.080989	0.9287	3
A_{11}	0.001007	0.082768	0.9880	1
A_{12}	0.023840	0.068963	0.7431	6
A_{13}	0.007791	0.080464	0.9117	4
A_{14}	0.003131	0.082288	0.9633	2

climate villages and other location development in carrying out climate change adaptation and mitigation actions through ProKlim in Paser Regency.

Muser Village was registered as a Climate Village in 2022 and successfully obtained Thropy Utama from the Ministry of Environment and Forestry. In addition to Muser Village, there are three other villages that also received appreciation as Main Climate Villages, namely Padang Pengrapat Village, Kendarom Village and Sei Terik Village. Muser Village is in accordance with the field conditions and the results of the analysis. Policies that need to be implemented in efforts to develop climate change adaptation and mitigation actions in Paser Regency are education and training, partnerships, socialization, comparative studies and regional regulations. The policies that have been implemented in Muser Village are in the form of education and training, partnership and socialization but have never conducted comparative studies to other regions and there is no Regional Regulation related to climate change adaptation and mitigation actions in Paser Regency. Although only three policies have been carried out, they have proven successful in carrying out climate change adaptation and mitigation actions efficiently and effectively. Community groups in Muser Village have received a lot of education

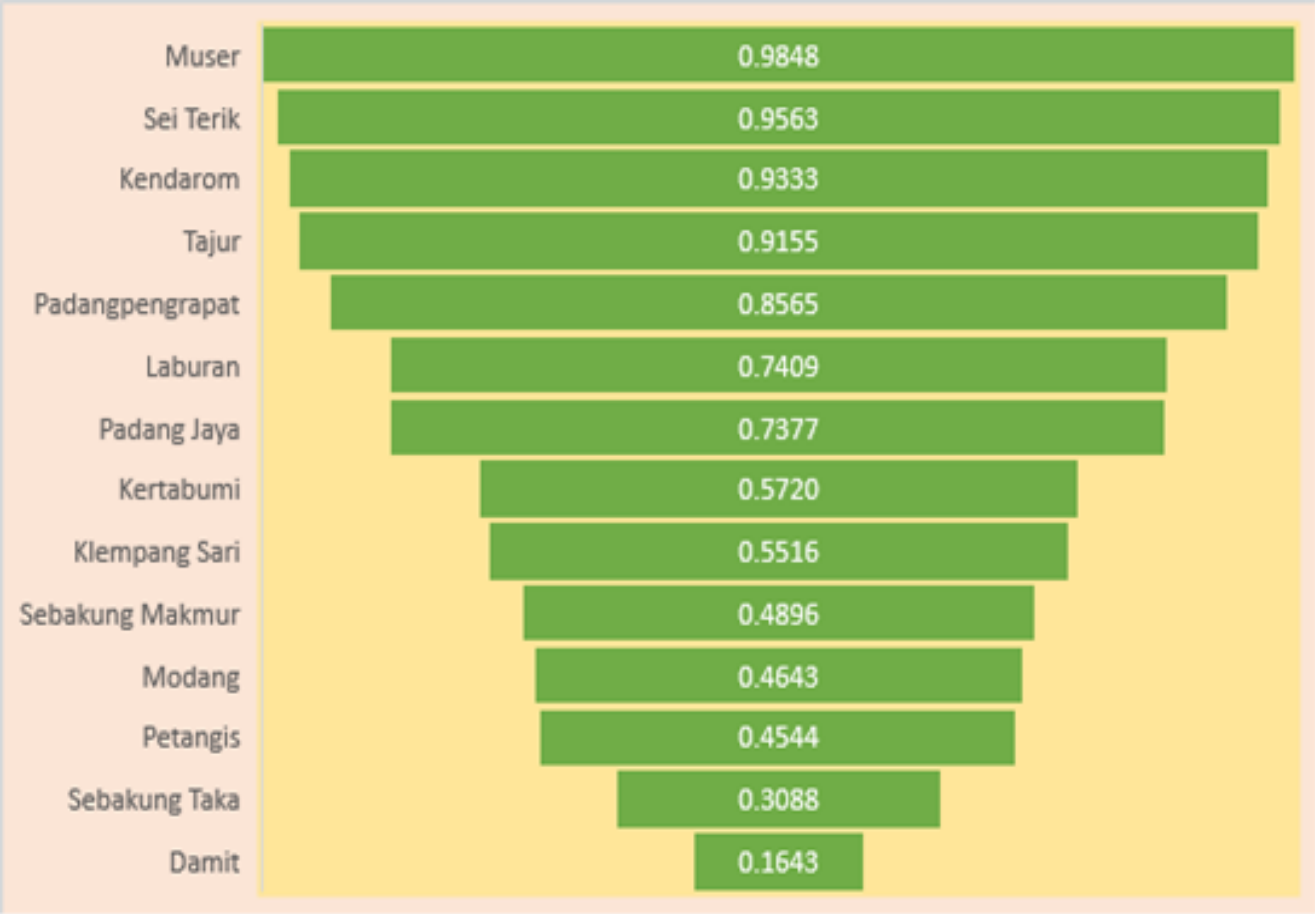

Figure 2. The relationship between the location of Climate Village and Closeness Value in Paser Regency

Figure 3. Education, Training and Mentoring Program through Partnership in Muser Village Climate Village (Source: PT Pama Persada)

and training through mentoring with coaching partners, in this case PT Pama Persada Nusantara. From Figure 3. It can be seen that the application of education and training to the community in groups and individuals has been proven to increase the success of climate change adaptation and mitigation actions in Muser Village, so that people who initially depended on forest resources in the form of wood slowly moved to other businesses that were more climate-friendly so that Muser Village could be used as a role model in Paser Regency in an effort to develop a Climate Village Program for other climate villages in an effort to raise the rank as the main climate village and for other locations in Paser Regency in carrying out climate change adaptation and mitigation actions through the Climate Village Program.

Conclusion

The choice of the best climate village location that can be used as a reference source so that all climate villages can obtain the main level in implementing the Climate Village Pro-

gram is Muser Village in Muara Samu District. Based on field conditions that the policy development of the Climate Village Program in Paser Regency shows that the best alternative that can be implemented is to conduct education and training for communities at the site level related to climate change adaptation and mitigation actions which can be followed by other policy options according to building partnerships with other parties; socialization of climate change control programs, conducting comparative studies and strengthening legal umbrellas in the form of regional regulations.

Sugestion

The suggestions that can be given amid limitations in the implementation of this research are as follows:

1. The need for the involvement of policy makers in efforts to control climate change in Paser Regency because the phenomenon of climate change has been felt to have a negative impact on the survival of humans and other living things.
2. External support in the form of a budget so that it can be maximized and implemented on target, as since 2023 the Paser Regency Government has received Forest Carbon Partnership Facility – Carbon Fund (FCPF-CF) grants from the World Bank starts with proper planning, effective and efficient implementation and accountable implementation supervision so that the goal of reducing carbon emissions as an effort to control climate change in Paser District can be achieved in accordance with the target.
3. There needs to be an integrated team authorized by the regional head regarding climate change control efforts consisting of all levels of society and professions as a forum for coordination in suppressing and reducing the impact of climate change in Paser Regency.
4. The need for further research related to the implementation of climate villages both in terms of technical and policy.

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