Eduvest - Journal of Universal Studies
Volume 5 Number 1, January, 2025
p- ISSN 2775-3735- e-ISSN 2775-3727

RESCUING LOCAL WISDOM IN AN ERA OF ANTHROPOGENIC CLIMATE CHANGE: A QUEST FOR ULTIMATE REALITY

Hani Hasanah[1], Teuku Fajar Shadiq[2]
Universitas Islam Syekh-Yusuf, Indonesia
Email: hanihasanah@unis.ac.id

ABSTRACT

This research aims to explore the role and relevance of local wisdom in facing the impacts of human-induced (anthropogenic) climate change. The main focus of this research is to identify how knowledge and practice of The local community can assist the community in adapting to the increasing environmental challenges. This research method uses a descriptive qualitative approach. Agriculture in Jayapura Regency is generally a plantation. Central Maluku is a plantation area which is generally a smallholder plantation. While in Manggarai Regency, dry land agriculture is common. Climate change projections in Jayapura Regency show a tendency to shift. While in Yapen Regency, Kaimana Regency, Maluku Regency, Maybrat Regency, West Halmahera Regency and Central Maluku Regency do not show any significant changes compared to baseline conditions. And in Kabupaten Manggarai there is the potential for climate change. Regional vulnerability was conducted at TEKAD target locations. In general, the level of village vulnerability is quite varied from non-vulnerable villages to vulnerable villages. Adaptation options in general that can be done include controlling drought, floods, landslides, improving farming and increasing food security, building and managing food granaries, strengthening community capacity, handling sea level rise, sea water abrasion and high waves.

KEYWORDS *Climate Change; Risk; Adaptation; Economy; Agriculture*

INTRODUCTION

One of the five priority targets of the National Medium-Term Development Plan (RPJMN) 2020-2024, as stipulated in Presidential Regulation No. 18 of 2020, is economic transformation. The Ministry of Villages, Development of Disadvantaged Regions, and Transmigration, in collaboration with the International Fund for Agricultural Development (IFAD), launched the Integrated Village Economic Transformation Program (TEKAD) for the 2020-2025 period. This program is designed based on the experience of the National Community Empowerment Program (PNPM) and the Independent Village Development Program (PPDM), which were previously integrated with the Village Law. TEKAD

How to cite: Hani Hasanah, et al (2025). Rescuing Local Wisdom in an Era of Anthropogenic Climate Change: A Quest for Ultimate Reality. Journal Eduvest. *5*(1): 1215-1232
E-ISSN: 2775-3727

aims to accelerate economic development in underdeveloped villages, particularly in Eastern Indonesia, by focusing on enhancing village communities' capacity to utilize local resources to drive economic growth (Perpres No. 18/2020).

Climate change poses a serious challenge to economic development, particularly in the agricultural sector. Climate change, driven by human activities such as greenhouse gas (GHG) emissions, has resulted in global warming and extreme weather pattern shifts. Its impacts include droughts, floods, and rising sea levels, threatening food production and agricultural systems. Agriculture, being the most vulnerable sector, faces risks of declining productivity and rising production costs due to climate change (Mirjalili, 2019; Lvova et al., 2022).

ndonesia, as an archipelagic country with more than 17,000 islands, is highly susceptible to the impacts of climate change, such as rising sea levels, floods, and droughts. These impacts threaten food security, rural livelihoods, and the fisheries and forestry sectors. Additionally, Indonesia is the world's third-largest GHG emitter, with 60% of its emissions coming from deforestation and forest degradation. Therefore, integrating climate-smart agricultural practices and enhancing disaster resilience are top priorities in addressing climate change (Rosenzweig et al., 2020; Springmann et al., 2018a).

The impacts of climate change are multidimensional, affecting resources, infrastructure, and agricultural production systems, as well as food security and farmers' welfare. Climate vulnerability is defined as conditions that reduce the ability of humans, crops, and livestock to adapt optimally. Meanwhile, the impacts of climate change include physical, social, and economic losses resulting from climate shifts. Indonesia ranks among the top three countries at the highest climate risk, with significant exposure to floods, extreme temperatures, and rising sea levels (Abass et al., 2022).

Climate change also affects people's incomes through reduced agricultural yields, decreased worker performance, and increased disaster risks. Extreme events such as floods and droughts have caused massive losses in the agricultural sector and triggered population displacement. Without effective adaptation, the number of people affected by floods is projected to increase significantly between 2035 and 2044. Additionally, rising sea levels could impact more than 4.2 million people by the end of this century, particularly in coastal areas (Myers et al., 2017; Wheeler & von Braun, 2013).

This study aims to analyze the impacts of climate change on the agricultural sector, focusing on risk and vulnerability assessments. Climate change and climate variability, such as temperature changes, rainfall pattern shifts, and increased frequency of extreme events (El Niño and La Niña), are the key factors influencing the agricultural sector. Adaptation to climate change requires planning and investment in infrastructure and new technologies to mitigate risks and enhance the resilience of the agricultural sector to climate change impacts (Vermeulen, Campbell, & Ingram, 2012; Bathiany et al., 2018).

RESEARCH METHOD

This study employs a descriptive qualitative method with a focus on vulnerability, hazard, and risk analysis. The research process begins with the development of a theoretical framework, identification of variables, preparation of instruments, data collection, and sample planning. Data is gathered through surveys and interviews, then analyzed to achieve the research objectives. The data analysis consists of three main components: vulnerability, hazard, and risk, designed to assess the impact of climate change on the agricultural sector and the resilience of adaptation strategies. A verification approach is used to formulate adaptation strategies based on evidence obtained from the theoretical framework and field data.

The research sample consists of 175 farmers and market intermediaries selected from target locations across various regencies. Primary data collection is conducted through surveys, with each regency represented by 15 respondents. The collected data is then analyzed to understand the impact of climate change on the agricultural sector, including the vulnerabilities, hazards, and risks involved. The results of this analysis are expected to serve as a foundation for formulating effective adaptation strategies in response to climate change.

RESULT AND DISCUSSION

The latest assessment report of the Intergovernmental Panel on Climate Change (IPCC) reaffirms the fact that climate change poses tremendous challenges to various social and economic sectors on a global scale (Intergovernmental Panel on Climate Change (IPCC), 2023). In its Global Risks Report 2020, the World Economic Forum, listed climate-related issues among the top five long-term risks for the first time (WEF, 2020). In addition to affecting average annual temperature and precipitation, climate change also increases the frequency of regional extreme weather events such as droughts, heat waves, heavy rains and floods (Intergovernmental Panel on Climate Change (IPCC), 2023; Lüttger & Feike, 2018; Mann et al., 2018; Westra et al., 2014). In this context, agriculture is often seen as one of the most vulnerable sectors to such changes (IPCC, 2007), negatively impacting, for example, on crop yields (Haqiqi et al., 2021; Lesk et al., 2016; Schlenker & Roberts, 2009), total factor productivity e.g. (Chambers & Pieralli, 2020; Stetter & Sauer, 2021), and ultimately on farm income and viability (e.g. (Dalhaus et al., 2020; Kawasaki & Uchida, 2016). Prime examples of years with extreme weather conditions are the 2003 European heatwave , the 2018 European drought and heatwave, or the 2010-2013 southern United States and Mexico drought. Nonetheless, agriculture is also considered one of the most important anthropogenic contributors to climate change (Lynch, 2022). Overall, farmers need effective adaptation and mitigation strategies to face the challenges of climate change.

The pattern of the rural economy needs to be synchronized with the Village Potential data, which includes data on agricultural land, labor, and economic facilities, namely markets and stalls. However, describing the Potential Village data requires a fairly large level of analysis due to the large number of villages. Therefore, it is necessary to simulate several types of villages that can describe rural economic clusters in Indonesia. One of the important indicators in the rural economy is the size of agricultural land, agricultural production, and livelihoods.

The types of superior agriculture in the research area essentially provide the same picture: food crops, horticulture to plantations, which are shown in the following data:

Table 1. Aggregate Commodity Types and Land Area in the Study Area

Commodity Type	Land Area (Ha)	Production (Ton)
Food Crops:		
Rice		4.00
Horticultural Crops:		
Pepper	28,000 +	-
Chili	105	212,9
Mango		2 435,40
Corn	109 + 3.238	631 + 11.469
Durian		1.022,5
Plantation Crops:		
Coconut	3,348.62 + 1,259.00 + 900.00 ++ 20.905,83 + 31.571 + 3,23	1,869.90 + 217,971 + 1,001 + 2.986,85 + 19.540,20 + 35 430 + 0,58
Cocoa	9,462.94 + 1,391.00 + 78.55 + 18 + 8152.71 + 3.021 + 3,29	2,288.37 + 779.00 + 650 + 1.361 + 0,62
Pinang	640.91 + 0.63	0.00 + 0,07
Coffee	0,02 + 309.00 + 20.00 + 541,40 + 30 + 7,51	511.35 + 7,227.00 + 240,29 + 6 + 2,55 +
Cloves	28.00+32.00+ 18.746,47 + 3,65	0.00 + 9.634,10 + 0,41

Sago	4,402.00 + 175,80	335.12 + 122,23
Vanilla	248.61 + 28.00	0.00 + 32,186 +
Nutmeg	8008 + 11.941,50	2.463,40
Cashew	6,58	1,63

Source: Various sources processed

Regional Climate Vulnerability and Risk

1. *Threat Analysis of Each District/City*
    a. Flood

Between 2009 and 2019, Papua Province experienced an increase in flood events, totaling 68 occurrences. These floods caused damage to educational, health, and religious facilities and reduced the adaptive capacity of the agricultural sector. However, the two research villages, Ayapo and Aib in Jayapura Regency, were not recorded as having experienced flooding during this period. InaRisk data indicates that the flood threat level in Jayapura Regency is in the moderate-high range (0.3-0.7), but no floods occurred in these villages. This suggests that the impact of climate change on the agricultural sector in this area is not significant.

In West Papua Province, 30 flood events were recorded between 1999 and 2019, primarily disrupting the livelihoods of residents. However, Kaimana Village in Kaimana Regency did not experience flooding during this period. Although InaRisk data shows that the flood threat level in Kaimana Regency falls within the moderate-high range (0.3-0.7), the impact of climate change on the agricultural sector in this village was not significant. Similarly, in Maybrat Regency, no flooding was recorded in Kampung Men and Kampung Kartapura, meaning the impact on the agricultural sector was also negligible.

Maluku Province recorded 158 disaster events in the past 10 years, with flooding being the most dominant disaster (62 occurrences). Flooding has tended to increase year by year, significantly affecting residents' livelihoods. In Central Maluku Regency, flooding was recorded once in 2021 in Kobi Murti Village. InaRisk data indicates that the flood threat level in this area falls within the moderate-high range (0.3-0.7), with fluctuating frequency. This suggests that climate change has had a tangible impact on the agricultural sector, particularly in flood-prone areas.

In North Maluku Province, 59 flood events were recorded between 2009 and 2019. Localized flooding occurred once in 2022 in Peot, Dere, and Golo Villages in West Halmahera Regency. Although 17 other villages were not recorded as experiencing floods, the fluctuating nature of flood events means that the impact of climate change on the agricultural sector should be closely monitored. InaRisk data indicates that the flood threat level in West Halmahera Regency is within the moderate-high range (0.3-0.7), with a high frequency of occurrences.

East Nusa Tenggara (NTT) Province recorded 145 flood events between 2009 and 2019, resulting in casualties and infrastructure damage. Localized flooding was recorded once in 2021 in Pongmurung Village, Manggarai Regency. InaRisk data indicates that the flood threat level in this area falls within the moderate-high range (0.3-0.7), with fluctuating frequency. These flood events demonstrate that climate change has had a tangible impact on the agricultural sector and should be considered a dominant disaster risk.

b. *Drought*

In Papua Province, drought was recorded only once in 2013. Although it did not cause physical damage to agricultural land, it increased the sector's vulnerability. However, two research villages, Ayapo and Aib in Jayapura Regency, did not experience drought during this period. InaRisk data indicates that the drought threat level in Jayapura Regency ranges from moderate to high (0.3-0.7), but no drought was recorded in these villages. This suggests that the impact of climate change on agriculture due to drought threats is not significant in this area.

In West Papua Province, drought was recorded only once in 2015 in Kaimana Village, Kaimana Regency. Although InaRisk data shows that the drought threat level in Maybrat Regency falls within the moderate-high range (0.3-0.7), its impact on agriculture in the research villages was negligible. The frequency of drought events in this area is low, making the overall impact of climate change on the agricultural sector insignificant.

In Maluku Province, drought was recorded once in 2021 in Kobi Murti Village, Central Maluku Regency. InaRisk data shows that the drought threat level in this area is within the moderate-high range (0.3-0.7), with a low to moderate frequency of occurrence. Although these drought events are short-term, their impact on agriculture requires attention. In North Maluku Province, localized drought occurred once in 2022 in Peot and Dere Villages, West Halmahera Regency. The frequency of drought events in this area is also low, making the impact on agriculture insignificant.

In East Nusa Tenggara (NTT) Province, drought occurred 56 times between 2009 and 2019, leading to reduced agricultural production and lower community welfare. In Manggarai Regency, localized drought occurred 20 times between 1996 and 2022 in Pongmurung Village. InaRisk data indicates that the drought threat level in this area is in the moderate-high range (0.3-0.7), with a high frequency of occurrences. This suggests that climate change has had a significant impact on agriculture due to drought threats, making it a serious concern.

2. Vulnerability Analysis

Vulnerability is the tendency of a system to experience negative impacts that include sensitivity to negative impacts and lack of adaptive capacity to overcome negative impacts. In this study, vulnerability is measured at the village level and in accordance with the area that cannot be generalized to all villages in the Regency in the Province of the study area. A village's resilience to climate change impacts is determined by its level of vulnerability. As an important indicator of the climate response capacity of natural and built systems (Burton et al. 2002), CCV is usually assessed based on three fundamental parameters-exposure, sensitivity, and adaptive capacity (Glick et al. 2011; Field et al. 2014).

The level of village vulnerability is linearly correlated to the level of resilience. Villages that are highly vulnerable have a very low level of resilience. Therefore, if a highly vulnerable village is exposed to climate change, the impacts caused by climate change will be very large compared to villages that are not vulnerable. Therefore, the effort to reduce the impact of climate change is to reduce the level of vulnerability of the village. The level of vulnerability of a village will be determined by its environmental, social and economic conditions.

To measure the level of vulnerability of an area, a vulnerability index is used, which is defined as a measure that describes 'the degree or extent to which a system is susceptible or unable to cope with the adverse impacts of climate change, including climate variability and climate extremes". Villages with a high level of vulnerability will have a low ability to cope with the impacts of climate change, or in other words, a low level of resilience.

The village vulnerability index is based on three determinants of vulnerability: exposure, sensitivity, and adaptive capacity. Exposure indicates the degree, duration and or chance of a system coming into contact with a shock or disturbance (Adger, 2006; Gallopín, 2006). Sensitivity is the internal condition of the system that indicates its degree of vulnerability to disturbance, which is strongly influenced by human and environmental conditions, such as population density, economic structure, ecosystem structure and function, and others. Adaptive capacity indicates the ability of the system to adjust to climate change (including climate variability and climate extremes) and anticipate potential hazards, manage impacts or cope with their effects (Intergovernmental Panel on Climate Change (IPCC), 2023).

The Exposure and Sensitivity Indicator (IKS) and Adaptive Capacity Indicator (IKA) as a reference used to present the Vulnerability Level in the research area consist of two indicators, namely the Exposure and Sensitivity Level (IKS) and the Adaptive Capacity Indicator (IKA), as listed in the following table:

Table 2. the value of village vulnerability

Weight	Indicator	Code	Data Source
Indicator of Exposure and Sensitivity (IKS)			
0.15	Riverbank settlements	KS1	Podes 2021
0.20	Source of Water for Drinking Population	KS2	Podes 2021
0.20	Population Density	KS3	Profile Village and Village Profile (PRODESKEL) 2022, BPS 2022
0.25	Poverty (poor families)	KS4	Podes 2021
0.20	Agricultural area	KS5	Profile Village and Village (PRODESKEL) 2022
Adaptive Ability Indicator (IKA)			
0.25	Education facilities	KA1	Podes 2021
0.20	Health facilities	KA2	Podes 2021
0.05	Families using PLN electricity	KA3	Podes 2021
0.30	People's Livelihoods	KA4	Podes 2021
0.20	Road infrastructure	KA5	Podes 2021

Source: Data Processing Results

The following table and figure show the value of village vulnerability in each research area based on the IKS and IKA vulnerability indicators analyzed based on secondary data processing according to the vulnerability scale: 1. very low (not vulnerable), 2. low (somewhat vulnerable), 3. medium (moderately vulnerable), 4. high (vulnerable), 5. very high (highly vulnerable).

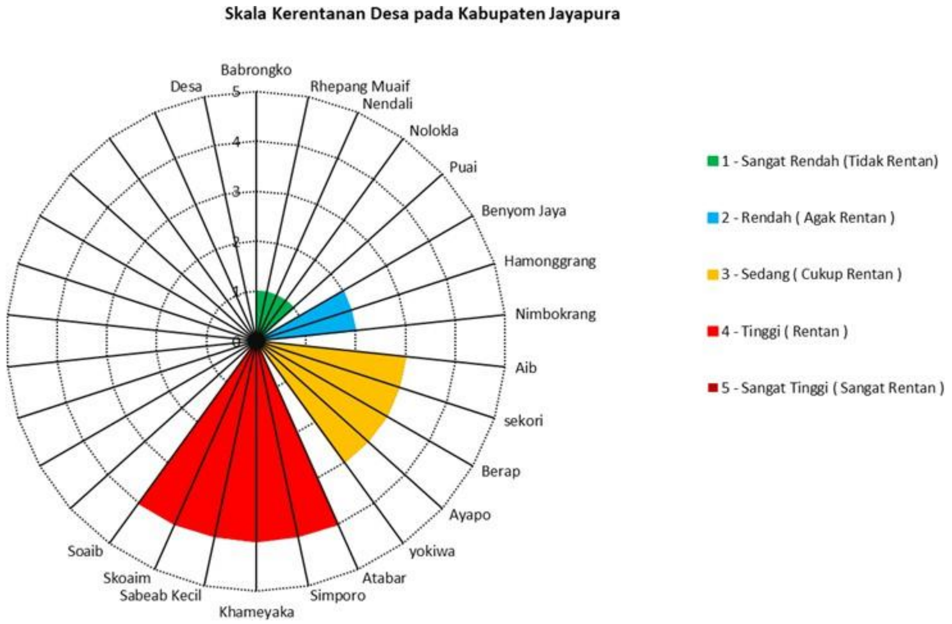

Figure 1. Village vulnerability scale in Jayapura District

Climate Influence on the Agricultural Sector in the Jayapura Regency Research Area In the agricultural sector, climate influence is an important factor that affects the sustainability of production levels. From the historical climate analysis in the Jayapura Regency area, rainfall data for 42 years in the period 1980 - 2021 was recorded at three BMKG observation stations (Staklim Jayapura, Stamet Sentani and Stamet DOK Jayapura), the total annual rainfall in Jayapura ranged from 1,000 mm to 3,200 mm per year.

With the monsoonal rainfall pattern, there are several types of crops that grow as superior commodities in the Jayapura Regency area spread across 19 village areas, dominated by non-rice crops, namely corn, sago, areca nut, coconut, peanut, cocoa and vegetable crops. There is only one rice farming area as a superior commodity in Hammongrang village, with a low vulnerability value. While in other areas with non-rice crops with high vulnerability values are in Atabar village (pottery), Kaeykha village (Cocoa), Soaib village (sago, areca nut, coconut), small Sabeyab village (corn, mustard, spinach), Skoaim village (sago, old coconut, young coconut).

Yapen Islands Regency

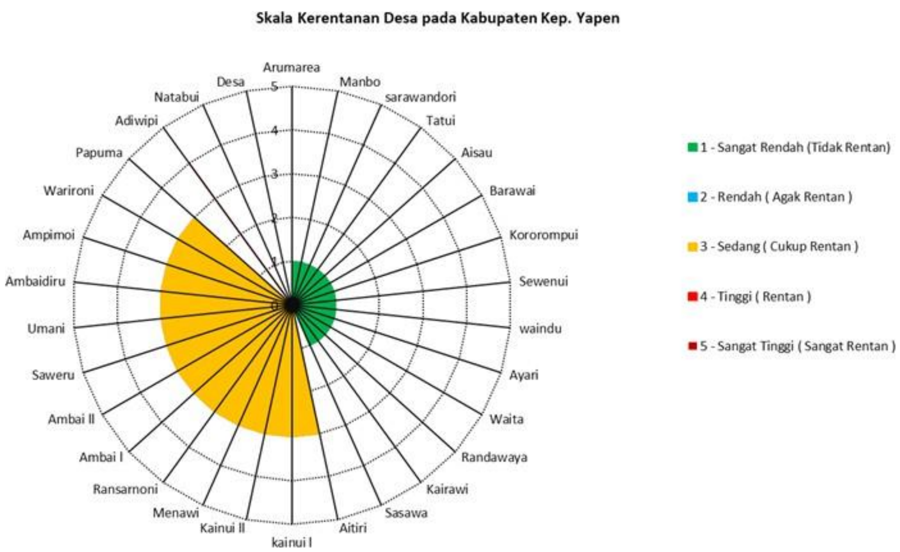

Figure 2. Village vulnerability scale in Yapen Islands Regency

Based on rainfall data for 21 years in the period 2001 - 2021, the total annual rainfall in the Yapen Islands Regency ranges from 900 mm to 4,100 mm per year. Based on rainfall data for 21 years in the period 2001 - 2021, the total annual rainfall in the Yapen Islands Regency ranges from 900 mm to 4,100 mm per year. The monthly rainfall distribution is classified as quite high, with the minimum monthly rainfall ranging from 187 mm per month in May while the maximum monthly rainfall reaches 268 mm per month in March. Throughout the year, rainfall in the Yapen Islands region always ranges from 200 mm or more. The rainfall pattern in the Yapen Islands Regency includes an equatorial type where based on the tendency graph has two rain peaks (bimodal form) in a year, namely in March (268 mm) and September (242 mm). The average monthly air temperature in Yapen Islands Regency ranges from 26.7^oC - 27.5^oC. The range of average air temperature is very small, which is below 1^oC

With the equatorial rainfall pattern, there are several types of plants that grow as superior commodities in the Yapen Islands Regency area spread across 32 village areas, dominated by non-rice crops of vegetable crops (Menawai village, Ransarnoni, Kainui I, Kainui II, coffee (ambaidiru village, natabui), cocoa (waindu village, barawai, sewenui, kororompui), and banana (aisau village). Some other areas have agriculture (randawaya, ayari, warironi) as their main commodity, with vulnerability values varying from low to medium.

Kaimana Regency

In the agricultural sector, climate influence is an important factor that affects the sustainability of production levels. Based on rainfall data for 8 years during the 2014-2021 period at Stamet Utarom Kaimana Regency, the total annual rainfall in Kaimana Regency ranges from 600 mm to 2,800 mm per year. The monthly rainfall distribution is classified as quite high with the minimum monthly rainfall ranging from 104 mm per month in August while the maximum monthly rainfall reaches 278 mm per month in April. The rainfall pattern in Kaimana Regency is of the equatorial type with a tendency to have two rain peaks (bimodial form) in a year, namely in April (278 mm) and November (205 mm). The monthly average air temperature in Kaimana Regency ranges from 26ºC - 28.65ºC. The range of monthly average air temperature is quite high at 2.65ºC.

With the equatorial rainfall pattern, there are several types of crops that grow as superior commodities in the Kaimana Regency area spread across 12 village areas, dominated by non-rice crops from coconut plantations (Adijaya village), nutmeg plantations (Kambala, Tanusan, Kufuryai, Lumira, Seraran, Sumun, Bahumia, Wamesa, Kooy, Edor villages) with vulnerability values varying from very low values (2 villages) to high values (5 villages).

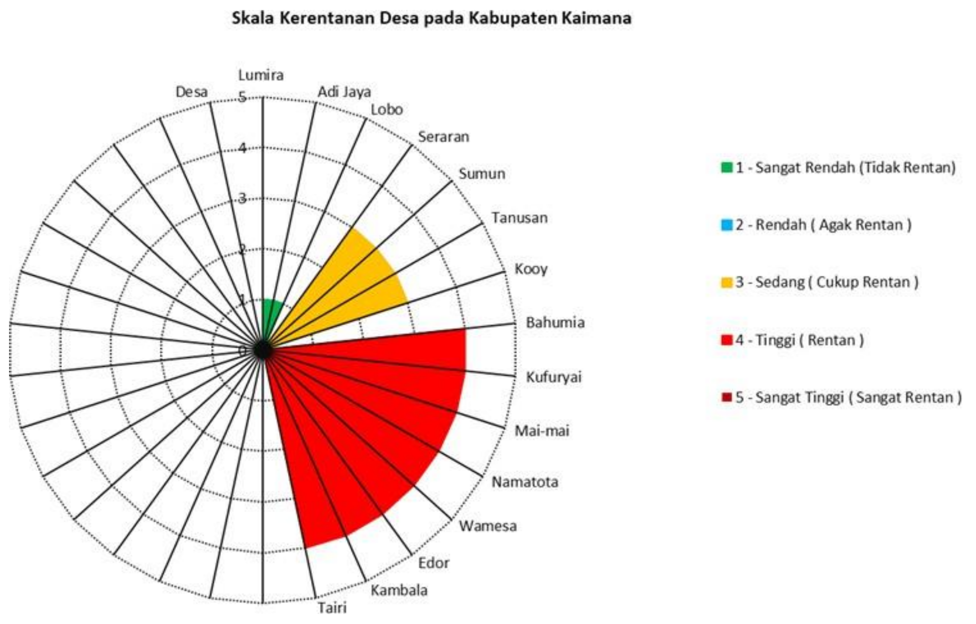

Figure 3. Village vulnerability scale in Kaimana Regency

Maybrat Regency

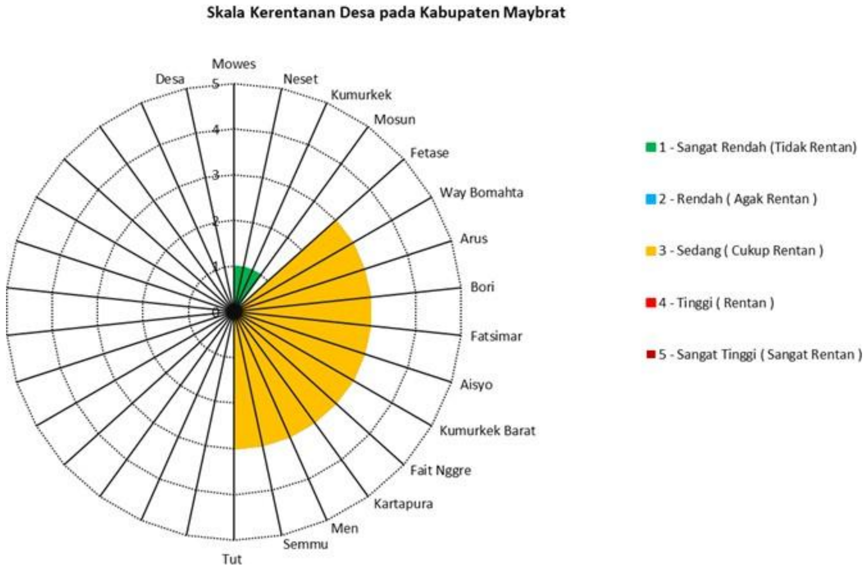

Figure 4. Village vulnerability scale in Maybrat District

In the agricultural sector, the influence of climate is an important factor that affects the sustainability of production levels. Maybrat Regency has relatively high to high rainfall throughout the year with one rain peak in the middle of the year between June and August. The maximum monthly rainfall occurred in July 2007 at 921 mm. Rainfall in Maybrat Regency has a local rainfall pattern where there is one rain peak. This local rainfall pattern is influenced by topographic conditions and sea surface temperatures around the region.

The average air temperature in Maybrat Regency is 25.72ºC. The average air temperature during the peak of the rainy season in June amounted to 25.34ºC. In time series, the highest average air temperature occurred in November 2003 which amounted to 27.11ºC while the lowest average air temperature occurred in August 2008 which amounted to 23.93ºC.

With the equatorial rainfall pattern, there are several types of plants that grow as superior commodities in the Maybrat Regency area spread across 16 village areas, dominated by non-rice crops of taro plants (neset village), chili (mowes village), groundnuts (waybomatah, fatase), and taro (semmu), field rice (kumurkek), bori, fatsimar, aisyo, kumurkek barat, fait nggre, kartapura, men, tut, mosun, with vulnerability values varying from very low (7 villages) to high (9 villages).

Central Maluku Regency

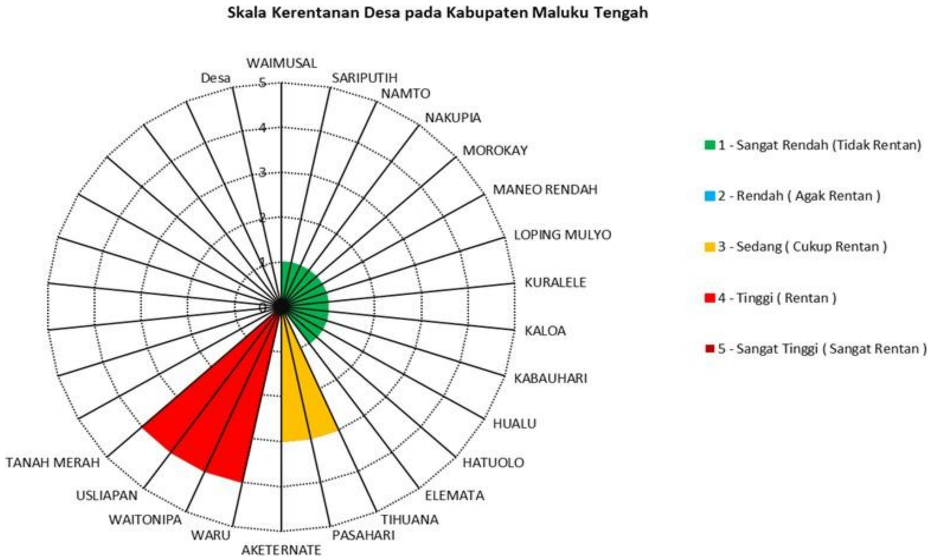

Figure 5. Village vulnerability scale in Central Maluku district

In the agricultural sector, the influence of climate is an important factor that affects the sustainability of production levels. Central Maluku Regency has moderately high to high rainfall throughout the year. Months with high rainfall occur in May-August while months with fairly low rainfall occur in September-April. Based on historical climate data from Staklim Maluku, the highest rainfall during the period 1982-2021 occurred in June 1989, which was 1532 mm. The local rainfall pattern in the Central Maluku Regency is characterized by one peak of rainfall. This local rainfall pattern is influenced by local topography.

The average air temperature in Central Maluku Regency is around 26.31ºC. During the peak of the rainy season in June, the average air temperature is 25.57ºC. Time series analysis of air temperature data for 40 years in the period 1982-2021 shows the highest average air temperature occurred in December 2015 and December 2019 at 28.2ºC. The lowest average air temperature occurred in August 1982 at 23.16ºC.

With this equatorial rainfall pattern, there are several types of plants that grow as superior commodities in the Central Maluku Regency area spread across 20 village areas, dominated by rice plants (loping mulyo village, namto, sariputih, waimusal, waitonipa, morokai) while non-rice plants consist of Coconut (kuralele village, usliapan, negeri waru, nakupia), horticulture (tanah merah village), Banana, sweet potato, Dragon Fruit (huaulu village), banana (negeri maneo rendah village), Patatas (negeri pasahari village), sago, diruang, damar, langsa (hatuolo village), resin (kaloa village), sago (kabauhari village), aketernate village, tihuana. The level of vulnerability varies from low (13 villages), medium (3 villages) to high (4 villages).

West Halmahera Regency

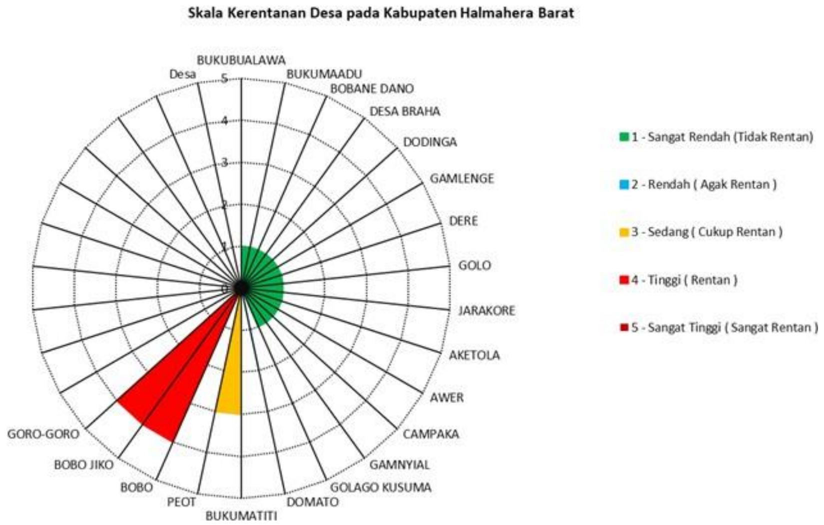

Figure 6. Scale of village vulnerability scores of West Halmahera District

West Halmahera Regency is a hilly and coastal area. In the agricultural sector, the influence of climate is an important factor affecting the sustainability of production levels. West Halmahera Regency has high rainfall throughout the year. The maximum monthly rainfall for the 1980-2021 period occurred in December 2016 at 455.5 mm. The equatorial rainfall pattern in West Halmahera Regency is characterized by two peaks of rainfall that occur in May and December. The average air temperature is around 26.39ºC. During the peak of the rainy season in May and December, the average air temperature is 26.79ºC and 26.52ºC. Time series analysis of air temperature data for 42 years in the period 1980-2021 shows that the highest average air temperature occurred in May 2002 and March 2004 at 27.52ºC. The lowest average air temperature occurred in February 1987 at 25.51ºC.

With this equatorial rainfall pattern, there are several types of plants that grow as superior commodities in the West Halmahera Regency area spread across 20 village areas, dominated by non-rice crops, namely coconut (awer village, gamnyial, aketola, dere), coconut, nutmeg, cloves (peot village, goro-goro, braha, dodinga, gamlenge, domato, bobane dano), coconut, nutmeg (campaka village), pepper, tomato, chili (golago kusuma village), groundnut, sweet corn, peanut, chili, durian (bukumatiti village), eggplant, long bean, cucumber, chili, water spinach, spinach (bobojiko village), cassava, peanut, mung bean, durian (bukumaadu village), sweet corn cassava, water spinach, spinach, mung bean (bobo village). The level of vulnerability varies from low (15 villages), medium (2 villages) to high (3 villages).

Under these conditions, it can be said that floods and landslides in the region are the biggest threat every year to the agricultural sector. Although the occurrence of disasters due to earthquakes also contributes to the loss of life and physical and agricultural damage, their occurrence is difficult to predict.

Manggarai Regency

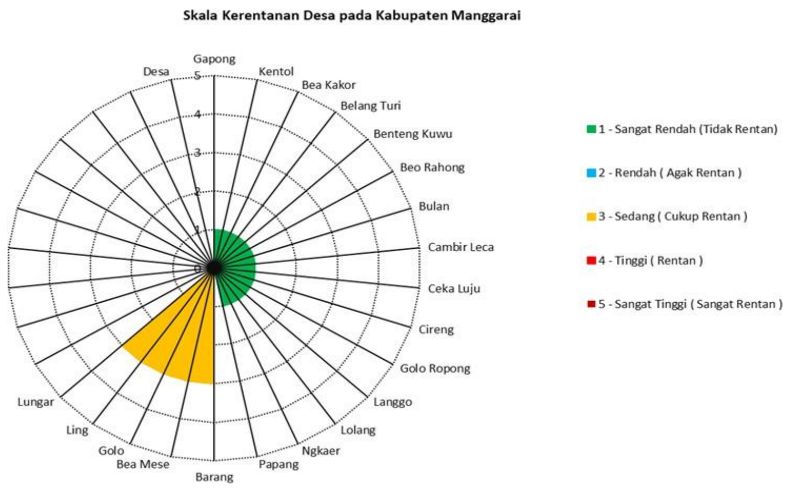

Figure 7. Scale of village vulnerability in Kabupaten Manggarai.

Kabupaten Manggarai, in terms of its topography, is a highland area dominated by undulating land surface, with 85.4% of the area still having a land slope of >15%. In the agricultural sector, the influence of climate is an important factor affecting the sustainability of production levels. The rainfall pattern of Kabupaten Manggarai is clearly monsoonal, with high rainfall at the beginning and end of the year and dry months in the middle of the year. The highest rainfall in the baseline and projection conditions occurs at the beginning of the year in January and February with a baseline range between 374 - 476 mm while the projection is between 348 - 422 mm. Meanwhile, rainfall began to decrease dramatically in May in both conditions. The dry season in both conditions has the same time span from May to October with rainfall values below 100 mm. The highest air temperature in the region also occurs in the same month, November with a temperature range in the baseline condition with a range between 22.7ºC - 26.9ºC, while the lowest air temperature in Manggarai is July with a range in the baseline between 20.7ºC - 25.1ºC.

With the monsoonal rainfall pattern, there are several types of plants that grow as superior commodities in the Manggari Regency area spread across 19 village areas, dominated by rice plants (ngkaer village, lolang, papang, belang turi, bulan, cambir leca, golo ropong). While non-rice crops are coffee (gapong village, bea kakor), nira, coffee (lungar village), candlenut (golo village, barang, cabal, kentol), cloves (benteng kuwu village), areca nut (wesa village/ ling village), corn (cireng village), peanuts (beo rahong village). combination of rice and non-rice, namely paddy rice, banana, candlenut, coconut (cekaluju village).

What needs to be watched out for from these historical events is the planting pattern of rice and secondary crops in the wet months (BB). Based on future rainfall projections, Kabupaten Manggarai has the potential to experience changes in climate type based on the Oldeman climate classification including seasonal shifts. Wet month shifts occur in the future where the wet month is one month later, starting in December. The number of wet months in the projection is 4 months (December - March). Based on Oldeman's climate classification, areas with Climate type D3 can only be planted with rice once or secondary crops once a year. Such planting depends on the availability of irrigation water. In the dry months no planting is done due to very low rainfall or dry season.

CONCLUSION

The climate change research presents a summary of agricultural conditions, climate projections, vulnerability levels, and adaptation options. Adaptation refers to measures taken to address the impacts of climate change, including various recommendations to mitigate future challenges. Different regions have distinct agricultural characteristics, such as cocoa, coconut, and sago plantations in Jayapura Regency, dryland farming in Yapen Islands and Maybrat, and horticulture as a key sector in Central Maluku and West Halmahera. Meanwhile, Manggarai focuses more on food crops like maize.

Climate projections indicate shifts in rainfall patterns that affect agricultural systems. Jayapura Regency is expected to experience a climate transition from type A1 to B1, which is more suitable for rice and food crops with proper planning. Some regions, such as Yapen Islands, Kaimana, and Maybrat, are predicted to remain in the A1 climate type, characterized by high rainfall throughout the year. On the other hand, West Halmahera will experience a shift in the wet season, while Manggarai is expected to transition from climate type C3 to D3, leading to fewer wet months and increased drought risk.

The level of vulnerability to climate change varies depending on exposure, sensitivity, and adaptive capacity. Jayapura Regency has villages with different vulnerability levels, ranging from highly vulnerable to not vulnerable. Other regions, including Yapen Islands, Kaimana, and Central Maluku, also exhibit varying degrees of vulnerability. To mitigate the impacts of climate change, various adaptation strategies are needed, such as drought, flood, and landslide control, strengthening food security, enhancing community capacity, and addressing rising sea levels and coastal erosion.

REFERENCES

Abass, K., Dumedah, G., Frempong, F., Muntaka, A. S., Appiah, D. O., Garsonu, E. K., & Gyasi, R.M. (2022). Rising incidence and risks of floods in urban Ghana: Is climate change to blame? Cities,121, 103495. https://doi.org/https://doi.org/10.1016/j.cities.2021.103495

Chambers, R. G., & Pieralli, S. (2020). The Sources of Measured US Agricultural Productivity Growth: Weather, Technological Change, and Adaptation. American Journal of Agricultural Economics, 102(4), 1198-1226. https://doi.org/10.1002/ajae.12090

Dalhaus, T., Schlenker, W., Blanke, M. M., Bravin, E., & Finger, R. (2020). The Effects of Extreme Weather on Apple Quality. Scientific Reports, 10(1). https://doi.org/10.1038/s41598- 020-64806-7

Haqiqi, I., Grogan, D. S., Hertel, T. W., & Schlenker, W. (2021). Quantifying the impacts of compound extremes on agriculture. Hydrology and Earth System Sciences, 25(2), 551-564. https://doi.org/10.5194/hess-25-551-2021

Intergovernmental Panel on Climate Change (IPCC). (2023). Climate Change 2021 - The Physical Science Basis. In Climate Change 2021 - The Physical Science Basis. Cambridge University Press. https://doi.org/10.1017/9781009157896

Kawasaki, K., & Uchida, S. (2016). Quality Matters More Than Quantity: Asymmetric Temperature Effects on Crop Yield and Quality Grade. American Journal of Agricultural Economics, 98(4), 1195-1209. https://doi.org/10.1093/ajae/aaw036

Lesk, C., Rowhani, P., & Ramankutty, N. (2016). Influence of extreme weather disasters on global crop production. Nature,529(7584), 84–87. https://doi.org/10.1038/nature16467

Lüttger, A. B., & Feike, T. (2018). Development of heat and drought related extreme weather events and their effect on winter wheat yields in Germany. Theoretical and Applied Climatology, 132(1-2), 15-29. https://doi.org/10.1007/s00704-017-2076-y

Lvova, I., Kozmuliak, K., & Strutynska-Struk, L. (2022). Reducing Climate Impacts On Water Resources As The Legal And Economic Basis For Environmental Security In The Eu Candidate Countries: The Case Of Ukraine. 8(3), 101-114.

Lynch, J. (2022). Between Habit and Thought in New TV Serial Drama. www.routledge.com

Mann, M. E., Rahmstorf, S., Kornhuber, K., Steinman, B. A., Miller, S. K., & Petri, S. (2018). C L I M A T O L O G Y Projected changes in persistent extreme summer weather events: The role of quasi-resonant amplification. https://www.science.org

Mirjalili, S. H. (2019). Climate Change and Crop Yields in Iran and Other OIC Countries. 11(1), 99-110.

Stetter, C., & Sauer, J. (2021). Give to AgEcon Search Help ensure our sustainability. Exploring the heterogeneous effects of weather on productivity using generalized random forests.

Water Resources As The Legal And Economic Basis For Environmental Security In The eu Candidate Countries: The Case of Ukraine. 8(3), 101-114.

Westra, S., Fowler, H. J., Evans, J. P., Alexander, L. V., Berg, P., Johnson, F., Kendon, E. J., Lenderink, G., & Roberts, N. M. (2014). Future changes to the intensity and frequency of short-duration extreme rainfall. In Reviews of Geophysics (Vol. 52, Issue 3, pp. 522- 555). Blackwell Publishing Ltd. https://doi.org/10.1002/2014RG000464