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Economic Vulnerability in South Sumatra Province with A Sustainable Food Security Index Assessment Approach

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ABSTRACT

Climate change will impact food security, thereby affecting rural economic vulnerability. South Sumatra's food security level is categorized as moderately resilient to highly resilient; however, climate change is not included in the resilience assessment. Therefore, it is estimated that food security in South Sumatra will be sustainably affected by the impacts of climate change. The research approach to solving this problem consists of data review, regression analysis, assessment of the sustainable food security index, and spatial analysis. The results show that climate change has a very low correlation with the measured food security index in South Sumatra, indicating that food security in South Sumatra is not based on climate change principles. Food security in South Sumatra tends to increase from 2018 to 2023. The sustainable food security index in villages in the food security index area categorized as somewhat vulnerable and somewhat resilient tends to have sustainability values categorized as unsustainable-low sustainable), while villages with a resilient food security index have an average sustainability value categorized as moderate-very high. This situation reflects an economic vulnerability in South Sumatra that is currently categorized as somewhat vulnerable to resilient yet remains susceptible to shifting toward either a better for areas with a high sustainability or worse category for areas with low sustainability - low sustainability.

Keywords: Food Security; Climate Change; Sustainability; South Sumatra; Rural Economy

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INTRODUCTION

The rural economy is heavily influenced by agriculture, which can contribute to improving food security (García-Díez et al., 2021). Food insecurity directly impacts rural economic vulnerability. Vulnerability indicates that future community well-being may decline owing to shocks and indicates rural economic vulnerability (Kalogiannidis et al., 2023). All aspects of food security, including food availability, access to food, food supply stability, and food utilization, are affected by climate change (Schmidhuber & Tubiello, 2007; Schneider & Asch, 2020). Good food security is an indicator of rural community well-being (Woodhill et al., 2022).

Climate change will impact food security because food production is highly sensitive to weather (Diallo et al., 2020; Gomez-Zavaglia et al., 2020; Muluneh, 2021). Climate variables that influence food security include air temperature and rainfall (Ceesay & Ben Omar Ndiaye, 2022; Kocur-Bera & Czyża, 2023; Schmidhuber & Tubiello, 2007). Disruptions to food production will impact income growth and distribution, as well as the demand for agricultural products (Schmidhuber & Tubiello, 2007). Climate change mitigation and adaptation practices can help improve food security (Smith et al., 2020).

The Food and Agriculture Organization (FAO) defines food security as a situation in which all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life (Schmidhuber & Tubiello, 2007). Food security can be measured through nutritional fulfillment and waste production because there is a correlation with food vulnerability (Bodirsky et al., 2020; Bofa & Zewotir, 2024; Christian et al., 2020; Y. Wang et al., 2021). The number of rural populations in developing countries affected by food vulnerability can reach 80% due to vulnerability to climate hazards (Ahmadi Dehrashid et al., 2021; Fahad & Wang, 2020). The existence of vulnerable populations and rapid population growth will lead to a decline in food security, resulting in an increase in malnutrition rates (Molotoks et al., 2021; Ngcamu, 2023; Schilling et al., 2020). Nearly 70% of people living in rural areas depend on the agricultural sector (Fahad & Wang, 2020). The food security of communities dependent on agricultural income will be highly vulnerable to the impacts of climate change (Muluneh, 2021). Poverty rates increase food insecurity, leading to reduced financial access and increased vulnerability (Diallo et al., 2020; Gupta et al., 2021; X. Wang & He, 2020).

Climate change has affected South Sumatra Province, and it is estimated that climate change will be unevenly distributed across regions (Sugiarto, 2023). South Sumatra has 2,029,165 farmers (22.96% of the total population), of which 54.57% are poor (BPS Provinsi Sumatera Selatan, 2025). The food security level in South Sumatra ranges from moderately resilient to highly resilient (Badan Pangan Nasional, 2024). Sustainable food security and rural economic vulnerability are related in a development economics perspective that includes the theory of agricultural shocks, poverty traps, and rural poverty dynamics. Carter & Barrett (2006) explain that farmer households with limited productive assets, capital, and access to financing sources are at risk of experiencing poverty traps, because low asset ownership limits their ability to invest and increase productivity. Furthermore, Barrett (2005) emphasized that the dynamics of rural poverty are greatly influenced by the vulnerability of households to various economic and agricultural shocks that can lead to a decrease in income and loss of productive assets. This condition is even more complex when smallholders face climate change that has the potential to reduce production yields, reduce incomes, and increase the risk of poverty (Barrett et al., 2016) . In relation to food security, these economic conditions affect the ability of households to maintain food production, access food through purchasing power, and maintain consumption stability when there is a decrease in income or an increase in food prices. The sustainable food security index can be understood not only as a measure of a region's success in maintaining food availability, accessibility, and sustainability, but also as an indicator related to the socio-economic capacity of rural communities in dealing with economic risks and pressures. Thus, the higher the vulnerability of rural economies, the greater the potential for disruption to the achievement of sustainable food security (Barrett, 2005; Barrett et al., 2016; Carter & Barrett, 2006).

However, the sustainable food security index in South Sumatra is expected to be affected by the impacts of climate change due to the significant interplay between climate change and food security. Addressing this issue requires sustainable economic development. The sustainable food security index must consider the concepts of sustainability and food security (Garcia et al., 2020; Kalogiannidis et al., 2023; Vågsholm et al., 2020).

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Therefore, research is needed to assess sustainable rural food security in the face of climate change impacts in South Sumatra Province as an indicator of rural economic vulnerability.

METHODS

This study uses a problem-solving approach, including climate and food security data studies, regression analysis, sustainability index assessment, and spatial analysis. Food security data for each village in South Sumatra were assessed using the National Food Security Index from the National Food Agency, categorized as very vulnerable to very resilient (Badan Pangan Nasional, 2024). The study focused on villages whose income came from the agricultural sector and was analyzed and processed using data from the South Sumatra Village Potential Statistics. Food security data were assessed for 2018, 2021, and 2023. The 2018 data was the initial year for the food security data, and the 2023 data was the most recent for the study area in South Sumatra. The study results were used to analyze changes in food security in South Sumatra over the years. Changes in the food security index were classified into seven typologies. The climate variables studied included data on average air temperature (Tavg), maximum (Tmax), and minimum (Tmin), and rainfall (R) in each village in South Sumatra from NASA Power for the last 50 years or from the initial year of data availability, which were then analyzed for change trends (Sugiarto, 2023; Sugiarto et al., 2024). Climate data is accessed in a single point and represented in a spatial map according to the coordinates of each area.

Correlation analysis tool between food security and climate change using excel (Rohima, Liliana, et al., 2020; Rohima, Riswan, et al., 2020). The sustainability index relates to climate change mitigation and adaptation, including water availability facilities, including irrigation (Ir), drainage (D), and rivers/reservoirs/lakes (RRL) (Ahmadi Dehrashid et al., 2021; Gomez-Zavaglia et al., 2020; Kocur-Bera & Czyża, 2023; Muluneh, 2021; Schilling et al., 2020). Variables are differentiated based on the function of the facility; therefore, the sustainability index is calculated using Equation (1):

$$Sustainability\ index\ =\ Ir + D + RRL \quad \ldots\ldots(1)$$

The Ir, D, and RRL values are based on variable value weighting with 1 = facility present and 0 = absent. The values of Ir, D, and RRL are given the same weight because they have the same function in supporting climate change mitigation and adaptation efforts. Weighting the value of the facility is 1 or 0 assuming that the value of 1 of the condition of the facility is functioning properly. The average of the village sustainability index analysis results was used to determine the sub-district sustainability index. The calculated sustainability index was grouped into six typologies. Sustainable food security index evaluation was conducted using an overlay analysis between the food security index and the sustainability index, resulting in sustainable food security index categories based on typological classification. The sustainable food security index mapping is divided into typological classifications (Rohima, Liliana, et al., 2020; Rohima, Riswan, et al., 2020). The sustainable food security index classification was derived from an overlay analysis of the sustainability index and the food security index, which were divided into 36 categories. Equation (2) was used to weight the sustainable food security index:

$$Sustainable\ food\ security\ index\ =\ food\ security\ index\ +\ (0.1\ \times\ sustainability\ index) \quad \ldots\ldots(2)$$

O.1 is used to convert the value of the sustainability index into a food security index with a value of 0.0 unsustainable – 0.3 sustainable high. The results of the typological classification are presented spatially in the form of a food security sustainability map of South Sumatra. Spatial analysis was conducted using ArcGIZ to present spatial data with regional categories based on the typological classification results. The steps began by loading the base map of South Sumatra, joining the sustainable food security index data table and the base map, and classifying typology. Rural economic vulnerability was evaluated based on sustainable food security index values because the sustainable food security index influences economic vulnerability (García-Díez et al., 2021).

RESULTS

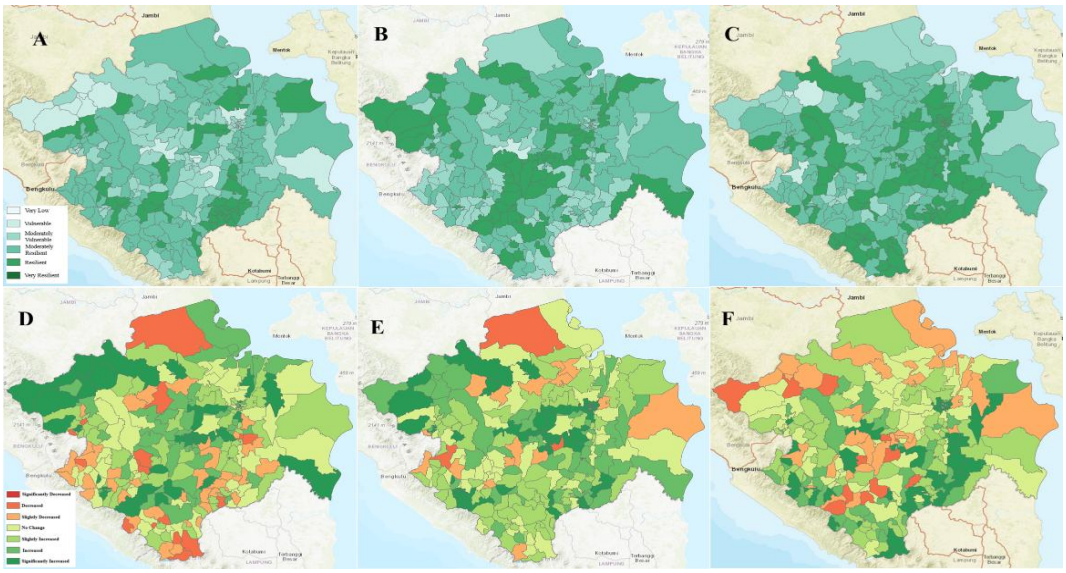
Food Security in South Sumatra

The average food security in South Sumatra (2018 – 2023) shows a somewhat resilient category, with six sub-districts categorized as vulnerable, 55 as somewhat vulnerable, 110 as somewhat resilient, and 70 as resilient. Food security in South Sumatra, as reviewed based on data from 2018, 2021, and 2023, continues to improve

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(Figure 1A, B, and C). This is evident in the continued decline in the number of sub-districts with vulnerable food security, while the number of sub-districts with resilient food security more than doubled in 2023 compared to 2018.

Overall, the change in the food security index in South Sumatra increased by an average of 9.23%, with a range of an average increase of 11.30% and an average decrease of -2.08% (Figures 1D, E, and F). This data confirms that the food security index in South Sumatra continues to experience significant improvement. The average food security index in 10.3 sub-districts categorized as severely declining has decreased from 16 to 3, and an average food security index increase in 47.7 sub-districts, from 39 (2018-2021) to 56 (2018-2023).

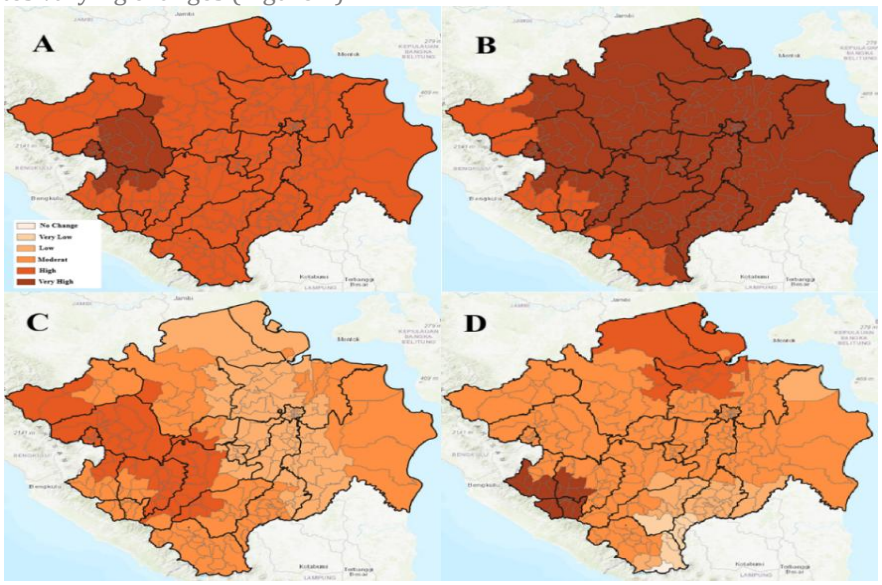


Source: Author, 2026

Figure 1. Food Security in South Sumatra (2018 (A), 2021 (B), 2023 (C)) and changes in food security levels (2018-2021 (D), 2021-2023 (E), and 2018-2023 (F)

Climate in South Sumatra

A review of climate conditions in South Sumatra from 1981 to 2025, including the Tavg, Tmin, Tmax, and R variables, indicates varying changes (Figure 2).



Source: Author, 2026

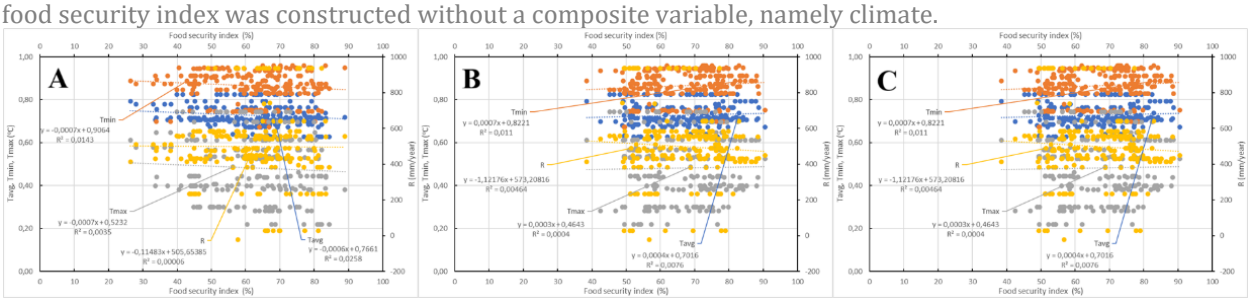
Figure 2. Climate change in South Sumatra 1981-2025, Tavg (A), Tmin (B), Tmax (C), and R (D)

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The average Tavg change is 0.73 °C (0.63 °C – 0.83 °C), which is categorized as high – very high with an average change categorized as high. The average Tmin change is 0.87 °C (0.67 °C – 0.96 °C), which is categorized as high – very high with an average change categorized as very high. The average Tmax is 0.48 °C (0.22 °C – 0.74 °C), which is categorized as very low – high with an average change categorized as moderate. A review of the R variable shows very varied changes compared with Tavg, Tmin, and Tmax. The average R change is categorized as moderate, ranging from 498.52 (-21.56 mm (very low) – 935.54 mm (very high)).

Correlation between Climate Change and Food Security

The correlations between the food security indices for 2018, 2021, and 2023 in South Sumatra and climate change (Tavg, Tmin, Tmax, and R) did not indicate a strong relationship (Figure 3). This is evident from the correlation analysis, which showed values ranging from 0.0001 to 0.065. These values are categorized as having very low correlations (Krisnayanti et al., 2020). This low correlation is likely due to the fact that the existing food security index was constructed without a composite variable, namely climate.

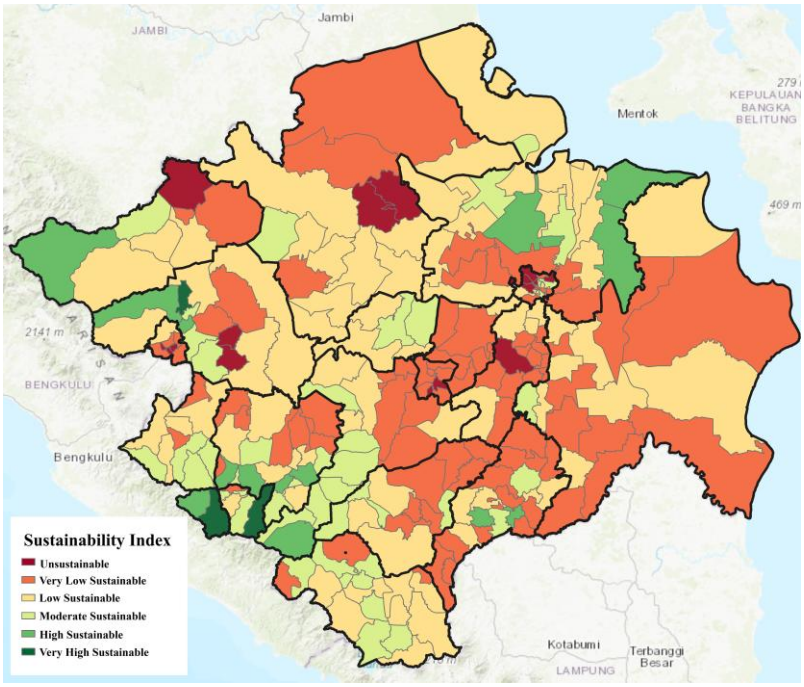


Source: Author, 2026

Figure 3. Correlation between climate change and food security in South Sumatra, 2018 (A), 2021 (B), and 2023 (C)

Sustainability Index

The assessment of the sustainability index of villages in South Sumatra shows that the average level of sustainability is very low, which may indicate that the villages in South Sumatra have uncertain food security because of the very low sustainability value (Figure 4).



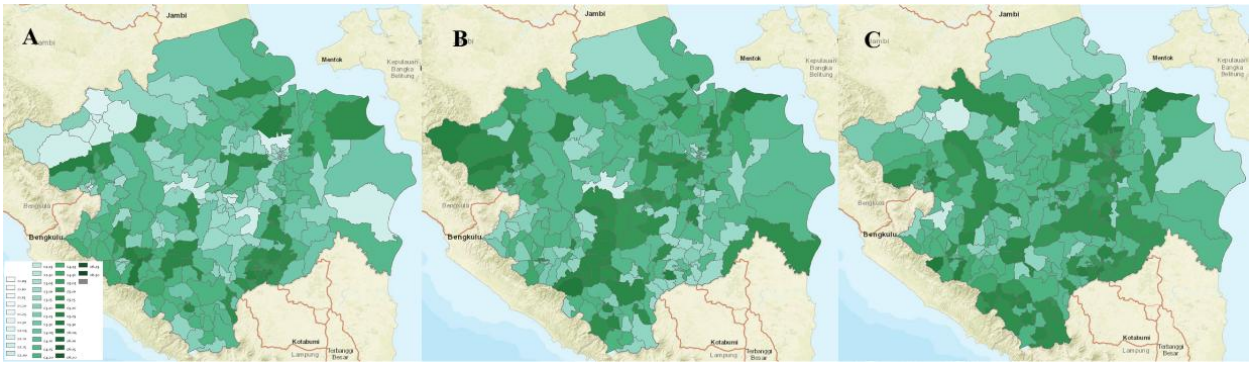
Source: Author, 2026

Figure 4. Sustainability index in South Sumatra

This condition is very concerning because only villages in three subdistricts are categorized as very sustainable, and villages in 15 subdistricts are categorized as unsustainable, the remaining 88 subdistricts are very sustainable, 77 subdistricts are low sustainable, 44 subdistricts are medium sustainable, and 14 subdistricts are highly sustainable.

Evaluation of Sustainable Food Security Index

Overall, the sustainable food security index in South Sumatra averaged 1 sub-district categorized as vulnerable and unsustainable, 1.7 as vulnerable and very low sustainable, 2.7 as vulnerable and low sustainable, 0.3 as vulnerable and highly sustainable, 1.7 as vulnerable and very high sustainable, 2.7 as somewhat vulnerable and unsustainable, 21.7 as somewhat vulnerable and very low sustainable, 16.3 as somewhat vulnerable and low sustainable, 9.7 as somewhat vulnerable and moderately sustainable, 2.7 as somewhat vulnerable and high sustainable, 1.3 as somewhat vulnerable and very high sustainable, 4.3 as somewhat resilient and unsustainable, 40 as somewhat resilient and very low sustainable, 39 as somewhat resilient and low sustainable, 19 as somewhat resilient and moderately sustainable, 5 as somewhat resilient and highly sustainable, 3.7 as somewhat resilient and very high sustainable, 3 as resilient and unsustainable, 24.3 as resistant and very low sustainable, 19.3 as resistant and low sustainable, 15.3 as resilient and moderately sustainable, 5.7 as resilient and highly sustainable, 0.3 as resilient and very low sustainable. High, and 0.3 for very resilient and very low for sustainable food.



Source: Author, 2026

Figure 5. Sustainable food security index in South Sumatra, 2018 (A), 2021 (B), and 2023 (C)

The sustainable food security index in South Sumatra shows an average of somewhat resilient, but the sustainable food security index shows an average of very low for sustainable food (Figure 5). The sustainable food security index assessment shows that villages in the food security index areas categorized as somewhat vulnerable and somewhat resilient tend to have sustainability scores categorized as unsustainable (low sustainability), while villages with a resilient food security index have an average sustainability score categorized as moderate (high sustainability).

Evaluation of Rural Economic Vulnerability in South Sumatra

The assessment of the sustainability index of villages in South Sumatra shows that the average level of sustainability is very low, which may indicate that the villages in South Sumatra have uncertain food security due to the very low sustainability value. This condition is very concerning because only villages in three subdistricts are categorized as very sustainable, and villages in 15 subdistricts are categorized as unsustainable, the remaining 88 subdistricts are very sustainable, 77 subdistricts are low sustainable, 44 subdistricts are medium sustainable, and 14 subdistricts are highly sustainable (Table 1).

Table 1. The level of vulnerability of rural economy in South Sumatra based on sustainable food security index categories

No.	Sustainable food security index category	2018	2021	2023	Average
1	Very Low and Unsustainable	0	0	0	0.0
2	Very Low and Sustainable Very Low	0	0	0	0.0
3	Very Low and Sustainable Low	0	0	0	0.0
4	Very Low and Sustainable Medium	0	0	0	0.0

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No.	Sustainable food security index category	2018	2021	2023	Average
5	Very Low and Sustainable High	0	0	0	0.0
6	Very Low and Sustainable Very High	0	0	0	0.0
7	Vulnerable and Unsustainable	3	0	0	1.0
8	Vulnerable and Sustainable Very Low	4	0	1	1.7
9	Vulnerable and Sustainable Low	6	1	1	2.7
10	Vulnerable and Sustainable Medium	0	0	0	0.0
11	Vulnerable and Sustainable High	1	0	0	0.3
12	Vulnerable and Sustainable Very High	4	1	0	1.7
13	Moderately Vulnerable and Unsustainable	6	1	1	2.7
14	Moderately Vulnerable and Sustainable Very Low	32	28	5	21.7
15	Moderately Vulnerable and Sustainable Low	17	20	12	16.3
16	Moderately Vulnerable and Sustainable Medium	12	12	5	9.7
17	Moderately Vulnerable and Sustainable High	0	4	4	2.7
18	Moderately Vulnerable and Sustainable Very High	0	4	0	1.3
19	Moderately Resilient and Unsustainable	2	6	5	4.3
20	Moderately Resilient and Sustainable Very Low	41	35	44	40.0
21	Moderately Resilient and Sustainable Low	40	36	41	39.0
22	Moderately Resilient and Sustainable Medium	22	17	18	19.0
23	Moderately Resilient and Sustainable High	7	5	3	5.0
24	Moderately Resilient and Sustainable Very High	2	2	7	3.7
25	Resilient and Unsustainable	0	4	5	3.0
26	Resilient and Very Low Sustainability	11	25	37	24.3
27	Resilient and Low Sustainability	14	20	24	19.3
28	Resilient and Moderate Sustainability	10	15	21	15.3
29	Resilient and High Sustainability	6	5	6	5.7
30	Resilient and Very High Sustainability	1	0	0	0.3
31	Very Resilient and Unsustainable	0	0	0	0.0
32	Very Resilient and Very Low Sustainability	0	0	1	0.3
33	Very Resilient and Low Sustainability	0	0	0	0.0
34	Very Resilient and Moderate Sustainability	0	0	0	0.0
35	Very Resilient and High Sustainability	0	0	0	0.0
36	Very Resilient and Very High Sustainability	0	0	0	0.0

Source: Author, 2026

DISCUSSION

Food security in South Sumatra was categorized as low to high. Existing food security indices have a very low correlation with climate change because food security is calculated using a composite variable that excludes climate. However, a literature review indicated that all aspects of food security, including food availability, access to food, food supply stability, and food utilization are affected by climate change (Schmidhuber & Tubiello, 2007; Schneider & Asch, 2020).

The variables used to measure food security in South Sumatra include the ratio of normative consumption to net production, percent of poverty, percent of food expenditure, percent without electricity, percent without clean water, length of schooling of women, ratio of health workers, life expectancy, and percent of stunting (Badan Pangan Nasional, 2024). The correlation between climate change and with a low food security index due to climate aspects is not used in calculating the vulnerability index. Sustainability perspective, food security is not only oriented towards meeting current food needs, but also considers economic, social, and environmental aspects, such as wise management of natural resources, ecosystem conservation, equitable access to food, and strengthening community capacity in dealing with climate change. Emphasized that sustainable food security is made to ensure food security and nutrition for current and future generations (El Bilali et al., 2019) . In line with that, Clapp et al. (2022) sustainability as an important dimension that reflects the sustainability of the ecological and social foundations of the food system in the long term.

The village sustainability index in South Sumatra has a very low average sustainability level, indicating that South Sumatran villages have uncertain food security because of their very low sustainability scores. This situation is due to the fact that most villages in South Sumatra lack or lack facilities for climate change mitigation and adaptation, such as water availability, including irrigation, drainage, and

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rivers/reservoirs/lakes (Ahmadi Dehrashid et al., 2021; Gomez-Zavaglia et al., 2020; Kocur-Bera & Czyża, 2023; Muluneh, 2021; Schilling et al., 2020). To improve the sustainable food security index through this approach, it is necessary to build water storage, excess water disposal (drainage), and water distribution facilities (irrigation).

Assessments of the food security index reveal that villages categorized as somewhat vulnerable and somewhat resilient tend to have sustainability scores categorized as unsustainable to low sustainability. While villages with resilient food security index generally have sustainability scores categorized as moderate to very high. This situation can be used to assess rural economic vulnerability in South Sumatra. Special attention is paid to sub-district villages in Keluang, Nibung, and East Lubuk Linggau 1, which have the highest economic vulnerability in South Sumatra due to their vulnerable and unsustainable food security index values. Good food security is an indicator of village community well-being (Woodhill et al., 2022).

CONCLUSION AND IMPLICATIONS

Based on the research results of this study that climate change has a very low correlation with the food security index in South Sumatra that has been measured. this indicates that food security in South Sumatra is not built on the principles of climate change. Food security in South Sumatra tends to experience an upward trend in resilience. The sustainable food security index of villages in the food security index area that are categorized as somewhat vulnerable and somewhat resilient tends to have sustainability values categorized as unsustainable–low sustainability). but for villages with resilient food security index on average have sustainability values categorized as medium–very high. The results of this study can provide further details regarding food security categories, particularly in South Sumatra, using a sustainable approach. To strengthen these findings, supporting data on village-level economic conditions are needed, and these should be compared with estimates of regional economic vulnerability.

Some suggestions to resolve this problem include sub-district villages in Keluang. Nibung. and Lubuk Linggau Timur 1. Districts that have the highest economic vulnerability in South Sumatra because they have vulnerable and unsustainable the sustainable food security index values. So, it needs to be a government priority to increase sustainable food security index in these villages which is expected to increase the economic resilience of the village. Further research is needed to add a composite index in determining food security in an effort to build good food security in an effort to face the impact of the climate crisis currently being faced. Efforts to improve the food security sustainability index using a climate change impact approach can be enhanced by building climate change adaptation facilities such as water storage facilities. excess water disposal. and water distribution. Increasing the number of climate-smart water management infrastructure can be directed structural allocations in the village budget (APBDes) or regional strategic planning (RPRD).

DECLARATIONS

Ethics approval: Statement This study does not require ethical approval as it does not involve human participants, animals, or sensitive data.

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Investigation: Siti Rohima, Anna Yulianita, Muhammad Teguh
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Supervision: Siti Rohima
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