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Effect of disaster events on regional food security spatially: A geographically weighted regression model

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A B S T R A C T

Natural disasters are one of the events that threaten food security in every region in Indonesia. Ciamis District is one of Indonesia's areas prone to natural disasters. One of the impacts of a disaster is on the agricultural sector because it will determine food security in the area and can affect the socio-economic community. This study aims to analyze the Geographically Weighted Regression (GWR) Model of the Effect of Disaster Events on Food Security. This study used quantitative methods, and data sources were obtained through secondary data searches. Data were processed using a Geographically Weighted Regression (GWR) analysis tool through a quantitative descriptive analysis approach. The results showed that the natural disasters directly or indirectly impacted food availability and security in Ciamis District. Natural disasters still occur even though food availability, affordability, and utilization are quite good. There are other factors, namely disasters, that come suddenly and cannot be predicted, thereby affecting the food security of a region. Efforts are needed to create togetherness in society to anticipate and respond to disaster events. In addition, it is expected that each individual can take the necessary actions to solve problems independently.

1. Introduction

The condition of a country or region's food security is an essential issue in agricultural development. Since food security is multi-faceted, comprehensive measures, including indicators, are needed to assess the food security situation (Wineman, 2016). These indicators are combined to produce a composite value of food security, which is then used as the Food Security Index (Ike & Kelly, 2017). Food is the most basic human need, so food security is one of the main priorities of every country (World Health Organization, 2023). Therefore, accurate and comprehensive food security can be used to prevent and overcome food and nutrition security. However, there were always some significant problems, such as a large population with a high growth rate, which caused a constant increase in the need for food in large quantities (Godfray et al., 2010). Additionally, competition for land and water continues to increase, affecting our ability to produce food. Meanwhile, food is still hard to come by in many areas due to famine or natural disasters. According to (Klomp & Hoogezand, 2018), natural disasters that occur and are sustained can cause a food security crisis and result in suboptimal production of agricultural products. Moreover, natural disasters can impact a country's socio-economic sustainability (Kalfin et al., 2020 & Kalfin et al., 2021).

Research related to natural disasters and food security has attracted researchers. For example, a study conducted by (Umar et al., 2017) considers the concept of food products that adapt to natural disasters. Determining the best food supply chain requires logistics, coordination, supply, and management knowledge. The concept can help food supply security against

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natural disasters. Guo et al. (2019) analyzed the food security strategies against natural disasters in Chinese highlands. The results showed that in recent years eight provinces in China, namely Sichuan, Heilongjiang, Henan, Hebei, Shandong, Hunan, Anhui, and Jiangsu, experienced a decrease in grain production during natural disasters. Therefore, improving China's food security and developing existing disaster prevention and mitigation policies are necessary.

Moreover, food security in each country is experiencing significant disruptions with the current state of the COVID-19 pandemic, which is supported by his study (Wang et al., 2010), which determined the size of the food supply during the COVID-19 outbreak in China. Following the epidemic situation in China, the local government will need basic food. The COVID-19 outbreak in China has significantly impacted food availability, making it necessary to predict changes in food demand and better understand consumer preferences during emergencies. The transportation system is limited, so upstream and downstream distribution activities are also disrupted. This condition is consistent with research from (Pereira and Oliveira, 2020) that the COVID-19 pandemic affects food and food insecurity in all countries. The role of government is needed to present the possibility of practical strategies and actions to improve food security.

In West Java Province, especially in Ciamis District, natural disasters include tsunamis, landslides, floods, droughts, earthquakes, and typhoons. Natural disasters can damage land, leading to economic losses and land degradation (Klomp and Hoogezand, 2018; Panwar & Sen, 2019). Natural disasters affect agriculture, especially food. Natural disasters, such as abnormal weather conditions in an area, cause partial or total damage to agriculture. Natural disasters have led to food insecurity, crop failures, and reduced agricultural productivity (Lesk et al., 2016). Consequently, the capacity for food production and distribution is limited, and the "food demand" cannot be satisfied (Reddy et al., 2016). Therefore, the government must develop mitigation policies to reduce the risk of natural disasters to maintain the food and nutritional security of the Ciamis District. One possible effort is to create a food security and vulnerability map of the Ciamis District. We want to use this as a base to focus more on our goals during the intervention (Sukono et al., 2020a, 2020b, 2021).

This research was conducted to lay a useful theoretical foundation for research related to the effect of disaster events on food security. In general, research on the effect of disaster events on food security is only seen from the availability and economic aspects. However, it does not look at the characteristics of the region itself. Because the characteristics of each region are different, using the Geographically Weighted Regression (GWR) model, it can be seen in more detail that geographical characteristics affect food security locally, not globally. Using Geographically Weighted Regression (GWR) makes it easier for decision-makers to deal with disasters based on the results of the maps generated from the analysis so that programming for problem-solving can be right on target.

Thus, this study aimed to analyze the effect of disaster events on food security through three indicators of food security, namely, food availability, food access, and food utilization. Furthermore, this study showed the influence of food security and its three indicators on the frequency of disaster events, including floods, landslides, droughts, and tsunamis. The results of this study provide an empirical reference to increase public awareness in anticipating the effects of disaster events on food security.

2. Materials and Methods

2.1. Effect of Disaster on Food Security

Natural disasters have significant short- and long-run impacts on economic growth, poverty reduction, and development. With climate change recognized as one of the most significant challenges facing humanity in the 21st century, it is predicted that it will become more severe and increase the risk of severe weather events. People in developing countries are generally thought to be more vulnerable to natural disasters and climate change due to their reliance on agriculture, lack of resources, poor construction, and unstable buildings (Trinth et al., 2020).

Disaster is an event that comes suddenly and disrupts the normal functioning of a society or community. Disaster is an event or series of events that cause loss of life, damage or loss of infrastructure, public services, and people's lives. This event exceeds the standard capacity of society to overcome it, thus requiring assistance from outside the community (Guan et al., 2021). One type of disaster that occurs is a flood. Flood is an event where water can inundate an area that is not usually flooded with water at certain intervals, caused by continuous rain, resulting in an overflow of rivers, lakes, seas, and drainage when the flow exceeds the accommodated volume (Shrestha, 2019).

On the other hand, a country located in a disaster-prone ring of fire region must continue to increase preparedness for the possibility of a disaster and the potential for transient food insecurity resulting from a disaster, likewise, with the anticipation of an increasing climate change anomalies that are increasingly difficult to predict which can cause crop failure and food and nutrition vulnerability of the community (Gu et al., 2016). The position of Indonesia's territory, which is on the equator and in the shape of an archipelago, creates a high potential for various types of hydrometeorological disasters, namely floods, flash floods, drought, extreme weather (tornado), abrasion, extreme waves, and land and forest fires. To better deal with the increasing potential and complexity of future disasters, an integrated, coordinated, and comprehensive plan needs. This plan is part of the preparedness response to the impact of the disaster (Zenhua, 2017).

2.2. Study Areas and Research Data

This research was conducted in Ciamis District, West Java Province, Indonesia. Ciamis District has 27 sub-districts and 265 villages. The location determination was carried out with consideration. Ciamis District is one of the disaster-prone areas in Indonesia, especially with droughts, landslides, floods, and tsunamis. This study is essential for preparing disaster-prone areas in planning the food supply for disaster management based on preparedness and disaster management and food distribution mechanisms. The dependent variable in this study is food security. The calculation of food security includes three aspects and six indicators. Food security can also be affected by disaster events, so in this study, the independent variable is the frequency of disaster events which consists of four indicators. Specifically, the variables in this study are shown in Table 1.

Table 1
Variable Selection

Variable	Aspect	Indicator	Scale
Food Security	Food Availability	The ratio of the standard area of agricultural land to the area of the village	Ratio
		The ratio of the number of economic facilities and infrastructure to the number of households	
	Food Access	The ratio of the population with the lowest level of welfare to the total population of the village	Ratio
		Villages that do not have adequate connecting access	
	Food Utilization	The ratio of the number of households without access to clean water to the total population of the village	Ratio
		The ratio of the number of health workers to the number of villagers	
Frequency of disaster occurrence		Flood	Ratio
		Drought	
		Landslide	
		Tsunamis	

2.3. Research Methods

This study used a quantitative method, and data sources were obtained through secondary data. Geographically Weighted Regression (GWR) analysis in this study was used to analyze the impact of disasters on food security in the Ciamis District. The general equation for GWR is:

$$y_i = \beta_0(u_i, v_i) + \sum_{i=1}^{p} \beta_j(u_i, v_i)x_{ij} + \varepsilon_i, i = 1,2,3, \dots, n \quad (1)$$

where:
y_i : dependent variable on observation to i
$\beta_0(u_i, v_i)$: value of the function of the independent variable to j on the observation to i
x_{ij} : value of independent variable to j on observation to i
p : number of independent variables
(u_i, v_i) : point of observation location coordinates to i
ε_i : random error assumed to be distributed.

The GWR model is a regression model converted into a weighted regression model. The GWR model is a statistical method generally used to analyze spatial heterogeneity, where the same independent variable (food security) will give a different response at each location in the research area. Meanwhile, the dependent variable is the frequency of disasters. The analysis results are an estimator of local model parameters for each point or location of the observed data (Fotheringham, 2018).

GWR modeling analysis can provide specific information down to the village level by looking at the effect of each independent variable on food security. The policy implications for each village in managing disasters to maintain food security will differ based on the results of the interpretation of the variable coefficients that affect food security. The GWR estimation results have variations in the parameter coefficients in each village, indicating variations in the influence of each independent variable for each village. This effect is based on the coefficient value; if the coefficient number is negative, this variable adds value to food security in each village.

3. Results and Discussion

Food security is an overview of the availability of sufficient, healthy, and balanced food access for all so that absorption can be good to ensure health and quality of life (Kneafsey, 2013; Liu, 2013; Trinh et al., 2021). National food security is the country's ability to produce enough food for all consumers at an affordable price (Ahmad et al., 2018). The Ciamis District Food Insecurity and Vulnerability Assessment considers three key factors: food availability, affordability, and access. Each variable is mapped and spatially analyzed to get an overview of existing food security. The conversion function is analyzed

step by step, starting with a pointer that calculates the ratio value and divides it by the equation. Each value is further divided into values that must be calculated together (Supian & Mamat, 2021).

3.1. Food Security

The most important aspect of food security is ensuring good food security, an essential human right. Food security remains the most critical part of national defense (Anis et al., 2022). Improving food security is a top priority in development because it is a basic human need. Uneven distribution of food is a constraint to realizing food security at the national level and impacts food insecurity. Food insecurity is a situation that must be handled appropriately and comprehensively because it is not only seen from the factor of meeting food needs (Mujuru et al., 2022).

Research on food security policies in developing countries has noted that there are two ways, direct and indirect, of evaluating new ideas related to food security policies. Policy directly affects changes in relative prices and food subsidy programs (Boratynska & Huseynov, 2016). On the other hand, new agricultural technology that can increase crop yield promotes convenience for farmers with indirect policies such as improving agriculture and environmental economics. To deal with climate change's potential variability and impacts, policymakers and stakeholders must design, implement, and evaluate economically efficient and sustainable policies. In developing countries, governments use short and long term policies to promote food security using a simple microeconomic approach that addresses operational issues in food security strategies (Nepal & Neupane, 2022).

Food security at the national level includes providing good and affordable food to the community, especially in rural areas. In general, food security is defined as the security of food accessible to all and economically sufficient for all to be productive and healthy, and the state of stable food demand, which can affect food availability. It is safe in quantity and quality, different, nutritious, balanced, cheap, and does not interfere with the religion and culture of the community (Sari & Munjati., 2020). To evaluate the achievement of food security development targets, the Food Security Agency compiles a Food Security and Vulnerability Atlas (FSVA), which is updated annually.

The preparation of the FSVA at the district/city level analyzes up to the village/urban village level, which consists of six indicators, namely, the ratio of the standard area of agricultural land to the number of villagers, the number of facilities ratio and infrastructure food supply to the number of households, the ratio of the population with the lowest welfare level to the total population, villages that do not have access to adequate liaison, the ratio of the number of households without access to clean water to the total households, and the ratio of village population per health worker to population density. This analysis uses an area map to create a food security map. All values of a scale are re-evaluated. Then the score is calculated by adding equal weights between each indicator (availability, affordability, and food utilization). The composite score was divided into six key indicators, shown in Table 2.

Table 2
Priority Class of Food Security Composite Score

Class	Level
Priority 1	**Very Food Vulnerable**
Priority 2	**Food Vulnerable**
Priority 3	**Low Food Vulnerable**
Priority 4	**Low Food Resistant**
Priority 5	**Food Resistant**
Priority 6	**High Food Resistant**

According to the weighing scale (Table 2), the villages are divided into six priority zones. Priority 1 is the highest priority that includes the highest level of vulnerability, while Priority 6 is more important for food security. In other words, priority 1 areas (villages) are more at risk of food insecurity than other areas (cities) requiring immediate attention. However, not all people in Priority 1 zone (village) are food insecure; conversely, not all people in large Priority 6 zone (village) are food secure. According to the analysis, out of 265 villages in Ciamis District, no villages are in priority 1 and 2, 8 villages are in priority 3, 26 villages are in priority 4, 176 villages are in priority 5, and 55 villages are in priority 6.

Food security in Ciamis District is mostly in the food resistant status. In terms of food availability, the status of very food in Ciamis District is supported by the economic condition of Ciamis District, which depends on the agriculture, forestry, and fishery sectors. The agricultural sector has a high role in GRDP based on current prices, which is 23.60%. The staples in Ciamis District are rice and corn, which account for almost 93.43% of the total cereal production. Apart from the availability of food commodities, food security is also supported by the availability of food supply facilities and infrastructure (30). The higher ratio of food supply facilities and infrastructure to the number of households in the village, it is assumed that the better the level of food availability in the village. This high ratio of food-providing infrastructure must also be ensured that it is spread evenly in every village. This situation will have a positive impact on aspects of the availability of food security in the Ciamis District.

In the aspect of affordability or access to food, the indicator that influences it is the ratio of the population with the lowest welfare level to the number of residents and villages that do not have access to good liaisons (Murdad et al., 2022). From 2016 to 2020, the percentage of the population of Ciamis District below the Poverty Line tended to decrease but increased again in 2020 to 7.62%. The increase in 2020 was due to the COVID-19 pandemic, which changed people's behavior and activities so that poverty increased and affected the affordability of safe and sufficient food. Based on the 2018 Social Welfare Integrated Data, 37 villages (13.96%) have the lowest ratio, so poverty reduction programs are still needed. Regarding transportation access indicators, according to PODES (Village Potential) 2020 data in Ciamis District, almost all villages have connecting access for 4-wheeled vehicles throughout the year. Several villages have connecting access that can be passed throughout the year except for specific times, such as when it rains and disasters such as landslides and high tides.

In the aspect of food utilization, things that must be reviewed are the use of food that the body can access and the individual's ability to absorb nutrients, which also includes the storage, processing, and presentation of food, including the use of water during the processing (Fraser et al., 2022). Regarding clean water access, Ciamis District has 57 villages or as much as 21.51% on priority 1, which means that the indicator of access to clean water significantly contributes to food insecurity. At the same time, the ratio of the number of villagers per health worker to population density in the Ciamis District is mostly in priority 3 and 4 of 20.38% and 20.75%, respectively. This utilization aspect can affect stunting rates, underweight, and maternal and under-five mortality rates.

All aspects of food security in Ciamis District still require alternative strategies to maintain food security status, even at the individual level. In addition, the Food Security Index also has other challenges, such as natural disasters that often occur in Ciamis District. This factor will affect the three aspects of food security. The occurrence of a disaster will hamper the availability aspect if the disaster damages agricultural products; it will also hamper the affordability if transportation access is damaged due to the disaster, and the utilization aspect will be disrupted, for example, if a flood or landslide occurs. Therefore, a strategy to mitigate disaster factors is needed because disasters are incidental, so a quick response is needed.

3.2. Geographically Weighted Regression (GWR) Model the Effect of Disaster Events on Food Security

Natural disasters threaten the government as they can occur suddenly and disrupt social activities by disrupting local food (Israel, 2012). Indonesia is in a tropical climate with two seasons, which are rainy and dry seasons, with extreme changes in weather, temperature, and wind direction. The number of disaster-prone areas in Indonesia requires efforts to reduce disaster risk. When there is a natural disaster, there is an organization that tries to do its best without coordinating with other organizations, which leads to conflicts between organizations. However, conflicts can arise due to differences in organizational or individual capabilities, leading to conflicts. This case is the government's task that must be carried out jointly and in collaboration with relevant agencies (Mishra et al., 2021; Zheng et al., 2020).

Natural disasters can occur due to many factors, either natural factors or natural factors themselves; one of the existing disasters is flooding (Kalfin, 2021). Flooding is the flow of river water that flows beyond the capacity of the river, and thus, the flow of river water will pass through the riverbank and inundate the surrounding area. Floods are the most destructive natural disaster. This flood disaster hit the sunken to the flat area located in the lowlands. Flood management can be distinguished between physical (structural measures) and non-physical (non-structural measures) (Wijerathna & Pathirana, 2022; Kalfin et al., 2020). Some of the physical managements are making check dams, embankments, and dams, while non-physical in the form of mapping vulnerable areas, dangers, or risks to flooding. Based on this understanding, it can be concluded that flooding is a natural disaster that causes natural events such as high rainfall, which often causes physical and material losses (Enjorlas & Kast, 2012).

Based on flood disaster data in Ciamis District, the usual occurrences are high winds, floods, earthquakes, fires, house fires, landslides, and ground movements. In 2020, there were 358 strong winds, 75 flood disasters, 2 earthquakes, 4 fires, 53 house fires, 336 landslides, and 56 ground movements. This disaster has an impact on the destruction of agricultural land and infrastructure for providing food for the community, which affects the aspect of availability, in addition to affecting the aspect of affordability because disasters can disrupt economic activity and damage access to transportation which results in hampering aspects of food affordability.

On the other hand, disasters can also damage clean water sources and food security, impacting food utilization. Most of the disasters in the Ciamis District in the 2020 food security and insecurity map in the Ciamis District still show a safe status. However, when viewed from another model, namely the Geographically Weighted Regression (GWR) model, the effect of floods on food security can be seen because this model produces local model parameter estimators for each observation location. The problem of disaster events is likely to be influenced by location and neighbors, so data between observation locations is challenging to assume to be independent. Parameter values are calculated at each geographic location point so that each location point has a different regression parameter value.

The dependent variable in this study is food security. The calculation of food security in Ciamis District includes three aspects and six indicators. Food security can also be affected by disasters. In this study, the independent variable is the occurrence of disasters in Ciamis District. To deal with the potential variability and impacts of climate change, policymakers and

stakeholders must design, implement and evaluate policies that are economically efficient and sustainable (Ruitz, 2013). GWR modeling analysis can provide information specific to the village level on the influence of each independent variable on food security. The policy implications for each village in tackling disasters to maintain food security will differ based on the interpretation of the variable coefficients that affect food security (Pangali, 2022).

Table 3
Estimation Result of GWR Paramaters the Effect of Flood Disasters on Food Security in Ciamis District

Variable	Elasticity	GWR Model		
		Min	Average	Max
Intercept		57,623971	61,24255192	63,677468
Food security (X_1)	0,05958838	-2,475577	0,059447908	1,670036
N				249
AICc				452,483379
SSE				5,015254357

The results of the GWR estimation have variations in the parameter coefficients in each village, indicating a variation in the influence of each independent variable for each village. This effect is based on the coefficient value; if the coefficient value is negative, this variable adds value to food security in every village in Ciamis District. Conversely, if the coefficient is positive, this variable will reduce food security. In this GWR modeling, some stages include selecting spatial weighting, determining bandwidth, parameter estimation, and model testing.

In this study, a composite effect model for total disaster was made on food security, and a model for the effect of floods on food security was made. Flood disasters are considered to have the most impact on hampering community activities. The results of the total estimation test of the effect of flood disasters on food security in Ciamis Regency are also depicted in the form of GWR modeling as in Fig. 2.

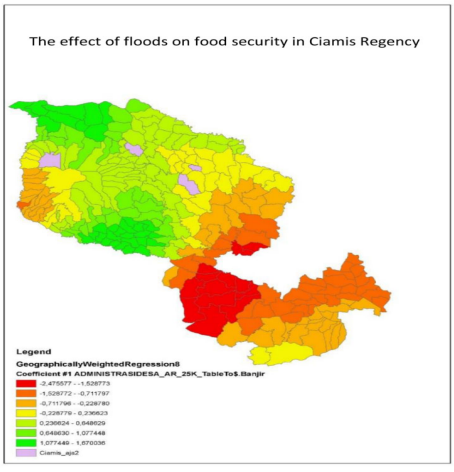

Fig. 1. GWR Model for Flood Disasters on Food Security

The effect of the flood disaster on food security in Ciamis District occurred in the Cisaga, Cimaragas, Cidolog, and Pamarican sub-districts which geographically located in the west borders the City of Tasikmalaya and in the east borders the City of Banjar. Meanwhile, on the food security and insecurity map of the Ciamis District, the Cisaga, Cimaragas, and Pamarican areas are in food resistant status; only the Cidolog area has a low resistant status. This condition showed that disasters have other effects on food security.

Fig. 1 shows that disaster variables affect each village in Ciamis District. The more north, the influence of flood events does not affect food security, while the southern area of Ciamis District has a considerable enough influence. Several characteristics, such as altitude, can affect the occurrence of flood disasters. The area with the highest impact of flooding on resilience occurs in the Cisaga sub-district, which has a height of 31 meters above sea level. Meanwhile, Cimaragas sub-district is 223 meters above sea level, Cidolog sub-district is 126 meters above sea level, and Pamarican District is 213 meters above sea level. The diversity of altitudes in this region has little impact on the effect of flooding on food security. Other factors contribute to the effect of flooding on food security (Tsai & Lee, 2022). The highest coefficient of flood disaster is 1.077449 , and the lowest is -2.475577. Simultaneously, the GWR estimation of the effect of flood events on food security in Ciamis District has a negative relationship, meaning that any increase in the incidence of flooding in a village will reduce food security. Flooding consists of two events; firstly, flooding occurs in areas not usually affected by flooding. Secondly, flooding occurs due to water runoff from rivers due to the large discharge river channels cannot carry. The excess water that floods an area that is usually dry occurs because the river's capacity cannot absorb the water that flows into it or the excess local

rainwater. Excessive local stormwater that causes flooding can be caused by the area's soil saturation and the stream's maximum water level. High soil saturation ensures low soil absorption (infiltration), so surface drainage is high. The river body can accommodate the high surface runoff due to the excess rain. As a result of excess water (flooding) due to overflowing river water or local rain, it will cause the formation of flood formations. On a wider scale, it is included in the class of formations of fluvial origin (Kumar & Karwariya, 2022; Zhang et al., 2022).

Many flood disasters occurred in food-insecure rural areas and villages, with many insecure villages in different locations within a village. However, the impact of the disaster does not affect the food status availability; when looking at the rice productivity in sub-districts, Ciamis District has increased and has exceptional food for consumption, so the flood does not change the food security of the affected villages. Flood disasters can also happen in the countryside with food insecure status, flood disasters may cause minor damage, and there are several villages in Ciamis District where floods happen with food insecure status.

The Ciamis District Disaster Management Office has implemented flood prevention strategies. Early mitigation should ensure food security in the District by reducing impacts on agricultural areas. According to (McConnell, 2018), if the development and environmental behavior of the community is similar to today, floods and other disasters caused by human activities will have more and more impact in many areas. It is taller and wider. Although many flood control measures have been put in place, floods (frequency, duration, intensity, and depth) continue to increase. Spatial or land-use changes affect or cause flooding more than physical means of flood control (O'Connell, 2007). Regional and urban spatial planning should cooperate with other organizations, and regions should pay attention to the situation during flood control, reduce the risk of damage, and utilize the capacity and potential of the flooded area of the community (De Haem & Henrich, 2007; Faber et al., 2009).

In addition to the model of the effect of flooding on food security, the model of the total effect of disasters on food security was also analyzed because the potential disasters in Ciamis Regency are not only floods. Other natural disasters such as drought, landslides, and tsunamis also affect food security in Ciamis Regency. The results of the estimation test of the total effect of natural disasters on food security in Ciamis Regency can be seen in Table 4.

Table 4
Estimation Result of GWR Parameters the Effect of the Total Disaster Incidence on Food Security in Ciamis District

Variable	Elasticity	GWR Model		
		Min	Average	Max
Intercept		56,517074	60,90982802	64,959915
Food security (X_1)	0,120912559	-1,233514	0,121286458	1,236268
N				249
AICc				1359,504229
SSE				4,60984

The results of the total estimation test of the effect of total disasters on food security in Ciamis Regency are also depicted in the form of GWR modeling as in Fig. 2.

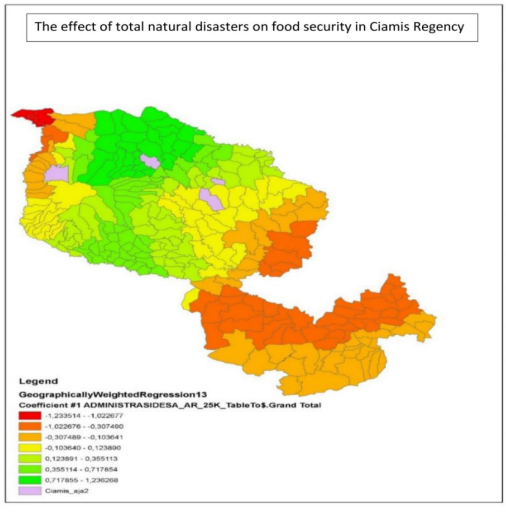

Fig. 2. Geographically Weighted Regression GWR Model of Total Disaster Incidence on Food Security

The most significant influence of total disaster events on food security in Ciamis District is mainly clustered in the southern area, marked in orange. However, two villages in the north have the highest impact, namely Sukamantri District, marked in red. Villages with orange color, if not associated with the impact of the disaster, have food resistant status; only a few sub-

districts, namely Cidolog, Pamarican, and Banjarsari, have low food resistant status. This showed that disasters have other effects on food security (Sataphaty, 2020 & Sianturi et al., 2018). If it is associated with geographical characteristics, the northern area of Ciamis District is bordered by Tasikmalaya and becomes a traffic lane that passes through the Cihaurbeuti sub-district (Pritchett et al., 2000).

Fig. 2 shows that the total disaster variable has various effects on each village in Ciamis District. The further north, the more the effect of the entire disaster event does not affect food security, but two villages are strongly affected. At the same time, it has a considerable influence in the southern area of the Ciamis District. The highest total disaster event coefficient is 0.717855, and the lowest is -1.235514. Simultaneously, the GWR estimate of the effect of flood events on food security in Ciamis District has a negative relationship, meaning that any increase in the incidence of flooding in a village will reduce the level of food security. According to the characteristics of Ciamis District, the southern part is bordered by Padaherang Village in Pangandaran District, which is famous for flooding events because it is close to the Citanduy Sub-watershed. This strengthens the statement of the geographical concept that the proximity between regions will have the characteristics of a region and have a strong influence.

In agriculture, food security is a complex issue. Multidimensionally, food security has a comprehensive assessment consisting of several indicators. Food security is faced with several problems in increasing demand for food needs. In addition, natural disasters that occur, primarily floods, cause food security crises and impact the sustainability of socio-economic aspects in a region (Munirah & Norfarizan-Hanoon, 2022).

The impact of the flood disaster can happen repeatedly every year, so, like it or not, people who live in the area must accept it. Communities living in these areas must adapt to maximize resources and turn disasters into opportunities and sources of livelihood (living in harmony with the flood) (Friedman et al., 2022). Living in harmony with floods is the best choice to minimize losses due to floods. These methods can be done, among others, by (a) Making a residence with a stilt house system or moving to a flood-free area. (b) In the months that are not flooded, the community actively works to earn income and set aside their income used when a flood occurs. (c) Saving part of the harvest, either in kind or in money used in the event of a flood. (d) Aligning cropping patterns that are not monotonous for rice cultivation with cropping patterns that can provide higher income, for example, by planting horticultural crops on their agricultural land. (e) Cultivating livestock that is easy to cultivate and easy to sell. (f) Introduction of water-resistant rice seeds.

4. Conclusions

Based on the food security analysis, the food security status in Ciamis District is mostly very secure. However, all aspects of food security still require alternative strategies to maintain food security status, even at the individual level. Besides that, food security also has other challenges, such as natural disasters that often occur. This factor will affect the three aspects of food security. The emergence of a disaster will hamper the availability aspect if the disaster damages agricultural products and affordability if transportation access is damaged due to a disaster, and the utilization aspect will also be disrupted if a flood or landslide occurs. Therefore, a strategy to mitigate disaster factors is needed because disasters are incidental, so a fast response is needed. Meanwhile, based on the analysis of the GWR model, the natural disasters that occurred had a direct or indirect impact on food availability and security in Ciamis District. Natural disasters still occur even though food availability, affordability, and utilization are very food secure. There are other factors, namely disaster, that come suddenly and cannot be predicted, thereby affecting the food security of a region. What can be done is to create togetherness in society. In addition, it is expected that each individual can take the necessary actions to solve problems independently.

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