Climate Change and Food Security: The Coping Strategies

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Abstract. Food security is associated with a vulnerability to various factors, such as climate change. The study aims to analyze poor household food security and their strategies to cope with the vulnerability that arises from climate change. Also, to examine the food security dynamic between El Niño and La Niña. We used cross-section primary data of poor households. The location of the study is Gunungkidul, Yogyakarta. Food security indicators use Coping Strategies Index (CSI). We use descriptive statistics, K-Mean Cluster, and paired sample t-test. Based on the K-Mean Cluster and sample t-test results, Household experiences food security dynamics. Households were facing food security when El Niño more secure than La Niña. It is possible that because the study location is a kart area, the Household has become accustomed to facing dryness. Households perform coping adaptation in the form of consumption-based and non-consumption based. We found that households prefer a consumption-based strategy. They often chose a food coping strategy relying on less preferred food and less expensive, purchasing food on credit and borrowing food from a relative. Moreover, households perform food diversification to cope with vulnerability using local habits. Another strategy is income-based, where heads of households and wives diversify their work. The findings provide information to households and the government to cope with food insecurity, especially from Climate Change.

Keywords: climate change, coping strategies, food security

1 Introduction

Food security is essential for many aspects of life, including the economy. Monitoring food security can help identify and understand the crucial elements of population welfare in groups or regions. Food insecurity leads to a loss of productivity, resulting in decreased performance. The condition of a child with malnutrition and early childhood health has long-term consequences. It will affect the development of school-age [1]. In addition, food security is a basic need for the development of human resources [2].

Food security is only sometimes attainable. It relates to the stability pillar, which explains that an entity may experience food security at one time but may experience food insecurity at another time. Food stability is associated with a vulnerability that trends, shocks, and seasons cannot control. One part of the shock is climate change, such as El Niño or La Niña. 2015 El Niño threatened food production because of declining rainfall and drought in some regions, including Indonesia. The other phenomenon, namely La Niña, is the cooling of the surface temperature of the seawater in the tropical Pacific. La Niña affects the pattern of global climate change in the opposite direction with El Niño. Indonesia is a priority country FAO related to the impact of climate change, namely the occurrence of drought, forest fires, and cyclones.

According to Gregory, Brklacich, & Ingram [3] and FAO [4], climate change has resulted in a prolonged drought, causing pressure on food systems in availability, access, and utilization pillars, putting pressure on food security. Climate change causes susceptibility to food systems when one or more of the four components of food security is uncertain and insecure [4]. The geographical, social, class, economic, ecological, and political factors determine a person or Household to achieve food security in the face of shock and climate trends [5]. Vulnerability is determined by a combination of the ability of people to deal with or recover from environmental change [3]. Vulnerability will decrease if the Household can adapt to a highly dependent capacity. It is necessary to strengthen household resilience to maintain food security when faced with vulnerability [4]. Resilience is the ability to anticipate, prepare, respond, and recover from various threats with minimal impact on social welfare, the economy, and the environment [6]. Therefore, it is necessary to integrate the influence of the human dimension to climate change in food security planning since human behavior and response to climate change is the primary food system supported [7]. Adapting the food system requires more than just attention to agricultural production alone [8].

Household strategies can provide a picture of households adapting to vulnerability. Based on the description can provide preliminary information for improving food security based on local experience. According to Wright et al. [9], the transfer of knowledge and practice from local adaptation experience is still rare when it is potential for food security. Therefore, this study examines how poor household strategies face vulnerability due to climate change. What is the condition of food security when facing climate change at a household level? Are there any dynamics of food security between times when climate changes occur? Furthermore, what do practical households do to cope with food scarcity?

2 Literature Review

People experiencing poverty in the face of vulnerability in the form of shock, trends, or seasons have a strategy to deal with the food problem, especially regarding access to food. At the time of the vulnerability, everyone has a different way of dealing with it, and the

Household is trying to adapt. There is a theory that explains this strategy, namely the Food Coping Strategies developed by Maxwell and Smith [10]. The theory of the prepared food security indicators is called Coping Strategies Index / CSI. Maxwell, Watkins, Wheeler, & Collins [11] describe the adaptation level as changing the diet, in the short term, improving household food availability, lowering the number of people eating, rationing, or arranging food shortages.

Several studies suggest that when households face food shortages, they conduct coping strategies. Each location shows a different coping strategy, but in general shows two strategies, namely consumption-based and income-based, for the consumption-based. Household efforts to meet food consumption needs. The strategy of consuming less favored and inexpensive foods, buying food with debt, borrow food became the primary choice [12] [13] [14] [15] [16].

For strategies, income-based Households do some coping, one of them to perform the migration [17]. According to Warner & Afifi [18], migration is a risk management strategy when dealing with livelihoods and food insecurity variability. In addition, it is to earn income as well as do the work side and engage in trade on a small scale [13], working odd jobs [15], selling livestock [17], and even sent children to work [14].

3 Methodology

Location

The research location is in Saptosari, Gunungkidul, Yogyakarta. The selection of the study sites depends on three criteria: poverty, typical geographical conditions, and food security dynamics condition. The research location is in Jetis and Nglora Village, Saptosari, Gunungkidul because this location meets the study's criteria, namely poverty problem, natural conditions or geographical differences, and food security dynamics. Data from BPS [19] suggest Gunungkidul in 2014 had the highest percentage of poor amounts in Yogyakarta (20.83%). According to Rachman [20], Yogyakarta Province in 2002 was an area with high food insecurity risk. Gunungkidul is one area with a high risk of food insecurity at that time. One of the sub-districts of food insecurity is Saptosari. Ngloro and Jetis are villages in District Saptosari in Gunungkidul and have dynamic food security conditions. The food security condition in Ngloro and Jetis Village in 2011 still experience food insecurity, but in 2012 reached a safe condition [21]. Based on the description, these areas have dynamic food security conditions. The third criterion is the type of natural condition. Gunungkidul's tropical climate area has a topography dominated by a karst hill area. The Southern region is dominant in a karst hill area with many natural caves and an underground river. Saptosari is one of the subdistricts in Gunungkidul, the karst hill area. The conditions because the land is less fertile in the southern region resulting in agricultural cultivation in this area, are less than optimal [22]. Consequently, wetland rice field is not available. All rice fields are paddy fields in dry land [22].

Data

This study is quantitative research. The data use cross-sections in the form of primary data. The appropriate respondents for analysis are women from poor households. Poor households are considered to have higher levels of food insecurity due to their ability to purchase food commodities [1]. Furthermore, according to Maxwell [11], women are the ones who prepare and look for food for family members. Respondents who meet these criteria are beneficiaries of the Family Hope Program (PKH). The amount of sample is 88 households.

Sampling using probability sampling design with random sampling area method. They were collecting data using a personally administered questionnaire with an interview method.

We used the Coping Strategies Index (CSI) to measure indicators of food security about vulnerabilities. It is one of the food security indicators that is relatively simple and easy to use, easy to understand directly and correlates well with other more complex food security indicators. CSI uses some questions about how households face declining short-term food consumption. Household levels referred to as 'coping' has "proven useful to operational humanitarian agencies and researchers in measuring localized food insecurity" [23].

There are four stages in calculating the coping strategies index. The first phase is to identify coping strategies based on habits in the research area, which consists of several household strategies. The second stage calculates the relative frequency measure. The procedure is to obtain the relative frequency segmented way, which measures how often in a one-week household coping strategies. Coping strategies range from "never" to "every day."Frequency is obtained by finding the midpoint of the range of each group and then assigning a value to each category. The frequency category values are every day $(7 + 7) / 2 = 7$), sometimes = (3-6 days / week = $(3 + 6/2) = 4.5$), occasionally (1-2 days / week = $(1 + 2) / 2 = 1.5$), Rarely (<1day / week = $(0 + 1) / 2 = 0.5$), and Never (0 days / week = $(0 + 0) / 2 = 0$). Furthermore, it determines severity and strategy weighting. The simple procedure is to group the strategy based on depth and give weight to each group. Grouping severity becomes most severe (4), severe (3), moderate (2), and mild (1). Finally, it is to combine frequency and severity. It multiplies the relative frequency with the weight of the level severity. The result is the value coping strategy index. Changes in CSI scores show changes in food security status, whether decreases or improves. The lower value of CSI indicates better food security conditions [11].

Analytical Tools

The analytical tools used were K-Mean Cluster, descriptive statistics, and paired t-test. K-Mean Cluster analysis aims to group objects based on specified characteristics and is used to analyze a group of individuals or objects that have similarities to a cluster [24]. Ziaei et al. [25] used this analytical tool to determine the position of food security. The K-Mean Cluster results will classify households as food secure, mild food insecure, and medium/ heavy food insecure, descriptive statistics used to describe the condition of food security and coping strategies chosen by the Household. Paired sample t-test to see the household food security dynamics when facing climate change from El Niño to La Niña.

4 Results and Discussions

Results

The results of the data analysis divide into three sections. First, it will explain the condition of households when facing climate change. Furthermore, we describe the description of food security using the CSI indicator. Third, we analyze the condition of household food security based on the K-Mean Cluster analysis. Poor Households divide into three clusters: Cluster 1, food secure; Cluster 2, mild food insecure; and Cluster 3, medium/heavy food insecure. The second section will explain the results of examining food security dynamics between El Niño and La Niña using paired sample t-test. Finally, we describe two types of coping strategies, namely non-consumption-based and consumption-based which have been

chosen by respondents, besides exploring whether the Household is experiencing difficulties and changing needs due to climate change.

Condition of Households when Facing Climate Change

Before explaining the coping strategies undertaken by households, it will be explained first about the condition of households when facing climate change. It is related to the difficulty of fulfilling food needs and the difference in the fulfillment of food needs between El Niño and La Niña. The Household has struggled to meet its food needs in the last 30 days, stated 65% of respondents. The leading causes of difficulty are income (34%), seasonal (25%), occupation (15%), harvest problem (13%), price changes (6%), and landless (5%). Furthermore, households stated there was a difference in meeting food needs during the long dry season (El Niño) with the rainy season (La Niña). It states that 85% of respondents. Several factors cause the difference, namely, too dry condition (34%), too wet (25%), harvest problems (16%), occupation (8%), and price (7%). These findings indicate that climate change (too dry, wet, harvested, and priced) causes difficulty in fulfilling household needs.

Household Food Security Condition

Table 1 suggests descriptive statistics, which show the mean value of CSI El Niño (50.8) lower than CSI La Niña (56.2). The CSI minimum value of El Niño (1.1) was lower than CSI La Niña (1.7), while the maximal value of CSI El Niño (130.8) was lower than CSI La Niña (158.3). Lower CSI values indicate that household food security during El Niño is better than food security when La Niña. Based on the descriptive value, the food security condition when El Niño is better than La Niña. The lower descriptive value of CSI indicates it.

The finding of descriptive statistics is consistent with a paired mean t-test result. It shows a significant difference between the CSI average when El Niño and La Niña at a 5 percent confidence level (Table 2). The finding indicates dynamic food security conditions between El Niño and La Niña.

Table 1. Descriptive Statistic

Descriptive Statistic	Season	
	El Nińo	La Nińa
Mean	50,8	56,2
Minimal	1,1	1,7
Maximum	130,8	158,3

Table 2. Paired Mean t-Test

Season	Mean of CSI	t	t critical	df	Sig
El Niño	50,81	-1,725	1,645	87	0,08*
La Niña	56,19				

Note : * Significant at α 10%

To determine the condition of household food security, we used *K-Mean Cluster.* The results of *the K-Mean Cluster* analysis as presented in Table 3. Three poor households are in

three clusters: Cluster 1: food security, Cluster 2: mild food insecurity, and Cluster 3: moderate/weight food insecurity. The position of food security in Saptosari during when long drought (El Niño) Cluster 1 consisted of 39, while Cluster 2 was 46, and Cluster 3 was 3. The most considerable proportion was in Cluster 2, 52.3%, followed by Cluster 1 (44.3%), and last is Cluster 3 of 3.4%. This finding indicates that many households have high food security and mild food insecurity.

Food security position during La Niña shows the proportion of food-secure households increased to 46.6%. Meanwhile, mild food insecurity decreased (44.3%), and moderate/heavy food insecurity increased (9.1%). These findings suggest that even though there is a shift in the position of household food security, it is just a slight change. The Household has an almost similar position between the two seasons.

Table 3 Food Security Position Based on *K-Mean Cluster* Analysis

Cluster	El Niño		La Niña	
	Number of HH	%	Number of HH	%
1: Food secure	39	44.3	41	46.6
2: Mild Food Insecure	46	52.3	39	44.3
3: Moderate/heavily food insecure	3	3.4	8	9.1
Total	88	100.0	88	100.0

The Coping Strategies

According to Mohiuddin, Islam, & Uddin [26], there are two *coping strategies*. The two types of coping strategies usually adopted by consumers are consumption-based and non-consumption based. The coping strategies index is a consumption-based type. Coping strategies demonstrate the strategies that households perform. There are six main strategies for households to face food problems [23]. There are consuming less preferred; limiting the portion of food; borrowing food or money to buy food; reducing food for a mother for her child; reducing the frequency of eating; not eating in one day.

Based on the survey, households prefer various coping strategies. Table 4 shows household coping strategies. When El Niño occurs, consuming less favored and inexpensive foods became the primary choice chosen by 78.6% of households. The following strategy is to buy food with debt, the second choice selected by 74.5% of households, and borrow food from relatives (71.4%). A rare strategy is asking family members for food (27.6%) and asking the children to eat at a neighbor's place (25.5%). The rarest strategy is not eating throughout the day, but households still use this strategy. Sixteen households use this strategy (19.40%).

The strategy chosen by the Household when facing La Niña showed little change (Table 4). Whereas buying food with debt became the first choice chosen by the Household (66.3%), followed by borrowing food from relatives (51.0%) and consuming less favorable and inexpensive foods (50.0%). There is a shift in strategy chosen by households compared to El Niño 's time, although the most dominant strategy remains the same. Similarly, rare strategies are still the same but with different ratings. Ask children to eat at neighbors' (25.5%) and family

members (24.5%) for food. For the most rarely selected households, strategies to do the same with El Niño, namely not eating throughout the day, were chosen by 17 households or 17.3%.

Table 4 Distribution Household Based on *Coping Strategies*

Coping Strategies	El Niño			La Niña		
	Number HH	%	Rank	Number HH	%	Rank
a. Rely on foods that are less favored and cheap	73	78.6	1	49	50.0	3
b. Borrowing food or relying on food aid from friends or relatives?	66	71.4	3	50	51.0	2
c. Buying food with debt	69	74.5	2	65	66.3	1
d. Using food that is not ready for harvest	47	53.1	6	47	48.0	4
e. Consuming plant seeds as food?	43	48.0	7	38	38.8	7
f. Asking the children to eat at a neighbor's place?	23	25.5	12	25	25.5	11
g. Asking family members to ask for food?	24	27.6	11	24	24.5	12
h. Reduce the food portion	35	38.8	10	30	30.6	10
i. Reducing the consumption of adults to feed the children	52	57.1	8	41	41.8	5
j. Feeding for members who work than for unemployed household members?	37	41.8	4	35	35.7	8
k. Money rationing and buying spare food	52	58.2	9	40	40.8	6
l. Reduce the amount of food eaten in a day?	34	38.8	5	32	32.7	9
m. Not eating throughout the day	16	19.4	13	17	17.3	13

According to Makoti & Waswa [17], another food coping strategy is food diversification. Our findings show that if a household does not have enough food or money to buy food, they diversify it. As many as 93.2% of households claim to have food consumed as a substitute for rice. Rice substitute food is cassava (52.8%), corn (38.2%), and others (9.0%). The reasons for choosing these rice substitutes are their own (16.5%), price (34.1%), habits (36.5%), income (8.2%), and others (4.7%). These results indicate that households have diversified food when they experience vulnerability.

Besides the household consumption-based strategy, there is another strategy, namely income based. In the short and medium term, to cope with drought, households do diversify opportunities to earn household income and food diversification [17]. For non-food diversification, households diversify their work, especially heads of households. There is an interesting phenomenon related to the type of work based on the season in the Saptosari District.

During when the rainy season, most household heads work as a farmer. However, when entering the dry season, there is a change type of work. Households shifted to be an artisan, traders, and odds. Table 5 shows seasonal work changes, where in the dry season, household head as a farmer has been decreasing (46.3% to 17.1%). In comparison, household head employment as an artisan, merchants, mixed jobs, and others. The same finding also happened to wives' work when drought respondents became farmers; 45.7% changed to 67.2% when facing rain.

Table 5. Shifting of Work by Season

Work	Husband				Wife			
	El Niño	(%)	La Niña	(%)	El Niño	(%)	La Niña	(%)
Farmers	14	17.1	37	46.3	32	45.7	45	67.2
Not a Farmer								
Artisan	6	7.3	3	3.8	-	-	-	-
Merchants	7	8.5	6	7.5	4	5.7	2	3.0
Mixed	26	31.7	16	20.0	13	18.6	7	10.4
Others	29	35.4	18	22.5	21	30.0	13	19.4
	82	100.0	80	100.0	70	100.0	67	100.0

These findings indicate that there are changes in employment during the rainy season and the dry season. This shift has the aim of maintaining their opportunity to get income. Even several household heads conduct circular migration to achieve their opportunity. According to Black et al. [27], migration is motivated by decisive socio-economic factors such as improving income, gathering with family members, running away from persecution, and escaping the environment or other threats, often temporary. One motivation for doing this is to look for extra income. According to Hastuti [28], migration is also an effort to reduce poverty. Respondents in Saptosari Subdistrict stated that they conduct migration t in the dry season when agriculture is complex. During the rainy season, circular migrants will return to the village to farm. According to Sunarto [29], this circular migration came from the lower levels of society, although not the lowest, with a low level of education, having less than 0.5 hectares of agricultural land area, and gender dominated by men.

According to Hugo [30], circular migration refers to the experience of repeated migration between origin and destination that involves more than one migration and return—workers working outside the area, especially farmers, during the dry season. When the rainy season comes, they will return to their area to farm because natural conditions are more likely to grow crops. This circular migration is also done because of the insistence on necessity because they do not have enough income. This condition is shown by the change in employment status from farmer to another job when the season changes.

Discussions

Most households expressed difficulties meeting their needs in the last 30 days. Furthermore, households stated there was a difference in fulfilling food needs during the long dry season (El Niño) and the rainy season (La Niña). Although poor households are experiencing

difficulties in meeting food needs, it turns out poor household food security when El Niño (long drought) is significantly more food secure than La Niña (rainy season). This finding is interesting because, in other regions, drought usually causes food security. Gregory et al. [3] suggest that drought causes pressure on food systems in availability, access, and utilization pillars, putting pressure on food security. This condition is possible because the research area is a dry land kart area. In other words, households have high resilience to face the dry season. One of the adaptation strategies households undertake is the diversification of food, where poor households have food instead of rice. Makoti & Waswa [17] suggest that short to medium-term drought coping mechanisms should focus on diversifying household food and income opportunities.

Households focus on food diversification. Households choose this strategy in almost all households (94%), where they have a replacement for staple food (rice). The main rice substitute foods are cassava and corn. The Household selects the food for several reasons, such as it has its food, so it does not need to buy, the price is affordable, custom, easy to obtain, and durable. The selection of cassava food is consistent with Habtezion [31], which states that households face food shortages to poor soil fertility, which is made worse by changing and unpredictable rainfall patterns. People have resorted to growing cassava as a staple food instead of yam as an adaptation strategy. Cassava grows in infertile soils better than yam. The strategy is consistent with the coping strategies of poor households and is the most preferred in the face of food insecurity, which relies on less favored and cheap food that is not ready for harvest. Cassava and corn became an option other than rice which may not be the foremost choice because it is affordable and does not need to buy.

Another strategy besides food diversification that many respondents choose is to borrow food from relatives and buy food with debt. It is consistent with the study from [12] [13] [14] [15] [16], which shows the efforts made in the form of either borrowing money from relatives or moneylenders and borrowed from the nearest shop is the strategy that most people do. Borrowing from relatives becomes the next strategy chosen by poor households. This condition relates to the limited income they have. Households change the type of work to overcome the limitation of income. Farmers dominate household occupations during the rainy season. Due to the rainy season, the soil becomes more easily planted. These conditions change during the dry season: non-farmers, artisans, mixed jobs, merchants, and others as dominants. Variations in these jobs are often followed by moving locations to other areas or migrating.

5 Conclusion and Recommendation

5.1. Conclusion

Based on the results, it identified that households had adapted adaptation practices in dealing with vulnerabilities that stem from different climates and soil conditions. Coping adaptation is in the form of consumption-based and non-consumption based.

5.2. Recommendation

In the future, it needs to be diversified and more varied and meet the elements of nutritional completeness. It has to adapt to local conditions. This good practice needs to be transmitted to households in other areas to maintain the stability of food security.

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