frontiers | Frontiers in Sustainable Food Systems

TYPE Original Research
PUBLISHED 20 September 2022
DOI 10.3389/fsufs.2022.987853

OPEN ACCESS

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SPECIALTY SECTION
This article was submitted to Land, Livelihoods and Food Security, a section of the journal Frontiers in Sustainable Food Systems

RECEIVED 06 July 2022
ACCEPTED 02 September 2022
PUBLISHED 20 September 2022

CITATION
Yusriadi Y and Cahaya A (2022) Food security systems in rural communities: A qualitative study.
Front. Sustain. Food Syst. 6:987853.
doi: 10.3389/fsufs.2022.987853

Food security systems in rural communities: A qualitative study

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Indonesia is rich in natural resources, but the problem of food insecurity is still a significant concern. However, few studies still examine the relationship of socio dynamics in contributing to local ecosystems to create food security. In this study, we discuss how social dynamics contribute to normative structures, community habits, and livelihoods to meet the living needs of rural communities in creating household food security and how they try to deal with worsening food insecurity through the local wisdom of rural communities. The research methodology is participatory qualitative, while data collection is through a Discussion Group Forum (FGD) and in-depth interviews with rural communities. Fifteen villages contributed to this study, interviewing 14 villagers individually, and the rest were grouped in FGDs based on livelihood categories and equal access to forest and coastal areas. Interview notes and transcription of citations were analyzed using the Thematic Framework Analysis (TFA). The study results illustrate that the village food system is vulnerable to human and natural capital. An adaptation of rural communities will experience food security difficulties when ecosystems do not provide sufficient protection due to a fluctuating climate, crop failure, and loss of household labor due to travel and health emergencies. In addition, food security is created through the dynamics of a well-maintained environment and rural local wisdom, which facilitates broad access to food provided by nature, agricultural land, marine resources, environmental knowledge, community relations, and labor. Our findings highlight the need for interventions that promote environmental conservation goals and introduce social structures that support food security.

KEYWORDS

coping methods, food security, subsistence farming, rural communities, Indonesia

Introduction

Food security remains a global goal, defined as achieving sufficient access to nutritious food for healthy growth (Banik, 2019). Data shows that 149 million children suffer from food insecurity worldwide (Khadija et al., 2022), one of the variables is the lack of adequate nutritional intake for child growth and development; until now, it is still a world problem (Bailey et al., 2015). The implementation of sustainable food security policies in Indonesia has ordered every province to address the issue of malnutrition by protecting ecosystems (Damanik, 2018). There is a consensus that further research is needed to understand better the role of natural ecosystems in developing food security systems for vulnerable communities, such as the poor, pregnant women, and children (Powell et al., 2015; Cruz-Garcia et al., 2016).

The results of previous studies have shown that natural ecosystem products support the regular functioning of food systems by providing a wide variety of food and nutritional intakes, as well as providing livelihoods for rural communities (Powell et al., 2015). In addition, research conducted in tropical forests shows that rural communities are more likely to consume a varied diet than those who mostly rely on buying food at the market (van Vliet et al., 2015). Significant resources, such as vegetables and fruits, can be obtained freely from nature; abundant natural resources enable people to generate income, such as ecotourism, fishing for sale, and farming (Cruz-Garcia et al., 2016).

The specific role of natural ecosystems in creating food security is still challenging. Food security is a condition that improves, such as food availability, or a person can eat their favorite food, thus avoiding hunger that can occur over a certain period (FAO, 2017). In the context of the contribution of nature as part of daily food security, it still seems to be an exciting thing to study, given the realities that exist in society, for example harvesting wild vegetables is not only a daily activity but can also reflect the level of food availability that is deteriorating depending on the environment and social acceptance of harvested items (Powell et al., 2015; Paumgarten et al., 2018). Meanwhile, in the context of adaptation to climate change, the current use of natural ecosystems as a mechanism for meeting the needs of life is expected to safeguard natural resources for future life because natural threats often occur, and the community gradually adopts steps to manage risks (Eriksen et al., 2005; Berman et al., 2012). Therefore, testing the contribution of natural resources in meeting food security requires a comprehensive study of resources and practices carried out by communities through several food security scenarios (Pramova et al., 2012; Powell et al., 2015).

In addition, it is also necessary to examine the contribution of food from natural resources to assess steps in creating food security because dependence on nature and livelihood practices can sometimes be a "poverty trap" (Paumgarten et al., 2018) which leads to increased vulnerability to natural disasters, such as droughts and floods. Such challenges usually force someone to sell their assets to make ends meet and increase the extraction of natural resources. In addition to reducing the availability of natural resources, this last problem will also impact the community regarding natural hazards due to ecosystem degradation (Ferse et al., 2014). In addition, despite having rich natural ecosystems and being easy to access, problems for vulnerable communities such as the poor are usually difficult to have an asset base to utilize sufficient varieties of natural resources (Paumgarten et al., 2018) or to invest in high-return ventures (Brouwer et al., 2007; Orsini et al., 2013).

This study further discusses the function of natural ecosystems in helping rural communities create food security by looking at the social dynamics that affect rural areas in Bone Regency, Indonesia. This study examines two problems; first, the extent to which adaptation to natural ecosystems supports the food security system in the village; secondly, the factors that influence how communities can benefit from natural ecosystems when food insecurity occurs in the village.

The scope of this research is to explain the social dynamics that make a beneficial contribution to the ecosystem toward the creation of food security in the village (Grote, 2014) because the community, on average, uses natural products (more than 85%), the population density is low, good access to nature, and lack of extractive activities directed at markets (Ramirez-Gomez et al., 2015). These variables are combined to describe an "ideal" case scenario (Yin, 2009), which serves to ascertain the role of natural resources in creating food security among communities whose food systems and livelihoods are well adapted to their environment (Paumgarten et al., 2018).

This research is related to the social dynamics in which people's livelihoods are related to subsistence in highland and lowland areas that are rich in biodiversity, especially in Bone Regency. This research believes collaboration between humans and nature to create food security is very much needed. While recent efforts have been made to produce policies related to environmental changes caused by global warming (Schuldt and Roh, 2014), topics such as these often ignore problems of rural communities that have not been addressed directly (Jang and Hart, 2015). Food security is a constitutive part of the reality of society; for example, a health and demographic survey found that Indonesia was ranked fifth in the prevalence of stunting in the world, and the results of research from Basic Health Research in 2013 showed the prevalence of stunting was 37.2%, including health problems who are heavy because they are in the range of 30–39% (Hadi et al., 2019). In addition, data from the Meteorology, Climatology, and Geophysics Agency shows that floods and droughts occur periodically in Indonesia (Pratiwi et al., 2016), and climatic conditions indicate seasonal weather patterns change in the region. In addition, conservation models highlight that areas rich in biodiversity may face extinction threats from other sites, as intensive deforestation can further affect sensitive plant and animal species (Joetzjer et al., 2013).

We assess food security through group discussions about the supports that affect food access and the adaptation mechanisms they adopt. We apply the concept of "strategy," which is the response adopted to deal with the constraints experienced in the social structure of society, such as knowledge and management systems (Bacon et al., 2012). This structure includes cultured adaptation to the environment that helps to cope with disasters, known as "adaptive strategies" (Schlueter et al., 2012). The literature on coping behavior is considered an appropriate indicator of food security. A comparison of previous studies found that coping strategies reflect worsening conditions of food insecurity as individuals seek to balance their food needs with increased income (Harvey et al., 2014). Families usually take advantage of available resources (such as wild food) when food insecurity is mild. However, as food scarcity worsens,

unsustainable ways to access food become more common, such as selling their assets (Kimani-Murage et al., 2014). Survival strategies such as fasting foreshadow problems to overcome. Transitions in the face of short-term food insecurity, for example, the livelihood systems of landless freelancers, are likely to experience hunger quickly when they are out of work for several days. In turn, the absence of a food insecurity type coping strategy despite a disaster indicates that the food security system can recover quickly to avoid the collapse of local livelihoods.

This research frames studies related to sustainable livelihoods (Serrat, 2017), using a qualitative lens to explain the socio-economic dynamics that affect the food security of rural communities, which are described in economic activities, lifestyles, and types of identities (Rigg, 2007). This approach contributes to a shift in the understanding of livelihoods from accumulating money and tangible goods to immaterial, like social connections, forms of association, and traditional knowledge (Reyes-Garcia et al., 2008). This study pays special attention to rural communities because they are subject to several social arrangements, such as village norms that regulate people's lives and the political economy related to the state. Such circumstances may be necessary as the ability of rural communities to benefit from agriculture may be limited by official constraints such as conservation rules (van Vliet et al., 2015) or informal barriers such as social prejudice (Kuhnlein et al., 2013).

Strand of concern

The study was conducted in Bone Regency, South Sulawesi Province, Indonesia. It comprises five sub-districts containing fifteen villages (Figure 1). The area has experienced substantial population growth in recent years. Indonesia's 2010 census reported 238 million people, while 2020 found 270 million people (Wardaningsih, 2021), with a land area of 1.9 million square kilometers, so the population density is 141 people per square kilometer.

The annual temperature varies from 26.6 to 27.0°C, while the annual rainfall ranges from 2,000 to 4,000 mm (Supriadi et al., 2019). Natural forests occupy more than 58 percent of Indonesia's territory, with no significant deforestation documented in the last decade (Mawardi, 2019). There are two seasons: wet (October–February) and dry (March–September). The highest river elevation and discharge in Bone Regency occurred in January and February (Dwiyanto et al., 2016). Bad weather events occurred seasonally, such as prolonged droughts in 1972, 1997, and 2019, while major floods occurred in 2003 and 2021. During the drought period, water discharge was around 30–50% lower than usual, whereas during the rainy season water discharge is higher than normal, ranging from 40 to 90% more than the average (Apriani et al., 2018).

Village government administrators are village heads assisted by village officials as elements of government administration. The villagers directly elect the village head through village head elections. The village already has electricity and running water and already has sanitation. For education, the village already has Elementary School, but Junior High School and Senior High School are still limited, and the majority are only found in the city. Rural communities' primary income sources are agriculture, fisheries, and livestock (Ray et al., 2021). Several types of agricultural land were carried out on highland and lowland plots. Rice and cocoa are grown in the lowlands, while corn is mainly grown in the highlands. Onions, carrots, cucumbers, eggplant, tomatoes, and spinach are intercropped. Households consume most of the agricultural products.

The fisherman's produce is also used for household consumption, although occasional sales are expected. Types of fish, such as tuna, skipjack, snapper, and *Decapterus*, are widely sold in the city market. In addition, some households also raise livestock, such as poultry. Paid agricultural labor also exists, but the work is usually short-term. Some of the reported forms of non-agricultural labor wages include (1) non-professional services (e.g., construction); (2) administrative work for the public (e.g., schools); (3) becoming a member of the village council.

Bone Regency is one of the leading rice-producing districts in South Sulawesi Province, Indonesia. Since the early 2010s, perceptions of ecological diversity have driven conservation actions to maintain village livelihoods. Local governments have developed natural resource management in collaboration with communities, including zoning schemes that divide community areas into use and conservation areas (excluding foraging activities) and prohibitions on forest destruction and fishing with dynamite or poison. This policy aims to save animals and help regenerate specific native flora and fauna (So, 2014).

Method

Between March-June 2022, data was collected using participatory approaches. Discussion groups (FGDs) focused on (1) local livelihoods, (2) nutrition, and (3) strategies to address food insecurity (Krasny et al., 2014). During the FGD discussions focused on livelihoods, the discussion participants shared their living conditions, economic activities, the role of household members, and the changing seasons. Participants also described the social classification of the community through local criteria. During the FGD on nutrition, participants jointly make a list of the foods they eat; this discussion provides contextual information for subsequent discussions regarding food limitations and strategies to overcome them.

Discussion use coping methods (Maxwell et al., 2008), participants focused on the specific circumstances that limited food availability and the approaches families used to deal with

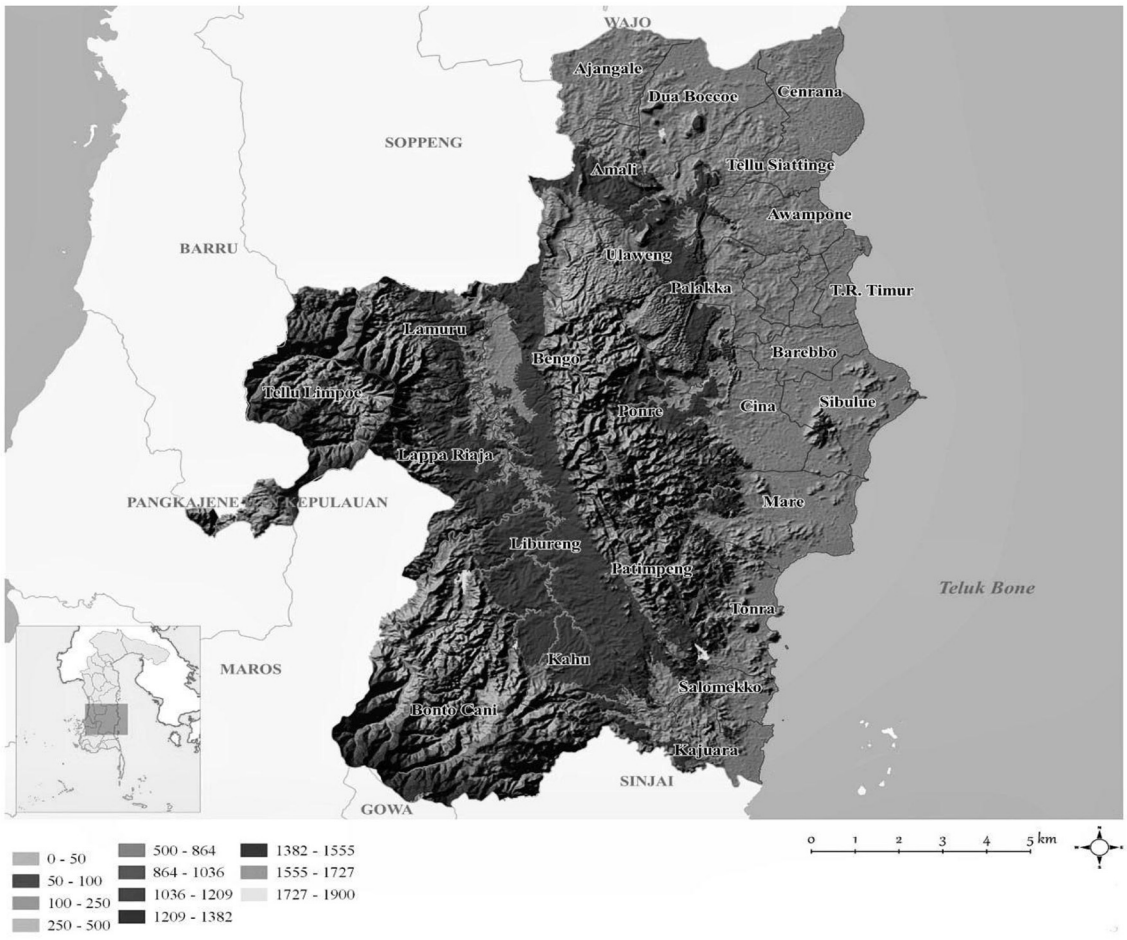

FIGURE 1
Bone Regency, Indonesia.

them. Food deprivation conditions are categorized in "severity scenarios,' which indicate how much household eating patterns are affected. This helps determine which set of coping methods is more commonly used according to varying degrees of a deteriorating situation. Finally, participants detailed the assets mobilized for every coping behavior and the formal norms influencing its implementation.

Fifteen villages contributed to this research, fourteen were interviewed individually, and the rest were grouped into two groups because they have the same livelihood and access to forest and littoral areas. Fifteen participated in the Forum Group Discussion (FGD) (Table 1), and all participants were chosen using a purposive method. Participants were grouped according to land ownership area and income. Livelihood discussion groups aim to get an alternative social description so that male and female residents of various ages are also invited to participate. Meanwhile, the nutrition discussion only involved women charged with preparing food for their families. Because one participant village considered everyone equally good, only one group discussion on coping strategies was conducted. Coping strategies are carried out separately with the "rich" and "poor" populations as a variable of susceptibility to food security (Horta et al., 2013).

One facilitator conducts a discussion group in Indonesian. When required, the fieldwork coordinator aids with the translation into local languages. Discussions were recorded, and freehand notes were collected. Contribution is optional, and written consent is collected from each person after explaining the study goals, participant rights, and data usage. The study obtained ethics approval from Sekolah Tinggi Ilmu Administrasi Puangrimaggalatung Ethics Committee.

Handwritten notes and transcribed citations were analyzed using thematic framework analysis (TFA). Food shortage scenarios and coping techniques were identified as the two main topics. According to the severity situations, the first category has three subcategories (Table 2). There are 14 subcategories in the

TABLE 1 Quantity of discussion groups and sources per topic.

Practice	Group discussion	Total duration (minutes)	Informants	
			Men	Women
Livelihoods	2	120	14	5
Native Nutrition	5	90	2	16
Adaptive methods	8	120	12	10

TABLE 2 Situations of food scarcity reported by socioeconomic aspects.

Scarcity Occasion	Group Discussions			Total
	Rich	Poor	Mixed*	
Seasonal reversal	4	4	2	10
Labor deficits in the home	4	6	2	12
Health crises	6	6	2	14

*A single discussion group in a village found that everyone there had the same income level.

second topic for each of the coping strategies that were found. Some subcategories are directly connected to the livelihood's framework: (financial, physical, social, cultural, and natural).

Capital mobilization patterns were identified by grouping coping techniques into categories based on their relevance to various severity situations; consensus ranking was applied (Maxwell et al., 2008). The approach is tailored to the severity scenario; if a strategy is tailored to both situations equally, the number of references in the adjacent category is utilized to establish the final categorization (Table 3).

Result

Native nutrition

Informants consider food filling and nutritious if it consists of rice, fish or meat, eggs, tomatoes, chilies, and stir-fried spinach. And drinks from fruit ingredients, such as oranges, apples, dragon fruit, and avocados. The main agricultural contribution to local food is rice, usually cultivated in the lowlands, and maize, available throughout the season. Residents stated that tomatoes, chilies, spinach, and long beans are typically grown in the house's yard. In contrast, fruit crops, such as chayote, lettuce, cocoa, sweet potatoes, and cassava, are usually produced in the highlands.

The contribution of natural food for the lowlands, which is often consumed, is fish, while for the highlands, it is corn. The fish captured for household use differ from those sold for commerce, such as milkfish. Most lowlanders fish for smaller species such as tuna, skipjack, anchovies, snapper, and mackerel. At the same time, food for the highlands is usually from vegetables such as corn, cassava, sweet potatoes, and pumpkin. Season affects the availability of wild food. Residents report more varieties of fish and maize during the rainy season when high water levels are thought to attract fish and crops to thrive, making farming and fishing easier.

Fishing and foraging for the lowlands (collectively known as fishermen), while farming and foraging (collectively known as farmers) are usually carried out daily. Besides corn, food is rarely stored due to humid climatic conditions for highlanders and residents' preference for fresh produce. Processed food products that are easy to store, such as instant noodles (*indomie*) and pasta, are sometimes added to food; the smoking technique of fish is used more as a culinary option.

Food scarcity

Participants consisted of two discussion groups: the "rich" community and the "poor" group. The results of the FGDs illustrate that there have been no cases of hunger in recent years, and there is always something to eat every day in the community. But the discussion results recognized several factors that affect the community's ability to obtain food in the desired proportion, diversity, or value (Table 2).

First, participants informed that for fishers, going to the sea to catch fish is spontaneous activity; although, in general, fishers manage to get fish to eat, it is not sure what kind of fish they will get every day. This uncertainty is considered more acute if the weather conditions are not good. Seasonal events (strong winds and heavy rains) usually occur in April, limiting fishing mobility. As in the rainy season, many fish species will be scattered on the edge of the sea or river. And for the highlands, vegetables and fruits will be fertile. During the transition from the rainy to the dry season, households whose livelihoods as farmers are negatively affected by the decline in agricultural yields; for fishers who catch fish in rivers, there is a decrease in river water, so the fish will also decrease. These difficulties were worsened by extremely dry or rainy seasons.

The second factor that affects food availability is the unavailability of household labor for the short term due to travel or illness; it interferes with farming and fishing activities for the family's daily needs. The last factor is a health emergency, especially one that requires hospitalization so that households will experience long and medium-term household labor unavailability; this will impact production effectiveness and financial pressure and cover travel and subsistence costs if seeking treatment in the city.

Based on the discussion, the participants described several scenarios related to the increasing condition of food insecurity. All group participants proposed a severity gradient of up to three levels, which was later adopted: (1) mild severity: short-term problems for meeting animal protein, when people find it challenging to fulfill fish or eggs for several days due to unsuccessful farming or fishing, weather effects, or the

TABLE 3 Allocation of coping methods by socioeconomic aspect and severity scenario.

Coping Strategies (CS)	Total	List of groups reporting CS to a socioeconomic aspect			List of groups reporting CS to a severity scenario			Consensus ranking
		Rich	Poor	Mixed*	Low	Medium	High	
Consuming wild foods that aren't as popular	15	3	10	2	9	5	1	Low intensity
Limiting meal servings	8	1	6	1	4	2	2	
Consuming the same foods every day (no meat or fish)	9	2	7	–	7	1	1	
Exploring seldom-visited fishing locations	11	4	6	1	2	8	0	Medium intensity
Heavy reliance on food that is given from nearby neighbors	10	1	7	2	3	6	1	
Women and children doing farming activities	8	1	6	1	2	5	1	
Agricultural profit-sharing system	11	4	5	2	2	9	0	
Relatives' financial contributions	10	2	6	2	0	1	9	High intensity
Borrow money from the bank or grocers	10	2	4	4	1	3	6	
Farming in a conservation area	10	1	8	1	1	2	7	

*A single discussion group in a village found that everyone there had the same income level.

temporary absence of domestic workers; (2) moderate severity: a more extended period of animal nutrition intake when diets are more dependent on agricultural process. This relates to weather conditions such as heavy rains or droughts and labor unavailability for a week or several days; (3) high severity: a period when families can no longer meet their nutrition needs through farming or fishing, usually because of a health crisis. These conditions lead to poor eating patterns, considering that the capacity of households to buy food is limited due to finances and medical expenses, especially if they travel to the city for health care.

Local approaches to food security improvement

Participants provide details of their opinions on food insecurity scenarios in Table 3. The "rich" and "poor" groups almost all responded similarly to coping strategies. Common coping behaviors include consuming less popular wild foods, limiting portions, and eating the same foods daily (no fish or meat). One way to avoid poverty, such as selling assets, is only mentioned once and is therefore excluded from the discussion. The only difference observed between participants for the socio-economic group in the form of dependency that seemed to be greater among the "poor" people was the profit-sharing system for the rice fields owners.

Low levels of food scarcity were associated with a response concentrating on managing local resources. This requires additional effort and energy in fishing and farming activities, which adopt rationing strategies and access to food sources. Allotment involves reducing food portion sizes or growing wild food consumption less desirable because of their flavors, such as eating eels, grasshoppers, and paddy birds. In addition, eat the same food source every day, consisting of corn, sweet potatoes, taro, and sago (without meat or fish) for several days until farming and fishing activities can resume.

Medium food severity relates to a strategy of shifting to the environment by adopting measures of nature exploration, collective consumption, mobilization of additional household resources, and a profit-sharing system. The natural exploration is carried out due to weather factors so that the affected people travel further than usual to catch fish; collective consumption depends on sharing food from neighbors or family; additional resource mobilization involves women and children in agricultural activities; undertaking a form of "profit sharing" of agricultural produce, in which households provide agricultural land to neighbors who then share the harvest or trade agricultural produce with grocers.

Responses to food insecurity of high severity focus on access to cash income, taking credit, and exploring protected areas. Increased access to cash is primarily met by unconditional financial assistance from families or selling fish catch or forest products in urban markets. To get wild vegetables or fruit, people sometimes enter conservation areas, where there are usually a lot of vegetables or fruit stocks. Sometimes it is also necessary for the community to take credit with the collateral being livestock, such as cows, to meet their daily needs.

Coping mechanisms and methods of capital utilization

In food scarcity of low intensity, local comments focus on humans as contributing to access to protein sources (Tables 4–6). The form of human capital in a healthy family member leads to access to food consumption provided by nature; the participants focus on the role of knowledge and skills possessed. This relates

TABLE 4 Addressing food insecurity with low intensity.

Coping Strategies	Types of capital						Norms
	Physical	Economic	Human	Cultural	Organic	Social	
Low intensity							
Consuming wild foods that aren't as popular	Harvest instruments		• Normal adults • Healthy adolescents	• Knowing recipes • An analysis of plant species • Foraging abilities	• Vegetables available • Fruits available	Consuming wild foods that aren't as popular	
Limiting meal servings	Harvest instruments		Normal adults	Processing knowledge of fruits and vegetables	Fertile farmland		Traditional land
Consuming the same foods every day (no meat or fish)	Equipment for processing crops		Healthy adolescents				

to the ability to identify edible plants or fruits that are not harmful to health and the habit of regulating food patterns daily so that you don't overeat. At this stage, culinary skills and recipes adapted to available ingredients, such as corn products, are the main thing, as well as growing fruits that do not need labor-intensive harvesting.

At the level of intermediate needs, households apply human, cultural, and social capital. Human capital in healthy household members leads to more vigorous efforts to access agricultural land to forest areas or catch fish in places that have never been visited, thus requiring physical capital such as spears or nets. Furthermore, the informants believe it is essential to have a strong awareness of spiritual values to avoid disturbing sacred sites when farming or fishing. In turn, social capital helps residents access crops and fruits through food-sharing behaviors rooted in traditional patterns of reciprocity as an expression of the bonds and closeness of the village community. This practice of sharing assistance does not require reciprocity on a specific timeframe or comparable exchange. This donation may be repaid at an indeterminate time in the future and other forms. Due to the lack of available labor, households sometimes mobilize women and children in farming and fishing activities. For fishing involvement, women and children are generally considered less understanding due to limited abilities and physical power compared to male fishers. The "rich" households provide agricultural land to the "poor" households so that they will share the results after harvesting. The period for managing this agricultural land varies according to the agreement between the parties.

The variety of equipment, knowledge, and abilities necessary at the most significant degree of necessity for farming or fishing is more limited than in the previous scenario because farming or fishing is aimed explicitly at observing market conditions. Social capital is also vital against severe shocks; establishing good relations with traders is very useful for commercializing crops or marine products. In addition, having family who lives in urban areas will make it easier to help financially for households experiencing health emergencies. Financial capital emerged as a factor to consider while gaining money in the form of credit at the bank, such as fulfilling the needs of agriculture or fishers. Although both "rich" and "poor" informants said they could get credit, the amount of credit that could be obtained depended on the value of their cattle. As for the monthly income in securing credit, only those with a fixed wage (village officials) can meet their food needs with this approach. In all these transactions, social capital is relevant but in the form of acquaintances with individuals who are not community members. This is different from a community-based, mutually supportive relationship; cooperation with external parties requires an agreement for payment.

Adaptation methods at the interaction of societies

Villagers' responses to different levels of food insecurity require engaging in other normative structures; in undergoing low food scarcity, the form of coping leads to community-based rules. The existence of dependence on agricultural products for daily food needs shows the importance of residents' rights to agricultural land. According to research observations, residents always have something to eat, regardless of wealth, they own at least one piece of land, and annual cultivation activities

TABLE 5 Addressing food insecurity with medium intensity.

Coping Strategies	Types of capital						Norms
	Physical	Economic	Human	Cultural	Organic	Social	
Medium intensity							
Exploring seldom-visited fishing locations	• Fishing equipment • Farming equipment • Travel gear		Normal adult male	• Knowledge of the terrain • Knowledge of fruits and vegetables • Farming or fishing skills	Vegetables, fruits, and fish are available.		• Community land rights • Gender roles • Community natural-resource management strategies
Heavy reliance on food that is given from nearby neighbors				Knowledge of reciprocity and sharing customs		A good relationship with family/ neighbors	Traditions of redistribution and reciprocity
Women and children doing farming activities	• Fishing tools • Harvest equipment		• Normal adults • Healthy adolescents	• Knowing recipes • Knowing fishing areas • Basic fishing techniques • Foraging abilities	• Fish available • Vegetables and fruits available		• Community land rights • Gender roles • Community natural-resource management strategies
Agricultural profit-sharing system	• Tackle for fishing • Tools for agriculture					A good relationship with neighbors/ family	• Gender roles • Equal profit-sharing rules

10.3389/fsufs.2022.987853

TABLE 6 Addressing food insecurity with high intensity.

Coping Strategies	Types of capital					Norms
	Physical	Economic	Human	Cultural	Organic	Social	
High intensity							
Relatives' financial contributions						• Significant connections with family • Cities with relatives	
Borrow money from the bank or grocers		Cash inflow				Excellent rapport with banks or grocers	Business rules
Farming in a conservation area	• Farming tools • Travel tools		Adults in good health: male or female	• Knowledge of where to farm • Farming skills	Land available		• Community land rights • Community administration structures • Market rules

provide immediate access to food, despite the constant nature of foraging practices.

With medium food insecurity, residents are exposed to a mix of local and external regulations. This includes the right of residents to exploit natural resources in their territory and the obligation to respect conservation areas. In addition, the tradition of sharing food with relatives or neighbors; harvest-sharing mechanisms, however, are highly dependent on the market economy. In the market, there is competition among people because they offer the same crops (vegetables, fruits, or fish). Meanwhile, seasonal effects on traditional products to market transactions sometimes create low market prices. Market prices are currently influenced by external factors, such as fluctuations in cooking oil and fuel prices.

This mix of local and global standards is also observed at high levels of food insufficiency. In times of severity following a health emergency, communities depend on agricultural land for essential food sources and exploitation rights in marine areas or forests to obtain vegetables, fruit, or fish to sell. If exploitation is carried out in a conservation area, communication with the village government is required; residents then convey the nature of the emergency and how many resources are needed. If vegetables, fruit, or fish are obtained, villagers face challenges in market economic conditions. The informant explained that selling vegetables, fruit, or fish is difficult to get high profits due to the presence of grocers and the market situation. Village markets are usually purchased by grocers at low prices, while transportation costs to the city are relatively high for urban markets. The informant's explanation of the "greedy" traders illustrates the villagers' obstacles in overcoming these problems.

Discussion

The explanation of diet, food security, and behavior in dealing with problems in Bone Regency focuses on three things from the socio-economic adaptive of food security in subsistence societies in Indonesia. First, similar to the results of research on nutrition in the socio-ecological environment, villagers have adapted to meet their daily needs through biodiversity, with natural food being the central part of residents' nutritional intake (Sunderland et al., 2013). However, dependence on raw food exposes citizens to constant fluctuations in access to food. Denial activity is inherently difficult to predict and does not guarantee stable access to quality nutrient intake, even though fishers and farmers have substantive skills and work in favorable climatic conditions. Villagers are also vulnerable to bad climates, such as floods or prolonged droughts, thereby reducing the availability of food from nature and directly limiting people's physical access to farming or fishing. Traditional livelihood activities are also vulnerable to the unavailability of labor in households. Given that farming or fishing activities are carried out every day, the unavailability of work due to illness will rapidly impact the

fulfillment of food in the household. Health conditions can potentially interfere with the household's ability to meet daily needs if they have bodily disabilities or chronic illnesses. The role of adult men in the household is the main thing; apart from being the head of the household, they are also responsible for agricultural or fishing activities.

Second, there is no indication that poor weather conditions, labor shortages, or health issues are creating hunger or poverty in the area, showing that regional food sources are robust enough to prevent acute food insufficiency (Diamond-Smith et al., 2019). While sharing food from family or neighbors becomes a mitigation measure if there is food insecurity in the medium term in Bone Regency, regular access to nutrition is mostly fulfilled through culturally entrenched community norms that support agricultural land management or fishing. The local wisdom system, intercropping seasonal crops, cultivating crops such as corn in the highlands, gardening in the yard, and ensuring a visit to staple crops throughout the year. During the same period, the agricultural production-sharing system allows residents to farm regardless of their wealth. Previous research has focused on the role of forest resources in insurance mechanisms (Paumgarten and Shackleton, 2011). The results of our study illustrate that for the same socio-economic part, forest and marine products have a role for villagers during food insecurity. This means that forest and aquatic products help provide nutrition for villagers dependent on agricultural and fishing activities through the availability of alternative protein sources (e.g., vegetables or fruits) and cash sources (fish) to buy processed foods that are easy and durable if stored. In addition, although sales of forest or marine products are usually low in the market because it depends on the market situation, as reported in the results of this study and elsewhere (Vliet et al., 2014), it is a practical method to deal with food insufficiency, because most of the villagers have been able to fulfill the most basic needs through agricultural products or fishers.

Third, as stated by the informant, villagers' response to the threat of food insecurity illustrates a sturdy dependence on ecological capital (Paumgarten et al., 2018). How to use it varies according to the level of food insecurity. At a low level of food insecurity, villagers can use a variety of natural foods to create food security. This limited choice illustrates a gradual change in the types of food fulfillment activities by villagers, namely shifting from non-monetary collective consumption to the trade sector. Under heavy pressure, villagers focus on the exchange rate of natural resources as products. As for the prevention of severe food insecurity, the informant explained that it might not be seen as a form of poverty but only described as a failure in the capacity for local livelihoods to meet household food needs. Villagers were forced to move away from their community life into a broad economic activity. For villagers, this is a big challenge because of the transition. Apart from being small economic actors, villagers rarely communicate with city traders and have minimal knowledge of market situations.

Fourth, from several levels of village food insecurity, this situation helps to identify sustainability challenges related to natural ecosystems and subsistence villagers' food security. Although local adaptation to the environment and forest or marine conditions is well maintained to create food security in Bone Regency, it is questionable if food stability will become periodic access to the fulfillment of sufficient nutritious food for healthy living and expected growth (preventing stunting) (FAO, 2017). Of course, research on nutrition shows that traditional food methods can provide a balanced and healthy diet (Kuhnlein et al., 2013). Fluctuations in the quantity and quality of food villagers consume, such as labor shortages and climatic conditions, are common. Historical meteorological data show frequent above-average droughts and floods (Runtunuwu et al., 2011). For example, a 2015 study in Batu City, Malang Province, found that farmers reported stopping agricultural activities during the dry season (Chiari, 2015). At the same time, the lifestyle of subsistence farmers who live in forest areas has increased for energy needs. Research in the Amazon region noted that subsistence means of support provide daily energy needs among 3,200 and 5,900 cal, closely related to seasonal situations (Duran et al., 2016). A temporary inability to meet the caloric intake is likely to impact villagers' health, especially for vulnerable groups such as pregnant and lactating women and toddlers (Burchi et al., 2011).

The design of prospective environmental dynamics raises additional concerns. To date, biodiversity in Bone District has been observed to support alterations in food availability such that times of food insecurity are short-term, and some of the less desirable natural foods are usually available when preferred alternatives are not available. Nevertheless, the local ecological balance could be due to the influence of environmental changes on a grander scale (Pramova et al., 2012). For example, climatological evaluations for parts of Indonesia have noted intensification and potential for drought in the dry season (Dewi, 2019), and data from conservation models show areas rich in biodiversity can overcome threats of severity originating in other regions due to the continued impact of deforestation (Ataur Rahman and Rahman, 2015).

The dependence test of natural capital with other capital produces significance based on the population's capacity to utilize the existing ecosystem. Human capital has a significant role considering that a healthy workforce can only manage natural resources in a subsistence economy. In Indonesia, villagers confront health hazards such as a lack of sanitary infrastructure, restricted access to health care, and living in places where widespread tropical illnesses such as dengue fever (Wulandari, 2016). Uncertainty about the effect of climate change on vector-borne diseases (Brondízio et al., 2016) emphasizes the need to include human capital issues in conservation arguments over food security. Village peoples' food security may be jeopardized not just by repeated short-term labor losses but also by the potential for minor diseases

to become health crises owing to a lack of care. Furthermore, endemic disorders might impair people's ability to absorb nutrients from meals (Sabagh et al., 2021).

Food insecurity is severe, yet a significant amount of money emerges as communities are compelled to seek resources in non-community. Cultural assessment and social capital work together as primary natural resource mediators. The style of communal eating that has become the villagers' local wisdom enables them to get food from relatives or neighbors (Kuhnlein et al., 2013). Similarly, environmental knowledge and the ability of communities to cultivate the land are essential for ensuring access to natural food (Paumgarten and Shackleton, 2011). Discussions discuss nature-based techniques that assist villages outside the local setting, where typically, the emphasis has been on the household-level economy (Ekici and Besim, 2016) or measurements of personal nutrition (Piperata et al., 2011). With this community-based support, there are apparent limits since the resources required to meet the nutritional needs of villages may not be accessible locally. For these conditions, networking with outside individuals as social capital becomes a link for offerings to villagers dealing with food insecurity (Bebbington et al., 2006). Link to external resources also shows that it has a vital role in increasing the cultural capital of villagers. Minimal market data access is an economic obstacle that affects market-oriented agriculture or marine products and subsistence households experiencing food insecurity (Vliet et al., 2014).

Some hierarchical obstacles raised concerns about the function of marine or forest components in making appropriate contributions to subsistence-oriented villages experiencing acute food insecurity. Furthermore, villagers' adaptability to the environment supports long-term capital, the value of which is restricted in the market system. The expression of human capital focuses on physical strength, and this physical capital comprises agricultural or fishing equipment (Almendarez, 2013). The qualities that allow a family to follow traditional livelihoods effectively disadvantage it in the larger political economy (Rigg, 2007). Furthermore, physical isolation to protect communities from biological diversity loss often promotes worsening market circumstances for unfavorable bargains (Vliet et al., 2014). This research shows that farmers and fishers are obliged to compete, transportation expenses are considerable, and merchants have pricing control. These obstacles erode environmental sustainability and nature-based nutrition insurance schemes. Furthermore, continual environmental changes harm livelihoods, putting additional strain on crops such as vegetables and fruits as locals resort to the vegetable or fruit commerce to supplement their earnings (Vliet et al., 2014).

Our findings on capital assets have possible implications for global and national policies. Many policies focus on strengthening the agricultural sector by increasing export-oriented production, focusing primarily on commodity crops; these initiatives often ignore pressing local needs, focusing on indirect benefits from ecosystems (Daw et al., 2011), and often unintentionally cause environmental damage. In the rural landscapes we studied, outcomes for food security were linked to biodiversity in terms of ready access to land for local people and human capital. In food security, the main themes considered include social, human, and natural capital; for example, food production depends on natural capital, requires health and knowledge, and often benefits from good social relationships with others (Wittman et al., 2017). These findings indicate that natural resource wealth and human capital influence food security in Bone Regency. It, therefore, seems essential to encourage synergies between food security and biodiversity conservation. As identified in this study, strategies appropriate for specific rural areas must be complemented by strategies tailored to urban areas and possible interactions between different landscapes. For example, in many developing countries, rapid urbanization uses resources generated in rural and suburban areas (Lerner and Eakin, 2011), thereby creating connections between different landscapes. Long-distance relationships between landscapes can also be meaningful. Our findings on the role of human capital and the environment demonstrate the relevance of interactions with places outside a particular landscape *via* socio-ecological (Liu et al., 2013).

Limitations

There are several barriers to using the participative technique in this investigation. First, while the study team has incorporated several sources, the informants do not constitute a statistically representative sample. This research examines socioeconomic situations and consistently delivers conclusions based on the discussion group and interview data. As a result, it is questionable if this concealed bias could influence informants (Mosse, 1994), limiting the study's generalizability to specific locations.

This research approach does not use strategies for dealing with food emergencies, like as calorie restriction or stunting (FAO, 2017). We explore the exact dimensions of food security that the informants have directly experienced and grasped since the participatory method stresses local representation and knowledge (Schreckenberg et al., 2016). This qualitative study's findings reveal a link between nature and people, which may be utilized as data for future quantitative research on food security. Furthermore, the results of this study give information that may be used to better understand villagers' policy decisions about nutrient intake and resource protection (Kuhnlein et al., 2013).

Because participatory research attempts to explain real situations in a limited amount of time (Mosse, 1994), its limitation is that it does not analyze in-depth knowledge and perception as a social method. Furthermore, concentrating on people's experiences restricts our understanding of the link to

outside variables. The resilience report will give preliminary data on complicated and dynamic phenomena, allowing the long-term study to expand knowledge. Future studies will add to firsthand monitoring of villagers' interactions outside the community.

Conclusion

This research examines the role of natural resources in ensuring food security for Indonesian villages. The study's results illustrate how ecosystems do not offer enough protection owing to fluctuating climates, difficulties anticipating farming and fishing activities, and significant food insecurity for families due to labor loss. Furthermore, solutions for substantial food insecurity are implemented outside local socio-ecological conditions, which might harm communities. Moreover, villagers are hesitant to employ tactics not in line with their livelihoods since previous experiences have resulted in the loss of culture and biodiversity (Kuhnlein et al., 2013).

Our findings suggest that the prevailing view of the relationship between food security and natural resources can trigger self-fulfilling prophecies. We see an urgent need to bring social system characteristics back into existing discourses on food security and nature conservation—including issues related to equity, social capital, and people (Sunderland, 2011; Zimmerer, 2013). To this end, a socio-ecological systems perspective can provide a helpful way forward. Thus, further research is required to investigate the socio-ecological impact of food security in various combinations of market integration and attempts to exploit natural resources (Poppy et al., 2014). The evaluation is based on more than just environmental factors, dietary intake, and economics. Social structures that enable natural resource cooperation for local food supply and promote the resilience of traditional ecosystems should be evaluated appropriately. Thus, examining people's understanding of food security is necessary for future policy implementation.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

Ethics statement

The study obtained ethics approval from Sekolah Tinggi Ilmu Administrasi Puangrimaggalatung Ethics Committee. Ethics review and approval/written informed consent was not required as per local legislation and institutional requirements.

Author contributions

YY planning and developing methods in studies and research in Bone Regency, the drafting of articles until the submission process, collecting data, and conducting interviews. AC helping analyze the findings, helping draft articles, participate in making observations and help analyze the results, provide input and participate in compiling and improving the writing, help process data, and perform similarity analysis in articles. Both authors contributed to the report and approved the submitted version.

Funding

Funding for this research was provided by the Ministry of Education, Culture, Research, and Technology of the Republic of Indonesia. The funder had no role in the design, data collection, analysis, interpretation, or publication decision.

Acknowledgments

We thank the Ministry of Education, Culture, Research, and Technology for sponsoring this research and the Sekolah Tinggi Ilmu Administrasi Puangrimaggalatung Research and Service Institute. We appreciate the Bone Regency Government for arranging field activities and the villagers for allowing us access to their community.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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