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(RESEARCH ARTICLE)

Local food resilience in an effort to anticipate extreme climate in small islands of the Bird's Head Papua

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Abstract

Food security and community resilience in small islands are very vulnerable to extreme climatic conditions that pass the northern shoreline of the Bird's Head Papua. Therefore, an effort to find out what the community uses local food types in food resilience and security in times of extreme climate in the small islands of the Bird's Head Papua. The benefit index (BI) will be used to identify local food resilience with survey and field observation using purposive sampling interviews with the local community in small islands. Development of the research laid out the highest BI value of staple foods was sukun (*Artocarpus altilis*), which reported 98%, thereafter to banana (*Musa* sp.) at 94%, sweet potato (Ipomoea batatas) at 90%, taro (*Colocasia esculenta*) 89%, and cassava (*Manihot esculenta*) 87%. Vegetable crops with the highest BI value were gedi leaves (*Abelmoschus Manihot*) 90% and papaya leaves (*Carica papaya*) 85%, next off sweet potato leaves (Ipomoea batatas) 55%, cassava leaves (*Manihot esculenta*) 50% and pumpkin leaves *(Cucurbita* sp.) 45%. The highest BI values in fruit crops are mango (Mangifera indica) 70%, papaya (*Carica papaya*) 65%, banana (*Musa* sp.) 60%, and soursop (*Annona muricata*) 50%.

Keywords: Food security; Community resilience; Small island; Burd's Head Papua; Benefit Index; Staple foods, vegetable crops and fruit crops

1. Introduction

Hydrometeorological disasters in Indonesia (such as forest and land fires, drought, floods, landslides, extreme weather, and tidal waves/abrasion) are ranked first in the disaster category, with a percentage of 99% of the total 3,383 disasters. Based on the InaRISK data, this hydrometeorological disaster also harmed the small islands due to climate change impacts in the Bird's Head Papua, which realized 4,110 islands with a high disaster vulnerability category in Sorong City, Sorong Regency, Raja Ampat, and South Manokwari [1,2,3,4,5]. Climate change with extreme climate and the aftermath of the resulting disasters is a threat from the TOWS analysis in several places in West Papua, especially in the small island areas. [6,7,8,9].

Opportunities from the TOWS analysis are demonstrated by several documents, such as the Disaster Management Plan and the Zone Plan for Coastal Areas and Small Islands at the Provincial level, which are needed for synergy and synchronization in the preparation of the Strategic Environmental Assessment as the main document for regional development to see the environmental carrying capacity [10,11,12].

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The weakness of the TOWS analysis is shown by the low accessibility, data, budget, coordination, early warning system equipment, and telecommunication networks to facilitate the stages of disaster management, especially in the outermost island areas [13,14,15,16].

The strength of the TOWS analysis is shown by the number of the largest small islands in Indonesia, reaching 28% of the total small islands, which are unique to the land biodiversity that is in the Sahul and ocean shelf that extends to the Bird's Head Seascape and the coral triangle [17,18,19,20].

In an effort to overcome problems from a weak point of view and, most importantly, in the supply of local food resilience in small islands, the focus of attention is on overcoming the goal of hunger by fulfilling the Sustainable Development Goals in the Papua Region. This research filled in the need to learn the benefit index for measuring staple food, vegetables, and fruits to build resilience in the local community of small islands in the Bird's Head Papua.

2. Material and methods

2.1. Study area

The study sites are accompanied by several small Islands of the Bird's Head Papua in Raja Ampat, namely Batanta, Arborek, Saonek, Waisai, Dorekar, Igi, and Fani Island, which is geographically located 1°04'46.84" N – 0°57'15.04" S and 130°08'34.29" - 131°20'58.04" E with height above sea level spreading from 0 – 506 m (Figure 1). The moderate annual precipitation for the period 2010-2022 was an increase from 2458.9 mm to 3749 mm, the lowest and highest temperatures changed from 24.0 - 31.4°C to 22.2 - 33.9°C, and humidity increased from 85% to 95% approximately [21,22].

Derived from the territorial viewpoint, Raja Ampat Regency has boundaries: North – Republic of Palau and the Pacific Ocean; South–North Seram Regency; West – Seram Sea and Central Halmahera Regency; East – Sorong City and Sorong Regency. Raja Ampat Regency is divided into 24 districts with a region of 7,559.6 km^2. The center of government is in Waisai, Waigeo Island, with distances between islands that can reach 10 minutes to the nearest until 2.5 hours to the outermost island of Fani, with all access to transportation using traditional boats and fast boats/ships.

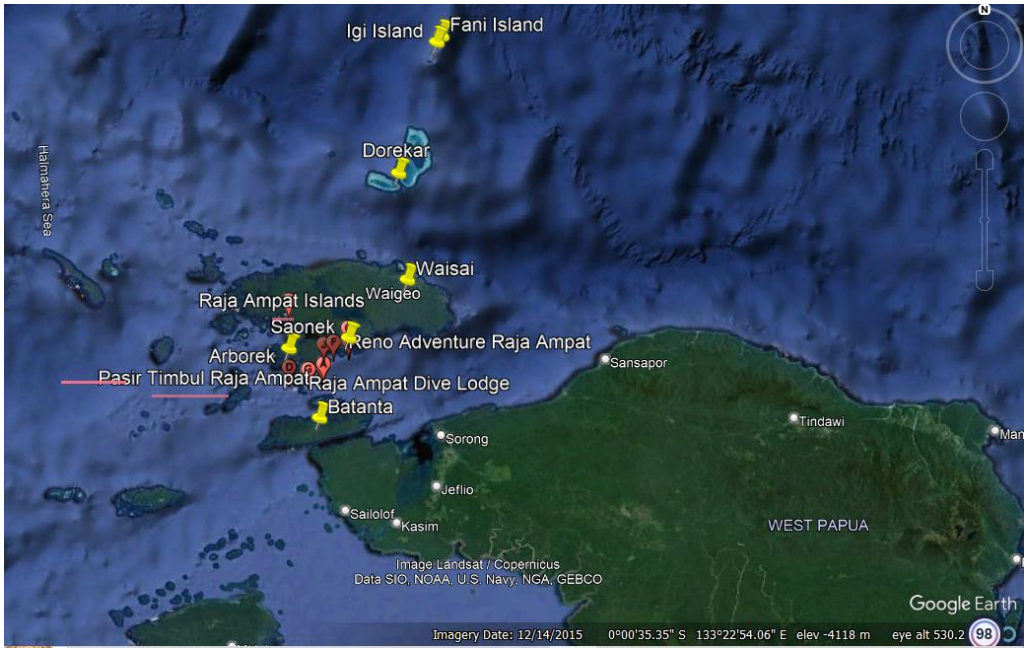

Figure 1 Research site in small islands of Raja Ampat

2.2. Method of data analysis

Data analysis of this study engaged 15 local families with an average of 6 members in each of the seven small islands in Raja Ampat who were selected by purposive sampling method from local communities living in the middle of the coast, northern and western coast, and eastern and southern coast.

Furthermore, the benefit index is used to estimate what percentage of local food contributes to local food security for the resilience of small island communities with the following equation [23]:

Benefit index (BI) = $\frac{Ji}{N} x$ 100% …….. 1

where: BI = benefit index, Ji = the number of occurrences of the use of a plant, N= the total number of occurrences of using a plant.

BI value classification consists of 0-33% (low), 34-69% (moderate), and >70% (high)

Detailed information was discovered from survey results on the seven small islands in Raja Ampat in tabular form using a Likert scale approach (prefer (like), 1; moderately preferred, 2; and highly preferred, 3) and then analyzed using a quantitative approach.

3. Results and discussion

3.1. Participant basic data

Participant basic data were collected from 15 local groups on each island with a midsize of 6 members in one group, provided in Table 1.

Table 1 Values of the participant's basic data

Participants basic data (unit)	**(Min-Max; Average)**
Length of husband's life (year)	30.0 – 50.0; 40.0
Length of wife's life (Year)	34.0 – 58.0; 46.0
Study of husband (year)	0.0 – 12.0; 6.0
Study of wife (year)	0.0 – 12.0; 6.0
Total of group members (people)	5.0 – 7.0; 6.0
Rate of income/capita/month (thousand Rp)	1,950.0 – 3,500.0; 2,725.0
Rate of income/capita/month (thousand Rp) during extreme weather events	1,600.0 – 2,400.0; 1,800.0

The middle length of husband-and-wife life is in the effective age category (15-64 years) [24]. For education, the average respondent only graduated from elementary school due to the lack of junior and senior high schools in their places, and they needed further access to reach the big island area of Waisai. Thus, education disparities still need attention, especially in small and outermost islands [25,26]. The average monthly income depends on weather conditions; with an average of half a month, fishing activities can reach 2.725 thousand rupiahs. Meanwhile, in extreme climate conditions, fishermen change their livelihood to become copra producers, with an average income per family reaching 1,800 thousand rupiahs.

3.2. Benefit Index of staple foods

The data showed that the level of satisfaction of the local community on the seven small islands in Raja Ampat can be seen that 60% of the average Villages highly preferred the local staple foods mainly dominated on the outer islands, 11% moderately preferred local staple foods, and 29% preferred local staple foods (Table 2). These results indicate that local communities in the outermost and small islands depend highly on local staple foods with minimum accessibility to reach the larger islands. However, for islands adjacent to Waigeo, access to other food options, such as rice, is more available compared to the outer small islands, which are far from transportation access. Thus, the people of the outer small islands still maintain their traditions to be resilient to the local staple foods in facing extreme climate conditions with more frequency and intensity [27,28].

Local food sources on small islands are obtained from their yards, except for large islands, where they can be planted in gardens with various crops based on local-based agroforestry systems [29,30].

Table 2 BI of the seven small islands in Raja Ampat towards local food resilience

Variables	Villages							Average
	Batanta	Aborek	Saonek	Waisai	Dorekar	Igi	Fani	
Level of satisfaction with local staple foods								
Highly preferred	50	50	50	40	70	80	80	60
Moderately preferred	5	5	5	5	20	20	20	11
Prefer (like)	40	40	40	55	10	10	10	29
Local staple foods								
breatfruit (*Artocarpus altilis*)	96	98	98	92	100	100	100	98
banana (*Musa sp.*)	94	94	94	94	95	95	95	94
sweet potato (*Ipomea batatas*)	90	90	90	80	93	93	93	90
taro (*Colocasia esculenta*)	88	88	89	79	91	92	91	88
cassava (*Manihot esculenta*)	86	86	87	77	90	90	90	87
corn (*Zea mays*)	30	30	30	25	50	50	50	38
sago (*Metroxylon sp.*)	10	10	10	10	15	15	15	12
Papua wheat (*Setaria italica L*)	5	5	5	2	10	10	10	7
Source of foods								
Garden	70	10	10	70	30	30	30	36
Yard	100	100	100	100	100	100	100	100

The results of BI analysis of local staple foods from the seven small islands in Raja Ampat showed that breadfruit and bananas had the principal advantage, followed by sweet potato, taro, and cassava. These local foods were resilient apart from being consumed as carbohydrate crops and contributed to income and other benefits. Bananas, besides being a source of carbohydrates, are used as fruit crops. Then, the banana blossom can be used for vegetables, whereas the succulent segment of the banana stem is practical as fodder [31].

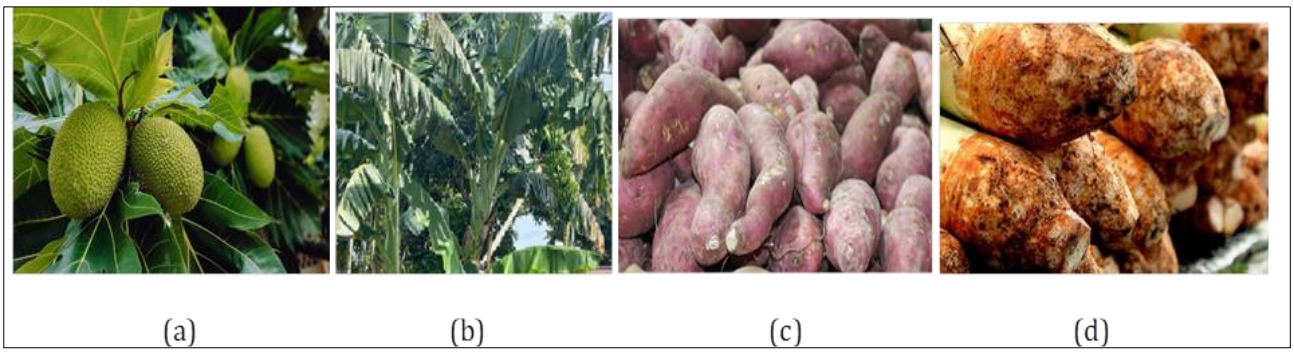

Figure 2 (a) breadfruit, (b) banana, (c) sweet potato, and (d) taro

Sweet potatoes are shown to have a high BI value due to their function. Apart from being consumed for food security, they can also be sold for household income and other benefits, with leaves as vegetables and medicinal plants with high antioxidants [32]. The same function and use are shown in taro and cassava (Figure 2).

Sago, bananas, and sweet potatoes are the main staple foods for the people of the big island of Papua and have a long historical value. In contrast, they are dominated by breadfruit, bananas, and sweet potatoes on small islands. Sago is less available on small islands due to rare swamp conditions [33].

3.3. Benefit Index of vegetable crops

The character of greenery preferred by the native community in the small islands in Raja Ampat was gedi leaves (*Abelmoschus Manihot*). The gedi plant is valuable in local communities due to its function as a vegetable, mineral, vitamin, and medicinal value. Thus, this gedi plant is widely planted in yards and community gardens [34,35].

The BI analysis for vegetable crops (Figure 3) found papaya leaves in the top two, sweet potato leaves in the top three, and cassava leaves in the top four (Figure 4). Several studies show that vegetable crops are part of the lifestyle of traditional communities, especially in the Pacific Islands, by playing an important role in the supply of minerals, vitamins, and medicines [36,37].

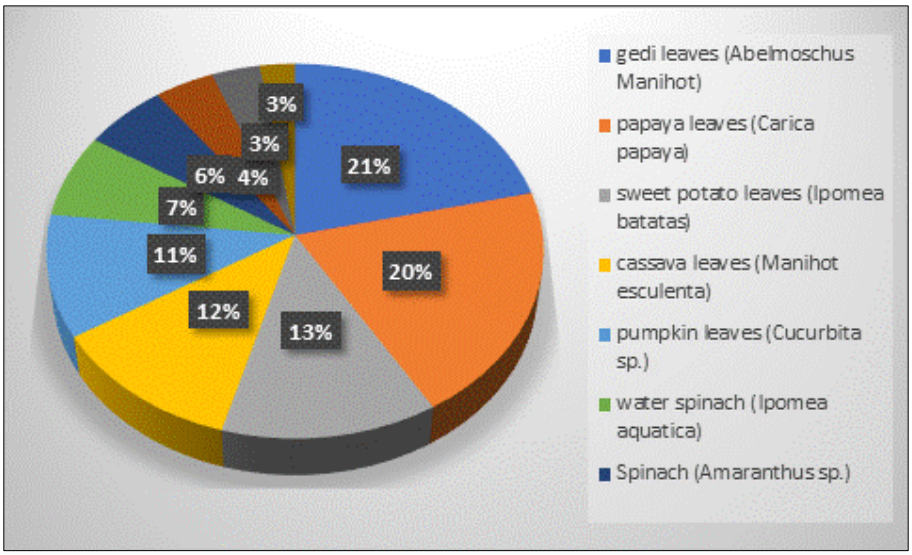

Figure 3 BI analysis for vegetable crops towards mineral, vitamin, and medicines resilience

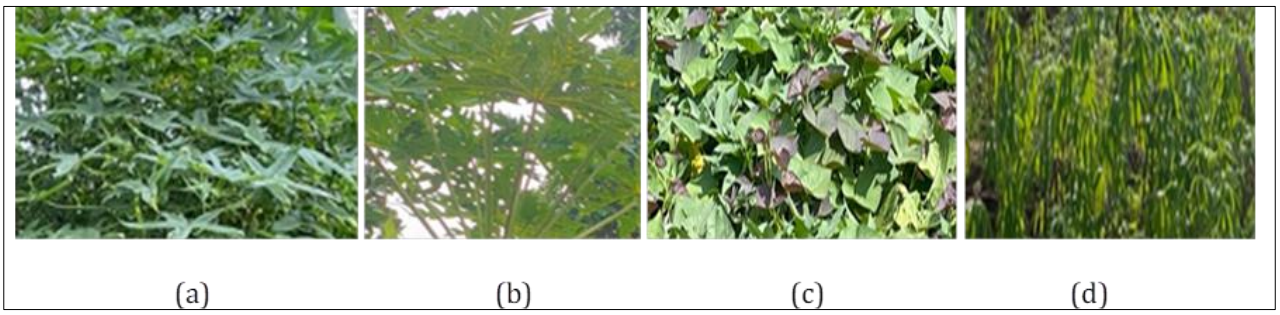

Figure 4 (a) gedi leaves, (b) papaya leaves, (c) sweet potato leaves, and (d) cassava leaves

3.4. Benefit Index of fruit crops

Based on BI analysis, the type of fruit crops most preferred by local communities in small islands is mango, followed by papaya, banana, and soursop (Figure 5 and Figure 6). Papaya and bananas are easy to find in the yard and in the garden and have a history in the people of Papua; especially bananas can be made into cakes, fried, and grilled, and are a source of carbohydrates [38].

These fruit plants are also for self-consumption as a source of minerals and vitamins, resilience, and increased income. However, along with climate change and climate extremes, there is a change in the timing of fruiting, especially in mango plants susceptible to flowering [39,40].

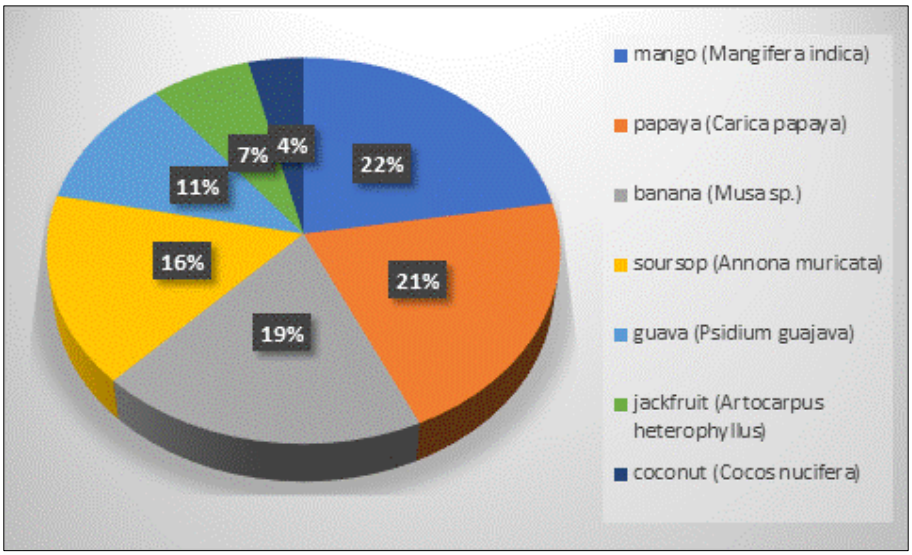

Figure 5 BI analysis for fruit crops towards mineral and vitamin resilience

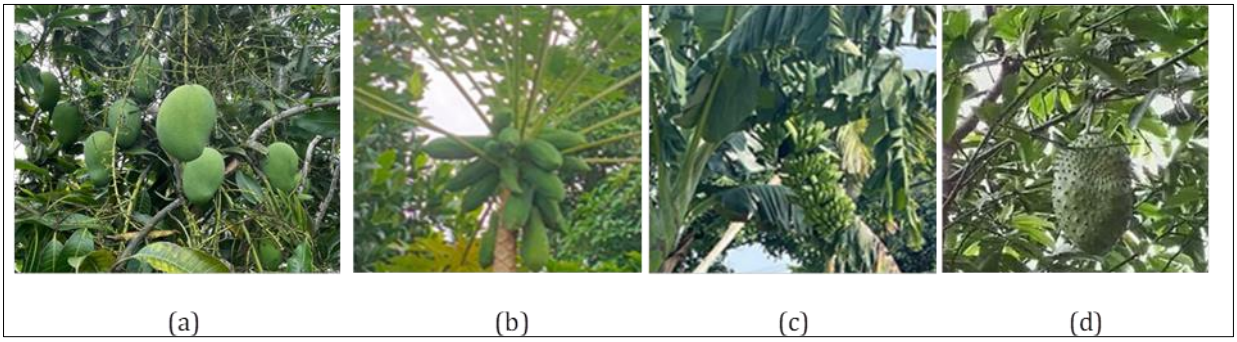

Figure 6 (a) mango, (b) papaya, (c) banana, and (d) soursop

4. Conclusion

Assessment from BI analysis on local staple foods for small island communities in Raja Ampat is dominated by breadfruit, banana, sweet potatoes, taro, and cassava as sources of carbohydrates, food security, food resilience during extreme climate, and at the same time as local income. Meanwhile, the types of vegetable plants are dominated by gedi and mangoes, and papayas and bananas dominate papaya leaves and fruits as a source of community resilience to minerals and vitamins and a source of income.

With the development of local agroforestry systems, these crops are generally available in yards for small islands and gardens for larger islands. Therefore, there is a need for further research related to economic optimization based on land availability and value benefits as well as mitigation for extreme climate conditions.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

There is no conflict of interest.

Statement of ethical approval

Ethical clearance was approved by the Ethics Committee of Food Crops, Horticulture and Plantations Agency, referring to the Minister of Agriculture Regulation No.43 Year 2009. concerning the Movement to Accelerate Diversification of Food Consumption Based on Local Resources.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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