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## **Climate Change Adaptation Strategies among Coastal Community**

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### **Abstract**

Using seven themes of adaptability strategies drawn from existing literature, this study examines the strategies for adaptation among the Bajau community in Lok Nunuk to cope with the impacts of climate change in the area. Questionnaires were distributed to 60 household heads, and descriptive statistics were used to analyze the data. The four obvious adaptation strategies identified in this study are social-related activities, physical infrastructure, technology-assisted, and government and organization support. There needs to be more than adaptation strategies to improve income among the people; they must be integrated into broader socioeconomic development programs and environment management levels.

**Keywords:** Climate change; Adaptability strategies; Indigenous; Bajau

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### **1.0 Introduction**

According to the Royal Society and the National Academy of Sciences (2020, p. 3), the earth's average surface air gathering and fishing, the desertification, deforestation, and flooding of their traditional temperature has increased by about one °C since the turn of the 20th century. The impacts of climate change are unequal but are more severe in places such as forests and other vulnerable environments inhabited mainly by indigenous peoples (World Bank Group and Asian Development Bank (2021). Climate change's catastrophic and devastating impacts on indigenous people include the decimation of their traditional homelands for hunting, homelands, total ecosystem collapse, flora, fauna and species extinction, food and water shortages, famine and disease, forced population transfers, and significant social and economic dislocation threatening the livelihoods and cultural identities (Williams, 2012).

Climate change has affected water availability in Borneo throughout the region due to the monsoon seasons (Payus et al., 2020). Climate change threatens the livelihood and way of life of sea gypsies in Borneo, which are threatened as fish catches dwindle and villages begin to sink due to change (Yusof, 2021). According to Abdul Rahman (2018), climate change in Malaysia may likely result in more droughts, rising sea levels, erosion of shorelines, increased flood intensities, coral reef bleaching, tidal inundation of coastal areas, reduced crop yields, greater diseases among forest species and biodiversity loss, increased incidences of disease, decreased water availability, and loss of biodiversity. The World Bank Group and Asian Development Bank (2021) predicted that Malaysia would

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experience meteorological (precipitation deficit) and hydrological drought (usually surface and subsurface water level), as well as increased flooding and surges in cyclones and storms. These create uncertainty in food security, such as future rice productivity in Malaysia (Herman et al., 2015).

## 2.0 Adaptation Strategies

Indigenous communities adopt various strategies to cope with climate change, for example, through traditional ecological knowledge and tribal experience (Wani & Ariana, 2018; Hosen et al., 2019). Switching to different crops, i.e., from rubber to oil palm, is another adaptation strategy (Widayati et al., 2021). Abu Samah et al. (2019) found that small-scale fishermen in Malaysia who use fisheries technologies, have alternative jobs, and possess higher education had better climate change adaptation practices than nonusers, full-timers, and less educated fishermen. Osman et al. (2022) found that coastal communities in Kudat addressed climate change's impact through changes in the career paths of the young generation and the existence of structural management. Mohamed Shaffril et al. (2020) conducted a systematic literature review on adaptation strategies for climate change impacts among indigenous people in the Asia Pacific. They identified seven themes of adaptation strategies to cope with climate change impacts. They are technology-assisted, traditional and local knowledge, livelihood diversity, government and organizations support, food and water securities, social-related activities, and physical infrastructure.

### 2.1 Adaptation Barriers

There are several barriers to effective climate change adaptation. According to Rijal et al. (2022), in seeking to adapt to the impacts of climate change, farmers are faced with weak institutions as well as financial and managerial difficulties, and thus, local-level adaptation strategies alone cannot cope with the impacts of climate change. Antwi-Agyei et al. (2015) identified financial barriers, socio-cultural barriers, institutional barriers, technological barriers, and a lack of information on climate change characteristics as constraints to effective implementation of climate change impacts adaptation. For Sia and Zainudin (2024), the barriers are related to economics and governance.

### 2.2 Importance of Local Context and Inclusion

Adaptation strategy should be based on local context, including alignment with cultural values (Nurse-Bray & Palmer, 2018). According to Wiseman and Bardsley (2013), indigenous communities must be included in local environmental management. Similarly, indigenous inputs and perspectives need to be considered in a new research agenda (Johnson et al. (2021), climate change adaptation policy (Amin et al., 2021), community-based monitoring (Kipp et al., 2019), planning (Setiajiati et al., 2019) and sustainable solutions (Mukhopadhyay & Roy, 2015).

More studies are needed to understand climate change adaptation strategies further through a framework of more comprehensive adaptation strategies. This paper aims to explore the adaptation strategies among the Bajau community in Lok Nunuk to cope with the impacts of climate change in the area using the seven themes of adaptation strategies by Mohamed Shaffril et al. (2020). That is, the objective of the paper is to identify the relevant climate change adaptation strategies used by the Bajaus in Lok Nunuk based on the seven themes of adaptation strategies to cope with climate change impacts suggested by Mohamed Shaffril et al. (2020), which are technology-assisted, traditional and local knowledge, livelihood diversity, government and organizations support, food and water securities, social-related activities, and physical infrastructure.

## 3.0 Methodology

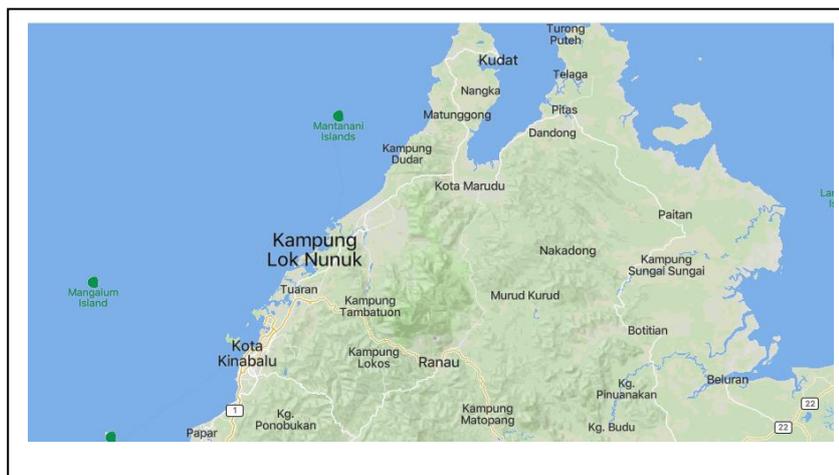


Fig. 1: Location of the study area  
(Source: <https://mapcarta.com/N5698227335/Map>)

### 3.1 Study Area

The Bajaus reside mainly in the coastal areas of the Sabah. Lok Nunuk is a small Bajau (Sama) coastal village (kampung) on the West Coast of Sabah within the Tuaran district. It is about 100km from Kota Kinabalu. According to the village head, Lok Nunuk was established around 1953-55 and has about 600 people and 70 houses. Most of the people are fishermen.

### 3.2 Data Collection and Analysis

Questionnaires were distributed to 60 respondents (household heads) through the village head (Ketua Kampung). The questionnaire has eight sections: demographic profile and seven mitigation and adaptation strategies for climate change, namely technology-assisted, traditional and local knowledge, livelihood strategy, government and organization support, food and water securities, social-related activities, and physical infrastructure. The adaptation strategies are based on the seven adaptation strategies by Mohamed Shaffril et al. (2020). The data collected is analyzed using descriptive statistics (frequency). In addition, an interview with the village head was made to obtain general information about the village, such as its origins, composition, and changes, as well as further details relating to answers given in the questionnaire. A face-to-face interview with the village head was conducted on 29 May 2022. The village infrastructure, land use, and landscape were observed during visits to the village.

Table 1. Profile of the Respondents

	N	%
Gender		
Male	42	70.0
Female	18	30.0
Age		
Below 21	1	1.7
21 – 30	3	5.0
31 – 40	7	11.7
41 – 50	14	23.3
Above 50	35	58.3
Education level		
Primary	23	38.3
Secondary	19	31.7
Others (no education)	18	30.0
Income (RM)		
Below 1000	50	83.3
1000 - 2000	6	10.0
2001 - 3000	2	3.3
3001 - 4000	2	3.3
Above 5000	0	0.0
Occupation		
Fisherman	57	95.0
Housewife	2	3.4
Unemployed	1	1.7
Ethnicity		
Bajau	60	100.0

(Source: Field data, 2022)

Referring to Table 1, the 60 respondents represent almost 90% of the household heads in Lok Nunuk. Most respondents are male (70%), above 50 years old, and 70% only had primary or no education. No one has a tertiary education. Almost all earned less than RM1,000 a month (83.3%). All are Bajaus, and 95% are fishermen.

## 4.0 Findings

### 2.1 Technology-Assisted

Table 2. Technology-Assisted

	Totally Disagree	Somewhat Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
1. I use information technologies such as; radio, TV, computer, internet, and mobile phone to help me.	0	0	0	1	59
3. I use transport technologies to help me.	0	0	1	59	0
4. I use other technologies to help me.	0	0	0	1	59

Referring to Table 2, most respondents strongly agree that they use information technologies such as radio, TV, computer, internet, and mobile phones to help. Similarly, most agree that they use transport technologies to help them. Almost all strongly agree that they use other technologies to help them. Thus, social-assisted technology is essential as an adaptation strategy.

#### 4.2 Traditional and Local Knowledge

Referring to Table 3, most respondents strongly agree that traditional knowledge of their community is essential to their livelihood and physical environment. However, almost all totally disagree that traditional knowledge of their community is essential to them relating to flora and fauna since fishing is the main livelihood activity in the area. Overall, traditional and local knowledge is essential to specific aspects of the people's livelihood activities but not generally.

Table 3. Traditional and Local Knowledge

	Totally Disagree	Somewhat Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
1. The traditional knowledge of my community relating to livelihood activities is important to me.	0	0	0	4	56
2. The traditional knowledge of my community relating to the physical environment is important to me.	0	0	0	4	55
3. The traditional knowledge of my community relating to local flora and fauna is important to me.	59	0	0	0	1

#### 4.3 Livelihood Diversity

Referring to Table 4, all the respondents somewhat disagree that they had changed their income-generating livelihood. However, most agree they have changed their income-generating livelihood relating to the use of land (A few have started to venture into agriculture, especially rubber planting and livestock such as goats). All agree that the change they made to their income-generating livelihood had been effective (probably due to the use of technology such as boat engines and modern fishing equipment and the availability of bigger boats that enabled them to venture farther into the sea). At the same time, all somewhat disagree that the changes they have made to their income-generating livelihood relating to the use of land have been effective. Overall, very few have started to venture into other income-generating activities, such as agriculture. Fishing is still the primary livelihood activity.

Table 4. Livelihood Diversity

	Totally Disagree	Somewhat Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
1. I have changed my income-generating livelihood.	0	60	0	0	0
2. I have changed my income-generating livelihood relating to the use of my land.	0	0	0	58	1
3. The changes I have made to my income-generating livelihood have been effective.	0	0	0	60	0
4. The changes I have made to my income-generating livelihood relating to the use of my land have been effective.	0	60	0	0	0

#### 4.4 Government and Organizational Support

Referring to Table 5, all of the respondents strongly agree that they have received support from the government. Though the respondents did not indicate the type of support, according to the village head, the support is in money (e.g., BR1M), material (e.g., a water tank), and information/training conducted mainly in the mosque. All agree they have received support from one or more NGOs. However, almost all somewhat disagree that they have received support from other sources. Overall, the government serves as a primary source of support for the community.

Table 4.5. Government and Organizational Support

	Totally Disagree	Somewhat Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
1. I have received support from the government.	0	0	0	0	60
2. I have received support from one or more NGOs.	0	0	0	60	0
3. I have received support from other sources.	0	58	0	0	0

#### 4.5 Food and Water Securities

Referring to Table 6, all respondents somewhat disagree that climate change has adversely affected their food supply, though all agree that climate change has adversely affected their water supply. All somewhat disagree that they could implement coping strategies to overcome the effects of climate change on food supply. However, almost all agree that they could implement coping mechanisms to overcome the impacts of climate change on the water supply. The respondents did not indicate the mechanism, but most probably due to the water supply availability from the government (piped water). Overall, the water supply problem was overcome with the assistance of the government.

Table 6. Food and Water Securities

	Totally Disagree	Somewhat Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
1. My food supplies have been adversely affected by climate change.	0	60	0	0	0
2. My water supplies have been adversely affected by climate change.	0	0	0	60	0
3. I have been able to implement a coping strategy to overcome the impact of climate change on my food supply.	0	60	0	0	0
4. I have been able to implement a coping strategy to overcome the impact of climate change on my water supply.	0	0	0	58	0

#### 4.6 Social-Related Activities

Referring to Table 7, almost all the respondents totally disagree that their community shares knowledge with each other to cope with the impact of climate change. However, almost all strongly agree that their social relationship is strong. In terms of people's influence in the community, almost all agree that the influence that people in their community have is essential. Almost all strongly agree that cultural values in their community are important and maintained. Almost all agree that members of their community have migrated. In terms of kinship support, almost all strongly agree that there is much kinship support in their community. Finally, almost all strongly agree that their community has implemented measures to ensure safety and security. Thus, social-related activities are essential support for the community.

Table 7. Social Related Activities

	Totally Disagree	Somewhat Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
1. My community shares its knowledge to help each other cope with climate change impact.	58	0	0	0	0
2. My community's social relationships are strong.	0	0	0	2	56
3. The influence that people in my community have is important.	0	0	0	58	0
4. The cultural values of my community are important.	0	0	0	0	58

5. The cultural values of my community are maintained.	0	0	0	0	58
6. Members of my community have migrated away.	0	0	0	58	0
7. There is much kinship support in my community.	0	0	0	0	58
8. My community has implemented measures to ensure our safety.	0	0	0	0	57
9. My community has implemented measures to ensure our security.	0	0	0	0	59

#### 4.7 Physical Infrastructure

Referring to Table 8, almost all of the respondents agree that there has been new infrastructure development and construction to help cope with the impacts of climate change, there has been new infrastructure development and construction to help prevent a climate-related disaster, there is a plan of new infrastructure development and construction to help cope or prevent a climate-related disaster and the infrastructure development and construction to help cope a climate-related disaster is effective. However, almost all respondents are still determining whether the infrastructure development and construction to help prevent a climate-related disaster is effective. Overall, physical infrastructure is a relevant adaptation strategy.

Table 8. Physical Infrastructure

	Totally Disagree	Somewhat Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
1. There has been new infrastructure development and construction to help cope with the impacts of climate change.	0	0	0	58	1
2. There has been new infrastructure development and construction to help prevent a climate-related disaster.	0	0	0	59	0
3. There is a plan for new infrastructure development and construction to help cope or prevent a climate-related disaster.	0	0	0	59	0
4. The infrastructure development and construction to help cope with a climate-related disaster is effective.	0	0	0	59	0
5. The infrastructure development and construction to help prevent a climate-related disaster is effective.	1	0	56	1	1

## 5.0 Discussion

The findings suggest that not all seven adaptation strategies were directly and equally relevant as adaptation strategies. The four obvious adaptation strategies include, first, social-related activities. The people use strong social cohesiveness, maintenance of cultural values, kinship support, and the ability to migrate as adaptation strategies to cope with climate change. Ironically, sharing knowledge to cope with the impact of climate change was not a necessary adaptation strategy, perhaps because such sharing is done indirectly through shared cultural values and observation since the influence people have in the community is considered necessary in

Lok Nunuk. This aligns with previous findings of the correlation between community social cohesion and resilience when facing disasters or environmental change (e.g., see Townshend et al., 2014 and Ford et al., 2020). Second, technology-assisted. Transportation technology increases the ability of local fishermen to go farther in the sea to boost fish catch. According to the Lok Nunuk head village, fish catch remained stable. This is probably due to technology. Bigger and better boats, such as fiberglass boats with engines, better fishing equipment, and more readily available fishing nets of various types and sizes, as well as better information about the weather, enable local fishermen to go farther to catch fish. The use of technology as an effective adaptation strategy for climate change impacts confirms the finding by Abu Samah et al. (2019) that small-scale fishermen in Malaysia who use technology have better climate change adaptation practices compared with the nonusers. Third, physical infrastructure. In its policy paper, the OECD (2018, p. 6) highlighted the critical role of infrastructure in strategies to manage the risks and minimize the negative impacts of climate change. Improvements in basic infrastructure such as roads, electricity supply, water supply, and internet connection catalyze other adaptation strategies such as food and water security, livelihood diversity, and technology-assisted. The availability of the internet makes it easy to communicate for various purposes, including promoting local homestays and weather forecasts. Last, government and organizations support. As Mohamed Shaffril et al. (2020) indicated, government and organizational support is a crucial adaptation strategy to cope with climate change impacts. Government and organizational support, especially government support, is a crucial adaptation strategy that complements most of the other adaptation strategies, including livelihood diversity, food and water security, and physical infrastructure. Disruption in the water supply, which frequently occurs, is alleviated through the government supply of water tanks to each house, enabling rainwater to be harvested.

The importance of the other strategies is less obvious due to the effects of other strategies. For example, although, as a whole, livelihood strategy was not relevant as an adaptation strategy in Lok Nunuk, it has the potential to be an essential strategy in the future. The fishing community in Lok Nunuk can still survive as fishermen, but livelihood diversity may become necessary in the future as marine resources dwindle. The diversification of livelihood includes farming (rubber and goat), and according to the village head, some villagers work in both the public and private sectors.

## 6.0 Conclusion & Recommendation

This study uses Mohamed Shaffril et al. (2020) seven themes of adaptation strategies (technology-assisted, traditional and local knowledge, livelihood diversity, government and organizational support, food and water securities, social-related activities, and physical infrastructure) towards climate change impacts as a framework to examine adaptation strategies among local fishermen in Lok Nunuk, Tuaran. Four obvious relevant adaptation strategies have been identified in Lok Nunuk, namely social-related activities, physical infrastructure, technology-assisted, and government and organization support. The most apparent strategy is social-related activities. This does not mean other adaptation strategies identified in the literature are unimportant but less evident in Lok Nunuk as a fishing community. Local context is important.

Furthermore, although the local fishermen in Lok Nunuk can maintain their livelihood as fishermen at the moment, the continued high incidents of poverty among the respondents suggest that more than local adaptation strategies are needed to improve income among the indigenous people in the area. More integrated planning and implementation are needed to sustain and improve the area's standard of living for indigenous communities. In terms of limitations, the paper only focuses on the Bajau people in the West Coast and is thus limited in its scope. Furthermore, further refinement of the questions in the questionnaire is needed to suit the local context. Future research should include other coastal communities, such as Ubians and Bajaus in the East Coast, as well as the different terrestrial indigenous communities in various locations in Sabah.

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## Paper Contribution to Related Field of Study

This study considers all or most of the climate change adaptation strategies together. It also considers the interactions among the adaptation strategies, contributing to a more holistic understanding of climate change adaptation strategies among indigenous communities.

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