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Indigenous Kinabatangan Perspectives on Climate Change Impacts and Adaptations: Factors Influencing Their Support and Participation

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Abstract: Indigenous perspectives on the effects of climate change are frequently elicited through surveys and interviews, and the responses are compared to meteorological data. However, there remains a limited approach to examining the underlying predictors that best determine Indigenous support for adaptation strategies. This study utilizes partial least squares-structural equation modeling (PLS-SEM) to identify the main indicators of Indigenous support for coping with unfavorable climate impacts. Using a case study and a purposive sampling approach, a survey of 328 Indigenous peoples was conducted in rural Kinabatangan, Sabah, Malaysia. Results showed that communities' attitudes had a large effect on the Indigenous support for adaptation (f^2 = 0.380), followed by the communities' awarenesses (f^2 = 0.063), rapid onset events (f^2 = 0.051), and climate impacts on tourism (f^2 = 0.016). Communities prioritize the impacts of climate change on their health, livelihoods, and environmental resources. Nevertheless, they do not draw a causal link between the effects and responses to climate hazards. Coping strategies such as the inclusion of Indigenous livelihoods, a bottom-up approach, and transparent communication are suggested to cultivate Indigenous support for climate change adaptation. Decision-makers can apply these findings to prepare climate change policies and enhance the adaptation strategies of Indigenous communities.

Keywords: indigenous perceptions; climate change impacts; climate actions; support adaptation; Kinabatangan Malaysia; PLS-SEM

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1. Introduction

Numerous studies show the profound impacts of climate change on Indigenous peoples across different countries [1–3]. These impacts have negative consequences for Indigenous communities, who are often poor and rely heavily on natural resources to sustain their livelihoods [4,5]. The extent of the impact of shocks and stresses at the community level depends on the intensity of climate hazards combined with the vulnerability and the capacity of those affected to cope with them [6,7]. Indigenous communities experience different levels of impact based on their livelihoods [4,8,9]. Rising temperature averages increase farmers' irrigation costs and reduce hunters' potential hunt, while extreme waves and wind reduce fishermen's working days [4]. In the tourism industry, storms, droughts, and floods adversely affect tourism destination areas [10]. These hazards cause damage to infrastructure and built assets while discouraging tourist arrivals because of risk perceptions of the regions as unsafe, thus causing significant economic loss [11]. These studies

show that Indigenous peoples experience various impacts on their livelihood routines and may resort to different coping strategies to alleviate these impacts [12]. However, there is not much understanding of how multiple climate change impacts affect Indigenous economic activities, such as loss of natural resources and reduced tourism income, and influence Indigenous persons' attitudes, support, and participation in climate adaptation.

Studies illustrate the importance of promoting Indigenous resilience and management support to increase their adaptive capacities in coping with recurring climate hazards, such as drought, floods, and storms [13,14]. Effective adaptation strategies need to be informed by the knowledge of the local Indigenous population and actively include them during any decision-making processes. Government and non-government organizations (NGOs) must provide social, economic, and health support during climate events [2,13,15]. Therefore, government practice and policy to solve climate issues at a national level should be made accessible to remote areas to achieve effective adaptation. At the community level, communities must know practical solutions and outcomes of programs that aim to reduce the impacts because not all interventions are equally beneficial to affected communities [16]. The ultimate goal is for communities to be able to adapt without the need for interventions [17,18]. These studies show the importance of communities' awareness, management support, and local inclusion in the decision-making process to attain successful adaptation.

Indigenous peoples' behavioral responses to climate change are heavily influenced by their perceptions; Indigenous peoples first need to perceive climate change to take appropriate adaptation strategies [14,19,20]. Misleading perceptions on the effects of climate change might lead to ineffective adaptation, exacerbating vulnerability [21,22]. Indigenous perspectives of climate change are often gathered through surveys and interviews, and the results are then compared to meteorological data [1,14,22]. The perceptions are usually understood by examining how climate variability (e.g., temperature and precipitation) and climate hazards (e.g., drought, storms, and floods) impact Indigenous livelihoods and wellbeing [9,14]. Some Indigenous peoples rely on Indigenous weather forecasting to reduce their vulnerability to weather-related disasters [23,24]. Both approaches that compare the Indigenous communities' perceptions with climate data and the Indigenous weather prediction often rank the dominant climate hazards based on the severity of their impact [14,23,24]. Indigenous adaptation is then prepared by developing specific adaptation plans intended to cope with climate variability and hazards [14,23]. Other studies show Indigenous farmers and pastoralists use a combination of Indigenous knowledge, meteorological information, and biological and astrological indicators in their seasonal forecasts for adaptation decisions [25,26]. These approaches provide solid guidance for creating adaptation plans, but Indigenous attitudes towards climate adaptation can vary in different contexts and geographical areas.

Indigenous peoples' perceptions of climate change and adaptive capacity can be influenced by multiple factors [21,27]. Climate hazards such as sea-level rise, drought, and floods can influence Indigenous peoples' perceptions and undermine their capacity to cope with climate impacts [1,25]. Other research indicates that non-climate variables such as sociocultural factors (e.g., age, education, and income), socio-political, and livelihoods can also alter Indigenous peoples' perceptions and increase their vulnerability [8,28]. As a result, focusing just on climate hazards may limit the understanding of how numerous components interact and affect Indigenous peoples' perspectives [18,21,27]. Due to the intricate interplay between many elements, changes in time, and context, measuring or ranking the most important factors impacting Indigenous communities' attitudes remains a challenge [27]. In this view, the current study employs partial least squares-structural equation modeling (PLS-SEM), an advanced multivariate method of statistical analysis that is useful for assessing the relationships between multiple factors simultaneously, hence identifying the key predictor of Indigenous peoples' perceptions of climate impacts [29,30].

This paper describes research conducted in two Indigenous communities in Kinabatangan Sabah, Malaysia, to learn more about Indigenous peoples' opinions on climate change and adaptation. In this regard, the Indigenous communities refer to the Sungai people who

lived in this region. This study aims to reveal what factors influence positive Indigenous attitudes towards and the likelihood of taking part in climate change actions. To begin, we look for publicly available material to learn about Indigenous peoples' perspectives on climate change consequences and coping strategies used in this region. However, we discovered early on in the research that climate change studies have largely concentrated on the ecological and biological issues [31–34]. Little attention is given to how the local communities are affected by and adapt to climate change. Since Sustainable Development Goals (2030 Agenda) aim to increase the adaptive capacity of marginalized communities [35], generating Indigenous support for climate action has become more important. We employ the partial least squares-structural equation modeling (PLS-SEM) to discover the most important determinant that can improve Kinabatangan adaption strategies. Partial least squares structural equation modeling (PLS-SEM) is a type of structural equation modeling that provides the estimation of complex cause-and-effect relationships in path models with latent variables [30]. The findings can help Indigenous peoples become more resilient to climate change and make more informed adaptation decisions. In light of the aforementioned gaps, this study addresses three pertinent questions:

1. How do the communities perceive the impacts of climate change in Kinabatangan Sabah?
2. How do the communities respond to the climate change impacts based on their knowledge and capabilities?
3. What factors influence the communities' attitudes to support and participate in climate change adaptation?

1.1. The Context of a Study

Out of thirteen states, Sabah (73,000 km^2) is the second largest state in Malaysia. The Kinabatangan district is located in East Sabah, under the administration of the Sandakan division. Kinabatangan River is the largest and longest river in Sabah. It has a length of 560 km and a catchment area of 16,800 km^2 and covers almost 23% of the total land area of Sabah. The river is one meter above sea level, but it can rise as high as 12 m above sea level during heavy rain. Most Kinabatangan villages are located in the lowlands along the river. Historically, the Kinabatangan area is dominated by natives known as Orang Sungai (River people) [36]. The majority of the Sungai people are Muslim, and they live in scattered settlements along the Kinabatangan River. The Sungai people have always lived along the Kinabatangan River to barter (a traditional exchange) forest products with traders who sail on this river [36,37]. The Sungai people engage in subsistence farming, fishing, seasonal fruit harvest, collection, and the sale of forest harvest [38,39]. Rice and vegetables are produced primarily for self-consumption, but excess crops are sometimes sold. Vegetables are usually grown on small private farms around each house, typically cultivated for one to two years. When the soil is no longer fertile, they find a different place, log, burn, and plant again [40]. Their local source of proteinaceous foods is from the river and lakes in this region. The Sungai people trap fish and prawns using cast nets, trammel nets, and a traditional trap known as 'Bubu' made of rattan and bamboo [36]. Bird's nests and rattans are a seasonal source of income for the local people here, but the trade of forest products has declined in recent years due to the expansion of the timber industry, oil palm plantations, and the establishment of Kinabatangan protected areas. Some Indigenous people work in different governmental, private, tourism, or conservation sectors [38,41]. Despite various economic opportunities, most Sungai people today still practice traditional livelihoods to sustain their daily living [41]. Conventional farming and fishing highly depend on climate, rendering them susceptible to climate hazards.

The Malaysian government implemented poverty reduction strategies over the past decades to improve the livelihoods of Indigenous peoples throughout the nation [42]. Nevertheless, this Indigenous population remains socio-economically marginalized [42]. In Sabah, they are denied native land customary rights. The majority of residents accept partial recognition of official land ownership, yet their lives and survival are dependent on

it. The Indigenous communities in Kinabatangan have limited access to basic amenities, such as a clean water supply. Some areas in the Kinabatangan cannot be reached by road. The communities have to cross over the Kinabatangan River using a boat or ferry [43]. In 2005, the Sabah government established Lower Kinabatangan Wildlife Sanctuary and enforced Wildlife Conservation Enactment 1997, which resulted in limited access to hunting and harvesting natural resources [44]. A proposal has been made to build a 350 m bridge to connect Sukau village to opposite villages across the vast Kinabatangan River. The bridge and paved roads are necessary for economic development in this area [43]. However, this suggestion sparked controversy among Kinabatangan stakeholders, including local and international conservationists. They have great concerns that the bridge would cause significant landscape changes and the potential risk of wildlife extinction when large-sized animals cannot migrate through fragmented landscapes [45]. In 2017, the Sabah government discarded this plan, resulting in a public protest by some Indigenous communities [46]. The marginalization of Indigenous peoples, insufficient access to proper amenities, and the conservation pressure are compound issues that challenge the survival and livelihoods of the natives in this region.

1.2. Climate Change Impact and Adaptation

The Kinabatangan area is well known for spectacular but critically endangered wildlife species, such as the Bornean orangutan, Bornean elephant, and the proboscis monkey. These animals attract local and international tourists to view the animals in their natural habitat [38,41]. These animals can be seen along the Kinabatangan River during the driest season between March to September. Few tourists come to the Kinabatangan from December to January because of heavy rain leading to flooding; thus, the villagers obtain lower incomes. Globally, the diminution of biodiversity is related to increases in extreme weather events, barriers to dispersal, and changes in trophic levels [47]. For example, cyclones can alter the onset of sexual maturity in turtles, floods can reduce plant species richness, and prolonged droughts have caused population collapse in koalas [48]. In Kinabatangan, extensive forest conversion to oil palm plantations has resulted in significant habitat loss and fragmentation, leading to biodiversity loss [31,33]. Habitat loss and climate change can act synergistically, thus amplifying their negative impacts on biodiversity [34]. Orangutans in the Kinabatangan feed primarily on fruits. The reduction in natural food sources during a prolonged drought can lead the orangutans to starvation and aggravate human-wildlife conflict when they resort to entering villagers' orchards to search for food [31,32]. Increased drought periods negatively affect tree survival, while warm temperature adversely affects fish species by correlating with disease proliferation [49]. The anthropogenic impacts on the biodiversity resources, coupled with a changing climate, have negatively affected the Kinabatangan tourism industry because the flagship attraction is wildlife [38,50]. Kinabatangan also attracts international organizations for conservation work such as tree planting in Batu Puteh and Sukau villages [31].

Other pressing issues occurring in the Kinabatangan are climate-related phenomena such as floods and forest fires, though the climate influences the latter indirectly. The communities in the Kinabatangan depend much on the Kinabatangan River and surrounding aquatic water resources for their livelihoods and domestic water consumption [51]. Unfortunately, timber logging in upstream Kinabatangan areas deteriorates water quality and increases flood risk due to changing hydrology. In addition, land clearance for oil palm plantations causes severe soil erosion, and the resultant displaced soil is washed into the Kinabatangan River [33]. During dry periods and less rainfall, the communities encounter a shortage of clean water supply. Seasonal floods are primarily linked to human factors and activities in land use. However, heavy rain also raises the water level of the Kinabatangan River, leading to severe flooding, which can cause human death, property damage, and economic loss [52]. The Indigenous communities encounter recurring floods with occasional landslides every year. Forest fires have significant effects on biodiversity resources. For example, a massive fire destroyed about 200 hectares of Kinabatangan forest reserve

in 2016; as commented by a conservationist, "Over the years, a huge amount of resources, such as time and money, have been spent by many stakeholders to conserve Kinabatangan biodiversity, there is still more that needs to be done to ensure that wildlife, forest, and Kinabatangan peoples can exist in harmony and benefit each other. Everybody loses if decades of hard work and dedication go up in smoke" [53] (p. 2). The recurring incidence of forest fires is commonly observed to be related to hunters utilizing unsustainable methods to drive animals out of their hiding places. During a drought season, dry and strong wind spread the fire to an adjacent sanctuary and Indigenous settlement [44]. Lessons learned from these issues are that the hazards can cause significant damage to Indigenous lives, properties, and natural resources. There is a need to engage the communities to solve this problem and participate in local climate adaptation.

The Malaysian government has included specific guidelines designed to address climate change impacts in the National Policy on Climate Change and the Malaysia Plans. However, many of the strategies prioritize mitigation over adaptation plans, such as promoting energy efficiency among the public and reducing GHG emissions [54]. At the national level, critical areas that require adaptation are agriculture, drought, flood, erosion, forest, biodiversity, and coastal marine habitat. Initiatives undertaken by the Malaysian government include increasing awareness among the public across the nation, such as the launching of an official website known as 'Infobanjir' (flood) and 'InfoKemarau' (drought) to provide information on forecasting and monitoring of both hazards, including to facilitate emergency responses [55]. There is a weather observation and radar station in the Sandakan Meteorological Office, which produces daily weather forecasts for Kinabatangan and early warnings of adverse weather phenomena, such as continuous heavy rain, thunderstorms, drought, strong winds, and haze. Several strategies undertaken to adapt to climate change impacts are: to improve drainage in Kinabatangan areas vulnerable to flooding, to slow down animal population decline by increasing habitat corridors, and quick responses from the District Disaster Management Committee to evacuate flood victims to safe places [34,56]. However, Malaysia's climate adaptation does not adequately incorporate Indigenous coping strategies [54]. Understanding Indigenous perceptions of climate change impacts is critical because the government requires their knowledge to prepare for effective adaptation strategies [16,57].

1.3. Modeling the Relationship between Communities' Attitudes and Climate Change

We develop a research model based on the available literature to assess Indigenous peoples' perceptions of climate change impacts in Kinabatangan (Figure 1). The process of identifying factors related to Indigenous support for climate change adaptation was carried out in three steps. First, we conducted a literature review to assess the impacts of climate change on the Indigenous communities and how they responded to these impacts. Second, we identified factors associated with Indigenous support for adaptation from the literature, which led to the identification of seven variables: communities' awareness, rapid onset events, slow onset events, climate impacts on tourism, climate impacts on the environment, communities' attitudes, and support towards adaptation. Third, each construct in the model was validated through interviews with the Indigenous people. The initial confirmation of the constructs was crucial to ensure the items (e.g., cold night, hot day, drought, and rainfall) selected to form each variable (i.e., rapid onset events) were applicable to the actual climate scenario in the Kinabatangan area. The following paragraphs describe the seven constructs employed in the research model.

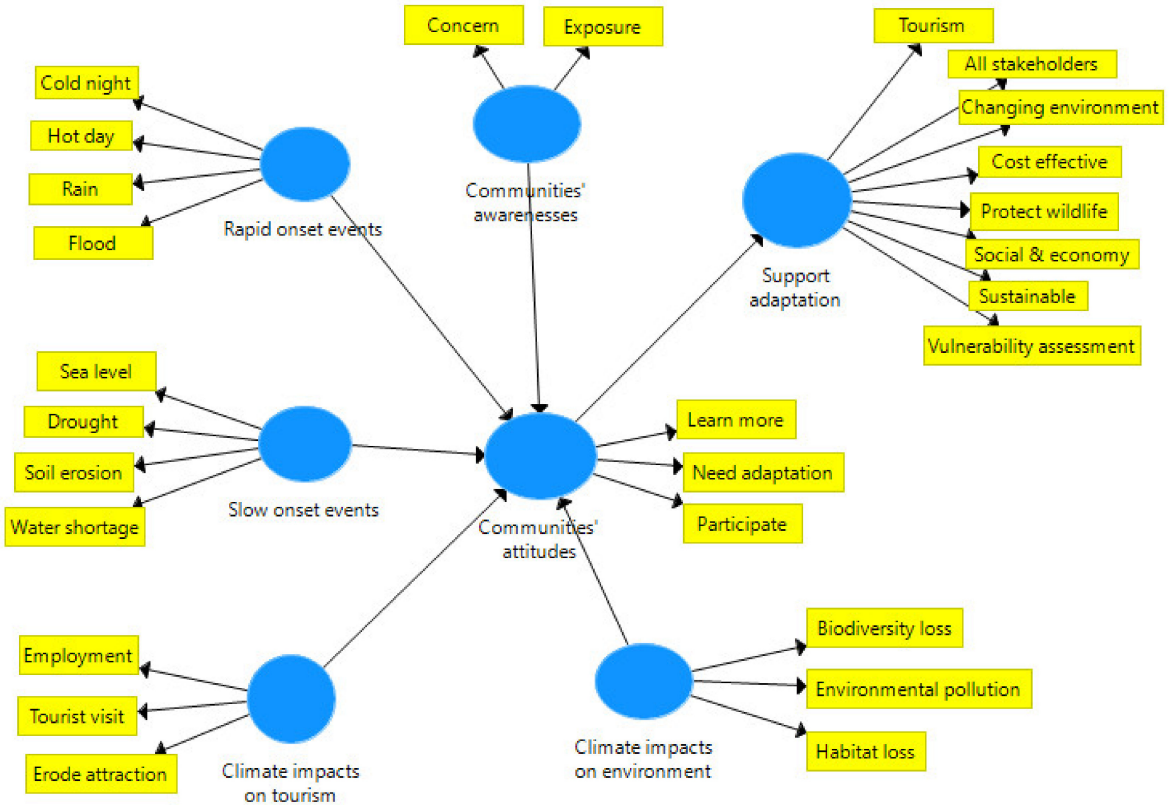

Figure 1. Research model to assess factors influencing Indigenous support for climate change adaptation.

Studies have shown that Indigenous awareness and knowledge of climate change and its impacts influence their perceptions and attitudes toward response strategies [3,12]. In this study, prior exposure refers to existing knowledge of Indigenous peoples gained through traditional learning methods or around the specific Kinabatangan environmental area before the survey [7]. Concerns about climate change impacts create anxiety among Indigenous people as they worry about its effects on their welfare. However, this component could also trigger awareness to learn more about climate change [20]. The extent of exposure to climate hazards that communities periodically experience will condition their responses to climate change [4,54]. The communities can deal with some deviation from average impacts, but changes in the incidence of extreme events will challenge their ability to cope. Empirical evidence indicates that Indigenous peoples with more knowledge of the causes and impacts of climate change are more likely to engage in and have better coping strategies in response to climate issues [12]. For instance, Indigenous peoples in Ghana leverage their knowledge to improve agricultural yield in changing weather patterns, whereas native Tharu peoples in Nepal integrate Indigenous and scientific knowledge to enhance agriculture-based livelihoods [1,14]. Both studies show the importance of Indigenous knowledge that can be transformed into practices to properly adapt to climate change. In Kinabatangan, we examine the effects of the communities' awareness (CA) on the communities' attitudes (CAT) using two indicators: their concern about climate change impacts and previous exposure to climate change. The hypothesized relationship for this effect was:

Hypothesis 1 (H1). *Communities' awareness positively affects the communities' attitudes in supporting climate change adaptation.*

Malaysia experiences an equatorial climate characterized by hot and humid weather all year round [58]. Apparent increases in extreme weather events are commonly used to elucidate climate change in this country [59]. The weather events are characterized by

days of high temperature, heavy rain, dry spells, strong winds, tropical storms, rough seas, and thick haze [58]. In Kinabatangan, the mean annual rainfall is 2500 to 3000 mm, and the daily temperature ranges from 23 °C to 35 °C [59]. Irregularities in rainfall and warming observed over the last two decades have been attributed to climate change and have affected the annual precipitation and daily temperatures, causing several severe flooding events [60]. Southwest monsoon season causes weather changes that often bring about prolonged and extreme drought, resulting in multiple water shortages, increased incidence of forest fire, and decreased crop yield. While these Kinabatangan weather results have been obtained from the meteorological station and previous reports, the Indigenous perceptions on climate change impacts are relatively less examined. Apart from relying on scientific meteorological data to predict weather changes, their views are crucial because Indigenous knowledge and experience on climate can influence coping strategies [12,14].

Pidgeon [61] (p. 95) emphasizes that "people view climate impacts as psychologically distant in both time and space . . . as disrupted weather patterns become more evident, they will begin to see climate impacts as more personally relevant". Indigenous communities perceive climate hazards as threatening to their survival and livelihoods. Hence as the effects become more intense, they resort to different coping strategies for changing weather patterns [1,14]. This study employs two climate stressors known as rapid onset events (ROE) and slow onset events (SOE) to explain how the climate factors affect the communities' attitudes toward supporting climate change adaptation in the Kinabatangan. The ROE comprises hot days, cold nights, heavy rain, and floods, whereas the SOE is characterized by drought, water supply disruption, sea-level rise, and soil erosion. Therefore, the following relationships have been hypothesized for both factors:

Hypothesis 2 (H2). *Slow onset events positively affect the communities' attitudes in supporting climate change adaptation.*

Hypothesis 3 (H3). *Rapid onset events positively affect the communities' attitudes in supporting climate change adaptation.*

Climate change affects Indigenous peoples involved with tourism because attraction depends heavily on natural heritage, such as religious monuments and historic places, and spectacular biodiversity species. Sea-level rises and extreme weather changes due to climate change, contribute to the loss of cultural heritage and natural resources, reducing tourism destinations' attractiveness [62]. Climate change increases the severity and frequency of storms, heavy rains, and floods, placing tourists' safety at stake, thus discouraging tourist visits during erratic weather [63]. Strong place attachment and reliance on limited environmental resources can put Indigenous communities at constant threat of environmental change and limit the potential for adaptations through changing livelihoods [64]. From an ecological perspective, changes in the severity of extremes of atmospheric weather and climate variables, such as temperature and precipitation, might exceed certain species' survivability thresholds, consequently leading to biodiversity loss [47]. Another study showed a negative interaction between climate change and habitat loss for animals that increased successively with higher levels of climate change [65]. In Kinabatangan, climate change might exacerbate the loss of valuable biodiversity species due to its adverse interaction with excessive land clearance, habitat loss, and fragmentation [33]. This study includes two non-climate factors (i.e., livelihoods) known as climate impacts on tourism (CIOT) and climate impacts on the environment (CIOE) to assess the Kinabatangan communities' attitudes. Both elements are essential because of the historical background of the study area, whereby environmental resources are connected with tourism development in this area [38,66]. To that end, seven constructs are included in the research modeling: communities' awareness, rapid onset events, slow onset events, climate impacts on tourism, climate impacts on the environment, communities' attitudes, and support adaptation in this region. The following relationships are hypothesized for these factors:

Hypothesis 4 (H4). *Climate impacts on tourism positively affect the communities' attitudes in supporting climate change adaptation.*

Hypothesis 5 (H5). *Climate impacts on the environment positively affect the communities' attitudes in supporting climate change adaptation.*

Hypothesis 6 (H6). *Communities' attitudes have a positive effect on communities' support for climate change adaptation.*

2. Materials and Methods

2.1. Data Collection

This study was conducted at Sukau and Batu Puteh villages in the Kinabatangan Sabah (Figure 2). There were 226 houses in Sukau village and 178 houses in Batu Puteh village, amounting to 404 houses [43]. We employed a case study research methodology and purposive sampling to select respondents in both villages [67,68]. The study also employed a quantitative approach, using 404 self-administered questionnaires distributed to each house in both villages. Purposive sampling was employed by requesting a leader from each house to take part in the survey. This approach was crucial because the leaders obtained incomes for their families through subsistence livelihoods and were often responsible for attending meetings to discuss various village matters, including livelihoods and climate change in the villages. Traditionally, the house leader was an adult male, except when married women had lost their husbands; in this situation, the married woman was regarded as the house leader. If the house leader was found not to be available at home during the research because of sickness or being away from the Kinabatangan, a house representative aged 18 years or older was invited to participate in their stead. If the representative surveyed was not a house leader, caution was exercised by writing notes and asking the representative for background information about the house leader. Additionally, if no one was at home during an attempted research visit, the researchers revisited the same house at a later time or date. The survey questions were structured based on previous studies [20,69,70]. The questionnaire was pre-tested with the communities in this area and subsequently changed according to their comments. The questions were used to assess seven variables: communities' awareness (CA), rapid onset events (ROE), slow onset events (SOE), climate impacts of tourism business (CIOT), climate impacts of the environment (CIOE), communities' attitudes (CAT), and support adaptation (SA). Each survey question was given a 5-Likert scale answer (Supplementary Questionnaire S1). One open-ended question was added at the end of the survey, which asked the respondents' opinions on climate change in this area: Please write your opinions regarding the effects of climate change and suggestions to solve this problem.

Considering the Indigenous communities had limited knowledge of English, the final survey was translated into the Malay language, which is the national language in Malaysia. From the outset of this project, we sent official letters to the District office of Kinabatangan and to the community leaders of both villages to request their permission to conduct research. Based on the recommendations of the community leaders, the researcher hired five local community members who had completed secondary high school to distribute the surveys in both villages. This was because the villagers were cautious about burglary cases and more likely to cooperate when they dealt with local people as opposed to researchers from outside communities. The five research assistants were trained to approach a respondent from each house, explain the purpose of the research, and obtain their consent to participate in this study. The self-administration of the survey helped identify problems encountered by the villagers when answering the questions. Participation in the survey was voluntary, and the respondents assured anonymity regarding their names, positions, and affiliations. This approach allowed the respondents to be open-minded and honest when answering the questionnaires.

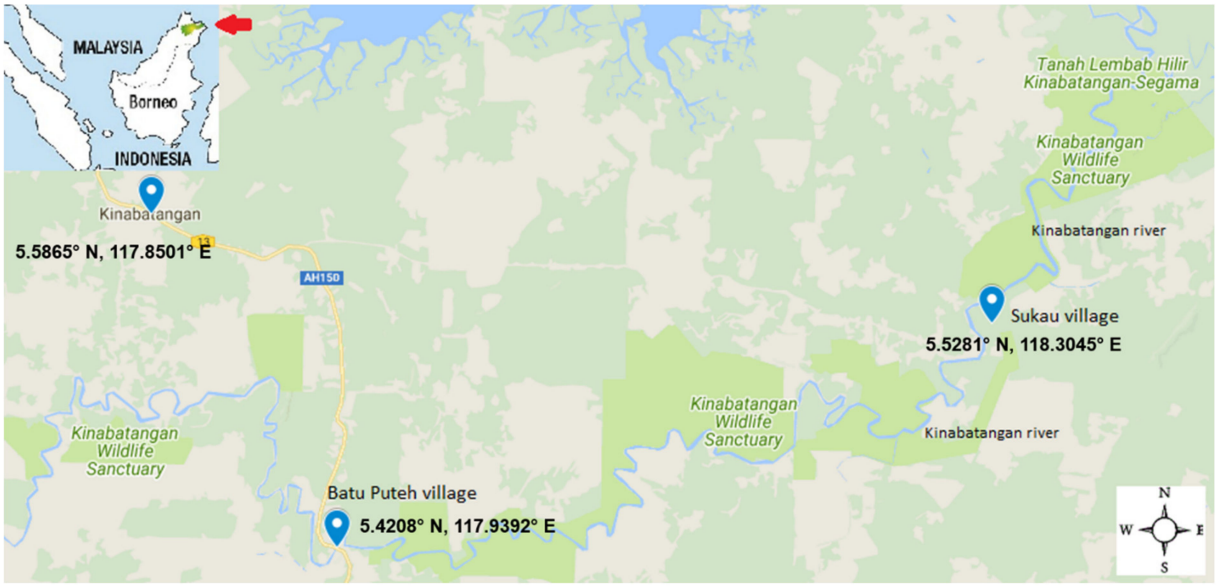

Figure 2. Location of Sukau village, Batu Puteh village, and Kinabatangan town. The red arrow appoints the location of the Kinabatangan Sabah in East Malaysia.

2.2. Data Analysis

The data obtained from the quantitative method were analyzed using partial least squares-structural equation modeling (PLS-SEM) of the SmartPLS version 3.3.2 (Oststeinbek, Germany) [71]. The PLS-SEM is a multivariate analysis that assesses the reliability and validity of constructs, including analyzing the relationships among all variables in a research model. The usage of PLS-SEM was appropriate in this study because the research focused on exploring new concepts of factors influencing the communities' support for climate change adaptation, including its purpose in predicting and identifying a key driver construct in Kinabatangan Sabah [30]. The PLS-SEM can estimate complex interrelationships simultaneously and is well known for predicting success factor studies [72].

The assessment of a research model using PLS-SEM involves two steps known as the measurement and structural models [29]. The examination of the measurement model requires evaluating the reliability and validity of latent variables, whereas the assessment of the structural model focuses on the relationship between the latent variables [73]. When assessing the indicator reliability, the purpose is to evaluate how an indicator is consistent with what it intends to measure. Hence, indicator reliability denotes the proportion of indicator variance explained by latent variables [74]. An acceptable value for the indicator reliability is greater than 0.7 [75].

The reflective measurement model is also assessed by convergent and discriminant validity. The convergent validity describes the degree to which two constructs are related. On the contrary, discriminant validity refers to the extent to which a construct is genuinely distinct from other constructs [75]. The convergent validity is assessed using an average variance extracted (AVE) with an acceptable value greater than 0.5. In contrast, the discriminant validity is measured using the square root of AVE, whereby the value for each construct should be higher than the correlation between each construct [73,75]. Before evaluating the structural model, it is crucial to ensure that the model does not contain lateral collinearity issues. Although discriminant validity criteria (vertical collinearity) are met, the lateral collinearity can obscure findings because it may mask a strong causal effect in any research model [76]. This occurs when two variables that are hypothesized to be causally related measure the same construct.

Two essential criteria when assessing a structural model are path coefficient and R^2 values. The path coefficient should be significant, whereas the R^2 value depends on the research field. Hair et al. [77] suggest R^2 value of 0.2 is acceptable for behavioral research.

This study outlined six hypotheses based on seven constructs. To test the significance level of each hypothesis, a t-statistic for each path coefficient was generated using a bootstrapping function in the SmartPLS software.

Another measure of the structural model is an effect size (f^2) that determines how a specific independent indicator affects an independent construct in a research model [73]. It is essential to interpret the f^2 because a *p*-value determines the effect between the independent and dependent constructs. However, it cannot reveal the size of such an effect [78]. The effect size is measured based on the values of 0.02, 0.15, and 0.35, representing small, medium, and large effects, respectively [79]. An additional criterion for assessing a structural model is to test the predictive relevance of a model using a blindfolding procedure in the SmartPLS software. The blindfolding method calculates the Stone-Geisser Q^2 value to determine the explanatory power and predictive capability of a research model [75]. A model has a predictive relevance for a particular endogenous construct when the Q^2 value is greater than zero [77]. Here, the effect size of Q^2 is evaluated according to the values of 0.02, 0.15, and 0.35, which represent small, medium, and large effects, respectively [77].

The data obtained from the open-ended question were analyzed using inductive content analysis [80,81], and the researchers employed a manifest analysis by "describing what the informants actually say, stays very close to the text, use the words themselves, and describes the visible and obvious in the text" [82] (p. 10). The inductive approach does not limit theme identification to researchers' pre-existing knowledge and allows the researchers to detect the emergence of new themes [80,83]. Two independent coders performed this analysis to reduce the data into themes and sub-themes. The researcher applied direct observation through socializing, having casual conversations, and observing the daily activities of the communities in the Kinabatangan Sabah. A triangulation method was employed by integrating the quantitative analyses with published reports and notes written during the sampling.

3. Results

3.1. Profile of Respondents

The profile of respondents was assessed based on gender, age, ethnicity, and occupation. Out of 404 distributed surveys, the study gathered 328 completed questionnaires which showed an 81% response rate. As we employed the purposive sampling, the respondents comprised more males (60.7%) than females (39.3%). The respondents were aged 18 to 30 years (37.8%), 31 to 49 years (48.5%), and above 50 years (13.7%). For ethnicity, 75.9% of respondents were Sungai people, while 24.1% were mixed ethnics of Malay, Kadazan/Dusun, and Bugis. Despite broad opportunities in the tourism business, only 5.2% of respondents worked in the tourism sector while most respondents engaged in subsistence livelihoods such as farming and fishing (25.6%), the conservation sector (25.3%), an established personal business (14.3%), and government staff (6.1%), and 23.5% of respondents were unemployed.

3.2. Assessment of the Model Using PLS-SEM

3.2.1. Assessment of the Measurement Model

Most indicators loaded higher than 0.7 on the respective latent variable, while five indicators loaded between 0.6 and 0.7 (Table 1). Hair et al. [29] state that indicators with loading between 0.4 and 0.7 can be retained if their CR and AVE values exceed the threshold of 0.7 and 0.5 for adequate indicator reliability, respectively. Therefore, all indicators were kept in this study because the CR and AVE values for the seven constructs met the requirement for indicator reliability.

Table 1. Assessment of the measurement model.

Construct	Loading	CR	AVE
Communities' awarenesses (CA)		0.785	0.646
1. Concern about climate change impacts	0.792		
2. Exposure before the survey	0.814		
Rapid onset events (ROE)		0.799	0.504
1. Cold night	0.740		
2. Hot day	0.850		
3. Flood	0.657		
4. Heavy rain	0.666		
Slow onset events (SOE)		0.805	0.510
1. Soil erosion	0.693		
2. Sea level rise	0.712		
3. Longer drought	0.723		
4. Water shortage	0.680		
Climate impacts on tourism business (CIOT)		0.894	0.739
1. Discourage tourist visits to Kinabatangan	0.816		
2. Erode natural attraction of tourism	0.906		
3. Affect communities' employment in tourism	0.855		
Climate impacts on the environment (CIOE)		0.843	0.648
1. Environmental pollution	0.608		
2. Biodiversity loss	0.889		
3. Habitat loss	0.885		
Communities' attitudes (CAT)		0.917	0.787
1. I want to learn more about climate change	0.896		
2. It is necessary to include climate change adaptation in Kinabatangan	0.891		
3. I want to participate in activities that address climate change impacts	0.874		
Support adaptation (SA)		0.918	0.582
1. Cost-effective and more accessible to the local communities	0.761		
2. Multiple social, economic, and cultural benefits for the local communities	0.812		
3. Follow resilience and sustainable management	0.814		
4. Include vulnerability assessment of policy	0.744		
5. Contribute towards wildlife protection	0.702		
6. Contribute towards tourism development	0.787		
7. Participation of all stakeholders	0.769		
8. Adapt to changing environment	0.707		

In this study, the AVEs for each construct exceeded 0.5, and the square root of AVEs exhibited higher values than the correlation among the constructs (Table 2). Therefore, the results showed that the measurement model possessed acceptable values for both convergent and discriminant validity.

Table 2. Discriminant validity.

Constructs	CIOE	CIOT	CAT	CA	ROE	SOE	SA
Climate impacts on the environment (CIOE)	**0.805**						
Climate impacts on tourism (CIOT)	0.622	**0.859**					
Communities' attitudes (CAT)	0.226	0.290	**0.887**				
Communities' awarenesses (CA)	0.147	0.103	0.336	**0.803**			
Rapid onset events (ROE)	0.201	0.331	0.418	0.303	**0.710**		
Slow onset events (SOE)	0.390	0.298	0.295	0.124	0.550	**0.714**	
Support adaptation (SA)	0.257	0.285	0.525	0.334	0.441	0.315	**0.763**

Note: Square root of average variance extracted (AVEs) is shown diagonally in bold.

3.2.2. Assessment of the Structural Model

Table 3 showed all inner VIF values for the six variables were less than 5, implying that lateral multicollinearity was not an issue in this study [77].

Table 3. Lateral collinearity assessment.

Constructs	Communities' Attitudes (VIF)	Support Adaptation (VIF)
Communities' attitudes		1.000
Communities' awarenesses	1.126	
Rapid onset events	1.694	
Slow onset events	1.649	
Climate impacts on tourism	1.776	
Climate impacts on the environment	1.852	

Table 4 illustrates the four relationships with a t-value of greater than 1.645, thus significant at $p = 0.05$. In particular, three predictors, namely communities' awareness ($\beta = 0.231$, $p < 0.01$), rapid onset events ($\beta = 0.254$, $p < 0.01$), and climate impacts on tourism ($\beta = 0.148$, $p < 0.05$) were positively related to the communities' attitudes, which explained 27.8% of the variances in the communities' attitudes ($R^2 = 0.278$). Therefore, the findings supported H1, H2, and H4 in this study. In addition, the effect of the communities' attitudes on the support adaptation showed that the communities' attitudes ($\beta = 0.525$, $p < 0.01$) were positively related to the support adaptation, explaining 28.5% of the variance in the support adaptation ($R^2 = 0.285$); thus the result supported H6 in this study. The R^2 values for both communities' attitudes and support adaptation were greater than 0.26, which showed a substantial model [79].

Table 4. Results of hypothesis testing.

	Hypothesis	Path Coefficient (β)	Standard Error	t-Value	Effect Size (f^2)	Significant (*p*-Value)	Supported
H1	Communities' awarenesses → Communities' attitudes	0.231	0.057	4.058	0.063	0.000 **	YES
H2	Rapid onset events → Communities' attitudes	0.254	0.078	3.240	0.051	0.001 **	YES
H3	Slow onset events → Communities' attitudes	0.074	0.065	1.142	0.005	0.127	NO
H4	Climate impacts on tourism → Communities' attitudes	0.148	0.074	1.988	0.016	0.024 *	YES
H5	Climate impacts on environment → Communities' attitudes	0.020	0.070	0.292	0.000	0.385	NO
H6	Communities attitudes → Support adaptation	0.525	0.054	9.693	0.380	0.000 **	YES

Note: * $p < 0.05$; ** $p < 0.01$.

Table 4 showed the communities' attitudes had a large effect on the support adaptation ($f^2 = 0.380$), followed by the communities' awareness ($f^2 = 0.063$), rapid onset events ($f^2 = 0.051$), and climate impacts on tourism ($f^2 = 0.016$) that exerted a small effect on the communities' attitudes. The results showed a small effect of Q^2 for the communities' awareness (0.040), rapid onset events (0.051), climate impacts on tourism (0.011), slow onset events (0.005), and climate impacts on the environment (0.001) on the communities' attitudes. Meanwhile, both communities' attitudes and support adaptation had a medium effect of Q^2 values of 0.190 and 0.155, respectively. Therefore, the study confirmed the predictive relevance of the constructs when the values of Q^2 were greater than zero.

3.3. Climate Change Impact and Adaptation

The analysis of the open-ended question showed contradictory views among the respondents. They reported hazards, adverse impacts, issues, and adaptation to climate

change (Table 5). The respondents prioritized the effects on different economic aspects. Most respondents stated they experienced reduced crop yield and fish catchment because of extreme weather changes in this region, including climate-related health problems. Some of the health problems reported by the respondents were flu and skin itchiness, which they perceived were difficult to heal (compared to the time when they were young), and they attributed this problem to the changing weather. Respondents who worked in the conservation sector reported degradation of biodiversity values, vegetation change, and destruction of forest cover. In contrast, those working in tourism enterprises were more concerned about low tourist visits during unfavorable weather, reducing tourism revenue. Respondents involved in subsistence farming cultivated small-scale oil palm and fruit crops. Heavy rain led to flooding, causing significant damage to young oil palms and fruits.

Table 5. Results of inductive content analysis.

Themes	Sub-Themes and Excerpts of Inductive Coding
Adverse impacts of climate change	Socioeconomic, agricultural yield, fish catchment, biodiversity loss, tourism revenue, tourism employment, vegetation change, destruction of forest cover, environmental pollution, and climate-related health problems. e.g., "The crops we planted hardly survive during severe drought." e.g., "I think normal illnesses have become more difficult to cure, and it must be related to the extreme weather."
Climate hazards	Prolonged drought, heavy rain, hot days, and cold nights Reduced food crop yields, forest fire, water supply disruption, Kinabatangan River water level, and soil erosion. e.g., "I have stayed over 40 years in Kinabatangan. The weather nowadays has become so extreme and unpredictable. For some reason, it does not follow the usual pattern. It keeps raining, suddenly changes to hot weather, and is back to rain again."
Climate change issues	The communities are not informed about adaptation strategies, indicating top-down decision-making is being employed. e.g., "Maybe there are plans, but they have not told us yet." e.g., "Usually, the head of villages is responsible for discussing any issue with the top authorities. Only then will they inform us later."
Climate change adaptation	Indigenous perceptions on effective adaptation strategies, communities' attitudes in support of and participation in adaptation intervention. e.g., "In my opinion, there are no specific guidelines or strategies to address climate effects in Kinabatangan." e.g., "There is a need to establish a specific agency or committee to plan for climate change adaptation here. We want to know the level of damage of climate change in various sectors such as tourism and agriculture, including a supply of clean water, flood, and forest fire." e.g., "If the authority wants to develop plans for solving climate change impacts, I hope they will consider the villagers' opinions . . . it is important to address the local needs to garner their support and encourage participation in this case."

The respondents reported climate hazards negatively affecting their survival and livelihoods. However, they also related loss of livelihoods to non-climate factors such as strict conservation rules and animal crop-raiding. They obtained information on climate and weather from social media such as television, radio, and online website. Field observation and personal communication with the Kinabatangan local authorities confirmed an absence of climate change adaptation plans explicitly developed for this region. The respondents reported that the communities' leaders were responsible for discussing matters with the

local authorities at the Kinabatangan district and state levels. The villagers were only informed after the discussion. Approaches undertaken were to post warnings of flood and thunderstorms on the Sabah Meteorological Department's official website and prepare for evacuation in times of flooding. There seemed to be no specific plans to address these climate-related livelihood issues in tourism, subsistence farming, and fishing to assist in adjusting to the changing drought and rainy season. According to their understanding of changing weather, suitable soil, and correct methods of planting and harvesting, the Sungai people use traditional knowledge to plant and harvest oil palms and fruits. Local authorities identified high-risk forested areas susceptible to fires, and increased monitoring and preparation to extinguish the fire to protect the natural resources.

The respondents were determined to describe the climate change impacts they experienced in this area. However, they could not identify any specific adaptation strategies to address these effects or reduce their vulnerability to climate hazards. The majority of respondents (n = 243, 74.1%) stated that there was a necessity to start adaptation plans to lessen the impacts. Some respondents commented that specific action was employed only after the occurrence of climate events. For example, when drought or flooding led to the disruption of clean water supply to the villages. Nevertheless, only after it occurred the water supply was distributed to the villagers. Another challenge was the clean water supply delivery to remote areas that could not be accessed by roads. The respondents recommended that: (1) Initiate evaluation of climate hazards and impacts; (2) establish a platform for robust and open discussion between the villagers, authorities, tourism enterprises, conservation researchers, NGOs, and private sectors, and; (3) to outline specific adaptation plans for the Kinabatangan by referring to the national adaptation strategies.

4. Discussion

This study investigates Indigenous peoples' perceptions of climate change impacts in the rural Kinabatangan. In particular, our research model shows how climate factors and communities' attitudes influence Indigenous support and participation in climate change adaptation. The findings show that communities' awareness positively and significantly affects the communities' attitudes towards climate change adaptation (H1). The respondents with higher awareness and prior exposure to climate change impacts were more likely to support climate adaptation in this region. Indigenous awareness and personal acknowledgment of climate change are the most crucial factors determining their decisions to employ adaptation measures [9,84]. Our results show that the Sungai people rely on traditional knowledge to resume subsistence livelihoods under prolonged drought and heavy rainfall [2,85]. In Kinabatangan, however, having Indigenous knowledge does not necessarily translate into adjusting actions in changing environments. Constant exposure to changing climate can alter Indigenous peoples' awareness and concern, influencing their traditional knowledge to adapt to climate change. Indigenous awareness of climate change impacts and concern about the frequency and intensity of climate hazards determine the Sungai peoples' attitudes on engaging in the adaptation. This finding implies that local authorities can apply this factor by providing scientific climate information and adaptation guidelines to ensure the communities respond appropriately to the impacts, thus improving adaptation outcomes in this region [12].

Respondents who score rapid onset events (ROE) due to hot days, cold nights, floods, and heavy rain have a positive and significant effect on the communities' attitudes, implying that they support climate change adaptation (H2). However, the slow onset events (SOE), measured by soil erosion, sea-level rise, prolonged drought, and water shortage, insignificantly affect the communities' attitudes (H3). The findings show that the frequency and intensity of changing weather have a substantial impact on Indigenous peoples' perspectives. This in turn determines their support for climate adaptation. Our results are consistent with previous studies that show that Indigenous communities perceive erratic rainfall, increasing warming temperature, and drought as obvious signs of changing weather patterns [1,3,14]. Extreme weather (ROE) is a prominent indicator for the Sun-

gai people to support climate actions more than the SOE factor that occasionally occurs. Previous studies illustrated that climate hazards could cause varying levels of damage to Indigenous livelihoods. Flooding is rated the most disastrous hazard by Indigenous communities involved in farming [14]. Erratic rainfall causes low agricultural output and changes livelihoods [1]. While we acknowledge the contribution of these studies in understanding Indigenous peoples' perceptions of climate change, these findings can be improved by considering the interaction between different climate factors on Indigenous communities' livelihoods. Using PLS-SEM, all interacting factors are analyzed simultaneously, thus producing more consistent estimates and reducing standard errors [30,72]. In this study, the PLS-SEM identifies the ROE as a significant factor among the seven constructs included in the modeling. Therefore, the Sabah government could focus programs and policies on the ROE factor, which the communities deem essential to garnering their support and participation in Kinabatangan climate adaptation.

The climate impacts on tourism (CIOT) positively and significantly affect the communities' attitudes (H4). Conversely, we do not find a significant relationship between the climate impacts on the environment (CIOE) and the communities' attitudes (H5). The climate change burden negatively affects the socioeconomics of rural Indigenous communities. Extreme climates such as prolonged drought and heavy rainfall reduce agricultural yield and fish catchment in the Kinabatangan River. Climate change impacts on environmental resources are varied, and Indigenous peoples rely heavily on these resources, which are vulnerable to a changing climate [20,64]. However, not much is known regarding what type of resources determine Indigenous peoples' perception to support climate action. This study fills this gap by understanding that the Kinabatangan communities prioritize the effects on different aspects such as reduced tourism revenue, biodiversity loss, and climate-related health problems. They make a distinction on the economic aspects–they perceive natural resources explicitly related to their livelihoods as more critical than other resources not related to their financial loss. In other words, loss of wildlife affects tourism revenue, and reduced crop yields are more alarming than vegetation and forest cover destruction. We found the divergences related to prior exposure to media communications [86]. Such differences are also shaped by their roles and experiences working in particular organizations. The respondents who work in the conservation sector link the impacts with biodiversity values, but those working in tourism enterprises worry more about its consequences on tourism employment and revenue. Studies that examine the effects of economic and environmental factors on Indigenous support for climate actions are limited [87,88], but this study provides evidence of economic importance in encouraging Indigenous peoples' participation in coping with climate impacts.

Despite the initiatives undertaken by the Malaysian government, our findings reveal that a practical approach to adapting to climate change impacts is not communicated well to rural dwellers, such as in the case of the Sungai people in the Kinabatangan, Sabah. The Indigenous communities report noticeable effects of changing climate, but they are not aware of specific adaptation strategies to solve this problem. The Indigenous peoples' expression of lack of knowledge on readily available initiatives to cope with the effects is an opportunistic area for immediate attention. This study contradicts Tunde and Ajadi [3], who report that Indigenous communities are given early warnings and employ different local adaptation strategies to cope with climate impacts. The lack of knowledge in responding to specific climate events could undermine a sustainable approach to coping with recurring climate change impacts. Common factors attributed to low awareness of climate change among Indigenous peoples are marginalization, limited access to education, poor communication, and top-down institutional processes that allow little Indigenous voice [20,21,89]. In Kinabatangan, our findings reveal that the communities are only informed after the planning and decision-making with government authorities. This scenario exhibits a fragmented, top-down approach that excludes Indigenous involvement, thus reducing adaptation acceptance. The Malaysian government needs to encourage the participation of marginalized Indigenous communities in dealing with the climate effects to

reduce poverty resulting from the loss of economic revenue because of climate hazards [42]. Strategies to cope with climate change impacts are likely to fail due to knowledge gaps that exist when a local community is excluded during a planning process [13,90]. Therefore, the top-down approach requires changes by acknowledging everyone's equal right to participate in planning and decision-making. Recognizing the valuable contributions that Indigenous communities can make using their unique local knowledge could assure that each individual across the country can express their opinions and holistically receive climate change messages.

There is no one-size-fits-all solution for different climate scenarios, as Indigenous communities in different regions, due to differences in culture, economic activities, and environment, experience varying levels of climate hazards [12,13]. Climate change adaptation policies that involve contradictory perspectives are complicated, but workable strategies are possible if planned based on local needs and consequences. Our research model shows that the respondents who view the factors related to support adaptation [H6] positively are more inclined to solve the climate issues in this area. However, any climate action should consider local needs, such as multiple social, economic, and cultural benefits for local communities. Other critical criteria to consider for the uptake of Kinabatangan climate change adaptation are the engagement of all Kinabatangan stakeholders, protection of the natural and tourism resources, adapting to a changing environment, and inclusion of vulnerability assessments. Overall, this study provides early guidelines for the Kinabatangan stakeholders, policymakers, and the Sabah government to pay extra attention to the adverse climate effects and the lack of adaptation actions. While this study focuses on Indigenous communities and climate change impacts, the adaptation strategies should include the interaction between climate change and natural resources conservation and the tourism sector. Careful planning is critical considering that this area has a complex interplay between biodiversity conservation, Indigenous reliance on depleting natural resources, wildlife-based tourism, and extensive land clearance, all of which place this area as highly vulnerable to climate hazards [32,91]. As the majority of the Sungai people live in this region, their perspectives are essential for the adaptation plans, and they should be included throughout the adaptation planning process.

Previous studies use meteorological data and climate projection models to examine Indigenous peoples' perceptions of climate change impacts, which have contributed to a greater understanding of Indigenous vulnerability and adaption to changing climate [1,14,26,85]. Some studies apply PLS-SEM to examine climate change impacts in various aspects [92,93], but these studies are not focusing on Indigenous peoples' perceptions. The Kinabatangan study is one of the few studies applying the PLS-SEM modeling to assess attitudinal factors influencing Indigenous support for climate adaptation. Using this modeling, we identify the communities' attitudes as the most influential factor determining their support for climate adaptation, followed by the communities' awareness, rapid onset events, and climate impacts on tourism. These findings will help the Sabah government improve climate adaptation by promoting Indigenous peoples' participation in initiatives that address climate impacts in the Kinabatangan and throughout the state. The results demonstrate that the government needs to provide scientific knowledge and management support to the Indigenous peoples, improving their awareness and focusing on the economic sector that the communities perceive severely affected by climate hazards. For example, the Kinabatangan authority can apply the CIOT factor to garner more support from the villagers in executing climate intervention. This is because of the more severe impacts of climate on the tourism sector, making the attitudes of the communities to support and participate more apparent. As this study provides early findings on the climate change issue, more research is needed to fine-tune adaptation strategies for the Kinabatangan Indigenous peoples.

For methodological implication, the model identifies significant factors that influence the Indigenous support for climate adaptation, but it overlooks other impacts such as climate-related health problems. Therefore, adding one open-ended question to the ques-

tionnaire assists in explaining factors that are not measured in the research model. This approach offers better explanations of Indigenous peoples' perceptions of 'what impact, how if affects, and why it happens.' For instance, the CIOT factor is significant, though only a few respondents working in tourism are involved in this study; this ambiguity can be validated by checking the respondents' comments in the open-ended question. Evidence shows that some respondents work as farmers, but they write comments about climate impacts on tourism in the open-ended question section. One probable reason for this is that while the respondents answering the survey are not themselves working in tourism and instead do subsistence work, they considered family members who have worked in this sector, such as homestay, housekeeping, and cooking. They consider the impacts of climate change on overall family income. The current study does not include gender analysis in the modeling, but this component can influence adaptation outcomes [16,57]. This information serves as a precaution for future researchers who seek to apply the PLS-SEM modeling technique to identify factors influencing Indigenous peoples' attitudes towards supporting climate change adaptation in different areas of study.

The Conference of the Parties (COP) is the highest decision-making body of the UN Convention Framework Convention on Climate Change (UNFCCC) [94,95]. Parties will discuss progress in adaptation to the impacts of climate change and the approaches to address loss and damage associated with these impacts. Developing countries will make suggestions for a global goal for adaptation and point out the importance of financial, technology, and capacity-building support. The UNFCCC defines adaptation more broadly as adjustments in ecological, social, or economic systems in response to climate change impacts [95]. Five components of adaptation activities are: observation; assessment of climate impacts and vulnerability; planning; implementation; and monitoring and evaluation of adaptation actions [94]. In this study, current approaches to dealing with climate impacts in Kinabatangan are inadequate and unsustainable in the long term. Coping mechanisms are developed only in the aftermath of major climate events, and Indigenous peoples do not undertake adaptation actions to deal with the negative consequences. Despite the evidence of absent climate change adaptation plans, the Sungai people are supportive and describe an urgent need to initiate adaptation actions. The PLS-SEM method provides new perspectives by highlighting the importance of incorporating climate stressors and attitudinal factors into adapting to climate change. Previous approaches focused largely on addressing climate hazards in developing Indigenous adaptation strategies [1,14,23,24]. The current study recommends that non-climate factors such as Indigenous peoples' awareness, attitudes, and livelihoods be included in the adaptation plans to secure Indigenous support and active participation in coping with the climate impacts. In line with the COP, the Kinabatangan study shows an important need for capacity-building support from top management authorities to the communities and incorporates the five components of adaptation activities to address the climate issues in this region.

5. Conclusions

The study contributes to the literature on understanding the factors that influence Indigenous support for climate change adaptation in rural areas. There are three major findings in this study. First, the respondents concur that climate change has affected their villages, but they prioritize the negative impacts on their health and economy. Second, the intensity of rapid-onset events and decreased tourism revenue influence the communities' support for climate adaptation. Third, the Indigenous communities cannot identify coping strategies for climate hazards in their villages.

Overall, this research contributes to a growing body of knowledge about the factors influencing Indigenous support of climate change adaptation in rural areas. The PLS-SEM provides a rigorous analysis to identify the key predictors of multiple factors affecting Indigenous peoples' perceptions by simultaneously assessing all relationships among the seven variables in the Kinabatangan area. The findings show both climate stressors and non-climate factors have different impacts on the Sungai peoples' support for climate change

adaptation. In Kinabatangan, the strongest predictor is the Indigenous peoples' attitudes, followed by their awareness, rapid onset events, and climate impacts on tourism. Therefore, climate change adaptation policies must take a more holistic approach by integrating these factors to acquire effective adaptation that addresses the vulnerability of Indigenous peoples in remote areas.

There are some drawbacks to this study. This study was conducted on a single Indigenous population in Kinabatangan, Malaysia. Hence, it may not be possible to generalize the findings to other Indigenous communities. Future research should incorporate other factors that are applicable to local Indigenous peoples who live in certain destination areas.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/su14116459/s1, Questionnaire S1.

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