ECOTOUR
Ecotourism and Environment Conservation
ECOTOUR 1(1): 1–8
ISSN 3048-2623

Institute for Advanced Science, Social and Sustainable Future
MORALITY BEFORE KNOWLEDGE

Adaptation of climate change: sustainable tourism development

GITA CEMARA[1], YUNITA ISMAIL[1]*

[1] *Department of Environmental Engineering, Faculty of Engineering, President University, Bekasi, 17550, Indonesia;*

*Correspondence: gitacemara@student.president.ac.id

Received Date: December 31, 2023 Revised Date: January 26, 2024 Accepted Date: February 21, 2024

ABSTRACT

Background: Climate change refers to rapid changes of natural phenomena like weather patterns that are not caused by natural causes. Tourism sector shows its vulnerability to climate change remembering that this sector really depends on the climate condition. This paper aims to explore the vulnerability of tourism to climate change, tourism under climate change scenarios, and tourism adaptation to climate change using literature review method. This paper also includes the estimation on global impact of climate change tourism industry. Many researchers agreed that a solid framework needs to be established as an effort to adapt and mitigate climate change. One form of effort to achieve this is by environmental education, provision of loans, green tourism, eco-tourism, and environmental conservation projects. Nevertheless, this is not an all-fit in solutions, further research needs to be established to build a solid framework that involves all stakeholders. **Methods**: This paper is arranged using a literature review method sherached from many resources on the internet. The tourism vulnerability is really affected by climate change. **Findings:** This paper aims to explore vulnerability of tourism to climate change, tourism under climate change scenarios, and tourism adaptation to climate change. **Conclusion**: The tourism industry requires many sources of energy such as water, electricity, fossil fuel, etc., hence evaluating the system and framework is important to keep the sustainability and its resilience to climate change.

KEYWORDS: adaptation; climate change; sustainable; tourism.

1. Introduction

Climate change refers to rapid changes of natural phenomena like weather patterns that are not caused by natural causes. Tourism consists of four main branches, i.e, sales and distribution, transportation, accommodation, and ancillary services (Camilleri, 2018). From these sectors, surely they need many energy resources (Qiu et al., 2017). For the overall tourism industry, environmental factors have a significant role in general. Also, factors like carbon emission from manufacturing and construction industries and carbon emission through other sectors have their significant impact on all dimensions of the tourism industry.

Stated that the growth of tourism sectors is in line with increasing fossil fuel usage and carbon footprint (Bamidele et al., 2021). Considering that tourism is the most important economic sector of the world, it certainly is a serious problem that needs to be addressed

Cite This Article:
Cemara, G. & ismail, Y. (2024). Adaptation of climate change: sustainable tourism development. *Ecotourism and Environment Conservation*, 1(1), .1-8 https://doi.org/10.61511/ecotour.v1i1.2024.670

(Li et al., 2018). This paper aims to explore the vulnerability of tourism to climate change, tourism under climate change scenarios, and tourism adaptation to climate change using literature review method.

2. Methods

The paper was carried out using a literature review approach. The procedures involved in this paper include doing thorough research and selecting relevant literature on the topic. The fundamental idea is to utilize search engines to explore various information resources, including databases like Elvesier, Google Scholar, MDPI, Springer, Science Direct, ResearchGate, Connected Paper, Open Access Journal, etc.

3. Results and Discussion

3.1 Vulnerability of tourism to climate change

Climate change remains a problem for us, even these days climate change is still the biggest threat in many sectors, without exception, the tourism sector. On the other hand, climate change also has an impact on economic activities (Albert, 2020). Extreme weather and natural disasters could bring out huge threats. If this is followed by unresponsive action to mitigate and adapt to the current situation, certainty it will influence more damage in the future.

In 2019, according to a study conducted by Scott et al., (2019), the vulnerability of tourism tends to be at its highest risk in the country where the largest proportion of Gross Domestic Product (GDP) is represented by the tourism sector. The same study also expresses that the tourism sector is the most vulnerable sector to climate change, remembering that this sector is expected to grow fastest throughout the 2030s, unfortunately, this sector has not got much attention whereas this sector might be quite promising to elevate the local economy.

Based on research by Cevik & Ghazanchyan (2020), the climate vulnerability of the study area has proven to have an economically significant impact on the international tourism revenue along the study area; this factor is considered as the most important factor among others that affect the tourism sector.

3.2 Tourism under climate change scenarios

Many natural phenomena occur caused by climate change and can affect the tourism sector. For example, the rapid increase of earth temperature makes winter become shorter, this can reduce the tourism potential of ski resorts because the ice sheet becomes thinner.

Based on the study conducted by Grimm et al., (2018) the following contents show the estimation of the global impact in many sectors regarding temperature rising in table 1.

Table 1. Estimation of the global impact regarding temperature rising

No	Sector	Impacts at 2^{o}C	Impacts at 3^{o}C
1.	Agriculture Food	It appears that you've provided information about potential challenges in tropical regions, particularly in Central-West and Northeast Brazil, related to a decline in crop production and increased inequalities and conflicts over food and water shortages.	600 million additional people, in relation to the 2 °C scenarios, may be living at risk of starvation. Rising world food prices. Northeast Brazil will be one of the most affected regions in the world. High-latitude

		These issues could have significant implications for the affected areas.	agricultural production is likely to increase.
2.	Water	The potential 20-30% decrease in water availability in regions like southern Africa and the Mediterranean poses a significant threat to a substantial population. With an estimated 600 million to 3 billion people facing the risk of water shortages, the impact could be severe and wide-reaching.	1 to 4 billion people will suffer from water shortages. Possible migrations caused by drought cause socio-economic and political instability. The Caatinga biome will become a rider and the Amazon will suffer intense periods of drought.
3.	Human Health	It seems like you're providing information about a potential risk scenario related to malaria and other diseases transmitted by insects or water, along with mentioning high rates of diarrhea and malnutrition in low-income countries. If you have specific questions or if you'd like more information on this topic, please feel free to ask. I can provide details on preventive measures, interventions, or any other related information you may be interested in.	More than 300 million people will run the risk of being infected by malaria and 5 to 6 million by dengue fever.
4.	Ecosystem biodiversity	It appears you've provided information about the alarming threats to biodiversity and ecosystems. The figures you mentioned highlight the severity of the situation, emphasizing the urgent need for global conservation efforts. The loss of species, particularly in the range of 15 to 40%, signifies a significant threat to the overall balance of ecosystems.	Beginning of the collapse of the Amazon rain- forest: losses of more than 10% of fish species; of 22% of wetlands in the coasts. 50% of endangered species, including 25 to 60% of mammals, 30 to 40% of birds, and 15 to 70% of butterflies in southern Africa. 88% risk of transformation from forests to non-forest systems. Possible loss and extinction of ice-dependent species.
5.	Glacier	As of my last knowledge update in January 2022, I cannot provide real-time or the most current information. However, I can share that the loss of Arctic ice, the melting of Greenland, and reductions in oceanic ice are significant concerns associated with climate change.	Total loss of oceanic ice during the summer in the Arctic. Complete loss of the ice sheet of Greenland and Antarctic glaciers with heating of 3 °C for several centuries.
6.	Sean and Ocean	Sea level rise and coastal flooding can put 35 to 50 million people. High cost recovery.	Rising sea levels, coastal flooding, and water stress will put at risk 180 million people. Hundreds of thousand will have to migrate.
7.	Extreme	It seems like you're discussing the increase in the frequency and intensity of various extreme weather events, particularly in Southern and Southeastern parts of Brazil. These events include floods,	The impact of these events is often socio-economic losses, and it disproportionately affects the world's poorest countries.

		droughts, storms, heatwaves, fires, and tropical cyclones.	
8.	Tourism	The discomfort caused by high temperatures can indeed have significant effects on tourism, particularly in traditional sun and beach destinations. As temperatures rise, tourists may be deterred from visiting these locations due to concerns about heat-related discomfort and health issues. This can lead to a decrease in demand for such destinations.	Maximum reductions in seasons (spring and summer) in relation to humidity, and increase of insolation cause losses for certain types of tourism. Reduction of tourist areas with detriment to the winter tourism sector (snow). De- cliningdemand means an economic loss to the mountain (snow melting), and coastal (sea rise, and bleaching, and mortality of coral reefs) destinations.

As stated above, many sectors associated with tourism are affected by the rising temperature. Moreover, the other study agreed that climate change has an influence on tourism destinations. Future city's tourism destinations are most likely to suffer because of climate change that leads to a decrease in the climatic suitability of destinations for tourism in the future (Friedrich et al., 2020).

While the analysis of factors, impacts, consequences, and challenges of climate change is stated in table 2 (Grim et al., 2018).

Table 2. Factors, impact, consequences, and challenges of climate change in the tourism sector

No	Factors	Impacts	Consequences	Challenges
1.	Temperature increase (supply and exposure demand)	- Reduction of the appropriate period of sun - Thermal stress - Increase in the incidence of skin cancer	- Redirection of demand to other potential destinations, such as conservation units - Adaptation of the travel period - Fragmentation of the holiday period with a reduction in stay - Poor quality of experience	- Promote a low-carbon activity - Offer destinations of nature all year round - Promote actions and run campaigns on sun protection issues
2.	Extreme Events (geographical space, demand, supply, and agents)	- Destruction of tourism infrastructure - Road blockades - Interruption of media services - Changes in the hydrologic cycle	- Real estate speculation - Contamination and spread of diseases - Lack of drinking water - High cost of recovery - Low capacity for emergency care (rescue, evacuation, medical services) - Unavailability of emergency accommodation, counseling and assistance to victims - Increase in the price of trips - Insecurity	- Foster new, more sustainable tourist destinations - Promote actions and run campaigns informing about the protection and rational use of resources - New investments, technologies and marketing strategies - Create plans and actions and develop strategies to deal with the consequences of extreme events - Implement warning measures that anticipate occurrences of extreme

			- Poor quality of experience - Consumer distrust	events and measures to mitigate the problem and protect the local population and the tourist
3.	Sea-level rise (geographical space, supply)	- Degradation of beaches - Bleaching of corals - Coastal erosion - Destruction of mangroves ---- freshwater reserve - Destruction of the waterfront infrastructure	Decrease of sand space for leisure Impacts on the freshwater reserve High cost of the waterfront restoration	- Promote mitigation and adaptation actions and initiatives - Plan and order the use and territorial occupation of the seaside -Implementation of coastal engineering works

3.3 Climate change adaptation and tourism

There is plenty of evidence that climate change will have a significant impact on the tourism sector, thus we need an adaptation strategy to mitigate the climate. Although there are no fit-all solutions regarding climate change adaptation in the tourism sector, following this, this section will explain the conceptual framework of climate change adaptation and tourism.

In 2019, Lemweli & Winja (2019) conduct research about sustainable tourism developments in Kilimanjaro National Park Mountain, Tanzania. The perfect climate change adaptation and mitigation from that study area is environmental education, provision of loans, green tourism, eco-tourism, and environmental conservation project, with one of their programs is afforestation. This program received a positive response from society and slowly could fix the deforestation problem, return some species like black monkey, and increase the amount of water.

Rahmawati et al., (2019), stated that the tourism sector has the potential capacity to empower the local community to fight the threats of climate change. Hence, making an effective framework is important as a foundation to build a systematic system. The framework of community adaptive capacity to climate change can be shown in figure 1.

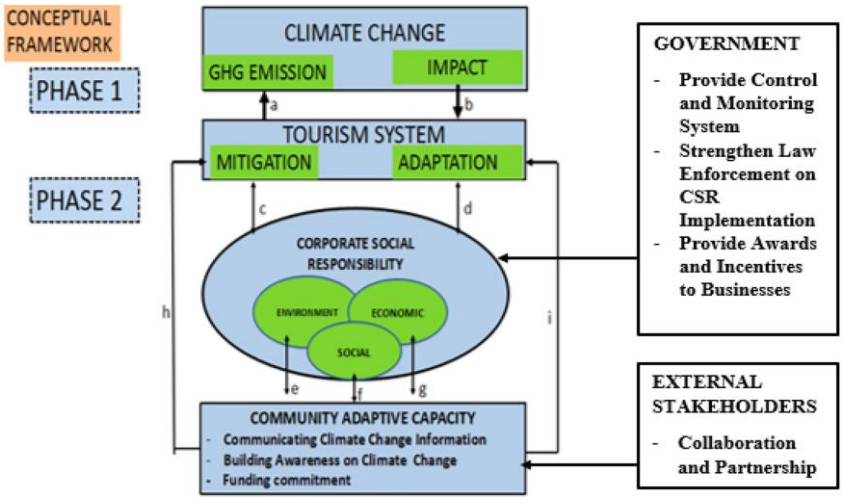

Fig. 1. The framework of community adaptive capacity to climate change.

4. Conclusions

The tourism industry requires many sources of energy such as water, electricity, fossil fuel, etc., hence evaluating the system and framework is important to keep the sustainability and its resilience to climate change.

Acknowledgement

This paper is part of the first author's final term project for Climate Change Adaptation and Mitigation subject at the Environmental Engineering Undergraduate Program, President University. The authors would like to express gratitude to Allah swt. for His generous blessings. We also would like to thank our lecturer, Dr. Ir. Yunita Ismail Masjud, M.Si., for her great assistance and guidance in this study and our beloved colleagues for their excellent support for this project.

Author Contribution

All author contributed fully to the writing of this article.

Funding

This research did not use external funding.

Ethical Review Board Statement

Not applicable.

Informed Consent Statement

Not applicable.

Data Availability Statement

Not applicable.

Conflicts of Interest

The author declare no conflict of interest.

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Biographies of Author(s)

GITA CEMARA, Department of Environmental Engineering, Faculty of Engineering, President University.

- Email: gitacemara@student.president.ac.id
- ORCID: -
- Web of Science ResearcherID: -
- Scopus Author ID: -
- Homepage: -

YUNITA ISMAIL, Department of Environmental Engineering, Faculty of Engineering, President University.

- Email: yunitaismail@president.ac.id
- ORCID: -
- Web of Science ResearcherID: -
- Scopus Author ID: -
- Homepage: -