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Factors in Community Adaptation for Climate Change Mitigation in Thailand

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ABSTRACT

This study reflects the experiences of communities who have adapted to climate change in three different geological locations in the country of Thailand: by the riverside, coast, and in the mountains. The communities presented the lessons learned and identified key adaptation factors. The study used in-depth interviews and focus group discussions, with results showing that the community's learning and adaptation to climate change were at a high level. The results broaden understanding of climate change in these locations and provide information for resource management approaches. Among the seven factors, five factors illustrated that they were highly adapted, including: (1) applying knowledge about nature, ecosystems, and traditional wisdom; (2) management that allowed the use of adaptations; (3) a shared vision of success; (4) collaboration; and (5) having a variety of options and approaches. Two factors that illustated that the community was only moderately adapted included: (1) learning about violent events and disasters; and (2) following government guidelines. It was found that a lack of information about the ecosystems and environmental resources they required for large-scale infrastructure construction caused issues. This is a problem, and the government must consult with local communities when setting long-term plans and assessing needs, because communities have diverse livelihoods and depend on natural resources. Hence, future studies should include climate change awareness and understanding of what is required by adding community needs linked to climate change adaptation into state development plans as well as utilizing the wisdom and traditional knowledge involving ecology held by these communities into sustainability plans.

1. INTRODUCTION

Humans can negatively affect the environment (Rambaree et al., 2019), with population change, development, and urbanization blamed by many for climate change. The Inter-Governmental Panel on Climate Change (IPCC, 2014) reported that since the year 2000 climate change has caused more climate-related changes,, with extremes such as increased rainfall and drought becoming more common. These events lead to problems such as coastal erosion, which are consequence of climate change causing rising sea levels. The 2021 global climate risk index ranked Thailand ninth for risk (Eckstein et al., 2021), and "climate change 2022: Impacts, adaptation, and vulnerability" described possible consequences up to 2100, stating that approximately 3.3 to 3.6 billion people live in locations that are highly vulnerable to climate change (IPCC, 2023). Climate change affects agriculture, health, and tourism, so it should be considered in policy formulation (Reynolds and Ortiz, 2010), yet a study by Mastrandrea et al. (2010) indicated that government policies does not reflect the needs of communities.

Globally, attention has been drawn to vulnerable communities affected by climate change. Vogel et al. (2020) showed that local communities are those most

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severely affected by climate change. Therefore, climate resilience must be built-in to reduce the impacts of climate change on these locations. Currently, most research and development focuses on collaborative development issues but decision support tools must be developed, the integration of databases including fundamental vulnerabilities in health, socio-economic factors, infrastructure, and the local environment (Tee Lewis et al., 2023). The American Agency for International Development (USAID) (2022) states that Southeast Asia faces challenges because it is the region most vulnerable to climate change.

Thailand suffers from extreme weather that causes issues leading to coastal erosion, and increased salinity in fresh water supplies (Smith et al., 2021). Disasters have become more frequent and severe over the past decade (IPCC, 2023), with the 2011 flooding the most devastating natural disaster in seventy years, causing billions of dollars of damage to the Thai economy. The National Economic and Social Development Plan (NESDP) (2023-2027) formulated development goals to counteract the issues (NESDP, 2021), with human settlements the primary focus in the Thai Climate Change Master Plan (MNRE, 2015). The plan aims to support vulnerable communities, helping them adapt to climate change and to learn from their collective experiences (Anh Tran, 2020). Agriculture remains critically important to Thailand, but if vulnerable communities had a model framework for analyzing experiences collectively, they could adapt by accessing knowledge related to culture, ethnicity, values, motivations, norms, beliefs, and behaviors, both social and environmental (Steg, 2016; Mohr Carney et al., 2022). Thailand's communities would generate knowledge by learning and brainstorming in order to solve problems in practice (Coppock et al., 2022). Brown et al. (2020) define community resilience as the existence, development, and participation of community resources in an environment of uncertainty and unpredictability. United States Environmental Protection Agency (U.S. EPA.) (2015) states that communities need critical knowledge to adapt and reduce the impacts of climate change. Therefore, the knowledge used for mitigation may vary from area to area.

The research objectives are as follows: (1) to identify common factors and levels in community learning that could be used to adapt and mitigate the effects of climate change; (2) to study learning and experience in managing community resources; and (3) to synthesize models of community adaptation to assist adaptation to climate change. Guideline for climate change mitigation, adaptation, and resilience, which can be applied to other communities will be formed.

2. METHODOLOGY

2.1 Study area

This study aimed to identify common factors in community adaptation to climate change using a mixed-methods approach (Ishtiaq, 2019). The study areas selected were surveyed using purposive sampling based on the behaviour demonstrated in human settlements, as communities in high risk locations are more likely to be affected (Aboda et al., 2023). The communities were selected from the areas shown in Figure 1 (a), (b), and (c).

2.2 Participants and data collection

The study was separated into three phases. The first identified common factors and levels of community learning used to adapt and mitigate the effects of climate change. Structured interviews (Rashidi et al., 2014) surveyed a total of 3,700 households, and results were calculated using Yamane (1973) with a 95% confidence level, and a p-value of 0.5 was assumed.

$$\text{Formula} \qquad n = \frac{N}{1+Ne^2} \qquad (1)$$

Where; n=the sample size; N=the population size; e=the acceptable sample error.

$$\text{Substituting the formula} \quad n = \frac{3,700}{1+(3,700)(0.05)^2} = 361$$

The second phase studied the learning and experiences used when managing community resources. The first in this two-step process was to undertake in-depth interviews to gain insights and rich experiences from different target groups. The sampling method used the snowball sampling technique, and the data collection used was that of standardized or structured interviews to collect information from key informants. The sample size was small with small group discussions five participants per area, totalling fifteen participants. Data collection from community leaders and experienced community members who understood the local context and had lived in the area for at least ten years, such as monks, local politicians, and volunteers. The data collection was hand-written and audio-recorded, taking approximately two hours per individual over three months.

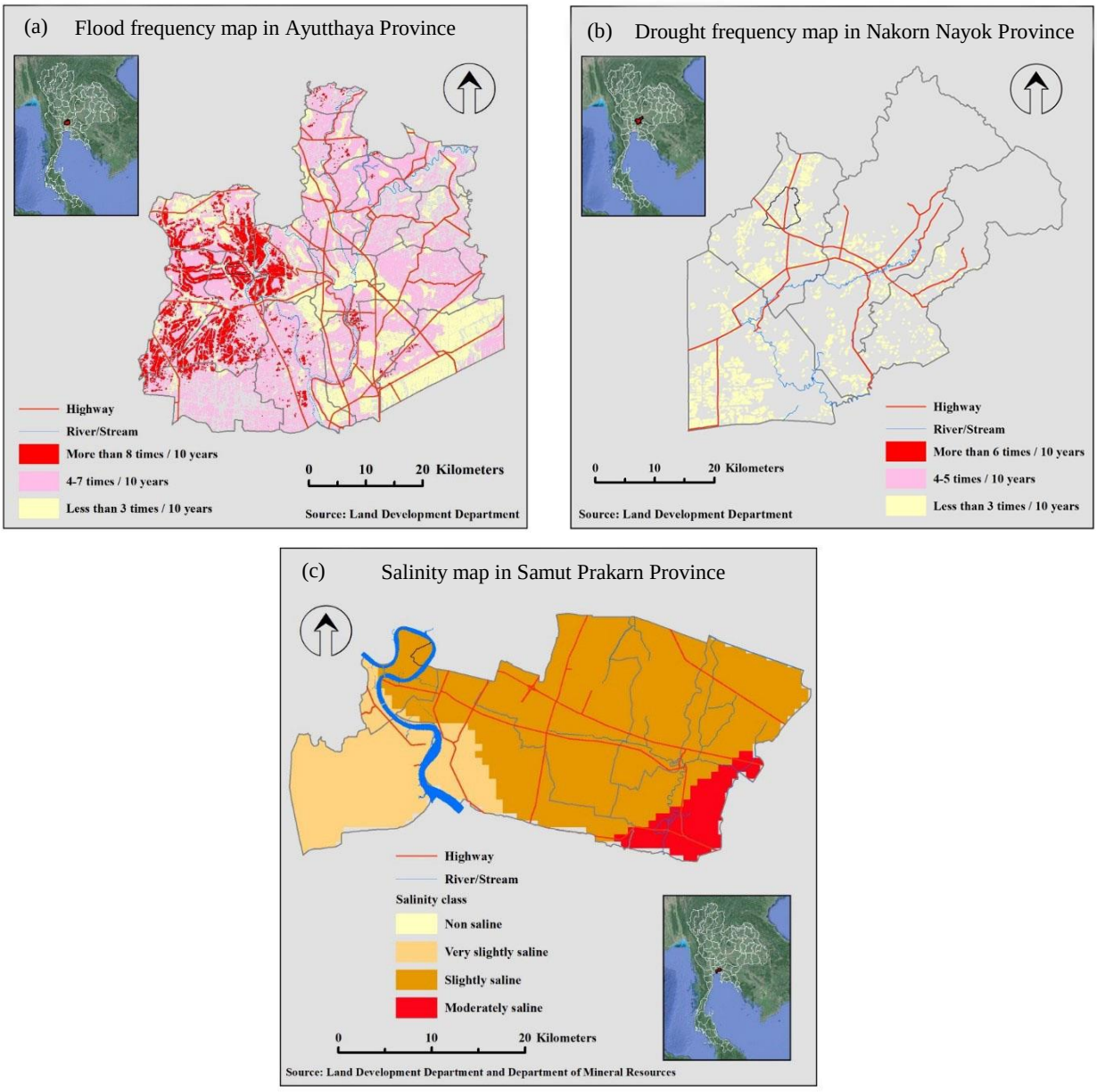

Figure 1. (a) Hua Wiang Sub-District, Sena District, Ayutthaya as riverside communities; (b) Pa Kha Sub-District, Ban Na District, Nakhon Nayok, as the mountainous communities; and (c) Bang Nam Phueng Sub-District, Phra Pra Daeng District, Samut Prakan as the coastal communities

The second stage used small group discussions or focus groups (Krueger et al., 2001). The sampling method uses the purposive sampling method technique to obtain diverse perspectives and group conclusions. The sample size used in the small group discussions was six participants per area, totalling eighteen participants. These discussions were a process of both learning about the experiences of different vulnerable groups in locations affected by climate change. The data collection by observation was hand-written as well as audio-recorded, and took three hours per group over a period of two months.

The third step involved synthesizing community adaptation models with climate change in local geographic areas. Both quantitative and qualitative studies were used to design innovative environmental resources by synthesizing community adaptation models.

2.3 Data analysis

Quantitative data analysis was obtained from the questionnaire to study the situations, people, and experiences in communities affected. Three hundred and sixty-one quantitative datasets from households were obtained from the questionnaires.

Qualitative data analysis, including content analysis, consists of data, opinions, situations, experiences, and community adaptations to climate

change. The process was: (1) analysis of recording transcriptions and handwritten documents for a preliminary conclusion; (2) coding, data analytical, and interpretation; (3) content analysis based on the framework of community adaptation; (4) analysis of the collected data using MS Office (Word and Excel); and (5) analysis of the results to achieve the objectives of the study. The content analysis followed the requirements of human research ethics and a variety of participants were selected to address the limitations in the research tool (Carter et al., 2021).

2.4 Research statistics

Quantitative data analysis was obtained from the questionnaire and analyzed using statistical software packages. Data processing discovered the mean (mean score), standard deviation (SD), and weighted mean score (WMS), in order to explain the levels of learning and analyze the capacity for adaptation in communities to cope the rating scale, based on the Likert (1967) method, has interpretation criteria to determine the average grade level, defined as the range of scores, and the range was divided for each grade using the interval scale as a data scale to determine both the direction and size of the data differences.

$$\text{Range} = \frac{\text{max score - min score}}{\text{frequency}} = \frac{5-1}{5} = 0.80 \quad (2)$$

In the case of levels 1-5, the mean score was level: The means were interpreted as follows: The lowest level was in the point range of 1.00-1.80, low level: 1.81-2.60, moderate level: 2.61-3.40, high level: 3.41-4.20, and the highest level: 4.21-5.00 as shown in (Table 1).

Table 1. The criteria for the distribution of the scores

Likert-scale description	Likert-scale	Likert scale interval
Lowest level	1	1.00-1.80
Low level	2	1.81-2.60
Moderate	3	2.61-3.40
High level	4	3.41-4.20
The highest level	5	4.21-5.00

3. RESULTS AND DISCUSSION

Factors in community adaptation to mitigate climate change in Thailand are presented in this section, including the results of the study and a discussion on the separate elements, according to the objective of the study. The phenomenology and theoretical framework of Howard's (2013) were applied to help gain perspectives on experiential learning, adaptation, community organizing, and resilience for climate change mitigation, with the results as follows:

3.1 Common factors and levels of community learning used to adapt and mitigate the effects of climate change

The results in (Table 2) show that informants were learning about and adapting to climate change to a high level ($\bar{x}$=3.41) However, there are two factors in which learning is moderate: (1) learning about violent events and disasters or understanding risks; Communities should accelerate awareness building (van Valkengoed et al., 2022; Abid et al., 2019); and (2) government support or policy approaches that require a participatory process, where the government should support projects that help communities reduce the impacts (Nydrioti et al., 2023).

Table 2. Common factors for learning about and adapting to climate change (361 households)

Learning elements and community adaptation	$\bar{x}$	S.D.	Learning level
1. Learning about violent events and disasters	3.05	0.971	moderate
2. Applying knowledge about the nature, ecosystems, and traditional wisdom relating to adaptation	3.56	0.941	high
3. The management needed to achieve adaptability	3.41	1.220	high
4. A shared vision success in adaptation	3.44	1.070	high
5. Collaboration	3.54	0.992	high
6. Adaptation options	3.53	0.971	high
7. Supporting guidelines or policy guidelines from the government	3.36	1.061	moderate
Total average	3.41	1.032	high

3.2 Learning and experiences in community resource management

To study the learning and experiences in community resource management, presenting the results and discussing the effects of phenomena, experiences, and learning used in adaptation, which will vary depending on the three different areas studied.

According to the study, "understanding of risk" is a factor in all three locations s studied. In the riverside community, people understand that flooding is normal, as it occurs most years, as shown in (Figure 2), with heavy flooding every four years. The tillering of bamboo tops, or ant migration are indicators of flooding, signaling that the community must prepare to mitigate the impact. Steps such as preparing boats are taken, and the community has a good understanding of risk and reduce its vulnerability. Where the community are accepting of recurring flooding, there is a change from negative to positive attitude, with boat races organized during floods. Adapting from crisis situations to opportunities is a coping mechanism, with flooding bringing fish, which are caught, dried, and sold to generate income for households, and also reduce the loss of income caused by the floods. In the mountain community, the people understand the signs and impacts of drought, so they have reduced the impact of climate change through integrated farming, which reduces water consumption. Finally, the coastal community has learned knowledge about ecology, making it possible to understand that the soil and water in the area accumulate salinity.

Figure 2. Flooded Hua Wiang District in 2022

Carmen et al. (2022) proposes that the use of social capital can promote adaptation and assist in proactive recovery, while Hosen et al. (2020) discusses the use of conventional ecological knowledge and observations of landscapes, plants, and soil (Table 3). Shahid et al. (2018) discusses salt degradation of soil, as soil salinity undermines the resource base and reduces soil quality, negatively impacting agricultural productivity and sustainability. The impact of these conditions can be mitigated against by developing soil use and management policies. However, it is important that communities can organize and manage themselves, so stimulating awareness in the community is necessary for them to participate in adaptation. This is in line with Abid et al. (2019), who reflect on the steps of adaptation, beginning with perception, intention, and adaptability. There are also other factors such as education, experience, cooperation, access to weather forecasts.

Table 3. Learning about violent events and disasters

	Statement of fact	Reference
	Understanding about the landscape, plants, and soil	Hosen et al. (2020)
	Understand and awareness in flood disaster management	Frank Jerome (2021)
	Farmers who are knowledgeable about mixed farming can better adapt to it	Abunyewah et al. (2023)
	Threatened biodiversity, local economy, and society	Romero Manrique et al. (2018)
	Affected by the salinity of the soil and water	Shahid et al. (2018)

"Local wisdom" is knowledge that comes from experience in working with local resources and ecosystems. In the riverside community, the experience of living through repeated floods led to knowledge being gained that *Elaeocarpus hygrophilus* Kurz are the only fruit trees that can survive in extreme flood situations. Mountain communities know to reduce the evaporation of groundwater by providing shade with banana trees, thereby allowing their vegetables to obtain water naturally, so farmers do not need to water their vegetables as much. In coastal communities, most of the soil has high levels of salinity, so wisdom advises locals to improve the soil or import the soil from outside and using it in elevated pots to generate income (Figure 3). Collectively, the reviews of conventional wisdom to discover species of plants that have good growth properties in saline conditions, such as coconut palms, betel nut trees, and mango are encouraged (Figure 4).

Local wisdom is a common and simple approach used by communities when faced with problems. Dhungana et al. (2023) states that knowledge from past experiences can help communities gain acceptance because those experiences relate to the lifestyle of the community (Table 4). In addition, communities use local wisdom to assess the situation (Kansuntisukmongkol, 2017), such as when predicting the expected flooding or drought levels each year. Mountain communities aim at sustainability in food production systems, in line with Singh and Singh (2017), who state that recognizes that conventional wisdom in farming has been around for a long time and is a wise approach when adaptation is needed because of a changing climate to produce sustainable levels of food.

Figure 3. Planting ornamental plants in pots to solve soil and salinity issues

Figure 4. Original garden or raised grove garden trees in the ground

Table 4. Applying knowledge about the nature, ecosystems, and traditional wisdom relating to adaptation

	Statement of fact	Reference
	Integrating traditional knowledge into strategic	Kansuntisukmongkol (2017)
	Knowledge from past experiences can help with acceptance	Dhungana et al. (2023)
	Traditional agriculture in the context of sustainable food is a climate-smart approach	Singh and Singh (2017)
	Traditional ecological knowledge in coastal communities	Leonard (2021)

Communities need to create local management systems to adapt systematically as the increased levels of climate change cause seasonal shifts. The rainy season is arriving earlier than usual more often, and floods are occurring at an increasing rate. Therefore, the riverside community needs to plan the crops planted in advance, shifting the seeding time to earlier than before and encouraging new seedling sowing times to be faster than ever before.

In the communities studied, they have managed this themselves by createing local management systems that have developed a water management system that uses a systematic manner to allow water flow paths to be linked with household water systems (Figure 5). The mountain community uses local management systems to assess the situation, plan, and supervise water management systematically, in line with a study by Ghorbani et al. (2021) that discussed that local management systems can occur spontaneously, and help enhance resilience from drought (Table 5). Adger et al. (2009) recommends integrating climate change risks into lifestyles, where knowledge, skills and practices change attitudes or behaviors in each society.

Figure 5. Household water management by storing water in shallow wells

Table 5. The management needed to achieve adaptability

	Statement of fact	Reference
	Importance of participatory, planning, and ecosystem-based adaptation	Reid (2016)
	Water management, store aqueducts' water inside the pool, reservoirs, and natural dams	Ghorbani et al. (2021)
	Low-cost agriculture by producing organic fertilizer instead of chemical fertilizers	Heisse and Morimoto (2023)
	Study on the planting of salt-tolerant plants	Rivero et al. (2022)

Community practice is an informal coherence, with households in mountain communities reducing their dependence on water for agricultural use during the dry season, and restoring household wells to increase the amount avaiable. Coastal communities have created floating markets, and riverside community building a common consensus on using public spaces to provide assistance to the vulnerable households affected by flooding. By sharing private land and creating evacuation sites for the victims, the community can quickly return to normalcy. Focus on building partnerships and building resilience to adaptation.

"Shared public spaces" is a concrete form of riverside community practice, where farmers have adopted adaptation practices to reduce their impacts (Khanal et al., 2019). Public spaces are connected to passable roads to enable connection to public

transportation, which reduces journey times dramatically. Space also allows use for other purposes, such as setting up tents for victims, and the creation of public restrooms. The project was successful as it enhanced the livelihoods and security of the community.

There are tangible results from the project, including the reduction in dependence from external agencies as communities worked together to create common goals to achieve justice and equality. Those who participated felt a more meaningful connection to the community (Ardoin et al., 2023) (Table 6).

Table 6. A shared vision success in adaptation

	Statement of fact	Reference
	Connection between civic engagement and environment education in area	Ardoin et al. (2023)
	Water management link to small farmers	Chandra et al. (2023)
	Stakeholder engagement in floating market	Kulsum et al. (2020)

Community collaboration in the three locations has different patterns, depending on the problems and situations affected by climate change. Community collaboration focuses on integration and networking, and in the riverside community, collaboration between communities and government agencies through communication channels, mainly LINE groups, was used to closely monitor water levels. In the mountain community, fruit growers shared knowledge between community leaders, volunteers, and farmers, providing advice on high-quality cultivation techniques amid climate change. In the coastal community, collaboration between different agencies helped communities adapt.

A study by Vogel et al. (2020) indicated that community levels are most severely affected by climate change, so, it is imperative to bring collaboration into local adaptation policies and planning. Carmen et al. (2022) stated that climate change challenges are complex issues that require partnerships to be built to encourage a proactive recovery. The coastal community created a collaborative network that coordinates joint action. Such cooperation is a social strategy to reduce risk, which can occur in the form of product networks, knowledge, cooperatives, enterprises, and occupational groups, in line with the work of (Kansuntisukmongkol, 2017). Communities collaborate with networks and agencies at (1) group level, “Bang Num Phueng Sufficiency Economy Group”, (2) local level, there are six sub-districts “Khung BangKachao Network” (Rambaree et al., 2019) (Table 7), and (3) at the national level “OUR Khung BangKachao” in which thirty-four organizations in the private and public sectors collaborate. Holme and Rocha (2023) reflect that networking can help address the complexity of climate change.

Table 7. Community collaboration

	Statement of fact	Reference
	Awarenes network and participatory manner with government agencies	Orathai et al. (2019)
	Supporting innovative agricultural practices	Ensor et al. (2019)
	The loosely organized group “Bang KaChao Group”	Case and Zeglen (2018)
	Development work between the local municipal and community	Rambaree et al. (2019)

Adaptation options are created after climate change is recognized, understood, and accepted. The three communities had separate coping mechanisms, with the riverside community formulatin a disaster response plan, where as the coastal community looked towards income generation. Opportunities related to community tourism, such as bicycle rental, boat rental, cafes, home stays, food sales, and Thai massage were common. In the mountain community, the people had adapted by connecting a variety of adaptation options, such as switching from a monoculture to an integrated farming method to reduce the risks of drought (Figure 6), which resulted in a diversified income for the community. Previously, there was one annual income from selling rice, but now there was added value from agricultural products.

In addition, resources were being maximized for benefit (Feleke et al., 2016) (Table 8), including

the processing of santol, as the skin is damaged by off-season rains. Nonvide (2023) reflects that if farmers have land security, they should make strategic choices to adapt to climate change. As such, farmers have changed their focus from mass production to high-quality products, including high-quality organic fruits (Yakah, 2016). Adaptation has resulted in a better quality of life for people in the community, both economically and socially, and they are more motivated to protect themselves rather than be afraid of the higher risks (Bagambilana and Rugumamu, 2023).

Figure 6. Integrated vegetable and fruit planting to diversify the risks of climate change

Table 8. Adaptation options

	Statement of fact	Reference
	Changing the sowing time to be faster	Nonvide (2023)
	Agriculture and ecology influence adaptation	Feleke et al. (2016)
	Water system interconnections by community	Maliva (2021)
	Diversity of income, market development, and prompt households to diversity activities	Jalal et al. (2021)

Government support can result in two resolutions: (1) it can support efficent adaptation; and (2) it can resist the community led adaptations. The three locactions received support that led to both resolutions. The mountain community, which received support from the government, shifted how it worked with communities to be proactive, reducing dependence on the climate in the economic dimension and improved human empowerment.

The coastal community benefitted from the construction of large public dams, but they proved to be a barrier to the community's adaptation as the community had not adapted successfully to the circulation of water being halted by the dams. Salt water accumulated in the area, resulting in salinity in the soil and water. Before the dams, the tide removed salinity from the soil. According to Mei et al. (2016), government policy of building large structures hoped to control downstream flooding. Lempérière (2017) and Kundzewicz et al. (2018) discussed when investigated how dam construction regulated the flow of water (Table 9). The state has facilitated the construction of dams for the right reasons, but it has caused difficulties for the communities. Therefore, it can be seen that flood prevention policies with dam construction is not successful for all areas, and that dam construction needs to be accompanied by assistance with adaptation (Jayadas and Ambujam, 2023).

This contrasts with riverside communities, which are good examples of stakeholder participatory work. Government and communities have worked together to recognize floods and reduce their impacts. For these communities, the government support has been a force for good, with governor-led community consultation on the accumulated release of water from the north and the rainfall in the area helpful. Both parties agreed to determine when water would be released into the fields, resulting in the decision to release it on September 15th every year. The government support has led to action for community adaptation, with Kansuntisukmongkol (2017)

documenting planting adaptation by advanced planning in areas with shifting seasons. Efficient plans also reduce the costs for government budgets, and increase revenues for the communities, as if the rice is not harvested in time, the government is required to pay compensation based on the value of the damage. In addition, the state has to spend money on rehabilitation for farmers after another disaster (Young et al., 2019).

Table 9. Supporting guidelines or policy guidelines from the government

	Statement of fact	Reference
	Adaptation policy of the flooding situation by the governor and community	Young et al. (2019)
	Stakeholder perception, awareness, and involvement	Nydrioti et al. (2023)
	Integrated water management, and implement a drought policy that would be proactive	Marengo et al. (2022)
	The construction of a dam to block salt water	Lempérière (2017)

3.3 Community adaptation patterns to cope with climate change

Community adaptation patterns to cope with climate change by creating environmental education models based on community adaptation to climate change. Howard's (2013) theoretical and model framework of phenomenon theory was applied in this study, which focuses on situations from the perspectives of experience and adaptation, as shown in Figure 7.

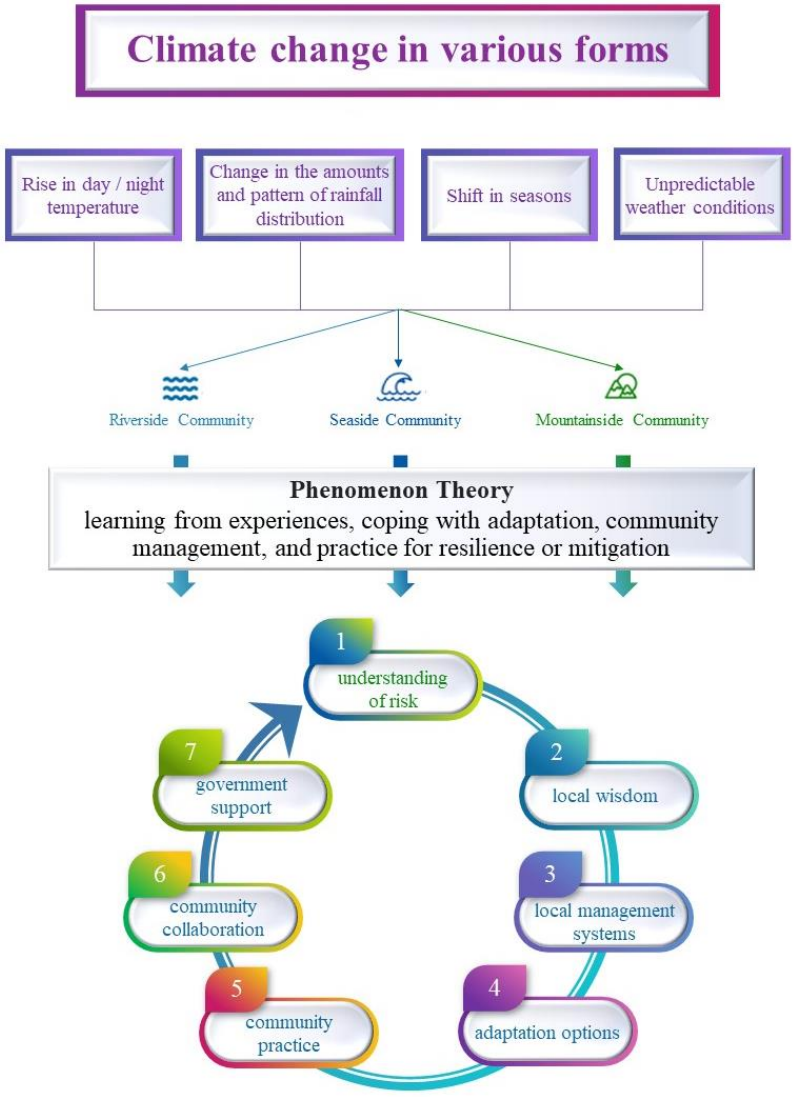

Figure 7. A framework of community adaptation for climate change

4. CONCLUSIONS

Common factors in community adaptation to mitigate the impacts of climate change consist of seven factors: (1) understanding of risk; (2) local wisdom; (3) local management systems; (4) adaptation options; (5) community practice; (6) community collaboration; and (7) government support. Overall, communities have learned to adapt to climate change at a high level. From the study of experience and learning to manage community resources, it was found that strong communities are characterized by self-management and community, relying on the resource base and environment before outside assistanced. However, when provided, they are, accepting, open-minded, and have a positive attitude, which helps to reduce the impact of climate change. In addition, economic, social, and natural resources and environmental factors differ each area. Researchers have developed an environmental education model for community adaptation to climate change, an innovative integrated environmental education that can be used as a guideline to develop people in the community to raise environmental awareness in other community areas. However, future research is recommended, and they should select study locations that cover all regions, and a comparative study should be conducted.

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