

# Impacts of Climate Change on Water Resources Affecting Tourism Industry in a Small Island: A Case Study of Koh Chang, Thailand

Wanvicechanee Tanoamchard and Sangchan Limjirakan

**Abstract**—The purpose of this paper is to examine the impacts of climate change on water on Koh Chang Island. The island has suffered from climate change and limitations of available water supplies, while they have also been confronted by an increasing demand on water for tourism activities. According to the 4<sup>th</sup> Assessment Report of IPCC, a study framework included the current sensitivity and vulnerability of the small island on water resources. Data collection was conducted by documentary research, interviews, and field surveys in 4 villages and in-depth interview of 24 participants including local governmental agencies, village heads, and tourism operators. The study found that this island would be affected by climate change regarding water scarcity. The changing of rainfall pattern has affected the amount of water supply and its due to salt water intrusion. While the numbers of tourists and people consume more water. This would be consequence impact on tourism economy and the quality of life of people. Therefore, the public and private sectors should cooperate setting appropriate strategies and practical actions on sustainable water resources management for a sustainable tourism in the island.

**Index Terms**—Impact of climate change, water resources, tourism industry, small island, Koh Chang

## I. INTRODUCTION

The adverse impacts caused by climatic change have been an issue of interest to people around the world. The consequences of climate conditions have impacted on natural resources, environment, economic sectors, and livelihoods. Not only has climate change caused negative effects on a wide range of the country's natural resources that are significant to tourism destinations, but also they slow down the country's competitiveness and sustainability. The attractiveness of a region for tourism activities depends strongly on the local weather and climate [1]. The impact of climate change means tourism is now becoming unsustainable, especially affecting the vulnerability of tourism that is particularly situated in areas where tourism constitutes the major livelihood of local communities, as is the case in many developing countries [2]. In Thailand, it has been well accepted that the tourism industry has become an important service sector generating significant income to the country. The government has promoted various tourist

destinations attracting tourists from all over the world. In 2002, a number of related policies have been set in place to promote Koh Chang (Elephant Island) to become one of the attractive tourist places in Eastern Thailand [3]. However, the island has a number of limitations to development especially water resources and its supply. To secure economic and social well being together with maintaining the integrity of the natural environment, and increasingly recognizing the implications of a changing climate are necessary. Thus, this study has been done to examine the impacts of climate change, which could directly affect water resources in Koh Chang Island.

### A. Impacts of Climate Change on Tourism

IPCC report (2007) made clear that climate change is now a serious risk. It creates poverty problems as well as being an obstacle to the accomplishment of the Millennium Development Goals. While climate change affects tourism, it is also necessary to respond to global challenges. In this way, tourism cannot be seen as separate from the environmental outcome. As a result, the IPCC has indicated that there is a need for societies and economic sectors like tourism to adapt to climate change in order to reduce associated risks and take advantage of new opportunities, in an economically, socially and environmentally sustainable manner [2][4]. The impact of climate change on tourism was also supported when UNFCCC (2007) recorded that in many countries, tourism is seen as an important sector which is also very vulnerable to climate changes [5]. Furthermore, UNDP (2001) viewed that there was a need to identify the impact of climate change on tourism and reinforce national capacities to deal with this consequence [6]. In addition, the impact of climate change has extended to the tourism sector in many countries as one of the factors impeding development. Because the tourism industry, especially with respect to nature, depends on the environment and climatic conditions, changes in climate can directly relate to a reduction in numbers of tourists such as changing the operating costs of heating, cooling, irrigation and water supply, and changes in patterns of extreme weather events. Furthermore certain indirect impacts, such as losses in biodiversity, degradation of the aesthetics of landscapes, changes in water availability and increasing natural hazards can become problems for tourism in the future [7].

### B. Characterization and Climatic Condition of Koh Chang

Koh Chang is located in the eastern region of Thailand, in Trat Province. It consists of more than 50 islands in the Gulf of Thailand and has a total area 650 square kilometers. The north of the island is connected to Leam Ngop District, and

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W. Tanoamchard and S. Limjirakan are with the Environment Development and Sustainability Program, Graduate School, Chulalongkorn University, Thailand (e-mail: wanvicechanee@hotmail.com; lsangcha@chula.ac.th)

the east of the island connected to Muang District. The south of the island is close to Koh Kut District, and the west of the island is open to the Gulf of Thailand. Most of the area is covered by mountains especially in the middle area of Koh Chang where the height varies between 100 to more than 700 meters above sea level. The slope areas are more than 30% of the total areas and the plain areas are only 15% of the total area. The type of soil depends on the geological characteristics in each area, however, most of such soils are shallow soil and rock which are not suitable for agriculture. The geological structure of Koh Chang is igneous rocks in Tertiary period, from 65 million years ago to 1.8 million years ago, sedimentary and metamorphic rocks. The types of igneous rocks are Rhyolite, Andesite, and Tuff. In the middle area of Koh Chang, there have been many high mountains. The Khao Yai in Koh Chang Tai Sub-district has the highest peak about 743 meters above sea level. However, in the Koh Chang Municipality, many high mountains have been continuously laid into two lines. One lies from the north to the east of Koh Chang. It has the highest peak at Kao Chom Prasat Nueng (661 meters). Another lies from the north to the west of Koh Chang at Khao Chom Prasat Song (626 meters). Those two mountain lines cause the small coastal plain in ravine and Klong Son Bay. The west and east coast of Koh Chang, in the boundary of Koh Chang Sub-district, are jagged shore. Anyway, the west coast has many beautiful beaches while most of east coast areas are rocky beaches. The famous beaches in the west coast are Sai Khao Beach (or White Sand Beach), Klong Praw Beach, and Kai Bae Beach. The southern area of Koh Chang is located on the boundary of Koh Chang Tai Sub-district. Because of a lot of bays, it has many high cliffs that are continuously set along the seashore in the southern area. The most famous bays are Bang Bao Bay, Salak Phet Bay, and Salak Kok Bay. Those areas consist of many mangrove forests and local fishing villages. Even though most of the southern coast is mudflats, there are a few narrow sandy beaches as well [8]. Koh Chang is located in Tropical forest. The average annual temperature is around 27 °C. The general climate of this island can be divided into three seasons which are (1) the summer season, which starts from March to April. During this period, the weather is warm, especially in April. The temperature range is around 21 to 38 °C; 2) the rainy season, which starts from May to October. It has been influenced by the Southwest monsoon. During this period, temperature ranges is around 19 to 36 °C. The average rainfall is about 5,500-6,500 mm per year; and (3) the winter season, which starts from November to February. It has been influenced by the Northeast monsoon. During this period, the temperature ranges is around 18 to 32 °C [8].

## II. MATERIAL AND METHODS

### A. Study Area

The study area has several notable distinctions in environment which can represent the entire area on Koh Chang. By paying attention to the differences of the locations, tourism activities, topography, and management, four villages namely Klong Nonsri, Klong Praw, Bang Bao, and Salak Petch were chosen as suitable areas to study (Fig. 1). The study selected twenty-four participants to investigate the

impact of climate change affecting water resources on the communities. They were chosen by specific sampling method and were people who had experience and were involved with water and its problems.



Fig. 1. Four villages studied, Koh Chang Island.

### B. Methodology

This study was carried out under research activities including collecting secondary data by documentary reviews, interviewing participants, and a field survey. Data for the study were collected through document analysis, interview, and visits to the communities sites. The data collection framework that created the interviews and survey guide was applied from the current sensitivity and vulnerability of the small island on water resources stated in IPCC report, Section 16.4.1 comprising the temperature and precipitation, sea levels, extreme events, as well as other relevant conditions [9].

## III. RESULTS AND DISCUSSIONS

### A. Changes in Rainfall Pattern Reduces Availability of Water Supply

Two main water resources used in Koh Chang comes from surface water source and ground water source. The most important source of water is the surface water that comes from rainfall which used to be prevalent throughout the year. However, the study found that there has been a significant changing in precipitation in the past three years. Data from Klong Yai district Weather Stations presented the changing in rainfall pattern in Koh Chang across past three years (2008-2010). There was more than 100 percent increase in amount of rainfall more in 2009 comparing to the previous year. In contrast, there was a decrease in number of rainfall in 2010. More surprises were found when there was an increase in amount of rainfall during December 2009 and January 2010 comparing to none in the previous year. It could be

understood that the change in rainfall pattern can possibly be an influence to climate change in this island. It also found that there was very little rain during certain periods, particularly during the peak periods of tourism (November-March). Whilst the amount of water necessary to use to operate many tourism businesses has created shortages (e.g. home-stays, resorts, and hotels), the demand for purchasing water has become necessary. Indeed, several tourism operators have to buy water from vendors who set up private ponds. The severe shortage of water has become the biggest problem on this island especially while the water resources on this place are limited, but there has been a continuous growth in the number of tourist operators each year. As a result, the natural water resources were depleted (Fig. 2).



Fig. 2. The dry canal in Klong Praw Village due to rainfall pattern change.

**B. Intrusion of Salt Water Decreases Ground Water Quality**

The study found that although people could use water directly from the surface natural sources such as waterfall or canals, actually not many communities could access these sources as they do not live close to these headwaters. Many people, therefore, use available water which they could pump from the ground and sometimes they need to purchase water from private ponds excavated specially for commercial purposes by other people. In addition, most people who could not access surface water and did not have their private pond had considered using their artesian well and shallow well. Even so, there was one concerning issue found in this study that many participants encountered when using water from artesian wells and shallow wells. Data from our participants revealed that during the process of pumping up water from the ground, salt water can be a contaminant. This is due to the fact that some areas of certain villages are located too close to the sea where drilling could not be done deeply.

Fig. 3 shows the distribution of the settlement of the community and tourism businesses in Klong Praw Village which has the greatest tourism development in the island. In this area, many businesses and households are located very near the coast about 100-800 meters. They were affected by the intrusion of sea water that reduces the ground water quality on properties that were built about 2-3 kilometers from the coast. Participants disclosed that the wells that water came from could be drilled only 30-40 meters deep from the ground. Also water from the wells that were dug from 5-10 years ago might not be good to consume since it was very

nasty like rotten mud, especially in the dry season. They also described that after their artesian wells were used for only 4-5 years, it could create rusty smell (e.g. corrosive smell, rotten mud smell, and salty) leading to unpurified water that cannot be drunk or consumed. The impact of this change was especially significant to the tourism industry as well as the community at large. Not only it can reduce the quality of water, but also increase the cost to businesses in buying fresh water for their services.

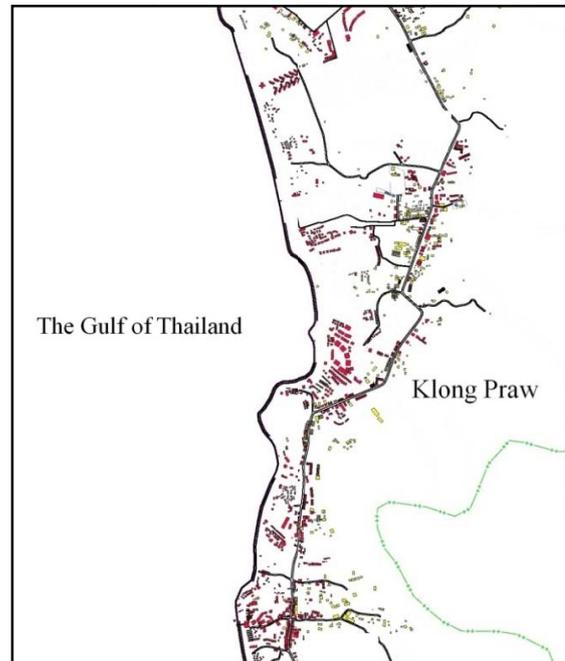


Fig. 3 The distribution of tourism industry along the coast of Klong Praw Village (adopt from Trat Office of Public Works and Town & Country Planning, 2009).

Another area which was severely affected by the intrusion of salt water is Bang Bao Village. This was due to the traditional nature of fishing houses that were built extended out into the sea (Fig. 4), giving the village the advantage of adapting their houses to be home-stay. Each year many tourists come to visit here. In this area, the study found that when the groundwater from the artesian well, which was already brackish was over-extracted, it will affect the quality of the availability of fresh water.

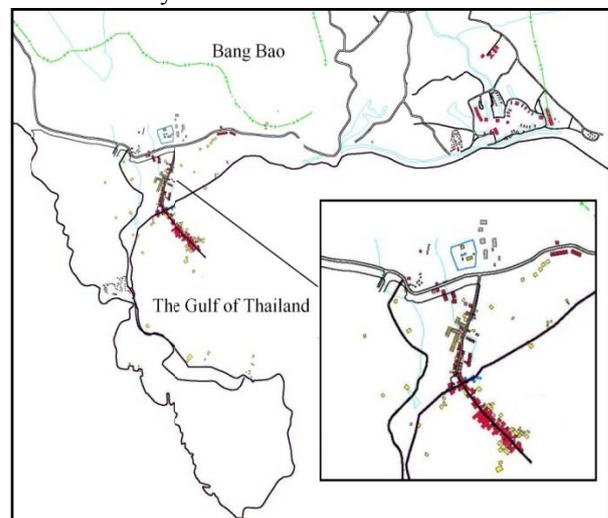


Fig. 4 The distribution of home-stay businesses in Bang Bao (adopt from Trat Office of Public Works and Town & Country Planning, 2009).

### C. The Severity of Extreme Events Destroys the Source of Water Storage

The impact of climate change on water resources has been aggravated due to the physical limitations of areas on the island. This is because most of the water routes were short and quite steep; therefore, when it rains, water was rapidly drained into the sea (Fig. 5).



Fig. 5. The short water routes in Koh Chang (adopt from Trat Office of Public Works and Town & Country Planning, 2009)

Moreover, climate change also affected the village weirs, which can slow down the water flows during the rainy season, as well as allowing it to store water for consumption, irrigation, and tourism. After considering the geography of the island which consists of many mountains and steep slopes, it could be found that weirs which have not been properly built could not resist the cataract and consecutive heavy precipitations that flow down rapidly from the mountains. As a result, much of the infrastructure regarding improper drainage and unstable weirs has been damaged (Fig. 6).



Fig. 6. The erosion of weir after facing sever water

### D. Other Relevant Issue Affecting Water Supply in the Island

Other relevant conditions affecting the water supply on the island is the high demand for consumption. Data from Department of Provincial Administration (DPA), 2009 presented an about 52.9 % increase in the population during the years 2000 to 2009 [10]. It can also be discovered that in every year, the percentage of population was raised by about 5.5%. This is due to the island has an increasing in tourism industry and their employees. However, the study found that the presented percentage of population collected by the DPA was stated as being lower that the actuality. Indeed, the evidence provided by the Bureau of Registration Administration of Koh Chang showed that there were the number of latent people and the number of Burmese (9,519 persons) and Cambodian (1,770 persons) migrant workers that was not included in the presented data of DPA [11]. An error in counting the actual number of people living on this island results in the limitation of budget requested from the central government in order to assist the local government organizations (e.g. drought budget). In addition, the study found that the high demand caused by increasing numbers of tourists affected supply of water of the island. Indeed, in areas where tourism has been over developed, water shortage problem was increased accordingly (e.g. Klong Praw Village and Bang Bao Village). It can be noted that the population numbers influence the amount of water in that area. Data from Trat office of public works and town & country planning (2009) presented the largest number of population in Klong Praw Village, which has the most tourism development in the island [12]. Meanwhile, this village has affected by water scarcity.

Notably, most participants in two villages which have the most tourism development noted that many years ago before tourism was developed on this island; their villagers were never faced with the water shortage problem. They, thus, felt strongly that this is happening because of the increasing number of visitors and tourism development projects. Participants clearly highlighted their opinions that even though there have been various sources of water available on this island, it will never be enough for the growing number of tourists coming to this island. Moreover, most participants emphasized that these threats had seriously affected the quality of their life as well as the development of tourism industry. Besides, this also leads to conflict in the areas between villagers and tourism operators when water is needed. This problem could be demonstrated when the demand of draining water from waterfall is needed by tourism operators and villagers who need water to use at home and to supply their agriculture during dry season.

## IV. CONCLUSIONS

Tourism industries in Koh Chang have been vulnerable to the effects of climate change especially regarding water shortages. The findings presented in this study can identify that climate change means the tourism sectors are now going through unsustainable development. Moreover, the tourism sectors have been facing economic vulnerability (e.g. rising costs of operation) and social vulnerability (e.g. quality of life

and conflicts among user groups). The conclusion can be stated as follows, first of all, the most severe impact of climate change was an increasing water shortage due to changes in precipitation patterns and intensity. Most of the water from natural resources including waterfalls and canals were not available throughout the year. Changes in rainfall patterns create prolonged dry periods. The issue of water sources drying up has created vulnerability to businesses especially during the high-season. Also, survey responses indicated that climate change exacerbated water risks, especially as the tourism demand grows. Secondly, there were parallel effects from climate change such as quality of water to the community and tourism. Change in climate also affects water quality, there have been contaminated coastal surface and groundwater resources due to the sea level rising, resulting in saltwater intrusion into wells. Thirdly, severe drought has been aggravated due to most water routes on the island being short and quite steep letting water rapidly drain into the sea. On the other hand, the island has a major problem in decreasing availability of water caused by limitations in catchment of water routes. This being heavy rain for several days and unusual storms as a result of climatic change, damaged and destroyed many water storage weirs which are an alternative to alleviate the drought during the dry season. Finally, under the continued growth of tourism demand, water and its scarcity as well as unsustainable supply, these created the issues of water-related vulnerability for tourism industry. Moreover, it seriously affected the home-stay businesses of local communities in order to be able to survive the increasing operational costs. Additionally, it will create more conflict between local communities, tourism operators, and other large-scale water users. Ultimately, the challenge of climate change will hinder the development of sustainable tourism on this most beautiful island in the eastern part of Thailand.

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