

CHAPTER II

LITERATURE REVIEW

The researcher has done some literature review which can be divided into 4 parts: (1) The sea level rise, (2) General information of Bang Khun Sai sub-distinct, (3) Economic value, (4) Environmental valuation, and (5) Thematic analysis; the details will be explained as follows:

2.1 The sea level rise

2.1.1 Impacts of climate change on the sea level

Climate change due to an increase of the greenhouse gases from human activities affects the coastal area in terms of an increase of the sea temperature, a decrease of the seawater pH, and an increase of the sea level. The increased sea temperature actually is one of the causes that increase the sea level. According to the temperature records from all around the world and the statistically analysis, it was found that the Earth's temperatures has increased 0.3-0.6 degrees Celsius since 1860, which is related to the global mean sea level increased about 10-25 cm in this past 100 years. The main cause (about 75%) for this effect is probably due to the expanded volume of the seawater as the temperature is rising including the warmer weather both on earth and on water; all of these factors causes the snow and the polar ice melting, turning into a large amount of freshwater flowing into the ocean even faster. As a result, the sea level is continuously increasing in this manner for a long time though the surface temperature does not change due to the sea level response very slowly to the sea temperature. In addition, there are some other factors probably affecting on the global sea level and the local sea level to be either higher or lower than the global mean sea level such as the changes of the tides in the ocean, winds as well as atmospheric pressure, movement of earth crust, land subsidence, underground water

level, tidal currents, sedimentation, etc. (Department of Marine and Coastal Resources, 2012; IPCC, 2013; IPCC, 2014; Wong *et al.*, 2014)

From the simulated situation that the greenhouse gases were released at the maximum level that the Intergovernmental Panel on Climate Change (IPCC) in 2000, it was found that by the end of this century the average global surface temperature will be increased from that in 1980-1999 for about 4 degrees Celsius and it was also discovered that the average global mean sea level will be increased for 70 cm. within 2100 compared to the sea level in 1990. However, in the case that the intensity of greenhouse gases is stable at the range of 450-550 ppm, it is expected that the global mean sea level will be increased about 40 cm. within 2100 compared to the sea level in 1990. The simulation result indicates that the increased sea level is partially caused by the intensity amount of greenhouse gases. As a result, if the amount of greenhouse gases is reduced, the future impacts will also be relieved. (Asian Development Bank, 2009; Stocker *et al.*, 2013)

Additionally, IPCC (2007) stated that the increased earth temperature causes the global mean sea level has been increasing about 1.8 mm/year since 1961 and about 2.4-3.8 mm/year since 2003 or the mean sea level has been increasing with the average ratio of 3.1 mm/year. While, IPCC (2013) studied about the sea level situation in this past century, it was found that the global sea level has been increasing continuously for approximately 2.8-3.6 mm/year in 1993-2010 and the global mean sea level or averagely 3.2 mm/year.

2.1.2 Impacts of the sea level rise

There are some predictions about the impacts of sea level rise as follows: in the case that the sea level increases about 30 cm., the sea will over flow the coastal lowland of China for about 81,348 km²; in the case that the sea level rise approximately 40 cm., it was found that there will be 13-94 million people, which is about 20% live in South East Asia such as Thailand, Vietnam, Indonesia, and the Philippines, affected by this (Cruz *et al.*, 2007); in the case that the sea level rise about 36 and 72 cm, it will affect the global wetlands to disappear approximately 33% and 44%, respectively (National Research Council of Thailand, 2009).

According to Lenton *et al.* (2009), it was discovered that in the case of the sea level increasing about 50 cm, the countries that will be affected the most are China, the United States, India, Japan, the Netherlands, Thailand, Vietnam and Bangladesh, respectively. In the case that the sea level increase around 100 cm, the seawater will overflow widely into the delta of Red River and the delta of Mekong River causing the loss of the mangrove forest area approximately 2,500 km². In addition, there will be some flooding in some areas of India and Japan. Nevertheless, the damages from floods depend on the level of protection such as the more effective protection system in Japan causing less effects from floods; whereas, the less effective protection system in China causing about 5-6 times of effects from flood (Cruz *et al.*, 2007).

In general, the coastal areas of Asia are facing with the impacts of the sea level rise for example flood in the coastal wetland, erosion of the coast, saltwater invasion into the freshwater, etc., which affects the agriculture areas and the decreased capability of food production including fishery products and aquaculture around the estuary (Hijioka *et al.*, 2014).

For Thailand, the Office of Natural Resources and Environmental Policy and Planning (2009) analyzed the changes in the sea level in the future as in provincial parts as follows: the sea level tends to increase in the Eastern approximately 3.58-6.57 mm/year, the sea level tends to decrease in the Southeast around 0.35-3.52 mm/year except that of Songkhla province and Nakhon Si Thammarat province tends to increase about 3.90-5.46 mm/year, the sea level tends to rise in the Southwest approximately 0.91-12.45 mm/year, and the sea level tends to increase in the Upper Gulf of Thailand about 3.61-22.45 mm/year. Additionally, the Office of Natural Resources and Environmental Policy and Planning (2011) predicted that in 2040, the mean sea level in almost every province in the South of Thailand tends to increase about 5-10 mm/year with the additional boosting factor that will intensify the impact of sea level rise i.e., the land subsidence due to the earthquake in 2004 that caused the net sea level increased in the Andaman coast no less than 12-14 mm/year and that of the Gulf of Thailand no less than 14-16 mm/year.

Department of Marine and Coastal Resources (2012) reported that the sea level increased differently in the Gulf of Thailand which the sea level increased a lot

more in the Upper Gulf of Thailand. As a result, there was a simulated scenario of the changes of sea level in the Upper Gulf of Thailand by setting the ratio of the sea level averagely 5 mm/year and the average land subsidence constant of 14 mm/year; it was found that in the next 10, 20, 50 and 100 years, the sea level rise accumulatively 19, 38, 53 and 78 cm, respectively. Furthermore, National Research Council of Thailand (2009) reported the result of the mathematical model about the impacts of sea level rise 50 cm on the coastal area of Thailand; it was discovered that the most affected coastal areas were the coast of Phetchaburi province, the coast of Samut Songkhram province, the coast of Samut Sakhon province, and the coast of Samut Prakan province of which the widths of the coasts decreased and many beaches would be flooded. Thus, in this research, the scope is set for the impacts in the next 20-50 years which the accumulative sea level rise would be 38-53 cm.

Besides the impacts on flooding in the lowland area, eroding of the coastal area, saltwater invading into the estuary including the crisis of the clean freshwater for consumption and for agriculture. Office of National Environment Board (2008) simulated the sea level rise in Samut Songkhram province; it was found that if the sea level increased 25 cm, the saltwater would overflow into all areas of Bang Cha Kreng sub-district, whereas, Laem Yai sub-district, Klong Kone sub-district, Bang Kaew sub-district got affected from flooding approximately 76.48%, 50.90%, and 20.88% of the areas, respectively. This would cause the loss of area about 4.295 km² and the damages of the areas because of permanent flood approximately 3,221 million Baht.

Additionally, the sea level rise affects the natural resources. Department of Marine and Coastal Resources (2012) divided the natural resources which could be affected by the sea level rise into 2 groups: (1) the coastal natural resources which is sparsely sensitive to sea level rise i.e., they have the ability of accommodation due to the sea level rise such as corals, seagrasses, fishery resources, plankton, etc. and (2) the coastal natural resources which is greatly sensitive to sea level rise, i.e., the coastal resources which are likely to be greatly affected by the sea level rise or have some limitation for accommodation due to sea level rise for example marine benthos, the mangrove forests, sea turtles, coastal birds, and coastal aquaculture, etc. Due to the sea level rise possibly causes the dynamic change of the tides then affects the sediment system which is related to the marine benthos such as cockles. There was a report that

in the Pleistocene era, 29 types of mollusks became extinct due to sea level rise (Lough, 2007).

The coastal wetlands are naturally able to accommodate themselves from the sea level rise and the flooding by retreating into the land; however, at present the natural mechanism and the retreated distance are limited by human buildings and construction which cause the changes of the wetlands and then affect the animals living in such coastal wetlands. Thepsiriamnuay *et al.* (2012) studied the changes of the wetlands due to sea level rise in Chanthaburi province, it was discovered that during 2000-2100, the relative sea level supposed to increase about 0.2-88.9 cm above the mean sea level which affected the loss of the mangrove forest area approximately 0.431-64.83 km². Department of Marine and Coastal Resources (2012) analyzed the impacts of sea level rise on the mangrove forest area of the Upper Gulf of Thailand for the next 20-50 years, it was found that if there is no protection plan of sea level rise, the mangrove forest area would be decreased about 13,110-19,830 Rai.

Based on gathering of such information, it was discovered that although the period and the ratio of the global sea level, Asia, and Thailand cannot be clearly specified, it tends to increase which will affect people who live in the coastal areas including the ecosystem and the coastal natural resources. As a result, there should be some preventive method to handle the situation in the future.

2.1.3 Guidelines for coping with the sea level rise

Asian Development Bank (2009) stated that the cost if every party neglects climate change, it will bring much more damages than the operation cost, which needs to be done efficiently and promptly. In addition, Kalther *et al.* (2014) mentioned that the value of the impacts or the damages due to sea level rise is much more than the operation cost of relieving such impacts. There are many organizations and authorities that value the guidelines to handle the impacts of a sea level rise both global level and domestic level as follows:

Intergovernmental Panel on Climate Change or IPCC (1990) proposed the guidelines to deal with the sea level rise for 3 main methods: (1) Retreat method which allows the loss of areas and ecosystem without any efforts for protection or accommodation (2) Accommodation method by which people still live as usual in the

risk area of sea level change without flood protection, though there is area reconditioning so that people can live there under the situation of sea level rise such as adapting some construction, accommodating the plants and the animals, adjusting the agricultural area to become the aquaculture area, etc. and (3) Protection method which can be categorized as the hard structure such as breakwater, seawall, saltwater levee, etc., and the soft solution such as beach nourishment, sand dune nourishment, afforesting the plants along the coasts and the intertidal beaches, creating the wetlands, etc. The implementation of those methods need careful consideration about physical, economic, social, politics and environmental conditions of each area. However, the success of such operation depends on public education about the situation and the collaboration from the locals.

James (1988) suggested the guidelines for protecting the loss of the wetlands in the future because of sea level rise as follows: (1) decreasing the rate of a sea level rise, (2) raising the ability of the wetlands to catch up with a sea level rise, (3) decreasing human intervention to the natural process so that the wetlands are able to adjust themselves as the sea level rise, and (4) creating and maintaining the artificial wetlands. Whereas, Pugh (2004) stated that there should be an analysis of the study area to determine the related factors in reducing the impacts of a sea level rise in each area as well as specifying the cost and benefit of the operation.

Although there is no direct plan for managing the impacts of sea level rise in Thailand, there are many hidden measures in many organization's plans but mostly are still in the study stage as follows: (1) plans involved with the climate change which is the main cause to sea level rise such as decreasing the release of greenhouse gases, increasing the green areas, using alternative energy, developing the compensation and the insurance systems, creating networks for collaboration among the organizations and the authorities in the area of the climate change, (2) most plans involved with the sea level rise emphasize the protection of the coast erosion, restoring and maintaining the coastal environment, creating data base, etc. (Chanworrawoot *et al.*, 2011; Department of Marine and Coastal Resources, 2012).

Nevertheless, the organizations in Thailand that involved with planning the management plan of the natural resources and environment have studied and proposed the guidelines as follows: the Office of Natural Resources and Environmental Policy

and Planning (2009) divided the problem into 2 stages, (1) for the sea level rise less than 1 m, the retreat and the accommodation methods are recommended as the main method to process together with the protection method for the important areas due to high budget cost is needed, and (2) for the sea level increase more than 1 m, the protection method by using the hard structure is recommended as the main method in dealing with the problem started by reinforcing the strength and elevating the street to get higher. In addition, the Office of Natural Resources and Environmental Policy and Planning (2011) mentioned that the hard structure should be used such as the saltwater levee which is considered as the good short term measure but in the future if we take the fluctuated climate change into account as well as land subsidence, then such hard structure cannot protect the area of saltwater. As a result, for long term measure, the local authorities should find the plan by using the ecosystem-based adaptation through proper mutual adaptation such as turning the rice field into the crab culture.

2.2 General information of Bang Khun Sai sub-district

Bang Khun Sai sub-district is located in Ban Laem district, Phetchaburi province. It's coastal to the Upper Gulf of Thailand. Its area was about 15,732 Rai or 25.17 km² and was divided into the freshwater area about 40% and the saltwater area about 60%. The seabed was quite a combination of sand and mud as the last area of the intertidal beach before it turns in to the white sand beach cover from Cha-Am beach to the South. It closes to Ban Laem sub-district, Tha Raeng sub-district, Pak Thale sub-district as well as the mangrove forests and the Gulf of Thailand as shown in Figure 2.1 (Bang Khun Sai Subdistrict Administrative Organization, 2011 a).

Bang Khun Sai has diversity of land i.e., the upland area and the lowland area as well as the mangrove forest about 450 Rai. There are the local authorities of which role in protecting and overseeing the mangrove forest areas i.e., Mangrove Resource Development Station Number 6 (Phetchaburi). Next to the mangrove forest, there is the mudflat area about 27 km² where it is the largest source of natural cockles in Thailand and possibly the last natural breeding place for the cockles in the country. So, most people called "Don Hoi Kraeng"; the supporting factors were the sediments from the Bang Pakong River, the Chao Phraya River, the Mae Klong River, and the

Phetchaburi River which creates the shallow area and become fertile food resources of aquatic animal. In addition, the concave of the gulf to prevent the winds, the low slope, the optimum temperatures and the optimum salinity of seawater, and the mud dry no more than 3-4 hours when the low tide. Additionally, there are rich mangrove forests as the breeding place as well as the nursery of the baby cockles; once the baby cockles are full grown, they will relocate to the mud outside the mangrove forest (Department of Marine and Coastal Resources, 2012).

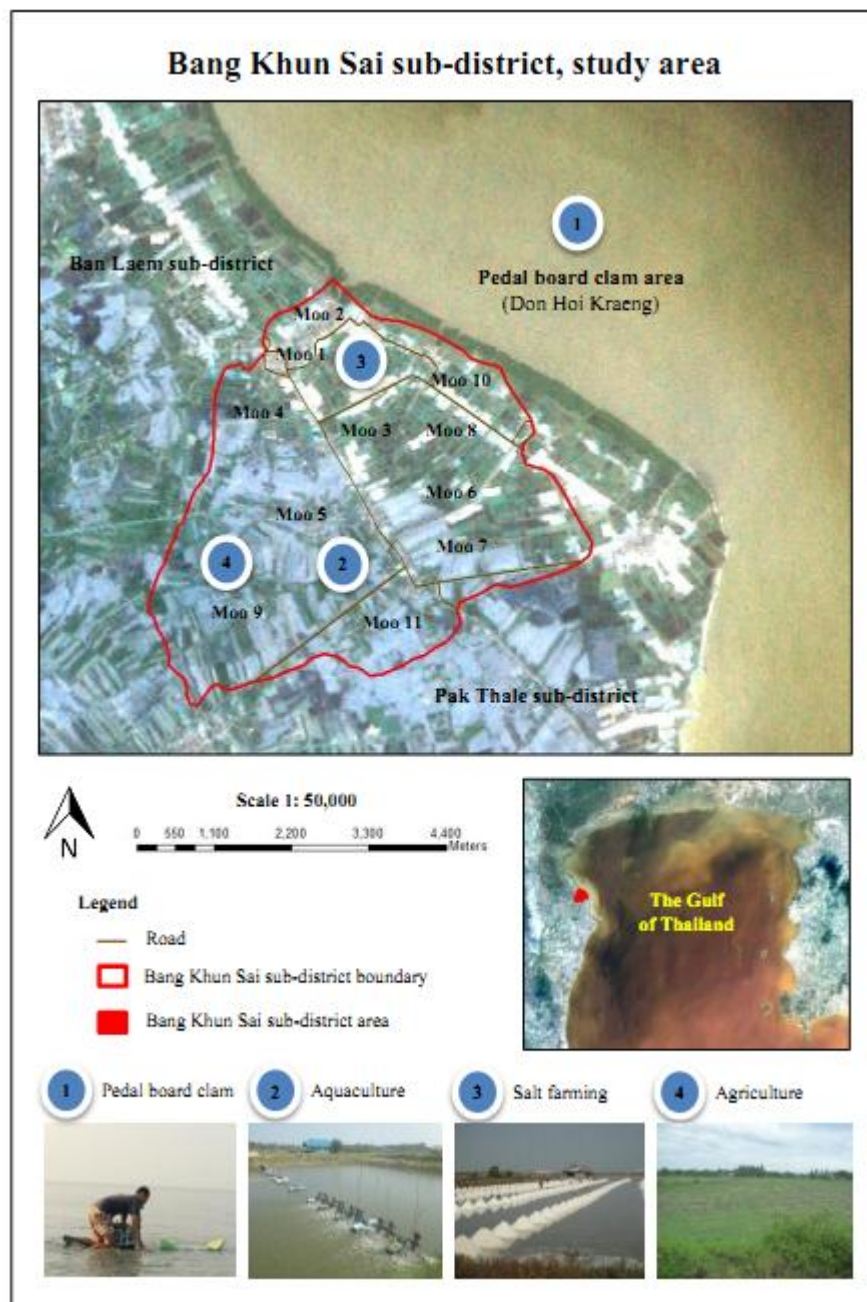


Figure 2.1 Generality of Bang Khun Sai sub-district

The Don Hoi Kraeng and the mangrove forest is very important to the local community because they are the food resource and the income resource for the local about 200-300 Baht/day. The cockles usually are born in October to December and the cockles can be caught every 22 days each month (Manitkul, 2009). So when it's low tide, most people will propel the plank on the mud bank to catch cockles. The community leader and the locals establish the Bang Khun Sai Subdistrict Marine Resource Conservation Group. Initially, there was a fundraising to collect some money from the locals for about 10 Baht/household/month to be used for protecting the natural resources and suppressing any violators in the conservation area as well as maintaining the ecosystem of the mangrove forest. There was a regulation about harvesting the cockles. The Phetchaburi Province Authority has officially announced the proclamation to prohibit the cockle fishery in this area except for harvesting cockles by hand in order to reduce the problem of dragging cockles by fishing boats. Also, it helps maintaining the ecosystem of the Don Hoi Kraeng area. ("The Proclamation of Phetchaburi Province-Prohibition of the cockle fishery" (September 18, 2008); Tosakul and Boonmathya, 2008; Bang Khun Sai Subdistrict Administrative Organization, 2011 a).

Bang Khun Sai has population of 6,977 people (3,466 male and 3,511 female) and has 1,858 households (Ban Laem District Office, 2013; Registration Administration Bureau, 2014). There is the local authority for overseeing the area directly i.e., Bang Khun Sai Subdistrict Administrative Organization. There are 11 villages in this sub-district which can be divided into (1) the upland area consisting of Moo 5, 6, 7, 9 and 11 which is suitable for agriculture such as rice paddy field, planting vegetation, raise animals, etc. and aquaculture for example snakehead fish culture, Nile tilapia culture, whiteleg shrimp culture, and (2) the lowland area consisting of Moo 1, 2, 3, 4, 8 and 10, where there are coastal ecosystem such as the mangrove forest and the mudflat areas. Most people in the lowland area pedal board clam for a living. Some people who live further away from the coast have their jobs for salt farming, aquaculture such as whiteleg shrimp culture, snapper fish culture, as shown in Figure 2.1. (Tosakul and Boonmathya, 2008)

Table 2.1 shows the number of population in each village and the upland area/the lowland area. People in Bang Khun Sai that have free time from the routine

job, they also pedal board clam that become the supplement job. (Thailand Environment Institute, 2003). The most making income job in the area is being hired to do various job, following by trade and coastal fishery, respectively. (Bang Khun Sai Subdistrict Administrative Organization, 2011 b)

Table 2.1 Population in each village and area (Ban Laem District Office, 2013)

Areas	People
The upland area	
Moo 5 Ban Don Ping Daed	802
Moo 6 Ban Don Wat	477
Moo 7 Ban Don Thai	691
Moo 9 Ban Pah Kard	702
Moo 11 Ban Don Hoi Kraeng	251
The lowland area	
Moo 1 Ban Bang Khun Sai	405
Moo 2 Ban Bang Khun Sai	453
Moo 3 Ban Bang Khun Sai	652
Moo 4 Ban Khaek	1,117
Moo 8 Ban Bang In	767
Moo 10 Ban Sa Mak Ki	660
Total	6,977

Current problems of Bang Khun Sai sub-district are the loss of income from pedal board clam because of dragging cockles by fishing boats, lacking of water for agriculture since the irrigation department are not able to distribute water to the area, flooding problem because of poor drainage system, and eroding of the riverbank. (Bang Khun Sai Subdistrict Administrative Organization, 2011 a). In addition, there is the prediction for the next 20-50 years of which the sea level will accumulatively rise about 38-53 cm., thus Bang Khun Sai sub-district including the Don Hoi Kraeng area will face the threaten problem of sea level rise because of the coastal natural resources

are greatly sensitive to sea level rise such as the mangrove forest and the mudflat areas, etc. (Department of Marine and Coastal Resources, 2012).

There areas of Bang Khun Sai both the upland and the lowland areas are affected by the sea level increase as follows: (1) flooding in the lowland area which can occur more often and longer period due to saltwater invade causing less effective drainage system, (2) saltwater intrusion into the freshwater area causing the changes of water quality which is used in agriculture and aquaculture and, (3) the loss of the wetland ecosystem i.e., the mangrove forest and the mudflat areas because of the retreat of the mangrove forest and the mudflat areas is limited by construction such as roads, walls, communities, etc. Thus, products and services from the ecosystem of the mangrove forest and the mudflat areas become decreasing. Moreover, Losing of the mudflat area affects to the cockles directly meaning the deeper sea level and the longer period of drainage flood may cause the ecosystem of the Don Hoi Kraeng changes. The areas where they get flooded all the time cause the reduction of living area for the cockles. Furthermore, Losing of the mangrove forest areas indirectly affect the cockles i.e., the fertility of the cockles maybe decrease due to factors to life of the cockles are come from the mangrove forests. However, the salt farming field may not be affected by sea level rise in the case that there is reinforce an elevation of the levees but this means higher cost as well (Lough, 2007; Office of Natural Resources and Environmental Policy and Planning, 2011; Department of Marine and Coastal Resources, 2012; Nakraksa, 2012).

It can be seen that the areas of Bang Khun Sai sub-district were not mentioned about the impacts of a sea level rise on the coastal erosion because the coast of Bang Khun Sai is considered as the stable coast meaning the erosion of the coast and the deposition rates are almost equal or equal (Sinsakul *et al.*, 2002).

2.3 Economic Value

The economic value of natural resources and environmental can be divided into 2 main parts: (1) the use value and (2) the non-use value (as shown in Figure 2.2). The details of the economic value are described as follows:

Firstly, the use value can be categorized into: 1) the direct use value meaning people get direct benefit from the natural resources and the environment; the direct use value can be divided into the extractive use such as the fishermen catch some fish for consumption, cutting the wood of the mangrove forest to be used as the firewood, and the non-extractive use such as tourists activities on the beach, and 2) the indirect use value meaning people get benefit from the natural resources as in the aspect of the natural balance of the ecosystem and the climate such as the mangrove forests help decreasing the coastal erosion, reducing the loss and damages due to storms, being as the habitat for some marine benthos, being as the filter of the toxic substance, and being as the carbon sink, etc.

Secondly, the non-use value is the value of the natural resources and environment that even though people do not utilize them for both at the present and in the future which can be divided into (1) the option value meaning people have not yet utilized the natural resources and environment at the present but expect to utilize them in the future such as the conservation of the biodiversity for utilizing its medical benefits in the future, (2) the bequest value meaning people reserve the resources for the next generation inheritance such as the conservation of the mangrove forests and, (3) the existence value meaning people are aware of the existence of the natural resources though they may not have an opportunity to utilize them such as being aware of the existence of sea cow in Thailand sea (Wattage, 2011; Seenprachawong, 2013).

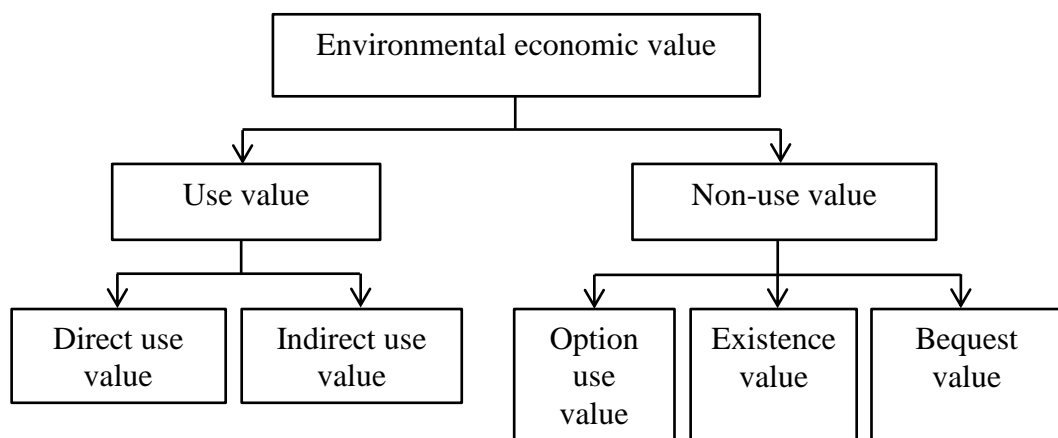


Figure 2.2 The component of environmental economic value (Seenprachawong, 2013)

In this research, there was the study of willingness to pay of the locals in Bang Khun Sai for reducing the impacts of sea level rise in many aspects including the direct use value such as decreasing the impacts from the loss of income; the indirect use value such as reducing the impacts from flooding; the use and the non-use values for example decreasing the impacts due to the loss of the mangrove forests and the mudflat areas.

2.4 Environmental valuation

Environmental valuation is a measurement of the importance of the value that people dedicate to the quality of environment through the conversion of the value in the form of money. Thus, whether the natural resources and environment is valuable or not, it depends on how people appreciate its value. (Nabangchang-Srisawalak *et al.* 2011)

2.4.1 Environmental valuation method

In general, there are 2 types of environmental valuation methods: the revealed preference method and the stated preference method.

The revealed preference method is used to value the use value only; there are 2 techniques of the revealed preference method i.e., (1) the hedonic pricing method (HPM) which is usually used to value the environmental quality such as water quality, sound quality, atmospheric quality and, (2) the travel cost method (TCM) which is used to value the recreational value based on the travel cost specifically the valuation of the natural tourist attraction.

The stated preference method is used to value both the use value and the non-use value; however, it is generally used to value the non-use value. There are 2 techniques for the stated preference method as follows: (1) the contingent value method (CVM) is the environmental valuation from the scenarios of which the consumers indicate the satisfaction value, that can be valued from both the willingness to pay (WTP) and the willingness to accept (WTA) and, (2) the choice experiment method (CEM) is the environmental valuation by having the consumers

choose the most satisfied choice from all choices. Even though the CEM method is more complicated than the CVM method, it gives more details for policymaker.

In addition, there is another technique called the benefit transfer method (BTM) that can be used for valuating every type of values due to it applies the values from previous research study sites, then transfers those values through the conversion process to be used at the policy site which can save some budget cost and times (Seenprachawong, 2013). The methods used in the environmental valuation were summarized and shown in Table 2.2.

Table 2.2 Summary of the environmental valuation methods (Seenprachawong, 2013)

The ability in economic valuation		Revealed		Stated		BTM
		preference method		preference method		
		HPM	TCM	CVM	CEM	
Use value	Direct use value	✓	✓	✓	✓	✓
	Indirect use value	✓		✓	✓	✓
Non-use value	Option use value			✓	✓	✓
	Existence value			✓	✓	✓
	Bequest value			✓	✓	✓

The methods of the environmental valuation through the market approach consist of 4 techniques: (1) the changes in productivity technique which is based on the idea of the change of the environment that increase more productivity is considered as the valuation of the increased benefit; but if such change causes the reduction of productivity, it is considered as the valuation of the increased cost, (2) the replacement cost technique which is used for determining the cost of the project aiming for restoring the quality of environment back to the acceptable standard level by comparing to the products or services which can be replaced the products or services from environment, (3) the prevent expenditure technique by which the consumers will invest in the protection plan to prevent any losses whenever they receive the environmental services that would value more than the loss without any protection plan and, (4) the relocation cost technique which considers the cost of the

activity in relocating people or households to another area in the case that the environmental quality in the same location changes. Most methods of the environmental valuation through the market approach are valuating the values of minimum benefits or costs.

It can be seen that there are many techniques of the environmental valuation that give the valuation in a form of money value. Each technique has advantages and disadvantages, so the application of such technique depends on the purpose of the research, the characteristics of the natural resources and the environment of the research, the characteristics of the changes of the environmental quality, pre-existing secondary data, etc.

In this research, the choice experiment method was selected to value the willingness to pay of the locals in Bang Khun Sai sub-district for reducing the impacts of the sea level rise. The main reason for choosing this technique i.e., want to know how people in the Bang Khun Sai value the reduction of the impacts. This method can also lead to the suggestion for managing the problems, which it can directly response to people needs. Thus, the literature review of the choice experiment method was explained as follows:

The choice experiment method (CEM) is the valuation of many attributes of the environment by having the consumers choose the most satisfied choice from all choices. This technique was originated from the conditional logit model by McFadden. Using the random utility model in data analysis which consists of 2 parts: the systematic component and the random component as shown in Equation 2.1,

$$U_{ij} = V_{ij} + e_{ij} \quad (2.1)$$

where U_{ij} is the indirect utility or the satisfaction of the consumer j obtained from the choice i ; the V_{ij} is the indirect utility function or the part that can explain systemically of the choice i ; and the e_{ij} is the random error with its average of zero. This equation can be rewritten as the Equation 2.2 and as the linear equation in the Equation 2.3:

$$U_{ij} = V_{ij}(X_{ij}) + e_{ij} = bX_{ij} + e_{ij} \quad (2.2)$$

$$V_{ij} = \sum_{n=1}^N \beta_n X_{in} + \sum_{m=1}^M \gamma_m Z_{jm} + \delta P_i \quad (2.3)$$

where X_{in} is the attribute n of the choice i ; Z_{jm} is the individual factor or the economic-social factor m of the consumer j ; P_i is the money attribute or the price of the choice i ; β_n , γ_m and δ are the coefficients of the choice attribute, the economic-social attribute, and the money attribute, respectively.

The choice experiment method can be used to value the willingness to pay by a comparison between the base choice of one case and the changes of such base choice, or the willingness to pay when there is the change of the environmental quality as shown in the Equation 2.4:

$$WTP = CS = -\frac{1}{\mu}(V_{i1} - V_{i0}) \quad (2.4)$$

where μ is the marginal utility of income; the V_{i0} and V_{i1} are the indirect utility before and after the modification of the product quality, respectively (Pramoon, 2008; Seenprachawong, 2013). In this research the $V_{i1} - V_{i0}$ is the result of the operation for decreasing the impacts of sea level rise compare to no operation at all.

2.4.2 Related research about the environmental valuation

Based on the literature review, it was found that there were many researchers conducting research about the environmental valuation as follows:

(1) the research about the valuation of the coastal resources and related projects involved with the coastal resources for example Sribencharak (2005) this research was about the economic valuation of the wetlands in Don Hoi Lot by using CVM technique; it was found that the willingness to pay for conservation and restoration of the wetlands of Don Hoi Lot specifically one sand bar out of 5 sand bars approximately in a range of 157.07-198.97 Baht/person/year; it also found that the main reason that the sample groups (the locals and the tourists in Don Hoi Lot) were willing to pay in a form of tax or donation was to reserve it for the next generation and

to make them feel satisfy that the environment will be in good condition. Whereas, the main reason that the sample groups were not willing to pay was that they thought it should be responsible by the government for the conservation project. In addition, Kulpraneet (2004) valuated the willingness to pay of the locals who live near the intertidal beach for sustaining the biodiversity of Don Hoi Lot using the CVM which was approximately 36 Baht/person/year; it was also found that the attitudes about the environment and the individual economic-social factors of the respondents i.e., occupation, income, and the number of years living in the area, affected the amount of money they were willing to pay.

Saengsupavanich (2012) using the CVM technique in the valuation of the willingness to pay for the risk of coastal erosion i.e., the locals who live on the coastal area far from the coast about 50 m were willing to pay to speed up the construction of the breakwater in Nakhon Si Thammarat province approximately 724,160 US dollars which was considered quite high for the locals who were quite poor. However, there were some people not willing to pay because they thought the government should be responsible for constructing the breakwater while some people could wait for slow construction process.

Nakaworapan (2013), whose research was about the valuation of the value of the coral reef around the Samed island using the TCM to valuate the recreational value. It was found that the surplus value of the tourists was about 8,819.54 Baht/person/time, when it was multiplied by the number of tourists that came to the Samed island per year. Thus, the recreation value was approximately 2,241.91 million Baht/year. The CVM method was also used in the valuation of the willingness to pay for restoring the coral reef around the Samed island from both the group who utilized the resources such as the tourists who visit the Samed island, and the group who did no utilized the resources such as the labors in Bangkok who never visit the Samed island. It was discovered that the willingness to pay was averagely about 922.302 Bath/person/year, thus when it was multiplied by the number of tourists visited the Samed island per year, the use value of the coral reef around the Samed island was about 234.45 million Baht/year; when it was multiplied by the number of labors in Bangkok, thus the non-use value of the coral reef around the Samed island was approximately 4,490.90 million Baht/year. In addition, it was found that if the

requested amount of money was increased, it would decrease the willingness to pay; but if people were educated about the biodiversity, it would increase the willingness to pay to restore the coral reef. The reasons that made some respondents not willing to pay were low income, unsure about the project, and believed that the project could be done without any donation, respectively.

The research that chose the choice experiment method (CEM) to value the coastal resources and the projects involved with the coastal resources were as follows:

Nabangchang-Srisawalak *et al.* (2011) valued the non-use value of the natural resources on Koh Tao (Koh Tao island) by using the CEM which allowed the respondents choosing the best choice from 4 choices i.e., 1 choice of the present condition (status quo) and 3 choices of the coast conservations. There were 3 the coast conservations attributes i.e., the coral conservation, the coral reef fish conservation, and the sea turtle conservation. It was discovered that the willingness to pay for the conservation of the coral reef, the coral reef fish, and the sea turtles were averagely 62.61, 300.87 and 76.35 Baht/person. When combined all the three values, the total willingness to pay was averagely 439.83 Baht/person; this total value could be used as the base data for constructing economic measures such as fee collection or payment for people who have the duty in maintaining the resources, etc.

Seenprachawong (2014) used the choice experiment method (CEM) in zoning the service areas for the tourists on the Samed island by valuating the willingness to pay of the Samed island tourists for establishing the changes of the environmental quality. There were 4 beach attributes specified in this study i.e., the number of the tourists, the number of the rooms, the amount of waste, and the quality of the seawater. The levels of changes due to zoning the areas were divided into 2 levels: the changes from the current level as in the good level and as in the excellent level. It was found that the tourists were willing to pay about 78 Baht/person for the excellent level of the natural resources, about 251 Baht/person for the excellent level of the cleanliness of the beaches, and about 229 Baht/person for the excellent level of transparency of seawater. However, the number of tourists had no impact on the tourist decision making. In summary, the factors that affected the selection of the

beach with the improvement of the environment quality were ages, genders, incomes and the levels of the tourist education.

Seenprachawong (2008) valued the economic value of the Phang Nga Gulf of which the ecosystem was complicated due to the coral reef ecosystem and the mangrove forest ecosystem were located not too far from each other causing the diversity of the products and the services from the Phang Nga Gulf. Thus, the choice experiment method (CEM) was used in the valuation by assigned the 4 attributes of the Phang Nga Gulf: the increase of the fertility of the coral reef level (reflected the recreation value), the increase of the income from fishery (reflected the living condition of the local fishermen), the flooding condition (reflected the duty on the ecosystem), and the increase of the conservation areas (reflected the habitat of almost extinct animals/birds). The levels of the changes of using taxes for restoring and reserving the resources were assigned in 2 levels: the changes from the current condition as in the good level and as in the excellent level. It was revealed that the gross economic value of the coastal ecosystem was about 2,263 Baht/person/year or approximately 5,784 million Baht/year. The recreation value had the most value of 1,133 Baht/person/year, followed by the values of the living conditions of the local fishermen, the duty on the ecosystem, the habitat of almost extinct animals/birds about 514, 504, and 112 Baht/person/year, respectively.

Christie (2009) employed the choice experiment method (CEM) to value the aesthetics obtained from building the coastal barrier by imitating the tropical natural coral reef. The 4 aesthetics attributes were assigned: the scenery, the height of the coastal barrier, the counter wave sports, and the beach activities. The local community meant the people who lived in the coastal area in Borth, England had the willingness to pay for building the new pattern of the coastal barrier instead of the old fashion one for about 171 Euro. If the tourists agreed with the local community, this new coastal barrier would attract more tourists as well.

Hoyos *et al.* (2012) selected the choice experiment method (CEM) to value the environmental impacts from the marine protected areas development project to become the new port city of Spain. There were 6 environmental attributes: the landscape, the plants, the local birds, the seabed, the underground water, and the atmospheric quality. Based on the decisions of the experts and the group discussion, it

was discovered that the underground water and the atmospheric quality had little impacts, so they were removed out of the attributes in the questionnaires. In addition, it was revealed that the environmental impacts due to such project had the values approximately 172-535 million Euros/year.

(2) the research that valued the losses and the impacts of the climate change and the sea level rise. Many research were gathered for both using the general environmental valuation methods such as the choice experiment method (CEM) and using the environmental valuation through the market approach such as the replacement cost technique, and the prevent expenditure technique including the research that used the benefit transfer method (BTM) as follows:

Department of Marine and Coastal Resources (2013) conducted the research about the valuation of the loss of the coral ecosystem due to the climate change by using the choice experiment method (CEM) to value the non-use value. The attributes of operation for improving the environment were creating the artificial coral reefs, growing the replacement coral reefs, and collecting the undersea waste from the Phi Phi islands tourists, the Samed island tourists and the people in Bangkok. It was found that the Phi Phi islands tourists who were just the general tourists not the scuba diving ones were willing to pay about 738 Baht/person, whereas the Samed island tourists and the people in Bangkok did not agree with the policy in general. It was also discovered that if the amount of money requested for the contribution to the coral conservation fund was high, the chances that the respondents were willing to pay would then be decreased. If the respondents were highly educated and knew about the corals, then they were more likely to financially support the operation to restore the coral reef ecosystem. Nevertheless, it was also found that the main reason some respondents were not willing to pay was that they thought it should be the duty and responsibility of the government, the following reason was the amount of money requested was too high.

Lin *et al.* (2013) valued the loss due to sea level rise situation in the southeast of Australia where it is the low plain around the estuary and has dense population by using the replacement cost technique to value the loss based on the number of the dwelling buildings, the value of the damages of the dwelling buildings, and the length of the street affected from the tidal bore. The expenditure per unit in

fixing the street at the present such as the labor cost, the material cost was calculated. It was found that the chance was as high as 50% in 2051 for the loss due to sea level rise in the southeast of Australia approximately 13.5 Australian dollars, which could be used in a comparison between the loss due to no actions and the loss with the operation to cope with possible impacts.

Kulpraneet (2013) used the prevent expenditure technique to value the accommodation and the protection of the impacts of sea level rise of the households living in the coastal area of the Gulf of Thailand in Samut Sakhon province and Samut Prakan province but excluded the retreat. It was found that the coastal households valued the accommodation and the protection of the impacts of sea level rise averagely 57,140 Baht/household. Most households expected the money to be used for house renovation, then the land improvement, building physical barriers, and others such as changing new crops. Additionally, it was discovered that the fishermen village valued the adaptation from a sea level rise obviously less than the urban village. The distance further away from the coast had no influence to the value for adaptation due to a sea level rise.

Kalther *et al.* (2014) predicted the economic value due to a sea level rise on flooding in the coastal area of Subang, Indonesia by using the benefit transfer method (BTM) from previous research for both the willingness to pay of the non-farmer group to protect the agricultural areas and the services from the ecosystem and the willingness to accept of the farmer group if there was any loss of the agricultural areas. It was discovered that the economic value due to a sea level rise was approximately 169,154,262,337.96 Indonesian rupiah which was divided into the direct use value about 84,651,712,287.96 Indonesian rupiah, the indirect use value around 1,004,050,050.00 Indonesian rupiah, and the non-use value approximately 83,498,500,000.00 Indonesian rupiah. These values were calculated only for the impacts of a sea level rise on flooding excluding any other affected aspects such as the saltwater intrusion, the increase of frequent disaster, etc.

2.5 Thematic analysis

Thematic analysis is the technique to analyze qualitative data analysis efficiently. It helps sorting the textual data so that the summary of the research can be done very thoroughly. The steps of analysis consist of transcribing from the in-depth interviews first; next reading all data to get used to with them; after that sorting all data and encoding the data (code material) specifically the useful data for the analysis. The next step is to create thematic networks to classify the data consisting of the data comparison and the data analysis i.e., passage, sentence, or idea. If there are some repetitive data, then they would be regrouped as the subthemes, then grouping the subthemes based on their dominant features, principles or question guidelines to be used as the theme, which may need to adjust wordings to interpret the meaning of the data comprehensive. Additionally, the themes should be re-investigated to the respondents to make sure they are correctness. The last step is the interpretation and the conclusion of the classified data by perhaps giving some example of the interview passage to support the descriptive research summary (Attride-Stirling, 2001; Braun and Clarke, 2006; Potisita, 2011).

The examples of the research done by using thematic analysis for make conclusion about the sea level rise are as follows: Hart (2011), whose research is about the vulnerability and adaptation of sea level rise in Auckland, New Zealand using thematic analysis for analyze the opportunity and obstacle of the accommodation process. The in-depth interviews was done by using the semi-structured questionnaires with the sample group consisting of the local authorities and related organizations such as scientific and coastal engineering scholars, legal authority dealing with the natural resources management. According to the analysis, the opportunity and obstacle of the accommodation could be divided into 2 main points: firstly, the current procedure for managing the risk coastal areas composing of the preparation to handle with sea level rise, the planning of the scope of operation in different terms, response options of the study areas such as having the map of the inundation area in Auckland; secondly, the retreat consisted of management or planning of retreat by using the existing and useful responded options and the obstacle in management or planning of retreat.

Graham *et al.* (2014), whose research about the comprehension of the local community in East Gippsland, Australia toward the sense of policy in adaptation due

to the future sea level rise. The data collection was done through the focus group and the data analysis by using thematic analysis. It was found that the expected operation could be divided into 5 main points as follows: 1) the investment for maintaining the existing basic infrastructure especially the drainage system, 2) the investment for the hard structure such as building the seawalls, constructing the levees, elevating the height of the streets and improving the drainage system, 3) the development of the city in the future such as investment in alternative energy or new types of industries, 4) advising the public about the rules and regulations which were made to protect the impacts such as the height of the building, 5) creating financial motivation to the people who were affected in the case of to migrate or relocate their dwelling areas or the corporations. All of these main points, there should be the obvious and vigorous agreement by the government sector, including the optimal operation plan to each local area.

Based on the literature review, the researcher knows the information about impacts of a sea level rise, the condition of the research area, the ideas of how to choose the technique to valuate the willingness to pay and the thematic analysis technique which are very important and useful in planning this research including assigning the sample size, creating research tools such as specifying the attributes and the levels. Also, it can be used in the data analysis, report of the results and research discussion later on.