

Analysis of factors related to bamboo structure for preventing erosion and restoration of coastal area on the Upper Gulf of Thailand

Patcharaporn Yaowasooth

Marine and Coastal Resources Research and Development Center, the Upper Gulf of Thailand, Muang District,
Samut Sakhon, Thailand

Corresponding author e-mail: yaovasuta.dmcr@gmail.com

Abstract: Coastal erosion caused by anthropogenic, as well as natural processes in the coastal region of Thailand and other countries is becoming a big issue at present days, because coastal erosion have negative impact on human and coastal ecosystem. To prevent coastal erosion in the Upper Gulf of Thailand, the Department of Marine and Coastal Resources (DMCR) carried out a project for the installation of bamboo structures and planting of trees in the coastal area. At the end of the project, it has been found that the restoration of coastal ecosystem and prevention from further coastal erosion were succeeded in some areas, on the other hand different result shown in other areas. Based on the DMCR project outcome, this study analyzed the factors related to prevention of erosion and the restoration of the coastal zone structure, in the Upper Gulf of Thailand. This study found that the success of the project that is the prevention of erosion and restoration of the coastal area related with people's participation, strong leadership, government support and specification of bamboo. From focus group discussion, it was found that strong policies for the protection and maintenance of installed bamboo structures and thereby appropriate revision of policy are also an important factor for sustainability of the project. Moreover, devoted local leader, and active committee members are needed to maintain, and monitor the project. This study results are applicable for other coastal regions of different countries, with similar soil characteristics, to prevent erosion and restoration of coastal areas.

Keywords: Coastal erosion, bamboo structure, Upper Gulf of Thailand

Introduction

Thailand has a coastline measuring of 3,148 km, divided into the Gulf of Thailand with a length of 2,055 km and rest 1,093 km with the Andaman Sea. Coastal erosion mainly occurs along the coast of the Gulf of Thailand. In seventeen provinces of Thailand 830 km along the coastline has been eroded, where 730 km belong to the Gulf of Thailand and rest only 100 km coastline belong to Andaman Sea (Suraswadi, 2016). It also observed that the path of erosion goes from the east to west coast of the Gulf of Thailand. Considering the erosion rate, some areas are declared as critical area, where the erosion rate is over 5 meters per year, in other areas rate of erosion is 1-5 meters per year. The Upper Gulf of Thailand, which started from the Bang Pa Kong River mouth to the Tha Chin River mouth with a coastline of about 41.8 km has suffered the most severe erosion. From 2009, the rate of mangrove forest deforestation in the Upper Gulf of Thailand is high and there has been a shift of livelihood along the coast to shrimp farms. This trend increased the shrimp farms from 64,336 hectares to 237,220 hectares within the year of 2009 to 2016, it also damaged mangrove forest higher than 64 % (DMCR, 2011). Besides that, growing salt farms, industry, agricultural and infrastructure make the deforestation problem more critical. The effect of coastal erosion, Thamma-apipon, (2012) found coastal erosion affected the local communities in three aspects; there was an economic impact, social impact, and environmental impact. Coastal erosion has effects to ecosystems and natural resources. Mangrove forests, coral reefs, sea grass and land will be affected directly, ultimately, it affects the ecological balance in the marine and coastal area. Coastal erosion affects the environment including; loss of land, mangrove deterioration, marine animal reduction, loss of coastal scenery, adaption of house structure and prevention of erosion. These directly affect the coastal community. Coastal erosion affected the economic on fisheries, aquaculture, housing, tourism, and industry. After the effect of an economic system, people lose their resources, land, jobs, and income etc. Tourism is the main source of income for Thailand. Besides that, industry of fisheries can create jobs and increase income for the community as well as the country. Almost one-fourth of Thai people live in the 22 coastal provinces. That coastal erosion has an effect on the economic sector by various ways. It reduces the value of land, results in income loss, and increases the retraction of the house and coastal defence structure costs. Dean (2009) found that the cost of different erosion control structures is especially pertinent given the current recession. The division of coastal management, in all states, reduces its budget by 7% (Gregson, 2009) and this reduction in budget made the impact on enforcement and permitting personnel for local erosion control structures. And coastal erosion has the impact on the social life of the people who live in coastal areas, and the number of affected people are more than 12 million. Communities affected by erosion, lose their land and property, must change lifestyle by migration. It is also the cause of changing the folkway of humans in coastal areas. Coastal communities migrated to other areas which resulted in loss of life and cultural traditions of the communities; left some communities

homeless and resulted in the unavailability of work which normally has effects to other sectors of the economy. Anxiety in a new career that may affect the state of mind and family relationships. Moreover, it is the cause of declining living standards or not as good as the original. (DMCR, 2011B)

Community leader Khok Kham and Phanthai Norasing, Samut Sakhon Province of Thailand organized a meeting with the local people for finding the solution of coastal erosion by bringing the folk wisdom. Local fishermen are using bamboo for make fish trap and stable for shell aquatic. Fishermen noticed that after installation of bamboo for aquaculture mussels, sediment accumulated near the area of bamboo streak. Observing that, they installed bamboo streak adjacent each other without keeping any space between the streaks, which generate more sediment accumulation easily and reduced the wave action. Local people used this technology to prevent coastal erosion and increase the sediment along the coastline, and also planted mangrove tree to restore mangrove forest.

Coastal erosion issues are recognized to be solved urgently. The technology of using bamboo streak to prevent erosion in the coastal areas by community are now proven. DMCR with community in coastal areas started DMCR project to prevent coastal erosion by installation of bamboo structure, which reduced the weave energy, generate sediment accumulate and helps for reforestation. The project started in 2011 on the Upper Gulf of Thailand and includes eight areas: Khok Kham Moo 3, Khok Kham Moo 8, Bang Ya Praek Moo 6, Phanthai Norasing Moo 6, Bang Krachao Moo 1 Sub-district, Samut Sakhon Province, Bang Kaeo Moo 10 Sub-district, Samut Song Kram Province, Laem Fa Pha Moo 11 Sub-district, Samut Prakan Province and Song Khlong Moo 9 Sub-district, Chachoengsao Province. Communities with DMCR improved the design of the bamboo structure. The summary of the design was bamboo size at least 3 inches width with 5 meters long, installed in 5 rows, depth of about 2 meters emerged into the ground and 3 meters kept above from the ground, installed row alternating zigzag design with the bamboo stick and at least 35 stick per 1meter bamboo structure combined with 5 row. The ways for boat is 10 meters long and had a bamboo streak to cover the boat ways about 10 meters (Figure 2). This project is a good example for prevent erosion, restoration of coastal area and local people are willing to prevent erosion to make their life stable. In 2013 Intatha studied about factors influencing the capacity of communities to respond to coastal erosion in the Upper Gulf of Thailand. This study shows. In the past most common method used to protect the coast was rock placements (hard structure). But later soft structure such as bamboo structure used to protect high coastal erosion. Moreover, the government and other stakeholders had applied a combination of protection and restoration by installation bamboo structure and planting trees. This combined method shows better results.

DMCR project found some areas were succeeded to prevent coastal erosion and restoration of coastal area by using bamboo structure, but some areas were failed. This experience make an interest to researchers to find the factors related to success of bamboo structure to prevent erosion and restoration of coastal area on the Upper Gulf of Thailand and to determine the findings to be incorporated in existing guidelines and policies for review as well as successful implementation by using bamboo structures to prevent erosion and restoration of coastal areas. Besides that, this study results will be useful for policy modification and implementation to prevent erosion and restoration of coastal area.

Materials and Methods

Study area

The study focused on three areas of the Upper Gulf of Thailand where DMCR project implemented. The areas are; Bang Ya Phraek Sub-district, Samut Sakhon Province, Bang Kaeo Sub-district, Samut Songkhram Province, and Song Khlong Sub-district, Chachoengsao Province, Thailand.

Data collection and sampling methods

Primary and secondary data both are collected for this research which is particularly relevant to the study. Primary data was collect from questionnaires (Quantitative survey) a sample population of 333 people from 1973 people (National statistical office Thailand, 2016) as well as from focus group discussion (Qualitative survey). This research conducted in coastal areas of Bang Ya Phraek sub-district, Samut Sakhon province, Bang Kaeo sub-district, Samut Songkhram province, and Song Khlong sub-district, Chachoengsao province, of Thailand. Secondary data was collected from various sources such as articles published in journals and books etc.

Sample size: Theoretical aspects, formulas. Simplified formula for proportions (Taro Yamane, 1967)

$$n = \frac{N}{1+N(e)^2}$$

$$n = \frac{1973}{1+1973(0.05)^2}$$

$$n = 333 \text{ people}$$

n = the sample size
 N = the population size
 e= the acceptable sampling error
 *95% confidence level and p = 0.5 are assume

Data analysis

Data analysis is one of the most sophisticated activities of the study to produce the correct results. In this study, quantitative and qualitative data were used for analysis. One of the best software for analyzing statistical data Statistical Package for Social Sciences (SPSS 15.0 for windows evaluation version) was used in this study.

Quantitative data analysis

The data collected through a personal interview by using pre-designed questionnaire and collected data analyzed by SPSS. Inferential statistics and descriptive both types of data were collected for quantitative data analysis. Collected data were coded, sorted, and categorized for analyzing by software. Analyzed data used to prepare Multinomial logistic regression to analyze the factors related to a bamboo structure to prevent erosion and restoration of coastal area on the Upper Gulf of Thailand.

Multinomial logistic regression

In logistic regression analysis, there is only one independent variable, the logistic regression model can be written as

$$Prob(event) = \frac{e^{\beta_0 + \beta_1 X}}{1 + e^{-(\beta_0 + \beta_1 X)}}$$

$$\text{Or } Prob(event) = \frac{1}{1 + e^{-(\beta_0 + \beta_1 X)}}$$

β_0 and β_1 Coefficients were estimated from the data

X is an independent variable

E is natural logarithm with a value of 2.718

From the above equation, we derive a new equation as

$$Prob(event) = \frac{e^z}{1 + e^z}$$

$$\text{Or } Prob(event) = \frac{1^{e^z}}{1 + e^{-z}}$$

By $Z = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_p X_p$ and the event not as incident from the equation.

$$Prob(no event) = 1 - Prob(event)$$

Qualitative data analysis

Focus group discussion and interview with community leader was done to accumulate qualitative data. In focus group, discussion representative from local dwellers, local government officer, and a representative from different occupation of that area were confirmed.

Result & Discussion

Socio-economic characteristics of the respondents

The number of population in the study areas were 1,973 people. For personal interview 333 respondents were chosen randomly. Almost 90% of respondents were local dwellers and their life is dependent on marine and coastal ecosystem for livelihoods. Most of the respondents age limit were in the range of 41-60 years. The main occupation of the dwellers in the study area was fishery and their education level was primary 71%, Major part of the respondents 66%, monthly income was in the class of \$142- \$425 (5,001 – 15,000 Baht) the result is similar to Thai people’s average income 3,976-12,275 Baht (World Bank, 2016).

Awareness about coastal erosion issue of the respondents

The study found that most of the respondents in the study area were aware of coastal erosion, and the value was higher than 85%. The awareness of respondents about social (migration, change occupation etc.), economic (loss of income, loss of land, spend money for protecting land and house etc.), and environmental (loss of mangrove forest, coastal resources degraded etc.) effect due to erosion also analyzed in the study. The results of the study showed that the respondents are firstly conscious about the social effect, then secondly the economic effect, and thirdly the environmental effect.

Respondent's opinion about the impact of bamboo structures

About the impact of bamboo structures in preventing erosion and restoration of coastal areas as well as in socio-economic factors a significant portion of the respondents had a positive view. 34% respondents thought the impact of bamboo structures on social benefit is high, where 37% respondents thought the impact bamboo structures of economic benefit is high, and highest 63% respondents thought bamboo structures have high positive impact on environmental benefit. On the other hand, for social benefits perspective, 39% respondents thought the impact of bamboo structure in social benefit is low, where 38% and 25% respondents thought the impact of bamboo structure in economic and environmental benefit is low respectively.

Respondent's opinion about factors of success

Budget

Budget is the main driving force in success to prevent erosion and restoration of the coastal area. Respondent's first preference was the government fund collaboration with the community. Their second choice was NGO fund collaboration with community and the third was only community funded project.

Participation of stakeholders

For success of the project, participation from different stakeholders is another important factor. Among all stakeholders, respondent's first priority was participation of leader, the second priority was participation of the community, and third was government official participation.

Miscellaneous factors

Comparing various factors together, the study results found shows that specification of bamboo (type, species, age, and thickness etc.) was the first preference from the respondent. Environmental (area, wave, and wind etc.) condition was in the second position and in the third position the species of tree used for restoration of the coastal area.

Respondent's opinion about policy and regulations

For management of coastal area "The strategies for erosion control" policy of Thailand was established in 2012. However, the contents of the policy is not enough to describe the management of bamboo structure for erosion control in coastal areas. This study found that most of the respondent's suggestion is to modify the current policy without delay for providing more emphasis on using bamboo structure to prevent erosion and restoration of coastal area. Moreover, almost 65% respondents suggested that policy should be modified after discussion with the community of the coastal area, as well as policy should be modified as per suggestion of the community. For the success of the policy implementation, 43% respondents recommended that collaboration of government and community will be the main factor.

Participation of the Respondents in the Project

Considering the full study area, the study found that participation in the project activity of respondents was significantly high. 75% of the respondents were present in clarification meeting about use of bamboo structure to prevent erosion and restoration of the coastal area. On the other hand, considering individual study area participation rate was different, and values were 92%, 65% and 46% in Bang Ya Phreak, Bang Kaeo and Song Khlong sub-district respectively.

Similar results found for installation of bamboo structures and planting mangrove trees. 56% respondents participated in the installation of bamboo structures and planting mangrove trees. But for individual area, participation rate was 79%, 45%, and 17% in Bang Ya Phreak, Bang Kaeo and Song Khlong Sub-district respectively.

Participation for monitoring after installation and planting for full study area was 50%. Where, for individual study area participation values were 63%, 49% and 27% in Bang Ya Phreak, Bang Kaeo and Song Khlong Sub-district respectively.

77% of all respondents, recommended that the maintenance activity should be continued after installation of bamboo structures, and planting mangrove trees to prevent erosion and to restore the coastal area. Besides that, respondents demand to continue maintenance activities were recorded at 94%, 71%, and 49% in Bang Ya Phreak, Bang Kaeo and Song Khlong Sub-district respectively.

Data related to participation in project activity shows, in Khlong Sub-district the participation rate was very low compared with Bang Ya Phreak and Bang Kaeo Sub-district.

Statistical analysis

33 factors were included in the questionnaire survey to find the most effective factors for using bamboo structures to prevent coastal erosion and restoration of the study area. The collected data was analyzed by Multinomial regression model of SPSS program. The output shows the factors that are significant with project success. In this study, failed and partially successful area's data was analyzed through comparing the data of successful area.

Multinomial logistic analysis showed among the 33 factors 4 factors were highly significance for project success and the significance results between project success and these four factors at 0.01 significance level (Table 1). Four significant factors are leadership, participation in project activities (includes meeting, installation of bamboo structures, planting trees, monitoring and maintenance), government support, and the specification of bamboo. It indicates, to make a project success for prevent coastal erosion and restoration of coastal area strong leadership, active participation of the beneficiary in project activity, government positive support, and maintain the quality of bamboo by following the specification is essential.

Project leader's opinion

The researcher also carried out personal interviews with the project leader of the 3 study area. All leaders came from the local community, but they have different views and different level of involvement in the project activity.

Bang Ya Phreak Leader's opinion

Leader of the Bang Ya Phreak was the initiator of using bamboo structures to protect coastal erosion in his area. Bang Ya Phreak area facing the coastal erosion problem for a long period of time, and it destroyed their land and property. Rock protection work, for controlling erosion, was not working properly in that area. Besides that, rock protection created more erosion to the adjacent area after construction. Another problem was the very clayey soil of Bang Ya Phreak area, which are not suitable for rock protection. At that time, he observed the success of protecting coastal erosion in Khok Kham Sub-district by using bamboo structures. This observation encouraged him to initiate bamboo structure installation in Bang Ya Phreak area to prevent erosion, and restores more area by increasing sedimentation. To start that activity, he spend his personal income, as well as convinced the community to organize a fund for installing bamboo structure to prevent erosion.

He identified erosion as an important issue for coastal ecosystem. He address erosion issues in the order of the economic effect, the social effect and the environmental effect. He has been highly involved with these activities for more than 11 years. The people who were not capable or had no interest in bamboo installation activity, he involved them in other supporting works like establishing a mangrove tree nursery by donating mangrove trees for restoration of the coastal area. He also invited the children in the area and took them to learn folkways and planting of mangrove trees. Moreover, he communicated with the universities, colleges, and schools to send their students for participating in bamboo installation and mangrove tree planting.

Among the factors related with the success of the prevention of erosion and restoration by using bamboo structures, he prioritized community participation with self-willingness is the most important factor for success, followed by the specification of bamboo and lastly, the involvement of stakeholders from outside of community such as government, NGOs for support knowledge and budget. His opinion about the future of the project was that, these activities should be continued to prevent erosion and restorations of the coastal area. Restore land and mangrove forest will enhance the aquatic life as well as natural resources of the area. Proper and sustainable use of those resources in the future, will enhance the community people's quality of life and help them to enjoy a comfortable and happier life.

Bang Kaeo Leader's opinion

The project starting story was in Bang Kaeo area almost the same to Bang Ya Phreak area. Bang Kaeo area also suffers coastal erosion for many years. The leader of Khok Kham project area known about the problem of Bang Kaeo. The leader with people from his community visit Khok Kham. After visiting, Bang Kaeo leader realized that, to prevent coastal erosion and restoration installation of bamboo structures should be start in Bang Kaeo area. To implement the same project, he talked with the local community of Bang Kaeo area, but unfortunately most of them were not agreed to do. At that stage, he decided to start the project by spending his own money for set an example in front of local community with the help of agreed people.

He was highly involved for more than 11 years with these projects as well as highly aware about coastal erosion issue and the importance of the coastal ecosystem. He chose to address these issues in the following order: social effect, economic effect and finally the environmental effect. He also communicated with some NGOs and organizations that could provide funds. He found that, if they can show some success NGOs and other organizations would support them because of their corporate social responsibility (CSR). He discussed all the findings with the community and finally, the community agreed to start to install bamboo structures to prevent coastal erosion and restoration of the area.

The leader of Bang Kaeo had a view that, the factors related with the success to prevent erosion and restoration by using bamboo structure are interconnected. He prioritized community participation are the most important factor for success. Quality of bamboo and monitoring the repair work were his second priority. His third priority was the approach of leader. He believes that a leader should maintain the approach of 'not give up on a task

until you succeed'. His opinion about the future of the project was that, these activities should be continued for a better future of the community. He believes that this project will be the best example for green technology to prevent coastal erosion and restoration. Besides that, from the success of the project, future generations will get a better quality life.

Song Khlong leader opinion

The project opening story in Song Khlong area was different from the other two study areas. Before starting the project activities, officers of the project organized a meeting with the leader and the community of Song Khlong area. In the meeting the number of participants from the community was low. After that, officers arranged more meetings with the leader and gave him instructions to ensure the participation of the community in the project activities. However, later on, without ensuring community participation, project officers installed bamboo structures with the help of laborers. Due to the lack of monitoring, after a few years they found all the bamboo structures were damaged.

He was involved in 5 years in project activities, He considered economic effect is the first, social effect is the second, and finally the environmental effect is the third important issue for erosion in the coastal ecosystem. He believes that, in Song Khlong area, rock structures will be effective for preventing coastal erosion instead of bamboo structure, but for restoration of that area planting mangrove trees will be the good solution. He also suggested that before starting the project, the government should make some focused group discussions with the community to check the willingness of the people to participate in the project.

Among the various factors, the participation of the community was chosen by him as the most important factor for successful prevention of coastal erosion and restoration of the coastal area by using bamboo structures. The natural environment in the coastal area (strong winds and high sea waves, soil characteristics, etc.) was selected by his as the next important parameter for success of the project. Beside these, he recognized specification of bamboo, and policies of the government are also important factors for success of the project.

Focus group discussion

In focus group discussion, the main topic was "Guidelines for policy modification on use of bamboo structures to prevent coastal erosion and restoration of the coastal areas successfully by the community". The guidelines for policy modification and implementation formulated by the focused group discussions were community involvement should be the first priority at the design stage of the project. Participation of local community should be ensured from the beginning of the project and continue until the end. At the start, this includes looking for the project site or area, planning for the project, analysis of the problem in the area, evaluation of the damaged resources. During implementation stage, it includes installation of the structures and restoration activities, monitoring activities, and finally evaluation of the project.

Sustainability of the structure depends on regular monitoring and maintenance, for this reason, sufficient budget have to insure for maintenance program. Knowledge should be shared with the community people as well as the officers of the project. Besides this, training about implementation, monitoring, and maintenance activities, as well as visits in success areas to get acquainted with their experiences should be organized.

Ownership of the newly restored areas should be belongs to the government. Restored area should not be sold or rented by the government. Moreover, the government must include instructions on the policy about the use of restored lands for community as public goods with sustainable resource management. The policy should emphasize for increase awareness about economic benefits, environmental benefits, and social benefits of the community by using bamboo structures for prevention and restoration of the coastal area.

Penalty impose methodology to a person or a group who destroy the bamboo structures or hampers project activities should also be included in policy. To select the leader with high morality and awareness on environmental, policy should provide a proper guideline through community discussions.

Conclusions

The Upper Gulf of Thailand facing severe coastal erosion because of natural process and human activities. The DMCR has the project to prevent and restoration of the coastal area on the Upper Gulf of Thailand by using bamboo structures. The bamboo structures suitable sediment characteristics in that areas. Sediment characteristic on the Upper Gulf of Thailand is sandy clay loam (Sawangrerruks at all, 2013). After implementation, DMCR found the bamboo structures can prevention of erosion were succeed in many areas, but in some areas it failed. This study was done to find the factors related to the success of using a bamboo structure for preventing erosion and restoration of coastal area in the Upper Gulf of Thailand.

A pre-designed questionnaire survey, consisting of 33 factors was done to collect data from 333 respondents about the success of the project using the bamboo structure for preventing erosion and restoration of coastal area. The data was analyzed by Multinomial regression model of SPSS program and found that among the thirty-three factors, four factors were highly significant with the significant value at 0.01 and had relation to the success of DMCR project. Four significant factors for success of the project were people's participation in the project (installation of bamboo, planting trees, meetings, and maintenance), strong leadership, government support for various

activities, and the specification of bamboo. The result from questionnaire survey shows that 75% of total respondents participated in the project activity, where the percentage of participation was higher than 90% in the successful area. Strong leadership is essential for project success was chosen by 60% of the respondents. Where government support on different activities is an essential factor for success was chosen by 84% of the respondents. Comparing with various quality issues and environment factors, specification of the bamboo was chosen by 90% of the respondents. (Appendices)

Three focus group discussions were carried out in the study area to get some guidelines for policy modification and implementation about using bamboo structures to prevent erosion and restoration of coastal areas. The findings from the focus group discussion were, policy should be more specific and details about using bamboo structure and current policy should be modified without delay for successful implementation of the project. Penalty impose methodology should be included in the policy for destroying the bamboo structures and hampering the project activity. Moreover, leader with high morality should be chosen by the community.

Policy recommendations

1. Do not carry out activities or do any actions that may result in or cause problems in increasing coastal erosion.
2. Establish rules for the construction process to prevent coastal erosion.
3. Continuing the project to prevent coastal erosion in the area.

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References

- Department of marine and coastal. 2011. "Prevention of coastal erosion in Thailand". Strategic Management Prevention of coastal erosion. Marine and Coastal Resources Journal, 20 December 2018. 70 – 78.
- Department of marine and coastal. 2011. Monitoring and evaluation result of monitoring and evaluation the restoration of coastal ecosystems. By planting bamboo slow wave Samut Prakan and Chachoengsao province case study. Chulalongkorn University. Bangkok: GRT.
- Department of marine and coastal. 2013. "Coastal areas of Thailand". Accessed February 25. 2016. <http://marinegiscenter.dmcg.go.th/km/coastal-zone-management01/#.V12fs7t97IU>.
- Department of marine and coastal 2015. Bamboo slow wave manual to prevent coastal erosion. DMCR, Bangkok: GRT.
- Gregson, J. 2009. Executive Secretary notes. Paper presented at the NC Coastal Resources Committee Meeting February 2009, Morehead City, NC.
- Intatha, C. 2013. Factors influencing the capacity of communities to respond to coastal erosion in the Upper Gulf of Thailand. Mahidol University, Thailand. National statistical office Thailand. 2016. "Number of population". Accessed May 8. 2016. <http://service.nso.go.th/nso/nsopublish/districtList/page1.htm>
- Statistics Solutions. 2016. "Multinomial Logistic Regression." Accessed December 23. 2016. <http://www.statisticssolutions.com/mlr/>.
- Suchart Sawangarreruks. S., Iertkasetvittaya. N., Yaowasooth. P., Luangkhamin. C., Passada and Nikomjit. S. 2013. "After effect of flooding on the Macro benthic community in the Upper Gulf of Thailand." Key challenge of marine Biodiversity Conservation in our Changing Climate 9-11 September 2013, Department of Marine and Coastal Resources Research and Development Center Upper Gulf of Thailand.
- Suraswadi Pinsak. 2016. "The new coastal resources law, Marine protected areas and nature-based solutions for coastal erosion in Thailand." Accessed December 20. 2018. https://www.iucn.org/sites/dev/files/import/downloads/1431_1443_the_new_coastal_resources_law__marine_protected.pdf
- Thama-apipon Sanaway. 2012. Studied the effects of the problems of coastal erosion on coastal communities. Silpakorn University, Thailand.
- World Bank. 2016. "Thai people average income." Accessed December 20. 2018. <http://www.worldbank.org/th/news/press-release/2011/08/02/thailand-now-upper-middle-income-economy>.
- Yamane, Taro. 1967. Statistics: An Introductory Analysis, 2nd Ed., New York: Harper and Row.



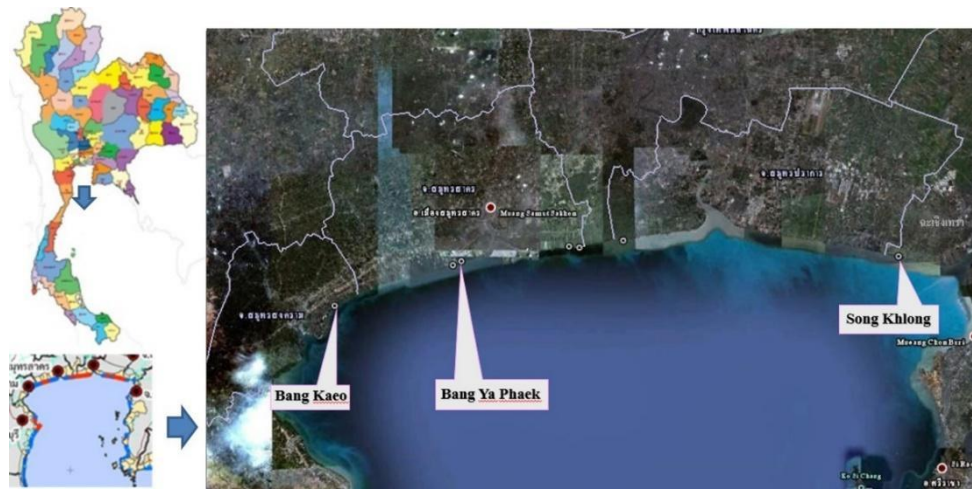


Figure 1. Study areas on the Upper Gulf of Thailand. DMCR, 2013

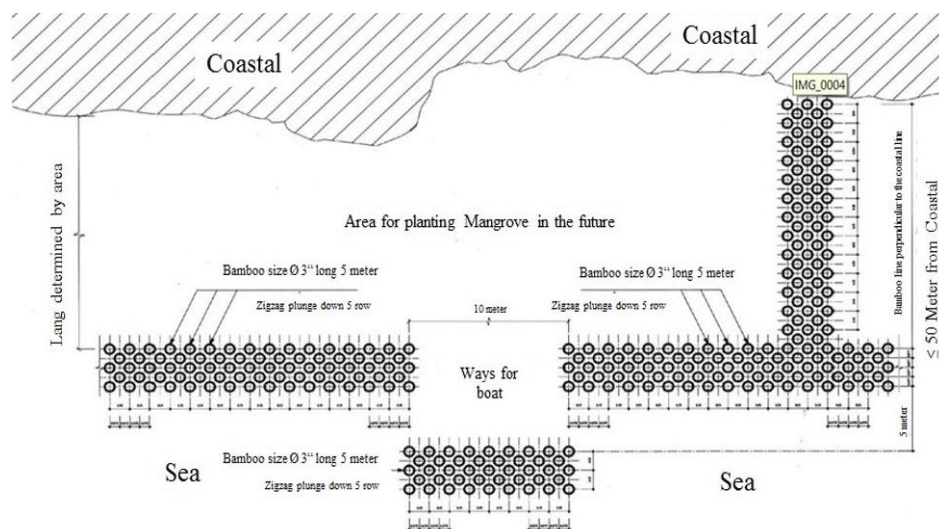


Figure 2. DMCR bamboo stick structure. DMCR, 2015

Table 1. The results of multinominal regression model.

Project (a)		B	S.E.	Wald	Sig.	Exp (B)
Failed	Leadership	3.481	.817	18.171	.000	32.498
	People's participation	2.174	.389	31.180	.000	8.792
	Government support	4.396	.786	31.273	.000	81.121
	Specification of bamboo	1.339	.551	5.903	.015	3.815
Partially success	Leadership	.513	1.035	.246	.620	1.671
	People's participation	1.386	.305	20.598	.000	3.999
	Government support	2.923	.780	14.047	.000	18.590
	Specification of bamboo	.068	.555	.015	.903	1.070

a. The reference category is: Success.

b. This parameter is set to zero because it is redundant

B = The regression coefficient of each independent variable that will be used to create the forecasting equation.

S.E. = Standard error.

Wald = Wald statistic, the way to find out if explanatory variables in a model are significant.

Sig. = Significant.

Exp (B) = Exponentiated of B.