A Study on Influence of Illegal Sand Mining on Coastal Marine Environments- The Kinmen, Taiwan and Xiamen, Mainland China

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Abstract

The aim of this study was to investigate the influence of sand mining on Kinmen coastline, marine ecosystems and maritime security. It evaluated the impacts of mainland China vessels engaging in illegal sand mining beyond boundary limits in the sea area between Kinmen and Xiamen by literature review, deep interviews, field surveys and expert opinions. It is expected that through this research, we can find a way to remedy and prevent the issue of Kinmen coastline deterioration, maintain marine ecosystems and maritime security. Moreover, since Kinmen, Xiamen, Zhangzhou and Guangzhou are in the same sea area, developing a mechanism which manages the sea area between Kinmen and Xiamen together, in order to efficiently protect the sea area between Kinmen and Xiamen is also of interest in this study. In summary, the present study plans to use the findings to draft a solution for the current status, as well as advocate for the "Space Planning of Greater Kinmen and Xiamen Waters" to set an administrative system for the sea area between Kinmen and Xiamen which is collaboratively governed by local governments of "Kinmen, Xiamen, Zhangzhou and Quanzhou".

Keywords: sand mining; coastal marine environments; marine ecosystems; maritime security

I. Introduction

The coastal areas of China have developed astonishingly, with tons of constructions in every city and as a result there is high demand for sand and gravel. In the past 2 decades, as a result of the over-mining of river sand and gravel, there has been frequent floods which endanger lives and properties, as well as the safety of local public facilities. Therefore, local governments have set certain laws or regulations against illegal sand and gravel mining[1]. Consequently, this has disrupted local river sand mining business activities in Fujian or mining in unfixed locations, and businessmen are now in search of other locations or are illegally pumping sand and gravel in the sea area around bayou for exorbitant profits (Zhong& Huang, 2012).

Currently, most sand pump dredgers are from Xiamen, Zhangzhou and Quanzhou areas in the southern Fujian sea area. Since the strict actions of the Chinese government against illegal sand mining, and the over-mining of sea sand in the aforesaid areas, mined sand now has a high silt content and poor quality. In addition, the Taiwan governed Kinmen County is near the sea areas around Xiamen, Zhangzhou and Quanzhou, and its inner bay contains many sandbanks, and such sea area is close to the main seaports and harbors of Xiamen, Zhangzhou and Quanzhou with convenient transportation. Thus, some sand miners come to these areas to conduct illegal sand mining (please refer to Fig. 1; 2). Furthermore, the governments of China and Taiwan have control over half the sea area between Kinmen and Xiamen; thus, China's law-enforcement agencies vessels are unable to cross the midline, to stop illegal actions in the Taiwan governed sea area. Therefore, illegal sand pump dredgers from China frequently change their dredging locations by crossing the restricted areas and water lines of Kinmen, to engage in illegal sand and gravel mining[2,3].

[1]It refers to Shenzhen Container Trailer Association, PROC (2016). Sand mining in Fujian's Minjiangriver threatens the safety of railway subgrade.Available at: http://www.cy.gov.tw/sp.asp?xdurl=./CyBsBox/CyBsR1.asp&ctNode=910 (accessed 4May, 2018).

[2]It refers to Kao, R. H., Hsu, C. H., Kao, J. C., & Yang, F. C. (2017). A study on the influence of the marine environmental deterioration and maritime safety from carrying illegal sand mining in the sea area between Kinmen and Xiamen-The case of mainland China boats.Transportation Planning Journal 46 (1), 51-84.

This makes Taiwan's coast guards fully engaged with stopping illegal sand mining businesses, but it has been ineffective. Kinmen is a small island experiencing serious coastline recession because of the illegal mining of sea sand. The "Orthophoto Map" showed overlapping comparison from 2007 to 2012, and the total recessed area was 256,631 square meters (m^2). The Taiwan Kinmen National Park Headquarters (KNPH), Water Resources Agency and Kinmen County Government also discovered that other possible causes may have eroded the Kinmen coast. However, the main cause should be the great deal of sea sand that has been mined by Chinese sand pump dredgers, which is also the main factor for erosion and ecological sabotage of the Kinmen coastline (Liu & Chang, 2015). Chinese Sand pump dredgers crossed the boundary for sand mining, this decreased sea sand productivity in Kinmen's east coast and north coast; collapsed the landscape of sea cliff in the west coast, caused coastline recession and loss, exposed concrete pile and revealed old military coast guard posts on the beach (as in Fig. 3), indicating that the Kinmen coastline near the sea area between Kinmen and Xiamen has been seriously damaged, and this is the main reason for this study.

This study also investigated whether environmental vandalism of the sea area would affect fishery resources. Furthermore, sand pump dredgers pumped sea sand that caused the current change in sea area and eroded the coastline. If there is sandbank drifting effect, vessels cruised in such sea area would encounter with unpredictable disasters[4]. As a result, this study would analyze how to plan and manage this aspect of maritime safety.

In view of the illegal sand mining of Chinese vessels in the Kinmen sea area, which caused ecological changes and coastal erosion, both China and Taiwan enforcement agencies should have intact countermeasures against illegal sand mining in the sea area between Kinmen and Xiamen. This study reviewed the case analysis, related data collection, in-depth interview or expert opinion surveys in order to investigate the influence of illegal sand mining on Kinmen coastline recession, sea area environmental vandalism and maritime safety, and furtheradvance the enforcement of cooperation between "Cross-strait Governments".

In summary, this study evaluated the influence of China's vessels' illegal sea sand mining on Kinmen coastline recession, environmental vandalism and maritime safety. Moreover, the present study plans to use the findings to draft a solution for the current status, as well as advocate for the "Space Planning of Greater Kinmen and Xiamen Waters" to set an administrative system for the sea area between Kinmen and Xiamen which is collaboratively governed by local governments of "Kinmen, Xiamen, Zhangzhou and Quanzhou".

II. Materials and methods

Basically, this study evaluated the common causes of coastline recession, specific causes of Kinmen coastline recession, and factors of illegal sea sand mining in the sea area between Kinmen and Xiamen.

2.1 Materials

Related Researches on Reasons for Coastline Recession Lin (2012) pointed out that Taiwan's Northeast Monsoon, coastal area construction, and placement of too many armor blocks may destroy the coastal landscape. In their research, Global Geomorphology & Lab (2013) showed that coastal area erosion could result from natural causes, such as natural terrain blocking, flying sands, Typhoon waves and storming tides. Chang (2014) analyzed the reasons for Taiwan coastline recession as shown in Fig. 4 and 5. Furthermore, Kudalc's (2010) research pointed out that the seasonal changes in tides, waves, cyclones, wind and climate have caused continuous coastline changes. Primary/secondary development in harbors and fishing ports including coastal buildings and structures, such as jetty, dock groin, embankment and dredging harbor, would result in major changes in submarine terrains. In addition, the loss of sand sources may possibly cause erosion. Chang,Chu andChuang (2018) showed that human activities, including artificial hard structures in coastline and upstream reservoir changed the balance of silt transfer, and caused recession and erosion of coastline gravels. Lastly, the sea embankment and marine jetty will continuously cause coastline recession.

In summary, coastline recession originates from natural and personal factors. The main natural factors are typhoon waves and invasion caused by storming tides, the Northeast Monsoon's influence, long-term effect of regular waves and tides, blocking of natural terrains, and flying sands. The main personal factors are over pumping of underground water in coastal areas, aquaculture, river and marine construction, improper use of armor blocks, drifting sand blocked by large coastal structures, establishment of reservoir and river dam, over-dredging of river sand and gravel, land over-consumed in coastal areas or illegal development.

[3]To prevent authorizing China according to United Nations Convention on the Law of the Sea and declare that its vessels can pass Taiwan's territorial waters and adjacent areas, Taiwan set restriction (24 nautical miles) and prohibition (12 nautical miles).

[4]Same as Note 2

2. 1. 2 Research on Reasons for Kinmen Coastline Recession

Few researches have been conducted on the causes of Kinmen coastline recession. The present study analyzed these researches by using literature, survey reports, media reports, and described them.

Liuand Chang (2015) investigated coastline recession in Kinmen and Lieyu Islands. After conducting certain investigations, it was concluded that the extensive sand pumping by China sand pump dredgers affected the sea current and eroded the islands surrounding Xiamen Bay. Thus, illegal sea sand mining is among the key factors affecting coastline recession and accelerating geological changes in the coast.

A field study on "Coastal Monitoring and Investigation in Kinmen", conducted by Taiwan Water Resources Agency in 2014, showed that the coasts are eroded and silted. In terms of the causes of coastal erosion, this was initially determined to be related to personal factors including local sand mining and illegal sea sand mining of China sand pump dredgers for a long period of time. Furthermore, KNPH surveyed the effect of ecological habits on precious marine Lancelet (Branchiostoma) and protected Chinese white dolphin, and the report stated that China's sand pump dredgers have pumped a great amount of sea sand. In addition to directly reducing the number of Lancelet clusters, sand pumping would cause smaller grains for submarine sands, which is not suitable for the Lancelet habitat. Moreover, in 2011, the Ecological Survey Report stated that the noise produced during dredging influenced the dolphins in Kinmen sea area, and made the Chinese white dolphin to avoid this sea area as their habitat. Chang (2015) showed that the long-term sea sand pumping action is the key cause of Kinmen coastal erosion.

2. 1. 3 Media Report and Cause Analysis

In the recent 10 years, there have been several reports on the influence of the actions of China's vessels' illegal sea sand mining on the Kinmen coastline. The media reports mainly included Kinmen Daily News, Taiwan's UDN network, and this study has been comprehensively organized and the following conclusions obtained:

Kinmen has mainly natural coastal terrains. The Jiulong River and Chin River, next to Kinmen Island, are the two biggest rivers in the southern Fujian area. As a result of strong mixing with the river, next to Kinmen Island, the effects of tides, ocean current and wave, silt migration, distribution and sedimentation would occur in Xiamen and the surrounding sea area, and this can possibly affect erosion and sedimentation in the Kinmen coast. The causes of coastal erosion include the long-term effect of natural factors, such as waves and tides, the blocking of natural terrains, flying sands, and invasion of Typhoon waves and storming tides, as well as coastline sand pumping, drifting sand blocking by large coastal structures, decreased river sediment, Groin Effect and improper coastal uses. In 2015, Taiwan's Common Wealth Magazine reported long-term illegal sand mining by China's unscrupulous businesses which crossed the boundary, and this has gradually damaged the ecological system in the Kinmen sea area, affected the safety of channels, made the Kinmen coastline continuously recessed and caused loss of lands; especially the shoreline of Guningtounorth cliff which has been continuously recessed, and this is a major risk in that area. This resulted in collapse of the military fortress in Kinmen coast (as in Fig. 6) which can be considered as an evidence.

The National Sun Yat-sen University, traced China's sand pump dredgers for their illegal sea sand mining that caused damage to the environment in the Kinmen coast, as well as verified that their sand mining operationcaused erosion and loss for Kinmen's lands, such as the military fortress foundation at Yangshan in Jinsha Township and Siyuan coast which have been seriously eroded. Apart from causing the erosion of the island coast, illegal sand pumping also affects the submarine ecology. The media has shown that during the Spring and Summer of 2014, Jinsha Township's oyster farms experienced a great deal of sudden deaths for Natal rock oyster (*Saccostrea mordax*). However, there are no such scientific researches on this issue, but sand pumping may possibly cause a great amount of slit and debris to be attached on the oyster field, which will thicken humus soil levels, produce toxic gas which will adversely affect the growth of Natal rock oyster, consequently leading to sudden deaths. According to the aforementioned findings, the Kinmen coast experienced the effect of erosion and loss, and the impact on marine ecology and maritime safety; all these are related to the operation of China's sand pump dredgers. If the sand pumping exceeds sediment transportation for Jiulong River and Chin River, then it would surely influence the balance and stability for the sea area sand sources. Therefore, it can be considered as one of the reasons for Kinmen coastal erosion.

2.1.4 Investigating the Factors of Illegal Sand Mining in the Sea Area between Kinmen and Xiamen[5]

The two major reasons for illegal sand mining of China's vessels are: 1) to seek exorbitant profits and 2) to respond to China's sea reclamation construction. First, because of the rapid development in China, the demands of sea reclamation,

[5]Same as Note 2

harbor construction and building sand have continuously increased. However, the supply of river sand is far behind the need of building sand nationally, and its prices are not cheap (in 2013, a cubic meter cost RMB 100). A 600-tons pump dredger can illegally mine1000 cubic meters of sea sand, and the sales price of a cubic meter of sea sand is RMB 13, thus their daily net income could reach RMB 10,000.

Consequently, the massive profits drove people who live around China's coastline to take risks in illegal sand mining in sea areas[6], since Kinmen has good quality sea sand with rough grains and good color, which has high economic value in China's market.

2. 2Research Methods

In the social sciences, various methods are used for investigation including qualitative research and quantitative research. In the case of conducting a systematic qualitative research, most researchers would frequently apply research methods, including Literature Review, In-depth Interview, Participant Observation, and Secondary Data Analysis (Jackson, 1980).

2. 2.1 Literature Analysis

This study adopted literature analysis by mainly collecting and analyzing related academic literature, journal, governmental publication, survey data, network or media information.

2. 2.2 Field Survey and In-depth Interview

Data were collected in the research period, surveyed and observed in the sea area between Kinmen and Xiamen. Data was observed for possible illegal sand and gravel mining. Also, the influence of the aforesaid marine activities on the loss of the Kinmen coastline, sea area environmental vandalism, ecology of fishery resources and maritime safety were evaluated. In addition, senior local fishermen in the Kinmen area, related marine and geography experts were randomly interviewed in order to understand the impact of illegal sand mining acts on the aforesaid issues. In addition, from environmental survey to field survey, modern tools, diagram or field survey record were used to enhance the reliability of this qualitative research.

2. 2.3Expert Opinion Survey

In this study, 6 experts and scholars were invited to conduct an opinion survey, 3 of them were invited each from Taiwan Kinmen and China Xiamen and included in the academic circle were empirical experts of law enforcement agencies in the sea area between Kinmen and Xiamen, or administrators in county government and local fishermen's association.

2. 3 Research Approach

2. 3.1Literature Analysis Approach

First, this study investigated the causes of recession of the common coastline and Kinmen coastline. Second, it investigated related researches of illegal sand mining and the influence of China's illegal sand mining vessels on the coast lines. In addition, from the available criminal record, it investigated the causes of illegal sand mining in the sea area between Kinmen and Xiamen, in order to understand its main causes, so as to discover the fundamental preventive method. Lastly, it investigated the "Cross-strait Joint Fight against Crime and Mutual Legal Assistance Agreement; CSJFACAMLAA)", to understand the difficulties in our law enforcement, as well as looked for the corresponding solutions.

2. 3. 2Field Survey Approach

In this approach, based on data obtained from analyzing the hot zone of illegal sand mining, real observations were conducted in the field. Next, an in-depth interview was conducted on local senior fishermen, sea area law enforcement officials or related experts and government.

2. 3.3Expert Opinion Survey Approach

Based on the literature analysis, this study set aspects and categories for "Cause Analysis for China Vessels' Cross Boundary Illegal Sand Mining" and "Cause Analysis of Influencing Coastline Recession, Marine Ecological Sabotage

[6]World Shipping, Current Status and Countermeasure Analysis for Supervising Quanzhou Coastline Sand Carrier, p.35.available at:http://www.lofter.com/postentry?from=search&permalink=1cc81401_42cf858.(accessed 30September, 2017).

and Maritime Safety", then discussed with related experts for the aforesaid data and information, as well as in accordance with their opinions to correct the contents obtained from related researches. Interviewees included cross-strait academic and empirical experts and officials.

III. Results and Discussion

Since Taiwan declared to end martial law in 1992, Chinese fishermen have continued to perpetuate illegal fishing activities. Also, China's sand pump dredgers continued illegal sand mining, which brought extreme risk and danger to the Kinmen coastline and sea area ecology.

This study analyzed the impact of such illegal sand mining in the sea area between Kinmen and Xiamen and the illegal sand mining law enforcement status as follows[7]:

3.1Analysis of the Impact of Illegal Sand Mining on Kinmen Coastline Recession

It was discovered that the supply imbalance of sand sources is the main cause of coastline change. The Kinmen coastline recession was influenced by natural factors; however, a stable and balanced status would be achieved between erosion and sedimentation in the long run (Lin, 2008). Furthermore, it can be seen from Lin's (2008) research, that the submarine terrain in the Kinmen sea area was stable within the research period, and was not subject to construction of the Shuitou Commercial Harbor. Kinmen has no large-size river and ocean construction, nor large-size coastal BOT development construction[8]. Therefore, viewed from the aforesaid information, illegal sand mining by vessels from China should be the main cause of Kinmen coastline recession. In recent years, there has been a great loss in the Kinmen coastline, except for the seasonal recovery at the north coast. In summer time, the coastal sand and gravel would be eroded and washed away but there is recovery through sedimentation in winter. Since Kinmen is a small island, the rest of the eroded areas without high mountains or long rivers can bring full sand sources to re-supply the coastline. Therefore, before cross-strait governments can stop illegal sand mining by China vessels in the Kinmen sea area, the coastline will be continuously recessed, even building sea embankment cannot protect coastal landscape or stop coastline recession[9]. In his 2014 study, Chung-Pan Lee stated that "if China sand pump dredgers mined 100,000 cubic meters (145,000 tons) of sea sand, it would cause one meter drop at the beach within 1km range at the north coast of Kinmen and the land would be recessed 100 meters (as in Fig. 7)" (Common Wealth Magazine, 2015). Clearly it shows that the great deal of illegal sea sand mining conducted by China's sand pump dredgers not only affected the safety of people's lives and caused seawater encroachment and soil salinization, but also caused landscape changes in Kinmen Island, leading to coastline recession and loss (as in Fig. 8 & 9).

3.2 Analysis of the influence of illegal sand mining in the sea area between Kinmen and Xiamen on environmental vandalism

3. 2. 1 The destruction of *marine* ecology and *fishery resources*

Based on the survey, so far there are two animals, which live in the sea area between Kinmen and Xiamen. The first is a prehistoric living fossil, "Horseshoe Crab" and the second is the protected Chinese white dolphin listed in China Class 2 "Lancelet" (precious marine invertebrates) in 1991. This study analyzed the influence of China's sand pump dredgers on submarine sand and gravel (Kao et al., 2017):

Horseshoe Crab's Living Environment has been sabotaged: Horseshoe crabs live in sandy and shallow sea area, where they frequently crawl or sneak in the silt, and during May to August and September, they lay eggs in the sandbank silt around the high water line of the intertidal zone. However, when the Northeast Monsoon arrives, they migrate to the 20-30-meter deep sea area during winter. China's sand pump dredgers directly sabotage their living environment and endanger their survival.

Lancelet's Habitat has been sabotaged: There are abundant Lancelet species in Kinmen-Xiamen waters which were once important local fishery resource. In 2010 and 2012, the Kinmen National Park authorized the Society of Streams, R.O.C. to conduct surveys, and the results showed that the base type of Lancelet's habitat should be sand or silt with mainly fine sieve grade of 0.25 – 2 mm granularity.

[7]It refers to Hsu, C. H. (2016). A study on the law enforcement ability in the sea area between Kinmen and Xiamen-The case of mainland Chinese vessels carrying illegal sand mining beyond boundary limits. Institute of Marine affairs, National Quemoy University, Taiwan, Republic of China.

[8]"Kinmen County Government: No-coastline BOT Development Project", reported on 2014/5/19

Therefore, if a great amount of sea sand has been mined and pumped, it would cause the base sand to become smaller and unsuitable to sustain the existence of Lancelets, which will directly decrease the number of Lancelet species (Kinmen National Park, 2012).

Chinese White Dolphin's Living Space has been suppressed: Chinese white dolphins live around the sea area 5-10 meters to the offshore. Chinese white dolphins make use of whistle sound to identify same or different animals. China's sand pump dredgers have sabotaged the habitat as a result of their illegal sand mining, and the noise and wastewater drainage would also directly suppress the sea area for their living environment and group activities.
Benthonic animals and plants cannot survive, reproduce and have hiding spaces: China's sand pump dredgers have disrupted the flat submarine sandy surface. This wiped out the sand level originally used for nursing shrimps and clams, and resulted in the depletion of fishery resources.

3.2.2 High Death Rate of Oyster in Kinmen Coast: In 2014, during spring and summer, Kinmen County's oyster farms recorded a great amount of sudden death for Natal rock oyster.Local oyster farmers strongly doubted that China's fishing vessels crossed the boundary to mine and pump the coarse, fine sand and gravel, so as to cause submarine silt to float to the coast oyster field and thicken the humus layer; this resulted in the production of toxic gas which caused sudden death for Natal rock oyster (Kinmen Daily News, 2015). Moreover, in Guningtou Offshore of Kinmen's Jinning Township, in recent years, the submarine silt generated due to illegal sand mining was attached on oyster sticks and made an original 1-meteroyster stick to be buried more than 50 cm(as in Fig. 10 &11), which seriously affected the productivity of Natal rock oyster and oyster farmers' living, hence the continuous protest of oyster farmers.

3.3 Analysis of the influence of Illegal Sand Mining on Maritime Safety in the Sea Area between Kinmen and Xiamen
Since the great loss of Kinmen coastline would change the ocean current in this sea area or cause corrosion, the related influential factors of maritime safety are as follows (Kao et al., 2017).

3.3.1Sabotaged submarine terrain would change the hydrographic data which will threaten the safe navigation of vessels in the sea area.

The difference between high and low tides in Kinmen sea area can reach 5meters, and the longest intertidal zone can reach 1,800 meters, leaving just 2-meter depth for the water routes that can be navigated in the north coast at the lowest tide. Therefore, marine channels between Xiamen and Quanzhou are shallow and rocky, vessels may be stranded if they are off course.

3. 3. 2 Sand pump dredgers invaded the sea area between Kinmen and Xiamen which may endanger the channels' safety and pollute the oceans

Kinmen and Xiamen are close to each other, but the sea area is narrow and crowded. Such small areas need to accommodate passenger ferry between Kinmen and Xiamen, cargo lines between Kinmen-Xiamen, and fishing vessels. At the same time, law enforcement agencies are almost saturated. Thus, China-registered sand pump dredgers (2-3,000 ton class) invade the sea area between Kinmen and Xiamen for the purpose of sand mining. This situation has caused great threat to maritime safety, making the vessels within this area to experience mooring, become stranded or collide with each other, and further cause damage to the sea environment. For example, on December 8, 2014, China's Putian's sand pump dredger, JianLong No.569, was stranded in the Guningtou-NorthShan sea area (as in Fig. 12).

3.4 Analysis of Illegal Sand Mining law enforcement in the Sea Area between Kinmen and Xiamen
3.4.1 Statistics and crime analysis of seized case by Taiwan's Coast Guard Administration (ROC)

The effectiveness of cross boundary illegal sand mining in Kinmen sea area for China's vessels captured by CGA 2005 ~ 2018 is shown in Table 1, and analyzed as follows (Kao et al., 2017):

Amount of Cases Captured: Being affected by China's export policy, the restriction of "natural river sand" in 2007, Taiwan CGA captured 9 cases of illegal sand mining, and detained 3,350 cubic meters of sand and gravel, which can be considered as the historic peak. On July 15, 2014, Taiwan's Common Wealth Magazine Issue No. 551 reported that there are about 6000 sand pump dredgers gathering around Fujian's Province offshore, and the "2013 Fujian Province Marine Administrative Law Enforcement Communiqué" revealed that Fujian Province banned 391 cases in 2013 with a fine of RMB 19,350,000. In addition, CGA only captured 4 cases at the same time (Coast Guard Administration, 2018). As informed, there are about 6000 sand pump dredgers around Fujian coastline, and most of them are inland river vessels or vessels without valid certificates or expired certificates. Taking Fujian Province as example, there are about 6000 sand pump dredgers around its coastline and offshore, but only 391 cases received due punishment per year with a very low fine rate of 6.52%.

Taiwan CGA only has authority to seize vessels within Taiwan governed Kinmen waters, thus it may be unfair and the objective might be lost based on all banned cases in China's Fujian province and the cases captured by CGA.

Criminal Types: For the analysis of those 50 cases shown in Table 1 (38 cases with known time), the time period of China's sand pump dredgers that crossed boundary and conducted illegal sand mining in Kinmen sea area can be divided into 2 major periods: 7:00-11:00 (16cases) in the morning and 17:00-21:00 (12cases) in the evening.

In addition, by re-analyzing those aforesaid 50 cases (39 cases with known time), Menghuyu, GuningtouNiousajiaoand Tianpu sea areas are the 3 major hot zones for China's sand pump dredgers crossing the boundary and conducting illegal sand mining in the Kinmen sea area. Moreover, vessels captured are mainly registered in China's Zhangzhou's Longhai City and Xiamen. Crew members are 4 to 10, and there are mainly 5 to 8 crew members for most vessels.

Avoid Seizing Types: The main strategy used by China vessels to avoid seizing when crossing the boundary for illegal sand mining include: (1) making use of Kinmen's fog season, and arguing to have mistakenly entered Kinmen waters in the fog; (2) the use of night time to conduct illegal sand mining, and assigning designated persons to watch over and act carefully; (3) the use of passive resistance without cooperation, intentionally damaging the steering engine or generator of sand pump dredger to prevent CGA from escorting the crew and vessel back to Kinmen; (4) using snaking method to drift towards the right side to make its own stern to bump CGA's vessel; (5) installing 2 rows of sharpened iron sticks on sand pump dredger's stern which point outward with the intention to hurt the inspectors on board or prevent law enforcement vessels from coming close for inspection(Hsu, 2016).

Taiwan's Law Enforcement Modes: Kinmen CGA mainly uses one or two vessels for converging attack, or they cooperate with Kinmen CGACP boats and Kinmen County Fishery Protection Task Force vessels to jointly execute law enforcement.

3. 2. 2 Current Status of Cross-strait Maritime Cooperative Law Enforcement Striking Illegal Sand Mining

Since 2009, cross-strait authorities have jointly executed the "Cross-strait Law Enforcement Cooperation".In 2010, the China Marine Surveillance Fujian Province Corps and our CGA set a contact window of marine law enforcement. In 2011, both parties extended the cooperative law enforcement area to the "Lienchiang-Mazu" sea area. As at May 19,2016, both parties already had 20 joint law enforcement actions and had captured 63 vessels for illegal sand mining. In terms of exchanging information, evidence collection and case delivery, both parties supported each other, which provided solid protection for marine ecology, environmental protection and cruising safety in Taiwan Strait (Kao et al., 2017). From 2009 to 2018, the in-depth cooperation and experience of cross-strait maritime law enforcement cooperation standardized the cross-strait corresponding liaison and cooperative law enforcement mechanism. However, since Taiwan's Democratic Progressive Party ruled on May 20, 2016, the cooperation has been placed on hold. The relation between cross-straits has been strongly varied, including the cross-strait joint strike force on criminals, the high-level cross-strait affairs meeting, cross-strait hotline, and the contact mechanism between Straits Exchange Foundation and Association for Relations Across the Taiwan Straits, even those execution agreements "CSJFACAMLAA" signed by both parties have also been affected[10].

IV. Conclusions and Suggestions

Furthermore, this study proposed several research findings and suggestions for the difficulties experienced by law enforcement and administrative principles in the sea area between Kinmen and Xiamen, and described them as follows:
4.1 Law enforcement difficulty in the sea area between Kinmen and Xiamen[11]

4. 1. 1 Legal Aspect

The hierarchy of cross-strait legal assistance, the difference of authority distribution and difference in criminal evidence system are the main issues in cross-strait cooperation for criminal investigation and evidence taking. For example, in Taiwan the prosecutor is only responsible for criminal investigation and evidence taking, but in China the prosecution agents are responsible for investigating cases of corruption, bribery crime and malfeasance for officials. It is the duty of the public security bureau to investigate other criminal cases (Xiamen Maritime Safety Administration, 2016).

On May 2015, after the "Xia-Zhang Conference" held in Kinmen[12], Taiwan CGA Kinmen Coast Guard provided photographic and recording evidence against those 13 sand pump dredgers from China that crossed the boundary and

[10] Refer to CDNEWS (2016). Cross-strait Cooperative Legal Assistance Agreement is going to fail after 520, published on 2016/10/3.
[11]Same as Note 2
[12]It is referred to as the session between leaders of Chinaand Taiwan governmentsforCross-Strait affairs.

illegally mined sea sand in the restricted waters as an evidence of violation to China. In this criminal investigation and based on evidence in the procedures between cross-straits, "CSJFACAMLAA" may be used to ban China's sand pump dredgers (Hsu, 2016).

4. 1. 2 Execution Aspect

No Specific Organs Responsible for Case Follow-up: Taiwan CGA is responsible for the sea area law enforcement, including illegal fishing, ocean pollution (conservation), smuggling and trafficking. However, the jurisdiction of these aforesaid violated laws are governed by different authorities and organs, each of them can respond in accordance with their own authority, but there is no such specific organization that is responsible for the follow-up operation for each case. As a result, the illegal sand mining group can continuously commit criminal acts between cross-straits, and this affects the efficiency of law enforcement in the long run.

Coast Patrol's Duties are too Complicated and Current Seizing Power is inadequate: Comparing China's laws and law enforcement power, Kinmen sea area can be considered as a shelter for illegal sand mining businesses, this is because of insufficient boundary length in Kinmen sea area. However, when the patrol boat approaches the specific sea area, the suspicious sand pump dredger only needs to turn back to Xiamen sea area to avoid seizure, which is one of the limitations to controlling maritime crime.

Legal effect is not enough to stop China's unscrupulous businesses: Kinmen County Government has placed a fine of NTD3,000,000 for such cases in accordance with Article 36 of Sand and Gravel Excavation Act (such regulation states a fine from NTD 1 million to 5 million). After filing such a case, the Kinmen District Prosecutors Office should inspect the suspect who has committed the crime within the probation period, then he/she should be prosecuted and sentenced, others should be punished by applying for Summary Judgment or Deferred Prosecution. Also, the suspect should be placed under the CGA's custody for one to several months. Thus, if any sand pump dredger has been seized by Taiwan's law enforcement agencies, the fine should be NTD 3 million, both the crew and vessel should be detained for about 2 months.

Restrict cross-strait maritime law enforcement cooperation controlled by China: It has been more than 7 years since the establishment of "CSJFACAMLAA" in 2009, the in-depth cooperation and experience of cross-strait maritime law enforcement cooperation has standardized the cross-strait corresponding liaison and cooperative law enforcement mechanism. During this period both parties already had 20 joint law enforcement actions by capturing 63 vessels for the case of sand mining that sabotaged marine environment. However, it is subject to China with 20 cooperative law enforcements in 7 years, or averaged 3-4 times per year. It has captured6 illegal sand pump dredgers, but there are tons of China's fishing vessels that still crossed the boundary for illegal fishing and several sand pump dredgers for illegal sea sand mining in the sea area between Kinmen and Xiamen during work days, and all these have great impact on cruising safety and the economy, thus there is no room to advance the frequency of cross-strait cooperative law enforcement.

4. 2 Management Principle and Mechanism in the sea area between Kinmen and Xiamen[13]

This study thought that we can go through the cross-strait negotiation mechanism which suggests China to enhance their management for illegal sand pump dredgers as described as follows:

4. 2. 1 Control illegal sand pump dredgers from the source

To solve the maritime violation in the sea area between Kinmen and Xiamen, it is suggested that China should establish a database of dynamics and gravel mining vessels, and create an entire record for further reference. Thus China should compile the entire record, control violated vessels, and realize the detention policy of "Vessels with 3 Nos", so as to solve such issues.

4.2.2 Strictly striking illegal sand mining dredgers that avoid law enforcement and supervision.

The avoidance of law enforcement and supervision in Xiamen, Quanzhou and Zhangzhou areas by sand pump dredgers should be restricted, especially during their illegal operation at noon and night time in an attempt to avoid paying the vessel regulation fee and maritime supervision for China's maritime authorities (Huang, 2013). For the abovementioned avoidance of supervision, China should use a strict method and detain vessels that violate the laws.

4. 2. 3 Urge Carrier Company to Upgrade Management Level and Lower Accident Rate for Vessels.

[13]Same as Note 2

In general, while cruising, illegal sand pump dredgers may turn off vessel's Automatic Identification System (AIS), and not receive and listen to Very High Frequency (VHF) Wireless Phone, which may easily cause contact damage, flipping over, and maritime accidents. Thus, when sand pump dredgers conduct illegal sand mining at anchorage and unordered cruising along channels, it may have major risk for the maritime safety by causing bumping accidents of vessels (Huang, 2013). Maritime supervision authorities should enhance law enforcement, urge sand pump dredger companies to improve their own management standard and reduce vessel's accident rate.

4. 3 Research Suggestion

4. 3. 1 Setup Specific Legislation

In Taiwan, there is the "Sand and Gravel Excavation Act" that businesses and law enforcement can follow, but its legal effectiveness is significant and insufficient to stop China sand pump dredgers' illegal sand mining acts, and the laws violated are minors. Thus, the Kinmen sea area is like an outlaw area for China's sand pump dredgers. It is suggested that the Taiwan authority should set specific and appropriate laws and regulations for the specialty and demand in this area.

4. 3. 2 Enhance Law Enforcement Power

Currently, CGA law enforcement agencies still have corresponding issues about law enforcement power, such as insufficient manpower, vessels' reliability and availability which still needs to be enhanced; in addition, insufficient affiliated utilizations; that is, there are only 2 seats of sand pump dredger committee provided by Kinmen County Government, CGA law enforcement agencies need to take responsibility to keep vessels and detain related crew members. Since there is horizontal liaison system among governmental organs, or there are no superior integrated organs to take charge of, this may easily result to incomplete law enforcement (Hsu, 2016). Thus, it is suggested that Kinmen County Government should set a supervision committee to negotiate and cooperate with those aforesaid issues, so as to integrate each organ's law enforcement power.

4. 3. 3 Enhance "Cross-strait Joint Fight against Crime and Mutual Legal Assistance Agreement"

Although both China and Taiwan received several effects within "CSJFACAMLAA"; however, from the aforesaid discussion it was discovered that a difference existed in cross-strait's needs of striking crime. By considering policy, politics and economic factors, China would have different response and reply to those issues proposed by Taiwan; that is, it showed that "CSJFACAMLAA" still has a high uncertainty. Therefore, except for both parties' continuous application of "CSJFACAMLAA" to enhance the effect of joint law enforcement, Taiwan also needs to enhance its locallaw enforcement power, such as enhance coast guard's law enforcement tools and professionalism. In addition, how to enhance the cross-strait relation is one of important methods to make "CSJFACAMLAA" more effective, since "Keep Taiwan Strait in a peaceful and stable situation is a joint responsibility for cross-strait, and is also the expectation and the greatest common divisor for the people of both parties and the international society". In the future, government should put in great efforts to maintain the current systems and mechanisms for cross-strait in accordance with conforming to Taiwan's latest public opinions and maximum consensus, as well as sustain the principles of peace and benefit-sharing, especially for those corresponding law enforcement and crime striking mechanisms(Kao et al., 2017).

4. 4. 4 To establish the joint administrative mechanism among Kinmen, Xiamen, Zhangzhou and Quanzhou – "Greater Marine Spatial Planning between Kinmen and Xiamen"

Notion of Marine Spatial Planning: Marine spatial planning (MSP) means to facilitate good and effective coordination between every unit or authority in the waters ways. To sum up, these 4 places, Kinmen, Xiamen, Zhangzhou and Quanzhou, are within the same sea area, thus every local government should have joint cooperative law enforcement, so as to effectively manage every action inthe sea area between Kinmen and Xiamen. This study described the management ideas and suggested reasons as follows, which are proposed for the "Greater Marine Spatial Planning between Kinmen and Xiamen":

Kinmen, Xiamen, Zhangzhou and Quanzhou are located within the same sea area

Kinmen, Xiamen, Zhangzhou and Quanzhou are located within the same sea area and can be generally categorized into the "Greater Kinmen-Xiamen" sea area. In order to effectively manage and prevent government marine ecology from being sabotaged and also maintain maritime safety in the sea area between Kinmen and Xiamen, the local governments of Kinmen, Xiamen, Zhangzhou and Quanzhou should organize every law enforcement related agencies, and authorities of fishery, agriculture, transportation and construction into the same management system (dispersed currently), with fishermen in this sea area and related marine consumers to jointly make the management plans;

meanwhile, the maintenance of marine ecology should be taken as the key starting point, as well as care in preventing and seizing every maritime illegal actions. In addition, local government or other law enforcement agencies need to improve the marine knowledge of their employees by getting personnel acquainted with the operation execution in this area, especially the unit leaders, giving them firsthand experience of their responsibilities and obligations, and further give them a sense of care about the benefits and development in such sea area by means of participating in this marine planning.

In conclusion, along with resource sharing, information exchanging and joint law enforcement, as well as expanding to the active participation for related people, such as fishermen, marine industry and ocean lovers and protectors, this mode can be applied to carry out the "Greater Marine Spatial Planning between Kinmen and Xiamen" among Kinmen, Xiamen, Zhangzhou and Quanzhou. It may have certain effectiveness for preventing illegal sand mining in the sea area between Kinmen and Xiamen. However, the high-level communication and negotiation between the governments of China and Taiwan is not smooth, but some contacting channels of certain local law enforcement agencies between them are well-linked and smooth. Therefore, this study reviewed the viewpoint of the law enforcement or academia of China and Taiwan, and thought that the decision-making power of law enforcement and maritime affairs should be fully distributed to other organs, as well as allows local government to have such power to organize and manage. Such approach requires high-rank officials of cross-strait governments to first see to such related laws and regulations before assigning local government to execute jointly. As for MSP setting, it is a mode of "decentralization"and "consistent management", and no-division spatial management. Therefore, the maritime management of China's Xiamen, Zhangzhou and Quanzhou should be considered as a whole, a cooperation should be initiated with Taiwan's Kinmen local government and CGA inlaw enforcement and management mechanism. In addition, the current law enforcement power in the sea area between Kinmen and Xiamen is not enough, since those local governments in China and Taiwan, and marine law enforcement agencies all act according to their own free will. In addition, the law enforcement scope of local law enforcement agencies is too small to execute the point, line and plane striking strategy and management. Therefore, this study thought that there is need to build a joint governance mechanism for the Greater Marine Spatial Planning between Kinmen and Xiamen"among Kinmen, Xiamen, Zhangzhou and Quanzhou.

References

Chang, S. Y. (2014).***Study of the influence on Wai-San-Ding sandbank by major rivers and Mailiaoindustrial harbor***.Unpublished master dissertation, Department of Marine Environment and Engineering, National Sun Yat-Sen University, Taiwan, Republic of China.

Chang, Y., Chu, K. W., &Chuang, Z. H. (2018). Sustainable coastal zone planning based on natural processes and human activities: A model from case study in Tainan, Taiwan. ***Landscape and Urban Planning***, 174, 24-32.

CDNews (ROC) (2016). ***Cross-Strait Cooperative Legal Assistance Agreement is going to fail after 520.*** Published on 10/3/2016. Available at: http://www.official.com.tw/discussTopic.asp?cat=official&id=102824. (accessed 12 Jan , 2018).

CommonWealth Magazine (ROC) (2014). China sold Taiwan with sand they illegally mined in Kinmen. ***CommonWealth Magazine***, 551. Available at:http://www.cw.com.tw/. (accessed 31 Dec, 2018).

Coast Guard Administration (ROC) (2018).***Coast Guard annual statistical report***. Available at: http://www.cga.gov.tw/GipOpen/wSite/ct?xItem=84702&ctNode=7792&mp=9997. (accessed 31 Jan , 2019).

Fujian Provincial People's Government (PROC) (2006). ***Grading management regulations for sand mining in Fujian's rivers***. Available at: http://www.fujian.gov.cn/inc/doc.htm?docid=73213. Reported on July 2, 2006. (accessed 31 Dec, 2018).

Hsu, C. H. (2016). ***A study on the law enforcement ability in the sea area between Kinmen and Xiamen-The case of mainland Chinese vessels carrying illegal sand mining beyond boundary limits***.Institute of Marine affairs, National Quemoy University, Taiwan, Republic of China.

Huang, M. D. (2013). Drifting trash and sand mining is a nightmare for Kinmen-Xiamen environment. ***World Sea Transportation***, 35. Available at: http://www.lofter.com/postentry?from=search&permalink=1cc81401_42cf858. (accessed 30 September , 2018).

Jackson , G. B. (1980). Methods for integrative reviews.***Review of Educational Research***, 50 (3), 438-460.

Lin, Q.Y. (2008). ***A case study of bottom topography variation under wave current interaction in the vicinity of Kinmen.***Unpublished master dissertation, Institute of Physical Oceanography, National Sun Yat-Sen University, Taiwan, Republic of China.

Lin, C. C. (2012). Influence and response of coastal changes in Taiwan's coastlines.***Landscape News***, 34, 1-4.

Lin, C. C. (2014). Possible links of climate change to the coastal hazard in Taiwan.***Landscape News***, 39, 5-8.

Liu, T. S., & Chang, K. M. (2015).***China sand pump dredgers crossed boundary to illegally mine sea sand in Kinmen sea area for a long time to sabotage local ecology, influence channel safety, and the land loss by coastline recession***. Done by Taiwan Control Yuan, Investigation Case No.: 104Nei-Diao0025. Reviewed on: June 4, 2015. Available at:
http://www.cy.gov.tw/sp.asp?xdurl=./CyBsBox/CyBsR1.asp&ctNode=910(accessed 15 August, 2018).

Kao, R. H., Hsu, C. H., Kao, J. C., & Yang, F. C. (2017).A study on the influence of the marine environmental deterioration and maritime safety from carrying illegal sand mining in the sea area between Kinmen and Xiamen-The case of mainland China boats.***Transportation Planning Journal***, 46 (1), 51-84.

Kinmen Daily News (ROC) (2014). Drifting trash and sand mining is a nightmare for Kinmen-Xiamen environment. Available at: http://www.kinmen.gov.tw/Layout/main_ch/ News-
NewsContent.aspx?NewsID=135251&frame=&DepartmentID=13&LanguageType=1.(accessed 31 Dec, 2018).

Kinmen Daily News (ROC) (2014). Let's protect the beautiful coastline for Kinmen. Reported on July 22, 2014.Available at: http://www.nsysu.edu.tw/m/404-1000-101791.php. (accessed 21 October, 2018).

Kinmen National Park (ROC) (2016). Kinmen island's geological terrain-hydrology. Updated on June 7, 2010. Available at:
http://www.kmnp.gov.tw/ct/index.php?option=com_content&view=article&id=690:2010-06-07-03-49-34&catid=93:
2010-06-07-03-45-39&Itemid=273. (accessed 15 August, 2018).

Kudalc, M. D.(2010). Impact of port development on the coastline and the need for protection.
Indian Journal of Geo-Marine Sciences, 39 (4), 597-604.

Shenzhen Container Trailer Association (PROC) (2007). Sand mining in Fujian's Minjiang has threatened the railroad foundation safety. Available at:
http://www.cy.gov.tw/sp.asp?xdurl=./CyBsBox/CyBsR1.asp&ctNode=910. Reported on
July 7, 2007.(accessed 28 September, 2019).

Taiwan Landforms Laboratory (2013).Impacts and Challenges of Climate Changes to Taiwan Coastlines.Landscape News, 36, 8-13.

United Daily News (ROC) (2016). Kinmen has been sabotaged, so did Xiamen. Reported on
May 3, 2007.
Available at: https://video.udn.com/news/483137 (accessed 17 October, 2019).

Xiamen Maritime Safety Administration (PROC) (2016). **Construction Diagram of Xiamen**
Maritime Bureau strikes inland vessels in transporting sea sand. Available at:
http://www.xmmsa.gov.cn/hshyw/484592.htm. (accessed 31 Dec, 2019).

ZhongZ. F., &Huang, Y. J. (2012).Research on Illegal activity Patterns by Mainland Chinese
Boats in the Maritime Space of Kinmen. The 19th Water Police Academic Seminar, Taoyuan: National Central Police University, Taiwan, Republic of China.

Yao, C. T. (2012). **Study of fine and punishment for China's vessels enter Taiwan's**
restriction and limit areas without permission. The 19th Water Police Academic Seminar, Taoyuan: National Central Police University, Taiwan, Republic of China.

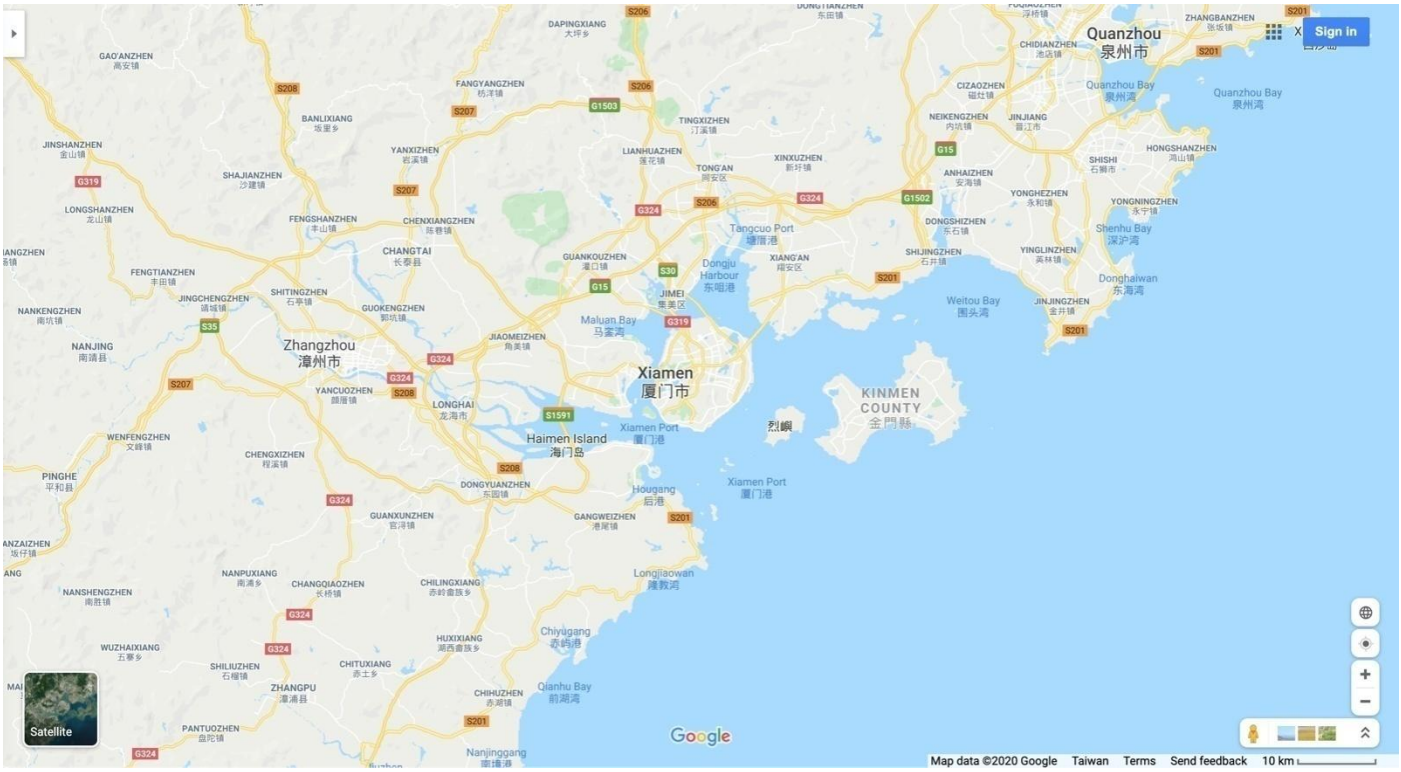

Figure 1. Kinmen and Xiamen map(Google map)

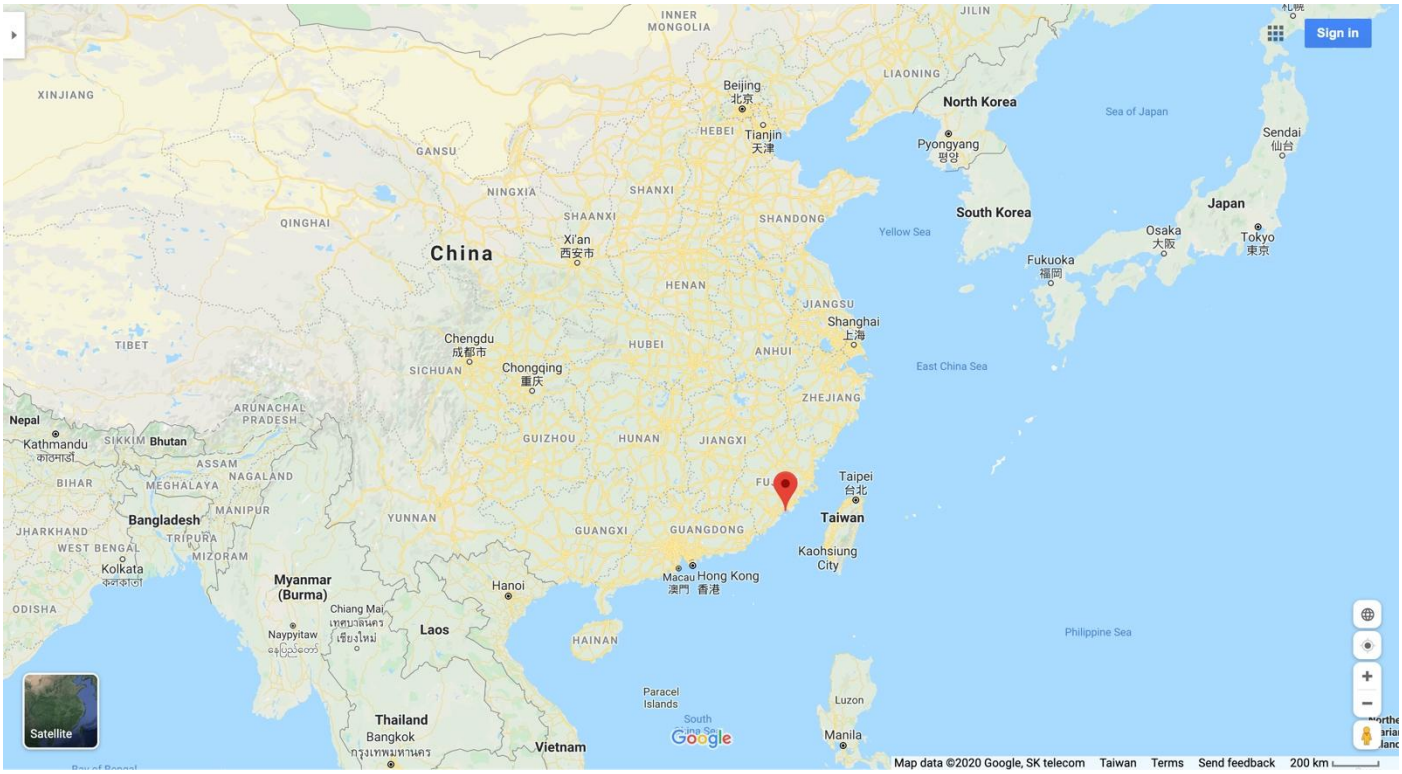

Figure 2. Location of Kinmen (Google map)

Figure 3. Photo of a Coastal Military fortress showing eroded foundation. (Kao et al, 2017)

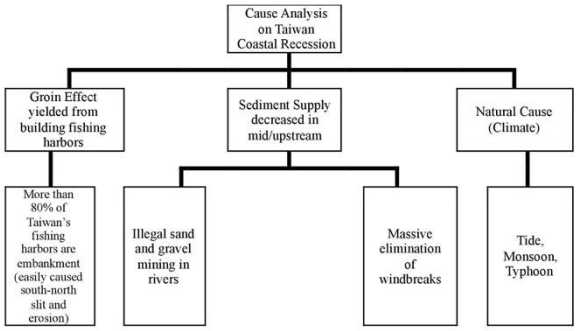

Figure 4. Taiwan Coast Recession Organized Diagram. (Chang,2014)

Figure 5.Groin Effect Diagram (Chang,2014)

Figure 6.Fortress Collapsed due to Recessed Coastline. (Kao et al, 2017)

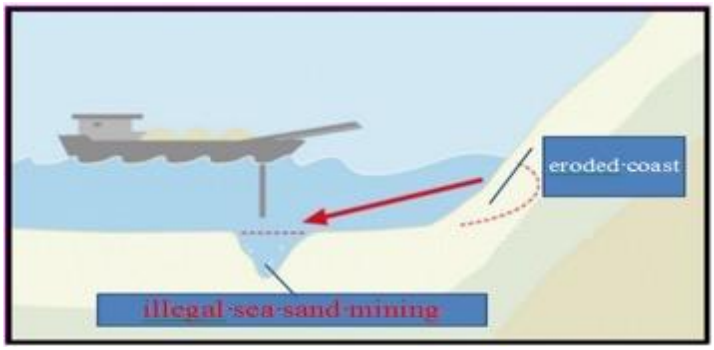

Figure 7. Diagram showing the relationship between Illegal Sea Sand Mining and Eroded Coast (Hsu, C. H, 2016)

Figure 8. Foundation of Coast Fortress Has Been Washed Away (Hsu, C. H, 2016)

Figure 9. The Bottom of Bollard for Navy Landing Boat's Supply Operation is exposed and Street Lamp Pole is collapsed (Hsu, C. H. ,2016)

Figure 10. Oyster sticks are buried more than50 cm (Kinmen National Park, ROC, Taiwan, 2010)

Figure 11. Oyster sticks are buried more than 50 cm (Kinmen National Park, ROC, Taiwan, 2010)

Figure 12. Photo of China Putian's sand pump dredger, JianLong No.569, stranded in Guningtou-NorthShan sea area (Kao et al., 2017)

Table 1. Performance chart of cross boundary illegal sand mining in Kinmen sea area for China's vessels captured by CGA 2005 ~ 2018.

Year	Number of Cases (Sand Pump Dredger)	Amount of illegal mining sand and gravel (cubic meters)	Kinmen County Government & Judicial Organs Amount of Fines (NTD 10K)
2005	1	0	100
2006	0	0	0
2007	9	3,350	700
2008	7	650	600
2009	6	1,250	600
2010	5	1,770	530
2011	5	873	983
2012	7	2,010	1,940
2013	4	1,400	1,475
2014	1	400	390
2015	3	1,560	0
2016	3	1,000	1,190
2017	2	812	600
2018	2	1,300	2,500
Sum	54	16,375	11,808

Data Source: Coast Guard Administration, ROC, Taiwan (2019)