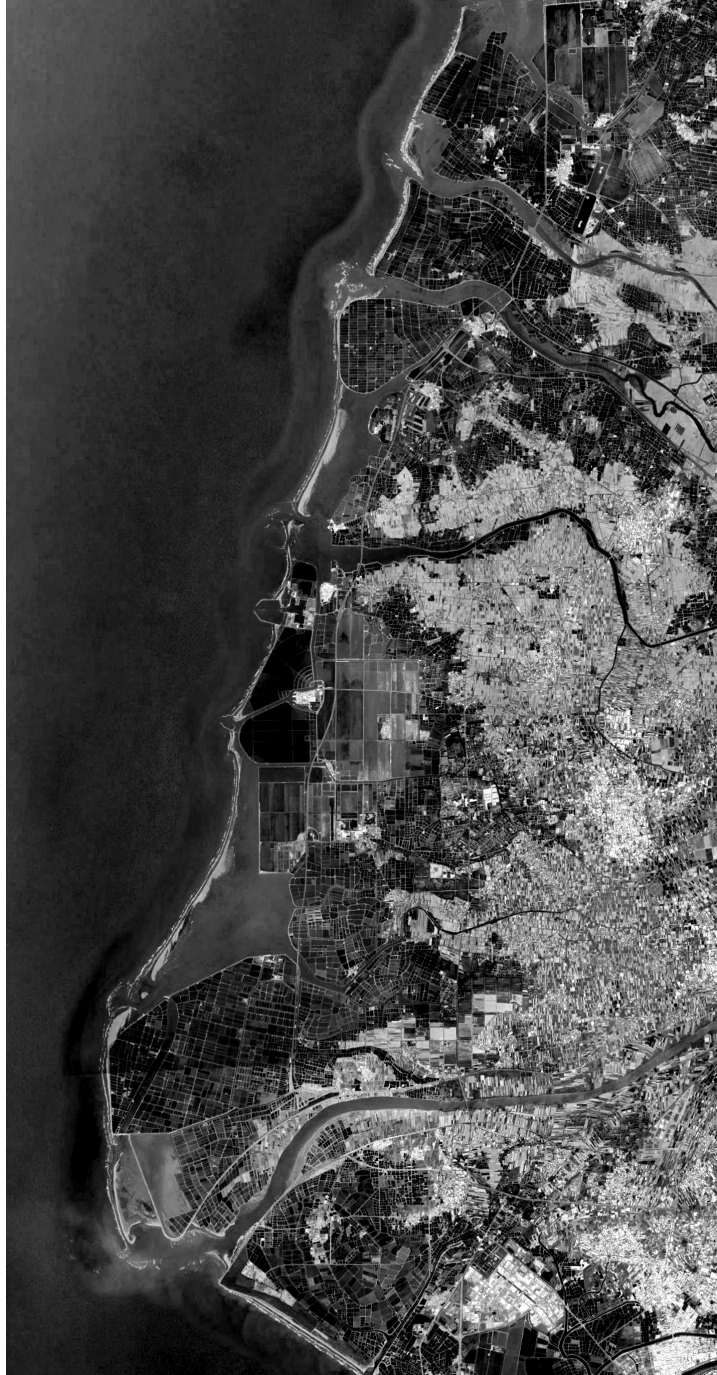


2020 NCKU / ArcDR³

Architecture and Urban Design for Disaster Risk Reduction and Resilience

Beimen	Environment
Jiangjun	Production
Qigu	Living



NCKU

Department of Architecture
National Cheng Kung University

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Studio Brief

Being explored by limited NCKU scholars, planners, and agencies, Tainan Beimen region urgently needs critical investigations in resilient approaches. The resilience for the area strongly depends on the holistic approaches on the nature, ecological habitat, community living fragments, productive landscape and water bodies, which are multi-scalar and interdependent. Such integration calls for use of latest techniques and knowledge of biological and natural systems with help from other NCKU research teams. Besides, it also requires more sensitive and bottom-up approaches feasible for the local communities.

Three(3) areas with different focuses are selected for broader exploration and discussion. Design project should identify the issues and provide design strategies in broader region, and propose the proper site(s) for interventions with multi-scalar design and programs mitigating the challenges from the climate change. The studio encourages foresighted integrated solutions of urban and architectural design keeping in mind that the area is a demonstration site for interventions in other parts of the region, as well as, promotes innovation in building technologies to insure a community's resiliency particularly prior to climate disaster events. The speculative proposal should engage with urban and architectural design, technology, and policies that connect the physical and the social aspects of a community to promote its resiliency.

In collaboration with ArcDR³ Initiative (Architecture and Urban Design for Disaster Risk Reduction and Resilience), the studio adopts the ArcDR³ Initiative Grand Syllabus, and will be informed by the Sendai Framework to demonstrate visionary design possibilities.

The following aspects to be considered:

- Regional and local challenges
- Resilient interdependent systems (environment, production, living...)
- Communal/ cultural/ religious/ industrial linkages
- Participatory and social engagement
- Urban and architecture typologies and prototypes
- Multi-scalar approaches
- Adaptation and Mitigation strategies
- Replicable and Scalable Solutions



BEIMEN
北門

BEIMEN

Beimen is located in the northwest coastal area of Tainan City, between River Bazhang and River Jiangjun. It is fringed by Chiayi City to the north and bounded to the south by Jiangjun District. This area is formed by the shallow sedimentation during the late Pleistocene so that Beimen was also called Nan-Khun-sin (Khun-sin means offshore bar) in the past. The terrain belongs to the Jia-nan coastal uplift plain. Different scales of sea transgression and regression have formed the lagoons, sandbanks, swamps and rivers on the landscape.

Since the coastline receded to the west about 3,000 years ago, the larger inland seas (lagoons), such as the Pongkang, Wan Kang, Dao-feng, Taijiang and Jockan, have gradually formed from Yunlin to Kaohsiung.

In response to geographical conditions, the early industrial development was mainly based on salt industry and fishery. During the Japanese colonial period, Beimen became the most important village in the coastal area of Tainan due to the convenience of the harbour and the large-scale development of the salt industry. At the end of the Japanese-ruled period, due to the siltation of the port and the gradual decline of the salt industry, agriculture and aquaculture took place. In the later stage, under the government and the plan of the Yunjia Southwest Coast National Scenic Area, the traditional buildings, natural landscapes and traditional industries of Beimen will be re-packaged to promote sightseeing and brings opportunities for development in Beimen.

Tourists can experience heaping and harvesting salt on the salt field, feeling the refreshing coolness of the hundred-year-old salt field through the soles of their feet. Additionally, the “sending off the sun,” the event that famous all over Taiwan, is held here at the end of every year. On the surface of the lagoons, the view of oyster farmers passing on small boats under the setting sun is commonly sighted. When the tide is out, the lagoon full of oysters creates a unique industrial landscape of Beimen.

ENVIRONMENT

Soil Salinization

It is a phenomenon that often occurs in agricultural and animal husbandry areas such as deserts and coastal areas with poor irrigation. When the evaporation is greater than the amount of rainfall and groundwater infiltration, the alkaline groundwater and salt in the soil would be led to the ground by evaporation (Capillary).

Due to its inland location, high temperature, low rainfall and sea water intrusion, the land of Beimen district has been heavily salted, which has greatly restricted the development of agricultural industry here.

Sand Bank

The coast of the Jianshui river to the Jiangjun fishing port in Tainan City is mostly surrounded by the tidal land and salt fields, where there is a geographically special landscape. In the early part of this section, there were coastal disasters in the early days. However, after many years of construction of seawalls and the protection of the dolosse, coupled with the protection of the sandbanks and the protection of windbreak forests, there have been no serious disaster in the coastal area in the past few years. In recent years, including the windbreak forest beach outside the Beimen tidal land and the coastline outside the lagoons, has retreated gradually.

Because of the different hydrological patterns and the development of the construction, the Beimen sand bank has added a third breach in the original two breaches. In 2012, the Talim Typhoon caused flooding in the community. Therefore, the government implemented the sand-fixing method. However, it led the lagoon that had at least double breaches leave only one breach. The drainage in the lagoon is not an easy task. Due to the remarkable results of the sand-fixing project, the sand continues to accumulate in the northern end of the lagoon. Without the break, the sand cannot be brought to the south, causing the lagoon area to become shallower and shallower. The water body is not only shallow but also susceptible to temperature increase. The Area and volume of water are reduced, and these problems have more complicated factors, such as the lack of drainage facilities, the water impervious area is too large, the low terrain, the ground subsidence, etc.

The Beimen tidal land has faced the problem of erosion from 1961 to 2010. The erosion in the northern part was the most obvious. It had reached 374m in 49 years. The Wangye Port and the sand bank showed a full retreat, With the middle section being the most significant and which has retreated about 468m in 49 years. Most of the sand was carried from north to south by the wind and then drifts into the lagoon. The height of the sandbar is slightly reduced and there is a tendency to move towards the inner and south sides of the lagoon. The lagoon continues to stay siltation (fig. 2-3), which is presumably due to the short supply of sand from the river. The reduction in quantity is caused by the structure that was vertically inserted into the coastline, which destroys the balance of sand transport. So that under the long-term effect of the marine camp, some coastal sections and the sandbanks are obviously invaded.

From 2013 to 2015, Wangye Port and sand banks gradually retreated eastward, and the Beimen tidal land was reduced, and the area of the Beimen lagoon was also reduced. The siltation in the lagoon became shallow. Not only because tides bring sand into the lagoon, also the northeast monsoon (fig. 4-5).



Fig.1 Aerial view of Beimen port and tourist spots

- **Sand-fixing Methods**

In the past, the Tainan County Government has targeted the protection of sandbanks and lagoons on the Beimen coast. It has adopted soft methods for protection, like sand-fixing sand, bamboo-fixing sand, bamboo fence and wind-proof fence, flexible sand-shelter protection, permeable pile-drilling dyke, coastal rushing piles and maritime solid-bag... and so on. From 2006 to 2008, it was tried to match the sand-fixing sand, maritime solid bag filling, bamboo branch sanding work (two rows along the coast) and the permeable bamboo pile jetty.

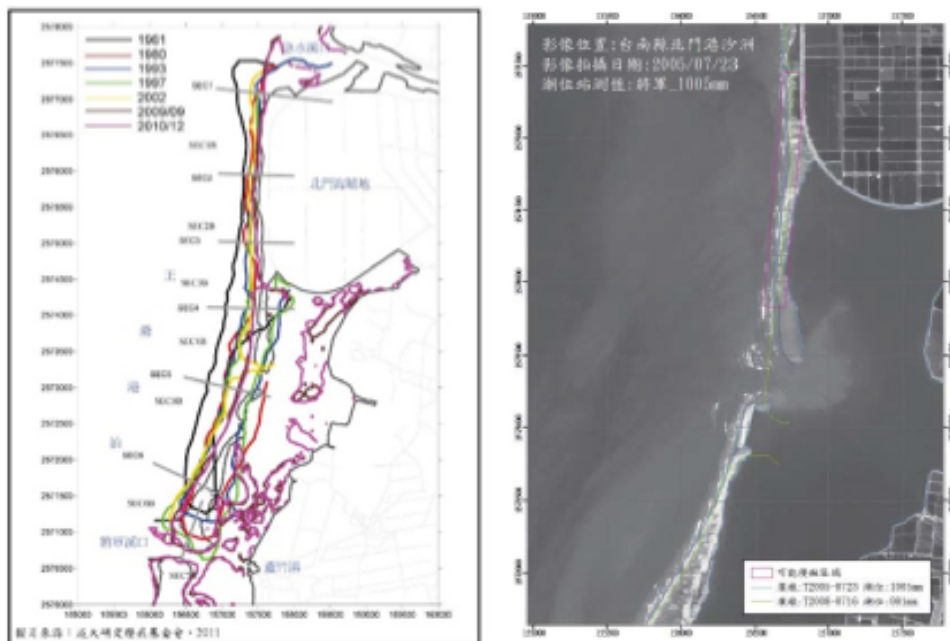


Fig.2 The transformation of Beimen sandbank

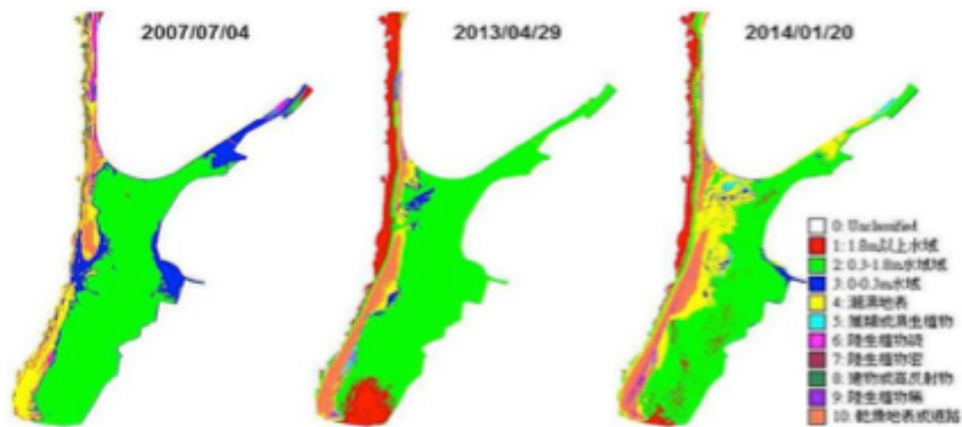


Fig.3 The Landscape change from 2007 to 2014

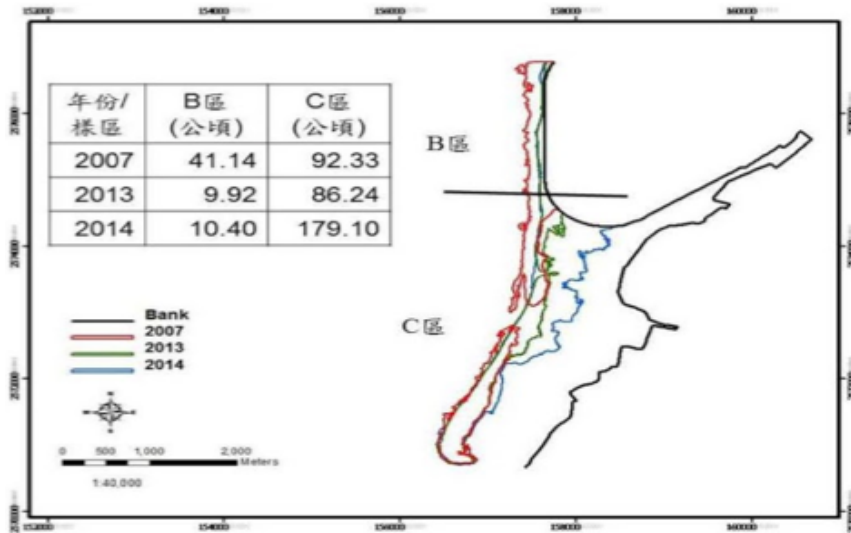


Fig.4 The area (ha) change of the sandbank from 2007 to 2014

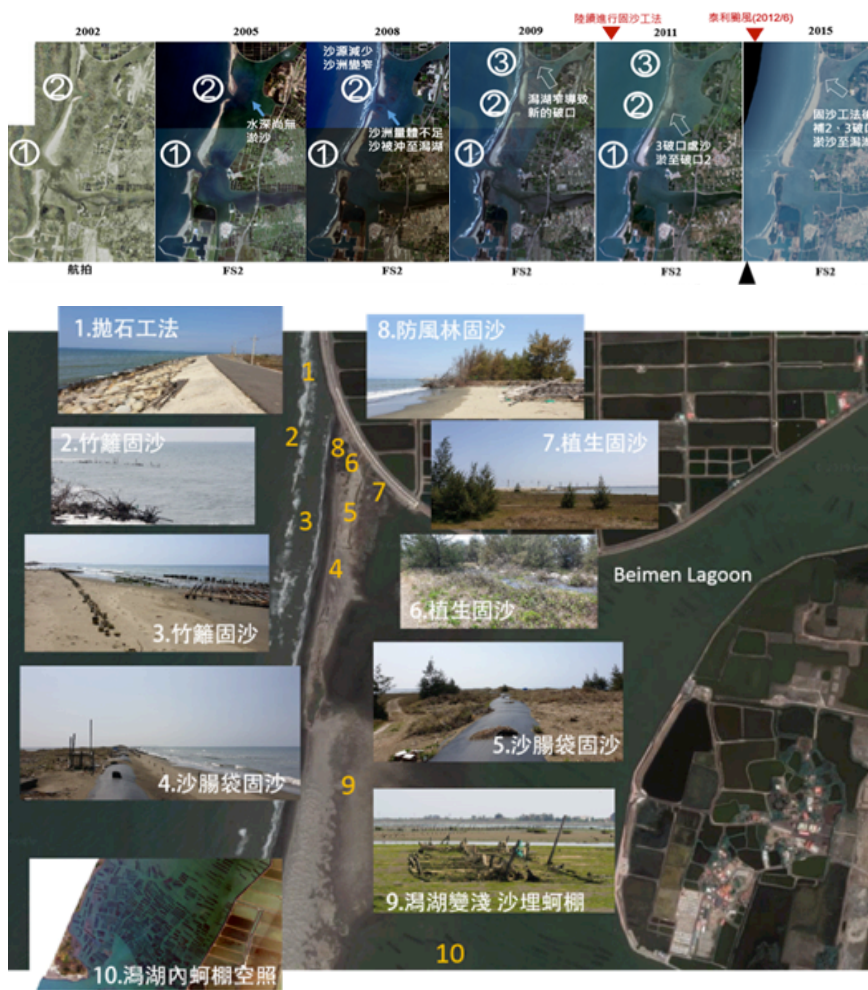


Fig.5 Types of sand-fixed method that have already be set on site

PRODUCTION

During the Japanese-occupied period, Beimen was booming due to the development of salt industry and fishery, attracting immigrants from other regions. The benefits of rich salt and port transportation in coastal areas made people gather together and form the villages in the coastal areas. Administrative construction, such as the Salt Industry Welfare Society (Qian Lai Ye), schools, temples, etc., was established due to the development of settlements. After the end of the Japanese occupation, due to the lack of expenditure for the salt workers and the government paid more attention to agriculture at the same time, the salt industry gradually declined. The development of agriculture is mainly suitable for local salt-tolerant crops such as onion and garlic. The original fishery has been transformed into aquaculture due to the change of environment and the problem of agricultural water source. It mainly cultures milkfish, prawn and oyster.

Recently, the spread of local characteristics become difficult because of the lack of promotion of industries. Adding the looseness of industry structure and the lack of mature skill training, people put emphasis on tourism industry.

Salt farm, fishery and other industries are the main characteristics, and people even created new tourism spots like the Beimen Crystal church. However, things didn't go well. Plug-in elements such as graffiti painting, mascots, etc. have weak connection with local residents. In addition, the outward migration, population aging and other problems has become more and more serious. All are urgent problems for the future of Beimen.

Salt Industry

Beimen Salt Field is one of the six salt fields set up by Taiwan Salt Factory after the Second World War. It is located in the south of Jiu Shui Xikou in the Beimen District of Tainan City, north of Sanliao bay River, Budai Town and Yizhu Township. There are two offices in Chaubei and Kaliao.

In the Beimen area, there were two salt fields in the eastern part of the Qing Dynasty, Chaubei and Laidung. They have been producing salt in the middle of the Qing Dynasty (Jiaqing and Daoguang years) to the Republic of China in 2000, so the local salt workers have rich bay-salting technology. Therefore, it is often hired by other newly established salt fields to work and become the "hometown" of many salt village residents.

After entering the Japanese ruled period, the three salt fields of "Zhongzhou", "Kaliao" and "Wangye Port" were built here. They were all tile-paved salt field and which were more than 300 Kah (1 Kah=0.9699 ha). The five salt fields were eventually forced to be acquired by Taiwan Salt Company. Only some land holders in Zhongzhou refused to sign the land and fled to protect their ancestral products. After the war, with the help of clan, they became the minority salt farmers who took back the land.

After the war, salt fields were arranged together as the Beimen Salt Field and was managed by the Chaubei Field Office and the Kaliao Office. In the 1950s, the Jing-Zai-Jiao slat fields, which belongs to the sub-type, began to be rebuilt to increase production. In 1969, the Jing-Zai-Jiao salt fields had been converted into a centralized tile. Later, due to the gradual loss of competitiveness of Taiwanese salt, the Beimen Salt Field was reduced to the "Qigu Salt Fields Beimen Branch" in 2000. A year later, the artificial bay-salt process of Beimen was ended. However, in recent years, in order to develop tourism, the Tainan City Government has hired workers in the multi-employment scheme to re-expand the Jing-Zai-Jiao slat industry.



Fig.6 Distribution area of salt field in Beimen

Tile-paved Salt Field

The crystallization pond of tile-paved salt field is made up of 6 cm thick broken tiles, which are laid on the salt field. It is the prototype of the ancient salt field. Almost all the salt fields built before the 9th year of the Taisho period (1920) belong to this type. Because the brine is not easy to leak, the salt field yield highly. It takes only about ten days from the introduction of seawater to the crystallization of salt because of that the radiant heat of the tile can absorb is more than that of the soil, and the brine can absorb a great amount of heat.

The crystallization process is fast, the yield per unit area is large. The white salt plasmid with high purity, good color, usually used for pickled food. However, because the crystallization is too fast for the impurities to release, the quality is not always the best. The salt particles are not solid enough because the area of this type of salt field is small, it is only about 1 to 2 Kah and the cost is relatively high.

The process of Tile-paved salt field:

1 Water inlet in the north side

Located near the sea, the seawater of about 3 baume degree is introduced from the water gate in conjunction with the tide time.

2 Large evaporation pond

When designing salt fields, people use the terrain to let the seawater flow naturally by gravity. The large evaporation pond is divided into 4 hills, which lowered by 4 cm to 6 cm hill by hill from the first one to the last. Exposure from the first hill, followed by evaporation of water and precipitation of impurities in each hill, precipitation of iron oxide for about 12 baume degree to the last hill (need about 6 days in the peak season, about 8 days in the off-season). Then introduce the brine into small evaporation pond with motor.

3 Small evaporation pond

The small evaporation pool is divided into 3 sections, with the gap of 4 cm between each section. The seawater continues to be exposed in the small evaporation pond in the first stage, and the calcium sulfate is gradually precipitated. By the third stage, the concentration reaches 25 baume degree (about 5 days in the peak season and about 7 days in the off-season period), and then introduced into the crystallization pond.

4 High and low brine pond

use high and low terrain and dark ditch to discharge high concentration seawater from small evaporation pond into low brine pool, then use motor to pump from low to high brine pool, then divert it to crystallization tank, or use brine truck to directly introduce brine into water ditch, split into the crystallization pond.

5 Crystallization pond

After exposure to a large evaporation pond and a small evaporation pond, the seawater near the saturated concentration is introduced into the crystallization pond to a concentration of 26.5 baume degree, and the seawater begins to crystallize into salt. When the seawater is exposed to the crystallization pond for about 3 to 5 days to 28 baume degree, the workers begin to collect the salt, and the remaining bitter brine is discharged from the drainage channel beside the crystallization pond.



Fig.7 The process of Tile-paved salt field

LIVING

The Beimen settlement is made up of three sub-districts, Beimen, Gangbei and Chiucheng. "Yonglong Palace" is a local temple of Beimen area. In the administrative area, the front of the temple is Beimen, and the back of the temple and the west side are Yonglong. The name of the place comes from the name of the temple. Chiucheng is the earliest place formed a village, and the salt field is here.

In terms of industry, only a few scattered factories still serve. The traditional salt industry is being eliminated, and the salt fields are deserted. When it comes to social, the settlements are also facing the situation of youth population outflow, aging, and the disappearance of the local features of the settlement.

With the decline and transformation of traditional industries, the industrial development of the Beimen area is dominated by agriculture and aquaculture. Until the establishment of the Yunjia Southwest Coast National Scenic Area in the Beimen, the saltery culture and salterns were preserved, visitors' center was built, and traditional religious activities were reproduced to promote local tourism, attracting tourists to the Beimen through events and new facilities, and bringing new industrial development to Beimen county.

RESILIENT ISSUES

High Temperature

Beimen is located in the subtropical climate south of the Tropic of Cancer. It has high temperature and high humidity. In recent years, due to the impact of climate change, the temperature is getting higher and higher, which decreases the will of foreign tourists to visit. The willingness to stay and revisit the Beimen area directly affect the development of the local tourism industry as well.

Coastal Erosion

The Beimen Coast is divided into the Beimen reclaimed land coast on the north side and both the northern and southern sections of sandbank in Wangye Port. The northern section of the Beimen reclaimed land is located on the south bank of the estuary of the Jishui River. The coastal area is stably distributed following the windbreaks. The coastal erosion in the middle section of the area is serious, and the windbreak has gradually disappeared. The southern section is the separation of the Beimen tidal land and the north section of the sandbank of Wangye Port. The seawall outside the reclaimed land is stable, and there are local sand fences built on the sandbank. At the southern end of the Wangye Port, there is a north diversion dyke at the exit of the Jiangjun River.

Sedimentation of Lagoon

The Beimen Lagoon is located on the south side of the tidal land, north of the gate. It is between Wangye Port, Qingshan Port and the inner land. It is about 6 kilometers long and 2 kilometers wide. It is the only remaining remnant of the inverted wind in the sea. Due to the accumulation of wetlands, there are abundant ecological and aquatic resources like wild crickets, red-billed larvae, shrimps, crabs and clams. Those facts make this intertidal zone the best natural fishing ground for residents to do fishery in the Beimen area. The lagoon water body is mainly affected by factors such as tides, torrents, drainage roads and rainfall. The Beimen lagoon is located at the tidal inlet of the Jiangjun River estuary, and the north side of the shoal has another tidal estuary, the north inlet moved north-south, and has gradually closed in recent years. The north side of the lagoon is mainly affected by the Jiangjun River through the Qijiang River; the south side of the lagoon is mainly affected by the sea area. During the rainy season, if the runoff of the Jiangjun River exceeds 200 cms,

the water level of the lagoon will rise, and the water flow of the Jiangjun River will be affected. The range will move north to the vicinity of Yonghong Bridge. The coast changes, Wangye Port and Shazhou are gradually approaching the inner shovel, which may cause the lagoon to be shallow.

Seawall subsidence

The Beimen tidal land seawall, the Jiangjun salt field seawall located by seaside, the Beimen Salt field dyke, the Qizhugou dyke, and the Sanguang dyke are inland sea dykes. Due to the subsidence of the strata, the seawall subsidence, including the Jiangjun salt field dike and the Luzhugou seawall dropped by an average of 3 to 5 centimeters, the Sanguang seawall fell by 9 centimeters, and the Haikou seawall of the Beimen fell by more than 6 centimeters. The descending trend near the Jishui River was relatively high, reaching a maximum of 17.9 centimeters. It is suggested that the elevation of the seaside dyke should be increased by 5 m, and the inner tidal levee is still within the safe range.

Due to the relatively low terrain in the coastal areas of Beimen, it has been reported to be affected by floods and accumulations. Under the threat of climate change, there are two main impact factors for coastal protection in this area: one is the extreme value of the sea during typhoon, and the other is the impact of rising sea level. The former is a short-term impact, while the latter as a long-term impact.

Flood

The terrain along the coast of Beimen is formed by siltation of alluvial plains and rivers. The soil is loose and has strong penetration. Due to the development of local industries, subsidence happens as the result of the groundwater overdraft, often after heavy rain or typhoon, which often causes serious flooding.

In recent years, due to the impact of climate change, rainfall time distribution and rainfall are in an extreme trend. The main disasters include storms, floods, slope slides, coastal disasters, etc., often happen multiply.

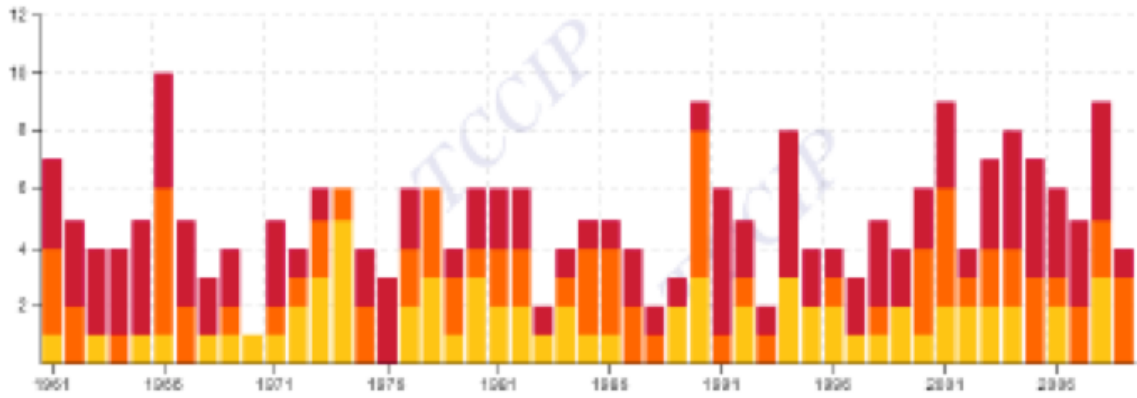


Fig.8 The amount of typhoon that hit Taiwan from 1961 to 2005



Fig.9 Typhoon Morakot - range of influence



Fig.10 Typhoon Morakot - disaster situations

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JIANGJUN
將軍

JIANGJUN

Jiangjun District is a coastal township at the west of Tainan City, and lies in the southwest region of the Jianan Plain. Neighboring districts include Syuejia and Jiali to the east and Qigu to the south. The Taiwan Straits and Penghu Islands lie off the west coast of Jiangjun. To the north is the Jiangjun River and Beimen District. Jiangjun District is rectangular in shape, and is about 8.7 km from east to west and 5.9 km from north to south, occupying a total area of 43 square kilometers.

The District has a total of 12 villages distributed according to the local environment. These villages are Changrong, Yushan, Guangshan, Changsha, Pingsha, Kunshen, Kunming, Sijia, Jhongjia, Lingzailiao, Siangpu, Jiangjun. Jiangjun District is part of Tainan's residential community and contains a number of agricultural and fishing communities.

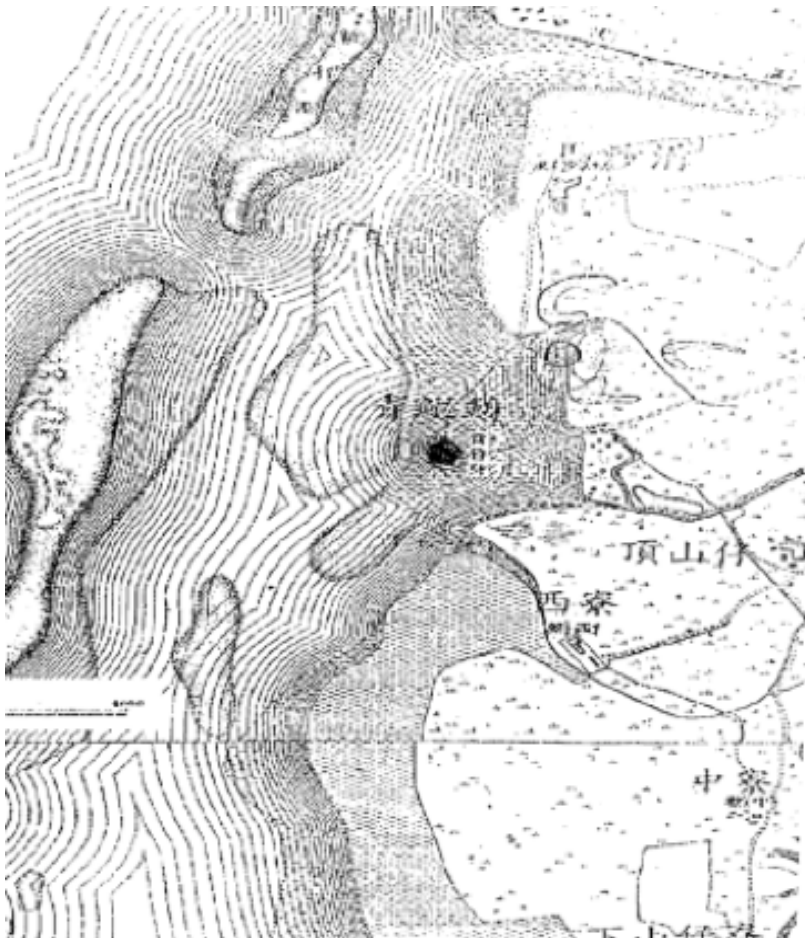


Fig.1 History Map of Chin-Khun-Sin

ENVIRONMENT

In addition to the offshore sandbanks in the early reaches of the Taijiang inner sea, there are many different types of sand Island in the vast waters. According to the records, during the Qing Emperor Yongzheng period (AD 1723~1735), Mashagou and Chin-Khun-Sin are not yet connected to the inner land. Because these sand islands are close to the open sea, they were military stations in the early days. When the inner sea of the Taijiang River began to accumulate and the coastline moved westward, residents began to open.

In the 31st year of Meiji of Japanese ruled period (AD 1898), there were more than 700 people on this island. Since it was surrounded by the sea, it was a small business port and fishing port. With the prosperity of fisheries and maritime trade, the villagers began to fill the sea with sand and shells. Created reclaimed land in both the north and south of the village. However, when encountered with typhoon and the northeast monsoon, the storms easily eroded the shore, so the village area did not expand much. At this time, the Chin-Khun-Sin is about 600 meters away from the coast. It can only rely on bamboo poles to go to the surrounding area, or through the water diversion channel when the sea water ebbs.

In the 11th year of the Showa era (1936), Chin-Khun-Sin finally had a road connecting the island and began to build dikes and roads. The tidal land was constructed to be fishing rods. In the 12th year of the Showa era (1937), Japan increased the demand for industrial salt due to war, and opened up the salt field with the undeveloped wetland shoal and the fish rafts of the inhabitants. The southeastern coastline was planned to be about 9 kilometers wide and wide in the Tainan coast. The 3km Yantian landscape, after the 60th year of the Republic of China (1971), expanded to the west a new salt flat, which has been surrounded by salt field since then.

The sand Island of the Taijiang inner sea has been accumulated for a long time and has gradually become a shoal. It has been slowly surrounded by villagers and became a fishing rod. The embankments separating the fishing rods linked together with irregular shape in the sand island and inland. The island landscape no longer exists.

In the end, these fishing rods were collected by the government and rebuilt a grid salt field. At the same time, the salt fields also restricted the expansion of the settlements. The range of these sand islands can still be seen from the large-scale aerial photographs today.



Fig.2 A view of Chin-Khun-Sin village

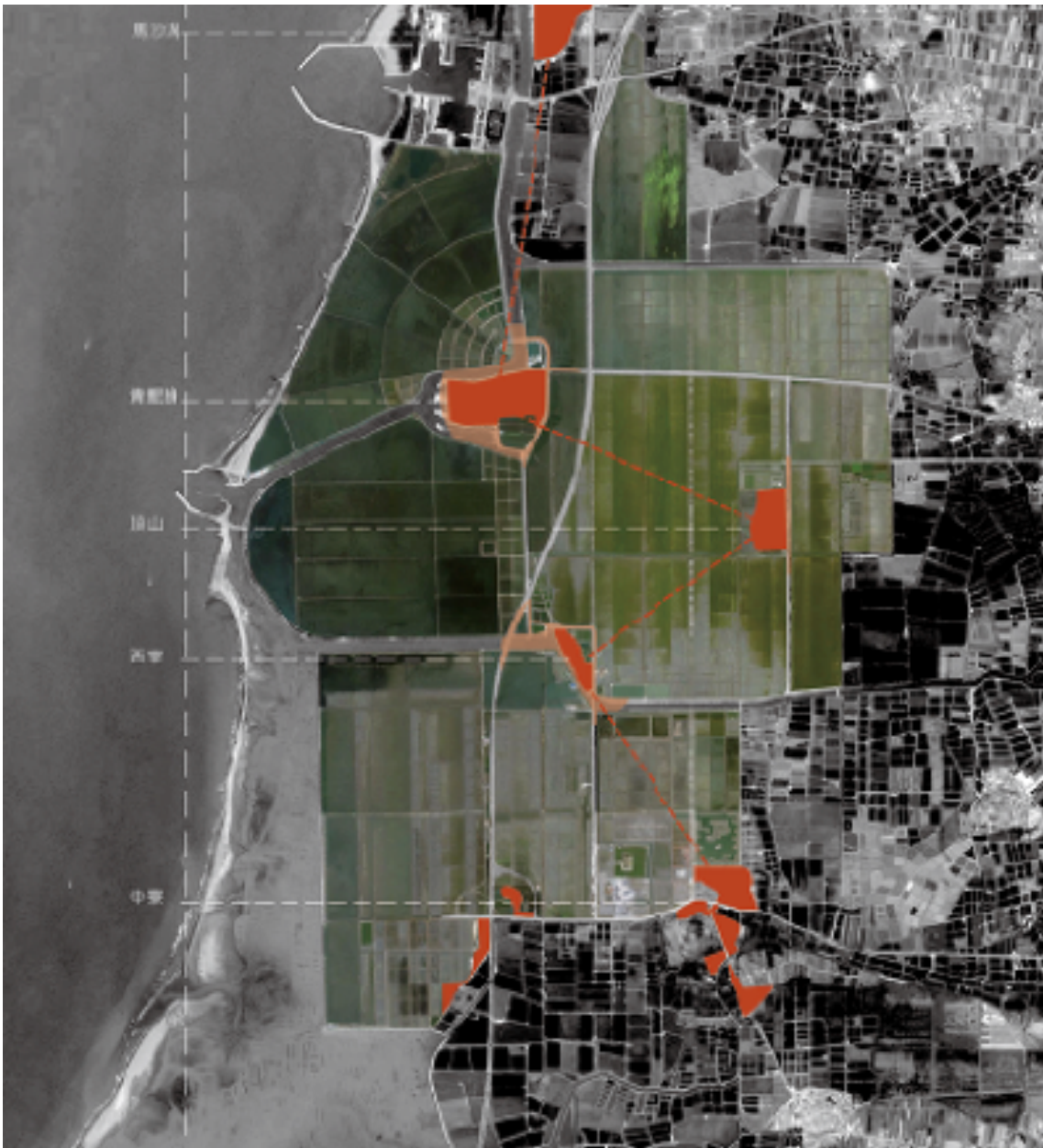


Fig.3 The distribution of settlements in the sand island in Beimen

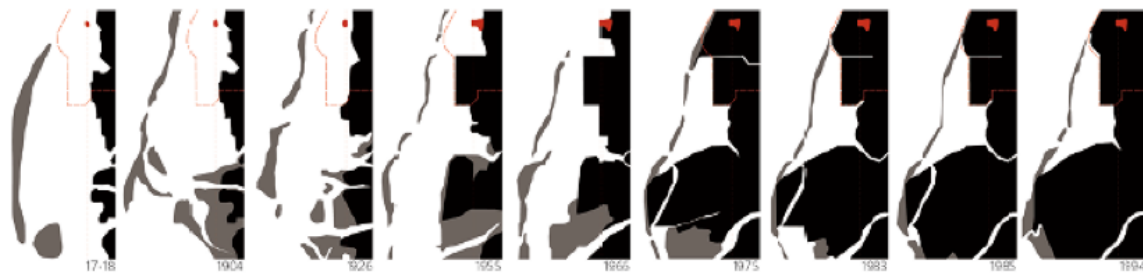


Fig.4 Changes of Sandbank and Land of Tainan coastal area

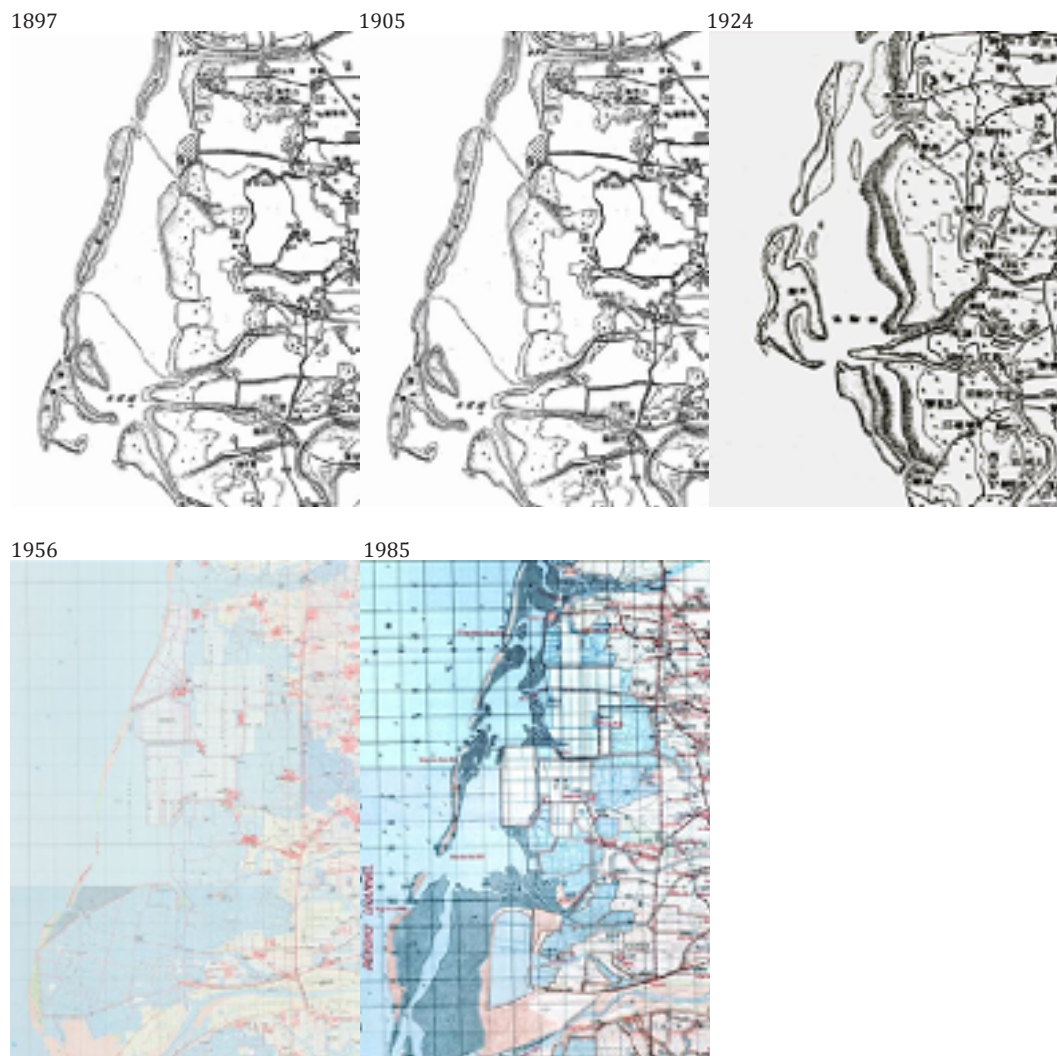


Fig.5 History Maps of Tainan coastal area

PRODUCTION

Fishery

The residents of the districts are mostly engaged in farming and fishing, but the recent fishing industry is sluggish. Leisure fisheries have gradually replaced the traditional fishing.

In addition to the aquaculture industry, people live in the surrounding settlements are also engaged in deep sea fishing.

There are five ports along the coast of Taijiang Area. The Mashagou Port and the Guosai Port are located far away from the sea and are gradually deposited. Jiangjun Port, Qingshan Port and Xiqiao Port are still in use. The rise and fall of fishing ports can also reflect the degree of sedimentation of the lagoon.



Fig.6 Dry shrimp and a view of the west part of Jiangjun port

Asparagus

The Jiangjun asparagus planting area is about 35 hectares. It is the largest asparagus producing area in Taiwan. There are two main planting types - Open-planted and Simple Greenhouses. The general growing season of asparagus is from March to June, but with the help of the net room cultivation, farmers can extend the season to deep winter.

The open-planted asparagus plants are relatively short, poor quality, and is susceptible to the weather. As long as the rain is too much, it will be rotten and cannot be harvested. In recent years, due to the investment in greenhouse cultivation, the farmers have made the harvest period longer, and has continued to expand the planting area and become the newly emerging asparagus producing area. Farmers planted about 15 hectares of asparagus in greenhouses with a production capacity of 450 metric tons. Asparagus 1 kg is about 200 NT, and the output value is 90 million NT.

Asparagus on markets are usually be cut to a certain length for better appearance, so that the lower part of the asparagus always be discarded as agricultural waste. The Youth Community Participation in Action 2.0 Changemaker plans to acquire the asparagus waste for recycling, which will be graded, washed and peeled by the elderly in Jiangjun area. Then return to the public restaurant of the community for packaging and marketing the "asparagus waste" will be transformed into new product. The value-added goods also give back the profits of the goods to the community, so that the elderly can have a work allowance and promote the community welfare system at the same time. Therefore, the product is named "silver asparagus".



Fig.7 Asparagus warm house and the proper temperature for growing

LIVING

Jiangjun, formerly known as the Chin-Khun-Sin, is the westernmost settlement in Taiwan. It was originally sand Island. Later, through the continentization effect, the surrounding waters gradually became land. Jiangjun area eventually surrounded by alt fields.

Jiangjun is consisted of two districts, Khun-Sin and Khun-Min. As of January 2016, the total number of households was about 1,191, with 1,627 males and 1,646 females, and a total population of 3,273. People here are basically elderly and children.

Lack of education construction, school-aged children often study elsewhere. In the presence, most of the fishery-related work in the village is carried on by the middle-aged and elderly people. Half of the young people will take over the processing of fisheries, and the other half will move outside the village.

Most of the buildings in the village are only 2 or 3 stories high. The tallest building is the Chao-Tien Temple.

The development of the settlement can be divided into two stages. The first stage is the completion of the outer embankment in the 11th year of the Showa era (1936). The fish rafts in the middle of the embankment began to be filled. In the south, the country was newly built, and the settlement slowly expanded eastward. The second stage was in the 65th year of the Republic of China (1976). The Chao-Tien Temple was built in the east. The temple was set up and the new residential complex began to be built. The planning of this area is square and the road is wider.

As for the small community on the northeast side, it is the "fifty households" built for the Qigu saltworks.

The Chao-Tien Temple in the Chin-Khun-Sin settlement originated during the Qing Jiaqing period. The local fishermen felt the blessing of Mazu (Taiwanese Sea Goddess), who was blessing them. So the temple was built with bamboo and thatch til the new temple was built in the 65th year of the Republic of China (1976). From the current settlement texture, it can be seen that there is a small open space around the site of the old temple, which should be the temple court in the past, and the new temple also affects the configuration of building in the east side.

Chin-Khun-Sin is surrounded by salt fields and fish rafts. The surrounding land looks vast, but the buildings are densely built, reflecting the historical background of the sand islands. In order to withstand the strong northerly winds in the early days, the buildings were built to be low and the houses were mostly oriented in the east-west direction to prevent the wind from the north. Only a few of them were facing north-south direction because of the geographical location, for example: the houses in front of the Chao-Tien Temple all face the square, because of that it is advantageous to operate the storefront. At the same time, the old community lanes on the east side of the settlement are narrow, so that it is not easy for the winds to directly pour in. The configuration of community buildings reflects the characteristics of the climate environment.

The Chao-Tien Temple is the main gathering space for the local residents. The school's performance activities, the residents' dance activities and the small night market in the past are all held here. However, due to the distance and no shelter, almost no one is here to play, even though the original fish raft on the east side of the garden has been transformed into a meadow and pond. The backyard becomes the only green belt and leisure space in the community.

The three main places of life in the settlement are located in the line of the community. From west to east, are the fish market of Qingshan Port, vegetable market and temples. The east-west lanes run through the entire settlement, and most of the stores are also close to this line. The sightseeing activities of Chin-Khun-Sin and the work activities that residents rely on for their livelihoods occur mostly on the shores of the settlements, while the daily functions of the locals are spread throughout the internal roads.

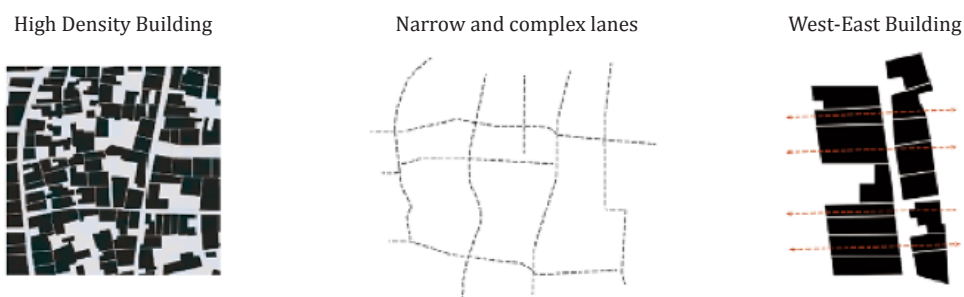


Fig.8 Features of settlements along the west coast of Taiwan



Fig.9 Diagram of Jiangjun village development



Fig.10 Area of activities of residents



Fig.11 Route of local religious events

Shelters

Residents of Jiangjun love to do things outside their homes. In order to adapt to the hot weather, various types of shelters have been developed. Some residents have built iron shelters in narrow lanes, or hanging canvas and black gauze on the walls of buildings to create a semi-outdoor space in front of the house for the neighbors to set up chairs and chat with each other, busy dealing with the fish that day, or even open a food stall. These intermittent shelters in the community define the residents in the lane - a gathering place.

Some activities, such as tidying up fishing gear, transporting catches and fishing, are due to geographical needs, close to river banks, salt flats, and often exposed to the blazing sun. In addition to the need for sheltered space, the residents of Jiangjun also need a hot climate to help them engage in activities such as drying fish or clothes.



Fig.12 DIY shelters and outdoor space

RESILIENT ISSUES

Because of the special climate, it is not easy for plant to grow. The community lacks green belts and leisure space. Residents build shelters for outdoor activities, but the space is limited, settlements are separated by a vast deserted salt fields. The extremely high temperature and humidity are very difficult for the development of tourism. The settlement faces the problem of the decline of the original industry. The wetland conservation method restricts the existing industries, and the new development is more severe in the future.

The main causes of flooding in this area are low-lying terrain, poor drainage system, seawater intrusion, and subsidence of the stratum. In order to avoid further serious disasters in the future, it is necessary to properly improve the treatment of regional drainage areas, subsidence areas and river turning areas.

1. Long-term pumping of groundwater has caused serious strata subsidence and seawater intrusion. Those problems result in the difficulty in removing internal water, and the outcome is not as good as which was expected.
2. The drainage system over towns often face the problems of rashly water input or serious siltation, which causes the water volume to decrease, so that the drainage overflows.
3. Places with poor drainage system of the towns are low-lying with heightened roads. Because of the accumulation of drainage channels, when the flood-cross section is reduced, it cannot be drained directly by gravity, thus blocking cause more serious flooding.

The main cause of flooding is the monsoon season from May to June each year and the southwesterly flow, tropical depression or heavy rain in July, August and September. The rainfall is excessively concentrated, and the drainage water capacity is insufficient. However, flooding happens.

According to statistics from 1897 to the 2011, a total of 395 typhoons hit Taiwan, with an average of 3.43 typhoons per year. Typhoons mainly invade Taiwan from July to September. Floods accompanying the typhoon are often caused by the upstream from mountain catchment that are discharged through the river. When the river cannot accommodate such a large amount of rain, the river overflows the embankment or revets or even breaks the bank. The disaster caused the rain to fall in the metropolitan area, and the drainage system could not store or exclude it in time to the river channel, causing floods.

REFERENCES

Vertical Monitor

The asparagus in the greenhouse can reach a height of 180 cm. In order to understand the temperature changes at different heights, the instrument is placed in a vertical manner from the soil to a height of 200 cm to monitor the air temperature, relative humidity of the air, soil temperature and solar radiation temperature. From the temperature analysis, higher air temperature was measured at 150 and 100 cm, with a high density of the asparagus leaves. Because poor ventilation causes the heat storage.

The strategy for local temperature reduction is to place the sprinkler system above the soil and use evapotranspiration to reduce the temperature. From the procurement of materials to the completion of the installation, the sprinkler irrigation system is affordable and easy to operate. It is hoped that many individual farmers can install and use them independently. The thermal imaging system is used to shoot the cooling effect of the sprinkler system, which shows a significant temperature drop. The soil temperature is reduced from 32 degrees to 29 degrees, which can reduce the temperature by 3 degrees.

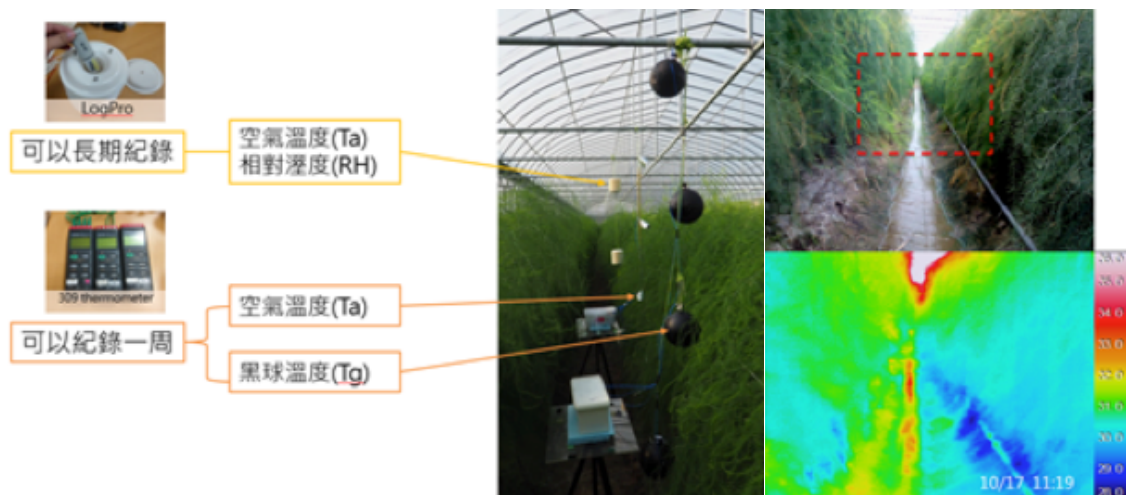


Fig.13 Green house vertical monitor

Flow Designer

The sprinkler irrigation system can be used with fans to drive the greenhouse ventilation, which is more efficient and can avoid pests and diseases that may be caused by high ambient humidity. The computational fluid dynamics (CFD) software "Flow Designer" simulates greenhouse ventilation through different amount, angular position and adjustment of the size of the air inlet, the software can simulate different situations to find the maximum ventilation efficiency to improve the environment in the greenhouse

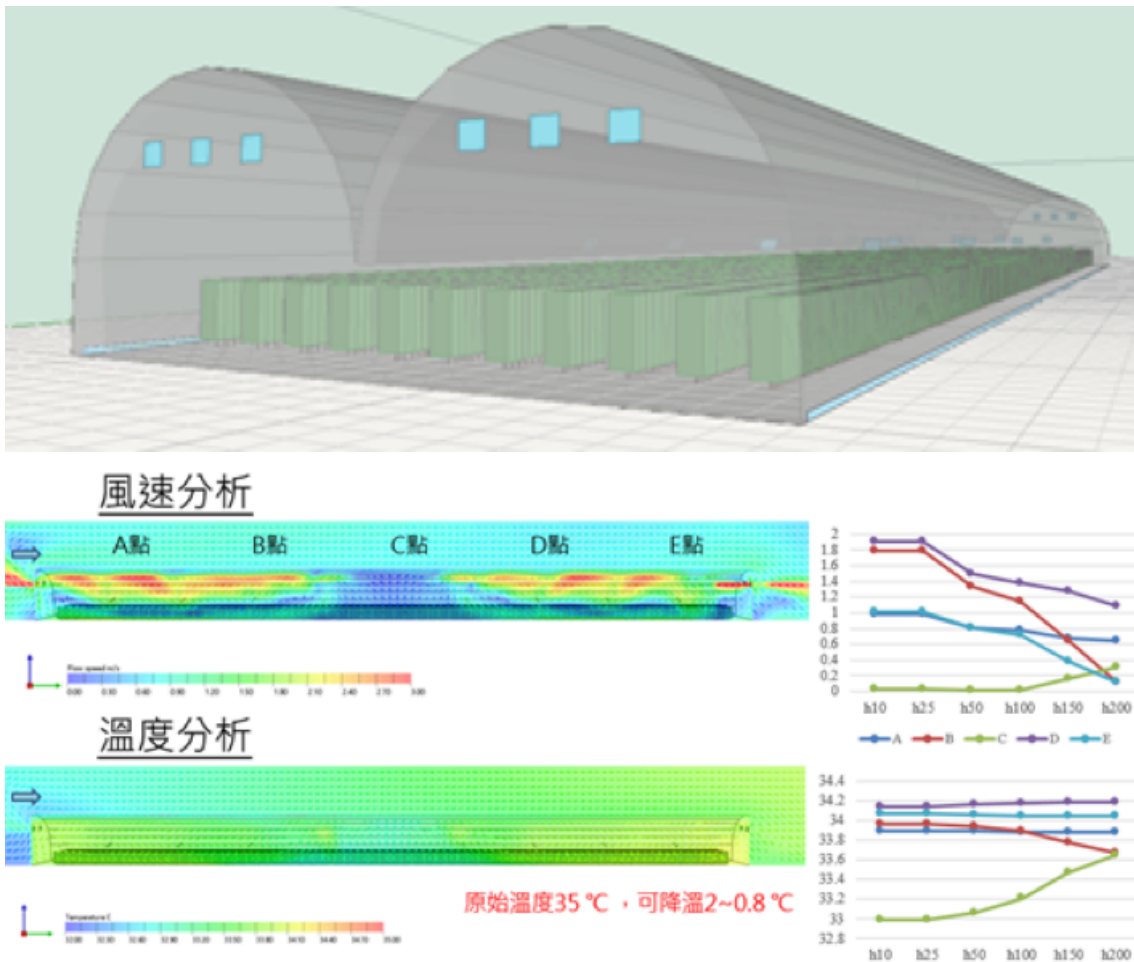


Fig.14 The analysis and stimulation of "Flow Designer" about wind speed and temperature

- <https://www.tjnp.gov.tw/FileDownload/Result/20171205150347455677.pdf>
- <http://www.tsoe.org.tw/downloads/thesis/2007C1.pdf>
- <https://www.bbhub.io/mayors/sites/14/2015/11/TainanCity--2014Climate-Change-Adaption-Plan1.pdf>
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- Multilayered Edge-landscapes, Yi Han Wang , NCKU, 2016



QIGU
七股

QIGU

The Qigu (Cigu) Township is located in the coastal area on the west side of Tainan City. It is bounded by Jiangjun River in the north and the Zengwen River in the south. It was formerly part of the Taijiang Inland Sea, which had gradually disappeared because of the Wanli River (now Zengwen River) deviated from the original track and then streamed into this Inland water. Together with abundant sediment and the natural impacts of wind, tide and waves, the Taijiang Inland Sea gradually accumulated to multiple scales of tidal flats and offshore sandbanks. Constantly, the tidal flats and sandbanks migrates eastward and the coastline gradually moves westward formed the current topography of the Qigu Lagoon.

Located at the northernmost tip of Taijiang National Park, the Qigu Lagoon is currently the largest ecological lagoon in Taiwan. The lagoon has a diverse ecological environment, which boosts high productivity in aquaculture, such as oysters, clams and a large number of milkfish farms in this area. Furthermore, the mangroves in Qigu, most of which grow along the fish farms, on the banks or riverbeds of drainage ditches, hold together a vibrant ecosystem nurturing various species of mudskippers, fiddler crabs and shells. The flourishing environment leads Qigu to become an ideal nesting sites for birds. Every year, black-faced spoonbills (*Platalea minor*) and other migratory birds flew southwards to the estuary of the Zengwen River during winter. The Qigu estuary wetland hence comes to be the prime habitat for this endangered species around the globe.

Some of the villages in Qigu have been through successful transformation and turned into sightseeing fishing villages and tourist attractions nowadays. The Qigu Salt Field has been idle for years, and the remains of this once prosperous industry have been transformed into the Taiwan Salt Industry Museum and a popular touring spot, the Qigu Salt Mountain.

ENVIRONMENT

At present, the Qigu Lagoon is mainly composed of Qingshangang, Wangzailiao, Dingtoue offshore sandbanks from north to south and plots of land. The appearance of the lagoon is a slightly triangular shape. The outer slender sandbank island is the bottom edge; the apex of the triangle is the entrance of the lagoon through the Qigu River.

The Qigu lagoon serves three functions. 1. Flood control: the lagoon is a natural flood pond. 2. Protecting the inland coast: the lagoon moderates the waves erode the coast. 3. Enriching ecosystems: the lagoon acts as natural farm and is beneficial to the local environment.

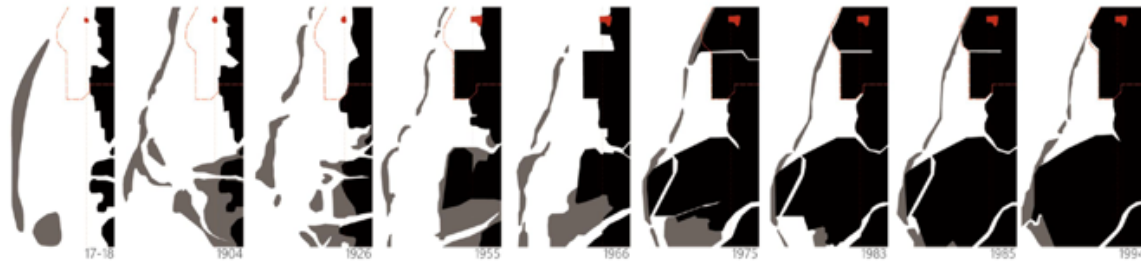


Fig.1 The transformation of the sandbanks (gray) and the land area (black) along Tainan coast

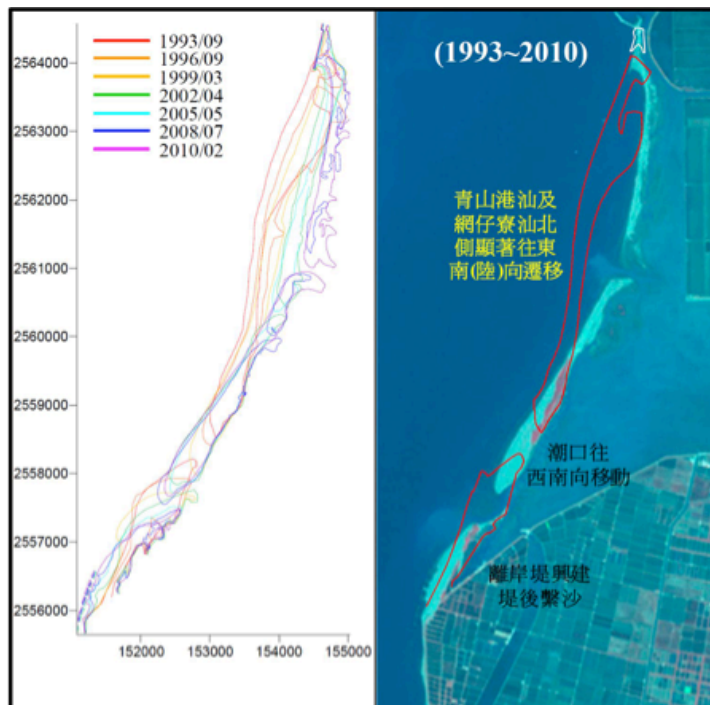


Fig.2 The retreat process of Qigu Lagoon coastline (1993-2010)

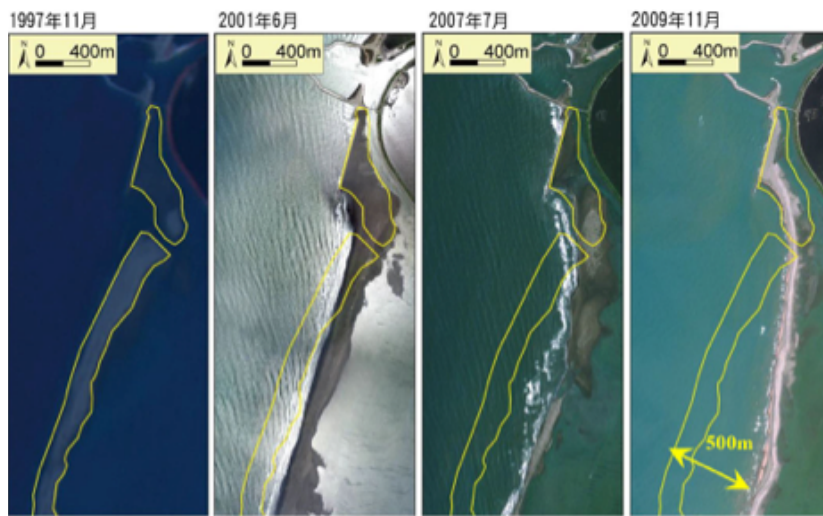


Fig.3 Transformation of the southern Qingshangang sandbank

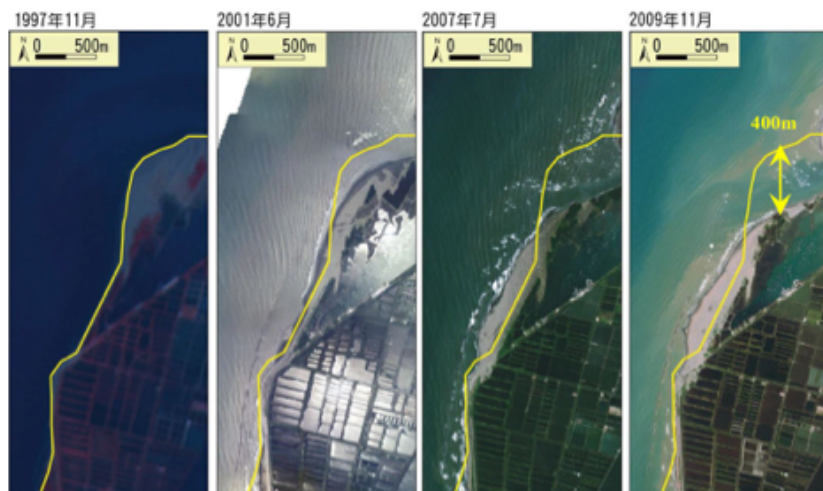


Fig.4 Transformation of the northern Dingtoue sandbank



Fig.5 Transformation of the Wangzailiao sandbank

The lagoon was still extensive in the 17th century. It covered an area of 3 to 4 hundred square kilometers and was able to dock thousands of boats. The stability of this water and the advantageous geographical location made Qigu Township became the center of Taiwanese politics, culture and economy at that era. However, according to a survey conducted by the Water Resources Agency, Ministry of Economic Affairs, the Wangzailiao sandbank retreated 885 meters from 1975 to 2005, in a speed of 29.5 meters annually. The Qingshangang sandbank retreated about 700 meters from 1989 to 2002 and the height fell from 6.5 meters to 1 meter. Furthermore, whenever the typhoon comes, the tide will directly cross the sandbanks and create gaps, which has accelerated the disappearance of the sandbanks. Simultaneously, the Qigu coast have been so far affected by human developments, for example, the land use of fish farms and salt fields had transformed the original coastal sandbanks and shoals into artificial facilities. Consequently, the Qigu lagoon has remained an area of about 1,455 hectares nowadays

Remote sensing images taken by French SPOT satellites have shown that there were a few changes in the landscape in the coastal zone of Qigu in 1994, 2004 and 2010. Evidently, Wangzailiao, Dingtoue and Xinfulun offshore sandbanks drifted eastward and/or southward.

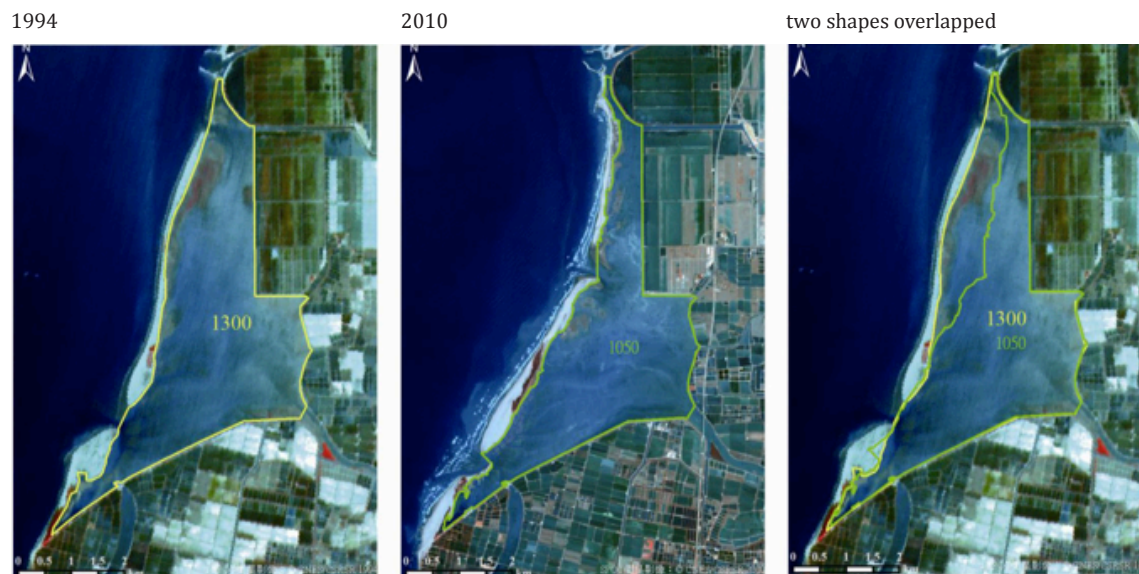


Fig.6 Satellite images show the changes of the area at the Qigu Lagoon

Fig.7 reveals the landscape transformation of the Qigu Lagoon. The translucent yellow part is the location of the sandbanks and the translucent red part is the location of the land. It is obvious that the sandbanks and the land area were surrounded by larger water and the coastline was more east in 1904 than the current one. In 1926, the coast had expanded to the west and the scope of land area became larger. In 1955, it points out that because of the continuous human development, mostly are salt fields and fish farms along the coast, the land areas have expanded westward. In 1966, the sandbanks along Zengwen Estuary migrated westward.

In 1975, the land area constantly moved westward to the sea indicated that more fish farms emerged due to the development of Zengwen tidal flats on the southern bank of the Qigu lagoon. Additionally, due to the development of the second district of Qigu, the land area grew outward more than 5 kilometers westward; the development further went south to Zengwen Estuary in 1985. Next, in the image of 1994, it can be clearly seen that the area of the sandbank located in Zengwen Estuary was significantly reduced than in 1975 since there were approximately 100 hectares of sandbanks developed into fish farms. The scope of land use has reached the maximum and the land around Zengwen Estuary was planned to become an industrial district. However, it has now become a black-faced spoonbill reservation and is a part of Taijiang National Park.

The image in 2001 shows the development of the land areas has been nearly completed and thus has no considerable changes. In contrast, only the lagoon sandbanks tend to approach the land in degrees. By comparing the images of 1985 and 2007, it is obvious that the sandbanks of the Qigu lagoon have moved eastward by about 1 km.

In addition to these changes in land surface, losses in coastal vegetation were also documented. In Fig.8, there were three mangrove swaths with a total area of 6.2 ha in the Qigu estuary in 1994. However, two of these were excavated in 2004, and in 2010 only an area of 5.1 ha remained. While the windbreak forest increased from 4.2 ha to 14.8 ha at the southern Wangziliao sandbank, its area reduced from 8.5 to 3.7 ha at the northern Dingtoue sandbank. Another windbreak forest eroded and disappeared at the southern Dingtoue sandbank, an area of approximately 87.8 ha in 1994 that diminished to only 7.3 ha in 2010. The windbreak forests have been seriously eroded and may even disappear completely at the southern Dingtoue sandbank. Therefore, urgent stabilization of the sandbank of this region is recommended in order to protect the greater Qigu area from further deterioration.

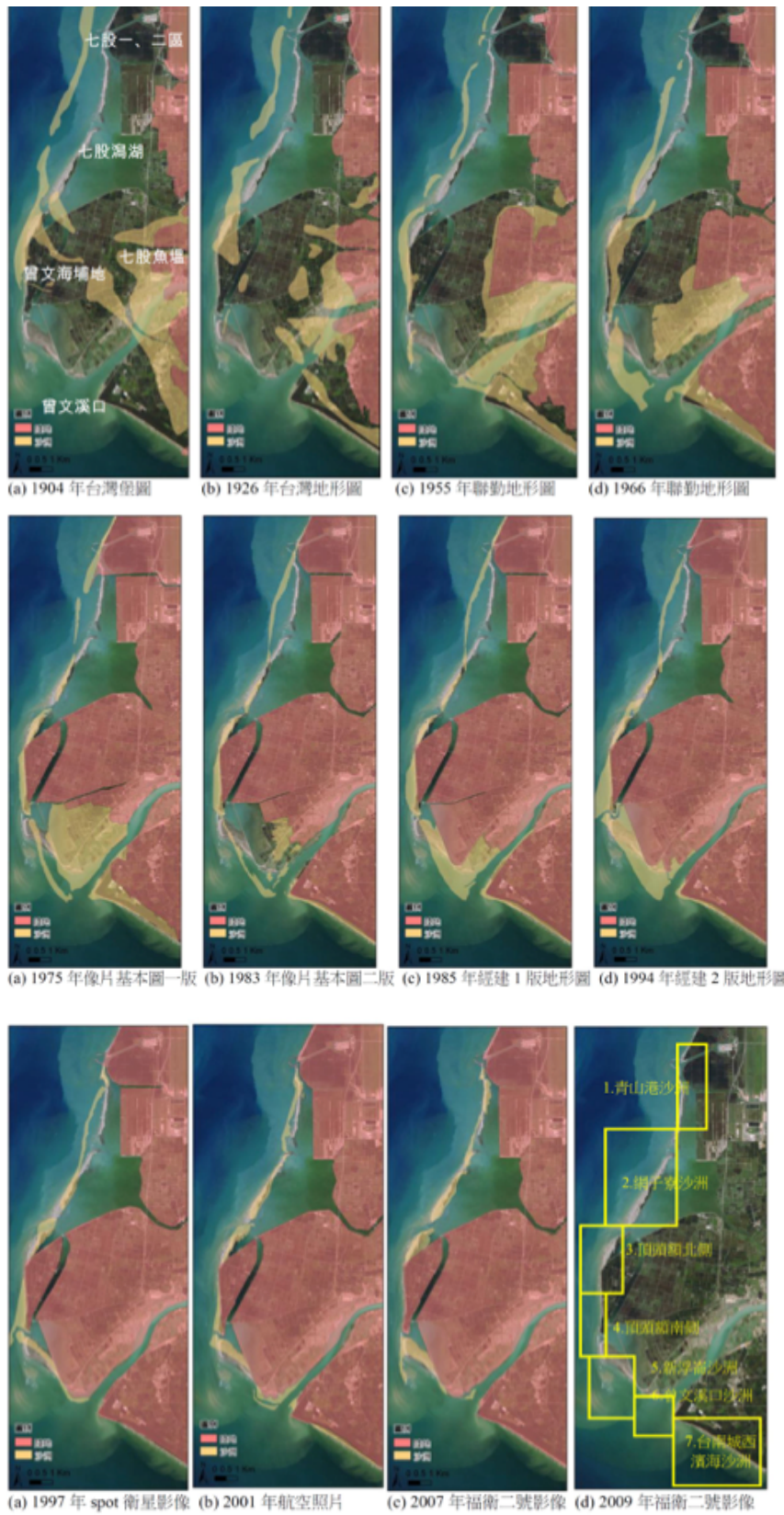


Fig.7 The transformation of the Taijiang Inland Sea (1997-2009)

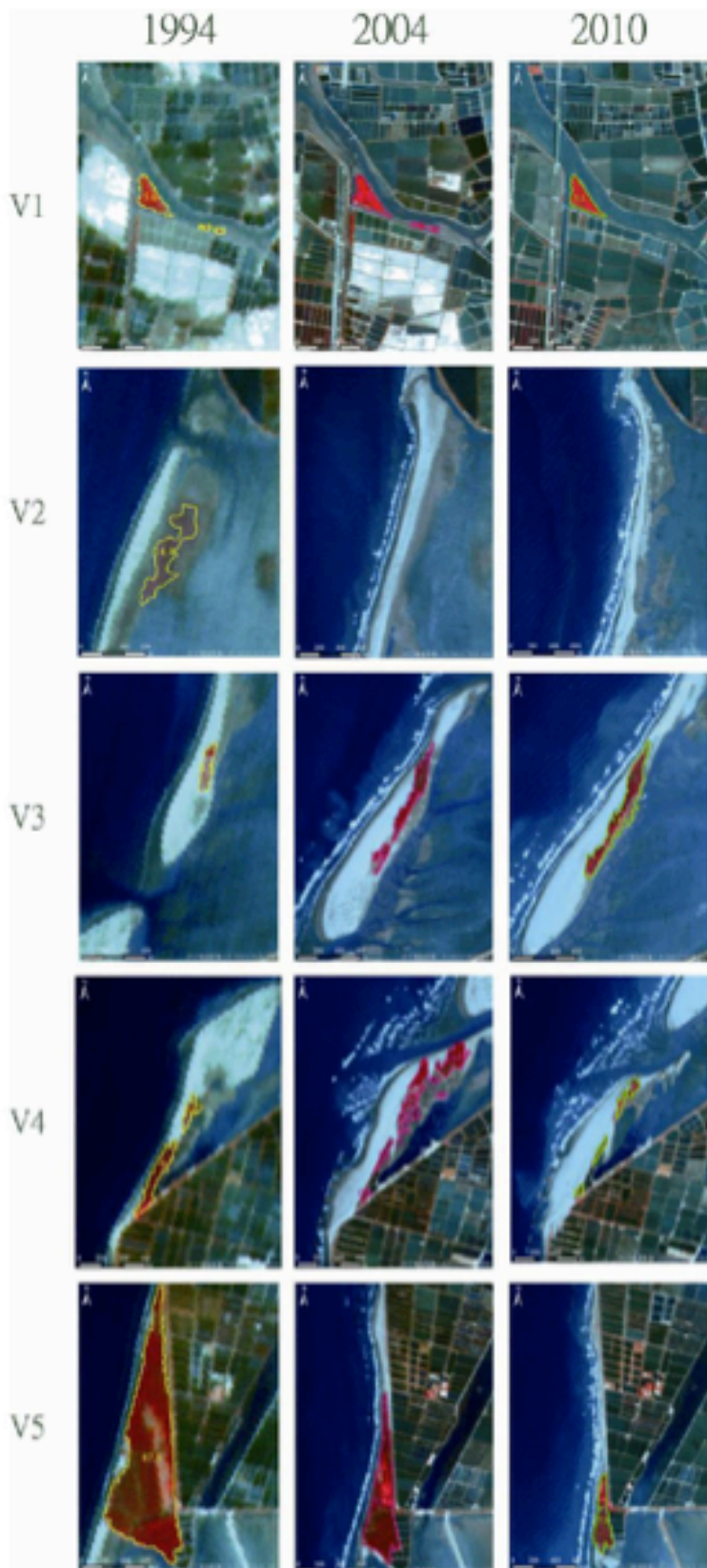


Fig.8 Satellite (SPOT) images showing the changes in coastal vegetation in the Qigu coastal zone

PRODUCTION

Due to the infertile soil in the coastal areas, the ancestors were mostly engaged in aquaculture. They constructed fish farms along the surrounding shoals and then cultivate oysters and clams in the lagoon. The arrangement of the fish farms presents a collection of multiple organic polygon shapes. To be more concise, a shallow-water fish farm usually has a bamboo shed built on it, and a deep-water fish farm usually equipped with waterwheel devices. In other words, the different depths of the water diversify the landscape appearance.

The Qigu lagoon is the transition zone between the fish farms in the coastal areas and the surrounding waters. The offshore sandbanks block the external waves and hence make the water in the lagoon more stable. Moreover, A large number of plankton thrives in the lagoon since there are two estuaries and still affected by the tidal cycle. It also provides a fruitful base for oysters, which are grown at the junction of saltwater and freshwater and mainly feed on plankton.

Oyster farming in the Qigu Lagoon has existed more than 100 years. Oysters can be harvested in every season while specifically more plump in summer. Generally, its abound from July to September and from November to February, respectively. The breeding process is mainly divided into stocking and nourishment. After the gonads of the oysters mature, they will start ovulating after being stimulated. Farmers will collect discarded oyster shells to create oyster strings for larvae stocking and placed them in the lagoon. The oyster larvae will adhere to the string to breed and about 30 larvae can be attached to one oyster shell. An oyster can reach 6 to 7 cm in about 20 days after stocking and can be cultivated dividly or sold at this time. The oyster farmers will put the oysters in cages and sprinkle water at any time when transporting to avoid dehydrating to death.



Fig.9 Qigu Lagoon is an important production area of oysters in Taiwan

From rack constructing, oyster larvae stocking, breeding, maintenance, harvesting to pre-market affairs, oyster farming is an industry that relies heavily on labor. It is a very burdensome job and cause occupational injuries easily. For instance, in the work of maintenance and harvesting, workers have to pull an oyster string, which weight from 30 to 50 kilograms, out of the sea without any equipment assistance. It turns out that fewer people are willing to engage in this industry. In other words, the aging and shortage of human resource has become more and more serious, which has severely affected the future development of this industry.

In the past, there were several ways to raise oysters in Taiwan: cutting method, hanging method, suspension method, raft drape method and lining method. The breeding racks are generally placed perpendicular to the current in order to increase the feeding opportunities for the oysters and the size is related to the water topography as well. In Qigu, depending on the difference of the seabed, the major approaches of oyster culture are suspension, hanging, and raft drape method. These methods are firmly related to the water exchange capacity. In the area near the junction of the tidal inlet and the sea, the raft drape method (the oysters are immersed in the water all day long) is operated due to the exchange capacity is better and the water depth is sufficient. However, in the internal area of the lagoon, the exchange capacity began to decline and the water depth was also affected by the tides. In this case, the suspension and hanging methods (the oysters are only immersed in the water at high tide) is operated.



Fig.10 Farmer collects mature oysters and operates the onerous pre-market affairs

Suspension Method of Oyster Culture

Suspension method is suitable at the intertidal shoal. Bamboo canes are used as the base column and the width each column, generally about 1 to 2 meters, is related to the topography. The oyster strings, which are tied to the column in two ends respectively, hang parallel to the beams with an interval of 30 cm each string. One string can contain about 7 to 15 mother shells.



Fig.11 Suspension method of oyster culture

Hanging Method of Oyster Culture

Hanging Method for oyster culture is suitable for the inner bay and the tidal ditch. The water depth can be about 1 meter when the tide is low, and the rack can be exposed to 50 cm above the water surface. Similarly, this method first sets up a base column, and then use bamboo canes or plastic tube as the beam. Parallel to the column, strings are hung every 30 centimeters, so there are about 40 strings can be hung on one rack. The length of the string is about 1 to 2 meters, each string has about 5 to 12 mother shells, and each mother shell is about 15 cm apart. Mother shells are tied with plastic hard rope, separated and fixed, so they can be collected by scissors. The bottom of the string is about 30 cm from the ground to avoid damage caused by the snails.



Fig.12 Hanging method of oyster culture

Raft Drape Method of Oyster Culture (Floating Oyster Farming Platform)

Raft Drape Method of oyster culture is more adaptable for deep-water zone and is not susceptible to tide. The raft system is made out of bamboo lattices, with an area about 96 square meters of each raft. The oyster mother shells with the seedlings are suspended vertically and are soaked in water for 24 hours. The raft floats on the sea surface of the Styrofoam. Generally, depending on the size of oyster groups, 12 Styrofoams will be combined as a pontoon for one rack and some will be gradually added to more than 20 to enhance buoyancy. Since the oyster farmers can work regardless of tide flood or ebb, working hours by using this method are more flexible. Additionally, it can be unaffected by the coastal pollution. Yet, the disadvantage is that it often drifts away from the original location and suffers from damages caused by typhoons or drastic waves. For example, when the southwesterly flow comes, the southern Zengwen River will become a windward surface, which is inadequate for cultivation since the rafts will easily be rushed away by the wind and waves.

The bulging Zengwen estuary allows the vast waters between the south of Zengwen River and Erren River to be unaffected by the northeast monsoon, making it an excellent place for operating raft drape method. Furthermore, by operating this method, the oysters possess a high growth speed and thus the harvest is rich. Every year, after the Mid-Autumn Festival, the stocking process will begin. After the Lunar New Year, farmers start to harvest and the peak season is around the Tomb Sweeping Day. Generally, the oysters will be collected before the end of May.



Fig.13 Raft drape method of oyster culture

LIVING

At the beginning of the Japanese occupation, Qigu town mostly belonged to the newly formed tidal flats and the natural environment was severe for crops. Specifically, the soil was barren and the strong winds struck the offshore. Moreover, Zengwen River had deviated several times and caused the agriculture around the downstream area hard to manage. Nevertheless, the vicinity of the coast where have not yet been fully transformed to land become a profitable spot for operating aquaculture. As a result, more than 70% of the area of the Qigu town was used in fish farms.

In the late period of the Japanese occupation, with the prevalence of militarism, the Japanese government sought to increase production of the industrial salt that related to the refining of military explosives. In this case, the salt fields in Taiwan expanded rapidly and the total number of Qigu reached about 1,000 hectares. The main economic activities also shifted from aquaculture to salt industry. However, in the 1980s, salt industry was facing the dilemma of the aging workers and the rising costs. Ultimately, in 2002, the bay salt industry became a history and related factories were closed.

North Qigu

The north Qigu district was the earliest developed area in the Qigu town. There were Han people came to settle during the Ming Dynasty. Compared with other district in the Qigu town, the north Qigu district was probably the first to transform to land around Taijian Inland Sea. Essentially, This district is not only beneficial for fishermen, but also for sea-trade merchants since the 16th century.

At the beginning of the Qing Dynasty, residents living near the Taijang Inland Sea sought to make a living by setting up fences in the inland sea to proclaim their ownerships. After the waters retreated, people further occupied the newly formed tidal flats. Next, in the middle and the end of the Japanese occupation, the Japanese government first changed the tidal flats into farmland and then further changed it to the salt fields because of the warfare. Besides, due to the needs of agriculture, salt industry development and warfare, several important traffic routes were also built to support during this period and at the same time connected each settlement. However, in the end of the Japanese occupation, many residents immigrated to Kaohsiung City and Tainan City for a living. This outflow of population has further caused the north Qigu to turn into an aging society faster than other districts.

Central Qigu

The central Qigu district includes eight villages: Yancheng, Jhongliao, Longshan, Xinan, Qigu, Yucheng, Dacheng and Daliao. Among these, in 1755, the Han people set up salt fields in Daliao and Yancheng. At this point, Daliao and Yancheng is not only the earliest development in the central Qigu district, but also the first where Han people settled in.

The flood in 1823 not only brought a lot of sediment and formed new land area, but also made the old separated lands expanded and connected into a vast tract , so called Jianzaipo. The new-formed plain attracted the residents of the nearby settlements to migrate in. Most of the central Qigu settlements were formed in the middle and late 19th century.

In the 19th century, several merciless floods extended the Qigu River westward. The river estuary became the important military base, where the Qing soldiers set up barracks and forts. In the Japanese occupation period, the Yencheng village, the westernmost part of this district, was chosen as the administrative center of the Qigu town because of its importance in the salt industry.

South Qigu

In the early Qing Dynasty, the south Qigu district was still part of the Taijang Inland Sea. Yet the ancient Zengwen River had southward diverted and constantly transported sand into the inland sea and thereby the reclaimed land gradually formed. People successively relocated at the reclaimed land or the sandbanks in south Qigu district and mainly operating fish farms for a living. This phenomenon continued until 1905, and most of the south Qigu were established during this period.

At the beginning of the Japanese occupation, after the construction of the Zengwen River embankment completed, the flood problem had been released. Moreover, the mud brought by the floods filled the original fish farms and unexpectedly created a fertile plain. After WWII, combined with the private fish farms, the Nationalist Government set up 1600 hectares of "Zengwen claimed tidal flats." it became an extensive area for fish farming and the only remaining inland sea is aimed to raise oysters as the main industry. In recent years, since the black-faced spoonbill has been inhabited here by winter, the ecological conservation consciousness is triggered and developed an eco-tourism industry in the south Qigu.

Settlement Pattern

There are many traditional settlements in Qigu town. The residential houses are called "the comb layout." This type of layout led the community to be dense and neatly arranged in the same direction and serves the climate moderation and defense functions.

The comb layout is mainly composed of Sanheyuan. In Qigu, this traditional architecture is designed to achieve wind protection. It is common to build a brick wall (front outer wall) under the eaves prevents the roof to be lifted up by the strong wind. This layout at the same time forms the narrow but winded lanes as well. The longitudinal lanes are parallel to the summer monsoon, and the traverse lanes are used as a shelter for the northeast monsoon in winter in the settlements.

Although the northern residential buildings have to endure strong winter wind, the rest residential buildings are less windy and warmer in the sheltered areas. Overall, the less area suffers from the wind strike means that the loss of heat could be reduced, which is the best way to maintain warmth in winter. On the other hand, during the high temperature at noon in summer, the entire settlement is covered with hot air, yet the densely connected buildings produce more shaded areas and are prone to convection by introducing south wind to blow directly into the room along the roadway.

RESILIENT ISSUES

Torrential Rain

In addition to the strong northerly winds blew in the inland area, the Qigu suffered from typhoon disasters in the summer. Typhoon is the most destructive weather in Taiwan. According to the data from 1897 to 2003, there were 375 typhoons hit Taiwan, four times a year on average. The typhoon path that directly strikes Qigu town accounts for about 40% of the total incidence. It will introduce a warm and humid southwesterly flow. Together with the southwest monsoon, it will bring in a lot of precipitation, for example, typhoon Morakot struck Qigu town with a serious flood in 2009. Essentially, the northerly winds of the winter and the southwesterly winds of the summer are all problems that residents in the area have to face.

In addition, the plum rain season is the second source of precipitation in this region. The area between Ali Mountain and Tainan has the highest frequency of heavy rains. Moreover, the largest precipitation area of typhoons and plum rains is often located in the Ali Mountain. In fact, Ali Mountain is the main catchment area of Zengwen River, which finally decided the fate of the diversion of the downstream of Zengwen River.

Coastal Erosion

Recently, serious erosions on the Qigu coast cause the disappearance of coastal forests and serious damage to the ecological environment. Coastal erosion can be attributed to natural and artificial factors, respectively. On the natural side, typhoons and waves affect the most. On the artificial side, the construction of the Zengwen Reservoir has declined the fine sand near the estuary. It turns out, at the the Zengwen River, this force transformation has led the coast of Zengwen River into a wave-dominated pattern and thus entered a stage of long-term erosion. Besides, due to the construction of ports and dikes, the way to accumulate and transport sediment has changed. It has also affected the terrain of the sandbank.

As a result of coastal erosion, the original wide beach surface and continuous dune terrain of the southern part of the Wangzailiao sandbank are gradually disappearing. The rapid retreat of the shoreline also causes the wind-proof forests, which about 100 meters offshore, to collapse.

Natural dunes on these sandbanks are piled up to more than 6 meters, which protect the coast from the direct impact of the waves and also serve the flood control function significantly. However, lack of sand source causes the elevation of the dunes to decrease gradually. When the typhoon strikes, the over-washing phenomenon will occur and create a new tidal gap. As a result, a large amount of sediment will be washed into the lagoon. After long-term coastal erosion, sandbanks and lagoons face a gradual disappearance crisis, causing coastal settlements and fish farms to be threatened by brutal waves.

Climate Change

Due to climate change and artificial development, the sandbanks have been greatly decreased. According to the report of the Taiwan government, since 1975, the sandbanks drastically retreated inward and the height has dropped sharply and finally become flattened in decades. Furthermore, with the tidal gaps appeared, the sandbanks' defensive ability reduced when storms surge. This area was reduced to 1,100 hectares in 2005 due to the sand was taken away by wind or washed into the lagoon and finally causing Qigu lagoon gradually level and transformed into land. Hence, the oyster farming areas became smaller and the oysters in the shoals were further buried by sand.

Recently, due to climate change, the fierce marine meteorology has become more frequent. A large amount of rainwater will dilute the plankton in the sea and then cause the oysters to be malnourished or even die. Even though farmers will drag the floating sheds into the harbor or the inner sea before the weather deteriorates, the limitation of shelter space still forced many floating sheds to be abandoned. These marine wastes not only are costly to the farmers, but also the main reason of the pollution of the coastal environment.

Coastal Pollution



Fig.14 Abandoned Styrofoam scatters and pollutes the coast zone

According to the survey by Greenpeace and The Society of Wilderness in 2018, the number of Styrofoam and discarded fishing gears is the second largest marine waste after the plastic bottle. It is arduous to clean since the wastes are usually stuck in the sea dikes and the wave blocks. However, in Qigu, the main materials used in the oyster culture are bamboo and Styrofoam.

In the past, the farmers did not develop the habits to do recycle. Because of the poor durability, these two materials are eliminated after two years of usage. As the result, under the effect of the front in June, the abandoned racks would usually caused pollution along the coast. Specifically, the Styrofoam, which is also a consumable and generally could be used for three years, would be discarded since the third year Styrofoam, perforated by epiphytes, was easy to break and suffer from poor buoyancy. In addition, Styrofoam crumbs will be produced to hurt the marine environment when the farmers scrape off the organisms attached to the Styrofoam or rearrange the Styrofoam on the racks to adjust the height.

Moreover, if the capricious ocean force invaded the breeding area before harvesting, it will cause a large number of the bamboo frames and the Styrofoams scatters. Every year from March, lots of bamboo canes, Styrofoam crumbs, and Styrofoam blocks appear along the coast and were driven ashore. In May and June, which is the peak period for harvesting oysters, is the time the most serious pollution emerges as well.

Salt Injury

Salty rain, a fine mist which contains salt, falls to the ground when a strong monsoon blow to the land from the sea with waves, droplets, fine sand become weak. In addition to directly causing damage to plants, the salt in the wind even infiltrates into the soil and degrade it. Salt injury not only affects crop cultivation, but also the various residential structures suffer from the erosions. Moreover, typhoons with violent wind and waves make the salt scatter in the air. When salt is blown to the land, it often adheres to the wires and cause insulation failure or attached to the foliage of the crops and cause to be withered.

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