

Han Migration and the Settlement of Taiwan: The Onset of Environmental Change

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This essay takes human settlement as its subject of study within the context of environmental history of Taiwan. The aim is to understand the process and significance of the changes occurring from about 1600 to 1900. The environment of any locality is no doubt affected by both natural and human conditions, but it is the people who construct the settlement and thus a main concern of environmental history is to see how people form and transform their settlements. The physical features and climate of Taiwan changed very little during this period.¹ Taiwan was converted, however, from an island of waste land to one of cultivated land. This environmental transformation was mainly caused by Han immigrants who settled down to farm the land. This paper looks into this process by focusing on the increase in Han settlements and the expansion of cultivated lands through the construction of irrigation works. Other related aspects, such as the issue of deforestation, are examined in a later chapter by my colleague, Kuo-tung Ch'en. The discussion is chronological; the administrative divisions and rivers concerned are shown on Map 1.

1. The Sixteenth and the Seventeenth Centuries (The late Ming, the Dutch, and the Zheng Periods)

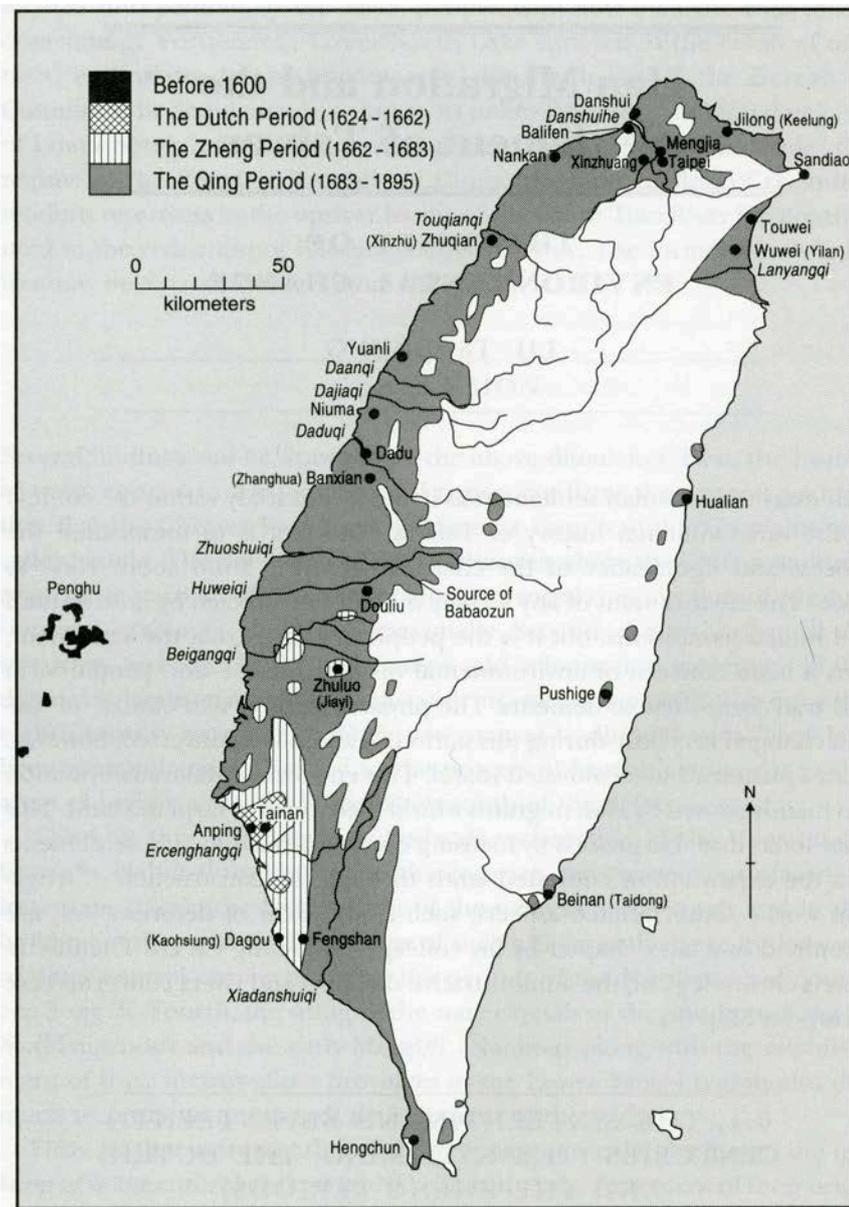
Before the seventeenth century, the Han Chinese came to Taiwan mainly for fishing and trading. The Southern Song records suggest that there were Han settlers in Penghu 澎湖 (the Pescadores) by the end of the twelfth century. The Ming literature reveals that the Han people came to Taiwan at latest in the mid-sixteenth century. At that time the international maritime trade route in the Far East had to pass by Taiwan, and traders and fishermen from southern Fujian visited the island frequently. The traders and fisher boats landed on the west coast of Taiwan at various ports, from Dagou 打狗 (today's Kaohsiung) in the south to Jilong 雞籠 (today's Keelung) in the north. Besides fishing, most fishermen also traded with the aborigines. They obtained deerskin, dried venison,

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**Pinyin is used in this article except for today's place names and some personal names.

¹ Chen Zhengxiang 陳正祥, *Taiwan dizhi* 臺灣地誌 [A geography of Taiwan] (Taipei: Fumin Geographical Institute of Economic Development, 1959-61), pp. 45-62.

and firewood for the cargoes of their return trips. It is also possible that some fishermen settled down in Taiwan.²



Map 1: Expansion of Han reclamation on Taiwan, 1600-1895

² Cao Yonghe 曹永和, "Mingdai Taiwan yuye zhilue [A study on fishing in Taiwan in the Ming dynasty]", *Taiwan yinhang jikan* 臺灣銀行季刊 [Quarterly of the Bank of Taiwan], 6.1(1953), pp.169-175; Cao Yonghe, "Mingdai Taiwan yuye zhilue bushuo [A further study on fishing in Taiwan]", *Taiwan jingjishi siji* 臺灣經濟史四集 [The fourth collection on the economic history of Taiwan] (Taipei: Bank of Taiwan, 1956), pp.16-47; Chen Zhengxiang, "Sanbainianlai Taiwan dili de bianqian [Geographic changes in Taiwan in the last three hundred years]", *Taiwan wenxian* 臺灣文獻 [Reports on Historiographical Studies of Taiwan], 12.1(1961), pp. 77-85.

The activities of these traders and fishermen must have modified Taiwan's landscape to some extent regarding environmental change. Their impacts, however, were certainly not as significant as those of immigrants who came later and settled down to open up new lands.

The number of Han settlers in Taiwan was still very small at the beginning of the seventeenth century.³ During the first half of that century, a larger number of the Han Chinese began to migrate to Taiwan. Lian Heng has noted two streams of this early immigration. The first stream came around 1624-26: more than 3,000 persons affected by droughts and famines in Zhangzhou 漳州 and Quanzhou 泉州 moved to Taiwan following the landing of some pirates, among them Zheng Zhilong 鄭芝龍 (Nicholas Iquan in the Dutch literature).⁴ The second stream came around 1628-31 when Xiong Wencan 熊文燦, Governor of Fujian, accepted Zheng Zhilong's device to move the people pressed by droughts to Taiwan. This consisted of "several tens of thousands" of starving people and they were provided with three taels of silver per person and one head of cattle for every three.⁵ The scale of the second immigration stream is, however, rather suspect.⁶ It is not clear where these immigrants settled down and how were they organized to cultivate the land, although Lian Heng states that the first group was not led under any official order and the second one paid rents to Zheng Zhilong; this suggests that these immigrants were not under the control of the Dutch who had built Fort Orange (renamed Fort Zeelandia in 1627) on a sandbank nearby Anping 安平.⁷

During the period of Dutch rule (1624-62), the Dutch East India Company promoted agriculture in Taiwan to achieve the Company's mercantile goals. As the aborigines still engaged in primitive agriculture, the Company encouraged Chinese peasants to move to the island. The Company provided land and capital, such as money and cattle, to Chinese peasants who tilled their fields as "Crown land". Partly due to the Company's promotion and partly to the disorder in

³ Wen-hsiung Hsu, "From Aboriginal Island to Chinese Frontier", in *Chinese Island Frontier*, ed. by R. Knapp (Honolulu: University of Hawaii Press, 1980), p.10.

⁴ Lian Heng 連橫, *Taiwan tongshi* 臺灣通史 [General history of Taiwan] (Taipei: Bank of Taiwan, 1962), pp.168, 727-728. For records of drought and famine see, *Zhangzhou fuzhi* 漳州府志 [Gazetteer of Zhangzhou prefecture] (1877), juan 47, p.9b; *Fujian tongzhi* 福建通志 [Gazetteer of Fujian province] (1871), juan 271, p.49b; Peng Sunyi 彭孫貽, *Jinghaizhi* 靖海志 [A treatise on pacification on the sea] (Taipei: Bank of Taiwan, 1959), p. 2.

⁵ Lian Heng, *General history*, pp.168, 647; Fang Hao 方豪, "Chongzhen chunian Zheng Zhilong imin jutai shi [On the event of moving people into Taiwan by Zheng Zhilong during the early Chongzhen reign]", in *Fang Hao liushi ziding gao* 方豪六十自定稿 [The collected works of Fang Hao on his sixtieth birthday] (Taipei: published by the Author, 1969), pp. 659-662.

⁶ Chen Shaoxin 陳紹馨 et al., *Taiwansheng tongzhi* 臺灣省通誌 [Gazetteer of Taiwan province] (Taipei: The Historical Research Commission of Taiwan Province, 1972), section on population, Vol.1, pp. 40-41. Chen contends that if the transport cost and available statistics of people and cattle at that time are taken into consideration, it is incredible that all of them were moved with such a scale of provisions.

⁷ Lian Heng, *General history*, p. 168. For relations between Zheng Zhilong and the Dutch see, Yang Yanjie 楊彥杰, *Hejushidai Taiwanshi* 荷據時代台灣史 [History of Taiwan under the Dutch rule] (Nanchang: People's Press, 1992), pp. 66-67, 155-156; Yang Xuxian 楊緒賢, "Zheng Zhilong yu Helan zhi guanxi [The relationship between Zheng Zhilong and the Dutch]", *Taiwan wenxian*, 27.3 (1976), pp. 164-165.

China during the dynastic transition, many people moved to Taiwan.

By the end of the Dutch period, the Han population in Taiwan was recorded by various authors to be 25,000 households, 30,000 households, or 100,000 persons. Modern scholars tend to agree that the most plausible figure should be below 50,000 persons. The total cultivated acreage was about 10,000 *jia* 甲 (1 *jia* is approximately 11 *mu*, 1 morgen, or 1 hectare). The area already reclaimed centered on today's Tainan 臺南 and in scattered fashion reached north to Beigang 北港 and south to Gangshan 岡山. The Company paid much attention to building irrigation and drainage systems. The main crops were rice and sugar cane, but the Company also introduced other crops, such as garden peas and tobacco, and promoted cultivation of indigo and medicinal herbs. In sum, the Dutch India Company left some legacies with crops, domestic animals, irrigation, and a land system for Taiwan's agriculture.⁸

In 1661, Zheng Chenggong 鄭成功 (known as Koxinga in the West), son of Zheng Zhilong, led his army to land on Taiwan and in the next year took over control from the Dutch, a new phase of the Han settlements in Taiwan thus begun. Shortly after the landing of Zheng's forces, a decree commanded the army to undertake military colonization. To solve the problem of labor supply, Zheng ordered the officers and soldiers to move their families to Taiwan and encouraged immigration. At the same time, the Qing government coerced the people living along the southeast coast of China to move inland to make it difficult for Zheng to survive on Taiwan. However, many people, mostly male adults, still took the risk of moving to Taiwan.

Among regulations announced for agricultural colonization, the following two points are the most notable concerning land acquisition and resource utilization: (1) All officials and officers might enclose lands for permanent holding according to the number of persons under their command. They should not enclose the land already reclaimed by the aborigines and the early Han settlers. (2) They might have rights over the forest and ponds situated within their enclosures as long as maps were presented to the authority for fixing the tax; these resources should be used sparingly, trees should not be cut without limitation in time and the water should not be drained just for fishing, so that later generations could enjoy the profits forever.

The task of opening up new lands began to bear fruit by 1666. The "Crown land" previously under the Dutch control was transferred to the Zheng government and known as "official land" (*guantian* 官田), the lands enclosed by officials and officers were known as "civil and military official land" (*wenwu guantian* 文武官田) or "private land" (*sitian* 私田), and the lands cultivated by soldiers at garrison posts were known as "garrison land" (*yingpan* 營盤).

⁸ Oda Iku 奥田彥 et al., "Heling shidai zhi Taiwan nongye [Taiwan's agriculture under the Dutch rule]", *Taiwan jingjishi chuji* [The first collection on the economic history of Taiwan] (Taipei, Bank of Taiwan, 1954), pp.38-53; Nakamura Takashi 中村孝志, "Heling shidai zhi Taiwan nongye ji qi jiangli [Taiwan's agriculture and its promotion under the Dutch rule]", *Taiwan jingjishi chuji*, pp. 54-69; Cao Yonghe, "Hejushiqi Taiwan kaifa shilue [A brief history of Taiwan's development during the Dutch period]", *Taiwan wenxian*, 26.4-27.1(1975-6), p.200; Yang Yanjie, *Hejushidai Taiwanshi*, pp.170-180; Chen Shaoxin, *Gazetteer of Taiwan province*, section on population, Vol.1, pp. 46-48; Wen-hsiung Hsu, "From Aboriginal Island," pp. 12-18; John Shepherd, *Statecraft and Political Economy on Taiwan Frontier 1600-1800* (Stanford, Calif.: Stanford University Press,1993), p. 86.

Besides these categories of official land, it is also known that there were twelve-and-a-half private villages (*minshe* 民社) and other settlements founded by immigrants from Zhangzhou and Quanzhou. These settlements were mostly scattered along the southwest coast. During the Zheng period (1661-83), although new assarts were still scattered, the scale was larger than before. Rice and sugar cane remained the main crops, and more than 20 irrigation works were built. By the end of this period, total cultivated acreage was about 18,000 *jia* and the Han population was estimated to be 120,000 persons.⁹

Throughout the seventeenth century, the primitive landscape of Taiwan had not been changed very much despite more lands being opened up. The best eyewitness can be found in *Pihai jiyou* 裨海紀遊 [Travel over a small sea] written by Yu Yonghe 郁永河 who visited Taiwan in 1697.¹⁰ This was only fourteen years after General Shi Lang 施琅 had led the Qing navy to conquer Taiwan. The purpose of Yu's travel was to obtain sulfur for the Fujian provincial government. On March 17, 1697, he landed on Taiwan at Luermen 鹿耳門, then the harbor for reaching the prefectural city (today's Tainan). After gathering equipment, he took land route to go northwards.¹¹ On May 26, 1697, Yu and his followers and servants, altogether 55 persons, departed from the prefectural city. His vehicle was a carriage harnessed to a young yellow ox and driven by the aborigines; the oxcart was changed at every aboriginal village on the way. It took them 20 days to arrive at their destination. A few landmarks reflecting comparative degrees of development in Taiwan can be gathered from his observations.

On the first day, they passed through three aboriginal villages, and Yu commented, "Houses in these villages are tidy and they are not very different from those in interior China." (p.17) This demonstrated the acculturation of the aborigines residing nearby the prefectural city. Four days later, they arrived at Banxian She 半線社 (later the site of Zhanghua Xian 彰化縣) in central Taiwan. Beyond this place, the road became stony and the surroundings were "Wildernesses of trees and bushes, and high grasses bury one's shoulders, as if it is under a different heaven from places south of Banxian." (p.19) This suggests that Banxian was then the line of demarcation of development. Two days later, they arrived at Niuma She 牛罵社 (today's Chingshui 清水), they had to stay there for ten days due to heavy rain. Then they crossed the Dajiaqi 大甲溪 to reach Yuanli She 苑里社. Yu noted: "The villages are all empty along this way, we are not able to obtain even a ladle of water; we will be happy if we meet

⁹ For details of agricultural expansion see, Cao Yonghe, "Zhengshi shidai zhi Taiwan kenzhi [Agricultural expansion in Taiwan in the Zheng period]", *Taiwan jingjishi chuj*, pp.70-85; Chen Hanguang 陳漢光, "Zhengshi futai yu qi kaiken [Restoration and reclamation of Taiwan by the Zheng regime], *Taiwan wenxian*, 12.1 (1961), pp. 39-54; Chen Zhengxiang, "Geographic changes," pp. 80-81. For estimates of the population see, Chen Shaoxin, *Gazetteer of Taiwan province*, section on population, Vol.1, pp. 51-52.

¹⁰ The page numbers cited below are those of the edition published by the Bank of Taiwan (Taipei, 1959).

¹¹ Originally, Yu had planned to take the sea route and bought two boats. He later accepted suggestion from a fellow-countryman and took the land route, but his equipment were still carried by two boats, one of which was damaged in a storm halfway, see *Travel over a small sea*, pp.16, 20-22.

anybody. From here northwards, the situation is about the same." (p.21) In other words, the Dajiaqi river was another demarcation line of development.

Two more days later, they arrived at Zhuqian She 竹塹社 (later the site of Danshui Ting 淡水廳 and Xinzhu Xian 新竹縣) and the next day, Nankan She 南嵌社. Yu recorded:

From Zhuqian to Nankan was a distance about eighty to ninety *li* 里 (1 *li* is approximately 0.5 kilometer). We saw nobody and no house and there was not a single tree to give us a shade. We dug a hole in the ground and on top of it to cook the food with an earthen pot; under the fierce heat of the sun we were satisfied with a meal enriched by the water obtained from a torrent. On the way, we came across groups of elks, deer, female elks, and does; my aboriginal followers were able to catch three deer. Upon arriving at Nankan, we entered into deep rushes and our caps and shoes were all broken after going through. This was just a cave for animals and not a place suitable for human beings to visit! (p.22)

Finally, they arrived at Balifen She 八里坌社, then they canoed to cross the river to Danshui She 淡水社. The headman welcomed them and had some twenty thatched huts built in five days about 10 *li* upstream from Gandamen 甘答門 (today's Kuantu 關渡) for the group to stay during their sojourn. (pp.22-3) In late June, Yu went up to the mountain to investigate the sulfur mine. He passed through stiff rushes that were more than ten feet high. He entered into a deep forest of small and big trees that he could not name; he saw old rattans climbing up trunks like dragons and huge trees that his guide identified as *nan* 楠 (*P. fmosana* Hayata). He heard for the first time a tremendous variety of birds' songs although he could not see the birds. The wind was cool and he almost forgot that it was in hot summer. (pp. 24-5) In short, he vividly described a scene of the forest in northern Taiwan.

Moreover, Yu Yonghe had some comments relating to the hardships of living in the natural environment of Taiwan. First, "miasma" (zhangli 瘴癘) was dreadful.

It was said that the climate of this place was harmful. Once one fell ill, the only outcome was death. Gentlemen at the prefectural city had talked about this carefully but I did not believe it. After only a short stay, however, the servants fell ill; nine out of the ten helpers were sick! Even the cook was sick and nobody could help with the cooking.....In my opinion, the mountains and the rivers are not different from those in China and there is no evidence for evil spirits, once one has arrived here, however, one suddenly falls ill. This is just because the deep mountains and the great rivers are still in the condition of wilderness; grasses and woods are dark and thick; there are not yet many people, and accumulated pestilential vapors can be easily sucked into the lungs and bowels. Thus one falls ill suddenly and the same symptom is found for thousands. (p.26)

Next, it is a hardship to travel long distances under rough and primitive conditions. Yu described how it was like to go along the west coast of Taiwan,

then mostly uncultivated.

When I look across the plain, I see nothing but flourishing grasses, the strong ones rise above my head and the weak ones reach to my shoulders, the carriage going through the grasses as if it were underneath the ground; the tips of the grasses cut my face and neck, mosquitoes and flies suck my skin and body and cannot be driven away, as if they were hunger eagles and tigers. Moreover, the flaming sunshine blazes and my neck and back are almost split open. This, indeed, is the greatest toil and suffering on this world." (p.26)

Furthermore, simple hovels and the natural surroundings not to some degree improved are rather inconvenient and dangerous.

The four walls and the roof of the thatched hut are all covered with rushes; the wind comes in from all directions as if it were arrows, and whenever I lie down I see the sky. Grasses grow up on top of the bed and after being plucked, grow up again quickly. When it rains, the room becomes a torrent, and after the rain, I have to get on to the bed with my wooden shoes for at least ten days. There are always the lutes of cicadas and flutes of earthworms underneath the bed, and the morning and evening tides always arrive at the front of stairs. Out of the house, grasses cover my shoulders, old trees tangle together, bamboos cluster, and I can not see through them over a short distance. The big adders which have swelling necks have a strength to swallow a deer; they can be heard every night nearby my pillow and sometimes the sound is as loud as snore of a cow; small snakes glide after the people as fast as flying arrows. Once it gets dark, I dread to go out of the door. (pp.26-27)

Yu's observations revealed that at the end of the seventeenth century, the Han people in Taiwan still could not avoid feeling threatened by miasma, had to endure extreme hardship when traveling over a long distance, and the aboriginal houses with natural surroundings were inconvenient and dangerous. These conditions changed gradually in the next century after more immigrants settled in.

Before going on to trace the agricultural expansion led by these Han immigrants, a problem of environmental protection in seventeenth-century Taiwan should be mentioned here: the protection of the deer. As mentioned above, since the mid-sixteenth century, traders and fisher boats carried deerskin and dried venison back to Fujian. It seems that up to the early seventeenth century such commercial activity had not sounded any warning of a decrease in the deer's number. For instance, in 1603, Chen Di 陳第 visited Taiwan and recorded the customs of aborigines in his *Dongfanji* 東蕃記 [A note on the eastern tribes]. Chen mentions that there were hundreds and thousands of deer, and among the aborigines, "It is prohibited to catch a deer privately. When winter comes and herds of deer appear, then a hundred more men are gathered to hunt; as soon as they catch up with a herd, they make a circle and drive the herd into it and then spear them." In this way, "Deer are caught year after year but

they are not exhausted."¹²

The situation changed in the first half of the seventeenth century when the Dutch East India Company shipped a large number of deerskins to Japan. The Company purchased deerskins from the aborigines and the Han people who had hunting licenses. The price paid by the Company for one piece of deerskin was four pence, but it was sold for three shillings in Japan, at least nine times the original price! The profit was high, but the volume of trade could not grow in sustaining fashion; the main reason for this was that the number of deer was decreasing. Available statistics show that during 1634-61, the annual quantity of deerskins shipped to Japan was over 100,000 pieces in 1634, 1638, and 1655; in most other years, it was over 50,000 pieces. Since a doe can produce only one fawn each time, a natural outcome of large scale hunting is thus a sharp decline in the deer population. To maintain the trade, the Dutch decided in 1640 to prohibit the Han people from using traps and nets. In 1645, the Dutch again decided to protect the deer by prohibiting the usage of traps, and by allowing hunting for two years and then enforcing a rest in the third year. These measures, however, did not have any effect. By the end of the seventeenth century, herds of deer were rarely seen in southern Taiwan. During the eighteenth century, most grasslands for deer were reclaimed by Han settlers. The Qing government also prohibited the usage of traps, but in vain.¹³ From the point of view of today's environmentalism, the story of Taiwan's deer may be counted as one among numerous spoiled strokes in the history of mankind's exploitation of nature.¹⁴

2. The Eighteenth and the Nineteenth Centuries (the Qing Period)

In the eighteenth century, more and more Han Chinese came across the Taiwan Strait and the cultivated lands on the Island also expanded from scattered points to connected areas. This section will first summarize the Qing policies regarding immigration and the opening up of new land in Taiwan; then trace the process of reclamation from south to north and then to the east.

¹² The two citations are from *Liuqiu yu Jilongshan* 流求與雞籠山 [A collection of essays on early Taiwan] (Taipei: Bank of Taiwan, 1964), p.91. On Chen Di's visit to Taiwan and the value of the *Dongfanji* 東番記 see, Chen Zhengxiang, "Geographic changes", pp. 78-79.

¹³ For various aspects about deer in Taiwan, see Nakamura Takashi, "Shiqi shiji Taiwan lupi zhi chuchan ji dui-Ri maoyi [The production of deerskins in seventeenth-century Taiwan and their trade to Japan]", *Taiwan jinjishi baji* 臺灣經濟史八集 [The eighth collection on the economic history of Taiwan] (Taipei: Bank of Taiwan, 1959), pp.24-42. Zhou Minghong 周鳴鴻, "Lu zai Taiwan [Deer in Taiwan]", *Taiwan jinjishi jiuji* 臺灣經濟史九集 [The ninth collection on the economic history of Taiwan] (Taipei: Bank of Taiwan, 1963), pp.104-116; Cao Yonghe, "Brief history", pp. 217-219; Yang Yanjie, *History of Taiwan under the Dutch*, pp. 200-213; John Shepherd, *Statecraft and Political Economy*, pp.74-75, 79-80. It may be noted that Zhou mentions that *Cervus Swinhoe* deer (*shuilu* 水鹿) were raised domestically at a few places in Taiwan in the 1960's. It may be also noted that on January 23, 1994, ten Formosan sika deer raised by Kenting National Park were sent back to the wild, see *The Free China Journal*, January 28, 1994.

¹⁴ For a debate on the environmental problem since the 1960s see, B. Harvey and J. Hallett, *Environment and Society* (Cambridge, Mass.: The MIT Press, 1977), pp. 76-85.

2.1 The Policy Background

In 1683, the Qing government took over the control of Taiwan and its policy of ruling this new frontier was rather cautious in the beginning. A passport was required for immigration, and the migrant could not bring his family along. Before 1790, the rule about bringing one's family was loosened four times and tightened five times; altogether it was loosened for 45 and tightened for 61 years. Finally, in 1790 this prohibition was abolished. A passport was still required, however, and this control was not relaxed until 1875. Moreover, due to Shi Lang's suggestion, the people from Chaozhou 潮州 and Hueizhou 惠州 were forbidden to move to Taiwan and this was gradually loosened only after Shi's death in 1696. Despite the prohibitive regulations, the Qing government was not able to prevent the people from going to Taiwan illegally.¹⁵

It is difficult to know exactly the number of Han immigrants due to a lack of reliable statistics. An investigation of the Baojia 保甲 (local policing system) in 1811 reported 1,944,737 persons in Taiwan and this figure can be taken as a comparatively reliable one for the Han population. If we compare this with the 120,000 persons estimated for the Han population around 1680, the annual growth rate during these 131 years can be seen to be 2.1%. As mentioned above, before 1790, immigrants were not allowed to bring their families for most of the years, and thus, the sex ratio was unbalanced. It is quite obvious that during the eighteenth century, the rapid increase of population in Taiwan was due mainly to the influx of immigrants. Another relatively comprehensive investigation of the population in Taiwan was taken during 1892-94. The result showed that there were 2,546,000 persons, most of them being the Han Chinese, except that aborigines were also included in Taidong Zhou 臺東州. Thus, from 1811 to 1893, the annual growth rate of the Han Chinese in Taiwan was about 0.3%. This suggests that during the nineteenth century, the population in Taiwan was gradually reaching a point of saturation, little room was left for new immigrants and the growth rate was much restrained by the frequent occurrences of riots and natural calamities.¹⁶

The Qing government also adopted a prohibitive policy on land to prevent Han immigrants from entering the mountain areas freely. This prohibitive policy was meant to have three aspects: to guard against the Han people occupying strategic locales for stirring up revolts, to restrict the Han people from encroaching upon aboriginal land, and to prevent the mountain aborigines from going out to kill fiercely. To carry out this policy, stones were set up as

¹⁵ See Chen Shaoxin, *Gazetteer of Taiwan province*, section on population, Vol.2, pp. 99-103; Huang Fusan 黃富三, "Qingdai Taiwan imin de gengdi qude wenti ji qi dui tuzhu de yingxiang [The problem of immigrant's land acquisition in Qing Taiwan and its impact on the aborigines]", *Shihuo Monthly* 食貨, 11.1 (1981), pp. 20-22; Shi Tianfu 施添福, *Qingdai zaitai Hanren de zuji fenbu he yuanxiang shenghuo fangshi* 清代在台漢人的祖籍分布和原鄉生活方式 [The distribution of the Han people in Taiwan as reflected by their native places and way of life] (Taipei: National Normal University, 1987), pp.36-37, 44-45; Lin Renchuan 林仁川 and Wang Puhua 王蒲華, "Qingdai Fujian renkou xiang Taiwan de liudong [The flow of population from Fujian to Taiwan in Qing times]", *Lishi yanjiu* 历史研究, [Historical studies] No.162 (1983), pp.132-137.

¹⁶ For population estimations, see Chen Shaoxin, *Gazetteer of Taiwan province*, section on population, Vol.1, pp. 53-57.

boundary markers and guards were posted at strategic passes along the mountains. The first boundary was set up in 1722 after the suppression of the revolt of Zhu Yigui 朱一貴. In the 1740's, ditches were dug at places where stones were set up. In 1760-61, the boundary was reinforced by opening deep ditches and building up earth heaps at places where there were no rivers to serve as a natural boundary. Since the earth heaps looked like oxen lying on the ground, they were called "earthen oxen" (*tuniu* 土牛) and the ditches next to them, *tuniugo* 土牛溝. In 1790, the Qing government allotted the grassland east of the ditch to the acculturated aborigines who served as post guards, and stones were set up for a new boundary. A general opinion held by scholars is that these boundaries served no effective purpose, in no way preventing the Han people from going beyond them. Nevertheless, the deep ditches with earthen oxen lying nearby did form a peculiar human landscape in the mountain areas of northern Taiwan.¹⁷ From the viewpoint of environmental change, the prohibitive policy and existence of these boundaries may to some extent have held back the speed with which the mountain areas were exploited, and hence deforestation.

For the acquisition of land, one had to apply for a license from the local government for opening up ownerless waste land, and for opening up aboriginal land, one had to negotiate a contract, usually through mediation of an interpreter, with the aboriginal landowner.¹⁸ Basically, the Qing government recognized aboriginal land rights and issued several decrees to protect them; the goal of this policy was, however, to maintain order in the frontier society and to reduce conflicts between ethnic groups rather than to secure the interests of the aborigines.¹⁹ Thus, from the eighteenth century on, aboriginal lands gradually changed hands. Of course, during the process of agricultural expansion, Han immigrants took various means to obtain the land. Cases of cooperation, conflicts, mutual marriages and shameless contractual tricks were all found, but the aborigines lost land rights mainly through mechanism of "leasing the land to Han people" and "borrowing money at a long-term low interest rate".²⁰ No

¹⁷ Wang Shiqing 王世慶, "Taiwan aizhi kao [On the system of pass guard in Taiwan]", *Taiwan wenxian*, 7.3-4 (1956), pp. 7-25; Shi Tianfu, "Taiwan lishi dili yanjiu zhaji (I): shishi tuniu hongxian [A note on Taiwan's historical geography (I): an explanation of earthen oxen and red lines]", *Taiwan fengwu* 臺灣風物 [The Taiwan Folkways], 39.2(1989), pp. 95-98; and "Qingdai Taiwan Zhuqian diqu de tuniugou he quyu fazhan [The earthen oxen ditches and development in Zhuqian area in Qing Taiwan]", *Taiwan fengwu*, 40.4(1990), pp. 1-68; J. Shepherd, *Statecraft and Political Economy*, pp. 182-191.

¹⁸ For instance, a license dated 1685 was issued to Shen Shaohong 沈紹宏 for opening up Luyecao 鹿野草 (in today's Chiayi); a contract dated 1730 was signed between Yang Daohong 楊道弘 (who had obtained a license in 1727 to open up Xingzhipu 興直埔 in today's Hsinchuang in Taipei county) and the aboriginal owner of Wulaowan She 武嘜灣社 to cultivate the aboriginal surplus land. See *Qingdai Taiwan dazhu diaochashu* 清代臺灣大租調查書 [Investigation records of big rent in Qing Taiwan], (Taipei, Bank of Taiwan, 1962), p.1, pp.5-7; Liao Hanchen 廖漢臣, *Taiwansheng kaipi ziliao xubian* 臺灣省開闢資料續編 [Collection of materials on the opening up of Taiwan province], (Taichung: The Historical Research Commission of Taiwan Province, 1977), p. 65, p. 74, pp. 109-112.

¹⁹ Shepherd, *Statecraft and Political Economy*, pp.239-307.

²⁰ Huang Fusan, "Qingdai Taiwan de tudi wenti [Land problems of Taiwan in the Qing period]", *Shihuo Monthly*, 4.3(1974), pp. 13-34; Chen Qiukun 陳秋坤, "Pingpuzu Anlishi Panxing jingying dizhu de jueqi, 1699-1770 [The formation of an aboriginal landlord in central

matter whether it was a matter of obtaining a license or negotiating a contract, usually only powerful people could do it. These powerful people customarily called for tenants and the latter were obliged to deposit some money or to open up new land at their own cost, including investments in irrigation works, as the conditions upon which they obtained permanent contracts. These tenants, in turn, called for their own tenants and thus the system of "Two owners of one field" was formed.²¹ The consequence was that the land system became very complicated and serious land problem were created.

2.2 The Area South of the Huweiqi

By 1725, most Han settlements were formed in the area south to the Huweiqi 虎尾溪. After taking over Taiwan, the Qing government established Taiwan as a Fu 府 (Prefecture) of Fujian province to govern this new frontier. Under Taiwan Fu, three *xian* 縣 (counties), Taiwan 臺灣, Fengshan 鳳山, and Zhuluo 諸羅, were set up. The jurisdiction area of Taiwan Xian included Penghu and the area between two rivers: the Ercenghangqi 二層行溪 and the Beigangqi 北港溪; that of Fengshan Xian, south to the former and that of Zhuluo Xian, north of the latter. These three counties extended only along the west coast, while the eastern part beyond the mountains was still rather unknown to Han settlers at this time.²²

The 1696 gazetteer of Taiwan prefecture provided a record about settlements already existed by the end of the seventeenth century. In the Fu city, there were 4 fang (urban wards); Taiwan Xian, surrounding the city, had 15 *li* 里 (villages); Fengshan Xian had 10 *li*, 3 *bao* 保 (rural wards), 5 *zhuang* 莊 (villages), and 12 *she* 社 (aborigine villages); Zhuluo Xian had 4 *li*, 14 *zhuang*, and 40 *she*. In urban wards of the *fu* city, there were already some streets (*jie* 街) and markets (*shi* 市). Streets also existed in some villages: 2 in Taiwan Xian, 3 in Fengshan, and 1 in Zhuluo. These streets and markets were places where commercial activities took place and were the original form of cities developed later. At fang, li, bao, and zhuang, the residents were predominantly the Han people; at she of Fengshan Xian, the Han people mostly lived intermingled with the

Taiwan]", *Bulletin of the Institute of Modern History, Academia Sinica*, 20 (1991), pp. 1-35; and "Shijiu shiji chuqi tuzhu diquan wailiu wenti: yi Anlishe de tudi jingying weili [The outflow of aboriginal land ownership nineteenth century: the case of Anlishe]", in Chen Qiukun and Xu Xueji 許雪姬, eds., *Taiwan lishishang de tudi wenti* 臺灣歷史上的土地問題 [The land issues in Taiwan History], (Taipei: Taiwan History Field Research Office, Academia Sinica, 1992), pp. 29-53.

²¹ Matsuda Yoshirō 松田吉郎, "Shindai Taiwan chū hokubu no suiri jigyo to 'Yi tian liang zhu' sei no seiritsu katei [Hydraulic enterprises in central-north Taiwan under the Qing and the process whereby the system of 'Two owners of one field' was established]", in *Chūgoku suirishi ronsō* 中國水利史論叢 [Collected articles on the history of water control in China, Dr. Satō retirement commemoration volume] (Tokyo: Kokusho kanko-kai, 1984), pp. 411-417; and "Taiwan no suiri jigyo to 'Yi tian liang zhu' sei [Hydraulic enterprises and the system of 'Two owners of one field' in Taiwan]", in *Taiwan lishishang de tudi wenti*, pp. 105-138. I would like to thank Prof. Elvin for providing the first article.

²² Gao Gongqian 高拱乾, *Taiwan Fuzhi* 臺灣府志 [Gazetteer of Taiwan prefecture] (Taipei: Bank of Taiwan, 1960), pp. 5-7; Zhou Wenyan 周文元, *Chongxiu Taiwan fuzhi* 重修臺灣府志 [Revised gazetteer of Taiwan prefecture] (Taipei: Bank of Taiwan, 1960), pp. 6-8.

aborigines; while at she of Zhuluo, the aborigines were predominant.²³

The area of the jurisdiction of Taiwan Xian was changed during the Yongzheng reign (1723-35). In 1727, Penghu was divided off from the county and set up as a Ting 廳 (Sub-prefecture); during 1731-34, some adjustments in the areas of villages were made along the boundaries with the two other counties.²⁴ From then on until 1887 when Taiwan Fu was renamed as Tainan Fu and Taiwan Xian as Anping Xian, the area of Taiwan Xian remained more or less the same.²⁵ The increase of settlements in this area is summarized in Table 1.

Table 1: Settlements in Taiwan Xian, 1720-1830

Time	Fu City		Taiwan Xian	
	N. of <i>jie</i> ^a	No. of <i>li</i>	N. of <i>zhuang</i>	No. of <i>jie</i>
1720	22	15	1	7
1752	45	0	0	(4?)
1807	56 ^b	20	2	8
1830	83	0	0	11

^a These *jie* (streets) existed in the villages.

^b There are also 20 *jie* in suburbs.

Source: Chen Wenda 陳文達, *Taiwan xianzhi* 臺灣縣志 [Gazetteer of Taiwan county] (Taipei: Bank of Taiwan, 1961), pp. 85-86, 91-92. Wang Bichang, *Chongxiu Taiwan xianzhi*, p. 29. Xie Jinluan 謝金鑾, *Xuxiu Taiwan xianzhi* 續修臺灣縣志 [Additional gazetteer of Taiwan county] (Taipei: Bank of Taiwan, 1962), pp. 9-11. Chen Guoying 陳國瑛 et al., *Taiwan caifangce* 臺灣采訪冊 [Records of inquiries in Taiwan] (Taipei: Bank of Taiwan, 1959), pp. 16-17.

Thus, during 1720-1830, the number of streets in the prefectural city increased 277%, and the number of *jie* in the villages increased 57%. In other words, the prefectural city grew quite remarkably.

As for the system of land utilization, during the Zheng period, since land was still abundant, it was possible to adopt shifting cultivation at some places, as noted in the *Zhuluo zashi* 諸羅雜識 [Miscellaneous notes on Zhuluo]: "The nature of the soil was light and loose, and after three years its fertility declined and the harvests decreased, so that many people abandoned their old farms and tilled somewhere else."²⁶ In the early eighteenth century, however, almost all available land around the prefectural city was cultivated and the natural fertility of land was almost exhausted. For instance, the 1720 gazetteer of Taiwan Xian recorded that rice paddies and sugar cane fields in this county had mostly been reclaimed during the Zheng period, "As this is already a long time ago and the fertility of the land is exhausted, the farmers have to apply night soil. It is not as in Fengshan and Zhuluo where lands are newly opened and harvests are ample

²³ Gao Gongqian, *Gazetteer of Taiwan prefecture*, pp. 35-38; Zhou Wenyan, *Revised gazetteer*, pp. 41-44.

²⁴ Wang Bichang 王必昌, *Chongxiu Taiwan xianzhi* 重修臺灣縣志 [Revised gazetteer of Taiwan county] (Taipei: Bank of Taiwan, 1961), pp. 26-28.

²⁵ *Taiwan tongzhi* 臺灣通誌 [Gazetteer of Taiwan] (Taipei: Bank of Taiwan, 1962), p. 29.

²⁶ Cited in Huang Shujing 黃叔璥, *Taihai shichalu* 臺海使槎錄 [A record of rafting over the sea to Taiwan] (Taipei: Bank of Taiwan, 1957), p. 20.

with no need of weeding."²⁷ In 1722, Huang Shujing 黃叔璥, who came to Taiwan as a censor, observed: "In recent years, the cultivated land in Taiwan Xian has become less fertile due to destruction by floods; some people already apply night soil to nourish their lands."²⁸ This shows the effect of population density on land utilization.

Moreover, population density also changed the environment nearby the prefectural city. The 1720 gazetteer described conditions there:

The habitations are dense. There are thousands of households. Heavy dew becomes scarce and miasma can not enter; this is different from Fengshan in the far south where the dew falls right after sunset and the fog disappears after sunrise. ... Nearby the prefectural city, the plain is wide and flat with only some small mounds; this is different from Jilongshan 雞籠山 [in the far north] where the threatening mountain vapors are most dreadful.²⁹

This suggests that around the prefectural city the threat of miasma had diminished because of population density.

It should be noted that in the early eighteenth century, there was no Hakka village in Taiwan Xian. But to the north of Zhuluoshan 諸羅山 and south to the Xiadanshuiqi 下淡水溪, farmers came mostly from Chaozhou; each village had several hundreds, even the smallest one had a hundred-odd persons.³⁰ In short, as the land fertility had declined and the population density was rather high in Taiwan Xian, the newcomers could only go southwards to Fengshan or northwards to Zhuluo.

In Fengshan Xian, villages of immigrants were mostly located along the Xiadanshuiqi and the Donggangqi 東港溪 valleys. The 1720 gazetteer of Fengshan recorded that this county had 9 *li*, 2 *bao*, 6 *zhuang*, 1 *zhen* 鎮 (town), and 12 *she*; moreover, there were 10 *jieshi* 街市 (market-streets).³¹ Compared with twenty-five years earlier, the number of villages had changed slightly, but the market-streets had increased from 3 to 10.

In 1721 when Zhu Yigui uprising occurred, more than 12,000 "righteous people" from 13 big and 64 small villages in Fengshan Xian gathered to assist the Qing army in suppressing the revolt. These people were immigrants from both Guangdong and Fujian provinces.³² This event showed that there were

²⁷ Chen Wenda, *Gazetteer of Taiwan county*, p. 56.

²⁸ Huang Shujing, *A record of fasting*, p. 53.

²⁹ Chen Wenda, *Gazetteer of Taiwan county*, p. 62.

³⁰ *Ibid.*, p. 57.

³¹ Chen Wenda, *Fengshan xianzhi* 鳳山縣志 [Gazetteer of Fengshan county] (Taipei: Bank of Taiwan, 1962), pp. 25-6.

³² Fan Xian 范咸, *Chongxiu Taiwan fuzhi* 重修臺灣府志 [Revised gazetteer of Taiwan prefecture] (Taipei: Bank of Taiwan, 1961), p. 360; Yu Wenyi 余文儀, *Xuxiu Taiwan fuzhi* 續修臺灣府志 [Additional gazetteer of Taiwan prefecture] (Taipei: Bank of Taiwan 1962), p. 450; Chan Shaoxin, *Gazetteer of Taiwan province*, section on population, Vol. 2, p. 106, cited the study of Inō Yoshinori, who did not mention that among the 12,000 people, there were some from Fujian.

already quite a number of Han settlements in this county. After suppression of the revolt, Manbao 滿保, the Governor-General of Fujian and Zhejiang, suggested that a boundary should be set up along the mountains (as discussed above). He also suggested that all houses at the place where Zhu had risen in revolt should be burned down, the people should all be driven back to their native places; those engaging in pulling rattans, sawing boards, burning charcoal, cutting firewood, and tilling land around should all be driven away. In response to Manbao's suggestions, Lan Dingyuan 藍鼎元 wrote a long letter to propose different opinions. He warned that the discarded villages might become resorts of robbers and the supply of timber and firewood would also be affected. Moreover, Taiwan had large profits of rice and sugar, there was no reason to draw back the frontier after it had been expanded.³³ The Qing government finally favored Lan's viewpoints.

In 1731, there was a minor adjustment of boundary between Taiwan and Fengshan Xian.³⁴ It was only until 1875 when the area south to the Shuaimangqi 率芒溪 was divided to set up Hengchun 恆春 Xian, then the area of Fengshan was changed once again.³⁵ There was no record about the number of villages in Fengshan Xian during the later half of the eighteenth century. However, in 1764, among the settlements of this county, 16 were named as jie; most of the jie had only one street but the county site at Xinglongzhuang 興隆莊 had 6 and Xiapitoujie 下陂頭街, located 20 Chinese 'miles' east of the county site, had 4 streets.³⁶ Compared with 40 years earlier, the number of jie again increased from 10 to 16.

The 1894 records showed that Fengshan Xian was divided into 14 *li* which consisted of 948 *zhuang* and 8 *jieshi* where markets were convened daily.³⁷ As for Hengchun Xian, the 1889 investigation recorded 13 *li* with 89 *zhuang*.³⁸ These numbers at least suggested that south to the Ercenghangqi, villages became more densely distributed and market-streets were increasing during the eighteenth and nineteenth centuries.

At the same time, together with the expansion of settlements, the number of irrigation works also increased. The 1720 gazetteer of Fengshan recorded water conservancy as follows: 17 reservoirs (of which 15 were constructed during the Zheng period, and 6 had springs and 11 had not), 5 pools (among which only one had a spring), 2 creeks, 1 lake and 1 gully. The reservoir, the pool and the

³³ Lan Dingyuan, *Dongzhengji* 東征集 [Collection of writings on expedition to the east] (Taipei: Bank of Taiwan, 1958), pp. 33-40. Lan Dingyuan also wrote some poems which carried similar ideas; see Chen Hanguang 陳漢光 ed., *Taiwan shilu* 臺灣詩錄 [Collection of poems on Taiwan], (Taichung: The Historical Research Commission of Taiwan Province, 1971), pp. 204-206. I would like to thank Prof. Elvin for calling my attention to these poems.

³⁴ Wang Yingzeng 王瑛曾, *Chongxiu Fengshan xianzhi* 重修鳳山縣志 [Revised gazetteer of Fengshan county], (Taipei: Bank of Taiwan, 1962), pp. 8-9; Lu Deji 盧德嘉, *Fengshanxian caifangce* 鳳山縣採訪冊 [Records of inquiries in Fengshan county] (Taipei: Bank of Taiwan, 1960), p. 1. The two records are slightly different.

³⁵ *Gazetteer of Taiwan*, pp. 11-12.

³⁶ Wang Yingzeng, *Revised gazetteer of Fengshan*, pp. 31-32.

³⁷ Lu Deji, *Records of inquiries*, pp. 1-14, 136-139.

³⁸ Tu Jishan 屠繼善, *Hengchun xianzhi* 恆春縣志 [Gazetteer of Hengchun county] (Taipei: Bank of Taiwan, 1960), pp. 125-129.

lake which had springs did not dry up during times of drought; both the creek and the gully had springs and flowed over a long distance. Generally speaking, the reservoirs were built, while the lake, pool, creek, and gully were based on the simple utilization of natural water, including rain water.³⁹ In 1722, Huang Shujing visited the area south of the Xiadanshuiqi and saw that the villagers were all Hakkas, "They built reservoirs for the supply of irrigation water and tilled very hard on their farms," he reported.⁴⁰ Again, the 1764 Fengshan gazetteer recorded that there were 27 reservoirs; 10 of them having existed since the Zheng period, and except for the one built by General Shi Lang, the remaining 16 had been newly built after 1722. In addition, there were 10 pools, of which 7 were new and some were no longer the simple utilization of natural water but built by the villagers; one was even built by the aborigines. Moreover, there were 2 creeks and 2 gullies, but the only lake no longer existed.⁴¹

Finally, the 1894 investigation produced detailed records and classified water conservancy in Fengshan Xian into five categories. Only a summary will be given here. The irrigation ditches were organized into three systems which consisted of at least 140 ditches and irrigated 10,161 *jia*. These irrigation ditches were mostly completed after 1838 when Magistrate Cao Jin 曹謹 initiated the construction. There were 135 reservoirs which actually functioned and irrigated 4,374 *jia*. Moreover, the 22 deep pools irrigated 835 *jia*, 18 ponds irrigated 116 *jia*, and 305 water pits irrigated 577 *jia*. Thus, the five categories irrigated a total of 16,481 *jia*; or about one fourth of the cultivated acreage (80,314 *jia*) in Fengshan Xian.⁴² It is also notable that there were only four artificial fishing ponds around 1720 but the number had increased to 96 around 1890.⁴³ In sum, the increasing number of irrigation works and fishing ponds indicated changes in the rural environment of Fengshan.

In Zhuluo Xian, the early stages of agricultural expansion by Han immigrants proceeded as follows:

- (1) "When the county was first established, the county site was situated among wild grasses, civil and military officials all stayed at Jialixing 佳里興; the crowd of migrating cultivators did not go farther beyond Douliumen 斗六門."
- (2) In 1704, "the crowd of migrating cultivators gradually moved north of Douliumen."
- (3) In 1710, "the crowd of migrating cultivators gradually moved beyond Banxian and north to the Daduqi 大肚溪. From now on, there were more and more migrants and some of them arrived at Rinan 日南, Houlong 後龍, Zhuqian and Nankan."
- (4) In 1717, the area between Banxian and Danshui was still a wilderness of trees, streams, and fertile lands, but migrating cultivators took boats to go

³⁹ Chen Wenda, *Gazetteer of Fengshan*, pp. 29-31.

⁴⁰ Huang Shujing, *A record of rafting*, p. 53.

⁴¹ Wang Yingzeng, *Revised Gazetteer of Fengshan*, pp. 35-39.

⁴² Lu Deji, *Records of inquiries*, pp. 65-112; for the total cultivated acreage, see Chen Shaoxin, *Gazetteer of Taiwan province*, section on population, Vol.1, pp.61-63.

⁴³ Chen Wenda, *Gazetteer of Fengshan*, p. 32; Lu Deji, *Records of inquiries*, pp. 112-116..

back and forth and already knew that there were strategic locales by land and water routes around Dajia 大甲, Houlong and Zhuqian.⁴⁴

Thus by 1720, the plain south to Banxian had almost all been reclaimed by Han immigrants, while to the north, besides some points scattered along the coast, it was still a wilderness.

As for the irrigation systems which were constructed along with the process of reclamation, the 1717 gazetteer of Zhuluo lists 75 reservoirs and ditches with the year of construction. The earliest one was Xinpi 新陂 (new reservoir) constructed in 1692. A simple distribution with time shows that 9 works were built before 1701, 27 between 1702 and 1711, and 39 between 1712 and 1717. Among the last 39 works, 36 were completed during 1714-17 when Zhou Zhongxuan 周鍾瑄 was the magistrate, and he had contributed silver or grain to help the construction of 28 works. As for the location of reservoirs, the northernmost one was located at Maowushu 貓霧揀 (in today's Taichung 臺中) and was built in 1717 with a contribution of grain by Magistrate Zhou. Next, five reservoirs located near Huweiqi and Banxian were also supported by Zhou's contributions. These six reservoirs were all given to Zhanghua Xian later.⁴⁵ Due to the fact that the plain south to Banxian was almost all opened up, the author of the Zhuluo gazetteer suggested: "The area north to Banxian should be divided to establish another county and allow the people to open up new land freely."⁴⁶

In fact, it was only after Zhu Yigui's revolt had been suppressed that Zhuluo Xian was divided to establish Zhanghua Xian in 1723 and Danshui Ting in 1731. Thus, the confines of Zhuluo ran south to the Huweiqi. Zhuluo was renamed Jiayi 嘉義 in 1787 by the Qianlong Emperor to compliment the people for their resistance to rebellious Lin Shuangwen 林爽文. In 1887, the area north of the Niuchouqi 牛稠溪 and south to the Zhuoshuiqi 濁水溪 was again taken from Jiayi to establish Yunlin 雲林 Xian.⁴⁷ New administration divisions implied to some extent the increase of new settlements.

There seems to be no record about the number of settlements in Zhuluo (Jiayi) from the 1720s to the 1890s. Scholars often used the names of *jie* and *zhuang* listed in the *Jiayi guannei caifangce* 嘉義管內采訪冊 [Records of inquiry in the jurisdiction of Jiayi] to discuss the situation in late Qing. However, this record was compiled during 1897-1901 when Taiwan was under the Japanese rule and should only be used as a reference for the period before Yunlin Xian was established. According to this source, Jiayi Xian had 5 *bao* 堡 (rural subdivisions) under which there were 166 *zhuang* and 4 *jie*.⁴⁸

⁴⁴ Chen Menglin 陳夢林, *Zhuluo xianzhi* 諸羅縣志 [Gazetteer of Zhuluo county] (Taipei: Bank of Taiwan, 1962), pp. 110, 112, 114.

⁴⁵ Chen Menglin, *Gazetteer of Zhuluo*, pp. 34-41; Zhou Xi 周璽, *Zhanghua xianzhi* 彰化縣志 [Gazetteer of Zhanghua county] (Taipei: Bank of Taiwan, 1962), p. 56.

⁴⁶ Chen Menglin, *Gazetteer of Zhuluo*, p. 112.

⁴⁷ Lian Heng, *General history*, pp.110-111, 115, 121-122; Chen Yan 陳衍, *Taiwan tongji* 臺灣通紀 [A chronology of Taiwan] (Taipei: Bank of Taiwan, 1961), pp.138-139.

⁴⁸ *Jiayi guannei caifangce* 嘉義管內采訪冊 [Records of inquiry in the jurisdiction of Jiayi] (Taipei: Bank of Taiwan, 1960), pp. 1-2, 15-16, 23-27, 49-51, 55-59; for an example of work based on the use of this material, see Chen Shaoxin, *Gazetteer of Taiwan province*, section on

It is also not clear whether new irrigation systems were added during this period. If we compare the records in the Zhuluo gazetteer and Lian's *General History of Taiwan*, we see that all 34 works included in the latter already existed in the former.⁴⁹ It is notable that Lujuegoupi 鹿堀溝埤, Shisijiazun 十四甲圳, and Meizikengzun 梅子坑圳 were not included in previous records, but the time of their construction is not clear.⁵⁰

As for Yunlin Xian, in 1894 this county was divided into 15 *bao*, with a total number of 708 *zhuang* and 18 *jie*. In regard to water conservancy, there were 34 reservoirs, 25 irrigation ditches, and one drainage ditch.⁵¹ In sum, increases in settlements and irrigation works in Jiayi and Yunlin can still be roughly seen on the basis of these limited records.

2.3 The Area South of the Dajiaqi

As mentioned above, Zhanghua Xian was established in 1723. This county governed the area north to the Huweiqi and south to the Dajiaqi. The western part of this area was situated along a cliff from which abundant springs flow out and this made it an ideal location for immigrants to establish new settlements.⁵² As late as 1735, Zhanghua was still a place where Han immigrants lived intermingled with the aborigines.⁵³ But new settlements increased rapidly. Around 1745, there were 110 *zhuang* and around 1830, there were 1090 *zhuang*.⁵⁴ During the same period, the number of *jie* increased from 9 to 41.⁵⁵ In other words, during eight-five years, *zhuang* increased 890 percent and *jie* 355 percent. It is notable that *jie* did not increase as fast as *zhuang* may imply that some *jie* had gradually become larger central places.

In respect to water conservancy, Babaozun 八堡圳, the most important irrigation system related to the development of central Taiwan, was initiated as early as in 1709 by Shi Shibang 施世榜, a migrant from the south, and was

population, Vol.1, pp. 69-71; Hong Cannan 洪燦楠, "Taiwan diqu juluo fazhan chi yanjiu [A study on development of settlements in Taiwan]," *Taiwan wenxian*, 29.2 (1978), p. 38.

⁴⁹ Chen Menglin, *Gazetteer of Zhuluo*, pp.34-41; Lian Heng, *General history*, pp. 673-675.

⁵⁰ *Record of inquiry in Jiayi*, pp.16, 29, 52, 61.

⁵¹ Ni Zanyuan 倪贊元, *Yunlinxian caifangce* 雲林縣採訪冊 [Records of inquiries in Yunlin county] (Taipei: Bank of Taiwan, 1959), pp.2-200.

⁵² Wen Zhenhua 溫振華, "Qingdai Taiwan zhongbu de kaifa yu shehui bianqian [Development and social changes in central Taiwan during the Qing period]", *Shifan daxue lishi xuebao* 師範大學歷史學報 [Historical Journal of Normal University], 11(1983), p. 43.

⁵³ "Guandimiao beiji 關帝廟碑記 [A stele of the Temple of the God of War]", in *Taiwan zhongbu beiwen jicheng* 臺灣中部碑文集成 [Collection of steles of central Taiwan] (Taipei: Bank of Taiwan, 1962), pp.1-2. The inscription was written in 1735.

⁵⁴ Liu Liangbi 劉良璧, *Chongxiu Fujian Taiwan fuzhi* 重修福建臺灣府志 [Revised gazetteer of Taiwan prefecture in Fujian], (Taipei: Bank of Taiwan, 1960), pp.77-80; Fan Xian, *Revised gazetteer of Taiwan*, pp. 67-68. The records of these two sources are the same, the year 1745 is taken as a proxy for Liu's gazetteer was compiled in 1741 and Fan's gazetteer in 1747. As for the number of *zhuang* in 1830, Wen Zhenhua counted it to be 983; see his "Development and social changes," p. 69. The number 1089 is a calculation from Chou Xi, *Gazetteer of Zhanghua*, pp. 43-51.

⁵⁵ Wen Zhenhua, "Development and social changes," pp. 73-74. The number counted from Chou Xi, *Gazetteer of Zhanghua*, pp. 39-42, is 34 in addition to the county city.

completed ten years later with the assistance of a Mr. Lin who solved the difficult technical problem of leading water from the Zhuoshuiqi into irrigation ditches.⁵⁶ The 1807 gazetteer of Zhanghua records 27 reservoirs and ditches, but mostly without giving the time of construction. There were nine exceptions including the aforementioned six reservoirs built originally in Zhuluo Xian during 1714-17 and three others built in 1721, 1735, and 1751. In addition, rivers and mountain springs were utilized for irrigation; it was only the coastal land that had not yet been irrigated.⁵⁷ As reconstructed by modern geographers, settlements were formed along irrigation ditches in this area during the process of reclamation.⁵⁸

The area of today's Taichung city and county roughly runs between the Daduqi on the south and the Daanqi 大安溪 on the north; this area was under the jurisdiction of Zhanghua Xian by 1887 when a new county was established.⁵⁹ The opening up of this area by Han immigrants was mostly after 1700. Some studies have been done recently on this subject, and it will suffice to summarize findings related to settlements below.

After about 1700, immigrants of Fujian and Guangdong origins came to this area. They arrived at about the same time, and at the beginning, there was no distinction on the lines that Fujianese tended to settle down in the plain while Hakkas lived on the hillside. This differentiation appeared only after 1782 when feuds among the local groups took place more frequently.

When Han immigrants first arrived, they tended to select a place that was well-drained but accessible to the water. In most cases, such a locality had already been chosen by the aborigines. Thus, whether or not Han immigrants could smoothly acquire the land depended on how well could they get along with and negotiate with the aborigines. The most famous example here was the case of Zhang Dajing 張達京 who signed up contracts with the aborigines of Anli She 岸裡社 to open up the land with the construction of the irrigation system at the area around present-day Fengyuan.

The extension of new assarts moved from the coastal plain up to the mountain side. During the Qianlong reign, except for the mountain areas, cultivable lands were mostly reclaimed. In the coastal plain, reclamation was mostly done by individual farming households, while near the mountain area, large scale cooperative organizations were formed and armed guards were posted at passes in the mountains in order to cooperate in cultivation and to provide defense against the mountain aborigines. This type of organization was commonly found

⁵⁶ Chou Xi, *Gazetteer of Zhanghua*, p. 56. For studies on Babaozhen see, Morita Akira 森田明, *Shindai suirishi kenkyū* 清代水利史研究 [Studies on history of water conservancy in Qing times] (Tokyo: Aki shobo, 1974), pp. 498-562; Wang Sung-hsing, "Pa Pao Chun: an 18th Century Irrigation system in Central Taiwan", *Bulletin of the Institute of Ethnology, Academia Sinica*, No. 33 (1972), pp. 165-176; and "Babaozhen yu Taiwan zhongbu de kaifa [The Babao irrigation canal system and opening up of central Taiwan]", *Taiwan wenxian*, 26.4-27.1(1976), pp. 42-49.

⁵⁷ Zhou Xi, *Gazetteer of Zhanghua*, pp. 55-58; Wen Zhenhua, "Development and social changes," pp. 60-64.

⁵⁸ Shi Zaitian 石再添 et al., "Zhuoda liuyu de juluo fenbu yu dixing zhi xiangguan yanjiu [A geographical quantitative study on the distribution of communities in the Zhuoshui and Dadu river drainage basins in central Taiwan]", *Taiwan wenxian* 28.2(1977), pp. 83, 87.

⁵⁹ Lian Heng, *General history*, p. 119.

in the reclamation of mountain areas in Taiwan.⁶⁰

2.4 The Area North of the Dajiaqi

The area north of the Dajiaqi was under the jurisdiction of Danshui Ting after 1731. The Ting site was located at Zhuqian, but the office of the Sub-prefect was first built at Zhanghua; a new office was built at Zhuqian only in 1756.⁶¹ The jurisdiction area of Danshui Ting changed four times in the nineteenth century. In 1826, the area beyond Yuanwangkeng 遠望坑 at Sandiao 三貂 was given to Gemalan Ting 噶瑪蘭廳. In 1875, Taipei Fu 臺北府 was set up to supervise the Danshui Ting, Gemalan Ting and the newly established Jilong Ting 基隆廳. In 1878, Danshui Ting was divided into Xinzhu 新竹 and Danshui Xian. Finally, in 1889, Miaoli 苗栗 Xian was established.⁶² This section discusses the area lying west to Gemalan.

In the early eighteenth century, most parts of Danshui Ting still remained a wilderness. As mentioned above, in 1697 when Yu Yonghe traveled between Zhuqian and Nankan, he saw groups of deer but not a single man. Han immigrants moved gradually to Rinan, Houlong, Zhuqian and Nankan after 1710. In 1721, however, Lan Dingyuan still noted: "The sphere of Zhuqianpu 竹塹埔 was about one hundred *li*, walking through it all day long and one saw no habitation."⁶³ In addition, there are two often cited passages. One is a poem entitled "Zhuqian" written by Ruan Caiwen 阮蔡文 in 1715, one line of which reads, "The deer fields are now half opened up by migrants."⁶⁴ The other is a statement of Huang Shujing in 1722: "Previously, all the lands near the mountains were aboriginal deer fields; now, Han settlers till them, good farm lands extend as far as one can see, and deer can be hunted only in the deep

⁶⁰ Hong Liwan 洪麗完, "Qingdai Taizhong difang Fu-Ke guanxi chutan: jian yi Qingshui pingyuan sanshan guowangmiao zhi xingshuai weili [A preliminary study on relations between Fujianese and Hakka in Central Taiwan in the Qing period: the case of the three mountain Kings' temple at the Qingshui plain]", *Taiwanshi yanjiu lunwenji* 臺灣史研究論文集 [Symposium of studies on Taiwan history] (Taipei: Research Center of Taiwan Historical Landmark, 1988), pp. 135-85; Wen Zhenhua, "Development and social changes," pp. 43-95; Chen Yanzheng 陳炎正, *Xinguangzhuang: yige Taiwan xiangcun de shehui fazhanshi* 新廣莊：一個臺灣鄉村社會發展史 [A study of social development of a village in Taiwan] (Taichung: Taichung Research Association on Poetry, 1984), pp. 32-60; Zhang Longzhi 張隆志, *Zuqun guanxi yu xiangcun Taiwan: yige Qingdai Taiwan pingpu zuqunshi de chongjian he lijie* 族群關係與鄉村臺灣：一個清代臺灣平埔族群史的重建和理解 [Ethnicity and rural Taiwan: an ethno-historical study of the Pazeh in Qing times] (Taipei: National Taiwan University, 1991), pp. 122-152.

⁶¹ Yu Wenyi, *Additional gazetteer*, pp. 4, 67; Chen Peigui 陳培桂, *Danshui tingzhi* 淡水廳志 [Gazetteer of Danshui sub-prefecture] (Taipei: Bank of Taiwan, 1963), p. 51.

⁶² Zheng Pengyun 鄭鵬雲 et al., *Xinzhu xianzhi chugao* 新竹縣志初稿 [Draft gazetteer of Xinzhu county] (Taipei, Bank of Taiwan, 1960), p.1; Shen Maoyin 沈茂蔭, *Miaoli xianzhi* 苗栗縣志 [Gazetteer of Miaoli county] (Taipei: Bank of Taiwan, 1962), p.17. *Xinzhuxian caifangce* 新竹縣採訪冊 [Records of inquiries in Xinzhu county] (Taipei: Bank of Taiwan, 1962), p. 2, records that Xinzhu and Danshui were divided in 1879.

⁶³ Lan Dingyuan, *Collection of writings*, p. 87.

⁶⁴ Chen Peigui, *Gazetteer of Danshui*, p. 434.

mountains."⁶⁵ In regards to these two passages, Shi Tianfu has pointed out that they were misused most of the time. He says that Huang's statement was applicable not to Zhuqian but to the area south of the Dajiaqi, or perhaps south of the Daduqi. Ruan's poem refers to Zhuqian or at most to its vicinity, and not to the entire Zhuqianpu. The pioneer cultivator of Zhuqian, Wang Shijie 王世傑, came around 1711, while the opening up of Zhuqianpu was mostly after 1723.⁶⁶

By 1735, new assarts were found only in the coastal plain of the Zhuqian area. Immigrants came mostly during the Qianlong reign (1736-95) and new arrivals could be found almost every year, farm lands were mostly reclaimed from the wilds and Han immigrants cooperated quite well with the aborigines. In the Jiaqing reign (1796-1820), cultivators gradually moved into the mountain areas and during the Daoguang period (1821-50), the reclamation was speeded up.⁶⁷ For opening up the mountain areas, at least 18 large-scale cooperative organizations were formed and the most famous among them was the Jinguangfu 金廣福. Besides farming, they also engaged in gathering the sap from camphor trees for the manufacture of camphor, and cutting camphor-wood for the building of warships. Tremendous progress was made in the development of the mountains. By the Tongzhi period (1862-74), almost all cultivable lands in the near mountain areas had been reclaimed.⁶⁸

After 1875, the Qing government started to adopt the positive policy of "open the mountains and soothe the aborigines (*kaishan fufan* 開山撫番)", old guards at strategic passes were abolished and new bureaus in charge of the task known as *fukenu* 撫墾局 (pacification and reclamation bureau) were set up. At the same time, some large-scale private organizations, among whom the most famous was Guangtaicheng 廣泰成, were also formed to undertake the opening up of the mountain areas. The cooperation between official and private

⁶⁵ Huang Shujing, *A record rafting*, p. 65.

⁶⁶ Shi Tianfu, "Taiwan lishi dili yanjiu zhaji (II): Zhuqian, Zhuqianpu he luchang banwei liuminkai [A note on Taiwan's historical geography (II): Zhuqian and Zhuqianpu and the deer fields being half opened up by the migrating crowd]", *Taiwan fengwu*, 39.3(1989), pp. 73-82; Shi Tianfu, "Qingdai Zhuqian diqu de kenquzhuang: Cuifengzhuang de sheli he yanbian [The reclamation village of the Zhuqian area in Qing times: the establishment of and changes in Cuifengzhuang]", *Taiwan fengwu*, 39.4(1989), pp. 33-69.

⁶⁷ For a chronology of the arrival of new immigrants, see Sheng Qingyi 盛清沂, "Xinzhu, Taoyuan, Miaoli san xian diqu kaipishi [A history of the opening up of the three counties of Xinzhu, Taoyuan, and Miaoli]", *Taiwan wenxian*, 31.4 (1980), pp. 168-176; 32.1 (1981), pp. 136-149.

⁶⁸ Shi Tienfu, "Earthen oxen ditches," pp. 30-33. Wu Xueming 吳學明, *Jinguangfu kenai yu Xinzhu dongnan shanqu kaifa, 1834-1895* 金廣福墾隘與新竹東南山區的開發(1834-1895) [The organization of Jinguangfu and the opening up of southeastern mountain areas in Xinzhu county, 1834-1895] (Taipei: National Normal University, 1986), pp. 121-265; Zhuang Yingzhang 莊英章 and Chen Yundong 陳運棟, "Wan Qing Taiwan beibu hanren tuoken xingtai de yanbian: Yi Beipu Jiangjia de kenpi shiye weili [The changing pattern of reclamation by the Han Chinese in northern Taiwan during the late Qing: the case of the Jiang family at Beipu]", in *Taiwan shehui yu wenhua bianqian* 臺灣社會與文化變遷 [Social and Cultural Change in Taiwan (Taipei, Institute of Ethnology, Academia Sinica, 1986), pp. 1-43; Matsuda Yoshirō 松田吉郎, "Gōkon soshiki 'Kinkōfuku' ni tsuite [On the cooperative cultivation organization: the inguangfu]", *Taiwanshi kenkyū* 台灣史研究, 9 (1991), pp. 1-18.

organizations in this process seems to have been quite effective.⁶⁹

The effect of the preventive boundaries along the mountains should be noted here. Recently, Shi Tianfu has been able to reconstruct the locations, distributions, and patterns of *tuniugou* in the Zhuqian area by matching materials from the local gazetteers and old contracts with findings of field works. He contends that the existence of *tuniugou* and the 1790 new boundary helped create three distinctive human geographical zones which had different land systems and social organizations but had one common feature, namely, that the pattern of settlements was predominantly scattered hamlets of individual farms of tenants, who used their own labor and capital to open up new lands. Among such scattered hamlets, some compact villages also developed revolving around places where the Han and aboriginal landlords or headmen of tenants collected rents.⁷⁰

As for the opening up of the area that is today Taipei, though a few scattered Han settlements might have been founded during the Zheng period, the earliest document related to the reclamation of the Taipei plain was a proclamation of reclamation at Dajiala 大佳臘 (in today's Taipei city). This document was given to a cooperative reclamation household (*kenhu* 墾戶), known as Chen Laizhang 陳賴章, in 1709 by the acting magistrate of Zhuluo county. From then on, small and large cooperative households were formed and more than 20 of them left valuable documents. Lands were reclaimed either from grassland or woodland. Among these households, there were competitions, cooperation, lawsuits and transfers relating to land acquisition. Only those who managed the reclamation in a manner of an "enterprise" were most likely to be successful.⁷¹ During the Qianlong reign, almost all cultivable lands of the Taipei plain were reclaimed and migrants began to open up the nearby mountain areas, such as Shiding 石碇 and Dakekan 大嵙崁. In 1886 a Fukenu was set up at Dakekan and in 1894 Nanya Ting 南雅廳 was established to govern the nearby area.⁷² It is to be noted that the commercial center of the Taipei plain was located at Xinzhuang 新莊 in the mid-eighteenth century; it was only around 1820 that Mengjia 艋舺

⁶⁹ Huang Zhoquan 黃卓權, "Taiwan caihai hou de zhuming kenai: Guangtaicheng kenhao chutan [A famous cultivation organization in Taiwan after the abolition of official posts: the case of Guangtaicheng]", *Taiwanshi yanjiu ji shiliao fajue yantaohui lunwenji* 臺灣史研究暨史料發掘研討會論文集 [Proceedings of conference on Taiwan history and the discovery of historical materials] (Kaohsiung: Research Center of Taiwan Historical Landmark, 1987), pp. 105-40; Huang Zhoquan, "Cong Shitan shanqu de tuoken kan wan Qing Taiwan neishan kenwu de yanbian [Changes in reclamation in the inner mountain areas of Taiwan in the late Qing as viewed from the case of the Shitan mountain area]", *Taiwanshi yanjiu lunwenji* 臺灣史研究論文集 [Symposium of studies on Taiwan history] (Taipei: Research Center of Taiwan Historical Landmark, 1988), pp. 103-131.

⁷⁰ For details see Shi Tianfu, "Reclamation village," pp. 33-69; Shi Tianfu, "Earthen oxen ditches," pp. 1-68; and Shi Tianfu, "Qingdai Zhuqian diqu de juluo fazhan he xingtai [The development and pattern of settlements in the Zhuqian area]", in *Land issues*, pp. 71-82.

⁷¹ Yin Zhangyi 尹章義, *Taiwan kaifashi yanjiu* 臺灣開發史研究 [Studies on opening up of Taiwan] (Taipei: Lianjing, 1989), pp. 29-150.

⁷² Mitsuura Yūshi 三浦祐之, "Taihoku heiya no kaitaku ni tsuite [On the reclamation of Taipei plain]", *Taiwan nōjihō* 台灣農事報 [Journal of agriculture in Taiwan], 29.11(1933), pp. 46-56, 30.2 (1934), pp. 58-62. Chen Shaoxin, *Gazetteer of Taiwan province*, section on population, Vol.2, pp. 106, 116; Chen Zhengxiang, *Geography of Taiwan*, pp. 1015-1020.

(Wanhua 萬華 in today's Taipei city) rose to take over its place.⁷³

The increase of settlements in Danshui Ting was at first quite rapid. In 1747, Danshui Ting was divided into 2 *bao*: Danshui Bao with 25 *zhuang* and Zhuqian Bao with 10 *zhuang*; moreover, there were 2 *jie*: Zhuqian and Balifen.⁷⁴ Around 1774, Danshui Ting included 132 *zhuang*, of which 29 were south of the Ting city and 103 north of it. As for the *jie*, six more were added, namely, Zhonggang 中港, Houlong, Yuanli, Xinzhuang, Mengjia, and Bazhilanlin 八芝蘭林 (today's Shihlin 士林 in Taipei city).⁷⁵ This shows that during twenty-seven years, *zhuang* increased 277 percent and *jie* by 300 percent. Furthermore, the 1871 gazetteer recorded that there were 6 streets in the Ting city; outside the city, there were 6 *xiang* 廂 (suburbs) with a total number of 80 *zhuang*. North of the Ting city (in today's Taoyuan and Taipei counties), there were 8 *bao* with 160 *zhuang* and among them 10 *jie*. South of the Ting city (today's Hsinchu and part of Miaoli counties) there were 4 *bao* with 137 *zhuang* and among them 5 *jie*. Altogether, there were 297 *zhuang* and among them 15 *jie*.⁷⁶ These figures show that between 1774 and 1871, the number of settlements was more than doubled (*zhuang* increased 125 percent and *jie* 150 percent).

The 1894 *Xinzhuxian caifangce* 新竹縣采訪冊 [Records of inquiry in Xinzhu county] recorded the situation after Danshui Ting had been divided. According to this source, Xinzhu Xian included three *bao*: Zhuqian, Zhu'nán 竹南, and Zhubei 竹北. It is quite difficult to compare these divisions precisely with those in 1871. Roughly speaking, the area of Zhuqian bao included the city and suburbs around it; besides the original six suburbs, two more were added. As for the number of *zhuang*, there were 9 outside the four city gates and 201 at the eight suburbs. It should be noted that the village names listed under the original six suburbs were not all listed again in the 1894 record. In terms of the total number, between 1871 and 1894, *zhuang* increased from 80 to 210, the rate of increase was 163 percent, or 7 percent per annum. Zhu'nán Bao (the former Zhonggang Bao) had 26 *zhuang* in 1871 and 66 in 1894, an increase of 154 percent, or 6.7 percent per annum. As for Zhubei Bao, there were 281 *zhuang* in 1894, but most of them can not be compared with earlier records.⁷⁷ In any case, it is obvious that during the last quarter of the nineteenth century, the number of villages in Xinzhu Xian was increasing faster than it had in previous one hundred years.

Also around 1894, the gazetteer of Miaoli Xian recorded that the county included 3 *bao* with 198 *zhuang*.⁷⁸ This figure may be compared with the 111 *zhuang* of the three *bao* in 1871; thus, it can be calculated that there was an increase of 78 percent during twenty-three years or about 3 percent per year. The increase of settlements in what is today Taoyuan and Taipei counties during the same period cannot be discussed here because of a lack of comparable documents.

⁷³ Yin Zhangyi, *Studies on the opening up*, p. 393.

⁷⁴ Fan Xian, *Revised gazetteer*, pp. 69, 78.

⁷⁵ Yu Wenyi, *Additional gazetteer*, pp. 75-78, 89-90.

⁷⁶ Chen Peigui, *Gazetteer of Danshui*, pp. 57-64.

⁷⁷ *Xinzhuxian caifangce* [Records of inquiries], pp. 68-83.

⁷⁸ Shen Maoyin, *Gazetteer of Miaoli county*, pp. 36-48.

Concerning water conservancy in Danshui Ting, the gazetteers of Taiwan prefecture, revised in 1747 and 1774, provided no record. However, this does not imply that Han immigrants did not build irrigation works along with reclamation in this area. The 1871 gazetteer of Danshui Ting records 42 items under the category of reservoirs and ditches, among which was one built by the pioneer cultivator, Wang Shijie. Obviously, irrigation works were constructed here along with the opening up new lands just as in other areas. The location of these irrigation ditches showed that 2 were near the Ting city, 22 north of the Ting city and 18 south of it. With available information related to builders and time, it is possible to figure out that 2 were built in the Yongzheng period and 15 were in the Qianlong period.⁷⁹

The 1894 *Records of Inquiries for Xinzhu County (Xinzhu caifangce)* stated that since the Qianlong and Jiaqing periods, numerous reservoirs and ditches were built: Zhuqian Bao had 46 irrigation ditches and one natural ditch, Zhu'nan had 12 irrigation ditches, and Zhubei had 16 irrigation ditches and one natural big water pit. Moreover, the three *bao* each had 4 reservoirs; those at Zhuqian and Zhu'nan were built during the Daoguang and Guangxu periods, while those in Zhubei were the big ones that had springs as water sources.⁸⁰

In Miaoli, there were 27 irrigation ditches around 1894. One of them, located six Chinese 'miles' north of the county capital had already been destroyed by the flood.⁸¹ Compared with the number in 1871, there was an increase of 10 ditches. It is notable that among the existing 26 ditches, 12 were old, but the irrigation acreage had increased. This suggested that not only new works were added but old ones were also expanded.

2.5 The Area Behind the Mountains

The area east of the Central Mountain Range was usually referred to as the area 'behind the mountains' in the Qing literature. The first administrative division set up in this area was Gemalan Ting in 1810; it was upgraded to Yilan Xian 宜蘭縣 in 1875.⁸² The earliest venturers to try to open up Gemalan were dated back to 1768, but they were killed by the aborigines. Some tried again but all failed. It was not until 1796 that Wu Sha 吳沙, a resident at Sandiao and a trader experienced in dealing with the aborigines, decided to open up the fertile land of

⁷⁹ Chen Peigui, *Gazetteer of Danshui*, pp. 73-80; also see Mitsuura Yūshi, "On the reclamation", pp. 54-56.

⁸⁰ *Xinzhuxian caifangce* [Records of inquires], pp. 141-163.

⁸¹ Shen Maoyin, *Gazetteer of Miaoli*, pp. 51-54.

⁸² For opening up of this area see, Chen Shujun 陳淑均, *Gemalan tingzhi* 噶瑪蘭廳志 [Gazetteer of Gemalan sub-prefecture] (Taipei: Bank of Taiwan, 1963), pp. 3, 329-330; Lian Heng, *General history*, pp. 853-855. Li Luping, 李鹿苹, *Taiwan xiaoquyu dili yanjiuji* 臺灣小區域地理研究集 [A collection of geographic studies on small areas in Taiwan] (Taipei: National Institute for Compilation and Translation, 1984), pp. 16-19; Zhuang Yingzhang 莊英章 and Wu Wenxing 吳文星, "Qingdai Toucheng de token yu fazhan [The exploitation and development of Toucheng under the Qing dynasty]", *Taiwan wenxian*, 36.3-4 (1984), pp. 215-223; Liao Fengde 廖風德, *Qingdai zhi Gemalan: yige Taiwanshi de quyu yanjiu* 清代之噶瑪蘭: 一個臺灣史的區域研究 [Gemalan in Qing times: a regional case-study in the history of Taiwan], (Taipei: Zhengzhong, 1990), pp. 79-109.

Gemalan. Wu Sha recruited vagrants of Zhangzhou, Quanzhou, and Guangdong origins to serve as vanguards to lead village-braves to go ahead and tenants to follow later; they built the first settlement at Touwei 頭圍. The encroachment of outsiders stirred up the resistance of the aborigines, toward whom Wu Sha took both measures of compromise and intimidation. It was, however, due to the fact that he cured the aborigines from an epidemic of smallpox that he was able to win their trust.⁸³ In 1797, Wu Sha went to Danshui Ting to obtain a license and recruited more tenants. The reclamation was quickly expanded to Erwei 二圍. At the end of that year Wu Sha died, and the leadership was entrusted to his nephew Wu Hua 吳化. Wu Hua negotiated with the aborigines for a cease-fire. He also mediated feuds among different Han immigrant groups. In 1802, the reclamation was extended to Wuwei 五圍 (Yilan city). From then on, more and more immigrants arrived and in 1809, they crossed the Lanyangqi 蘭陽溪 to open up the south bank of this river. During 1821-50, the fertile lands on both banks of the Lanyangqi were almost all cultivated and new immigrants moved toward the hillside area. The opening up of these hillsides was led by Chen Huihuang 陳輝煌 and the land reclaimed was more than 800 *jia* by 1874. Among the Han Chinese, the Zhangzhou group constituted the majority and settled on the rich soils in the middle of the plain, the Quanzhou group at the two sides of the plain, and the Guangdong group at the hillsides. Hamlets in this area were mostly as scattered as those in northern Taiwan. However, the land tenancy system did not play a significant role in shaping the settlement pattern here.⁸⁴

The number of settlements increased very rapidly in the beginning. The 1832 gazetteer recorded that the Ting capital had 22 streets and that outside the city, there were 11 *bao* with 97 *zhuang* and 3 *jie*.⁸⁵ This shows that the number of Han settlements increased from one to one hundred in 35 years. If we compared these figures for 1832 with the number of 276 *zhuang* and *jie* that existed in 1898, over that period, the increase averaged 2.7 percent per year.⁸⁶

With regard to water conservancy, the 1832 gazetteer recorded 19 irrigation ditches, 5 dikes and 8 reservoirs with no reference to the date of construction.⁸⁷ A later estimate suggested that in the Qing period, Gemalan had more than 80 reservoirs and irrigation ditches; they were all privately owned and the earliest work could be dated back to the time of Wu Sha. In other words, just as in other area, the works of irrigation were undertaken simultaneously with reclamation. It is notable that the Lin family of Banqiao (板橋林家) was deeply involved in investment in water conservancy and in the camphor trade of this area since the

⁸³ See Wen Zhenhua 溫振華, "Taiwan tuzhu tianhua chuanbo chutan [Preliminary study on infection by smallpox among Taiwan aborigines], in Liao Yunfan 廖運範 et al., eds., *Chen Shengkun ishi jinianji 陳勝崑師紀念集* [Essays in memory of Dr. Chen Shengkun] (Taipei: Jujing, 1992), pp. 82-94.

⁸⁴ Cho-yun Hsu, "The Chinese Settlement of the I-lan Plain", in R. Knopp ed., *China's Island Frontier* (Honolulu: University of Hawaii Press, 1980), pp. 69-86.

⁸⁵ Chen Shujun, *Gazetteer of Gemalani*, pp. 25-28. Ke Peiyuan 柯培元, *Gemalan zhilüe 噶瑪蘭誌略* [A short gazetteer of Gemalan] (Taipei: Bank of Taiwan, 1961), pp. 27-8, listed 12 *bao*.

⁸⁶ Liao Fengde, *Gemalan in Qing times*, pp. 34-36.

⁸⁷ Chen Shujun, *Gazetteer of Gemalan*, pp. 17, 36-41. Ke Peiyuan, *Short gazetteer of Gamalan*, pp.36-42, listed the same number.

Daoguang period.⁸⁸

Although some earlier venturers went to the area south of Gemalan, the opening up of eastern Taiwan mostly proceeded after 1875 under the policy of *kaishan fufan*. In that year, Beinan Ting 卑南廳 was established and it was upgraded to Taidong Zhou in 1887.⁸⁹

Two measures were taken to open the mountains: (1) the army was dispatched to build roads and to provide defense and (2) people were recruited to open up new lands. To begin with, three roads were constructed in 1875 to connect west and east, and people who were willing to follow were recruited. In 1886, three bureaus (*fukenu*) were set up at Beinan, Pushige 璞石閣 and Hualian 花蓮. Moreover, bureaus for recruiting cultivators (*zhaokenju* 招墾局) were set up in Amoy, Swatow, and Hong Kong. The recruits were provided with rations and one *jia* of land per person; they were also assisted with cattle, seeds, and implements; and it was ruled that the land reclaimed would be exempted from tax for three years. However, few people were recruited to Taiwan for most of those who migrated went to Southeast Asia rather than Taiwan. Thus, Huang Yanzhao 黃延昭, Magistrate of Hengchun, suggested that farmers already in Taiwan be recruited to move east on the same terms. In the 1880s, more people did move east and the cultivated lands were somewhat expanded. But not many movers actually settled down, for some of them died and most of them left due to maladjustment to the local climate.⁹⁰ In 1894, Taidong Zhou had 32 Han settlements: the smallest one had only 2 or 3 households and the largest one, no more than 90 households.⁹¹

The area behind the mountains was opened up much more slowly than the west coast. Lian Heng has two comments on this situation. According to him, eastern Taiwan remained a wilderness and agriculture had not been extended after twenty years of administration, for there was a lack of transportation facilities and "miasma" was still dreadful.⁹² Herein lay the environmental problems to be tackled for further development of this area.

2.6 Penghu

Finally, let us have a look at Penghu where the Han Chinese had settled earlier than on the Island of Taiwan itself. Penghu was established as a Ting in 1727, and this status did not change until the end of the Qing period.

The unit of settlements at Penghu was known as the *ao* 澳 (bay); the local gazetteer described it as follows: "The houses are all built in the hollows of the hills or at the bays, and so a place is called an *ao*."⁹³ This shows the influence

⁸⁸ Liao Fengde, *Gemalan in Qing times*, pp. 190-202.

⁸⁹ Lian Heng, *General history*, pp. 125-127, 417; Chen Xianzhong 陳顯忠, "Tan Taiwan houshan zhi kaifa [Discourse on the opening up of the area behind the mountains in Taiwan]", *Taiwan wenxian*, 32.1(1981), p. 187.

⁹⁰ Chen Zhengxiang, *Geography of Taiwan*, p. 1215.

⁹¹ *Taidongzhou caifangce* 臺東州采訪冊 [Records of inquiries in Taidong district] (Taipei: Bank of Taiwan, 1960), pp. 18-21.

⁹² Lian Heng, *General history*, p. 126, p. 447.

⁹³ Lin Hao 林豪, *Penghu tingzhi* 澎湖廳志 [Gazetteer of Penghu sub-prefecture] (Taipei: Bank of Taiwan, 1963), p. 322.

of particular natural conditions on the pattern of settlement in Penghu. During the Kangxi period, there were only 9 *ao*, from the Yongzheng period on, the population increased and 4 more were added; during the Qianlong period, there were 13 *ao* and under them some 75 *she* 社 (villages).⁹⁴ The 1893 gazetteer recorded that there were 13 *ao* and 82 *she*, but among them, only Magong She 媽宮社 was densely populated. Furthermore, only six *she* had 300 to 1,000 households, while the rest were just very small villages scattered on isolated small islands.⁹⁵ Again, this shows that the pattern of settlement in Penghu is rather peculiar. Due to its special geographical conditions, Penghu had no water conservancy; some concerned local officials tried, however, to promote it by paying much attention to digging wells.⁹⁶

The residents in Penghu came mainly from Quanzhou.⁹⁷ The genealogical records show that from late Ming to early Qing, the majority of immigrants were from Jinmen 金門.⁹⁸ From the Qianlong period on, the population of Penghu increased rapidly but famines occurred frequently (during 1762-1892, on the average, there was one famine in every 4.1 years), and thus, there were outmigrations to Taiwan.⁹⁹ Outmigrations were mostly seasonal prior to 1850, and most people went to the Hengchun area to work on farms or to make charcoal; after 1850, most of them went to the Tainan area to engage in commerce or to learn handicrafts; and after 1900, most went to the Kaohsiung area.¹⁰⁰ In short, Penghu is no longer a fisherman's island group as the Portuguese saw it in the sixteenth century.

2.7 Different Patterns of Rural Settlements

As mentioned above, in the process of reclamation in the Zhuqian area the isolated farmhouses of tenants gradually formed scattered settlements. Researches in this area touch on the issue of relationship between reclamation and the pattern of settlement. Tomita Yoshirō was the first scholar to do field-work on this problem and published his findings in 1933. He pointed out that forms of rural settlements were different in Taiwan; villages in the south were compact while those in the north were dispersed; the dividing line between these two regional patterns was marked by the Zhuoshuiqi, with a transitional area between this river and the Daduqi. This general viewpoint was repeated in

⁹⁴ Hu Jianwei 胡建偉, *Penghu jilüe* 澎湖紀略 [Notes on Penghu] (Taipei: Bank of Taiwan, 1961), p. 33.

⁹⁵ Lin Hao, *Gazetteer of Penghu*, pp. 78-82.

⁹⁶ Hu Jianwei, *Notes on Penghu*, p. 46; Lin Hao, *Gazetteer of Penghu*, p. 309.

⁹⁷ Du Zhen 杜臻, *Penghu Taiwan jilüe* 澎湖臺灣紀略 [Notes on Taiwan and Penghu] (Taipei: Bank of Taiwan, 1961), p. 2.

⁹⁸ Chen Shaoxin, *Gazetteer of Taiwan province*, section on population, Vol. 1, pp. 19-20; Xu Xueji 許雪姬, "Penghu de renkou qianyi: yi Baisha Wadongcun weili [Migration of the population in Penghu: The case of Wadongcun at Baisha]", in *Zhongguo haiyang fazhanshi lunwenji* 中國海洋發展史論文集 [Essays on Chinese maritime history] (Taipei: Institute of Three People's Principles, Academia Sinica, 1988), pp. 61-92.

⁹⁹ Chen Shaoxin, *Gazetteer of Taiwan province*, section on population, Vol. 2, pp. 21-30.

¹⁰⁰ Cited in Xu Xueji, "Migration of the population," p. 62.

Tomita's later works.¹⁰¹ In 1951, Chen Zhengxiang also did fieldwork in many places. He used the number of main house in a village as a criterion of classification and proved once again that a regional pattern did exist.¹⁰² Both Tomita and Chen contended that the regional pattern was a result of interactions between natural and human conditions, and that the most relevant factors were the limitation of water sources, differences in natural geographic features, the necessity of defense, and the organization of the land system. Most scholars who have dealt with this issue have accepted this generalization about regional differences; even when quantitative geographical methods are applied to measure the distribution of settlements more precisely, the basic regional pattern is not changed.¹⁰³ With regard to the relevant factors, some scholars have tended to reiterate the above four;¹⁰⁴ while others have tried to emphasize the applicability of certain factors at certain localities.¹⁰⁵ On this issue, further study should be done case by case, and more attention should be paid to changes in the twentieth century, particularly those taking place during the process of Taiwan's industrialization, but these are beyond the purview of this paper.

3. Further Remarks

To sum up, in the seventeenth century, more Han settlements laid the foundation for further development in Taiwan; in the eighteenth century, despite the prohibitive policies of the Qing government, agricultural expansion proceeded rapidly from south to north; by 1895, when Taiwan was ceded to Japan, the plains, the uplands, and the hillsides in the west and northeast of the Island were almost all cultivated, and the opening up of the eastern longitudinal valley was already initiated. Total cultivated acreage in Taiwan at that time was 600,000 hectares, more than thirty-three times that at the end of the Zheng period.¹⁰⁶ The legacy of agricultural expansion by the Han people was summed up succinctly by Lian Heng when he said: "Taiwan was indeed but an island of waste land,

¹⁰¹ Tomita Yoshirō 富田芳郎, "Taiwan ni okeru noson shuraku no keitai ni tsuite [On the rural settlement forms in Taiwan]", *Taiwan chigaku kiji* [Description of Taiwan's geography], 4.2-4.3(1933), pp.11-14, 18-24. I have not yet collected all Tomita's works related to this topic, but fortunately, Shi Tianfu has collected 29 works and reviewed Tomita's theory and methodology. See his "The development and pattern," pp. 58-62. To save the space, this paper will not list all Tomita's works.

¹⁰² Chen Zhengxiang, *Geography of Taiwan*, pp. 256-260.

¹⁰³ For examples, Chen Fanghui 陳芳惠, "Taoyuan taidi juluoqing de jiliang dili [A geographical quantitative study on the distribution of communities on the Taoyuan plateau]", *Taiwan wenxian*, 27.2 (1976), pp. 311-318; Shi Zaitian et al., "Geographical quantitative study," pp. 91-92.

¹⁰⁴ For example, Hong Cannan, "Study on development," pp. 37-42.

¹⁰⁵ For examples, Ronald Knapp, "Settlement and Frontier Land Tenure," pp. 55-68, has pointed out that land-tenancy system was a major factor in the Taoyuan alluvial plain; Cho-yun Hsu, "The Chinese Settlement of the I-lan Plain," pp. 69-86, has argued that *per contra* the land system was not a significant factor for the I-lan region; Shi Tianfu, "The development and pattern," pp. 63-64, has suggested that the organization of reclamation was the major factor that influenced the original pattern of the settlement, but that the maintenance of the pattern was affected by natural conditions such as climate, physical features, and hydrology as well as human factors such as the style of agricultural management.

¹⁰⁶ Chen Zhengxiang, *Geography of Taiwan*, p. 30.

[our ancestors] lived in a humble way and opened up the mountains and forests, [their achievements are] what we have relied on until today."¹⁰⁷ Here I will only propose a few points for further study on the environmental history of Taiwan.

First, there is a problem of “miasma” or endemic disease. When Taiwan was first opened up, its bad climate was a great source of dread that deterred immigrants. As mentioned above, in 1697, Yu Yonghe accepted that accumulated “miasma” was the reason for the illness of his followers; he mentioned that the patients quivered, but he had no idea that chills were a symptom of malaria.¹⁰⁸ Prior to the twentieth century, a common idea of those who talked about climate in Taiwan was that “miasma” would diminish with the spread of human habitations. As mentioned earlier, the 1720 gazetteer of Taiwan Xian stated that “miasma” was no longer harmful there for habitations were already quite dense. A few more examples are given below.

The 1717 gazetteer of Zhuluo stated:

The vapors of mountains and rivers have accumulated to become “miasma”; once human beings have brought them under their management, these vapors have a means of being dissipated and what is closed up is gradually opened; this is a common rule of nature. When garrisons are numerous, villages dense, roads opened and trees uprooted, then insects, serpents, and other harmful species are gradually driven away, and as soon as the darkness and viciousness have disappeared, the pestilence ceases of its own accord. On top of this, as long as the people manage to have clean houses and food, and with supplement of medicine, they do not have to worry about bad environment anymore.¹⁰⁹

In the early nineteenth century, Xie Jinluan held this opinion:

Taiwan was originally a place of poisonous “miasma”....After the administration was set up, the people gathered and the population increased, the epidemic vapors disappeared and the fogs, the dews, the winds, and the rains can no longer have anything to pick up to become “miasma”. Thus we know when the *yin* and the *yang* are in harmony, the cold and the warm whether will be in right season. Ever since the ancient time, many people have held this view, isn't it due to the efforts of man?"¹¹⁰

Similarly, in the mid-nineteenth century, Ding Shaoyi commented: “We know that the local climate [*diqu* 地氣, literally, 'the energy-vitality of the earth'] will be changed by man. ...When Gemalan was first opened up, there were more rainy days than sunny ones; now, however, cold and warm are both the same as

¹⁰⁷ Lian Heng, *General history*, p.15, Author's preface.

¹⁰⁸ Yu Yonghe, *Travel over a small sea*, p. 26. For the identification of *zhangqi* 瘴氣 as malaria, see Chen Shengkun 陳勝崑, *Zhongguo jibingshi* 中國疾病史 [History of disease in China] (Taipei: Jujing Publishing, 1992), pp. 159-169.

¹⁰⁹ Chen Menglin, *Gazetteer of Zhuluo*, p. 113.

¹¹⁰ Xie Jinluan, *Additional gazetteer*, p. 47; the same words were also cited in Zhou Xi, *Gazetteer of Zhanghua*, p. 30.

in the interior, and there is no more poisonous 'miasma'."¹¹¹

In short, the above statements all carry the same idea that "miasma" would disappear by human management although none of these authors recognized it as malaria. As a matter of fact, it was not until 1965 that malaria was eradicated in Taiwan as the result of great human efforts.¹¹²

The fact is that "miasma" was still quite dreadful in Taiwan at the end of the nineteenth century. When the Huai 淮 and the Japanese armies landed on Taiwan at different expeditions, they were infected by epidemics (*yili* 疫癘).¹¹³ Some of these have been identified as malaria, cholera or other diseases.¹¹⁴ But the issue of *yili* needs further study. Moreover, studies should also be done on the effects of changing grassland into rice paddies. Was the style of paddy rice cultivation in Taiwan also related to certain kinds of disease introduced by parasitic insects, such as hookworm?¹¹⁵ Further studies are required to look into the relationship between environment and health in Taiwan.

Next, there is a problem of the living environment. As mentioned above, Yu Yonghe talked about how inconvenient and dangerous the thatched huts and their natural surroundings were. According to a study by Fang Hao, the roofs of houses in southern Taiwan had been gradually changed from thatch to tile in the Kangxi period, but in the Yilan area, the same change started only in the Daoguang reign.¹¹⁶ Because of the limited availability of building materials, most houses in rural Taiwan were still thatch-roofed until the end of the nineteenth century. For example, an observation on Yunlin Xian around 1894 reported:

This place does not have many cryptomeria, the columns and pillars of houses in the county city are mostly made of bamboo (the kind is *cizhu* 薊竹, *Bambusa stenostachya* Hack.) and on top are tile-roofed; but in the villages most houses are thatch-roofed. Even though the simple ancient style is thus still preserved, it is apt to catch fire. Recently, houses have been roofed by split Makino's bamboos (*guizhu* 桂竹, *B. makinoi* Hayata), which is not as durable as tile, but can last for seven to eight years.¹¹⁷

The materials and forms of houses are important components of the environmental scene, thus, it is important to investigate into changes in houses.

¹¹¹ Ding Shaoyi 丁紹儀, *Dongying shilüe* 東瀛識略 [A note on the eastern ocean] (Taipei: Bank of Taiwan, 1957), p. 56.

¹¹² Chen Shengkun, *History of disease*, p.169. Wang Jinmao 王金茂 et al., *Nüe'ji chengyin yu kongzhi ji qi genchu fazhan zhixiang* 瘧疾成因與控制及其根除發展指向 [The cause and control of malaria and the direction of its eradication in Taiwan] (Taichung: Taiwan Provincial Government, 1974), pp. 85-103.

¹¹³ See Chen Yan, *Chronology of Taiwan*, pp. 203-256, for records by year.

¹¹⁴ Chen Shengkun, *History of disease*, p. 46, 168.

¹¹⁵ Jacques May, "The Ecology of Human Disease", in Jack Bresler, ed., *Environment of Man* (Reading, Mass.: Addison-Wesley Publishing, 1968), p. 79.

¹¹⁶ Fang Hao, "Taiwan shishang de yimao yiwa [On changing thatch to tile in the history of Taiwan]", in *Collected works*, Vol. I, pp. 738-743.

¹¹⁷ Ni Zanyuan, *Records of inquiries*, p. 27.

Some fieldwork has recently been done, but more is needed.¹¹⁸ Scholars interested in the built environment have paid much attention to the concept of space reflected in vernacular houses.¹¹⁹ More important, studies should be undertaken not only on the spatial structure of individual houses, but also on the built environment of entire settlements; this kind of study is still rather rare.¹²⁰ It seems that only architects can handle the topic of the built environment with ease;¹²¹ however, if the subject concerned is not limited to the spatial structure of buildings, then many aspects related to human habitation, such as water supply, garbage disposal and so on, still require further studies.¹²² In particular, during recent decades, houses in Taiwan have been undergoing great changes, and the living environment is certainly an important topic for future study.

This chapter only traces changes in the number of settlements and irrigation works; this is, no doubt, only a very rough approximation. Further studies are required on the growth and decline of settlements and irrigation systems, and these studies should be done with meaningful specific cases.¹²³

Finally, it should be noted that this paper does not deal with issues in the twentieth century. From the 1930s onwards, Taiwan has been gradually changing from an agricultural society into an industrial one; thus, new environmental issues relating to settlements are emerging, and with a greater urgency. These issues will have to be dealt with by other studies.

¹¹⁸ For example, see Xu Xueji et al., *Taizhong xian jianzhu fazhan: minzai pian* 台中縣建築發展 – 民宅篇 [Development of vernacular houses in Taichung county] (Fengyuan: Cultural Center of Taichung County, 1991 and 1993).

¹¹⁹ For example, Guan Huashan 關華山, "Taiwan chuantong minzhai suo biao xian de kongjian guannian [Spatial concept presented in the vernacular houses in Taiwan]," *Bulletin of the Institute of Ethnology, Academia Sinica*, No.49 (1980), pp. 175-215.

¹²⁰ For example, Lin Huicheng 林會承 and Qiu Yongzhang 邱永章, "Wugoushui shizhi huanjing zhi xingcheng yu jiegou [Formation of material environment and its structure: the case of Wugoushui]," *Taiwanshi yanjiu xueshu yantaohui lunwenji* 臺灣史研究學術研討會論文集 [Symposium of studies on the history of Taiwan] (Taipei: Research Center of Taiwan Historical Landmark, 1989), pp. 127-175.

¹²¹ For the theory of built environment see, Amos Rapoport, *The Mutual Interaction of People and Their Built Environment* (The Hague: Mouton, 1976).

¹²² For example see, Liu Ts'ui-jung 劉翠溶 and Liu Shi-yung 劉士永, "Jingshui zhi gongji yu wushui zhi paifang: Taiwan juluo huanjingshi yanjiu zhi yi [Water supply and water drainage: a study on the history of environment in Taiwan]," *Academia Economic Papers*, 20.2 (1992), pp. 459-504.

¹²³ For example, a study on spatial changes in harbors in Taiwan has just been completed by Lin Yuru 林玉茹, "Qingdai Taiwan gangkou de kongjian jiegou [The spatial structure of harbors in Taiwan during the Qing period]," M.A. thesis, National Taiwan University (1993). Further studies still need to be done to relate environmental change with the growth and decline of harbors.