Chapter VI

Environment Versus Water Control: The Case of the Southern Hangzhou Bay Area from the Mid-Tang through the Qing Period

Introduction

This chapter is an attempt to illustrate in considerable detail the historical interplay between a progressive movement of colonization and eventual change in environmental settings which took place in the lower Yangzi River (Yangzijiang 揚子江) region.

From the earliest times the Chinese have been distinguished for a pervasive tendency to settle in lowland areas, while proving themselves with a genius for developing both advanced technology and organizational skill required for draining and reclaiming wild lowlands. A superb illustration of such water control skills may be found in the extensive reclamation carried out in the lower Yangzi delta from the eighth to the thirteenth century. How such a difficult, large-scale project was feasible in the rather short span of time of only a few hundred years is a question that will be examined here within a wider context including the lower Yangzi delta and its neighbor, the southern Hangzhou Bay (Hangzhouwan 杭州灣) coast, and over a longer span of time. I will then examine the ecological distribution patterns shared by both these areas. Next, based on the fact that the southern Hangzhou Bay coast historically preceded the lower Yangzi delta in the development of systems for reclaiming swampy floodplains, I will analyze the essentials of the methods of water control that emerged in the bay area, inferring that these methods were implemented on an extensive scale when the lower Yangzi low1ands were later opened.

The southern Hangzhou Bay coastal area also preceded the lower Yangzi delta in experiencing the worsening balance between resources and population characteristic of late-imperial times. In the final section of this chapter, I will examine how the people of the bay area responded to the intensifying environmental crisis they were facing.

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1. The Lower Yangzi Region

1.1 Formation and Settlement of the Delta

A preference for low-lying locations for settlement has been a traditional feature of Chinese society. Professor Chang Sen-dou argues:[1]

> Among the 1276 county (*xian* 縣) capitals in the eighteen provinces of China Proper in the 1890s, 913, or well over 70 percent, were located at elevations below 400 meters. Even those cities situated above that level were largely concentrated in the lowest-lying portions of each province. Yet areas below 400 meters account for less than a quarter of the total territory in the eighteen provinces.

The Chinese preference for low-lying urban sites is closely associated with the heavy concentration of their predominantly agrarian population in the lowlands—in flood plains, river valleys, intermontane basins, and small oases along the foothills. As a result, upland areas, marginal for Chinese agriculture, remained largely unsettled and undeveloped. Indeed, the drainage basins provided colonists with higher levels of agricultural productivity and crucial transport advantages.

By the eighth century, the feasibility of expanding intensive rice culture, salt production, and commercial tea plantation in South China became widely apparent throughout the empire. Immigrants from distant areas, northerners in particular, moved into the southeastern provinces filling the open spaces and trying to occupy the unsettled lowlands of the lower Yangzi delta, among other areas. This ushered in a massive reclamation movement in the delta during the succeeding several centuries.

From a long-run perspective, the land formation of the lower Yangzi delta was basically the product of natural processes.[2] Prior to the Neolithic Age, Tai Lake (Taihu 太湖), located in the center of the present-day delta, was a bay directly open to the sea. At that time the whole Yangzi valley was covered with thick forest and vegetation. The amount of sediment carried by the Yangzi River was small, and a portion of it settled as mud on the bottom of natural reservoirs existing

[1] Chang Sen-dou, "The Morphology of walled capitals," in *The city in late imperial China*, ed. G. William Skinner (Stanford: Stanford University Press, 1977), 85–86. See also Chang Sen-dou, "Some aspects of the urban geography of the Chinese *hsien* capitals," *Annals of the Association of American Geographers* 51 (1961): 309; Ho Ping-ti, *Studies on the population of China, 1368–1953* (Cambridge, Mass.: Harvard University Press, 1959), 147.

[2] Tan Qixiang, "Shanghai shi dalu bufen de hailu bianqian he kaifa guocheng" [The process of land formation along the coastlines and of the reclamation of such alluvium in the vicinity of present-day Shanghai], *Kaogu* 1 (1973): 2–10.

here and there along the course of the river. In time, a thin sandy elevation of headland developed from the northern part of the bay later to become Tai Lake, advanced eastward, and then, blocked by oceanic tides and currents, made a bend southeastward. Meanwhile, the silt that flowed from the mouth of the Qiantang River (Qiantangjiang 錢塘江) facilitated a gradual development of a flat plain to the south of what was to become Tai Lake. The headland of this flat plain also moved eastward, finally joining headland building up from the northeast to form the earliest historical shorelines of the delta. The easternmost coastlines ran parallel with those of the present day, but they were more than ten kilometers towards the interior what would become the city of Shanghai 上海. With the emergence of these coastlines, Tai Lake became a lagoon. A long elevated belt with a width of 1.5 to 8.0 kilometers, and running closely parallel with the eastern-most coastlines was formed by the forces of the oceanic tides and currents. The central area between this elevated stretch and Tai Lake remained for a long while as a marshy lowland throughout which numerous small islands were interspersed.

Human habitation in the delta area began in the Neolithic Age. At first colonists preferred to settle in the areas around Tai Lake. The further direction of colonization seems to have moved from there to the flat plain to the south and southeast of the lake, and to the elevated belt along the eastern coastlines. Up to the fourth century AD, the formation of an alluvium seaward from the easternmost shorefront remained minimal at a rate of one kilometer per several hundred years. The delta's southern coastlines facing Hangzhou Bay were unstable because they were open to erosion by currents and tides. Between the fourth and seventh centuries, the eastern shorelines of the delta advanced for about ten kilometers at a rate of one kilometer per forty years. Nevertheless, only scattered population distribution existed in the eastern section of the delta. From the Former Han 前漢 through the mid-Tang 唐 period, the establishment of three county capitals can be ascertained there. However, two of them were abolished in the late sixth century due to administrative restructuring.[3]

A dramatic change in the colonization of the delta took place during the eighth through thirteenth centuries. The construction of long earthen seawalls along the eastern shorelines in the early eighth century indicates the advent of intensified reclamation of the delta. The lines of these seawalls ran parallel with the eastern edges of the sandy elevation about ten kilometers seaward of it. At one point they passed the site of modern Shanghai. Soon the seawalls were extended along the delta's shoreline facing Hangzhou Bay so that they reached Hangzhou. The final step of this construction was taken during the time of the Wuyue Kingdom (Wuyueguo 吳越國) (907–78). This was the building of stone seawalls at the mouth of the Qiantang River where Hangzhou, the capital of that kingdom, was located.

[3] Tan, "Shanghai shi dalu bufen de hailu bianqian he kaifa guocheng," 3–4.

Reflecting the sudden progress in the reclamation of the delta areas as a whole, the eastward advance of the land was accelerated on the eastern coastlines. Hence a second line of seawalls had to be built at a distance of around seven kilometers seaward of the Tang seawalls during the first half of the tenth century, and again a third line at a distance of around six kilometers seaward of the second line in 1172. Thus during the fifth through twelfth centuries, the total advance of land eastward in this section came to approximately thirty kilometers, a pace of one kilometer per twenty-seven years. Formerly, the areas bordering the southern and eastern coastlines of the delta had had only one county-level capital, Haiyan 海鹽, which had been maintained since Han times. This location was dominated by salt production, located near the southern end of the elevation. In 751 the capital of Huating *xian* 華亭縣 was founded to the east of Haiyan. In order to administer these two counties, Xiuzhou 秀州 prefecture (later Jiaxing 嘉興) was established to the southeast of Tai Lake.[4] We may conclude from these facts that the colonization of the eastern part of the lower Yangzi delta was carried out in relatively recent times.

1.2. The Physiography of the Lower Yangzi Region

In advance of the detailed description that follows, it would be useful to take a look at the physiographic features of the lower Yangzi region. Map 1 shows, in simplified manner, a distribution pattern of various ecological zones that together form the region's overall topography.[5]

A six-fold zonal subdivision of the region is possible in terms of ecological differences: in order of elevation, (1) hills, (2) fan/slope complexes, (3) elevated

[4] Tan, "Shanghai shi dalu bufen de hailu bianqian he kaifa guocheng," 4–7; Akiyama Motonobu, "Shanhaiken no seiritsu" [The formation of Shanghai county], in *Chūgoku kinsei no toshi to bunka* [The city and urban culture in early modern China], ed. Umehara Kaoru (Kyoto: Kyōto Daigaku Jinbun Kagaku Kenkyūjo, 1984), 455–484.

[5] Map 1 was drawn with reference to the discussion and the accompanying map in Gong Chunsheng, "Taihu diqu tudi leixing tezheng" [The characteristics of physiographical types in the Tai Lake area], in *Taihu liuyu shuitu ziyuan ji nongye fazhan yuanjingyanjiu* [Water and land resources in the Yangzi valley and a long-term agrarian development in the area] (Nanjing: Zhongguo Kexueyuan Nanjing Dili Yu Hubo Yanjiusuo, 1988), 60–69. See also Shiba Yoshinobu, *Sōdai Kōnan keizaishi no kenkyū* [Studies in the economy of the lower Yangtze in the Song] (Tokyo: Tōkyō Daigaku Tōyō Bunka Kenkyūjo, 1988), 167–179; Takaya Kōichi, "Tai inasaku no shizen kōzō: Chikei to inasaku" [The physical structure of rice culture in Thailand: Geomorphology and rice culture], in *Taikoku: Hitotsu no inasaku shakai* [Thailand: A rice cultivating society], ed. Ishii Yoneo (Tokyo: Sōbunsha, 1975), 215–239; Takaya Kōichi, *Nettai deruta no nōgyō hatten* [Agrarian development in tropical delta regions] (Tokyo: Sōbunsha, 1982), 10–19.

plains, (4) low-lying plains, (5) sandy elevations, and (6) lowlands.[6] Rice cultivation had been practiced in the region throughout historical times, and it goes without saying that the "lowland" areas stand out among the rest in terms of rice production scale. However, the region's history indicates that the conversion of the lowlands into paddy through the construction of enclosures did not occur until the tenth through fourteenth century, due to the unavailability of a sustained, regulated supply of fresh water into the paddies there before that time.

Given population scarcity and underdeveloped water control technology, cultivators were primarily concerned with stable production and livelihood. It was the upland areas which abounded in small separated basins, surrounded by forests, that best filled such needs. When the population came to exert severe pressure on the resources of these upland basins, those outnumbered found the areas of the "fan/slope complex" to be their second-best choices for cultivation and settlement. While people enjoyed a larger area there, its physical surroundings were less favorable than those in the hills. During the rainy season, torrents of water ran down through the area. Furthermore, since surface water percolated into the ground water through the loamy soil, the areas generally tended to possess an arid topography. The building of artificial reservoirs at the heads of alluvial fans in this ecological zone was indispensable for sustaining livelihood there. The reservoirs served several functions: protection against seasonal inundation and providing a supply of regulated irrigation and fresh drinking water.

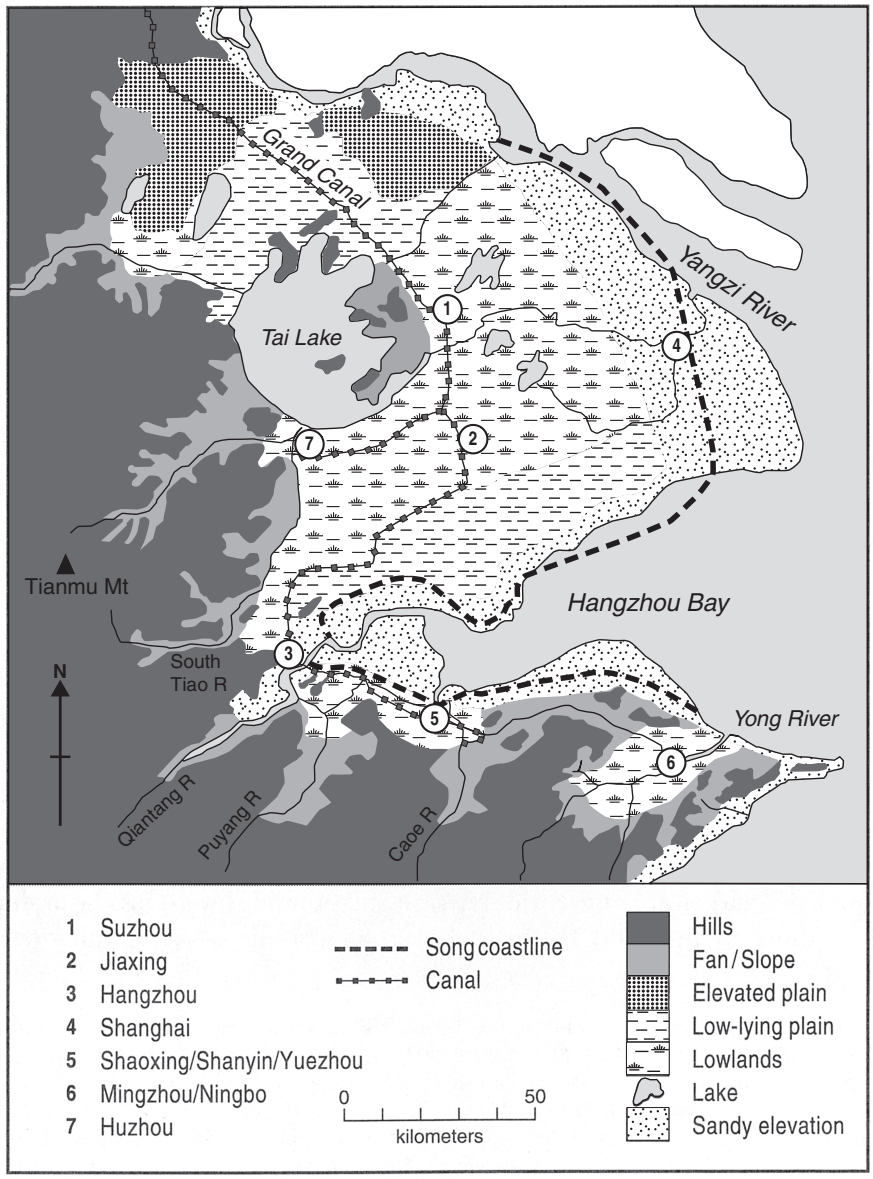
As stated above, the "lowlands" resisted settlement over a long period of time. Though they were very extensive in their dimensions, these areas in earlier times were covered with brackish water. The amount and the level of such water fluctuated considerably, either in response to seasonal variations in the amount of stream water from the uplands or in accordance with the ebb-and-flow movement of the tide. Conditions for settlement and production in the "elevated plains," "lowlying plains," and "sandy elevations" in earlier times were somewhat better than those in the "lowlands." People in the elevated plains could survive by cultivating dry and wet crops, while those in the low-lying plains near Hangzhou Bay and in the sandy elevations along the eastern coast carried on salt production and fishing.

All in all, if we assume that the lines delineated by the Grand Canal and the Zhedong Canal (Zhedonghe 浙東河) (parallel to the southern Hangzhou Bay coastline) are indicative of the boundary between the old and the new deltas, we may infer that the region's colonization in earlier centuries took place in the old delta, its centers being located in a "fan/slope complex."[7]

[6] See Takaya, "Tai inasaku no shizen kōzō," 216–239, and *Nettai deruta no nōgyō hatten*, 10–19.

[7] Shiba, *Sōdai Kōnan keizaishi no kenkyū*, 169–179.

Map 1. Ecological Zones of the Lower Yangzi Delta



2. Water Control Prototype in the Southern Hangzhou Bay Area

2.1 Jian Lake in the Shaoxing Plain

The size of the Shaoxing 紹興 Plain encompassed a moderate area of about 700 square kilometers, mostly ten meters or less above sea level. In earlier times there was no peninsula-like salient of sandy sedimentation projecting northward into Hangzhou Bay from the shoreline of the area's western half. The plain lay between the shorelines of the bay and the foothills at the base of the mountain ranges (300 to 700 meters high) to the south. The northern half of the plain was low at two to three meters above sea level. The plain's eastern end was bounded by the Caoe River (Caoejiang 曹娥江), while its western end was demarcated by the Xixiao River (Xixiaojiang 西小江), or the lower reaches of the Puyang River (Puyangjiang 浦陽江). The Caoe and the Puyang Rivers formerly joined to form a common estuary at the seashore near where the Caoe still flows. Later, in the middle of the fifteenth century, an artificial diversion of the Puyang River into the Qiantang River was constructed at the point where the Puyang flowed into the plain. Prior to that, the river water was drained off into the bay by way of the Xixiao River. Thus before the mid-Ming 明 period, the runoff from the southern mountains, which was collected by these two rivers caused chronic seasonal flooding in the plain. In addition, the currents and tides of the bay transported brine up into its interior, leaving salt deposits there to form countless saline marshes. It is known that the capital of the ancient Yue Kingdom (Yueguo 越國), which existed for several centuries prior to 222 BC, relocated from the rim of the southern foothills to the site of present day Shaoxing city, and that its subjects lived mostly in upland basins, in fan/slope complexes and their vicinities (see Map 2a).

Under the Qin 秦 and the Former Han dynasties, the plain remained virtually untouched by colonizers. At that time the Shaoxing area was a part of Guiji *qun* 會稽郡, a very extensive jurisdictional unit including the Yangzi delta and the later provinces of Zhejiang and Fujian 福建, with its capital located in Wu *xian* 吳縣 (later Suzhou 蘇州). In AD 120, Guiji *qun* was subdivided into the Wu and new Guiji *qun*s. The capital of the latter was set up at the seat of Shanyin *xian* 山陰縣 (later the city of Shaoxing). The jurisdiction of the Guiji *qun* was still extensive, covering the territories of the later provinces of Zhejiang and Fujian, but excluding the Qiantang and the Tiao River (Tiaoxi 苕溪) basins.

In AD 140, the first large-scale water conservation project was undertaken in the center of the plain at the initiative of Ma Zhen 馬臻, the governor of the new commandery. An artificial reservoir was constructed there, measuring 20,600 hectares with a circumference of 148 kilometers. The most important portions were the massive earthen embankments running east to west and serving as the linear northern flank of the reservoir. They were designed for storing water from the southern

hills at levels of four to five meters higher than the surface land in the northern part of the plain. Furthermore, since the bottom of the eastern half of the reservoir was a bit higher than that of the western half, an earthen partition was made in the middle so to make the regulation of the water within the reservoir more efficient. The proper name of the reservoir was Jian Lake (Jianhu 鑑湖), but it was popularly called Yue Lake (Yuehu 月湖) due to its shape.

In order to regulate the water in and outside the lake, elaborate systems of sluices and lockgates were installed along the embankments, though it is hard to identify the exact time when each facility was built. Their total number comes to forty-three. The largest most important were the eight floodgates (*doumen* 斗門) built at key positions on the embankments, through which any excess water in the reservoir could be drained off into the bay via several channels. Next in size were seven lockgates (*zha* 閘) and twenty-eight mini-watergates (*yan* 堰). There were also thirty-three tunnels (*yin'gou* 陰溝) at the interstices of the floodgates. The lesser lockgates functioned to supply irrigation water and provide passage for water traffic to the northern part of the plain. Around the year AD 300, a canal was constructed from the port town of Xixing 西興, located on the opposite shore from Hangzhou at the mouth of the Qiantang River, to the lower reaches of the Caoe River. This canal was for commercial traffic, and its course through the plain ran closely parallel with the lake embankments (see Maps 2b and 2c).[8]

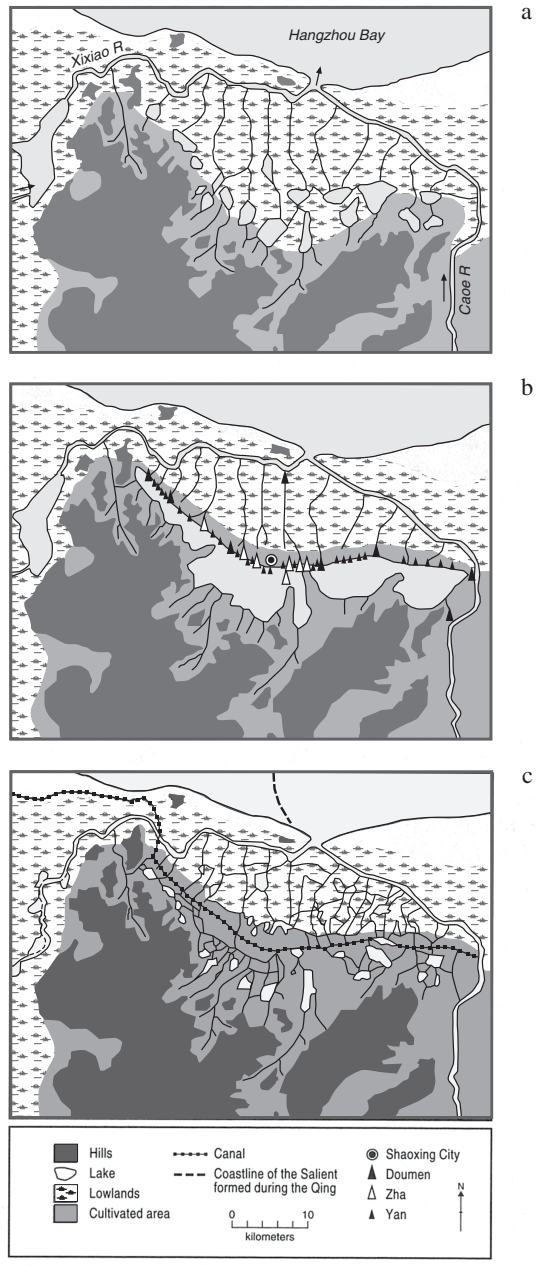
A second-century record mentioning the lake boasts that the acreage of cultivable land irrigated by it amounted to the equivalent of 4,122,000 hectares, either a blatant exaggeration or the total aggregation of area including paddy and salt-fields along the beachfront. There is evidence to show that concurrent with the creation of the lake, crude earthen seawalls were built along the shorelines, while a few floodgates were built at the junction of the Caoe and the Xixiao rivers.[9] However, as will be discussed later, complete control of the water in the northern part of the plain was not undertaken until Ming times. For centuries after the creation of the lake, its prime beneficiaries were the cultivators who lived immediately to the south of it. When the lake was filled, there were dwellings and tombs in the southern part that were submerged, causing Governor Ma Zhen, the lake's creator to be accused by the victims for the loss of their property and sentenced to death by the authorities.[10] Nevertheless, the lake did protect the southern portion of the plain from both seasonal flooding and brine flowing in from the sea. After its construction colonists

[8] Chen Qiaoyi, "Gudai Jianhu xingfei yu Shanhui pingyuan nongtian shuili" [The ancient Jian Lake with the special regard to its role in the agriculture of Shanhui Plain], *Dili Xuebao* 28.3 (1962): 187–202; and "Lishi shiqi Shaoxing diqu juluo de xingcheng yu fazhan" [Formation and development of the settlements of Shaoxing area in historical periods], *Dili Xuebao* 35.1 (1980): 14–23.

[9] Chen, "Gudai Jianhu xingfei yu Shanhui pingyuan nongdian shuili," 193.

[10] Chen, "Gudai Jianhu xingfei yu Shanhui pingyuan nongdian shuili," 193, n. 1.

Map 2. The Shaoxing Plain during Three Periods: (a) before A. D. 140; (b) from the Later Han Dynasty through the Tang Dynasty; (c) during the Southern Song Dynasty



settling at the foot of the hills were able to extend their arable down to the shores of the lake and enjoy more stabilized yields and the benefits of improved communications.

Records of the Shaoxing region from the first quarter of the fifth century indicate that the southern section of the plain was already affected by ever-worsening overpopulation and that the local government was forcing landless people, who then composed one-third of the population of Shanyin *xian* to emigrate to the counties of Yuyao 餘姚, an area immediately to the west of later Yuyao *xian*, Yin 鄞 and Mao 鄮, both located near later Ningbo 寧波, to reclaim land using the "Jian Lake method."[11] Other evidence from the same period tells of the creation of many small reservoirs, all replicas of Jian Lake, in Shangyu *xian*上虞縣 near the Shaoxing Plain.[12] In other words, in physiographically similar areas, people were able to expand their cultivable by using the method first tested and developed in the Shaoxing Plain.

2.2. South Lake in Yuhang Xian to the North of Hangzhou

In AD 173, thirty-three years after the construction of Jian Lake and forty-four years after the subdivision of the original Guiji *qun*, another important water-control project in the region was implemented in Yuhang *xian* 餘杭縣, located in the heart of the small South Tiao River basin. The construction of a man-made reservoir known as Nan Lake (Nanhu 南湖) was only one-third as large as Jian Lake (794 hectares), but its construction lent great assistance not only in securing the stability of agricultural production and livelihood, but also eventually in expanding agricultural and other activities down to the low-lying plains of present-day Huzhou 湖州, Jiaxing 嘉興, and Hangzhou to the east and the northeast of the basin.

As previously mentioned, in the western sector of the Yangzi delta (i.e., the old delta), the areas of human habitation were largely limited to the upriver basin and fan/slope complex zones, and other surrounding elevations around Tai Lake. The major source of water for these areas was the runoff from Tianmu Hills

[11] Amano Motonosuke, "Chūsei nōgyō no tenkai" [The growth of medieval agriculture in China], in *Chūgoku chūsei kagaku gijutsushi no kenkyū* [Studies in the history of science and technology in medieval China], ed. Yabuuchi Kiyoshi (Tokyo: Kadokawa Shoten, 1963), 417; Nakamura Keiji, "Rikuchō jidai Sango chihō ni okeru kaihatsu to suiri ni tsuite no jakkan no kōsatsu" [Some observations on development and water control in the lower Yangzi region during the Six Dynasties period], in *Chūgoku suirishi ronshū: Satō hakushi kanreki kinen* [Collected works on the history of water control in China: Festschrift celebrating the sixtieth anniversary of Dr. Sato Taketoshi], ed. Chūgoku Suirishi Kenkyūkai (Tokyo: Kokusho Kankōkai, 1981), 43–84.

[12] Nakamura, "kaihatsu to suiri ni tsuite no jakkan no kōsatsu," 63–99.

(Tianmushan 天目山) (elev. 794 meters) to the west. The water drained into the West and South Tiao River systems, then flowed down into Tai Lake. The lake was surrounded by sizable, low altitude (3 or 4 meter above sea level) plains lying to its west, south, and southeast, so it was not until the eleventh century that successful water control was achieved here.

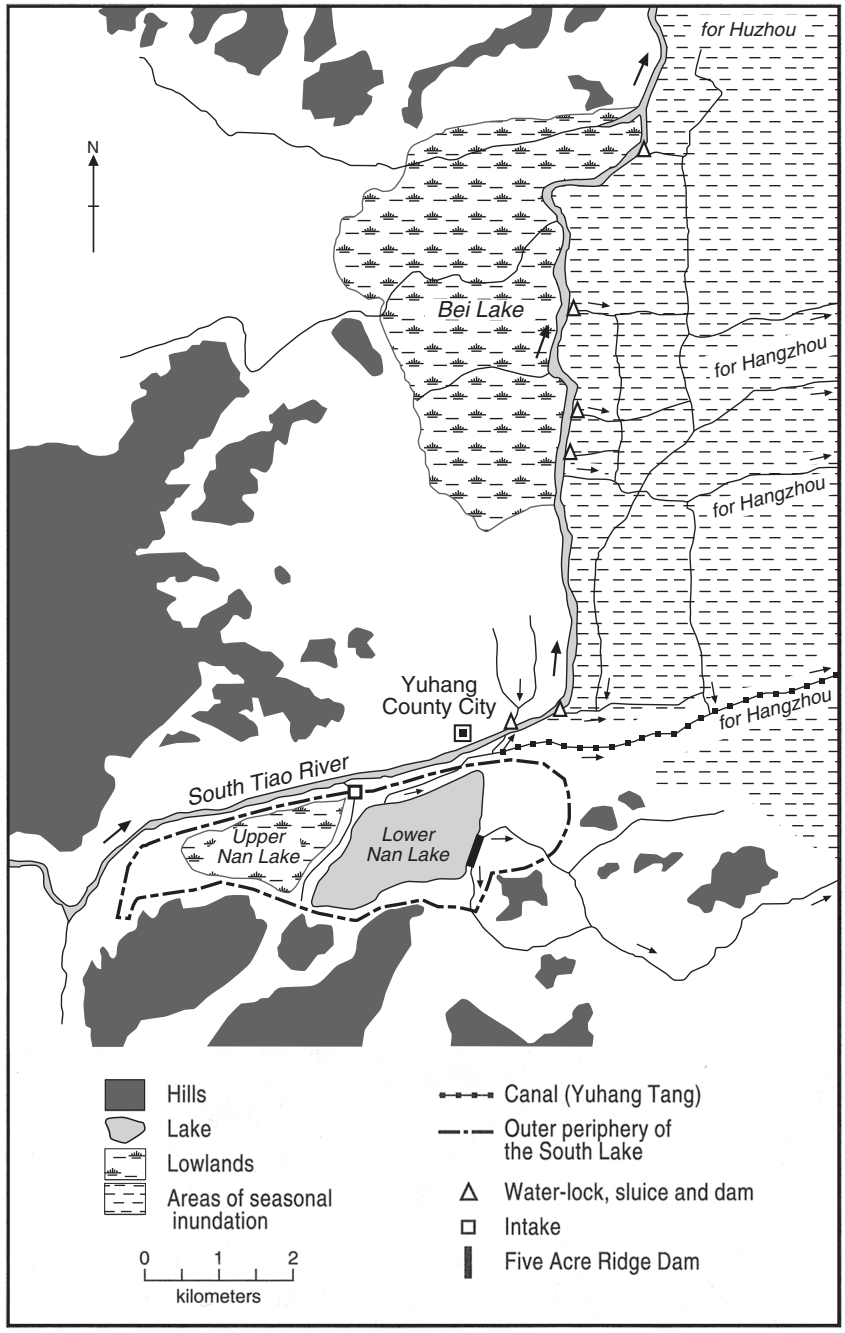
The altitude of the riverbed of the South Tiao River at the foot of Mt. Tianmu was 35 meters above sea level. As the river passed along the southern walls of the city of Yuhang, it grew wider to 114 meters across, descending to 30 meters above sea level. Soon after passing the city, the course of the river was blocked by a chain of low hills, against which it made a sharp bend northward, continuing its journey toward Tai Lake. Near the city, the river's water level fluctuated widely from highs of 2.7 meters during the rainy season to lows of 1.5 meters during the dry season. Excess volumes of water flowing into the river from the mountain was liable to inundate not only the small basin around the city but also the wide, low-lying neighboring plains to the west and south of Tai Lake.[13]

Prior to the building of the lake in AD 173 at the initiative of Chen Hun 陳渾, the magistrate of Yuhang *xian*, the city of Yuhang was moved from its former site on the river's southern bank to the opposite side. Along the southern bank of the river and close to the city, twin lakes, known as Upper and Lower Nan Lake, were constructed with a partition shared between them. Upper Nan Lake, the shallower of the two, was designed to hold excess water during the rainy season, while Lower Nan Lake, was to provide a controlled amount of irrigation water to paddy lying to its southeast. A loose demarcation of the twin lakes' outer periphery was drawn by local authorities, which defined the area as publicly owned land to protect the twin lakes and their banks from arbitrary encroachment by local families (see Map 3).

The circumference of Lower Nan Lake was banked and the intake for the river water, equipped with a stone sluice, was built at Shimen Bridge (Shimenqiao 石門橋) situated at the northern edge of the partition. One of the two outlets from Lower Nan Lake was built on its northern bank to let any excess water run back into the river through a drainage channel. The other outlet was built at the lake's southeastern and deepest corner. Close to this outlet outside the embankments stood Wumucheng 五畝塍 Dam, an earthen structure 1,485 meters in length and 2 meters in height. When the amount of water in Lower Nan Lake approximated normal capacity, the excess water flowing through the outlet would find its way into the

[13] Shiba, "The history of water conservancy: Nan Lake in northern Zhejiang province," in *Zhongguo jinshi shehui wenhuashi lunwenji* [Papers on the history of the society and culture of early modern China] (Taipei: Institute of History and Philology, Academia Sinica, 1992), 563–585, esp. 569; Zheng Zhaojing ed., *Taihu shuili jishushi* [The history of technology for water control in the Tai Lake area] (Beijing: Nongye Chubanshe, 1987), 49–61.

Map 3. Nan Lake during Tang Times



open reserved space behind the dam, at first detouring along the foot of the dam, and then spilling over the dam's two lowered ends. All in all, Nan Lake was a device to rid the basin of seasonal inundation and also promote rice cultivation there.[14]

However, aside from the repair work done in AD 436, Nan Lake sank into obscurity for about five centuries. Then in 816, water conservation in the basin saw considerable improvement, as Gui Yao 歸珧, the magistrate of the county, took the initiative in revitalizing water control in Yuhang. Basing his efforts on a close examination of the original plan by Chen Hun, he reconstructed the twin lakes just as they had been in 173. He also had the course of the South Tiao River embanked for about eight kilometers from its bend near the city to the northern boundary of the county. Several floodgates were installed here and there in the new embankments. This project turned the arid plain north of the city into a reserve, called Bei Lake (Beihu 北湖), for receiving excess water in the wet season. While this project indicates a gradual malfunctioning of Upper Nan Lake due to siltation, it eventually facilitated colonization and reclamation not only in the plains to the east of the north-bound course of the river, but also in the river's lower reaches. Gui's project was followed up in a more sophisticated manner by county magistrate Jiang Zhi 江帙 in 1122.

As a result of these improvements, the effectiveness of Nan Lake reached its peak in the twelfth century. The total dimensions of the arable land in the Yuhang basin that came to enjoy the benefits of a controlled supply of water grew to 5,800 hectares, which was cultivated by about 7,000 households. Ironically, it was at this zenith that Nan Lake began to see the first sign of incipient deterioration. During Song 宋 times (960–1279), reclamation was progressing in the much smaller upriver basins along the South Tiao River, concurrently with the growing stabilization of cultivation in the Yuhang basin. The amount of silt flowing into Nan Lake thus tended to grow. In 1122, Jiang Zhi witnessed the appearance of a cross-patterned shallow developing in the middle of Lower Nan Lake. This natural process was followed by the beginning of encroachment on the peripheral zone and shallower parts of the lake by powerful private persons. Thereafter, the history of the lake would mostly concern how to rejuvenate it to its former condition and how to protect it from greed.[15]

Be that as it may, from the eighth century onward the major focus of reclamation and colonization in the old delta moved from the fan/slope complex to low-lying plains zones around Tai Lake. The basic technology widely used at this stage in reclaiming plains was not the construction of reservoirs, but building dense networks of channels through the area. Regardless of differences in terms of size,

[14] Shiba, "The history of water conservation," 569–574.
[15] Shiba, "The history of water conservation," 576–578.

they were generally called *tang* 塘. In most cases each *tang* was a line of embanked channel for the multiple purposes of water and land traffic, drainage, and irrigation. We have some evidence of the development of a network of such channels in the southern shorelines of Tai Lake during the later half of the Tang period. In 810 a bypass of the Grand Canal was built along the shorelines to link it with the South Tiao River. In time, several lines of channels were built so as to run parallel with this bypass. This was accompanied by the construction of numerous smaller channels that not only linked larger channels, but also functioned to discharge excess water into Tai Lake. By the eleventh century the southern and western shorelines of the lake were circumscribed by massive walls with thirty-six floodgates built into them.[16] The lakeshore walls and the network of channels played a key role in converting the low-lying plains into arable land. Needless to say, a plot of land partitioned by such channels became the basis of enclosed fields (*weitian* 圍田, *yutian* 圩田); but here again, we can see the precedent of this kind of water control in the drainage basins of the southern Hangzhou Bay coastline in the mid-Tang period.

3. Water Control in the Lowlands

3.1. The Yong River Valley in the Mingzhou/Ningbo Area

During the mid-Tang period, the lowlands along the southern Hangzhou Bay coast were reclaimed by introducing a network of *tang* channels in the central portion of the Yong River (Yongjiang 甬江) basin, the immediate hinterland of what was later to be the city of Ningbo. The first known mass migration of landless people from the Shaoxing region into this basin took place in the early fifth century. At that time three county-level cities existed there, all of which were located at ecological boundaries separating the foothills and low-lying plain, the latter still being largely saline due to the subsurface intrusion of seawater. Settlement was limited to the seashores and upriver basins, hence the region's industries were represented by fishing, salt making, pottery, and hill products. With the unification of the empire by the Sui 隋 dynasty, the original territory under Guiji *qun* was reduced to the area around the southern Hangzhou Bay coast. Then in 738 the Tang Dynasty subdivided Guiji *qun* into the two prefectures of Yue 越 and Ming 明. In response to this move, the work of building a prefectural capital in the center of the lowlands was begun and completed in 821. The capital construction necessitated reclamation of the central lowlands.[17]

[16] Shiba, *Sōdai Kōnan keizaishi no kenkyū*, 373–374.

[17] Shiba, "Ningbo and its hinterland," in *The City in late imperial China* (see note 1), 391–439, esp. 395–396; Shiba, *Sōdai Kōnan keizaishi no kenkyū*, 469. Also see *MGYXTZ* [Republican gazetteer of Yin *xian*], *Yudi zhi, Ji bian, hequ*, 63–104.

The external factor prompting such changes was the rise in the sea trade along the eastern coast. Yangzhou 揚州, a leading port in the lower Yangzi region, was losing its locational advantage of direct access to the Yangzi River due to siltation occurring in or around 738. However, the Yong River in Mingzhou 明州 and Ningbo 寧波 was deep enough (from five to eight meters depending on the tide) in its lower reaches to allow large oceanic junks to navigate thirteen miles in from the river's mouth to its tributaries, the Yuyao and Fenghua Rivers (Yuyaojiang 餘姚江 and Fenghuajiang 奉化江). It was at this confluence that the prefectural capital was located; and in expectation of the rise in commercial prosperity in this new delta port, an extension of the Zhedong Canal in Shaoxing was built so as to link it with the city of Mingzhou by way of the Yuyao River. This amounted to the extension of the Grand Canal to Mingzhou.

The reclamation of Mingzhou's central lowlands started with draining the brackish marshland in the southeastern sector. In 744 an old reservoir at the foot of the hills to the east of the city was enlarged to 5,660 hectares and renamed Dongqian Lake (Dongqianhu 東錢湖) or simply Dong Lake (Donghu 東湖). It was circumscribed by massive embankments, along whose western side three major outlets were installed in the form of large sluices. Three major drainage channels (*tang*) were built, running across the lowlands westward and emptying into the Yong or Fenghua River. The northern Front Channel was 18 kilometers long, 30 meters wide, and 1.9 meters deep; the central Middle Channel was 9 kilometers long, 24 meters wide, and 1.5 meters deep; and the southern Rear Channel was 18 kilometers long, 30 meters wide, and 1.4 meters deep. As it flowed through these channels the fresh water from the lake was distributed by numerous auxiliary smaller channels to reclaimed paddy. Along the Yong and Fenghua rivers embankments were built to protect the lowlands from salt water inundation. Several floodgates were installed on the embankments at important points, including the junctions of the three major channels and the two rivers, for the purpose of water control. Both the drying and desalination of this sector of lowland was thenceforth carried out (see Map 4).

Meanwhile, the improvement of the western sector of the lowlands was of vital importance not only for agricultural production, but also for the growth of the city itself. Due to the existing topography, a rich and constant supply of fresh water to the arable land and residents in this sector was only obtainable by diverting water from Zhangxi Stream (Zhangxihe 章溪河), which collected runoff from Siming Mountain (Simingshan 四明山) (elev. 916 meters) in the westernmost part of the area. However, after passing the foothills, the Zangxi Stream flowed into the Yin River (Yinjiang 鄞江), a tributary of the Fenghua. The force of the tide on the course of the Yong River was so strong that saltwater was able to reach the confluence of the Yin River and Zhangxi Stream. Therefore, the diversion of the Stream before it reached this confluence was crucial for the future development of

the western plain and the city. During the years between 713 and 741, pivotal work was done to solve this problem. A huge stone dam, called Tashan Dam (Tashanyan 它山堰), was constructed at a site 1.6 kilometers before the Zangxi Stream flowed into the Yin River. This was a trapezoidal stone dam 131 meters wide, consisting of thirty-six terraces apart from its upper-middle section, which was left open in the form of a channel with a rectangular cross-section. Then a large channel, 23 kilometers long, 34 meters wide, and 1.5 meters deep, was built along the southern rim of the western lowlands, reaching the South Gate of the city. It was called the South Channel. This channel received the Stream's water at an intake located 500 meters upstream of the dam site, where the Zhangxi made an abrupt bend southward. During the rainy season, three-tenths of the Stream's water flowed into the channel, letting the rest of the water flow into the Yin River. During the dry season, the distribution ratio of the water between the channel and the river was reversed. Water flow was regulated by means of a sluice gate installed in the upper-middle part of the dam. A final touch was added in 1242 with the construction of a lock at a point about 100 meters upstream of the dam. Since the flow of the Zhangxi was blocked by this lock, the sediment carried by the stream accumulated in its bed there, where the the water flow was slow due to partial discharge of water into the South Channel 500 meters upstream. Hence dredging the silt was easy.

After long embankments were built along the courses of the Fenghua and Yuyao rivers, two more channels were dug: the Middle Channel, 12 kilometers long, 30 meters wide, and 1.5 meters deep; and the West Middle Channel, 12 kilometers long, 20 meters wide, and 1.5 meters deep. They were dug across the lowlands, both reaching the West Gate of the city. The reclamation of the lowlands followed and sub-channels were dug alongside all three. As early as 773, Guangde Lake (Guangdehu 廣德湖), the area in the central part of the western sector of the lowlands containing brackish water all year long, underwent an initial conversion into arable around its periphery. By the end of the twelfth century the lake itself had vanished as the result of reclamation. During the Southern Song 南宋 and early Yuan 元 periods, cultivation in the western lowlands became highly productive. The rice grown there fed the city, and the straw mats woven there became renown even in Cambodia among the Chinese goods traded there. Sometime between 1225 and 1227, Wu Qian 吳潛, prefect of Mingzhou and a provincial military commissioner who had done much to improve the water-control system of the area, took a boat trip from the city to Tashan Yan. On his return he had a stone memorial erected in the canal at the center of the city engraved with the character *ping* 平 (equity) carved on it to mark the water level there appropriate for the city's water supply and irrigation of the western plain. From this episode we also learn that the city was freely accessible to plain dwellers by boat via the channels. By this time the rest of the lowlands in the area had largely been converted into arable land (see Map 4).[18]

[18] Shiba, *Sōdai Kōnan keizaishi no kenkyū*, 471.

3.2. The Seawalls and Enclosed Wet-Fields

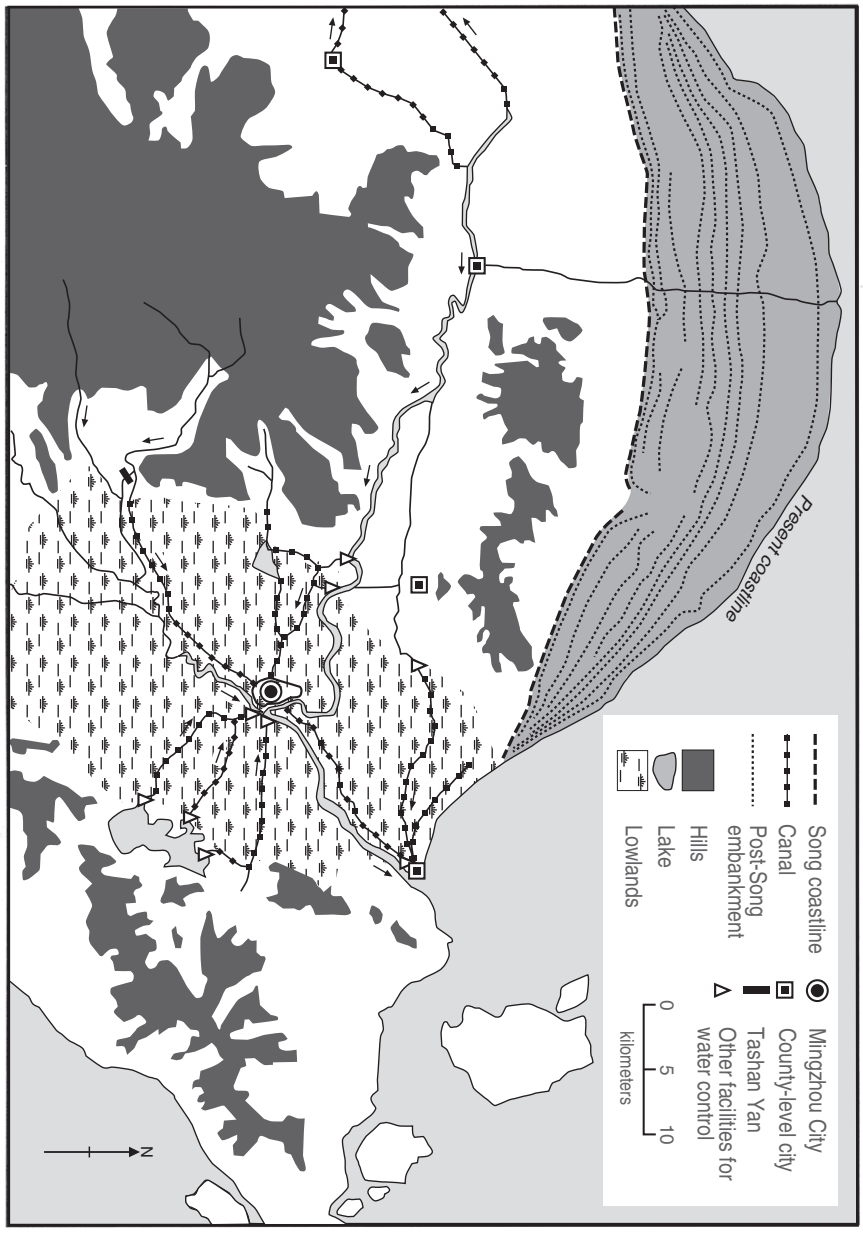
The Yangzi delta during the eighth century experienced a marked transition in the mode of its water control. Spatially, the region's reclamation was moving from the upriver areas to the lowlands. Along with this, the dominance of the reservoir in water conservation in the upriver areas was tending to be supplanted by a new technology for reclaiming the lowlands combining seawalls, channels, and enclosed wet-fields, bearing a resemblance to the polders of the Netherlands. The use of the reservoir did not, however, come to an end. It was still proving its general efficacy for the opening of terraced fields in the hilly areas. Nevertheless, the aggregate amount of land served by reservoirs was no match for the arable opened by the new technology. Furthermore, the old reservoirs of considerable size, such as Jian Lake, were in the process of shrinking mostly due to the irresistible demand of local people to convert them into paddy (see Map 2c).[19]

Meanwhile, the adoption of the new technology in the taming of the wild lowlands would have been hardly feasible without the involvement of the state. What attracted the attention of the central government to lowland reclamation in the region was the emergence of commercial salt production along the coastlines. In 758 the government set up a new monopoly over salt production centered in the lower Yangzi region. This was designed to meet the state's fiscal need for dealing with the threat of the centrifugal power being wielded by military governors. Under the system the areas of salt production were densely distributed along the coastlines of what were later to be the provinces of Jiangsu 江蘇 and Zhejiang 浙江. Among them major centers of salt production existed in the Hangzhou Bay area at Hangzhou, Jiaxing 嘉興, Shaoxing, and Mingzhou. Production was carried on by licensed producers under official supervision. Licensed merchants purchased the salt at an assigned center of production, prepaying custom duties for the privilege of trading the monopoly product. The merchants then distributed the salt to officially designated market areas in the Yangzi River valley.[20] Before monopolization, a long stretch of seawalls running from present day Shanghai to Hangzhou along the northern shoreline of Hangzhou Bay had been built during the first quarter of the eighth century. Simultaneously, the construction of seawalls from Shaoxing to Mingzhou along the southern coastlines of the bay had been undertaken. In 910, the king of the Wuyue Kingdom (907–78), who ruled over the region during the interregnum of the Five Dynasties period 五代十國時代 (907–60), rebuilt the seawalls at

[19] Chen, "Gudai Jianhu xingfei yu Shanhui pingyuan nongdian shuili," 195–201.

[20] Seo Tatsuhiko, "Tōdai kōhanki ni okeru Kōwai enzei kikan no ricchi to kinō" [Geographic locations and function of salt production intendancies in Jiangsu and Zhejiang provinces during the later half of the Tang period], *Shigaku Zasshi* 91.2 (1982): 1–37 and Saeki Tomi, *Chūgoku enseishi no kenkyū* [Studies in the history of governmental policies concerning the production and exchange of salt in China] (Kyoto: Hōritsu Bunkasha, 1987), 88–110.

Map 4. The Yong River Basin during Tang-Song Times



the mouth of the Qiantang River near the kingdom's capital city of Hangzhou into solid stone structures.[21] Thus the initial construction of seawalls in the Hangzhou Bay area was carried out for hydraulic defense and to encourage the salt industry emerging within the walls. Meanwhile, in the Mingzhou area, the lowlands to the west of the Yong River were being converted into arable from the later Tang to the Northern Song 北宋 period. There, the seawalls along the seashores, the river embankments installed with sluices, and skeletal channels were built to work in combination for draining the saltwater that had accumulated in the lowlands.

In the delta lowlands, the pace of reclamation seems to have progressed more gradually. Some historians have suggested that the overall reclamation there got underway during the Wuyue Kingdom;[22] but such a view seems a bit exaggerated. Rather, the evidence suggests that agriculture in the central delta lowlands remained unstable until the mid-Northern Song period.[23]

In order to assess the long-term process of reclamation in the delta lowlands, we have reliable statistics from 1377 concerning on land utilization in the prefecture of Huzhou 湖州, which was located south and west of Tai Lake, consisted of six counties. Of these, Anji 安吉 occupied a large hilly area to the west of the lake, while Wukang 武康, lying to its southeast, was an area mixed with hills and slopes and known as the oldest settlement in the prefecture. The other four counties of Wucheng 烏程, Guian 歸安, Deqing 德清, and Changxing 長興 were all located in the lowlands south and west of the lake. As mentioned before, the first reclamation of the lowlands in Huzhou took place along the southern shorelines of the lake in the early eighth century, in the vicinity of the prefectural capital, which was also the county seat of Wucheng.[24]

Let us first examine the distribution pattern of four land categories in the prefecture as a whole.

Category	Percent
Paddy	51
Dry field	11
Hill	34
Marsh	4
Total	100

[21] Zheng, *Taihu shuili jishushi*, 189–190.
[22] Zheng, *Taihu shuili jishushi*, 82–86.
[23] Shiba, *Sōdai Kōnan keizaishi no kenkyū*, 137, 138; Ōsawa Masaaki, "So-Ko jukusureba tenka taru: kyozō to jitsuzō" [Rethinking the saying "When Suzhou and Huzhou reap a good harvest, the food supply throughout the empire will be suffice": True or false?], *Atarashii Rekishigaku no Tameni* 179 (1985): 1–10.
[24] Shiba, *Sōdai Kōnan keizaishi no kenkyū*, 376–399.

Here are the distribution patterns of the same land categories according to each of the prefecture's counties.

	Wucheng (WC)	Guian (GA)	Deqing (DQ)	Changxing (CX)	Wukang (WK)	Anji (AJ)
Paddy	69	66	71	50	46	15
Dry field	8	10	15	12	20	8
Hill	19	16	6	36	21	77
Marsh	4	8	8	2	13	0
Totals	100%	100%	100%	100%	100%	100%

Next, here are the distribution patterns of each land category by county across the prefecture as a whole.

	WC	GA	DQ	CX	WK	AJ	
Paddy	27	25	16	23	3	6	100%
Dry field	15	18	17	26	7	17	100%
Hill	11	9	2	25	2	51	100%
Marsh	19	36	20	12	11	2	100%

Finally, here are the distribution patterns of the amounts of enclosed wet-fields (polders) by county. It is safe to assume that these statistics show the aggregation by county of larger sized polders in the prefecture.

WC	GA	DQ	CX	WK	AJ	
45	25	14	13	3	0	100%

An explanation is in order here concerning the very low 3% figure for hill land in Wukang by prefectural comparison. One part of the explanation can be found in the small size of the county. At one time, it encompassed extensive territory and included Deqing county to its east, but in 691 a subdivision made Deqing independent. Secondly, Wukang long remained the central area where the earlier colonists had settled. The opening of the hillside through the construction of reservoirs and terraced fields is documented in earlier records. In other words, we may infer that a considerable part of the former "hills" had already been converted into dry-fields by 1377.

The higher percentages of paddy shared equally by Wucheng, Guian, Changxing, and Deqing suggest successful reclamation of wet-fields in the lowlands there. This observation is reconfirmed by looking at the distribution pattern of enclosed wet-fields. [Note: The original data includes village-by-village figures.] The distribution pattern for marsh land in Wukang, Guian, Deqing, and Changxing

helps identify them as counties with surpluses of unreclaimed lowlands. In prefecture-wide comparison, Guian (36%) stood out above the rest.[25] Now what about the overall picture of the lowlands located in the center of the delta (see Map 1). Unfortunately, the gaps in our knowledge are still too wide to make any reasonable assessment, but we may speculate that a full reclamation of the lowlands there probably occurred by the middle of the Ming period.

Finally, let us turn to the aftermath of the seawall construction in the Hangzhou Bay area.[26] While the project was of great benefit to productivity and the livelihood of the people there, it also produced an unexpected result, a changeable flow of water from the Qiantang River into the bay. Partly blocked by solid seawalls along the shorelines of the bay and partly by the influx of ocean currents from Song times, the muddy water discharged from the mouth of the river made sharper meanders within the bay than before. The result was the gain and loss of accretionary land along the shorelines, which occurred from place to place in accordance with the frequent changes in the course of the river. The wide inward curve of the northern coastline to the east of Hangzhou formed by the force of the river discharging into the bay was now replaced by a reverse jutting out of accretionary shallows there. This change in turn led to the gradual enlargement of an islet located in the middle of the bay to the north of Shaoxing. This caused a further slowing down of the flow of muddy water discharged from the mouth of the river, enhancing the level of sedimentation there. Finally, by Qing 清 times, a peninsula-like alluvium was formed from the western coast of Shaoxing, extending into the bay for about forty kilometers. These changes increased the danger of rainy-season inundation on the Shaoxing plains and the territory west of them.[27]

Part of the sediment near the mouth of the river floated eastward along the southern coastline and formed another wide salient of land jutting into the bay to the north of Mingzhou. The total area of this alluvial extension was about 600 square kilometers, 7.5 kilometers at its widest part, and about 70 kilometers long. From the mid-Tang through the mid-Northern Song period extension of land toward the sea in this area remained minimal; but after the construction of solid earthen seawalls in 1047 continuously covering the shorefront, the pace of salient accretion increased. From that time to the present, the area saw the construction of nine separate lines of seawalls. (see Map 4).[28]

[25] Shiba, *Sōdai Kōnan keizaishi no kenkyū*, 376–399.

[26] For a detailed discussion of this environmental change, see to Mark Elvin and Su Ninghu, "Man against the sea: Natural and anthropogenic factors in the changing morphology of Hangzhou Bay, circa 1000–1800," *Environment and History* 1 (1995): 3–54.

[27] Zheng, *Taihu shuili jishu shi*, 178–184.

[28] *Cixi shuili shi* [The history of water control in Cixi *xian*, Zhejiang province] (Hangzhou: Zhejiang Renmin Chubanshe, 1991), 41–51. See also the discussion in Mark Elvin and Su Ninghu, "Action at a distance: The influence of the Yellow River on Hangzhou Bay since A.D. 1000," in *Sediments of time* (see note *), 344–407.

4. The Exhaustion of Open Space in the Region

4.1. The Delta Lowlands

During the Song period, the eastern half of the delta was left unincorporated as a single prefecture of Xiuzhou 秀州/Jiaxing, which administered its extensive territory through its three counties; but the area underwent gradual progress in industry and commerce up 1166. Hydraulic improvements along the Wusong River (Wusongjiang 吳淞江) and the Grand Canal at its section in Suzhou in the 1040s brought about an unexpected trend toward the overall siltation of the river systems in Huating and threatened the capital's position as an important port of trade, that role being eventually taken over by the rising port of Qinglong *zhen* 青龍鎭, then by Shanghai. During the Southern Song period, seven such local economic centers grew within Huating.

In 1277, two years before the final collapse of the Southern Song dynasty, Huating *xian*, formerly under Xiuzhou/Jiaxing prefecture became an independent prefecture and was renamed Songjiang 松江 the following year. During the Yuan and early Ming periods, Songjiang was enlarged to include the two counties of Huating and Shanghai (newly established in 1290) within its jurisdiction. Geographically, the territory of Songjiang covered most of the eastern half of the delta. We may infer that the administrative subdivision indicates progress being made in reclamation and colonization there. This inference is supported by the increase that took place in the share of the tax grain burden shouldered by Xiuzhou/Jiaxing during the late Southern Song period and by Songjiang during the early Ming period. In late Southern Song times, the figure for Jiaxing came to 67,000 Song *shi* (6,357 kiloliters), while the figures for Songjiang alone rose to 199,755 Yuan *shi* (27,293 kiloliters) in Yuan times and 878,377 Ming *shi* (833,377 kiloliters) in early Ming times.[29] Such a sudden increase must, however, be regarded with some caution.

From 1263 through the early decades of the Ming period, official revenue from grain in the six prefectures of Suzhou, Hangzhou, Huzhou, Jiaxing, Changzhou 常州, and Zhenjiang 鎭江, all of which were located in the vicinity of Tai Lake, came from two sources: public and private land. In 1263, the Southern Song regime, in a desperate effort to cope with diminishing revenues from grain taxes owing to increasing landlordism, introduced a state demesne system in those prefectures. The resulting public estates were aggregations of many plots of land acquired by purchase and/or confiscation. By the early Ming period the total area occupied by these estates in Suzhou had doubled and comprised two-thirds of the total arable of the six prefectures. Interestingly, the management of state demesnes did not preclude the existence of landlordism within them. While only a handful of

[29] Shiba, *Sōdai Kōnan keizaishi no kenkyū*, 154–155.

landlords and mostly poor peasants occupied the estates, they were regarded by the government as their "tenants" (*dianhu* 佃戶) without distinction. The "rent" (*zu* 租) levied on the estates was most commonly about twice the rate charged on privately owned land, customarily set at one-tenth the yield per acre, but in some cases rose as high as tenfold or more. In the long-run, the system fostered the redistribution of land resources in the area, while as a short-term fiscal measure, it provided great relief to the regimes of the late Yuan and the early Ming periods. For example, in Yuan times revenue from grain in the Jiangnan 江南 region amounted to 37 percent of the whole empire's revenue, while 40 percent of the amount came from the state demesne system.[30]

The sociopolitical unrest that characterized the lower Yangzi region during the transition from the Yuan to the Ming dynasty was successfully settled within a century or so after the founding of the latter. This was followed by a resumption of traffic on the Grand Canal in 1415, the relocation of the imperial capital from Nanjing 南京 to Beijing 北京 in 1421, and a simultaneous revival of inter-provincial traffic, commercial transactions, and silver circulation. By the sixteenth century, the lower Yangzi region had gained an advantageous position as the hub of the empire's economy. Consequently, people in the region enjoyed the advantages of the division of labor and specialization in production. Cotton growing and cloth production grew in the prefectures of Songjiang and Suzhou, while sericulture and silk production became the specialties of Hangzhou, Huzhou, Suzhou, and Jiaxing. In these latter prefectures, people tried to combine sericulture with rice cultivation, dividing paddy into 60 percent for mulberry plants and the rest for rice cultivation.[31]

These economic changes in the region attracted an ever-increasing influx of immigrants. Owing to the spread of intensive cultivation of the soil and the increasing deforestation and denudation of the region, the bottom of Tai Lake grew more and more shallow. Reductions in the lake's water discharge in turn led to the increasing dysfunction of the Wusong River, a major drainage system that received its water from Lake Tai and drained the excess water into the central lowlands and the sea to the east. There is plenty of qualitative evidence indicating an overpopulation crisis throughout the region.[32] Shortages of arable land and food were relieved

[30] Mori Masao, *Mindai Kōnan tochi seido no kenkyū* [Studies of the land system in Jiangnan during Ming times] (Kyoto: Dōhōsha, 1988), 45–69; and Otagi Matsuo, "Gen no Chūgoku shihai to Kanminzoku shakai" [Yuan rule over China and Han-Chinese society], in *Iwanami kōza sekai rekishi*, vol. 9 (Tokyo: Iwanami Shoten, 1970), 304–308. It should he noted that Mori's table on p. 140 mistakenly gives the units as *dou*, rather than *shi*.

[31] Li Bozhong, "Sang zheng daotian yu Ming-Qing Jiangnan nongye shengchan jiyuechengdu de tigao" [The simultaneous single paddy double cropping of mulberry trees and rice as evidence of intensified agriculture in the Jiangnan area during the Ming and Qing periods], *Zhongguo Nongshi* 12 (1985): 1–11.

[32] Ho, *Studies on the population of China*, 217–221.

to some extent by the gravitation of lowland reclamation from the Yangzi delta to river basins in the provinces of Jiangxi 江西, Hunan 湖南, Hubei 湖北, and eastern Sichuan 四川 and the transshipment of surplus rice from those regions to the lower Yangzi.[33] Shortages of fuel also became a serious problem, for the producers of salt in particular. As early as the middle of the Northern Song period, producers along the southern shoreline of Hangzhou Bay became involved in mortal combat and litigation over access to firewood in the nearby hills.[34] By the Yuan period, the fuel scarcity had forced salt producers on both the north and south sides of the bay to adopt the solar evaporation method.

4.2. The Disappearance of Jian Lake

Jian Lake had already vanished from sight by the beginning of the Southern Song period (see Map 2c) on account of private encroachment. In time, the plain lying between the southern lines of foothills and the former northern banks of the lake was turned into an area boasting the richest paddy in Shaoxing. According to a local history edited in 1587, local authorities had given the area the premier rank in their fourfold classification of taxable land under their control, the second rank being given to the "hill" land zones, the third to the "shorefront" zones, and the lowest to the "lowland" zones.[35]

In the meantime, the overpopulation of Shaoxing was undeniable during the Ming and Qing periods. According to the 1820 statistics, the population density of the area was 510 persons per square kilometer, the second highest figure among the thirty most populous prefectures in the empire next to 838 persons psk in Suzhou prefecture.[36] In response to this population pressure, attention was given to improving the area's nearby periphery. Such attempts date back as far as 1112. At that time, Xiaoshan *xian* 蕭山縣, the western neighbor to Shaoxing, suffered from flooding by the Puyang River and occasional drought. A 2,094 hectare artificial reservoir called Xiang Lake (Xianghu 湘湖) was constructed in 1112 to the south of the county seat, lying between two lines of hills. With the installation of additional embankments and eighteen stone tunnels to handle the discharge of water, the reservoir became capable of irrigating the paddy lying around it over an area of

[33] Ho, *Studies on the population of China*, 136–158; Wang Yeh-chien, "Food supply and grain prices in the Yangzi Delta in ca. eighteenth century," in *Proceedings of the second conference on modern Chinese economic history* (Taipei: Academia Sinica, 1989), 424–429.

[34] Guo Zhengzhong, *Songdai yanye jingjishi* [The economic history of the salt industry in Song times] (Beijing: Renmin Chubanshe, 1990), 123.

[35] *Wanli Shaoxing fuzhi* [Wanli gazetteer of Shaoxing *fu*], chap. 14.

[36] Gilbert Rozman, *Population and marketing settlements in Qing China* (Cambridge: Cambridge University Press, 1982), 12–14.

8,312 hectares. A very elaborate method was devised to distribute the water equally among the various sectors of paddy.[37]

During the mid-fifteenth century, Shaoxing and Xiaoshan saw their last, but noteworthy, water control project. The project's first step was to split the flow of the Puyang River in two. A small hill lying west of where the river ran into the low-lying plain was excavated to allow a new westward branch of the Puyang to flow into the Qiantang River. A sluice was built just upstream from where the hill was cut and on the northern bank at the place where the hill had been with the dual functions of blocking salt water from the Qiantang River and regulating the amount of water to be sent to the Xixiao River, or the former lower course of the Puyang. Near the fork in the river, three auxiliary sluices were built to regulate the flow of water into the Xixiao more efficiently. The final step was the construction in 1536 of a huge sluice, called the Sanjiangzha 三江閘, with twenty-eight gates at the end of the Xixiao near the shore of Hangzhou Bay. In the dry season, water from the Puyang River was transferred into the Xixiao River through upriver sluices and was stored in channels connected to the river. In the rainy season, the upriver sluices were closed and the gates of the Sanjiangzha were opened to drain excess water.

4.3. Nan Lake

South Lake in Yuhang *xian* 餘杭縣 (present-day Yuhang *zhen* 鎮) still exists today, but not without considerable reduction in its former size. The degeneration of its overall functions, which was first witnessed in 1122, could not be effectively reversed during the Ming or Qing periods. The year 1149 is the date of the last record of the lake's recovery to its size as of 1122 in response to extensive inundation of the South Tiao River that victimized the paddy alongside it not only in the vicinity of Yuhang, but also in the prefectures of Huzhou, Hangzhou, and Jiaxing. With the exception of controlling large-scale floods, the importance of Nan Lake for water control tended to dwindle in the eyes of people residing downstream, where the development of a network of enclosures protected them from the ordinary ebb and flow of the river.[38]

In 1544 the central government dispatched Fu Fengxiang 傅鳳翔, a touring census inspector, to Yuhang *xian* to investigate the situation at Nan Lake. During his stay there, Fu surveyed the lake and confiscated illegally reclaimed land within

[37] Shiba, *Sōdai Kōnan keizaishi no kenkyū*, 558–583; Keith Schoppa, *Xiang Lake: Nine centuries of Chinese life* (New Haven: Yale University Press, 1989); Keith Schoppa, *Chinese elites and political change: Zhejiang province in the early twentieth century* (Cambridge, Mass.: Harvard University Press, 1982); Chen Qiaoyi, "Lun lishi shiqi Puyangjiang xiayou de hedao bianqian" [Changes in the course of the Puyang River during historical times], *Lishi dili* 1 (1981): 65–79.

[38] Shiba, "The history of water conservation," 580–582.

its shores totaling 473.28 hectares. He then drew a new boundary for the lake and its periphery, the area enclosed by the new boundary being much smaller than in the past. Fu's survey excluded Bei Lake, most of Upper Nan Lake, and a fairly large area on the former periphery zone from the new boundary of Nan Lake. During the years 1609–10, one last effort was made to restore the size of the lake to the boundaries redrawn by Fu.[39]

The final blow that paralyzed Nan Lake was dealt by the cultivation of the upriver highlands to the west of Yuhang by "shack people" (*kemin* 客民 or *pengmin* 棚民) during the Qing period. They were mostly people from the land-scarce southeastern provinces who were invited in by hill districts landlords of the Yangzi valley to serve as labor for the production of such goods as lumber, jute, indigo, lacquer, charcoal, and tobacco. They sustained themselves on the hillsides by planting maize, sweet potatoes and peanuts. With their settlement in the hill districts in northwestern Zhejiang province, deforestation occurred everywhere beginning in the 1720s. Then, during the late phase of the Taiping Rebellion, when the hilly portion of the two provinces of Jiangsu and Zhejiang was under attack by the rebels, the depopulation of such areas prompted another influx of the shack people. They tilled the slopes intensively, causing chronic erosion of the soil.[40] By the late nineteenth century, Upper Nan Lake had been fully transformed into paddy by the shack people, who then took the lead in the encroachment of the region. Fortunately, Lower Nan Lake survived as the result of official enthusiasm for its maintenance. Finally, in 1901, the Bureau of Commerce in Beijing shifted in its position from the traditional upkeep of Lower Nan Lake to the encouragement of its reclamation. Under the People's Republic of China, the construction of countless modern reservoirs in the upriver basins of the South Tiao River has contributed to the reduction of flooding along the river. Former Nan Lake has now been transformed into a state farm.

[39] Shiba, "The history of water conservation," 582–583.

[40] Morita Akira, "Shinmatsu Sekkō Yokō-ken no Nanko suiri to kyakumin mondai" [Water control of Nan Lake and the problem of the shack people in Yuhang *xian*, Zhejiang during the late Qing period], in *Chūgoku suirishi no kenkyū* [Studies in the history of water control in China], ed. Morita Akira (Tokyo: Kokusho Kankōkai, 1995), 493–513; Morita Akira, "Shinmatsu Sekkō-shō Yokō-ken Nanko suiri ni tsuite: Kaishun jigyō o chūshin to shite" [Water control of Nan Lake in Yuhang *xian*, Zhejiang during the late Qing period focusing on dredging], *Kyūshū Sangyō Daigaku Kyōyōbu Kiyō* 29.3 (1993): 41–68. On the problem of the shack people in Zhejiang, see Ho, *Studies on the Population of China*, 146–148, and Anne Osborne, "Highlands and Lowlands: Economic and Ecological Interactions in the Lower Yangzi Region under the Qing," in *Sediments of Time* (see note *), 203–234.

Conclusion

Several conclusions can be drawn from the above discussion. First, the history of water control in the lower Yangzi region confirms the general assumption that the Chinese by cultural preference were traditionally plains and valley people. The flat delta plain was the area where the Chinese cultural repertoire, particularly technology and the social organization of production and exchange, developed best. Secondly, the technological devices widely used in reclamation and colonization movements in the delta lowlands with increasing sophistication from the eighth century on were not so much new as traditional methods. They accumulated and were tested in the process of human settlement in higher elevation areas immediately south of the delta.

Thirdly, in the earlier stage of lowland reclamation in the Yangzi delta, from the eighth through the thirteenth century, the government played an important role in laying down a network of channels and building seawalls. The climax of such governmental enthusiasm in the task of water control occurred under the Northern and Southern Song dynasties. Next, the location of the state capitals of the Southern Song (Hangzhou) and the early Ming periods (Nanjing), along with the establishment of urbanized provinces in the lower Yangzi region also did much to promote the overall development of the region.

On the other hand, there was an apparent secular decline in the upkeep of water-control systems in the region after the formation of their original skeletal structures. In other words, from the Ming period onward, official efforts to maintain key facilities for water control were challenged by counter-efforts on the part of local people to privatize them. Finally, the trend of diminishing official involvement in water control in the region was paralleled by an increasing imbalance between natural environmental resources and human activity.