

# 1

## THE LONG RIVER 长江

Floods would not be a hazard were not man tempted to occupy the floodplain.

Gilbert White<sup>1</sup>

Cartographers have always struggled to represent rivers. To render nature legible, they are forced to freeze water in time, turning complex evolving systems into fixed blue lines, which cut simplistic linear trajectories from origins to destinations. If it were possible to view history on a time-lapse – condensing millennia to minutes – we would see rivers writhing across their plains like living entities; expanding and contracting with the pulse of the seasons, rising and falling with long- and short-term climatic changes. This chapter reconstructs the history of one such river – the Yangzi – a watercourse that shaped and was shaped by the people who made their homes on its plains. We focus, in particular, on Hubei, a province in the middle reaches of the Yangzi that is dominated by rivers, lakes and wetlands, and, as a result, is naturally highly flood-prone. Humans did not always see this as a problem, as abundant water could be a blessing as well as a curse. It took a particular mode of human interaction with the environment to transform natural floods into humanitarian disasters. This chapter describes the history of this transformation, tracing the long-term evolution of the modern disaster regime from which the 1931 flood emerged.

The epigraph from the renowned geographer of disasters Gilbert White encapsulates much of what is argued in this chapter. Flooding, as a human hazard rather than a hydrological process, is never entirely natural. Disastrous inundations occur when people interact with water in particular ways. Succinct as it may be, however, White's assessment does not do justice to the complexity of environmental history.

<sup>1</sup> White, *Natural Hazards*, p. 3.

For floodplains do not remain static; their contours change continuously under the influence of environmental and anthropogenic processes. Hence, people may settle in a dry area that may become a floodplain over time. Furthermore, living on a floodplain does not necessarily put one at risk of disaster. Inundation becomes truly disastrous only under particular configurations of subsistence and settlement. The population of Hubei constructed a lifestyle that depended on flood-suppressing technologies. When these failed, they faced calamitous consequences. The fact that such hydraulic strategies have become ubiquitous in the modern world should not be taken as evidence that they were the historical norm. People can learn to accommodate and even benefit from regular infusions of water, while avoiding larger floods by tactical evacuation or by using technologies to float on water.<sup>2</sup> We might augment White's conclusions, therefore, with the observation that floods would not be hazards if humans could adapt themselves to the environment rather than adapting the environment to themselves.

The story of how floods became disasters in Hubei can be read as part of the broader history of the human transformation of the hydrosphere. Throughout the world people have drained wetlands, channelised rivers, and denuded forested catchments. Much of Hubei was once a vast wetland, which fostered a highly biodiverse ecosystem. As wetland became farmland, the environment was deprived of complex biogeochemical systems. The ecologists William Mitsch and James Gosselink have described wetlands as the 'kidneys of the landscape' – they cleanse water, recharge aquifers and absorb flood pulses.<sup>3</sup> Losing these kidneys is a serious blow, not just to the environment but also to human beings. In detailing the evolution of flooding, this chapter also describes the decline of biodiversity and the loss of the wetland culture practised by a people who found ways to live between water and land. Yet this should not be read solely as a declensionist narrative.<sup>4</sup> Wetland species and wetland culture were never erased entirely. Both survived, albeit in muted forms, offering vital resources for flooded communities. Unfortunately, residents of Hubei

<sup>2</sup> Examples of societies that have learned to accommodate and benefit from flooding include certain pre-colonial cultures in the lower Mississippi and the flood recession agriculturalists on the Zambezi in Mozambique. See Morris, *Big Muddy*; Isaacman and Isaacman, *Dams, Displacement*.

<sup>3</sup> Mitsch and Gosselink, *Wetlands*, p. 4.

<sup>4</sup> William Cronon has rightly criticised the tendency for environmental historians to favour tragic narrative arcs, in which humans are pictured inflicting irreparable damage upon nature. See Cronon, 'A Place for Stories'.

had to cope not only with the primary hazard of inundation but also with flood-induced famines and epidemics. By the twentieth century, these secondary risks killed far more people than the physical impact of inundation itself. In detailing the long-term evolution of the modern disaster regime, this chapter provides an environmental history not only of flooding, but also of the hunger and disease that came in the wake of water.

### *Natural Floods*

Forty-five million years ago, the Indian and Eurasian tectonic plates collided, lifting the Himalayas and creating the Tibetan–Qinghai Plateau.<sup>5</sup> As water drained off these new highlands over millions of years, it etched the basins of many of the greatest rivers in Asia.<sup>6</sup> Some flowed south to create the Indus and Brahmaputra, which would shape the lives of millions of South Asians. Some flowed southeast to form the Mekong and Salween, which would nurture the forests and farms of mainland Southeast Asians. Some flowed east, creating two major rivers. The first of these was the Yellow River, an unpredictable watercourse that cut a meandering path through a loess soil landscape. The second would become the greatest river in Asia – and the third longest in the world. Known in the English-speaking world as the Yangzi – a name that locals use to refer to a small eastern stretch of its course – to Chinese people this is the Long River or Changjiang 长江.<sup>7</sup>

The valley carved out by the Yangzi would eventually drain over a million square kilometres.<sup>8</sup> As water cut through the surface of the land it met ancient seams of granite and quartzite, which formed ridges that divided the valley into distinct basins.<sup>9</sup> These basins came to define the three major reaches of the river. The upper Yangzi flows down from Tibet, across Yunnan, and then through the distinctive red sandstone of the Sichuan basin. As it funnels through a mountainous area in western Hubei, it carves the scenic yet treacherous rapids of the Three Gorges. Beyond this point the river is known as the middle Yangzi, a broad watercourse distinct in character from the fast-flowing upper reaches. In its journey across the alluvial and lacustrine plains of Hunan and Hubei, the middle Yangzi drinks up vast quantities of water, increasing in size

<sup>5</sup> Flad and Chen, *Ancient Central China*, p. 19.      <sup>6</sup> Hodges, 'Tectonics of the Himalaya'.

<sup>7</sup> Flad and Chen, *Ancient Central China*, p. 19.

<sup>8</sup> Del Moral and Walker, *Environmental Disasters*, p. 116.

<sup>9</sup> Van Slyke, *Yangtze*, pp. 9–10, 30–1.

dramatically before narrowing to cut between the highland ridges that form the border with Jiangxi.<sup>10</sup> Having met Poyang Lake, the river continues to Anhui and Jiangsu, where it becomes the lower Yangzi. It splits into multiple streams, forming a delta, and finally, having travelled 6,380 kilometres, completes its journey by flowing into the East China Sea.

Long before humans set foot in Hubei, the region was already experiencing natural floods. These occurred when the stream flow of rivers exceeded the discharge capacity of their channels.<sup>11</sup> Much of Hubei is located within a geological depression tapering into a mountainous bottleneck in the east. Water accumulates easily yet is slow to discharge.<sup>12</sup> In the east of the province, the Yangzi meets the Han River 汉江, its largest single tributary. The plains formed by these two great watercourses are crisscrossed with smaller rivers and dotted with lakes and marshes. These once formed part of a vast network of wetlands, more extensive than any others found in the temperate world, which stretched continuously along plains of the middle and lower Yangzi.<sup>13</sup> The stream flow of rivers in Hubei varies in accordance with the cycle of seasons. In average years, the basin experiences three surges of high water, in the spring, summer and autumn.<sup>14</sup> The water table is at its lowest in the winter. Relatively little rain falls between October and May, and precipitation in highland catchments gathers as snow. These frozen reservoirs melt in the spring, infusing rivers with large volumes of water at the same time that the region experiences the first of its three annual waves of precipitation.<sup>15</sup> In the summer, cold fronts collide with humid air masses from the subtropics, causing the heaviest rainfall.<sup>16</sup> These summer deluges tend to be the trigger for major flooding.

The middle Yangzi is the intermediary zone between the hammer and anvil of two monsoon systems. The East Asian monsoon determines the

<sup>10</sup> Flad and Chen, *Ancient Central China*, pp. 27–8.

<sup>11</sup> White, 'Human Adjustment to Floods', p. 36. A river or stream has base flow, which is the discharge derived from groundwater excluding runoff from precipitation and snowmelt. It also has a bankfull discharge, which is the level at which a stream may flow without rising above its banks. The average flow of a river will be somewhere between base flow and bankfull discharge. See Reice, *Silver Lining*, p. 108.

<sup>12</sup> Yin et al., 'On the River–Lake Relationship'. See also Rowe, 'Water Control'.

<sup>13</sup> Li, 'Domestication of Plants', p. 40.

<sup>14</sup> Gemmer et al., 'Seasonal Precipitation Changes'; Zhang *Coping With Calamity*, p. 30.

<sup>15</sup> Oxenham, 'On the Inundations of the Yang-tse-Kiang'; Wang et al., 'Terrestrial Contributions', p. 2.

<sup>16</sup> Yu, Zhu and Wang, 'Radiocarbon Constraints'.

level of precipitation in the basin itself. The South Asian monsoon affects rain- and snowfall in the upper Yangzi, thereby helping to determine how much water is discharged downstream.<sup>17</sup> Both monsoon systems are subject to external climatic influences. The sulphur dioxide emitted during volcanic eruptions affects atmospheric temperatures and may have an influence on the stream flow of the Yangzi, though the exact nature of volcanic–monsoon linkages remains unclear.<sup>18</sup> Fluctuating sea surface temperatures in the Pacific Ocean – the infamous El Niño Southern Oscillation (ENSO) – have a more discernible influence. There is some evidence to suggest that large floods, including those of 1954 and 1998, are caused by El Niño and La Niña events. Caution should be exercised before drawing direct causal links, however. Unlike the well-established teleconnection between El Niño and rainfall patterns on the North China Plain, the exact role that ENSO plays in Yangzi flooding remains a matter of debate.<sup>19</sup>

The annual rise and fall of rivers and lakes helped to forge a highly diverse ecosystem in Hubei. As with many river systems, the flood pulse came to play a vital role in the biogeochemical cycle, transferring valuable nutrients between aquatic, terrestrial and wetland areas. Fast flowing water stripped millions of organisms from riverbeds and floodplains, creating empty patches that were colonised by a wide range of biota.<sup>20</sup> Floods also helped to distribute seeds and fruit, increasing the range of local plants, and purged invasive species that may otherwise have become overly dominant. Far from being simply destructive, regular flood pulsing was, as the ecologist Seth Reice has put it, ‘an essential recharge mechanism’, bringing life to both rivers and

<sup>17</sup> Jiang et al., ‘Yangtze Floods and Droughts’.

<sup>18</sup> Atwell, ‘Volcanism and Short-Term Climatic Change’.

<sup>19</sup> The exact teleconnection between ENSO and Yangzi floods remains an issue of debate. Some have argued that during El Niño years ‘the enhanced subtropical high at the western North Pacific strengthens the summer East Asian monsoon, and brings larger amounts of precipitation to the Yangtze River catchment than the normal years.’ See Yu et al., ‘Analysis of Historical Floods’, p. 210. See also Zhang et al., ‘Possible influence of ENSO’; Jiang et al., ‘Yangtze Floods and Droughts’; Gough et al., ‘The Variation of Floods’.

<sup>20</sup> Various ecological models are used to describe the dynamic interaction of rivers and plains during flooding. These include the *river continuum concept*, *flood pulse concept* and the *river productivity concept*. See Arthington, *Environmental Flows*, esp. pp. 50–2. Recent evidence suggests that the fluvial ecology of the middle Yangzi conforms more closely to the flood pulse concept, as lateral transfers of nutrients are more important than transfers from headwaters stressed in the River Continuum Concept. See Wang et al., ‘Terrestrial Contributions’.

floodplains.<sup>21</sup> The biodiversity created by natural flooding would have been extremely attractive to early humans, who could exploit a rich mosaic of aquatic, riparian and terrestrial habitats. From the outset, then, people did not settle Hubei in spite of floods, but because of them.

### *Settling Floodplains*

For much of human history Hubei looked quite different from the way it does today. At the beginning of the Holocene, around 11,500 years ago, the Yangzi was a branched river, flowing in three distinct streams that were prone to shifting course and wandering across the basin. Most of central and eastern Hubei was home to a vast wetland known as the Yunmeng Marsh 云梦泽.<sup>22</sup> Though hard to imagine today, the zoologist Samuel Turvey suggests that the middle Yangzi was then the ‘Amazon of the East’, home to a vast assemblage of flora and fauna.<sup>23</sup> Rivers and lakes teemed with fish, turtles, alligators, finless porpoises and Yangzi river dolphins. The plains were covered with thick forests of coniferous and deciduous trees, home to pandas, elephants, giant tapirs, gibbons and rhinoceroses. The wetlands supported abundant waterfowl and wading birds, including five species of crane that nested in thick reed beds.<sup>24</sup> This natural abundance was attractive to hunter-gatherers, and later helped to support early experiments in plant and animal domestication.<sup>25</sup>

Early settlers were particularly drawn to a form of semi-aquatic grass known as wild rice. Although there remains some debate about when and where this species was first domesticated, we know that communities in the middle Yangzi region were cultivating it deliberately, rather than simply foraging for it, by at least as early as 7500–6000 BCE.<sup>26</sup> Rice became central to the economy and society of this region not least because it proved to be the perfect biological technology to colonise wetlands. Unlike dry land crops, which require aerated soil, rice can grow under water, thanks to its specialised aerenchyma tissue that diffuses oxygen down its stems to its roots.<sup>27</sup> This water resistance may help to explain

<sup>21</sup> Reice, *Silver Lining*, p. 120. See also Middleton, *Flood Pulsing in Wetlands*.

<sup>22</sup> Yin Hongfu et al., ‘On the River–Lake Relationship’. <sup>23</sup> Turvey, *Witness to Extinction*.

<sup>24</sup> Lu, *Transition from Foraging to Farming*, pp. 75–82; Li, ‘Domestication of Plants’; Turvey, *Witness to Extinction*.

<sup>25</sup> Christian, *Maps of Time*, p. 238.

<sup>26</sup> Stark, *Archeology of Asia*, pp. 83–4. Theories that suggested a Southeast Asian origin of rice have now been disproven by genetic evidence. See Anderson, *Food and Environment*, p. 39.

<sup>27</sup> Kellman and Tackaberry, *Tropical Environments*, p. 232.

the rapid growth of rice cultivation between 6000 and 3000 BCE, which was a particularly warm and therefore wet climatic epoch.<sup>28</sup> Flood pulses were the lifeblood of rice agriculture, bathing the land in a nutrient-rich cocktail of minerals and water, leaving fertile deposits of nitrogen and phosphorus in their wake.<sup>29</sup> This natural redistribution of biomass meant that rice farmers had to introduce far less fertiliser than those cultivating dry land.<sup>30</sup>

Rice domestication allowed farmers to maximise yields, yet it also created a nutritional system that was dependent on predictable patterns of meteorology. Wild rice (*Oryza rufipogon*) articulates its seeds individually, maximising the chance of sustained reproduction in a wetland environment subject to fluctuating water levels. By encouraging the seeds of domesticated rice (*Oryza sativa*) to ripen synchronously, people could harvest the grain much more easily, yet this process made the plant less flood resistant.<sup>31</sup> Should the rains prove overabundant, farmers would lose a whole generation of crops and a source of nutrition that represented significant inputs of labour and time. In this sense, the subsistence crises that would, in later eras, help to make floods substantially more dangerous, were, as David Christian has argued, 'a paradoxical by-product of the agricultural revolution'.<sup>32</sup> The catastrophic famines of the modern era had deep roots in an ancient interaction between people and plants.

Just as humans changed rice, rice also changed humans. To furnish their chosen plant with a habitat conducive to successful propagation, people transformed their patterns of settlement. In doing so, they fundamentally altered their relationship with rivers. Early rice farmers practised flood-recession agriculture, planting their crops on mud banks after the annual inundation had abated. Over time this minimally invasive form of cultivation was augmented with a form of

<sup>28</sup> Yu, Zhu and Wang, 'Radiocarbon Constraints'.

<sup>29</sup> On nutrient flows during flood pulses see Del Moral and Walker, *Environmental Disasters*, pp. 100, 115.

<sup>30</sup> Thorbjarnarson and Wang, *Chinese Alligator*, p. 144. For added fertility farmers would allow fields to remain fallow for a year and then burn off weeds and vegetation, leaving a layer of fertilising ash, and then flooding fields with water. See Lewis, *Early Chinese Empires*, p. 106.

<sup>31</sup> On the difference between wild and domesticated rice see Stark, *Archeology of Asia*, p. 78. Humans change the nature of domesticated grains by choosing to replant particular seeds. For example, people tend to gather and replant more tightly clustered seeds. See Christian, *Maps of Time*, p. 217.

<sup>32</sup> Christian, *Maps of Time*, p. 223.

landscape modification, in which farmers transplanted rice shoots onto banded terraces known as paddy fields. By 2500 BCE these structures were beginning to spread throughout the Yangzi Valley.<sup>33</sup> Paddy fields were essentially artificial wetlands, allowing farmers to imitate the flood pulse while guaranteeing its regularity. They formed part of a suite of technologies that would eventually spread across a vast rice belt in Asia, which continues to feed much of the population of the world today. By the early modern era, paddy fields were helping colonists to transform wetlands as far afield as the lower Mississippi. Before commercial crops such as tobacco and cotton lured plantation owners to drain the land in this region, the lower Mississippi was known as the China of America.<sup>34</sup>

The rise of sedentary agriculture marked a key conceptual shift in the relationship between humans and water. Hunter-gatherers and flood-recession agriculturalists could evacuate with relative ease when threatened by floods. This is also a strategy favoured by many wetland animals, which retreat from water to shelter in areas known as refugia. Those who had modified the landscape risked losing significant investments of labour and time if they simply abandoned their homes. Being stuck in the path of a flood was one of the many consequences of what David Christian has described as ‘the trap of sedentism’.<sup>35</sup> Later, growing populations and changing modes of social organisation made it virtually impossible for people to return to the nomadic solution for flooding. By the modern era, evacuees had become refugees. To ameliorate the trap of sedentism somewhat, communities in Hubei constructed elevated pilings or platforms, which turned into islands when the plains were flooded.<sup>36</sup> These platforms are still in evidence today, and can be identified by the character *tai* 台, a common component in local toponyms.<sup>37</sup> Similar pilings were used historically to avoid floods in regions as diverse as the lower Mississippi and the Gangetic Plain.<sup>38</sup> Unable to retreat to natural high-land refugia, people built their own.

Though the environment had already been marked significantly by agriculture by the first century CE, for those from the relatively developed north, the middle Yangzi was still a wild region. The historian Ban

<sup>33</sup> Chang, ‘Domestication and Spread’; Marks, *China*, p. 86.

<sup>34</sup> Morris, *Big Muddy*, p. 121. <sup>35</sup> Christian, *Maps of Time*, p. 235.

<sup>36</sup> Marks, *China*, p. 26.

<sup>37</sup> Gao, ‘Transformation of the Water Regime’, p. 59. For a nineteenth-century description see Blakiston, *Five Months on the Yang-tsze*, pp. 65–6.

<sup>38</sup> Morris, *Big Muddy*, p. 20; Wisner et al., *At Risk*, p. 136.



Gu 班固 described how those living in the region had a mixed system of subsistence, augmenting cultivated rice with food they had foraged, hunted, and fished from the wild.<sup>39</sup> By this stage human predation had already depleted biodiversity significantly, having pushed appetising and slow-moving species, such as tapirs and wetland deer, to the brink of extinction.<sup>40</sup> Over the next two millennia species loss would increase dramatically, as humans homogenised the ecosystem to furnish their agricultural needs. This was not only ecologically damaging, but also diminished the capacity of humans to survive floods as it deprived them of water-resistant flora and fauna. By replacing wetland species with cultivated grain, humans deprived themselves of vital reservoirs of wild food.<sup>41</sup> Yet these reservoirs were never drained entirely. As we shall see, even in the twentieth century flood-stricken populations often fell back upon the wild wealth of the wetlands.

Agriculture did not erase the natural environment, but rather created agro-ecosystems.<sup>42</sup> Paddy fields were remarkably diverse habitats. Farmers used them to rear a variety of species alongside rice, including cultivated aquatic plants such as lotus and water chestnuts. They also encouraged the growth of ferns that helped improve soil quality.<sup>43</sup> Fish and frogs either were introduced or naturally colonised paddy fields. They not only provided farmers with valuable protein, but also consumed harmful weeds and insects and fertilised crops with their faeces. These species in turn attracted predators, including birds and turtles, which provided a source of nutrition for humans and for larger predators, including wolves and tigers, that left the forests and mountains to hunt on the fringes of the human world.<sup>44</sup> When floods struck, the remnants of the agro-ecosystem offered a valuable source of nutrition to inundated communities. Eventually, salvaging various species of wild and domesticated flora and fauna from inundated farmland was probably more important to human survival than gathering them from wild areas.

As well as hunting, the population of Hubei formed alliances with animals.<sup>45</sup> While domesticated pigs, chickens, and ducks provided useful

<sup>39</sup> Quoted in Oxenham, 'History of Han Yang', p. 367; Marks, *China*.

<sup>40</sup> Lu, *Transition from Foraging*; Turvey, *Witness to Extinction*.

<sup>41</sup> Elvin, *Retreat of the Elephants*. <sup>42</sup> Marks, *China*.

<sup>43</sup> Li, 'Domestication of Plants'; Gorman, *Story of N*, p. 37.

<sup>44</sup> Marks, *China*, pp. 116, 136–7.

<sup>45</sup> On domestication see Christian, *Maps of Time*, pp. 216–17.

protein and manure, ruminant species such as water buffalo, oxen and yellow cows proved the most useful.<sup>46</sup> Far too valuable to eat, these animals were kept primarily for their formidable energy output. Alongside rice, they were a vital biological technology that helped farmers modify the environment. Domestic animals both benefited and suffered from their alliance with humans.<sup>47</sup> Farmers crafted excellent habitats for them, protecting them from competitors, pests and predators. Yet they also placed them in flood-prone areas, constraining them with tethers and fences that inhibited their natural survival behaviours. By the modern era floods were more lethal for domesticated animals than they were for people. As animals drowned, starved or succumbed to epizootics, people lost a vital source of nutrition and energy.

Not all species suffered as humans modified the environment. Pathogens thrived in the agro-ecosystem. Malaria had travelled with early humans into the middle Yangzi. Over time, the plasmodia responsible for the disease became locked into the flood pulse, thriving as mosquito populations swelled during the wet summer months. The draining of wetlands deprived these insects of their natural habitats, yet they found an excellent replacement in paddy fields and irrigation channels.<sup>48</sup> The agro-ecosystem also proved to be an accommodating habitat for freshwater snails, which were the vector of the waterborne disease schistosomiasis, also known as 'snail fever'.<sup>49</sup> The blood fluke that causes this disease has a complicated lifecycle, starting in the intestinal tracts of humans and other mammals, travelling via faeces to freshwater snails and then returning to a mammalian host. Snail fever thrived in areas where humans and cattle spent a long time submerged in water contaminated with faeces. The wetlands and paddy fields of the middle Yangzi offered a perfect habitat. Thus, through fostering the development of an agro-ecosystem, the population of Hubei had laid the foundations of a disaster regime. By encouraging people to settle on floodplains, increasing their reliance on vulnerable plants, and incubating endemic and epidemic diseases, farming helped to make floods much more dangerous.

<sup>46</sup> Smil, *China's Past*, pp. 29–30. <sup>47</sup> Bankoff, 'Bodies on the Beach'.

<sup>48</sup> Marks, *China*, pp. 116, 130; Webb, *Humanity's Burden*, pp. 42–3.

<sup>49</sup> Schistosoma, or blood flukes, lay eggs in the intestinal tracts of humans and other mammals. These are deposited in faeces, becoming larvae that infect freshwater snails. Mature larvae, which are left behind in snail slime trails, burrow through the skin of mammals and then travel to the intestines to lay their eggs, beginning the lifecycle anew. Gross, *Farewell to the God of Plague*, pp. 3–4; Marks, *China*; Elvin, 'Three Thousand Years'.

**Engineering Risks**

For the inhabitants of northern China, the south had long been considered a land of swamps, jungles, disease, poisonous plants, dangerous animals and savage people.<sup>50</sup> This did not stop successive waves of northern migrants from flocking to the Yangzi beginning in the fourth century. The traditional story is that these migrants brought with them new ideologies and technologies of river management that helped to transform the hydrography of the middle Yangzi. Recently, Brian Lander has unearthed documents that question this narrative, dating the use of hydraulic technologies in Hubei to centuries earlier. It seems likely that the reason that locals employed these structures rather modestly in comparison to their northern neighbours was not because they were technologically backward, as has often been assumed, but rather because they could feed themselves adequately without modifying their environment.<sup>51</sup> Whatever their true provenance, hydraulic technologies would have a profound impact on the relationship between people and rivers in Hubei.

The artificial topography of dykes and polders prevented water from encroaching upon arable land, thereby precipitating a dramatic increase in agricultural productivity. Yet it also created new risks. Inherent within the structure of hydraulic technology is the possibility of hydraulic failure, which tends to be a much more catastrophic form of flooding than anything that exists in the natural world. Rapid-onset inundations can occur naturally, such as during large storm surges or when natural ice dams collapse. Yet for the most part, the natural rising of rivers and lakes is a far slower process than the bursting of retained water through a broken dyke or dam.<sup>52</sup> Roger del Moral and Lawrence Walker observe that the ‘more engineering that is done to control a river’s path, the greater are the floods when they burst the barriers – as they always do, eventually.’<sup>53</sup> The catastrophic deluges that poured into communities in 1931 were a product of this form of engineered risk.

Avoiding hydraulic failures is hard work. Dykes require regular maintenance and river channels must be dredged regularly.<sup>54</sup> Communities that neglected these tasks have often found themselves under water.

<sup>50</sup> Lewis, *China between Empires*, p. 13.      <sup>51</sup> Lander, ‘State Management’.

<sup>52</sup> An ice dam break happened, for example, on Lake Missouri 12,000 years ago. See Del Moral and Walker, *Environmental Disasters*, p. 24.

<sup>53</sup> *Ibid.*, p. 115.

<sup>54</sup> For a classic discussion of dredging in disaster prevention see Deng. *Zhongguo jiu Huang shi*, pp. 386–8.

Mark Elvin has suggested that in China hydraulic structures created a form of ‘technological lock-in’ – by building them, communities encumbered future generations with an arduous and expensive task of maintenance, which they had to continue no matter how limited the returns on their investments became over time.<sup>55</sup> Furthermore, by constructing dykes to mitigate natural uncertainties, those living under their protection became vulnerable to human uncertainties. Social phenomena such as financial collapses and armed conflicts often resulted in the neglect of vital hydraulic infrastructure. As people intervened in river flow, floods were no longer determined solely by climate and hydrology but also by economics and politics. Human agency became a key variable in the disaster regime.

Hydraulic agriculture developed incrementally over the course of two millennia. Using techniques first pioneered in the construction of paddy fields, the local population gradually created larger dykes to surround its communities, before beginning to construct larger river defences.<sup>56</sup> By the fourth century the population had begun to construct large dykes in central Hubei along the northern banks of the Yangzi. These would eventually evolve into the Great Jingjiang Dyke 荆江大堤.<sup>57</sup> Dykes were not only a useful agricultural tool, but were sometimes also used as weapons. They allowed defenders to unleash huge quantities of water onto oncoming enemies.<sup>58</sup> The Great Jingjiang Dyke seems to have been constructed at least in part to serve as a rampart against northern invasions.<sup>59</sup> The ancient strategy of ‘militarising rivers’, as Micah Muscolino has put it, would remain a prominent tactic well into the twentieth century, as modern armies continued to use flooding as a weapon.<sup>60</sup>

River dykes became a vital technology of agricultural colonisation in Hubei, allowing farmers to settle previously inaccessible areas to the north of the Yangzi. At the same time, to the south of the river in Hunan,

<sup>55</sup> Elvin, ‘Three Thousand Years’; see also Newell and Wasson, ‘Social System vs Solar System’.

<sup>56</sup> Lander, ‘State Management’.

<sup>57</sup> The Great Jingjiang Dyke is the modern name for a structure that was known throughout much of its history as the Wancheng Dyke 万城堤. There are regional differences in the English terms used for hydraulic structures. What British people refer to as dykes Americans call dikes or levees. Here I distinguish polder dykes from river dykes, in keeping with Chinese descriptions, which use the character *di* 堤 in both compound terms. The term *dadi* 大堤 – literally ‘great dyke’ – which I translate as river dyke, might otherwise be translated as embankment. In this book I use this particular term only to refer to embanked railways, which, confusingly, were sometimes also used as dykes.

<sup>58</sup> Ball, *Water Kingdom*, p. 180. <sup>59</sup> Will, *State Intervention*, p. 300.

<sup>60</sup> Muscolino, *Ecology of War*.

communities were building dykes between the Yangzi and Dongting Lake 洞庭湖. With dykes on both banks, the Yangzi would eventually become consolidated into a single powerful stream. This process is known as channelisation.<sup>61</sup> It not only changes the flow of rivers but also has profound effects on their ecosystems. Channelisation had been occurring naturally in Hubei for thousands of years, as sedimentation and the inclined uplift of the eastern mountain ranges consolidated the unpredictable branched Yangzi into a more fixed stream. The same processes also caused the major flood basin to shift to the south, draining the Yunmeng Marsh and creating Dongting Lake.<sup>62</sup> From the drained wetlands emerged the Jiangnan Plain 江汉平原, a fertile rice basket that became the economic heart of Hubei. Though nominally a plain, this area never quite forgot its marshy origins and remained chronically flood-prone.<sup>63</sup>

Meanwhile in Hunan, nature quickly adapted to the new hydrographic realities. Dongting Lake became a spawning ground for numerous aquatic species, including Yangzi river dolphins and finless porpoises, which swam in large pods throughout the region.<sup>64</sup> Over the next 2,000 years these species would find themselves in direct competition with human beings. Though fisherfolk caught them and starved them of prey, it was farmers who harmed them the most, draining their habitats and dividing their territories with dykes. Today the Yangzi river dolphin is functionally extinct and the finless porpoise is critically endangered.<sup>65</sup> Though pushed over the brink by dams and industrial pollution, it was hydraulic agriculture that initiated the retreat of the cetaceans.

Expanding agriculture built thriving cities. Urbanisation tended to occur at major intersections within the river system where communities could exploit trading opportunities. John McNeill has observed that, prior to the construction of railways, no inland transportation system in the world could rival the Chinese riverine network.<sup>66</sup> Convenience came at a heavy price, as port cities would suffer periodic inundations. Hubei boasted some of the best-located and most flood-prone cities in all of China. The east of the province formed a natural transportation hub,

<sup>61</sup> Brookes, *Channelized Rivers*. Channelisation should not be confused with canalisation, a process designed less for flood control and more to turn rivers into navigable waterways, much like artificial canals. Many rivers in Hubei were both channelised and canalised.

<sup>62</sup> Yin et al., 'On the River-Lake Relationship'. <sup>63</sup> Perdue, *Exhausting the Earth*.

<sup>64</sup> Zhang et al., 'Yangtze River Dolphin'. These creatures once ranged from the Yichang to the Yangzi Delta.

<sup>65</sup> Turvey, *Witness to Extinction*. <sup>66</sup> McNeill, 'China's Environmental History'.

as it was the point where the Yangzi was at its closest proximity to the Yellow River. Junks and sampans were able to navigate a relatively easy path between two major arterial trade routes by sailing along tributary rivers. Lying between Dongting and Poyang Lakes, eastern Hubei was also an access point for the southern trading networks that drained into these watercourses.<sup>67</sup> By the Song dynasty (960–1279) several urban settlements had developed around the confluence of the Yangzi and Han. These would eventually evolve into the conurbation known today as Wuhan.

When the scholar-official Fan Chengda 范成大 visited the Wuhan area in the twelfth century, he found thriving market cities, home to tens of thousands of households and rows of shops ‘as thick as teeth in a comb’. There was, apparently, nothing known in the world that was not sold here.<sup>68</sup> Urban commerce would play an important role in transforming the environment of Hubei. Merchants rarely deforested catchments or reclaimed wetlands with their own hands, but they made great profits by selling timber and rice. Port cities also changed the epidemiological environment. Their dense populations provided sustainable chains of infection for crowd diseases, which were unable to persist in their most virulent forms in smaller human communities.<sup>69</sup> Meanwhile, urban trade networks acted as conduits for rapid dissemination of pathogens across large areas.<sup>70</sup> The diseases incubated by cities would transform the disaster regime, escalating to epidemic proportions in the wake of floods.

Hydraulic agriculture may have begun its inexorable rise, but by the beginning of the second millennium many residents of Hubei still retained elements of an earlier wetland culture. When the scholar-official Lu You visited Hubei in the twelfth century he noticed an obvious divide between those living on higher ground, who farmed millet and buckwheat, and those living among the marshes and lakes, who hunted, fished and gathered lotus and water chestnuts.<sup>71</sup> Lu painted an idyllic picture of the latter population, describing them as living freely among lakes and marshes. In reality, wetland communities could not escape the strictures of state regulation, as the use of wild resources was subject to rigid controls.<sup>72</sup> Over the next few centuries hunting and fishing would be

<sup>67</sup> Worcester, *Junks and Sampans*, pp. 18, 145–58.

<sup>68</sup> Hargett, *Riding the River Home*, p. 147.

<sup>69</sup> Crawford, *Deadly Companions*; Elvin, ‘Three Thousand Years’.

<sup>70</sup> Marks, *China*, p. 130. <sup>71</sup> Watson, *Grand Canal*, pp. 124–35.

<sup>72</sup> Elvin, ‘Three Thousand Years’, pp. 25–7.

curtailed as wild areas were incorporated into a regime of property and usufructuary rights. Yet the wetland world that Lu described was not a complete fiction. Many people truly did manage to find ways to evade some of the worst consequences of sedentism.

Some did so by living outside the law. Like the dark forests of northern Europe, the wetlands of China had always been imagined as spaces of mystery and crime. Fan Chengda described the trepidation that he and his crew had felt when they sailed through an area to the west of Wuhan known as the Hundred Miles of Wasteland 百里荒 (Baili Huang). This was 'all lakes and meres, and stalks and reeds, with no further traces of humans, and where powerful bandits appear and disappear'.<sup>73</sup> Others found legal ways to live in the wetlands. One of the most remarkable adaptations to regular inundation was the use of floating fields, which could be found on rivers and lakes. Lu described seeing large structures formed of knitted aquatic grass covered with earth. They were large enough to support entire communities – complete with chickens and dogs, vegetable allotments, wine shops, and temples.<sup>74</sup> Floating fields represented a radical alternative to hydraulic agriculture – a way of life based on accommodating rather than suppressing water.

### *Fighting Water for Land*

Two interlinked processes defined the history of flooding in Hubei over the course of the second millennium. The first was the repetitive growth and collapse of floodplain agriculture that Pierre-Étienne Will has described as the 'hydraulic cycle'.<sup>75</sup> This began with heavy investment in dykes, which helped to precipitate a period of rapid agricultural expansion and economic growth. When growth exceeded the capacity of hydraulic technology, the region experienced increased flooding and a concomitant economic recession. A period of crisis could be ameliorated only when the state renewed its investment in water control, thereby beginning the hydraulic cycle anew. The hydraulic cycle played out twice over the course of the second millennium, roughly corresponding with the rise and fall of the Ming and Qing dynasties. History may not have repeated itself but it certainly rhymed. These cycles were nested within

<sup>73</sup> Fan quoted in Hargett, *Riding the River Home*, p. 146.

<sup>74</sup> Watson, *Grand Canal*, p. 147.

<sup>75</sup> Will, 'Un cycle hydraulique,' pp. 261–88. Peter Perdue identified a similar pattern in the Dongting Lake area of neighbouring Hunan. See Perdue, *Exhausting the Earth*.

a second, more profound process of environmental change, in which all available land was gradually turned over to agricultural production. Mark Elvin has described this as a trajectory towards the ‘maximal arablization’ of the environment.<sup>76</sup> To feed an insatiable appetite for land, people trapped rivers in channels, drained wetlands, and denuded forests. Together, these environmental encroachments helped to increase the frequency and intensity of flooding.<sup>77</sup>

Song engineers consolidated the piecemeal river dykes in Hubei into continuous hydraulic systems. They were careful to incorporate outlets and sluice gates that would allow rivers to discharge excess water and silt onto their floodplains.<sup>78</sup> At the same time, local communities began to construct dykes to encircle their communities known as polders or *yuan* 垸.<sup>79</sup> These would become the primary units of cultural and social organisation in Hubei, serving a role similar to that played by villages in other regions.<sup>80</sup> River dykes and polders – together with new technologies such as waterwheels and treadle paddle pumps – allowed farmers to drain wetlands.<sup>81</sup> This process expanded dramatically during the Ming dynasty (1368–1644), due, in part, to a large influx of migrant colonists from downstream Jiangxi.<sup>82</sup> This period of growth corresponded roughly with the onset of a period of global cooling known as the Little Ice Age. As cold periods tend to precipitate a decline in flooding in the middle Yangzi, it is possible that the climate may have made it easier for colonists to drain the wetlands.<sup>83</sup> Soon the Jiangnan and Dongting plains became largest rice-exporting area in the empire, exceeding even Jiangnan region in the prosperous eastern provinces. ‘If Hubei and Hunan have a good harvest’, it was said, ‘All-under-Heaven will be fed’ 湖广熟，天下足 (Huguang shu, Tianxia zu).<sup>84</sup> Hydraulic agriculture – an inherently risky business – was now a vital constituent of one of the largest regional economies in the world.

<sup>76</sup> Elvin, ‘Three Thousand Years’.

<sup>77</sup> On this increase see Yu, Chen and Ren, ‘Analysis of Historical Floods’.

<sup>78</sup> Will, ‘State Intervention’.

<sup>79</sup> Gao, ‘Transformation of the Water Regime’; Perdue, *Exhausting the Earth*; Zhang, ‘Environment, Market, and Peasant Choice’.

<sup>80</sup> Gao, ‘Transformation of the Water Regime’.

<sup>81</sup> Elvin, *Pattern of the Chinese Past*, pp. 126–7. <sup>82</sup> Will, ‘State Intervention’, pp. 307–8.

<sup>83</sup> Ts’ui-jung Liu notes that the period between 1470 and 1520 was particularly cold. Liu, ‘A Retrospection of Climate Changes.’ Timothy Brook has noted that the broad transformation to the Little Ice Age was punctuated by a succession of nine ‘sloughs’, during which China experienced bouts of severe weather. Brook, *Troubled Empire*, 6–24.

<sup>84</sup> Di, ‘Xin Zhongguo’; Zhang, *Coping with Calamity*, p. 101.



In 1465, Hubei experienced one of its most historically significant floods. The Han River suddenly shifted course, revealing a thin strip of land at the point of its former confluence with the Yangzi. This would eventually become named Hankou 汉口, literally the Mouth of the Han. With an unrivalled position in the riverine network, by the late imperial period this was the greatest inland entrepôt in China, and one of the biggest cities in the world.<sup>85</sup> Like so many other great trading centres – such as Paris, New Orleans, Kolkata and Saint Petersburg – Hankou was a city designed by rivers. Water defined its economic life, forged its urban morphology, influenced its vernacular architecture and saturated its religious life. This intimate relationship with water came at a heavy cost. A city that owed its very existence to the capricious nature of rivers would remain at their mercy throughout its history, as time and again Hankou would find itself under water.

The rapid growth of the agricultural economy eventually proved unsustainable. Excessive wetland reclamation deprived rivers of natural flood reservoirs. As the surface area of marshes and lakes decreased, the wetlands no longer absorbed excess water.<sup>86</sup> Poor hydraulic governance hastened the systemic decline. The outlets that Song engineers had included in river dykes silted up or were deliberately blocked. This allowed agriculturalists to colonise more land but also prevented rivers from discharging excess water and silt.<sup>87</sup> Siltation would eventually elevate the Han and Yangzi above their plains, and lead to disastrous dyke breaches. In the 1560s Hubei was struck by a succession of catastrophic floods.<sup>88</sup> These inundations marked the beginning of a deeper hydraulic crisis. Waterlogging and localised flooding became the norm, and basin wide floods struck Hubei in 1592 1593 and 1600. Although we know that this was an era of intense El Niño activity in areas such as Burma and India, the general pattern of flooding in the sixteenth and seventeenth centuries does not correspond neatly with ENSO activity.<sup>89</sup> The political climate was at least as important, as the collapse of Ming governance prevented effective hydraulic reforms. The most significant factor

<sup>85</sup> Rowe, *Hankow: Commerce and Society*; Rowe, *Hankow: Conflict and Community*.

<sup>86</sup> Yin et al., 'On the River-Lake Relationship'; Will, 'Un cycle hydraulique'.

<sup>87</sup> In most cases sluice gates were sealed so that colonists could open new land, yet some were also deliberately sealed for geomantic reasons, as officials wished to prevent the flooding of an imperial tomb. See Will, 'State Intervention', pp. 311–13.

<sup>88</sup> Will, 'Un cycle hydraulique'.

<sup>89</sup> Ricklefs et al., *New History of Southeast Asia*, p. 96. A chronology compiled by Brook cites five El Niño events in the 1560s and three in the 1590s. See Brook, *Nine Sloughs*.

was the unsustainable pattern of river basin settlement. By the time that the Ming dynasty fell, the hydraulic crisis had become so severe that the Jiangnan Plain had reverted to being a depopulated wetland once again.<sup>90</sup>

Although hydraulic agriculture had proven vulnerable to climatic and political stress, its economic benefits were hard to resist. Hence, when the Qing dynasty (1644–1912) took over Hubei, its governors began to invest heavily in dyke reconstruction. From the mid-seventeenth century the wetlands and floodplains of Hubei were reoccupied. This time the impetus was provided by internal demographic growth rather than immigration.<sup>91</sup> The population increased dramatically as New World crops such as maize, corn, peanuts and sweet potatoes improved nutrition. These hardy plants allowed agriculturalists to colonise inhospitable highland environments with acidic soils.<sup>92</sup> As agriculture climbed hills the pace of deforestation increased dramatically. Meanwhile merchants continued to strip highland forests and float timber rafts along rivers to urban markets.<sup>93</sup> The denuding of catchments exacerbated the problem of flooding. Removing trees and vegetation caused water to drain off hillsides faster and in much greater volumes. Increased water runoff stripped the topsoil, which was no longer bound by forest root systems, from the land. As soil leached into watercourses the silt-load of rivers increased, meaning that their beds were raised and their discharge channels were blocked.<sup>94</sup>

<sup>90</sup> Oxenham, 'On the Inundations', p. 175; Will, 'Un cycle hydraulique'; Perdue, *Exhausting the Earth*.

<sup>91</sup> Zhang, *Coping with Calamity*. The 225 million people who populated the empire in 1750 had risen to 420 million by 1870. See Marks, *China*, p. 170.

<sup>92</sup> Osborne, 'Highlands and Lowlands'. Although the late imperial increase of deforestation, starting in the eighteenth century, was by far the most intense, there had been several major waves of deforestation in Chinese history. The loss of forests first began to have a discernible impact in the first millennium CE, increasing dramatically at the start of the second millennium CE, around the same time that the dyke network in Hubei was evolving. This was a period of relative climatic and economic stability, known as the medieval economic revolution. See Elvin, *Retreat of the Elephants*. China was far from unique in decimating its forest resources in the early modern period. See Richards, *Unending Frontier*.

<sup>93</sup> Worcester, *Junks and Sampans*, p. 420.

<sup>94</sup> There remains some debate among hydrologists regarding the link between deforestation and flooding. For a view in support of the link see Bradshaw et al., 'Global Evidence that Deforestation Amplifies Flood Risk'. For an argument that rejects simple causation see Dijk et al. 'Forest–Flood Relation Still Tenuous'. Qing scholars such as Wei Yuan seem to have believed strongly in the link. See Wei, 'Huguang shuili lun'.

While colonists drained wetlands and denuded forested slopes, administrators failed to address the structural problems in the river dyke system. Rather than opening blocked outlets, Qing engineers consolidated dykes into uninterrupted networks, finally separating rivers from their floodplains entirely.<sup>95</sup> Farmers later exacerbated this process by building polders next to the river dykes.<sup>96</sup> The Yangzi and Han Rivers, which had once wandered across their plains in a continuum of multiple streams, were now effectively channelised. As they were unable to discharge water and silt, alluviation raised their riverbeds.<sup>97</sup> Communities on the plains now lived below the level of rivers, with only dykes to protect their homes and livelihoods. When these dykes failed, as they inevitably did from time to time, the constructed landscape funnelled water down onto these communities. Hydraulic agriculture had helped to create a mutant form of flooding, far more destructive than any natural inundation.

In 1788, the Yangzi burst through the Great Jingjiang Dyke. Water poured onto the Jiangnan Plain and turned polders into reservoirs.<sup>98</sup> This was the first in a series of mega-floods that would devastate Hubei over the next two centuries. The ultimate cause of this disaster lay in the human interaction with the environment, but its proximate cause was meteorological. The final two decades of the eighteenth century were a period of extreme weather worldwide, with droughts in Egypt, India and Mexico killing millions. The common link seems to have been a powerful and prolonged El Niño event.<sup>99</sup> This may well have contributed to the flooding of Hubei in 1788.

The climate could not have precipitated such a calamitous inundation, however, were it not for the profound anthropogenic transformation of the environment. Observers at the time were not unaware of this fact. The great nineteenth century polymath Wei Yuan 魏源 wrote an incisive account of how excessive deforestation and polder construction had exacerbated flooding. Inundation is inevitable, he observed, when ‘people fight water to derive the benefits of land.’<sup>100</sup> To prevent flooding, Wei

<sup>95</sup> Yin et al., ‘On the River–Lake Relationship of the Middle Yangtze.’ The Great Jingjiang Dyke was further elongated in the Republican period and finally extended to Jianli County in 1954, thereby reaching a total length of 182.35 km. Zhang, ‘Water Calamities and Dike Management’, p. 70.

<sup>96</sup> Wei, ‘Hubei difang yi’; Wei, ‘Huguang shuili lun’.

<sup>97</sup> Zhang, *Coping with Calamity*, p. 30.

<sup>98</sup> Will, ‘State Intervention’, p. 342.

<sup>99</sup> Grove, ‘Great El Niño.’ See also Grove and Chappell, *El Niño*, p. 17.

<sup>100</sup> ‘Ren yu shui zheng di wei li 人与水争地为利’, Wei, ‘Hubei difang yi’, p. 399.

argued, the people of Hubei would have to allow rivers to reclaim some of their natural floodplains. This sustainable approach to river management had a long pedigree in Chinese environmental thinking. Though water conservancy had long been dominated by a Confucian doctrine of decisive environmental interventionism, there had always been a counterculture of intellectuals who advocated a more Daoist approach, suggesting that rivers be allowed to follow their own courses.<sup>101</sup> In the years since Wei Yuan offered his analysis of flooding, his non-interventionist perspective tended to be marginalised. In China, as elsewhere, modern states have been determined to fight water for land.<sup>102</sup>

It took two decades for Hubei to recover from the 1788 flood. The provincial government eventually funded an extensive rehabilitation of the dyke network, which bought temporary respite but could not arrest the incipient hydraulic crisis.<sup>103</sup> Over the next century the frequency and intensity of flooding would increase dramatically. This was partly a matter of perception. As Eduard Vermeer has observed, when agricultural colonists occupied marginal land in the late Qing, the previously unremarkable ebb and flow of water suddenly came to be recorded in local gazetteers as flooding.<sup>104</sup> This observer bias cannot explain the increase in flooding in established agricultural areas such as the Jiangnan Plain, which had long been under official surveillance. In 1831 Hubei experienced one of the most devastating inundations of the nineteenth century. One hundred thousand refugees descended upon Hankou, where they were fed for months at rice porridge kitchens. Later, Wuhan itself was flooded to such an extent that large ships could sail through the streets – scenes that would be repeated exactly a century later.<sup>105</sup>

Zhang Jiayan has argued that the hydraulic crisis that Hubei experienced between the mid-nineteenth and mid-twentieth centuries was due largely to poor governance. Administrators embezzled tax revenue, neglected dyke management and used substandard construction materials.<sup>106</sup> These localised failures were part of a broader pattern. Historians today rightly eschew the teleological view of the late Qing, which pictures it as a polity limping meekly to an inevitable demise. Beset by serious domestic and international pressures, governors often responded with flexibility and innovation. Yet the capacity of the state

<sup>101</sup> Pietz, *Yellow River*; Ball, *Water Kingdom*. <sup>102</sup> McNeill, *Something New*, p. 150.

<sup>103</sup> Will, 'State Intervention', p. 342. <sup>104</sup> Vermeer, 'Population and Ecology'.

<sup>105</sup> *Wuhan shi zhi: Minzheng zhi*, p. 141.

<sup>106</sup> Zhang, 'Environment, Market, and Peasant Choice', p. 39; Zhang, 'Water Calamities', p. 97.

undoubtedly declined, helping to set the stage not only for the hydraulic crisis in the middle Yangzi but also for the long century of disasters more generally. This ailing state not only failed to maintain its hydraulic infrastructure, but also underfunded its once formidable granary network. This meant that not only were floods more devastating but the famines they caused were also significantly worse. Politics and economics had helped to forge a modern disaster regime, which left people chronically vulnerable to hazards.

### *Living with Floods*

In the 1840s Évariste Huc wrote one of the first European travel accounts of Hubei. Among numerous remarkable sights, he described whole communities living on floating fields. These seem to have changed remarkably little in the seven centuries since Lu You had travelled through the region. Whole villages sat on bamboo rafts covered with soil, floating in a leisurely fashion across lakes and rivers. Huc characterised the existence of those thereon as a life of 'peace and abundance'. These nomads of the wetlands, who cultivated rice and caught fish, had 'constructed themselves a little solitude in the midst of civilisation'.<sup>107</sup> These were not the only people who found ways to accommodate water by floating on its surface. River merchants and fisherfolk often lived their entire lives aboard sampans and junks, which had kitchens and sleeping areas in the aft.<sup>108</sup> This floating population enjoyed a way of life that was radically different from that of the sedentary majority.

Though farmers were far more vulnerable to inundation, they also found ways to live with floods, as the historian Zhang Jiayan has described eloquently. For those at the ecological fringes, living on land prone to inundation, the threat of water formed an imperative far stronger than the market. They eschewed profitable cash crops in favour of water-resistant varieties such as deep-water rice and sorghum.<sup>109</sup> They also continued to practise older forms of wetland culture, supplementing their nutritional intake by foraging and hunting. Habitat loss and human predation had severely depleted biodiversity, but as the accounts of foreign travellers and hunters in the late nineteenth century attest, Hubei

<sup>107</sup> Huc, *Journey Through the Chinese Empire*, pp. 95–7. See also Zhang, *Coping with Calamity*.

<sup>108</sup> Worcester, *Junks and Sampans*, pp. 466–7.

<sup>109</sup> Although a dry land crop, sorghum is relatively water resistant. See Zhang, *Coping with Calamity*, p. 109.

was far from the ecological wasteland that the North China Plain was becoming.<sup>110</sup> Thomas Blakiston, who sailed up the Yangzi in the 1860s, saw a wide variety of flora and fauna, including pods of porpoises ‘disporting themselves in the still muddy current’ of the Yangzi, which followed him for much of his journey through the region.<sup>111</sup> Great flocks of water birds still gathered in the region to exploit the wide variety of fish species, including bream, carp, catfish and perch, which could be found in great abundance in the many rivers and lakes of the region.<sup>112</sup>

Fish still formed an important part of the diet of the local population. The Japanese diplomat Mizuno Kokichi, who made a detailed study of the markets in Wuhan in the first decade of the twentieth century, remarked on the huge variety available to local consumers.<sup>113</sup> Though many of these fish were raised in ponds, aquaculture still relied heavily on the natural environment, as the spawn of most species was harvested from the wild.<sup>114</sup> Fisherfolk cast lines or dip-nets into rivers and lakes, or caught fish using lime, which deprived their quarries of oxygen.<sup>115</sup> Some people even exploited the fishing expertise of wetland animals. Cormorants and egrets were domesticated and used to catch fish, their throats bound to prevent them from swallowing their catch.<sup>116</sup> In western Hubei people trained otters to flush fish into their nets.<sup>117</sup> As the main fishing season coincided with a slack period in the agricultural year, farmers often took to the water to supplement their diets and incomes.<sup>118</sup> Fish stocks were also sufficient to support a large population of occupational specialists, who lived on lakeshores and riverbanks, or aboard boats. Fisherfolk tended to be poor, but their way of life was highly adapted to their perilous environment.<sup>119</sup>

<sup>110</sup> The foreign hunter William Spencer Percival remarked that waterfowl ‘swarm all over the river in the winter months.’ Spencer Percival, *Land of the Dragon*, p. 76. See also Blakiston, *Five Months*, p. 98.

<sup>111</sup> Blakiston, *Five Months*, pp. 61, 73, 119. On later extinction see Turvey, *Witness to Extinction*.

<sup>112</sup> Wang et al., ‘Terrestrial Contributions’; Rowe, ‘Water Control’.

<sup>113</sup> Shuiye, *Hankou*, pp. 139–140. <sup>114</sup> Worcester, *Junks and Sampans*, p. 136.

<sup>115</sup> Upward, *Sons of Han*, p. 56; Blakiston, *Five Months*, pp. 30, 137; Worcester, *Junks and Sampans*, p. 138.

<sup>116</sup> *Special Catalogue of the Chinese Collection of Exhibits for the International Fisheries Exhibition*, p. 46; Laufer, *Domestication of the Cormorant*. For a description of cormorant fishing in Hubei see Cornaby, *String of Chinese Peach-Stones*, pp. 4–5.

<sup>117</sup> *Special Catalogue of the Chinese Collection of Exhibits for the International Fisheries Exhibition*, p. 6.

<sup>118</sup> On the fishing season see Shuiye, *Foreign*; Zhang, *Coping with Calamity*.

<sup>119</sup> Rowe, ‘Water Control’.



Figure 1.1. A fowler in the middle Yangtze region in the late nineteenth century. (Ayeon Kum, 'Some Chinese Methods of Shooting and Trapping Game', in *With a Boat and Gun in the Yangtze Valley*. Shanghai: Shanghai Mercury, 1910. Reproduced courtesy of the Cambridge University Library)

In addition to fish, people exploited many other natural endowments of the wetlands. They foraged for edible plants such as lotus, water chestnuts and wild rice, and marketable varieties, such as duck weed, hemp and indigo.<sup>120</sup> They hunted terrestrial mammals such wild pigs, deer, badgers and weasels in forested upper catchments. The most important sources of wild protein, besides fish, were the eggs and meat of birds. Hunters used dragnets, bamboo cages, traps and guns to catch pheasants and snipe and a large selection of waterfowl, including geese, ducks, teal, swans, pelicans and cranes.<sup>121</sup> Figure 1.1 gives an impression of the innovative nature of wetland culture. Fowlers wore oilskins and camouflaged themselves with grass, before floating over to flocks of waterfowl on large

<sup>120</sup> Zhang, *Coping with Calamity*; Rowe, 'Water Control'.

<sup>121</sup> Wade, *With Boat and Gun in the Yangtze Valley*, pp. 19, 24, 29; Kum, 'Some Chinese Methods of Shooting and Trapping Game'; Jernigan, *Shooting in China*, p. 212; Worcester, *Junkman Smiles*, p. 48.



wooden boards attached to their necks. Using tame ducks as decoys, they caught their unsuspecting quarry with their hands.<sup>122</sup> Hunting was a profitable enough business to support a specialised market for the meat and feathers of game birds in Wuhan.<sup>123</sup> These reservoirs of wild food may not have been sufficient to support a large population on a permanent basis, yet they helped bolster nutritional intake in normal years and offered a vital resource during floods.

If managed correctly, flooding did not have to be a problem for farmers. In Bangladesh, rural communities distinguish between *borsha* floods, which they depend on for regular agricultural production, from *bonna* floods, which cause widespread loss of crops and life.<sup>124</sup> Those cultivating the lowlands of Hubei drew similar distinctions. They were drawn to areas such as lakeshores precisely because they were flood-prone, as they knew that the regular rise and fall of water deposited rich halos of fertility.<sup>125</sup> In the 1910s the poet Luo Han 罗汉 described how those who cultivated lakes to the north of Wuhan reaped great fortunes from the nutrient-rich soil.<sup>126</sup> This agricultural strategy was not without risks, as entire harvests could be destroyed if water was overabundant. Yet with considerable skill and a little good fortune, the profits accrued during good years easily made up for occasional losses.<sup>127</sup>

For those unable to maintain this delicate balance, lakeshore agriculture could become a poverty trap. The regular loss of crops meant that some communities subsisted on little more than wild plants. Local histories relate descriptions of lakeshore communities who were so poor that their residents became infertile.<sup>128</sup> While travelling through rural Hubei in the 1880s, Archibald Little was confronted with this stark poverty. ‘Nothing could be more wretched than the appearance of the few villages we passed – collections of ten to twenty reed-huts perched on the top of a steep mound, which is covered to the water’s edge with

<sup>122</sup> For description of waterfowl see Little, *Through the Yang-tse Gorges*, p. 22; Blakiston, *Five Months*, p. 93.

<sup>123</sup> Shuiye, *Hankou*, p. 141. <sup>124</sup> Zaman, *Rivers of Life*.

<sup>125</sup> Del Moral and Walker, *Environmental Disasters*, p. 130.

<sup>126</sup> Luo, *Minchu Hankou*, p. 8. <sup>127</sup> Zhang, *Coping with Calamity*.

<sup>128</sup> Pi, *Wuhan Tongshi: Minguo Juan (Shang)*, p. 222. Such claims may well have been apocryphal, speaking to a cultural idiom in which an inability to produce descendants was considered a highly pitiable fate. Yet severe malnutrition, coupled with the effects of endemic diseases such as snail fever, can cause a dramatic decline in fertility rates. Ó Gráda, *Famine*, p. 108. Gross, *Farewell to the God of Plague*.



buffalo dung.<sup>129</sup> Flooding was often both a cause and a consequence of economic distress. The only places that people could afford to live were the same places that kept them poor.<sup>130</sup> This was not unique to Hubei. In flood-prone regions of northern India members of lower castes can often be found in disproportionately high numbers in littoral areas around the edges of elevated settlements, their social marginality consolidating them in a position of geographic vulnerability.<sup>131</sup>

Chronic water control problems had serious health effects, which cascaded into further economic problems. By the early twentieth century snail fever was so rife that it infected around 10 million people nationwide, killing around 400,000 annually.<sup>132</sup> People living in infectious zones could do nothing but leave, meaning that large tracts of fertile land remained uncultivated. In Hanyang County, snail fever wiped several dozen villages off the map. Those who refused to be pushed off their land by molluscs soon developed debilitating symptoms, which further hindered their economic productivity. Late-stage snail fever sufferers developed hugely distended stomachs, a symptom so notorious that locals named the condition 'big belly disease' 大肚子病 (*da duzi bing*). Snail fever was particularly prevalent in the villages around Dongxi Lake 东西湖, where eight out of ten people were infected. Residents of this area, so it was said, could be easily identified, as their stomachs entered the room before the rest of their bodies.<sup>133</sup> For those living in such conditions, floods merely amplified ongoing problems – they caused epidemic outbreaks of endemic poverty.

Few epidemics of poverty surpassed that caused by the catastrophic 1849 flood. In some ways this disaster adhered to the typical pattern found in the region, having been caused by heavy summer rains in Hubei, Hunan and Sichuan. Yet the flood also coincided with – and was perhaps precipitated by – a highly unusual period of cold weather in June. The residents of Wuhan, who would ordinarily be sweating in the oppressive humidity of the early summer, instead found themselves wearing furs and skins.<sup>134</sup> Curiously, at the same time, their counterparts in the southern United States were experiencing similar conditions, with a cold and wet

<sup>129</sup> Little, *Through the Yang-tse Gorges*, p. 53.

<sup>130</sup> In some areas there was a direct correspondence between the elevation of land and its value. Zhang, *Coping with Calamity*, p. 153.

<sup>131</sup> Wisner et al., *At Risk*, p. 136. <sup>132</sup> Gross, *Farewell to the God of Plague*, p. 17.

<sup>133</sup> Pi, *Wuhan tongshi: Minguo juan (shang)*, pp. 220–3.

<sup>134</sup> Oxenham, 'History of Han Yang,' p. 175.

spring in the tributaries of the Mississippi helping one of the worst floods in the history of New Orleans.<sup>135</sup>

As rural communities across Hubei descended into famine, in Wuhan another deadly secondary effect of flooding seemed to be raising its head. The geographer Edward Oxenham suggests that the 1849 flood precipitated an outbreak of cholera.<sup>136</sup> Reconstructing the history of this disease in China is fraught with difficulties. The term *huoluan* 霍乱, which in the modern era came to signify a specific condition caused by cholera vibrio, had been used for millennia as a generic term for any kind of acute gastrointestinal distress.<sup>137</sup> Believing that China was the fountainhead of all things infectious, foreigners often assumed that references to *huoluan* in ancient medical texts were evidence that modern cholera had been present in the country since time immemorial.<sup>138</sup> This was not the case. It is likely that foreigners themselves imported cholera into China during in 1820s, with the vibrio travelling along shipping routes from their home in deltaic India.<sup>139</sup>

Cholera quickly found a niche in the cities of the middle Yangzi, and thrived when humans were pushed into contact with infected water in the summer months. Along with other enteric conditions, it proved particularly lethal to overcrowded settlements of flood refugees who lacked any sanitary provisions. Thus established, cholera became a defining component of the modern disaster regime. It was already exacerbating the effects of flooding in the Yellow River in 1821.<sup>140</sup> Alongside typhus, malaria and dysentery, it would become one of the leading causes of death during nineteenth century famines.<sup>141</sup> Historians have paid relatively little attention to the role that modern diseases played in modern disasters. The epidemiological transitions of this era had a profound influence on the nosological profile of hazards. Populous yet unsanitary cities linked by rapid transportation created new possibilities for transmission of pathogens.<sup>142</sup> These new disease ecologies proved lethal to

<sup>135</sup> On the Red River see Blair and Rannie, 'Wading to Pembina'. On the New Orleans floods see Morris, *Big Muddy*.

<sup>136</sup> Oxenham, 'On the Inundations', p. 175.

<sup>137</sup> On traditional Chinese medical conceptions of cholera see Rogaski, *Hygienic Modernity*, esp. p. 96.

<sup>138</sup> For example, in the 1890s, J. C. Thompson published an article stating 'Cholera has been known in China since time immemorial', noting its appearance in records as early as 2,000 years earlier. Quoted in *The China Medical Journal* XLI, no. 7 (July 1927).

<sup>139</sup> MacPherson, 'Cholera in China'; Marks, *China*, p. 227.

<sup>140</sup> Li, *Fighting Famine*, p. 264. <sup>141</sup> Ó Gráda, *Eating People Is Wrong*, p. 145.

<sup>142</sup> Crawford, *Deadly Companions*; Harrison, *Disease and the Modern World*.

large populations of refugees, thus greatly exacerbating the humanitarian consequences of the disaster regime.

Even by the standards of the nineteenth century, the 1849 flood seems to have had been particularly devastating. The poet Ye Diaoyuan 叶调元 wrote of a million homes washed away by water, impoverished refugees starving to death on the streets and women forced to sell themselves into prostitution. A prevalent theme in his poems was the inequality of disaster outcomes. Wealthy people had fled for safety while poor people had simply died. The rich transported their dead for burial on local hillsides, while the poor were forced to abandon corpses to floodwater. Those who lived in large houses moved to higher storeys, while the lowly houses of the poor were reduced to rubble.<sup>143</sup> While residents of Wuhan were experiencing the inequality of disaster outcomes, their counterparts in New Orleans were also discovering the profound influence that household income has during floods. When the city was inundated, wealthy people 'vertically evacuated' into the upper storeys of their homes, while their poorer neighbours were forced to flee from single-storey shacks to higher ground.<sup>144</sup>

The cultural historian Andreas Bernard has linked the desire of modern urbanites to live in upper storeys to the invention of the lift. In modern cities such as Paris and New York, mechanical lifts helped to transform inconvenient garrets into desirable penthouses.<sup>145</sup> Yet in flood-prone cities such as Wuhan and New Orleans, height had always been a premium commodity, demonstrating that there was more than one form of architectural modernity. In Hubei, there was a distinct convergence between the literal and figurative stratification of the urban landscape. Wealthier citizens built large timber-framed buildings on strong stone or earth foundations, with walls constructed from a variety of materials including brick, stone, timber and bamboo.<sup>146</sup> Those with fewer resources constructed housing frames from cheap timber or bamboo and made walls from tamped earth, thatch or woven reeds. During floods, humble houses dissolved in water or were torn from the landscape, leaving nothing but skeletal wooden frames.<sup>147</sup> At the literal and figurative bottom of the urban landscape people lived in huts

<sup>143</sup> Ye, *Hankou zhuzhici*. The aftermath of this disaster offered little respite for the population, as receding water gave way to invading Taiping armies. Rowe, *Hankou: Conflict and Community* p. 151.

<sup>144</sup> Morris, *Big Muddy*, pp. 71, 106–7.      <sup>145</sup> Bernard, *Lifted*.

<sup>146</sup> Knapp, *China's Old Dwellings*, p. 79.

<sup>147</sup> *Ibid.*; Buck, *Chinese Farm Economy*, p. 401. Upward, *Sons of Han*, p. 73



Figure 1.2. The Wuhan riverbank in the early twentieth century. (Author's personal collection)

棚子 (pengzi) or low houses 矮屋 (aiwu), which offered virtually no protection from flooding.<sup>148</sup>

Nowhere was the convergence of literal and social stratification more evident than on the riverbanks of cities. Here river merchants lived in stilt houses that would remain above rivers even during the wet summer months. On the banks below people lived in shacks and huts, where they had to contend not only with unpredictable watercourses, but also with sewage and rubbish being thrown down from stilt houses.<sup>149</sup> Some shacks were constructed from urban detritus – discarded planks, pieces of broken metal or anything that could be gleaned from the city above.<sup>150</sup> Other huts were knitted together from reeds, which grew in thick stands on riverbanks and lakeshores often reaching a height of four or five metres.<sup>151</sup> The reed huts that stood on the riverbanks of Wuhan (Figure 1.2) were known colloquially as duck eggs 鸭蛋 (yadan).<sup>152</sup>

Huts offered little protection from the elements, and could easily be washed away by flash floods, yet had the advantage of being cheap and

<sup>148</sup> Xie, *Yi jiu san yi nian Hankou dashui ji*, p. 141.

<sup>149</sup> Bird, *Yangtze Valley and Beyond*, p. 67.      <sup>150</sup> Li 'Matou gongren'.

<sup>151</sup> Rensselaer, *A Legacy of Historical Gleanings*, p. 341; Little, *Through the Yang-tse Gorges*, pp. 21–2.

<sup>152</sup> Li, 'Fuhe rensheng', pp. 55–7; or a contemporary description of life in this area see Jie, *Hankou zhi kuli*.

portable. Their occupants could cope with the threat of flooding using one of the most venerable of techniques – evacuation. The occupants of duck egg shacks lived a semi-nomadic existence, moving their homes to high-ground refugia when rivers rose in the summer. Living in a hut, though hardly desirable, was a pragmatic adaptation to a hazardous environment, which allowed people to survive on the littoral and economic margins of the city. To survive this life, one had to be keenly attuned to minor environmental changes. Riverbank communities knew that when the Yangzi assumed a copper hue it was time to move, as there must have been heavy rain upstream in the red sandstone basin of Sichuan.<sup>153</sup> Such signals served as natural early warning systems for the poor, and were a key component of the wetland culture that helped them to live with floods.

There was also a city beyond the riverbanks – one that floated. The Yangzi and Han did not form a hard border; their surfaces extended crowded streets and alleyways out onto the water. Many people worked, slept and ate in floating neighbourhoods. The customs official G. R. G. Worcester estimated that by the twentieth century there were 25,000 junks engaged in traffic between the Wuhan cities. ‘They lie 10 or 12 abreast on both the banks of the Han River for a distance of 5 miles back and are packed so close that the Chinese expression “like scales on a fish” is not inappropriate.’<sup>154</sup> These vessels came in all shapes and sizes, from the humble sampans that darted about the harbour unloading larger junks to opulent floating brothels known as flower boats 花船 (huachuan).<sup>155</sup> Just as riverbank neighbourhoods advanced and retreated with the rise and fall of water, so too did this floating city. When Wuhan was inundated, those who lived and worked on the water often encroached beyond the riverbanks; their sampans became water taxis and floating markets. For those habituated to a life on water, flooding was not just a disaster. It was also an opportunity.

### *A Water-Plagued Land*

During the late nineteenth century, a new wave of migrants began to colonise the riverbanks of Wuhan. Under the terms of the 1858 Treaty of Tianjin, the British had been granted the right to navigate the river and build a settlement in the newly designated treaty port of Hankou.

<sup>153</sup> Oxenham, ‘On the Inundations,’ p. 177.

<sup>154</sup> Worcester, *Junks and Sampans*, p. 354.

<sup>155</sup> Ye, *Hankou zhuzhici*, p. 193.

Many new arrivals believed the devastating floods that they witnessed in their new home were simply a pathological feature of the local environment. The geographer Edward Oxenham claimed that the natural sloping of the earth coupled with incessant rainfall had conspired to turn Hubei into a 'water-plagued land'.<sup>156</sup> What foreign observers mistook for environmentally determined inundations were in fact the symptoms of a hydraulic crisis. The decline of Qing infrastructure had been greatly exacerbated during the Taiping Civil War (1850–1864), when Hubei had endured waves of invasion and counter-invasion. This caused the already ailing hydraulic network to spiral into complete decay. Dyke breaches went unrepaired for years on end, and in 1856 Qing commanders militarised a tributary of the Han River, opening the sluice gates to drown their Taiping enemies.<sup>157</sup> Such strategies may have helped to quell the insurgency, yet they came at a huge humanitarian cost. Some 20 million people lost their lives before the Taiping Heavenly Kingdom was defeated, making this probably the most lethal civil conflict in history.<sup>158</sup> The war helped to turn much of China into a water-plagued land. Communities living in the Huai and Yellow River basins faced a series of calamitous floods, which were second only to droughts in their humanitarian cost.<sup>159</sup> By crippling infrastructure and draining resources, warfare had helped to forge a lethal disaster regime. It would continue to do so over the next century.

The Taiping Civil War was not the only conflict raging in the mid-twentieth century. Foreign powers, led initially by the British, launched a series of attacks upon the sovereignty of the Qing Empire. Lying well beyond the coast, Hubei was rarely at the centre of these conflicts. It was influenced by these wars, nonetheless, particularly when Hankou was designated as a treaty port. British High Commissioner James Elgin, who sailed his gunboat up the Yangzi to reconnoitre Hankou, was sorely disappointed. Having read tantalising descriptions of the great commercial entrepôt, he found a city 'almost completely destroyed' by the Taiping invasion. Wuchang was little better. Though there were the 'remains of some buildings of pretension', most areas had been 'sadly mistreated by the Rebels'.<sup>160</sup> As Wuhan recovered over the next few decades, it continued to be plagued by both urban inundations and devastating provincial

<sup>156</sup> *Ibid.*, p. 183.      <sup>157</sup> Gao, 'Transformation of the Water Regime', p. 244.

<sup>158</sup> Spence, *God's Chinese Son*, p. 17.

<sup>159</sup> Pietz, *Engineering the State*; Dodgen, *Controlling the Dragon*; Ball, *Water Kingdom*.

<sup>160</sup> Elgin, *Letters and Journals*, p. 294.

floods. Between 1869 and 1872, almost all of Hubei was subsumed under water three times.

These floods proved so serious that administrators finally decided to heed the advice of non-interventionists such as Wei Yuan, and allow two natural breaches in the river dyke network to remain unrepaired.<sup>161</sup> Flood peaks would now flow south towards Dongting Lake. This eased the pressure on the Great Jingjiang Dyke, which would not collapse again until 1931.<sup>162</sup> Yet many of those living around Dongting Lake were not impressed with this solution. The population of Hubei had discovered one of the most effective means of preventing inundation – drown your neighbour's land. The zero-sum nature of water control ensured that hydraulic systems remained a perennial source of political conflicts, not only prompting tensions with neighbouring provinces, but also generating bitter inter-village disputes. This was not unusual. In Ottoman Egypt, neighbours often took to the courts to settle disputes over irrigation channels, while in Louisiana plantation owners became embroiled in prolonged feuds over levees.<sup>163</sup> Most disputes in Hubei centred on issues of dam and sluice construction. They were known to precipitate violent altercations between whole communities, which could last for decades. On some occasions the government was forced to send troops to demolish illegally constructed dams and quell popular unrest.<sup>164</sup>

Among the many communities struggling for hydraulic security during this period were the Britons of treaty port Hankou. Eschewing the insecurity of what they referred to as the native city, they built a segregated concession on the banks of the Yangzi. For the first few decades, this concession failed to live up to their grand expectations. When Archibald Little visited in the 1880s, he noted that the place had 'the lifeless depressing aspect' much like that of 'a seaside watering-place, in the off season'.<sup>165</sup> Things changed dramatically in 1895 with the signing of the Treaty of Shimonoseki. This allowed the French, Germans, Russians and Japanese to build their own concessions. Eventually these formed a contiguous strip, fronted by an embanked riverbank known as a bund. In practical terms, this prevented the river from rising into the concessions and served as a convenient location for wharfs and warehouses.

<sup>161</sup> Will, 'State Intervention,' p. 343.      <sup>162</sup> Zhang, *Coping with Calamity*, p. 123.

<sup>163</sup> Mikhail, *Nature and Empire*, Morris, *Big Muddy*, pp. 61–2.

<sup>164</sup> Rowe, 'Water Control', pp. 353–87; Gao, 'Transformation of the Water Regime', esp. pp. 279–85.

<sup>165</sup> Little, *Through the Yang-tse Gorges*, p. 44.



Yet the bund also allowed foreigners to stamp their alien physical signature upon the city.<sup>166</sup> Travellers arriving in Wuhan were confronted by an imposing skyline of consulates and banks, behind manicured gardens and avenues of trees. The bund was central to the founding myth of the Britons of Hankou. They pictured themselves wrestling a tiny sliver of stability and civilisation from a malaria-ridden swamp on the fringes of an exotic city.<sup>167</sup> This bore an uncanny resemblance to the story that Britons liked to tell about the founding of Shanghai, in which ingenious foreign engineering was pictured civilising a watery Chinese wasteland. While this narrative bent the truth in Shanghai, in Hankou it broke it altogether.<sup>168</sup> The riverbank area had been populated for centuries and the bund was built on the same kind of platform that people in Hubei had been employing for millennia to avoid water.<sup>169</sup>

The bund made a rather minor contribution to the hydraulic safety of Wuhan. Floodwater did not generally enter the city from the rivers, but from the lakes and wetlands to the northwest. Every summer these filled with water, and in wet years this ran into the city streets. The wetlands reclaimed Wuhan three times between 1887 and 1889, finally prompting the local government to take definitive action.<sup>170</sup> The renowned Qing statesman Zhang Zhidong 张之洞, then serving as governor of Hubei, ordered the construction of a large dyke network to surround the city.<sup>171</sup> Wuhan would continue to suffer waterlogging, yet these urban flood defences offered several decades of respite from major inundations. The dykes also changed the perception of risk. In the aftermath of the 1931 flood, the missionary H. Owen Chapman would observe that the defences had been built so well that much of the urban population had forgotten that they were ‘living under Dutch conditions, several feet below the average and twelve feet below the maximum summer level of the great river’.<sup>172</sup>

Flood defences lulled people into a false sense of security. Soon they began to build a dry land city in the middle of the wetlands. Vernacular architecture, which used materials such as wood and reed that could be repaired easily following floods, gave way to more rigid architectural

<sup>166</sup> Taylor, ‘Bund’. <sup>167</sup> Upward, *Sons of Han*, pp. 34–8.

<sup>168</sup> On the myth of the Shanghai foreign settlement see Bickers, *Empire Made Me*. On bunds more generally see Bickers, *Britain in China*, p. 141.

<sup>169</sup> Dean, ‘Sino-British Diplomacy’.

<sup>170</sup> On these floods see *Wuhan shi zhi: Minzheng zhi*, p. 141.

<sup>171</sup> Rowe, *Hankow: Conflict and Community*, p. 92.

<sup>172</sup> Chapman, ‘Fighting Floods and Famine in China’, SOAS Archives 10/7/15.



styles, wrought in brick and stone. These new materials allowed Wuhan to cloak itself in the garb of modernity. The brick shopping malls, banks and tenements that sprang up around the city soon dwarfed the timber shop houses and guild temples that had once dominated the skyline. The brickification of Wuhan was the ultimate expression of sedentism – an architecture of permanence created by a culture confident in its abilities to keep itself dry. With the new dyke preventing the north from turning into a giant lake during the summer months, Wuhan sprawled ever further out into the wetlands. By the 1920s it formed the vast conurbation that can be seen in Figure 1.3. The new land created opportunities for novel forms of urban space, such as the large private garden that the businessman Liu Xinsheng 刘歆生 constructed in the north of the city, which the city government would later transform into Sun Yat-sen Park.<sup>173</sup> The foreign population turned their stretch of marshland into a playground for the leisured elite, complete with a racecourse, golf links and swimming pool.<sup>174</sup> Easily the most important development in this newly reclaimed area was the railway line that linked Hankou to Beijing. The embankment elevated trains above the plains and also acted as an extra barrier against flooding.<sup>175</sup>

This urban sprawl had a dramatic effect upon the local environment. In 1910, a foreign hunter named E. G. Bryrne described how the ecological shadow cast by the modern city was already beginning to deplete the wildlife found in the surrounding hinterland. Although the new dykes had helped to prevent summer floods, he noted that they had also

... brought about the ploughing up of considerable areas of grass lands, and so limiting the snipe grounds... One can no longer make a big bag near the French Consulate, now in the centre of the Settlement, nor around the walls of Hankow, while further out, the railway depot, oil installations and factories occupy the ground that used to be the haunts of the pintail... One unfortunately cannot take any hopeful view of the future of shooting round Hankow.<sup>176</sup>

These oil installations and factories formed part of a wave of industrialisation that had begun to sweep over Wuhan in the 1890s. Once again, Zhang Zhidong had played the principal role in precipitating this seismic change. Although there were already some small-scale foreign

<sup>173</sup> Liu, 'Hankou Zhongshan gongyuan'. On Liu see MacKinnon, Wuhan.

<sup>174</sup> The atmosphere of this club is captured in C. S. Archer's fictional account of life in wartime Wuhan. Archer, *Hankow Return*.

<sup>175</sup> MacKinnon, *Wuhan*, 1938, pp. 10–11. <sup>176</sup> Bryrne, 'Yangtze Notes', pp. 199–200.

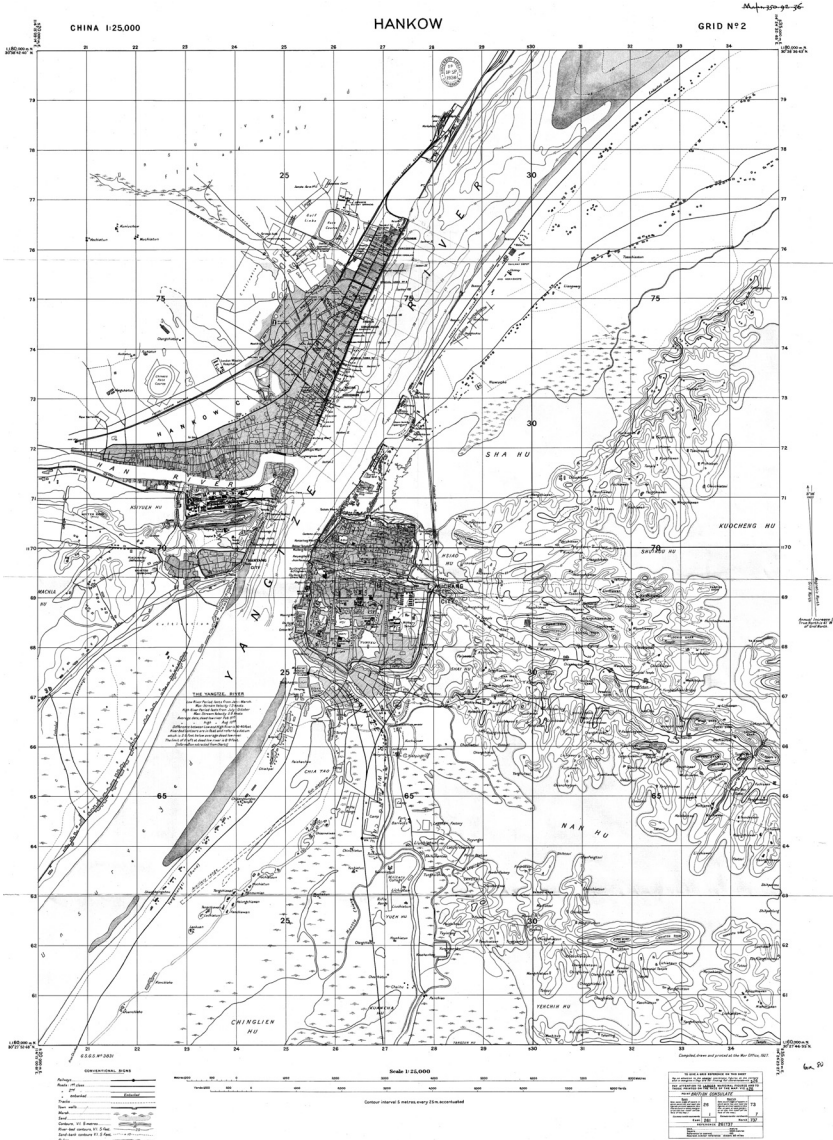


Figure 1.3. A map of the three Wuhan cities in the late 1920s. (British War Office, *General Geological Map of Hankow*, 1946 [1927]. Reproduced courtesy of the Cambridge University Library)

enterprises in Wuhan, most notably a Russia brick tea factory, it was the state-sponsored iron and steel works and the arsenal in Hanyang that initiated urban industrial transition.<sup>177</sup> Factory chimneys were soon rising across the urban landscape. They manufactured a vast array of products, ranging from matches and cigarettes to machinery parts and powdered egg.<sup>178</sup> These new industrial products were sold alongside local agricultural goods, such as rice, sesame, tobacco and sugar; more exotic items from upstream provinces, such as medicinal plants, furs, musk and opium; and also foreign imports, such as kerosene, petroleum and milled flour.<sup>179</sup> Shanghai may have been the Paris of the Orient, but Hankou was Chicago of the East 东方芝加哥 (Dongfang Zhijiage) – a port city with thriving docks through which people and produce never stopped flowing.<sup>180</sup>

Industrialisation would eventually revolutionise the relationship between humans and rivers, as concrete and steel replaced tamped earth and stone. The Nationalist leader Sun Yat-sen had a clear vision of how China could use these new materials to exploit its hydraulic potentials. In the late 1910s, he promulgated a plan to prevent floods and extend electrification by damming the Yangzi.<sup>181</sup> Although these ambitious objectives would finally be fulfilled a century later, at the time they were distinctly unrealistic. While politicians dreamed about damming rivers, they were incapable of maintaining the simple tamped earth dykes that they had inherited from their imperial predecessors. In 1910, the dykes along the Han broke, leaving thousands living in huts throughout the winter.<sup>182</sup> The fall of the Qing the next year brought no respite. The dawn of the new Republic was marked by serious flooding along the Yangzi and Huai basins in 1912.<sup>183</sup>

The collapse of imperial prohibitions against land reclamation precipitated a renewed assault on the wetlands. Farmers could now colonise rivers and lakeshores in exchange for certificates of ownership.<sup>184</sup> The

<sup>177</sup> Pi, *Wuhan tongshi: Wan Qing juan (xia)*, p. 16; Tian, *Wusi Yundong shi*.

<sup>178</sup> For a list of foreign industries see Yuan *Hankou zuzhi*, Shuiye, *Hankou*, pp. 93–132; Wright, *Twentieth Century Impressions*, pp. 701–23.

<sup>179</sup> Richards, *Comprehensive Geography*, p. 127.

<sup>180</sup> Quite where this epithet originated is unclear. Mizuno Kokichi used the phrase in 1907. Shuiye, *Hankou*, p. 1. The first English language reference I have found is Weyl, 'Chicago of China', pp. 716–24. The comparison is often invoked in local histories of Wuhan today. See for example Pi, *Wuhan tongshi: Wan Qing juan (shang)*, p. 315.

<sup>181</sup> Sun, *International Development*. <sup>182</sup> *North China Herald*, 17 March, 1911.

<sup>183</sup> Will, 'Un cycle hydraulique', p. 286.

<sup>184</sup> Will, 'State Intervention', p. 347 [note 126].

Department of Agriculture and Forestry established by the Beiyang government was dismissed by many contemporary critics as an entirely cosmetic gesture. The historian Deng Tuo 邓拓 remarked on the irony of politicians holding special tree planting events while elsewhere forests were being driven to the point of extinction.<sup>185</sup> The militarists who ruled Hubei in the early Republic were not totally inactive. Xiao Yaonan 萧耀南 commissioned a far-reaching survey of the hydraulic network with the intention of addressing the deteriorating conditions of flood prevention.<sup>186</sup> Yet incessant warfare prevented any meaningful rehabilitation. In 1921 Wu Peifu 吴佩孚 demonstrated his priorities, blowing up one of the most important dykes in eastern Hubei in order to drown an invading army led by the rival militarist Xia Douyin 夏斗寅.<sup>187</sup>

More serious than these individual acts of sabotage was the unsustainable burden that the economics of war placed on the local environment. This was a symptom of what Edward McCord has described as the 'predatory warlordism', a parasitic mode of governance that blighted Hubei in the 1910s and 1920s.<sup>188</sup> To fund their military adventurism, and often also to line their pockets, warlords embezzled funds earmarked for hydraulic maintenance. They also cut down trees that were planted in dykes to prevent erosion so they could sell the timber.<sup>189</sup> The hydraulic network was left in such a perilous state that by the time that the Nationalists began to advance on Wuhan in 1927, dykes throughout Hubei began to collapse. Only a herculean effort on the part of the local workforce prevented floodwater from bursting through the dykes surrounding Wuhan.<sup>190</sup> Disaster was averted this time. Five years later the city was not so lucky.

### *Weathering the Storm*

The 1931 flood was not an isolated incident. During the late 1920s and early 1930s the world witnessed a succession of weather-induced catastrophes. When the rains failed in eastern Rwanda between 1928 and 1930, as many as 40,000 people died.<sup>191</sup> At approximately the same

<sup>185</sup> Deng, *Zhongguo jiu Huang shi*, pp. 388–93; Tao, 'Yi jiu san yi nian'.

<sup>186</sup> Xiao, *Hubei difang jiyao*. <sup>187</sup> Rowe, *Crimson Rain*, p. 236.

<sup>188</sup> McCord, *Military Force*, pp. 16–49.

<sup>189</sup> Tao, *Yi jiu san yi nian*; Zhang, *Coping with Calamity*.

<sup>190</sup> Todd, *Two Decades in China*, p. 51. <sup>191</sup> Pedersen, *Guardians*, pp. 243–50.

time, a severe drought struck northern China, killing 10 million.<sup>192</sup> In 1930, French Indochina succumbed to a drought-induced famine, which proved particularly lethal in Vietnam. The desiccation of the Southern Plains of the United States helped to create the Dust Bowl, one of the most iconic images of this troubled era.<sup>193</sup> Meanwhile in the Soviet Union, between 1932 and 1933 drought and crop diseases contributed to the horrific humanitarian catastrophe that may have killed as many as 6 million people in the Ukraine.

The role that the climate played in each of these disasters remains as confusing as it is contentious. Unlike the 1780s or 1870s, when we can be confident in tracing links between disasters and El Niño events, the teleconnections that existed in the 1920s and 1930s were complex and fragmented. Though some climatologists have detected an alternating succession of El Niño and La Niña events between 1928 and 1933, this was not a period of coherent ENSO activity.<sup>194</sup> Even if it were possible to reconstruct the climatic history of this period with any degree of accuracy, we would still need to exercise caution when drawing causal links between climatic anomalies and humanitarian catastrophes. Historians are often seduced by the allure of ENSO, which offers a neat explanation for disasters while also binding them to a climatic process with a distinct celebrity status. What we sometimes forget is that temporal correlations do not necessarily imply teleconnections – just because a climatic hazard coincided with an ENSO event does not mean it was caused by it.

More importantly, none of the foregoing catastrophes were entirely natural disasters. Drought may have destroyed harvests in Rwanda and Vietnam, yet the subsequent famine was also caused by Belgian and French colonial policies, which were themselves influenced by the general economic malaise of the Great Depression.<sup>195</sup> Likewise, a dearth of rain killed crops in northern China, yet it was internecine warfare that drove millions into starvation, while broader processes

<sup>192</sup> Janku, 'From Natural to National Disaster'. On the El Niño link see Marks, *China*, pp. 254–6.

<sup>193</sup> On recent theories linking the Dust Bowl to La Niña see Schubert et al., 'On the Cause'.

<sup>194</sup> Per Quinn and Neal's classic analysis, there were moderate and strong El Niño events in 1930 and 1931 respectively. See Quinn and Neal, *Historical Record*. Diaz and Kiladis suggest that 1928 and 1931 were La Niña years, and 1930 and 1932 were El Niño years. See Diaz and Kiladis, 'Atmospheric Teleconnections', p. 18. This alternating pattern is supported by the amalgamated dataset offered at [www.el-nino.com](http://www.el-nino.com) (Accessed 7 October 2015).

<sup>195</sup> On Rwanda see Pedersen, *Guardians*, pp. 243–50; on Vietnam see Scott, *Moral Economy*, p. 128.

of systemic decline, similar to those detailed in this chapter, had left them chronically vulnerable.<sup>196</sup> Stalinist agricultural collectivisation, rather than drought and wheat rust alone, helped to plunge the Soviet Union into famine.<sup>197</sup> Finally, although an acute water shortage may have helped to whip up dust storms, the calamity suffered by American farmers had been incubated by decades of unsustainable agricultural expansion.<sup>198</sup> In each instance, the climate was a proximate cause but not the sole determinant of disaster. This was also the case during the 1931 Central China Flood.

The cold winter of 1930 caused a heavy build-up of snow in the upper Yangzi. This may possibly have been influenced by the El Niño event of the year.<sup>199</sup> Similarly, the heavy rains that fell throughout 1931 may have been caused by the onset of a La Niña event.<sup>200</sup> Whatever the climatic cause, we know that 1931 was incredibly wet. Early in the year, melting snow and ice flowed downstream from Tibet, arriving in the middle Yangzi at the same time as a period of heavy spring rain. Ordinarily the region experienced three waves of high water, during the spring, summer and autumn; in 1931, there was just one continuous deluge. By June those living in low-lying areas had already been forced to abandon their homes.<sup>201</sup> In an average year this region might expect to experience two cyclonic storms; in 1931 seven occurred in July alone.<sup>202</sup> The water flowing through the Yangzi had soon reached the highest level since records were first kept in the mid-nineteenth century.<sup>203</sup> There was no possibility that the rivers of Hubei could drain this huge volume of water through their artificially restricted channels. Neither could the ailing flood defence system withstand the extreme pressure of water. In the early summer the Great Jingjiang Dyke failed for the first time in sixty years. The water that flowed through multiple breaches went on to

<sup>196</sup> Conflict played such an important role in inducing this famine that some foreign aid agencies argued that no relief should be provided, as giving food would prevent warring parties from reaching a political solution. See Nathan, *History of the China International Famine Relief Commission*.

<sup>197</sup> The extent to which the environment played a role in precipitating the Soviet famines remains highly contested. For a summary of the debates see Wheatcroft, 'Towards Explaining Soviet Famine'.

<sup>198</sup> On the environmental history of the Southern Plains see Worster, *Dust Bowl*.

<sup>199</sup> On the cold winter see Barrett, *Red Lacquered Gate*, p. 265. On the 1930 El Niño see Diaz and Kiladis, 'Atmospheric Teleconnections', p. 18; [www.el-nino.com](http://www.el-nino.com) (Accessed 7 October 2015).

<sup>200</sup> Diaz and Kiladis, 'Atmospheric Teleconnections', p. 18; [www.el-nino.com](http://www.el-nino.com) (Accessed 7 October 2015).

<sup>201</sup> RNFRC, p. 1. <sup>202</sup> Buck, *1931 Flood*, p. 8. <sup>203</sup> Stroebe, 'General Problem'.

compromise 90 per cent of the dykes on the Jiangnan Plain.<sup>204</sup> Still the rain did not stop. It continued throughout the summer, culminating in another series of storms in the early autumn. High winds swept across the inundated landscape, whipping floodwater into a series of devastating waves.<sup>205</sup> Water began to recede only in the midautumn, yet even then large tracts of land remained inundated, as the polders that had been built to keep water out now turned into reservoirs.

This flood would not have occurred were it not for nature. Yet the rain that fell drained through a landscape that had been modified by thousands of years of human action. It flowed over denuded slopes and reclaimed wetlands into channelised rivers. Its force was amplified by the constructed landscape that people had built to keep themselves dry. Having domesticated the natural resistance out of plants and animals, and placed them in areas vulnerable to inundation, farmers had created a subsistence system that relied on predictable meteorology, all the while living under unpredictable skies. Agriculture, urbanisation and trade had cultivated diseases that rose to epidemic proportions during floods. The cumulative effect of all these dynamic interactions had established a lethal disaster regime. Long before rain began to fall, all the ingredients for a catastrophe were already in place.

<sup>204</sup> Zhang, *Coping with Calamity*, p. 123.

<sup>205</sup> F. G. Onley, 'Letter Extract', SOAS Archives 10/7/15.