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THE FLOOD PULSE

> Disturbances are paradoxical. What we see and fear is their destructive power, yet these same disturbances help create and maintain the biodiversity that benefits both the ecosystem and ourselves.
>
> Seth Reice[1]

By August 1931 a gigantic flood lake had swallowed much of Hubei. In urban areas, a noxious cocktail of water was running through the streets, contaminated with animal carcasses, industrial chemicals and human waste. Outside of cities the situation was quite different. The plains to the north of Wuhan were covered with a vast expanse of clear green water, its surface broken by the treetops and the roofs of houses. Between the vestiges of this submerged terrestrial world, shoals of small fish now darted around, exploiting ordinarily inaccessible prey, while green water snakes swam about on the surface of the lake.[2] For water-resistant species, the flood was larger than normal, but it was not a disaster. Millions of organisms had died as the erosive force of water had torn them away from riverbeds and plains, buried them in thick layers of sediment or starved them of oxygen. Yet for those that survived, through luck or adaptation, the pulse of water that surged along the rivers had distinct benefits.

The organisms killed by large flood pulses merge together with other forms of biomass to send ripples of nutrition through both aquatic and terrestrial food webs.[3] The resultant burst of fertility benefits those plants that have not been crushed or uprooted by the force of water.

[1] Reice, *Silver Lining*, p. ix.

[2] H. Owen Chapman 'Fighting Floods and Famine in China', SOAS Archives 10/7/15.

[3] The following section draws upon insights from a range of ecologists. The flood pulse concept was first advanced in Junk, Bayley and Sparks, 'The Flood Pulse Concept'. See also Bayley, 'Understanding Large River-Floodplain Ecosystems'. Recents studies suggest this model is most applicable to the middle Yangzi; see Wang et al., 'Terrestrial Contributions'. For a discussion of the debates among fluvial ecologists regarding this concept see

Herbivorous fish, molluscs and amphibians consume flourishing vegetation, and, in turn, provide a nutritional windfall for predatory species, including many birds, reptiles and mammals. The redistribution of nutrients is not the only beneficial effect of the flood pulse. As water recedes, empty patches of territory that have been scoured of biota offer new habitats for opportunistic flora and fauna. The seeds and fruits of plants that have been disbursed across the river basin by currents now colonise these patches, as do animals returning from their refugia. The frequent stripping and repopulating of habitats helps to prevent certain species from becoming dominant and purges harmful invasive species. Regular flood pulsing helps to promote biodiversity. Given these numerous beneficial effects, the ecologist Peter Bayley has argued that we should stop describing floods as disturbances. Riverine ecosystems suffer far more when people build structures that cause 'significant departures from the average hydrological regimen'.[4] For nature, it is often the human attempt to control flooding that proves disastrous.

When historians study floods they tend to focus on a single ecological dimension. They examine the effect of inundation on the edible plants consumed by human communities.[5] This approach is, to a great extent, dictated by the limitations of the documentary record. Literate observers who described floods tended to be concerned primarily with their economic effects on the agricultural system. The picture of past deluges that we inherit from these sources is influenced by the nutritional paradigm that defined their priorities. Yet the fact that edible plants continue to dominate historical analyses is not because their absence was the sole determinant of human mortality. It is, rather, because these species possessed the greatest economic value and cultural significance. The nutritional paradigm not only diminishes our understanding of what happened to the ecosystems during historic floods, but also distorts our view of what happened to people. It perpetuates an erroneous assumption that the primary challenge facing disaster-stricken populations was an absence of food. In reality, starvation was just one of many harmful effects of flooding, and was usually not the most lethal.

Arthington, *Environmental Flows*; Likens, *River Ecosystem Ecology*, esp. p. 209. For an analysis of disturbance ecology more generally see Reice, *Silver Lining*; Del Moral and Walker, *Environmental Disasters*. For an interesting historical application of some of the ecological models discussed in the foregoing see Morris, *Big Muddy*, esp. p. 205.

4 Bayley, 'Understanding Large River-Floodplain Ecosystems', p. 154.

5 Two studies that do not do this are Muscolino, *Ecology of War*; Morris, *Big Muddy*.

This chapter offers a more holistic ecological history of the 1931 flood. Though still bound by the limitations of the documentary record, it uses the evidence available to examine how a huge pulse of water affected a range of species that inhabited the ecosystem. It then demonstrates how this biotic response helped to condition the disaster regime. Some of the ecological effects of flooding had positive effects for humans. The aquatic plants and fish that survived and thrived provided vital sources of food. This was not sufficient to make up for the loss of millions of domestic plants and animals, which helped push many areas into famine. Harmful though the loss of nutrition was, its impact on the human population paled in comparison to that of the lethal epidemiological environment. Contrary to the notion that inundation is a destructive event, this chapter suggests that one of the reasons that floods are so lethal for human beings is precisely because they are so ecologically productive. Mosquitoes and molluscs thrived in the new wetlands, and flies gorged themselves on untreated human waste. The pathogenic microbes carried by these vectors soon colonised malnourished human bodies. Before long, the subsistence and health crises had become indistinguishable, as human communities succumbed to a deadly synergy of hunger and disease. A socioecological perspective reveals that the flood pulse was dangerous not only because it destroyed useful species but also because it allowed harmful species to flourish.

Water

The erosive force of floodwater is deadly to many kinds of organism. Strong currents scour algae, plants, fish and aquatic insects from riverbeds, leaving nothing but desolate and lifeless patches in their wake.[6] As water rises onto floodplains, terrestrial flora and fauna are swept into rivers, drowned or buried in sediment. When rivers burst into the human world they prove equally destructive. A witness to a Han River flood in the nineteenth century, described seeing 'an immense rush of water . . . carrying with it numbers of junks, boats, houses, trees, cattle, and I should be afraid to say how many human beings, all mixed up in the most inextricable confusion'.[7] The floodwater that pulsed across Hubei in 1931 had similarly catastrophic effects. It scoured away houses, huts, granaries and shops almost as easily as it washed away topsoil and loose

[6] Lake, 'Flow-generated Disturbances', pp. 75–92.78; Death, 'Effect of Floods'.
[7] Captain Todd quoted in Percival, *Land of the Dragon*, p. 59.

rocks. Fast currents swept people under water never to be seen again, or turned their homes into sediment, burying them alive. Around 150,000 people were killed by these initial flood waves.[8] Water did not discriminate between its victims. It followed a path determined by gravity, sweeping away anyone who got in its way. Given the indiscriminate nature of this destruction, it might tempting to assume that those who drowned were simply victims of misfortune, people who happened to be in the wrong place at the wrong time. Yet in a region that suffered recurrent water hazards, being in the wrong place was hardly a matter of chance. The distinctions created by the long-term interplay of water, earth and people, described in Chapter 1, now helped to determine patterns of vulnerability.

The generic term *flood* actually comprises a wide variety of different kinds of water hazard. China experienced numerous floods in 1931. The first were highly destructive mountain floods 山洪 (shanhong).[9] Powerful thunderstorms had been rumbling across the highlands throughout much of the spring. When the heavens opened in July, powerful freshets swept along the courses of the hillside tributaries, wiping away those living adjacent to rivers.[10] In the valleys below, the disaster began not with dramatic flash floods, but with the slow onset of waterlogging disasters 渍灾 (zizai). These may not have been as destructive as flash floods, but were nevertheless catastrophic for agricultural communities. The most lethal form of flooding was yet to come. This occurred when the pressure of water caused dykes to suffer breaches 溃口 (kuikou), the aftermath of which can be seen in Figure 2.1. The proximate cause of hydraulic failures was excessive rainfall, yet the floods they unleashed had an anthropogenic dimension. The constructed landscape amplified the erosive force of water, funnelling it through narrow breach points at high velocity. In late August, water cascading through the dykes of the Grand Canal wrought terrible destruction on Yangzhou 扬州 in Jiangsu. The nearby city of Gaoyou 高邮 seemed initially to have been saved by its walls which acted as a dyke. Unfortunately, the walls collapsed in the dead of night, unleashing a wall of water that killed around 2,000 people, many of whom were still sleeping in their beds.[11] Similarly, in southern Sichuan, water poured over the flood defences of Fushun 富顺,

[8] Buck, *1931 Flood in China*, p. 35.

[9] The typology of flooding used in this paragraph is borrowed from disaster investigations conducted during the 1954 floods. See 'Hubei sheng zaiqing jiankuang, 6 September 1954', *HFKDX*, pp. 225–7.

[10] Yan. *Macheng xian zhi*, p. 44. [11] RNFRC, p. 8; *Hankow Herald*, 30 August 1931.

Figure 2.1. An aerial view of a dyke breach during the 1931 flood. (The Charles Lindbergh Collection. Reproduced courtesy of the Missouri History Museum)

sweeping an estimated 10,000 residents into the river.[12] These were just a few examples of the numerous localised tragedies nested within the larger disaster.

The location of a community and its capacity to maintain its flood defences played a critical role in determining vulnerability. It was no coincidence that the last area of Hankou to be flooded was the Japanese Concession. Those who ruled this thin strip of land were able to marshal considerable resources, constructing sandbag barriers and pumping the streets dry.[13] The situation was very different for those living near Dongxi Lake, who had very few funds to invest in defences. When the flood struck this area forty families were killed.[14] One particularly impoverished community located next to the Yangzi in Wuchang found itself in a similar predicament. Though this was a highly precarious area, the local cottage industry of chopstick making did not provide enough income for locals

[12] *Hankow Herald*, 23 August 1931.
[13] Tao, *Yi jiu san yi nian da shuizai*; Clubb, 'Floods of China'.
[14] Pi, *Wuhan tongshi: Minguo juan (Shang)*, pp. 220–23.

to invest in a flood wall. When Wuchang's outer dykes collapsed they were submerged beneath 3 metres of water.[15]

Architecture was another area in which economic marginality translated into physcial insecurity. Many people lived in low-standing dwellings built from cheap and flimsy materials. Even if their homes survived the initial flood waves, they would often collapse as water ate away at their foundations.[16] In the wake of the flood, the Nationalist government commissioned academics from the University of Nanjing, headed by the renowned agricultural economist John Lossing Buck, to conduct an extensive survey into the effects of the disaster – referred to hereafter as the Nanjing Survey. The report detailed how almost half of the homes in the flood zone had been completely destroyed, with more than a third of villages wiped off the map. Although the formidable force of water had played a critical role, the report noted that inadequate building standards had left many homes chronically insecure.[17] In Wuhan, those occupying small huts were the most seriously affected by the initial flood waves.[18] This reflected not only architectural vulnerability of these communities, but also the fact that their members were squatting on the cheapest, most flood-prone land.

Even within impoverished neighbourhoods, there were gradations of vulnerability. The least settled – those who lived in huts constructed of reeds, bamboo and salvaged materials – enjoyed something of an advantage, as they were so habituated to being moved on, either by water or by the police, and so were adept at disassembling their homes at speed. When floodwater advanced they simply carried their huts to higher ground. The earthen homes occupied by slightly more established households were much less portable, yet were hardly less vulnerable. Whole neighbourhoods simply melted into the flood, their occupants drowning in a cocktail of mud and water.[19]

Those who lived in taller houses fared much better. The journalist Chen Bing 陈兵 occupied a second-storey room in Wuhan. While

[15] Xie, 'Hankou shuizai', *Xinminbao*, HSSDX; *Hankow Herald*, 18 August 1931.

[16] *Hankow Herald*, 23 August 1931.

[17] Forty-five per cent of homes collapsed, 37 per cent of villages were completed destroyed and a further 15 per cent were partially damaged. See Buck, *1931 Flood*, p. 15.

[18] There were numerous reports describing the inundation of hut-dwellers. See Xie, 'Hankou shuizai', *Xinminbao*, HSSDX; *North China Herald*, 11 August 1931; F. G. Onley (Letter Extract), 28 August 1931, SOAS Archives 10/7/15.

[19] On the vulnerability of earth housing see Buck, *1931 Flood*, p. 15. On the effect of the flood on earthen sections of Wuhan see *North China Herald*, 1 September 1931; *Time Magazine*, 31 August 1931.

his flooded downstairs neighbours had to live on wooden boards, his home remained a dry sanctuary above the destruction.[20] Those wealthy enough to occupy multi-storey housing could vertically evacuate to the top of their homes.[21] Life above the water could be surprisingly comfortable. A medical missionary described 'balancing on rafts and planks over unspeakable filth, climbing over banisters in the pitch dark, and finally coming up for air into marvellously kept top floors with electric fans and every comfort one could wish'.[22] In another instance, residents of an alleyway tenement were able to survive the flood by blocking their doors with wooden boards to prevent water coming up stairs.[23] Even within inundated areas, it was possible to forge enclaves of security.

Flood risk cannot be explained by crude socioeconomic determinism. Not all wealthy households were immune from inundation in 1931. The residents of the Jardine Matheson Estate, who were rich even by foreign standards, were among the first flood refugees in Wuhan, having to flee to the city centre when their seculded suburban neighbourhood was inundated.[24] For the most part, however, impoverished people living in insecure areas and insubstantial homes felt the worst effects of the flood. The challenges facing this vulnerable stratum of social landscape did not end with the collapsing of dykes. The geographers Michael Watts and Hans Bohle have cautioned scholars not to think of vulnerability just as a pre-existing condition – new forms of vulnerability are generated continually throughout the disaster process.[25] Such was the case in 1931. Those who had become homeless due to inadequate or poorly located housing later found themselves vulnerable to exposure, with the incessant rainfall and heat in the summer giving way to a bitterly cold winter. They had lost their granaries and other food stores, meaning that they were more vulnerable to famine.[26] Worst of all, being displaced from their homes and corralled into overcrowded and unsanitary camps, they were vulnerable to a range of diseases.

The risks associated with homelessness could be ameliorated by money or social connections. Many wealthy Chinese citizens of Wuhan simply left the city, packing into the steamships for areas such as Shanghai. Their Japanese counterparts sent women and children away from

[20] Chen, 'Wuchang zaiqu', *Yaxi Yabao*, HSSDX.
[21] On vertical evacuation see Godschalk, Brower and Beatley, *Catastrophic Coastal Storms*, p. 38.
[22] *The Chinese Recorder*, January 1932.
[23] Xie, *Yi jiu san yi nian*, p. 144. [24] *North China Herald*, 1 September 1931.
[25] Watts and Bohle, 'Space of Vulnerability'. [26] Buck, *1931 Flood*, p. 15.

the city, while the British departed for their summer residences in the mountains of Jiangxi.[27] Those who remained had to find alternative lodgings. Soon the cost of dry ground began soaring, with some landlords and hoteliers even doubling the price.[28] Unscrupulous property owners sought to maximise their profits by packing in as many tenants as possible. Overcrowded buildings with inundated lower floors quickly became structurally compromised. In mid-August, a hotel collapsed near the railway station in Wuhan, killing many people sheltering therein.[29] After a string of similar events the municipal government commandeered some local hotels, so that refugees might have somewhere to shelter.[30] For the journalist Xie Qianmao 谢茜茂, himself homeless during the flood, the economic calculations of his fellow citizens were simply intolerable. 'If our hearts have become this cruel', he mused, 'there is little wonder that a disaster has befallen us.'[31]

Cultivated Plants

Rapid river currents killed millions of plants, scouring them off the surface of the earth, burying them in silt or drowning them. This was the leading cause of the subsistence crisis that struck in the summer of 1931, lasting for at least a year. By the early autumn, many areas had descended into full-blown famine. Across the entire Yangzi Valley, the yield of rice and wheat was reduced by 15 per cent.[32] In flood-stricken areas these losses were much higher. The Nanjing Survey estimated that the total economic cost incurred by each family was equal to one and a half year's net income.[33] Millions of people lost their entire summer harvests and all the grain that they had stored for the future.[34] In monsoon regions such as China, North India and Bangladesh, it is not only the size of a flood but also its timing that determines its humanitarian consequences. Inundations that occur in the lean season – the point furthest away from

[27] *Hankow Herald*, 18 August 1931; *North China Herald*, 1 September 1931.
[28] Xie, *Yi jiu san yi nian*, p. 54.
[29] Ibid., p. 105; *North China Herald*, 11 August 1931; *Hankow Herald*, 20 August 1931. Estimated fatalities varied from 15 to 1000.
[30] *North China Herald*, 11 August 1931.
[31] Xie, *Yi jiu san yi nian*, p. 55.
[32] Kueh, *Agricultural Instability*, p. 178. For a contemporary discussion of the impact of the losses on the economy see 'Shuizai hou zhi liangshi wenti', *Nanjing Shi Zhengfu Gongbao*, 95 (1931).
[33] Buck, *1931 Flood*.
[34] An estimated $79.6 million of stored food was lost. Ibid., pp. 10–12.

the main harvest of the previous year – are by far the most destructive. It is then that farmers are most eager to replenish their food stocks.[35] The late spring and early summer floods of 1931 deprived Chinese farmers of their main harvest, meaning many households had to stretch food stocks harvested in the summer of 1930 until the summer of 1932. Unsurprisingly, many struggled to do so.

Flooding did not destroy plants completeley. When water began to rise in central Jiangsu, villagers quickly rushed to their fields and cut as much rice as they could, regardless of whether it was ripe. As it rose again, reaching to more than a metre in depth, they rowed boats across their inundated fields, gathering more of their crops using rakes.[36] The Nanjing Survey estimated that the agricultural population was able to salvage as much as 17 per cent of its harvest using such techniques.[37] To supplement salvaged grain rural communities consumed semi-edible agricultural by-products, such as rice husks and chaff.[38] To these meagre supplies they added foraged plants, such as lotus and wild rice.[39] Others found ways to access the minimal nutrition available from terrestrial flora, stripping the bark and leaves from trees and digging up grass shoots.[40] Even this sophisticated repertoire of coping strategies could not make up for the huge nutritional shortfall. By the mid-summer many areas had slipped below the minimum subsistence level.[41] Over the following year much of central China was struck by a famine, which was particular severe in Henan, Anhui and Hubei.[42] Even in relatively

[35] Wisner et al. *At Risk*, p. 129.

[36] Li, *Village China*, pp. 12–13.

[37] Buck, *1931 Flood*, p. 12.

[38] *Wuhan Ribao*, 15 January 1932.

[39] Clubb, *Communism in* China, p. 105.

[40] 'Wuhan yi cheng canghai', *Guowen Zhoukan*, 8 (1931); RNFRC, p. 62; extracts from letter of Sir J. Hope-Simpson to Mr. F. B. Bourdillon, 16 January 1932, SOAS Archives 10/7/15; Clubb, 'The Floods of China.'

[41] Buck, *1931 Flood in China*, p. 45.

[42] In her brief discussion of the 1931 flood Lillian Li asserts that there were no major food shortages. Li, *Fighting Famine*, p. 306. Her assessment – a brief aside in an otherwise masterful and superbly researched book – is based exclusively on literature published by relief workers. This relatively positive assessment is contradicted even within the sources she herself cites, which attest to the existence of famine in several areas. See RNFRC, p. 68. Several other studies of the flood suggest there was a famine including Yue and Dong, 'Zai lun 1931 nian; Li et al., *Zhongguo jindai shi da zaihuang*; Pietz, *Engineering the State*. The descriptions of widespread malnutrition, an increase in moneylending, the divesting of assets, crime and rioting, the sale of children and, most tellingly of all, homicidal cannibalism, described in this current book all represent classic famine symptoms. Using the qualitative index designed by Howe and Devereux to determine the intensity of subsistence crises, this behaviour would seem to indicate a fairly severe famine. See Howe and Devereux, 'Famine Intensity'.

well-provisioned areas such as Wuhan, many refugees seemed to be in a state of near starvation.[43] Those who reached camps were often so weakened by hunger that they were unable to survive on the rice rations provided.[44]

In some rural areas hunger became so acute that people resorted to the ultimate act of famine survival – cannibalism. In Anhui, a missionary named Reverend Bostock claimed to have witnessed members of flood-stricken communities consuming human flesh.[45] The historian Ouyang Tieguang has found evidence of homicidal cannibalism in government reports, with one elderly woman in Hubei killing and consuming her own son. When her crime was discovered, the legs were all that remained. Elsewhere a farmer killed his youngest son for food, and admitted that he was later planning to consume his eldest.[46] Kathryn Edgerton-Tarpley has cautioned historians not necessarily to accept reports of cannibalism in Chinese documentary records at face value, arguing that they were sometimes figurative illustrations rather than literal accounts.[47] The fact that reports of cannibalism in 1931 came from multiple witnesses – including government officials, relief workers and missionaries – suggests that, in this instance at least, people really had consumed human flesh. Famine had revealed a brutal ecological reality, disavowed in the ordinary course of social relations; in extremis, human beings can sometimes reduce one another to edible biomass.

Although the physical destruction of cultivated plants played a vital role in depleting the nutritional intake of inundated households, the famine had an important economic component. Amartya Sen has argued, famously, that famines do not occur simply because food is unavailable, but also because certain groups cannot access available food.[48] This lack of access to nutrition is described as an entitlement failure. The flood precipitated a collapse of both production-based and exchange entitlements – with their crops destroyed people were unable to access food they had cultivated themselves, and were also unable to

[43] 'Wuhan yi cheng canghai', *Guowen Zhoukan*, 8 (1931); *North China Herald*, 4 August 1931; *North China Herald*, 25 August 1931; Dwight Edwards, 'The CIFRC Report' 1932, DEP 12/14/153.

[44] Edith S. Wills, 'Hanyang 1931', SOAS Archives 10/7/15.

[45] Cited in Clubb, *Communism in China*, p. 105; David Pietz also cites evidence provided by relief workers who personally witnessed people eating their own children. Pietz, *Engineering the State*, p. 68.

[46] Ouyang, 'Zaihuang yu nongmin'.

[47] Edgerton-Tarpley, *Tears from Iron*.

[48] Sen, *Poverty and Famines*.

Table 2.1. *Index of changes to the prices of important commodities during the first three months of the flood*

81 Counties in the 1931 flood area in the Yangzi and Huai Valleys Period just before the flood = 100

	Commodities rising in price				Commodities falling in price					
Province	Grain	Fuel and fodder	Interest rates	Building materials	Land value	Draft animals	Other animals	Farm year wages	Farm day wages	Tools
Hunan	138	146	152	114	68	84	90	81	80	100
Hubei	117	125	111	98	74	82	101	85	82	97
Jiangxi	117	118	101	123	74	74	106	86	77	104
S. Anhui	121	148	128	127	67	75	79	77	81	119
S. Jiangsu	104	126	112	105	79	83	92	89	81	103
N. Anhui	124	142	149	112	51	49	70	80	86	80
N. Jiangsu	117	133	161	106	61	59	98	70	71	88
Average[a]	120	130	133	113	63	70	88	80	80	99

[a] Average by county 县 (xian), not province.

use the market economy to purchase the available food that had been grown by others. Table 2.1 captures the economic quandary facing flood-stricken households. Everything they needed to survive had become prohibitively expensive, while the few commodities that they still possessed were rapidly becoming worthless. Probably the most devastating blow was the steep decline in the value of labour. This meant that, even where work was available, people struggled to earn enough to purchase food.

Even in the absence of a large crisis, the balance of rural employment was already stacked firmly in favour of those purchasing labour. During the flood, the already precarious position of agricultural workers was weakened as the labour market became saturated with refugees. Wages dropped by 20 per cent while grain prices rose by 20 per cent. This 40 per cent difference meant that soon agricultural labourers had to work an entire day for a small meal. With much arable land remaining inundated, even these minimal opportunities were quickly exhausted.[49] The economic shock caused by the flood lasted long after water receded,

[49] Buck, *1931 Flood in China*.

with the price of rice remaining inflated for at least a year.[50] The famine that ensued is best understood as a dual-pronged attack upon the subsistence of certain sections of society; an ecological shock caused rapid food availability decline and an economic shock caused acute entitlement failure. This has been the pattern found during most historic famines.[51]

As is so often the case during famines, some people found ways to profit from the hunger of others. Inundation had created what economists describe – appropriately in this context – as a liquidity crisis, as millions of people were unable to actualise the value of their commodities. In this economic climate, those who controlled the flow of assets accrued financial rewards, either directly or through credit markets. Debt was an endemic feature of economic life in rural China. With cash incomes seasonal, credit as a form of deferred payment played a vital role in sustaining production.[52] Credit arrangements had long been a mainstay of the rural economy, but, as Prasenjit Duara has argued, the consequences of debt worsened in the twentieth century. Unscrupulous entrepreneurs took control of rural credit markets, replacing the village elites who had tended to adopt a more paternalistic approach to lending.[53] In Jiangsu, for example, between 60 and 70 per cent of rural households were in debt in the 1930s.[54] Disasters increased the necessity for credit while decreasing the capacity for repayment.[55] This allowed creditors to acquire the land and property of impoverished people at extremely low prices.

Pawnbrokers were another common source of credit for the rural poor. Many relinquished vital assets, including tools, clothes, furniture and even roof beams, on an annual basis.[56] Owing to their tendency to capitalise on catastrophes, moneylenders and pawnbrokers were a common target for progressive reformers of all political stripes.[57] Yet

[50] Shiroyama, *China During the Great Depression*, p. 94.
[51] Dyson and Ó Gráda, *Famine Demography*, p. 14.
[52] Shiroyama, *China During the Great Depression*, p. 103.
[53] Duara, *Culture, Power and the State*.
[54] Shiroyama, *China During the Great Depression*, p. 103.
[55] Will, *Bureaucracy and Famine*, p. 53.
[56] 'They pawn their crops in summer, their farm implements in winter and their household belongings throughout the whole twelve months.' See Tawney, *The Attack*, pp. 44–5; see also Shiroyama, *China During the Great Depression*.
[57] See Zanasi, *Saving the Nation*, p. 151. Richard Tawney noted the terrible rates of interest charged by Chinese moneylenders; 'twenty-five to fifty per cent is common; interest at fifty to one hundred per cent is not unknown. As far as the poorer peasants are

while credit markets undoudtedly accentuated long-term inequalities, they could help to diminish the immediate impact of crises.[58] In rural areas, where other forms of credit were conspicuously absent, it was the much-derided moneylender or pawnbroker who often prevented acute starvation.[59] This is not to suggest that credit speculators were misunderstood philanthropists. The exploitative debt arrangements they created not only contributed to the immediate poverty of disaster-stricken people, but also helped to accentuate the underlying destitution that made people vulnerable to disasters in the first place.

Both moneylending and pawning were rife during the flood. The increased demand for money allowed creditors to raise interest rates by as much as 50 per cent. At the same time, the value of land, the most commonly used form of collateral, declined by as much as 50 per cent. As prolonged inundation delayed agricultural recovery, many farmers who had taken out loans were unable to maintain interest payments. This resulted in high levels of land foreclosure.[60] Meanwhile, the crisis terms offered by pawnshops meant that flood-stricken households often surrendered possessions for very little remuneration.[61] In the aftermath of the flood, if they had not managed to secure other forms of credit, they could not redeem vital assets, most notably farm tools, without which reconstruction was impossible.[62] The flood pulse itself may have lasted only a few months, yet the effect of water would continue to ripple through the economy for years to come. The Nanjing Survey summarised the situation succinctly, noting that during the disaster the 'rich got richer, and the poor, poorer.'[63]

Domestic Animals

Animals are often credited with having uncanny instincts that alert them to hazards and allow them to survive. Greg Bankoff has criticised this somewhat sentimental notion, observing that animals tend to perish in far greater numbers than their humans during disasters.[64] There is a key distinction in this regard, between domesticated and wild animals. The

concerned, permanent indebtedness is the rule rather than the exception.' See Tawney, *The Attack*, pp. 44–5; see also Tao, *Yi jiu san yi nian*.

[58] Ó Gráda, *Famine*, pp. 78–81.

[59] On the condition of the rural credit market in early 1930s China see Rajchman, *Report of the Technical Agent of the Council*.

[60] Buck, *1931 Flood*, p. 38. [61] Shiroyama, *China during the Great Depression*, p. 36.

[62] Xie, *Yi jiu san yi nian*, p. 124. [63] Buck, *1931 Flood*, p. 38.

[64] Bankoff, 'Learning About Disasters'.

disaster vulnerability of domestic animals depends to a certain extent upon their relationship with the human population. Both horses and dogs, for example, benefitted from their social association with people in 1931, as we will see in a later chapter. Animal vulnerability also depends on the nature of the hazard and the resilience of the particularly species. For obvious reasons, the flood was not as serious a problem for domesticated ducks and geese as it was for pigs and chickens. Thousands of these latter species drowned during the initial flood waves, and later millions starved, succumbed to disease or fell victim to human predation.[65] More than a third of households in Hubei lost pigs and hogs and half lost poultry.[66] The fate of chickens, in particular, reveals the extent to which an association with the humans could increase vulnerability, as the undomesticated junglefowl that were the ancestors of domesticated chickens could simply have flown away from the flood.

Undoubtedly the heaviest blow for farmers was the loss of labour animals. In non-mechanised agricultural societies, animals such as oxen, buffalo, donkeys and cows form the backbone of what John McNeill has described as the 'somatic energy regime'. They convert the solar energy captured by plants into muscular force that could be harnessed for a variety of agricultural tasks.[67] Ruminants were particularly valuable, as they were able to access energy stored in inedible phytomass, such as grass and crop residues, which is otherwise inaccessible for human beings.[68] Bovine labour animals were so important in rural China that they were accorded a high social and even religious status, as Vincent Goossaert has observed. To mistreat such animals was considered deeply immoral (Figure 2.2). Although not as well-known as its Indian equivalent, there was a strong taboo surrounding the consumption of beef, which lasted well into the twentieth century.[69] The value that a culture attributes to animals should not be reduced to a naïve form of functionalism – religious injunctions are never simply expressions of material necessity – and the Chinese beef taboo had numerous influences, not least the Buddhist vegetarian tradition imported from India. Nevertheless, culture cannot be divorced entirely from its ecological and economic contexts. The anthropologist Marvin Harris argued that those who characterise Hindus

[65] Xie, *Yi jiu san yi nian*, p. 41.
[66] In Hubei households losing productive animals were as follows – chickens 52 per cent, pigs 34 per cent, ducks 10 per cent, geese 1 per cent. Buck, *1931 Flood*, p. 23.
[67] McNeill, *Something New*. See also Muscolino, *Ecology of War*.
[68] Smil, *China's Past*.
[69] Goossaert, 'Beef Taboo'; Simoons, *Eat Not This Flesh*, pp. 122–4.

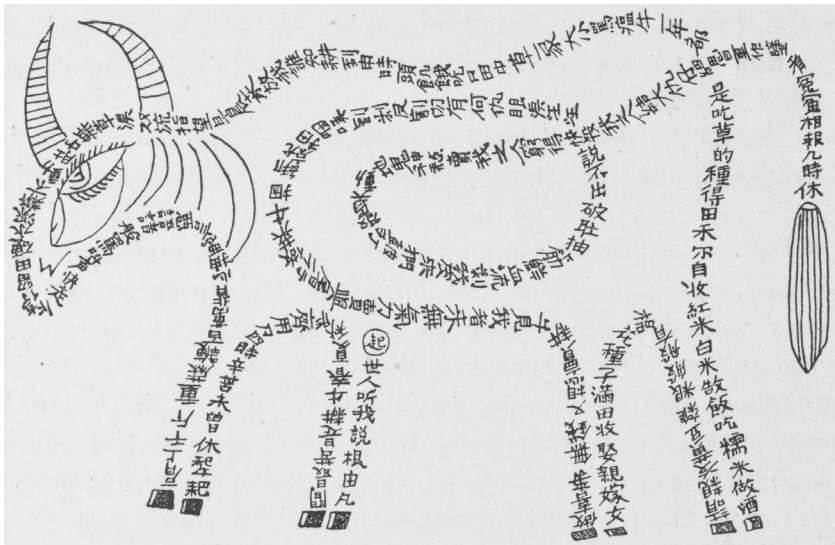

Figure 2.2. A moral injunction against the mistreatment of labour animals. Collected in Hubei at the turn of the twentieth century, it gives a clear indication of the high cultural and moral value attributed to such creatures. The characters form the shape of an ox, narrating its imagined autobiography. They describe a life of constant toil, pulling a heavy plough with only a little grass to eat. The passage also serves to warn people that if they mistreat cattle they can expect grave spiritual, economic and social consequences.[70] (William Arthur Cornaby, *A String of Chinese Peach-Stones*. London: Charles H. Kelly, 1895, p. 9. Reproduced courtesy of the Cambridge University Library)

as victims of 'Oriental mysticism' for worshipping cattle fail to appreciate the dreadful fate that would await a 'poor farmer unable to replace a bullock lost through disease, old age, or accident'.[71] In 1931, millions of farmers were forced to contend with just such a fate.

Almost 2 million draught animals were lost during the flood, which was around half the total population. This included water buffalo, oxen, yellow cows, donkeys and mules. After the destruction of crops and housing, this was the greatest economic expense incurred.[72] Many of these creatures drowned, others starved and some were consumed. For rural households, slaughtering cattle meant sacrificing a vital source of energy

[70] Cornaby was given this illustration by a watermelon seller in Hankou around the turn of the twentieth century.

[71] Harris, 'Cultural Ecology', p. 56. [72] Buck, *1931 Flood*, pp. 15–17.

and prestige. Alex de Waal has observed that famine-stricken farmers in Sudan in the 1980s were often willing to endure months of starvation rather than part with cattle.[73] The situation was similar in 1930s China. In a short story written to raise money for the flood relief effort, the American novelist Pearl Buck captured the painful loss suffered by a farmer forced to kill his precious buffalo.

> If any one had told him that he would eat his water-buffalo that had ploughed the good land for him, and year after year pulled the stone roller over the grain and threshed it at harvest he would have called the man an idiot. Yet it is what he had done . . . But what else could they do on that dark winter's day when the last of their store of grain was gone, when the trees were cut and sold, when he had sold everything . . . Besides, the beast was starving, also, since the water had covered even the grass lands . . . When he did it, even in his despair, he groaned, for it was as though he killed his own brother. To him it was the last sacrifice.[74]

Buck was raised in China and had a profound knowledge of the problems facing rural populations. Even so, it might be tempting to dismiss her description as somewhat sentimental. Yet it is corroborated by evidence from other disasters. Even in the depths of the hunger caused by the famine of the late 1950s, Yang Jisheng's stepfather could not bring himself to eat his ox, being simply too close to the animal.[75]

Labour animals that survived inundation now faced an economic crisis alongside their human owners. With vast tracts of pasture under water, they were forced to rely on stored fodder. Unfortunately, the price of these plant residues was subject to the same rapid inflation as human food, rising in some areas by as much as 46 per cent. Soon oxen and buffalo were suffering their own form of entitlement failure; the value of their labour was no longer sufficient to guarantee their endowments. The resultant bovine famine was compounded by the fact that humans were now prepared to consume animal food such as rice husks, cattle feed, and chaff.[76] As the economic crisis worsened, rather than slaughtering their labour animals, many farmers tried to sell them. The simultaneous decision of thousands of people to bring their creatures to market caused the value of cattle to plummet. Government attempts to introduce legislation designed to control the slaughter and sale of oxen had little

[73] De Waal, *Famine That Kills*. [74] Buck, *First Wife*, pp. 235–6.
[75] Yang, *Tombstone*. [76] 'Wuhan yi cheng canghai', *Guowen Zhoukan*, 8 (1931).

impact.[77] In Northern Anhui, where famine was at its most intense, cattle sold for less than half of their ordinary price.[78] Once again, economic calculation amplified the crisis.

Wild Animals

In comparison to domesticated species, the wild animals of the wetlands tended to have a far greater tolerance for flooding. Those that survived the initial waves of water could exploit newly expanded habitats and sources of food. These creatures offered a nutritional windfall for those with the requisite knowledge to catch and prepare them. Along with wild vegetation, these animals offered what we might describe as the *ecological endowments* of the flood pulse. It is impossible to quantify the value of these endowments to the human population. While administrators and philanthropists left detailed records enumerating the tonnage of grain distributed to refugees, those who hunted and foraged left precious few traces of their activities. Worse still, as the use of wild food was governed by a complex regime of property and usufructuary rights, in many cases they were positively motivated to conceal their activities.[79] The only knowledge we have of their use of wild food comes from accounts of outside observers, who tended to record such behaviour largely as an index to measure the suffering of the population. Venerable coping strategies based on a profound vernacular knowledge of the environment were usually seen simply as acts of desperation. Though witness descriptions can offer little more than a glimpse, they are the best evidence that we have to

[77] Xie, *Yi jiu san yi nian*, p. 76. Cattle speculation remained a problem during the 1954 Yangzi floods, even though the Communist government by then exerted far stricter control over the rural economy. 'Yue xiaxun kuikou fenhong diqu qingkuang', *HFKDX*, pp. 239–40.

[78] *North China Herald*, 11 August 1931.

[79] Historians discussing the use of famine foods in China often refer to botanical encyclopaedias written by scholars from at least as early the Ming dynasty, such as the *Roots and Herbs for Famine Relief* 救荒本草 *(Jiuhuang Bencao)*. Such official knowledge was sometimes presented on wall posters pasted up in famine zones. The extent to which ordinary members of the public referred to such texts is unclear. Given the relatively low levels of literacy among the rural poor at the highest risk of famine, it would seem more likely that for most people knowledge of famine foods was transmitted through oral instruction, forming part of what E. N. Anderson has described as the 'foodways' of Chinese culture. See Anderson, *Food of China*. On botanical encyclopaedias see Needham, Lu and Huang, *Science and Civilisation*, Vol. 6 Pt. 1, pp. 331–3; Needham, Robinson and Huang, *Science and Civilisation*, Vol. 7, p. 192.

determine how local communities used knowledge and skills to exploit the ecological endowments of flooding.

Undoubtedly the most useful skill was fishing. Rapid currents would have scoured away countless millions of incubating fish eggs and young spawn, but those that survived would have gorged themselves on aquatic plants and invertebrates, and exploited ordinarily inaccessible sources of terrestrial prey.[80] There are numerous witness accounts describing people fishing in 1931, even in urban areas.[81] Stranded householders in Wuhan leaned from their sagging roofs using small nets to catch the fish that had 'invaded the city from the river'.[82] It is possible that the natural survival behaviour of fish may have made them easier to catch, causing them to seek out the hyporheic zone at the edge of the stream where the current is weakest.[83] Fish sheltering from the flood would have found themselves in close proximity to people living at the edge of the water. Soon there were reports of bumper catches in the flood zone.[84] In some areas the reliability of fishing prompted people to change their professions permanently. In the Hubei district of Songzi 松滋 the number of registered fisherfolk rose from hundreds to thousands in the aftermath of the flood.[85]

Humans were not the only ones who exploited fish. Wetland birds are among the greatest net beneficiaries of inundation. Being able to fly, they can escape the worst effects of flooding with ease and are free to scour the landscape searching for mud banks and shallow pools, where they can exploit stranded fish and invertebrates. Residents of Hubei were certainly adept at hunting such birds, as we have seen, yet there are only a few accounts of them doing so in 1931. A nurse in Wuhan, for example, described how her local colleagues caught and cooked two geese that had been nesting in the grounds of the missionary hospital.[86] We know from other witness accounts that waterfowl were swimming near the human world.[87] As with fishing, the winter was the optimum season to

[80] On the effects of floods on fish populations see Reice, *Silver Lining*, p. 120; Ross, *Ecology of North American*, p. 320; Bayley, 'Understanding Large River-Floodplain Ecosystems', p. 155.

[81] *Wuhan Ribao*, 15 January 1932; Chen, 'Wuchang zaiqu'; H. Owen Chapman 'Fighting Floods and Famine in China', SOAS Archives 10/7/15; Edith S. Wills, 'Hanyang 1931', SOAS Archives 10/7/15.

[82] *Hankow Herald*, 28 August 1931. [83] Death, 'Effect of Floods'.

[84] *North China Herald*, 22 September 1931. [85] Zhang, *Coping with Calamity*, p. 178.

[86] 'Letter from Miss Stephenson' SOAS Archives 10/7/15.

[87] Xie, *Yi jiu san yi nian*, p. 341.

catch game birds such as pheasants and snipe.[88] This would have proved timely for famished communities, whose food stocks had run perilously low by late autumn.[89] Other birds, such as snipe, teal, ducks and cranes, made their homes in Hubei in the wet months of the spring and summer. It is likely that hungry people exploited these ecological endowments, yet the extent to which they did so remains unclear.

While the evidence is frustratingly patchy, it certainly suggests that the use of wild food remained quite important to flood-stricken populations. The availability such ecological endowments may help to explain why, throughout Chinese history, floods have tended to kill fewer people than droughts, in spite of the greater physical destruction that they cause.[90] Historians have offered various explanations for this disparity, including the geographic spread and duration of floods, and also the relative poverty of drought-prone areas.[91] Surprisingly little attention has been paid to the ecological differences between inundation and aridity. Droughts cause a great deal of stress for flora and fauna, which are able to survive only by becoming dormant.[92] As the land dries out, insects seek

[88] Bryrne, 'Yangtze Notes', pp. 199–200.

[89] Buck, *1931 Flood*. [90] Pietz, *Yellow River*, p. 74.

[91] The Qing scholar Wang Fengsheng 王凤生 explained this in terms of the differential geographical impact: 'Famine caused by flooding stretches like a thread; famine caused by drought spreads like a sheet.' As Pierre-Étienne Will has noted, this was a gross oversimplification. Will, *Bureaucracy and Famine*, p. 25. There was certainly nothing narrow and thread-like about the 1931 inundation, which spread hundreds of miles beyond rivers. Statistical evidence from the twentieth century does not support the theory that the major difference is one of relative impact on areas of cultivation. Since the 1930s floods in the south have tended to cause a *greater* absolute loss of agricultural produce than droughts in the north. Kueh, *Agricultural Instability*, p. 31. A more convincing explanation lies in the longer relative duration of droughts, which often span several years. See Li, *Fighting Famine*, pp. 131–4; Cohen, *History in Three Keys*, pp. 71–2. Although this theory is persuasive up to a point, it does not account for the prolonged effect that waterlogging and flood deposits can have on arable land after floods. See for example Muscolino, *Ecology of War*. One of the most convincing explanations can be found in the underlying poverty that exists in drought-prone regions, which leaves people highly vulnerable to instability in the food supply. Each of these factors goes some way to explaining why droughts have proved more catastrophic than floods. Yet none account for the numerous harmful effects that inundation has on human communities that are entirely absent during droughts. The desiccation of the landscape does not physically injure or kill people directly, nor does it destroy their homes and granaries. Droughts do not deprive agriculturalists of their tools directly or ruin transportation networks and market infrastructure. In short, the comparison of droughts and floods still needs a good deal of research.

[92] Hardy plants survive by remaining dormant until water returns, while others develop complex taproot systems to access deeper reserves of groundwater. See Lambers, Chapin III, and Pons, *Plant Physiological Ecology*.

refugia, reducing the food available to birds and amphibians. Aquatic species suffer, as the quantity and quality of water recedes and its temperature rises. Fish experience a loss of habitat and become stranded in isolated pools. Their supply of food diminishes as the aquatic faunal assemblage is depleted.[93] The extensive pressure that droughts place on biota within affected ecosystems limits the nutritional opportunities available for human beings – there are few ecological endowments.[94] By the twentieth century, drought-stricken communities in China tended to subsist on agricultural by-products, such as corncobs, peanut hulls, straw roots and cottonseed. The only edible plants hardy enough to survive were trees, which offered scant nutrition, and tuber crops such as sweet potatoes.[95]

The biotic response to flooding was dramatically different. It provided a range of ecological endowments, including fish, aquatic plants and waterfowl. This basic ecological difference may help to explain the varying human experience of inundation and aridity. The literature on flood coping strategies is not as well developed as that describing behaviour during droughts. We know that during the Yellow River floods of 1938 refugees ate wild food and supplemented their incomes by smuggling.[96] Historically, flood-stricken communities in Bangladesh fished and consumed jute leaves.[97] Marine produce may also have helped Irish coastal communities to survive the catastrophic famine of the 1840s.[98] It is important neither to romanticise nor overemphasise the role played by wild food during disasters. Hunting and foraging was almost always a supplementary tactic, used in concert with a range of other coping strategies. For example, in 1931 some fisherfolk left women and children in urban areas, while the men sought to survive on the rivers, relying on a mixture of wild food and charity.[99] Ecological endowments were clearly not a total solution for the problem of famine, yet

[93] Lake, *Drought and Aquatic Ecosystems*; Lake, 'Flow-generated Disturbances', pp. 82–85; Matthews, *Patterns in Freshwater Fish Ecology*, pp. 341–4.

[94] Another way to conceptualise this distinction would be to examine the effect on flows of nitrogen, the adequate supply of which, as Vaclav Smil observes, 'is an irreplaceable condition of human existence.' Smil, *China's Past*, p. 110. Nitrogen is dispersed throughout river valleys by the erosion of minerals in upper catchments, and is fixed by aquatic and riparian plants within the fluvial ecosystem. The impact of floods and droughts on the nitrogen cycle is, then, extremely different. See Arthington, *Environmental Flows*, pp. 65–9.

[95] Mallory, *China*; Thaxton, *Catastrophe and Contention*, p. 27.

[96] Muscolino, *Ecology of War*. [97] Del Ninno et al., *1998 Floods*, p. 81.

[98] Ó Gráda, *Black '47*. [99] *Wuhan Ribao*, 15 January 1932.

their use demonstrates that the population of the middle Yangzi still possessed formidable environmental knowledge. Their vernacular skills went almost entirely unrecognised in the official accounts of the flood, as politicians and relief workers posited their own charitable efforts as the only variables preventing starvation.

Microbial Environments

Despite severe food shortages, the major driver of disaster mortality was not starvation. This is clear from the Nanjing Survey statistics, which reveal that during the first 100 days of the flood, only 1 per cent of rural communities starved to death, and in refugee camps there were no cases of starvation. Later, the government would use these statistics to claim that famine had been successfully averted.[100] The health minister Liu Ruiheng 刘瑞恒 observed that people in Wuhan were 'dying of diseases, mainly malaria, typhoid fever and dysentery, instead of starvation'.[101] Such claims were predicated upon a pervasive misunderstanding – or perhaps a convenient misinterpretation – of the nature of disaster mortality. They assumed that deaths could be attributed *either* to hunger *or* to disease. Indeed, this assumption is embedded deep within the popular understanding of disasters, in which the English term *famine* and its Chinese equivalent *jihuang* 饥荒 are taken to imply events in which whole populations starve to death.[102] Very few people literally starve to death during famines. Most fall victim to infectious diseases, at least as their proximate cause of death.[103] Cormac Ó Gráda and Joel Mokyr have observed that during famines hunger and disease 'interact in complicated ways, some of which operate through the human body and some through the fabric of human society.'[104] Malnutrition suppresses both individual and collective immune systems – making human bodies more susceptible to disease and human communities more susceptible to epidemics.[105] Rather than separating hunger from disease, then, we should try to understand the deadly synergy that they form. Disease was certainly the leading proximate cause of death during the 1931 flood. It caused 70 per cent of deaths in rural areas and 87 per cent of deaths in relief camps. Yet those who succumbed to infections had been significantly weakened by malnutrition. It is highly probable that disease

[100] RNFRC. [101] *Hankow Herald*, 10 September 1931.
[102] On the history of the English concept of famine see De Waal, *Famine That Kills*.
[103] Ó Gráda and Mokyr, 'Famine Disease'. [104] Ibid., p. 20. [105] Ibid., p. 20.

Table 2.2. *Causes of flood mortality*

	Information from	
	11,791 farm families in 245 localities in 87 counties 县 (xian)	3796 farm families in refugee camps in Wuchang, Shanghai and Nanjing
Per cent of deaths caused by		
Drowning	24	10
Disease	70	87
Starvation	1	0
Others	1	–
No information	4	3
Number of deaths (in the first 100 days of the flood)		
Deaths per 100	2.2	6.3

masked the true scale of the famine. In the lethal microbial environment created by the flood, people simply did not live long enough to starve to death.

The most dangerous aspect of any famine is usually mass displacement. This pushes malnourished people with weakened immune systems into contact with deadly pathogens, while depriving them of their customary defences against infection. It is for this reason that migration, which is one of the most widely adopted reactions to disasters, is often a spectacularly unsuccessful survival strategy. Table 2.2 demonstrates that the mortality rates suffered in urban refugee camps were almost *three times* higher than those found in rural areas. The sample used was probably too limited to determine whether this pattern applied throughout the flood zone, yet it certainly suggests that those who stayed in the countryside, eking out salvaged crops, fish and aquatic weeds, survived better than those who headed to relatively well-provisioned cities. Of course, many people had little choice but to relocate, as their homes had been inundated. Others simply could not tolerate the lack of food. Hunger may not have been the most lethal of maladies, but it was certainly one of the most persuasive. Politics also played a role. The conflict raging across the flood zone forced many people to become refugees while encouraging local governments to corral homeless people into large camps. Whatever their reason for leaving their homes, refugees were by far the most vulnerable members of the population.

Even in the absence of a disaster, infectious diseases remained the leading cause of death, accounting for more than half of all fatalities

in 1930s China.[106] The public health campaigns and medical advances that had helped to bring down infection rates in some urban areas were largely absent in the countryside and in the more deprived quarters of cities.[107] As wealthier populations heightened their defences against infection, susceptibility to disease came increasingly to correlate with poverty.[108] Such differences were amplified during times of disaster. From a global perspective, medical and health improvements tended to intensify the link between disaster mortality and economic inequality, by selectively reducing the vulnerability of elites.[109] This goes some way to explain why certain sections of the population seem to have been relatively immune to flood-related diseases in 1931.

The relative invulnerability of the foreign community in Wuhan provides a particularly visible example of this dynamic at work. Although there were few isolated cases of dysentery and measles, for the most part foreigners survived the flood relatively unscathed, despite the catastrophic health crisis that was unfolding all around them. Even seemingly high-risk groups, such as medical missionaries, do not seem to have suffered substantial fatalities.[110] The reasons for this included their relatively hygienic living conditions, greater access to chemicals to purify drinking water and, most importantly of all, prophylactic inoculations against conditions such as cholera and smallpox.[111] Elites could not be protected from all infections. There were still some diseases, most notably typhus, that killed relief workers and refugees indiscriminately. Though one might assume that the socioecological conditions created by the

[106] Lee and Wang, *One Quarter*, p. 44.

[107] On the creation of new public hygiene in urban areas see Rogaski, *Hygienic Modernity*; on prevalence of disease in rural areas see Notestein, 'A Demographic Study'. On the history of public health in the Nanjing Decade see Yip, *Health and National Reconstruction*.

[108] By the 1930s the hygienic deficit suffered by the rural majority meant that male children reaching the age of five in urban areas lived on average fourteen years more than their rural counterparts, and young urban girls ten years more. See Campbell, 'Public Health Efforts', p. 199.

[109] Ó Gráda, *Famine*, pp. 113–15.

[110] A medical missionary named Dr. Hadden contracted dysentery but seems to have survived. 'Handwritten notes in diary format by an unknown individual relating to the flood of Hankow', SOAS Archives 5/1201. Rewi Alley caught malaria while working on the flood relief effort. Airey, *Learner in China*, p. 106. The only foreign fatalities reported in Wuhan during the flood were five Franciscan missionaries who drowned when their boat overturned in the French concession *North China Herald*, 22 September 1931.

[111] Practically all foreigners had been inoculated against cholera and typhoid. *North China Herald*, 22 September 1931.

flood would have been conducive for the lice that spread typhus, mercifully this was one disease that did not make an appearance in 1931.[112]

At the other end of the spectrum, rural refugees arriving in cities were often pushed into lethal microbial environments. Their situation was particularly precarious in Wuhan, which itself succumbed to inundation. Refugees were forced to survive as best they could on an archipelago of flood islands formed on dyke tops, hillsides and railway embankments. The overcrowded conditions on such islands offered a perfect habitat for the measles virus – a perennial enemy of refugees.[113] In one camp, measles infected 1,491 in December alone, resulting in 682 deaths, mostly among children.[114] Measles outbreaks exemplified the complex synergy between hunger and disease. Individuals whose immune systems had been compromised by vitamin deficiencies were more susceptible to viral infections, while communities whose collective immune systems had been compromised by overcrowding were much more susceptible to epidemics. The same dynamic contributed to the smallpox epidemic, which dispatched thousands of undernourished and overcrowded refugees.[115] Most people had yet to be vaccinated against this highly destructive disease, which remained one of the leading causes of death.[116]

The almost total absence of sanitation amplified the risk of disease greatly. With little dry fuel for boiling, those stranded in the oppressive heat of the summer were forced to drink river water contaminated with human and animal faeces. Gastrointestinal infections such as dysentery and typhoid soon ranked among the most prominent causes of death.[117] As rivers emptied sewers into the city streets, coprophagous insects such as flies gorged themselves on human waste. Small fragments became caught on their stiff hairs and were later deposited on human food, helping to extend the range of gastrointestinal diseases.[118] As the flood pulse

[112] E. C. Lobenstine, 'The Work of Missionaries and Other Westerners in Flood Relief', SOAS Archives 10/7/15; H. Owen Chapman 'Fighting Floods and Famine in China', SOAS Archives 10/7/15. On typhus in the 1938 Henan flood see Muscolino, *Ecology of War*, p. 63.

[113] On the history of these conditions see Toole, 'Refugees and Migrants', p. 117; Curtin, *Disease and Empire*.

[114] RNFRC, p. 169.

[115] 'Handwritten notes in diary format by an unknown individual relating to the flood of Hankow', SOAS Archives 5/1201; H. Owen Chapman 'Fighting Floods and Famine in China', SOAS Archives 10/7/15.

[116] Notestein, 'A Demographic Study', p. 77.

[117] H. Owen Chapman 'Fighting Floods and Famine in China', SOAS Archives 10/7/15; Xie, *Yi jiu san yi nian*.

[118] Aldrete, *Floods of the Tiber*, p. 149.

interacted with the built environment it created excellent ecological conditions for flies. They were drawn in great swarms to large concentrations of human beings who were unable to dispose of faeces and corpses. The population of Wuhan was soon being plagued by large swarms, which would land on food that was left uncovered for more than a moment.[119] Winged insects are, theoretically, democratic vectors of infection. They can fly between the physical and social barriers that separate human populations, infecting rich and poor alike.[120] Yet homeless refugees lacked walls and fires, the two most basic repellent technologies that people can use to ward off insects, and so there was little they could do to avoid the unwanted attention of these pests.[121] One Irish missionary reported a particular gruesome scene in which an elderly woman living in a hut was 'literally black with flies of the worm generating, blue headed type'.[122]

Flood-stricken communities may have possessed an impressive range of techniques to alleviate starvation, yet they were relatively defenceless in the face of epidemics of gastrointestinal disease.[123] With the flood easily overwhelming the capacities of medical practitioners, most people had to rely on vernacular treatments and dietetic techniques. Some rural communities mixed a form of white clay known as Goddess of Mercy Earth 观音土 (Guanyin Tu) with flour and bran to make cakes.[124] This was a common practice during famines.[125] Historians have tended to characterise the consumption of earth as the ultimate symbol of hopeless desperation – famished people are pictured consuming such materials in order to delude their stomachs into a fleeting feeling of satiation. Yet earth eating, known technically as geophagy, has been found in a wide variety of cultural contexts throughout human history.[126] It is doubtful that it offers valuable nutrition, but coating the gastointestinal tract with clay may offer protection from toxins and pathogens, and may also ease the pain of hunger.[127] Earth, in other words, may have been consumed more as medicine than as food.

[119] *North China Herald*, 22 September 1931; *Hankow Herald*, 13 September 1931.
[120] Biehler, *Pests in the City*.
[121] Webb, *Humanity's Burden*, pp. 44–5.
[122] Barrett, *Red Lacquered Gate*, p. 276.
[123] 'Jizhenhui ling', HSSDX, pp. 166–7.
[124] JHS 10, p. 161.
[125] Mallory, *China*, p. 2; Will, *Bureaucracy and Famine*, p. 33; Li, *Fighting Famine*, p. 361.
[126] Young, *Craving Earth*. Although geophagy has been documented worldwide as a response to hunger, it is not limited to situations of food insecurity. Today, pregnant women and children are among the most enthusiastic geophagists, consuming earth to satiate cravings, known as pica.
[127] For a detailed analysis of the literature see Young, *Craving Earth*; also Hooda and Jeya, 'Geophagia and Human Nutrition', pp. 89–98.

The health properties of earth were well known in China, and had been extolled by medical theorists since at least the Ming dynasty.[128] Famished communities were known to consume earth specifically for its medicinal properties.[129] Certain types of earth even found there way into modern biomedical practice. In 1934 a team of physicians led by Chen Yonghan 陈永汉 experimented with using kaolin clay 高岭 (gaoling) to treat the symptoms of cholera.[130] This must have proved efficacious, because kaolin became a key ingrediant in anti-nausea and diarrhea medicines.[131] It is doubtful that the Goddess of Mercy Earth consumed by famished populations was always pure kaolin. Even if it was, excessive consumption would still have caused dangerous gastrointestinal complaints. Yet recognising that geophagy may have had some medical efficacy helps to complicate our image of the behaviour of disaster-stricken communities. Rather than being an act of desperation, eating earth may have been a dietetic technique, which allowed people to treat common symptoms of disaster. Unfortunately, such techniques were at best palliative. When major epidemics of gastrointestinal disease struck, as they did in 1931, most people were largely defenceless.

Refugees could also do little to protect themselves against mosquitoes. These parasitic insects benefited not only from the ready supply of human blood available in overcrowded camps, but also from the huge increase in available surface water in which to breed. The swarms that flew over Wuhan were 'like armies of locusts . . . attacking the miserable unclothed population'.[132] These mosquitoes soon gave rise to an epidemic of malaria.[133] The League of Nations malariologist Mihai Ciuca reported that of the 711 persons he examined during the flood, 166 were infected with the disease.[134] It was later estimated that 60 per cent of the population contracted malaria due to the flood, causing as many as 300,000 fatalities.[135] Malaria did not affect all members of the population equally. Biology afforded some people natural immunity. Socioeconomic advantages also played a role. Hungry refugees living without repellent technologies near standing water were highly vulnerable. In

[128] Young, *Craving Earth*, p. 41. [129] Will, *Bureaucracy and Famine*, p. 33.
[130] Known as John Wing-hon Chun Wu et al., *Cholera*, pp. 128–9.
[131] Young, *Craving Earth*. [132] *Hankow Herald*, 28 August 1931.
[133] *North China Herald*, 22 August 1931; 'Handwritten notes in diary format by an unknown individual relating to the flood of Hankow', SOAS Archives 5/1201.
[134] RNFRC, p. 182; for more on League of Nations anti-epidemic measures during the flood see Borowy, 'Thinking Big'.
[135] Yip, 'Disease, Society and the State'.

Wuhan malaria quickly became one of the leading causes of death.[136] Thankfully, the dominant local species of the parasite causing malaria was *Plasmodium vivax*. In other areas communities were infected with the even deadlier strain of *Plasmodium falciparum*.[137] For the population of Wuhan, there were at least some small mercies.

Succession and Reconstruction

Ecologists refer to the process of natural recovery that occurs in the aftermath of disturbances as succession. Under natural conditions, biological colonisation and weathering repair much of the damage inflicted by extreme climatic and geophysical events.[138] Had the middle Yangzi been left to recover naturally in 1932, with the passage of time, succession would have encouraged wetland flora and fauna to recolonise the basin. Instead, through the human process of reconstruction communities established their favoured anthropogenic environments once again. Some chose to adapt themselves to the new hydrographic realities. One community in Mianyang 沔阳 converted its flooded polder into a fishing lake.[139] In most cases dykes were repaired and polders drained. This allowed people to dominate the process of succession, capturing the biomass deposited by rivers and colonising empty patches with crops.

Floods have variable effects on soil fertility. They sometimes leave deposits of sand and rock that make cultivation virtually impossible. This became a major problem for residents of Henan following the 1938 floods.[140] In other cases the alluvium deposited during inundations helps to stimulate the growth of vegetation. Such natural fertility had long been prized by flood recession agriculturalists.[141] By all accounts, Chinese farmers enjoyed a bumper harvest in 1932, suggesting that the flood had, in aggregate, helped to improve soil quality.[142] Unfortunately, the economic afterlife of the disaster prevented many farmers from capitalising on this sedimentary windfall. Having sought credit

[136] H. Owen Chapman, 'Fighting Floods and Famine in China', SOAS Archives 10/7/15; Xie, *Yi jiu san yi nian*, p. 74.
[137] RNFRC, p. 301.
[138] Del Moral and Walker, *Environmental Disasters, Natural Recovery and Human Responses*.
[139] Zhang, *Coping with Calamity*, p. 123. [140] Muscolino, *Ecology of War*.
[141] Reice, *Silver Lining*, pp. 114–15. On the role of rivers in the nitrogen cycle see Arthington, *Environmental Flows*, pp. 65–9.
[142] Kueh, *Agricultural Instability*, p. 144; RNFRC, p. 193.

from moneylenders to survive the flood, many households had to hand over a large proportion of their harvests in debt repayments. A similar pattern occurred with those employed in labour relief, who sometimes had to pay 60 per cent of their already paltry wages to creditors, who waited at grain depots.[143] While millions were struggling to rebuild their lives, creditors now profited from the ecological endowment offered by the bumper harvest. Even if they had managed to retain full rights to their land, there was no guarantee that households could cultivate the land, as many had lost labour animals and farm tools. One of the most evocative images that emerged during the period of reconstruction was that of farmers forced to harness ploughs to their own backs, using their bodies to till their land.[144]

Urban populations were not immune from the economic hangover of the flood. The export market in Wuhan was long in disarray. The flood had destroyed huge quantities of cash crops such as cotton. In the year after the flood exports of this commodity were down by as much as 70 per cent.[145] Urban mills that had been flooded in 1931 faced a cotton famine in 1932.[146] The loss of domestic animals was also a serious economic blow, decimating the powdered egg and leather industries.[147] For urban workers, many of whom had lost their jobs when factories were flooded, it was the hike in food prices that proved most devastating.[148] This continued for at least a year. Staple goods remained prohibitively expensive despite the deflationary effect of a large wheat loan from the United States, discussed later in this book. Table 2.3 gives some sense of the prolonged effect that the flood had upon the urban economy. In comparison to Nanjing, which was only lightly inundated, Hankou continued to suffer for at least two years.

When tallying the cost of floods, people seldom think of the loss of trees. Yet this had serious implications during the reconstruction phase. The flood had uprooted and drowned a third of the trees in the disaster zone. A fifth more had been used as fuel or sold as lumber. As timber was the major building material, these losses seriously prolonged the housing crisis. Buildings that had survived the flood were often structurally compromised. Whole neighbourhoods in Wuhan leant precariously, ready to collapse at any moment.[149] When members of the community set about

[143] Yorke, *China Changes*, p. 72. [144] JHS 10, p. 163. [145] Hou, *Shuizai hou Wuhan.*
[146] On the flooding of urban mills see *Hankow Herald*, 18 August 1931.
[147] Hou, *Shuizai hou Wuhan.* [148] *Hankow Herald*, 28 August 1931.
[149] *Hankow Herald*, 28 August 1931.

Table 2.3. *Comparison of prices in Hankou and Nanjing, 1930–1933*

	Food	Clothing	Fuel and light	Building materials	Misc.	General index
Index of wholesale prices in Hankou[a]						
1930	100	100	100	100	100	100
1931	109.6	114.1	121.7	126.7	109.2	114.5
1932	108.5	109.4	120.9	125.7	103.9	112.4
1933	94.0	95.9	101.8	116.2	95.5	98.7
Index of wholesale prices in Nanjing[a]						
1930	100	100	100	100	100	100
1931	99.0	109.6	112.9	108.9	112.4	106.1
1932	93.0	102.5	104.8	109.3	115.7	100.8
1933	85.9	83.3	95.7	102.8	96.7	92.1

[a] Simple geometric averages.

reconstructing their homes, they found that timber prices had become prohibitively expensive.[150] Unlike quick growing grasses such as rice and wheat, the succession of woodlands took years, if not decades. Although one of the key recommendations of the Nanjing Survey had been that all homes should be constructed upon sturdy foundations, given the chronic lack of trees, many people had little choice but to reconstruct their own vulnerability, relying once again on cheap materials with low water resistance.[151] The dearth of trees also meant that farmers struggled to replace essential tools, such as ploughs, carts, and wheelbarrows, and lacked even the most basic furniture such as beds and chairs.[152] The silk industry was devastated by the loss of mulberry trees, which left sericulturalists with nothing to feed their silkworms.[153] This blow came at the same time that they were facing a steep depreciation of the value of silk exports caused by the Great Depression. With meteorology and economics conspiring against them, many converted their mulberry groves into rice paddies.[154]

Agricultural reconstruction usually outpaced ecological succession. In most areas, wild flora and fauna did not have a chance to exploit the rich alluvial deposits of the flood. One exception to this was the plains to the

[150] Buck, *1931 Flood*, p. 38. [151] Ibid., p. 46.

[152] 18 per cent of ploughs, 4 per cent of carts and 4 per cent of wheelbarrows had been lost among numerous other items of farmyard equipment. Ibid., pp. 18, 22.

[153] Ibid., p. 19; Zhongguo jingji xue she', Jiuzai yijian shu', *Dongfang Zazhi*, 28 (1931).

[154] Shiroyama, *China during the Great Depression*, pp. 122–4.

north of Wuhan. Here the foreign traveller Gerald Yorke described vast tracts of untilled land, where wild grasses and brushwood thrived.[155] The reason was not that the local population had discovered some latent form of ecological consciousness. It was, rather, because the ongoing conflict between the Nationalists and Communists that had prevented them from returning their land to the plough. The succession of the local ecosystem was, in this instance, an evocative reminder of the extent of human suffering. Micah Muscolino has argued that war should be understood as an ecological process, in which militaries metabolise vast energy inputs extracted in the form of human labour and natural resources.[156] This ecological model certainly helps to explain how human conflict and environmental disaster conspired against the population of northern Hubei.

Long before the flood struck, the subsistence system was already straining as a result of the ravages of war. In early 1931 the Nationalists launched the latest of their encirclement campaigns designed to dislodge the Communists from their Soviet at E-Yu-Wan 鄂豫皖, a mountainous borderland region between Hubei, Henan and Anhui.[157] With supply lines cut, the dwindling sources nutrition and energy upon which the three and a half million residents relied were quickly metabolised by the Red Army. Then, in the late spring, flash floods coursed down the mountain slopes, washing away a huge quantity of crops.[158] Starvation and disease followed soon after.[159] With the resources of this region exhausted, Zhang Guotao 张国焘 ordered his half-starved troops to march south and commandeer supplies from market towns, expanding the metabolic reach of the Red Army.[160] Draining as it must have been, the effects of Communist parasitism paled in comparison to the destruction caused by the brutal scorched earth policies launched by the Nationalists. In 1932, with much of Hubei still struggling to cope with hunger and disease, the provincial governor Xia Douyin ordered his troops to commandeer grain supplies and poison drinking wells, making life around the Communist stronghold unliveable.[161] Soon many areas of northern Hubei had been reduced to 'districts of the dead' 死人区 (siren qu).[162] Yorke estimated that as much as a third of the population had been killed, with most

[155] Yorke, *China Changes*, p. 61. [156] Muscolino, *Ecology of War*.
[157] Benton, *Mountain Fires*. [158] Yan, *Macheng xian zhi*, p. 44.
[159] Rowe, *Crimson Rain*, pp. 240, 316. [160] Ibid., p. 317. [161] Benton, *Mountain Fires*.
[162] NB: Huang'an is now known as Hong'an. See Tang, *Hong'an xian zhi*, p. 4. This gazetteer, which offers a typically pro-Communist interpretation, attributes most of this destruction to the Nationalists.

survivors fleeing to urban areas.[163] According to the head of the government relief efforts John Hope Simpson, the majority of the refugees in Wuhan were actually escaping war rather than water.[164] In reality, these two maladies were inextricably linked. The grass and brushwood that flourished in northern Hubei owed its existence to a deadly combination of flooding and conflict.

These were not the only species that thrived in the post-disaster environment. *Cholera vibrio* also found a beneficial niche among starving and overcrowded refugees. Rumours of cholera outbreaks had been circulating since the earliest stages of the flood. Having investigated conditions in Wuhan on behalf of the quarantine service, Wu Liande 伍连德 reported in September that the cholera situation had been 'much exaggerated'.[165] This renowned Malayan-Chinese epidemiologist may have correctly diagnosed a case of collective paranoia at this time, but by the winter cholera really had begun to colonise the city.[166] It dispatched undernourished people at terrifying speeds. As one nurse put it, 'they start with diarrhoea in the evening and are dead the next day.'[167] Doctors, who had little but saline injections to counter these symptoms, were easily overwhelmed by the scale of the epidemic.[168] The quarantine service later estimated that flood-related cholera had killed more than 800 people in Wuhan, with infected refugees then spreading the condition throughout the region.[169] Cholera later climbed the mountains of north Hubei, carrying away thousands of Red Army soldiers.[170] It would seem that the environment was also capable of metabolising armies.

[163] Yorke, *China Changes*, p. 61.

[164] Extracts from letter of Sir J. Hope-Simpson to Mr. F. B. Bourdillon, 16 January 1932, SOAS Archives 10/7/15. It should be noted that this picture adhered to the Nationalist representation of the disaster, which tended to blame Communists for displacement. See 'Wei daishou gongfei qu nei nanmin zaikuan qishi', *Jiuguo Zhoukan* 1 (1932).

[165] *North China Herald*, 13 October 1931. Wu Liande was known as Wu Lien-teh.

[166] H. Owen Chapman 'Fighting Floods and Famine in China' SOAS Archives 10/7/15; Xie, *Yi jiu san yi nian*, p. 74; 'Handwritten notes in diary format by an unknown individual relating to the flood of Hankow', SOAS Archives 5/1201.

[167] 'Handwritten notes in diary format by an unknown individual relating to the flood of Hankow', SOAS Archives 5/1201.

[168] H. Owen Chapman 'Fighting Floods and Famine in China', SOAS Archives 10/7/15.

[169] Wu and Wu, *Haigang jianyi*.

[170] Yan, *Macheng xian zhi*, p. 498. During earlier stages of the flood the Communists had kidnapped government relief workers to demand autonomy over the reconstruction effort. Tellingly, when they later ransomed Captain Charles Baker their primary demand was for medicine. See George Andrews, 'Letter to John Hope Simpson', 6 June 1932, JHS 6i.

In the summer of 1932, China experienced probably its most deadly cholera outbreak of the twentieth century. Spreading over 300 cities in 20 provinces, the epidemic infected more than 100,000 people, killing around 30,000.[171] Caution should be adopted before reducing the outbreak of epidemics to any single factor. As David Arnold has noted, cholera and famine may have frequently coincided, but there is no automatic correlation between the two.[172] The Nationalist government was certainly keen to downplay the links between the flood and the epidemic.[173] There is little doubt, however, that inundation had created a comfortable habitat for cholera. It had lowered collective immunity by destroying sanitation systems and disrupting the water supply. Cities such as Yichang and Wuhan, which were still struggling to recover from inundation, suffered among the worst levels of infection.[174] By causing widespread food shortages, inundation diminished individual immunity, as *Vibrio* thrived in malnourished bodies.[175] The flood may not have caused the cholera epidemic, but it had certainly helped to forge a conducive epidemiological environment.

The complex links between the flood and the subsequent cholera epidemic illustrate how a socioecological perspective can help to broaden our understanding of the dynamics of humanitarian catastrophes. By moving away from a narrow nutrition-centred approach, we can begin to unpick the tangled knot of causes that helped to form the disaster regime. This shift forces us to confront many of the assumptions that still permeate historiography. Rather than asking only how well the state and society managed to nourish the people, we must also examine how a range of socioecological interactions helped to nourish pathogens. Recognising the impact of water on non-human species also forces us to reframe our understanding of the temporality of disasters. The effect that inundation had on cattle, trees and *Cholera vibrio* demonstrates that acute climatic shocks can have prolonged consequences. This, in turn, raises questions about how we quantify the effects of catastrophes. The convention of determining excess mortality within a limited time frame fails to appreciate that humanitarian catastrophes are never discrete events – they are complex processes that unfold on a variety of

[171] RNFRC, p. 17; Poon, 'Cholera'; Zhang, *Minguo shiqi*, pp. 143–5.
[172] Arnold, *Colonizing the Body*, p. 167. [173] RNFRC; compare p. 132 and p. 149.
[174] RNFRC, p. 17; Poon, 'Cholera'.; For statistics on the Wuhan outbreak see Zhang, *Minguo shiqi*, p. 144.
[175] Thomas, *Lambeth Cholera Outbreak*, p. 38.

temporal scales.[176] Our insatiable urge to count and compare disaster mortality conjures an illusory order out of messy, fragmented and prolonged processes.

If we were to draw temporal boundaries around the flood, limiting the period in which its effects could be examined, we could never hope to understand the role played by endemic diseases such as snail fever. Local histories claim that there was a sharp spike in cases of this waterborne complaint in the aftermath of the flood.[177] But what does this really imply? Inundation certainly seemed to have created an excellent habitat for both pathogens and vectors. Large refugee populations were pushed into proximity with polluted water, in which both schistosome cercariae and freshwater snails thrived. Yet unlike conditions such as dysentery or cholera, which rip through the body at a terrifying pace, snail fever unfolds in prolonged and complicated stages. The acute phase is extremely dangerous, having symptoms much like malaria. Those who survive enter a chronic stage, during which they can remain asymptomatic often for years. Eventually some develop late-stage snail fever, which gives rise to the characteristic distended stomach and other debilitating symptoms.[178] A snail fever sufferer may be pushed from chronic to late-stage disease by various forms of physical stress, including malnutrition.[179]

Given the complex and prolonged nature of snail fever, it is quite possible, likely in fact, that many people who became symptomatic in 1931 may have already been infected, and that malnutrition and other stresses pushed them into late-state schistosomiasis. Conversely, the blood flukes that burrowed into the skin of refugees would have left many in an infectious yet asymptomatic state. Many may have died from a condition they contracted because of the flood, years or perhaps even decades later. Snail fever played a fiendishly complex role in the disaster regime, involving dynamic interactions among hydrology, ecology, epidemiology and biology. This is before we even consider the economic complications caused by snail fever infecting oxen and buffalo. The complexity of this one single condition reveals quite how difficult it is to capture the effects of a disaster using the blunt instrument of excess mortality – a mode of quantification that takes insufficient account of both pre-existing

[176] An argument well established in the social science literature dealing with disasters. See Wisner et al., *At Risk*; Oliver-Smith, 'Anthropological Research'.

[177] Pi. *Wuhan tongshi: Minguo juan (shang)*, p. 222.

[178] Gross, *Farewell to the God of Plague*, p. 4.

[179] Gross, *Chasing Snails*, pp. 19–20.

vulnerabilities and long-term implications. It also shows that if we are to view flooding from a socioecological perspective, we must think about how individual events fit into the broader life of both communities and their environments. Long after rivers receded to their courses and refugees returned to their homes, the effects of the flood pulse lingered within human gastrointestinal ecosystems.