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Abstract

Demographic crises and famines were recurring phenomena in China before the mid-20th century, with the Great Leap Forward Famine of 1959-61 often regarded as the last and one of the most severe in Chinese History. This article delves into the repercussions of the Great Flood of 1975 in Henan province. We reassess the demographic implications of this hydrological catastrophe and employ a well-established methodology to identify demographic crises and occurrences of famine. Contrary to official perspectives, our findings indicate absolute mortality numbers and population losses in excess of officially accepted accounts and the emergence of localised famine episodes in the last years of Maoist China, suggesting that the last famine in China might have occurred in the mid-1970s. We argue that this demographic crisis was not solely the result of a high-magnitude natural disaster but also had other components: long-term economic policies that failed to achieve a solid and strong population's nutritional status in Henan before 1975, along with short-term political decisions made during the flood, likely exacerbated its impact. Moreover, this disaster cannot be viewed in isolation from Mao's hydraulic policies in the 1950s.

JEL Codes: I18, J11, N55, Q10

Keywords: Demographic crisis, famine, hydraulic catastrophe, nutritional conditions, China

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1. Introduction

The frequency and intensity of mortality crises and famines have diminished over time, yet this decline has been neither linear nor geographically uniform (e.g., Davenport 2021). In China, demographic crises have been recurrent throughout history and remained severe until relatively recent times (e.g., Mallory 1926, Davis 2001, Li 2007, Manning and Wemheuer 2011, Lee and Zhang 2013). For the years between 1600 and 1899, estimates suggest that China experienced 94 famines, 500 wars (including minor rebellions), 187 epidemics, and 217 natural disasters (such as floods, droughts, and other calamities), resulting in up to 150 million deaths (Lee and Zhang 2013). The Republican era (1911-1949) was also marked by significant demographic crises, driven by the Civil War (1927-1949), the Japanese invasion (1937-1945), and recurring famines in the North China Plain (1920-21, 1924, 1927, 1929, and 1943) (Devereux 2000). The Great Leap Forward (GLF) famine (1959-61), the most catastrophic famine in Chinese history in absolute figures (e.g., Ó Gráda 2008, 2011, Dikotter 2010, Manning and Wemheuer 2011, 2012), occurred during the Maoist period and has received extensive scholarly attention.[1]

Since then, various perspectives have converged on a general consensus that the GLF demographic crisis was the last recorded famine in China (e.g., Li 2007, Wemheuer 2014; Eisenman 2018, Harrell 2023). This assumption is largely based on the fact that, in response to the GLF disaster, the Chinese government undertook significant efforts to boost agricultural yields through an extensive modernization of the primary sector, particularly during the Cultural Revolution (CR) (1966-76) (e.g., Perkins and Yusuf 1984, Eisenman 2018).

While most studies acknowledge the national gains in food production brought about by the Green Revolution, to our knowledge, limited research has examined the extent to which these improvements prevented further demographic crises following the GLF

[1] It is impossible to comprehensively reference all works addressing the GLF. Notable examples include Ó Gráda's (2008) reassessment and the reviews of Dikotter's (2010) book by Ó Gráda (2011) and Wemheuer (2011). Yang's (2014) literature review also provides a valuable synthesis. More recent contributions include, among others, Clément (2012), Meng, Qiang, and Yared (2015), and Kasahara and Li (2020) on the causes of the GLF, as well as Cao, Xu, and Zhang (2022) and Yixin (2024) on survival strategies. Additionally, studies by Kim, Fleisher, and Sun (2017) and Li, Wang, and Zhang (2024) explore the long-term consequences of childhood exposure to the GLF, particularly in terms of health and economic policies. For specific discussions on the impact of the GLF on mortality, health, and biological living standards, see Álvarez-Klee (2021a).

famine. However, some evidence points to malnutrition and precarious living conditions among peasants in certain areas (e.g., Ash 2006, Manning and Wemheuer 2011, Wemheuer 2014). This raises critical questions: Were there additional demographic crises in Maoist China after the early 1960s? If so, were these crises linked to famine episodes?

To address these questions, we focus on Henan province, located in the North China Plain, for two key reasons. First, Henan has historically faced recurring food shortages, leading to elevated mortality rates, primarily due to natural disasters. Between 1949 and 2014, Henan experienced 44 droughts, 38 floods, and 19 other natural disasters (Alvarez-Klee 2021a: 28). Secondly, this province was the site of what is considered by some to be the world's most devastating hydrological catastrophe (Yi Si 1998), resulting in significant infrastructure damage and loss of life. This disaster, known as the Great Flood of 1975, or Qiwu-ba Great Flood (七五八大洪水) in China, has sparked controversial debates regarding the number of fatalities and the wider aftermath (Human Rights Watch 1995, Yi Si 1998, Ying 2012, Qiao et al. 1987).

The discrepancies between reported figures and various claims make the Great Flood of 1975 a valuable case study for exploring the central research question of this article. In investigating evidence of demographic crises and famine episodes in Maoist China post-GLF, this study seeks to contribute to two interrelated fields of literature: one on demographic crises and famines, and the other on the outcomes of Mao's economic policies.

Within the literature on demographic crises and famines, a key issue that emerges is the definition of famine. Various approaches and definitions exist, presenting a significant challenge in establishing a universally agreed-upon definition (Devereux and Howe 2004: 355-361; see also Sen 1981, de Waal 1989: 9-32, and Devereux 1993, among others). The conceptualizations of famine vary. There are theoretical definitions, but also pragmatic approaches providing nutritional outcome indicators; some scholars consider famine as an event, while others view it as a process; and one can find broad definitions, alongside more delimited perspectives of famine. To illustrate this diversity, Amartya Sen (1981:40) distinguished between starvation and famine, asserting that he used starvation "*in the wider sense of people going without adequate food, while famine is a particularly virulent manifestation of its causing widespread death*". In contrast, Martin Ravallion (1997: 1205)

argued that "*a geographic area experiences famine when an unusually high mortality risk is associated with an unusually severe threat to the food consumption of at least some people in the area*", emphasizing the presence of life-threatening starvation rather than a mere contraction in food availability and consumption. More recently, Cormac O'Grada (2007: 5) defined famine as a "*lack of food leading directly to excess mortality from starvation or hunger-induced illnesses*" (see also O'Grada 2009: 4, for a similar definition). While some authors suggest that famine involves hunger and malnutrition but not necessarily death, in this article, we also consider that food availability and excess mortality should be regarded as components of famines.

A second challenge in identifying famine deaths lies in untangling the causes of death during a mortality crisis, a question that we discuss in this research. Humanitarian crises result in increased morbidity and mortality in the subsequent months following a shock. Besides direct mortality, catastrophes such as wars, droughts, floods, and other phenomena exacerbate disease and food insecurity, potentially leading to famine (Malilay 1997). Throughout history, in periods of mortality crises, infectious diseases have been the ultimate cause of death. However, infectious diseases have generally interacted with hunger and starvation, making it complex to determine whether mortality should be mainly attributed to diseases or famine (e.g., Appleby 1975, Mokyr and Ó Gráda 1999, 2002).

A third point of debate is about the causes of famine, which we also address at the end of this article. It has been long debated whether famines are caused by 'natural' or by 'manmade' events (e.g. Ó Gráda 2007). Whereas 'natural' events are generally related to adverse climatic conditions, 'manmade' is generally associated with political decisions. Additionally, a third group of factors—information and knowledge—might have also played a crucial role by constraining the state's capacity to act (Roy 2016).[2] Finally, economic performance and the level of development and, therefore, the degree of vulnerability, may explain why some regions are more susceptible to famine than others (e.g. Watts and Bohle 1993, Ó Gráda, 2008).

[2] While there is a broad debate on famine causation based on the food availability decline and food entitlement decline, the scope of this article is on the developmental environments in previous years of the flood and during the flood. The study on famine causation in the aftermath of the disaster is only broadly addressed and future research must be done in this field to reach more assertive conclusions.

The second body of literature this article engages with —an aims to contribute to— concerns the economic performance of China under Mao's leadership —an issue that remains highly debated (Deng 2011). Recently, critical views on Mao's achievements have resurfaced. At the macroeconomic level, it has been argued that Mao's China exhibited a "gloomy performance" marked by unbalanced and unsustainable growth, modest structural change, and limited improvements in the material conditions of ordinary citizens (Deng and Shen 2019, Shen, Guo, and Deng 2022).

In agriculture, the largest sector of the economy, positive views on Mao's rural policies and agricultural transformation have not been insignificant and have gained renewed attention in recent years (e.g., Eisenman 2018). However, pessimistic perspectives remain dominant, challenging recent favourable reassessments of the commune system, which was central to the organization of rural China under Mao, and the overall outcomes of Chinese agriculture following the GLF (e.g. Wemheuer 2020, Lu, Luan, and Song 2020). As already argued, most scholars agree that food production improved at the aggregate level after the GLF due to the Green Revolution, while assessments at the regional level are more mixed, with certain regions showing less progress. Additionally, scholars who acknowledge national improvements in both absolute and per capita food production since the GLF argue that other factors, such as grain imports and restricting the growth of urban centres, played a crucial role in preventing food shortages (Wemheuer 2014). Finally, studies comparing food production levels and dietary composition between the early 1970s and the early 1950s, before the GLF, have highlighted a decline in diet quality and a reduction in per capita access to basic foodstuffs (Ash 2006).

The estimations presented in this article indicate that the Qiwu-ba Flood in Henan province led to approximately 80,000 excess deaths, with the total population loss reaching nearly half a million between 1975 and 1977. These figures illustrate a more pessimistic view of the disaster than that accepted by the Chinese government since the 1990s. While these results are likely conservative, the Great Flood represents the most severe crisis in Henan since the GLF. Challenging the prevailing views and even though localised at the prefectural level, our evidence suggests that the last famine in China might have occurred in the mid-1970s, just a few years before the implementation of the economic reforms. We argue that this demographic crisis was not solely the result of a

high-magnitude natural disaster but also had additional components: long-term economic policies that failed to achieve a solid and strong population's nutritional status before 1975, along with short-term political decisions made during the flood, likely exacerbated its impact. Moreover, this disaster cannot be viewed in isolation from Mao's hydraulic policies of the 1950s[3].

The article is divided into seven sections. Section II provides a brief overview of the hydrological policies implemented during the early Maoist period and details the development of the flood. Section III presents evidence of the demographic crisis. Section IV examines food availability and nutritional intake on the eve of the flood. Sections V and VI address the presence of disease and famine in 1975. Finally, Section VII offers the conclusion.

2. The collapse of the Banqiao and other dams and the Qiwu-ba great flood of 1975

The development of hydropower constructions in China represented an essential plank in the political agenda since the establishment of the PRC. Seeking to improve agricultural conditions and bolster the industrial sector, the country engaged in a wide- ranging construction of dams during the First (1949-57) and Second (1958-62) Five-Year Plans (Habich 2017). The campaign to "Harness the Huai River" in the 1950s was established by the State Council as a response to the great damage of the Huai River flood in Henan province in 1950. The campaign consisted of building dams in order to obtain hydropower and achieve flood control in the area. Two main dams were constructed at the beginning of the decade: the Banqiao dam (1951-52) and the Shimantan dam (1951), built on the upper reaches of the Ru River and the Hong River, respectively (see Figure 1).

[3] In this article we take the definition of disaster as "the result of a vast ecological breakdown in the relation between humans and their environment, a serious and sudden event on such a scale that the stricken community needs extraordinary efforts to cope with it, often with outside help or international aid". Disasters can be divided into two categories: natural or man-made disasters. The former arises from the forces of nature, while the latter can be derived from technological disasters or complex emergencies (National Center for Environmental Health and Centers for Disease Control and Prevention 1997: 26). We understand the Qiwu-ba flood disaster to have been instigated by a high rate of precipitation and aggravated by the complexity of the hydrological construction policies set during the Maoist period.

Figure 1
Location of Banqiao dam and other reservoirs in Zhumadian Prefecture, Henan Province

Source: Wikipedia. The Free Encyclopeia
https://en.wikipedia.org/wiki/Banqiao_Dam#/media/File:Banqiaomap.png (Accessed February 27, 2024)

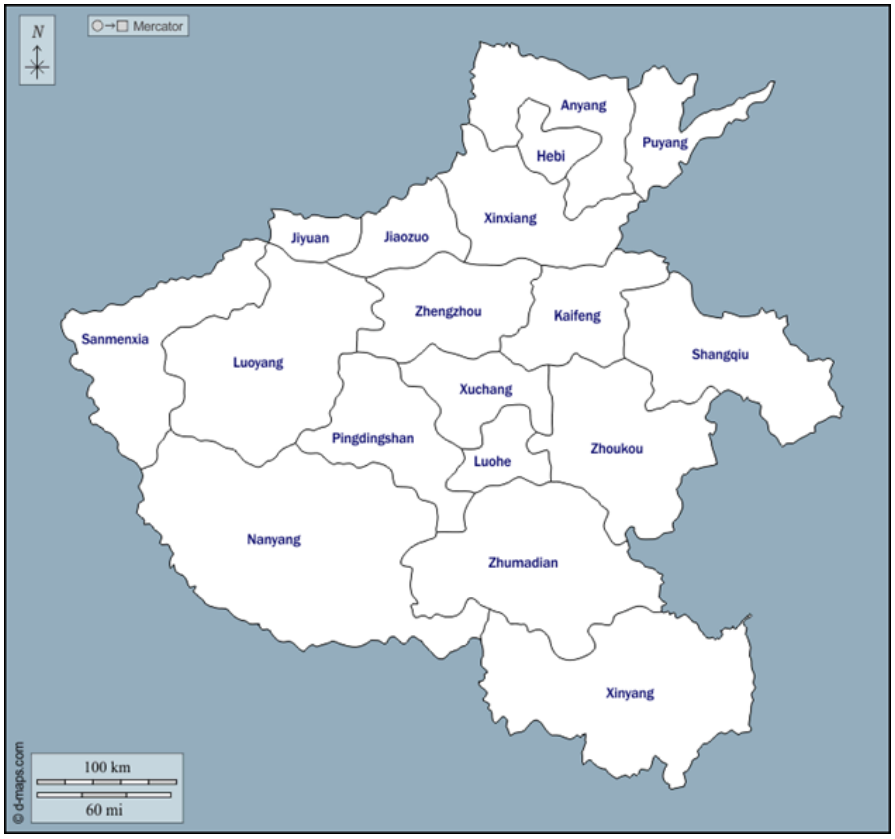
As with other large structures built nationwide, the construction of the two dams reflected a lack of knowledge of hydraulic engineering, expert warnings were ignored, and the socio-economic outcomes were deficient (Shapiro 2001, Zhou 2010, Habich 2017). By 1955, the dams had to be reconstructed with expert Soviet supervision. The remodelling focused on the reinforcement and expansion of both dams. The Banqiao dam, at 116.34 meters, allowed for a maximum storage capacity of 492 million cubic meters and a flood storage capacity of 375 million cubic meters. The dam was constructed to withstand 1-in-1000-year flood conditions. The Shimantan dam, at 109.9 meters, allowed for a maximum storage capacity of 94.4 million cubic meters with a flood storage capacity of 70.4 million cubic meters (Yi Si 1998).

In 1957, after the construction of both major dams, the building of other dams and reservoirs spread beyond the mountainous areas and towards the central plain. In total, more than one hundred structures were built in Zhumadian prefecture over the following two years. By 1958, the "Harness to the Huai River" campaign in Henan province had become a model to follow nationwide. However, despite criticism from hydraulic experts, the dams and reservoirs constructed in Zhumadian prefecture during this period were built based on negligent decisions, such as a reduction in sluice and spillway gates. Such decisions led to serious floods in the region during the Great Leap Forward (1958- 62). This fact gave rise to a new campaign in 1961: "rectify deviations and correct past errors", which led to the repair and demolition of several dams (Yi Si 1998, Shapiro 2001). However, despite the efforts of Zhou Enlai, premier of the country, to achieve a more comprehensive approach to water resource management in 1962, the campaign of the 1950s remained latent and several hundred dams were built again, while many others were neglected even though they were not in good conditions (Fu 1998; Habich 2017; Yi Si 1998). In the early 1970s, 32 million cubic meters of retention structure were added to the Banqiao dam, surpassing the dam's safe capacity. With similar negligence, a 1.9-meter-high earthen embankment was added on top of the Shimantan dam (Yi Si 1998).

Figure 2
Map of Henan province

Figure 2a. Location of Henan province in China

Figure 2b. Henan Prefectures



Sources: Directly downloaded from https://d-maps.com. Figure 2a: https://d-maps.com/carte.php?num_car=11572&lang=en. Figure 2b: https://d-maps.com/carte.php?num_car=18524&lang=en.

The flood was a three-stage process of continuous rainfall between August 5th and August 8th, 1975, in the prefecture-level cities of Zhumadian, Xuchang, Nanyang, Luohe and surroundings (see Figure 2). The torrential rains came with Typhoon Nina, which originated in Taiwan, gathered increasing force through Fujian, Jiangxi, and Hunan provinces, and finally reached its peak in Henan province. In the first stage, on August 5th, precipitation reached 448.1 millimetres, a figure never before recorded in the region. On that day, the Banqiao dam reached near-full capacity rising to 107.9 meters. The second stage, on August 6th, developed into a rainstorm that lasted for sixteen hours, raising the levels of rainfall in the Banqiao dam to 112.91 meters and surpassing its safe storage capacity by more than 2 meters. Finally, in the third stage, on August 7th, the rainfall lasted for thirteen hours, resulting in a total of 1600 millimetres of precipitation over the three days, almost doubling the figure for yearly average precipitation.[4] The

[4] Based on the Henan Annals, the yearly average precipitation between 1951 and 1980 in Zhumadian prefecture was 953.8 mm per year (驻马店地区志，上编，第一编 自然环境), Zhumadian Gazetteers, Volume 2, Part 1: Natural Environment, Chapter 4: Climate). Based on the China Meteorological

rainfall for these days was recorded as a 1-in-2000-year condition, exceeding expectations at the time of the dam's building (Henan Gazetteers, Volume 2, Chapter 2 and Volume 5, Chapter 9).

The Zhumadian Municipal Committee warned of potential flooding from the collapse of several small dams. According to prefectural gazetteers, several communications to neighbouring prefectures were reported in the initial days of the storm asking for emergency assistance from the People's Liberation Army (PLA) and the flood control headquarters. But the torrential rain destroyed soon all communications. Early on August 8th, the Banqiao dam surpassed its maximum capacity by reaching 600 million cubic meters and a height of 118 meters high. The structure collapsed. In seconds a waterfall measuring 6 meters by 12 kilometres flooded the whole area. The Shimantan dam also collapsed after reaching 120 million cubic meters capacity, 25 million cubic meters greater than its capacity. The collapse extended to other dams and reservoirs in the region. The calamity resulted in a lake measuring 300 kilometres by 150 kilometres, 1-to-7-meters in depth, submerging entire counties and having a severe effect on thirty-three districts. In the process, 842 rivers flooded; 296 bridges were destroyed; 3 million houses were washed away; and 666,667 ha of arable land went underwater (Henan Gazetteers, Volume 2, Chapter 2).

It was not a minor flood. According to a report by the U.S. Department of the Interior, Bureau of Reclamation (2015:114-119), the collapse of the Banqiao and Shimantan dams was considered a 'medium severity dam failure and flooding case,' although it acknowledged that severity could be high depending on the location. Other dam failures in China considered by this source include the Liujaitai Dam (Hebei Province, August 8, 1963), Hengjiang Dam (Guangdong Province, September 15, 1970), Lijaizui Dam (Gansu Province, April 27, 1973), and Shijiagou Dam (Gansu Province, August 25, 1973) (U.S. Department of the Interior, Bureau of Reclamation, 2015:120-125). In the case of the Banqiao and Shimantan dams, the catastrophe was triggered by a natural calamity, but available evidence suggests that hydraulic failures were also significant factors in explaining the collapse of Henan dams and the subsequent Qiwu-ba great flood.

Administration, the yearly average precipitation between 1971 and 2000 in Zhumadian prefecture was 972.9mm. See also Xu, Zhang, and Jia (2008).

3. Challenging the official narrative: excess deaths, birth shortages and total population loss

Mortality also increased, although the impact of the 1975 flood on the population of Henan province remains undetermined. Shortly after the disaster, Qian Zhengying, Minister for Water Resources and Electric Power in 1975, declared that the death toll in the region had reached 85,600. This figure accounted for individuals who drowned in a two-hour period immediately after the dam failures. The Ministry of Water Resources and Electric Power published this statistic in July 1989. However, the limited number of printed copies prevented widespread public awareness. Three years later, a second edition from the same source revised this figure to 26,000 deaths, referring to the initial estimate as a mistake (Yi Si 1998). [5]

However, there are alternative figures available. In the 1980s, eight members of the National Committee of the Chinese People's Political Consultative Conference (CPPCC) reported that the death toll reached approximately 230,000 people (Human Rights Watch 1995). This count included 85,600 fatalities during the flood and an additional 144,400 deaths post-disaster due to starvation and related diseases, summing up to a total of 229,400 casualties. [6] The Henan Province Annals for 1975 specify that 12.3 million people (18.2 percent of Henan's total population) were affected by the year's flooding in the province. However, when referring to casualty figures, the source provides a rough estimate such as 'more than tens of thousands of people [died]' (Henan Gazetteers, Volume 2, Chapter 2).

Accurately assessing the demographic impact of the 1975 flood presents a significant challenge. Estimates have to hinge on official records, as, to our knowledge, no alternative data sources are currently known. Understandably, these records align with the official narrative concerning the demographic repercussions of the Qiwu-ba great flood. While the dependence on official sources constitutes a notable limitation in reconstructing data,

[5] This second edition was published four months before the China's National People's Congress approved the Three Gorges Project, the largest dam construction in the world, which had been questioned within the government and by academics and has led to great controversy (Human Rights Watch Organization 1995, Yi Si 1998, Shapiro 2001).

[6] Presumably, the eight members of the CPPCC had direct access to internal government files on the disaster of 1975 in Henan province, including the confidential Huai River Water Resources Committee report of March 1979 (Qiao et al. 1987).

we posit that a more nuanced understanding, deviating from the officially accepted figures, can be achieved through a methodologically sound approach.

This section delves into this prospect. Our analysis draws on demographic information sourced from official records such as the Department of Comprehensive Statistics of National Bureau of Statistics. (*Xin Zhongguo Wushi Nian Tongji Ziliao Xupian)*, Henan Province Statistical Yearbook (1985) (Henan Tongji Nianjian, 河南统计年鉴), Henan gazetteers (1985) (Henan Sheng Zhi, 河南省志), and Zhumadian prefecture gazetteers (1950-1985) (Zhumadian Diqu Zhi; 驻马店地区志). While, by using governmental sources, we may find discrepancy on the figures, the aim of this article is to give the most approximate estimations and emphasize that the current official figures provided by authorities markedly underestimate the demographic negative impact of the 1975 flood.

In the initial phase of our analysis, our objective is to discern whether there is evidence of the impact of the 1975 flood on the main population occurrences of Henan province, even within the constraints of using official records. Specifically, we anticipate observing a decline in the crude birth rate (CBR), at least in the year the flood took place, an increase in the crude death rate (CDR), and a deceleration of the rate of natural increase in population (RNIP) for 1975 and the immediate years. However, we acknowledge that other factors, alongside data quality, may interfere with this expected picture. A primary consideration is the fact that the disaster occurred in four out of the 18 prefectures forming the province of Henan, namely, south Xuchang, Luohe, east Nanyang, and Zhumadian prefectures (see Figure 2).[7] For this reason, data at the provincial level might somewhat obscure the dimensions of the disaster at first glance.

A second factor to consider is that the Qiwu-ba Flood coincided with the onset of the demographic transition in China, including the province of Henan. The classical demographic transition is characterized by a reduction in the crude death rate (CDR), followed by a declining trend in the crude birth rate (CBR), finally accompanied by a gradual deceleration of the rate of natural increase of the population (RNIP) (e.g., Livi Bacci 1999, Lee 2013).

[7] Another of the prefectures affected by the 1975 flood was Fuyan, in Anhui province.

A notable aspect of China's demographic transition was the implementation of systematic birth control policies and campaigns, contributing to a simultaneous reduction in fertility rates and mortality rates (e.g., Aird 1990, Peng 1991, Greenhalgh and Winckler 2005, Scharping 2005, White 2006, Mellors Rodriguez 2023). Although the one-child policy was formally applied in Henan province in 1980, policies controlling population growth initiated in 1971. These policies aimed to delay the age of marriage, subsequently postponing childbearing age and reducing the number of children per woman (Henan Gazetteers, Volume 9, Chapter 11). Such measures contributed to the demographic transition in Henan province since the early 1970s.

Given that these population control policies were in effect during the time of the Qiwu-ba Flood, the impact of this catastrophe on the CBR, CDR, and RNIP in 1975 and the immediate aftermath may be somewhat obscured. For example, while the years following demographic crises often witness a rebound in fertility rates (e.g. O'Grada 2007:23, Garnaut 2013), this might not be the case in mid-1970s Henan due to population control policies.

While all these factors interfere with the expected pattern, the period from 1975 to 1977 –encompassing the flood year and its aftermath– emerges as a distinct and noteworthy episode in the demographic history of the Henan province spanning from the onset of Mao Zedong's Cultural Revolution to the commencement of Deng Xiaoping's economic reforms. For this timeframe, we computed three-year annual averages in crude birth rates (CBR) and death rates (CDR). The results are presented in Table 1, Panel 1.

Crude birth rates, which had been steadily decreasing since the early 1970s, experienced a more pronounced drop, declining from 30.5 to 22.3 per thousand between the three-year periods of 1972-1974 and 1975-1977. Although the reduction in birth rates persisted into the early 1980s, the pace of decline slowed down. Similarly, crude death rates exhibited a declining trend, but this trend halted during the period 1975-1977, only to resume its decline between the late 1970s and the early 1980s. Finally, the rate of natural population increase, which had been gradually decelerating since the early 1970s, fell from 23.2 to 15.0 per thousand between 1972-74 and 1975-77, followed by a slightly lesser decline in subsequent years.

Table 1
Population trends in Henan Province, 1960s-1980s
(three-year annual averages)

Period	Population (000s)	Births (000s)	Deaths (000s)	CBR (‰)	CMR (‰)	RNIP (‰)
Panel 1: Henan Province						
1966-1968	55,193.3	1,896.2	455.0	34.4	8.2	26.1
1969-1971	60,270.0	2,205.5	445.8	36.6	7.4	29.2
1972-1974	65,026.7	1,985.6	474.4	30.5	7.3	23.2
1975-1977	68,556.7	1,526.0	499.8	22.3	7.3	15.0
1978-1980	71,803.3	1,517.7	453.8	21.1	6.3	14.8
1981-1983	75,023.3	1,466.8	466.2	19.6	6.2	13.3
Panel 2: Zhumadian Prefecture						
1966-1968	4,756.7	163.6	30.9	34.4	6.5	27.9
1969-1971	5,253.3	177.6	36.4	33.8	6.9	26.9
1972-1974	5,726.7	181.5	37.9	31.7	6.6	25.1
1975-1977	6,093.3	145.2	44.0	23.8	7.2	16.6
1978-1980	6,450.0	124.4	35.0	19.3	5.4	13.9
1981-1983	6,716.7	110.6	38.8	16.5	5.8	10.7

Sources: See text.

Not surprisingly, the distinctive nature of the 1975-1977 period becomes more evident when transitioning from provincial data to figures at the prefectural level. The prefecture of Zhumadian, at the epicentre of the Qiwu-ba great flood, is representative of the territories most negatively affected by the 1975 catastrophe. Table 1, Panel 2 provides evidence on CBR, CDR, and RNIP for this particular prefecture, and this evidence speaks for itself. Between 1972-74 and 1975-77, and in contrast to other periods, birth rates dropped intensively in Zhumadian, death rates increased, modifying the long-term downward trend, and the rate of natural population growth fell more than in other of the considered periods.[8]

What then was the demographic impact of the Qiwu-ba great flood? Did it lead to a demographic crisis? Did it result in population loss? Although the evidence presented in

[8] It is noteworthy to mention that family planning initiatives were implemented in Zhumadian prefecture since the early 1970s, and the promotion of one child per family had been in place since the mid-1970s. These factors might have influenced the data presented in Table 1, Panel 2. Zhumadian Gazetteers, Volume 1, Section 2: Population and Family Planning, Chapter 2: Family Planning.

Table 1 might suggest an affirmative answer, this evidence alone is inconclusive. For example, the data we presented did not distinguish between 'natural' or 'normal' and 'unnatural' or 'abnormal' births and deaths caused by an exogenous shock such as the 1975 flood —differentiating between those who would not have died or been born under normal conditions and those who experienced mortality or nonexistence due to the flood. This distinction is crucial. Demographic crises are primarily associated with an 'abnormal' short-term increase (decrease) in the number of deaths (births), and the methodological challenge lies in establishing what the 'natural' or 'normal' mortality (natality) level is.

Evidence of an excess of deaths and a shortage of births is also crucial for another reason: it enables the assessment of the extent of population loss. Population loss is the result of two factors: excessive mortality, referring to those who die in excess due to exceptional circumstances, and depressed fertility, related to a shortage of births due to a sudden external shock. By combining unnatural deaths and the shortage of births, we can better approach the calculation of population loss during a crisis period, providing a more comprehensive understanding of the actual impact of the 1975 flood on Henan's population (Yang 2012:394-96, 406-16; Fotheringham et al. 2013; McAlpin 1983:356; Cheng and Zhan 2018:174-75).

To identify 'unnatural' or 'abnormal' levels of mortality and natality, we employed a relatively simple yet effective, transparent, and well-established methodology. This approach was initially developed by Del Panta and Livi Bacci (1977) to recognize demographic crises from a historical perspective. They defined a demographic crisis in terms of mortality, considering it as “a short-term disturbance in the normal death rate" that "reduces the size of the cohort so that it would be unable to ensure its replacement, even after exhausting all its capacity for recovery”. According to their criteria, “a 50% increase in the number of deaths in a given year can no longer be offset by the recovery capacity of the generation born in the year of the crisis, but a fourfold increase in the number of deaths cannot even be offset by the recovery capacity of the fifteen generations which, at the time of the crisis, are less than fifteen years old” (Del Panta and Livi Bacci 1977: 405, 443). The former is defined as a small crisis, while the latter is considered a great crisis.

Recently, scholars dealing with mortality crises in modern Europe (e.g., Alfani 2013, Curtis 2016, Llopis and Sánchez 2016, Alfani and O'Grada 2017, Curtis and Dijkman 2019, Llopis et al. 2021) have adapted and applied Del Panta and Livi Bacci's methodology. Using data in absolute numbers of births and deaths, we calculated the moving truncated average of eleven years, considering only seven after discarding both the two maximum values and the two minimum values. For mortality, this exclusion allows for discarding the two highest values, which usually correspond to a period of crisis, and the two lowest values, which correspond either to years with exceptionally favourable conditions or to years of post-crisis conditions when a compensation effect may operate. For natality, the situation is the reverse.[9] Therefore, the seven-years moving truncated average values represent the development of 'normal' or 'natural' births and deaths for the period of study, considering the population and its nutritional, health, and climatic conditions. Values that deviate from the mean of the truncated average represent the absolute number of 'unnatural' or 'abnormal' births and deaths for that particular year. The sums of both values represent the total population loss.

Table 2
Total population loss during the Qiwu-ba Flood crisis years in the province of Henan

Year	Population	Births		Deaths		Population Loss	
	(000s)	Shortage (no)	Intensity (%)	Excess (no)	Intensity (%)	Absolute (no)	Relative (%)
Panel 1: Total Henan Province							
1975	67,580	-131,571	-7.7	47,314	10.1	-178,885	0.3
1976	68,520	-167,534	-10.2	17,710	3.7	-185,244	0.2
1977	69,570	-101,594	-6.4	14,826	3.1	-116,420	0.3
1975-77 (cum.)		-400,700	-24.3	79,849	16.9	480,549	0.7
1975-77 (avg.)		-133,567	-8.1	26,616	5.6	160,183	0.2
Panel 2: Zhumadian Prefecture							
1975	5,980	-589	-0.4	19,941	53.6	-20,530	0.3
1976	6,090	-14,657	-9.7	858	2.3	-15,515	0.3
1977	6,210	2,926	2.1	-1,156	-3.1	1,770	0.0
1975-77 (cum.)		-12,321	-7.9	19,643	52.8	37,815	0.6
1975-77 (avg.)		4,107	-2.8	6,548	17.5	12,606	0.2

Notes and sources: The negative sign indicates shortage of births and deaths as well as population loss, whereas the positive sign means excess of births and deaths, as well as population gains. See also text.

[9] Although some variations of Del Panta and Livi Bacci's methodology exclude the central value of the 11-year truncated moving average, we have not done so, as the central year is considered an 'abnormal' year, typically captured by excluding the two highest and lowest values.

In addition to absolute numbers of births and deaths, we have calculated the deviations from the truncated average in relative terms. Specifically, we estimated the percentage variation of the figures for the crisis year (*c*) relative to the 'normal' level (*n*), using the formula (((*n*/*c*) x 100) - 100). According to Del Panta and Livi Bacci (1977), percentages are useful as they allow classification of the intensity of different crises and provide information on the potential for cohort replacement.

The results of our estimates are presented in Table 2. In terms of mortality absolute figures, we have identified 80,000 'abnormal' deaths as a consequence of the Qiwu-ba Flood, representing nearly 54,000 additional fatalities compared to the figure reported by government sources today (26,000 deaths). This finding is significant because, while it remains lower than the highest number of 230,000 deaths reported in other sources, particularly by the National Committee of the Chinese People's Political Consultative Conference (CPPCC), it provides evidence that the government's reported death toll was underestimated, and the actual figure is more than three times the official amount. When we combine the unnatural excess deaths with the substantial shortage of births, the total population loss amounts to almost half a million people, roughly around 0.7 percent of Henan's population in the mid-1970s.

Furthermore, the intensity of the crisis appears substantial even though our results likely represent a conservative estimate of the demographic impact due to the use of official data. In the period 1975-1977, the cumulative number of deaths was 17 percent higher relative to the norm, and births were 24 percent lower, with peak over-mortality and under-natality of around 10 percent in 1975 and 1976, respectively. It is noteworthy that the shortage of births is lower in the year of the flood than in 1976. This is not surprising given that the flood occurred five months before the year ended, and the impact can be expected to have been more pronounced in the year immediately after the disaster.

Concerning mortality, the excess of deaths falls below the 50 percent threshold identified in the literature on early modern Europe as indicative of a mortality crisis (e.g., Del Panta and Livi Bacci 1977: 405, Alfani 2013: 417-18). However, this threshold is typically applied to periods characterized by recurrent mortality crises in smaller territorial areas, such as municipalities. In the case of larger territorial areas, the threshold identifying a mortality crisis tends to the lower. For example, Llopis et al. (2021: 21) applied a 15

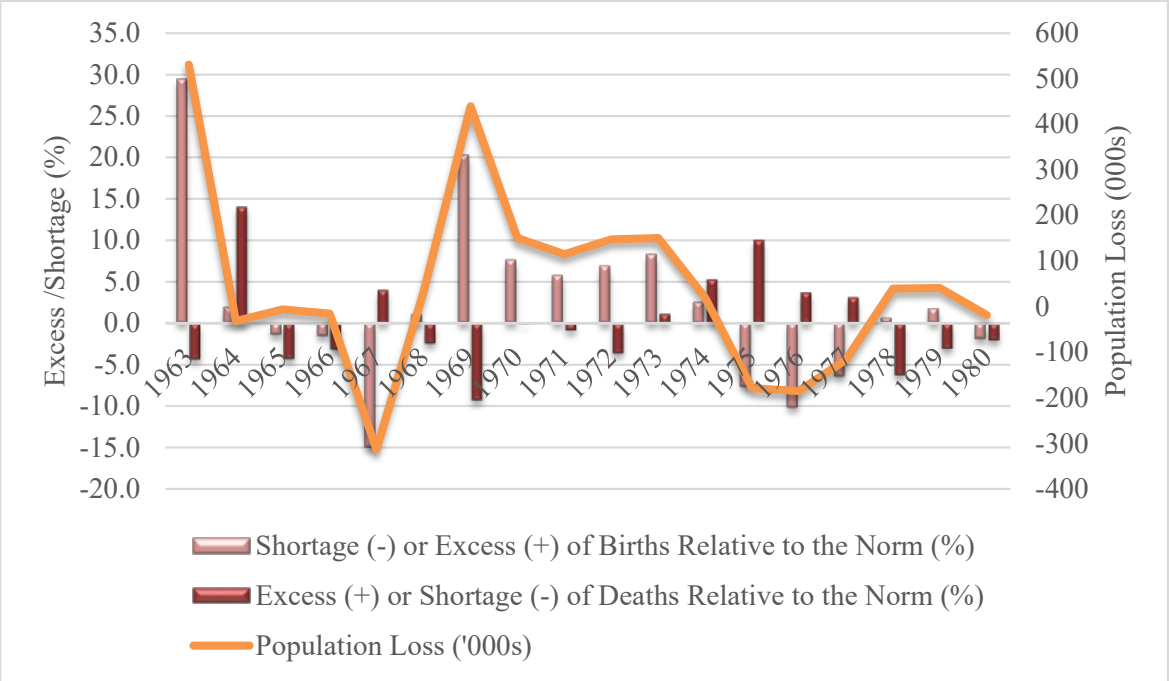
percent threshold to identify mortality crises in late-19th and 20th-century Spain at the regional level. We will delve into this issue later in this paper. For now, it is sufficient to note that as we move from the provincial to the prefectural level, we observe a much higher intensity in terms of excess deaths.

The data presented in Table 2, Panel 2, for the prefecture of Zhumadian, illustrates this phenomenon. Our estimates indicate that the cumulative percentage of excess deaths relative to 'normal' mortality exceeded 50 percent, with the peak occurring in 1975. These estimates also reveal that Zhumadian, representing less than one-tenth of the provincial population, concentrated around one-fourth of the excess mortality of Henan province, indicating a geographic concentration of death tolls in areas where the infrastructure collapsed. Interestingly, Table 2, Panel 2, also notes that in 1976, the number of deaths was below the norm, and the number of births surpassed normal levels. Local sources indicate that substantial aid was provided to Zhumadian until August 1976, with neighbouring prefectures affected by the flood sending considerable amounts of food and medical resources (Zhumadian Gazetteers, Volume 1, Section 12: “75.8” Flood Fighting, Chapter 5: Disaster Relief). These factors may help explain the patterns of under-mortality and over-natality observed in 1976 and subsequent years. Another contributing factor to the observed under-mortality and over-natality in 1976 could be the rebound mechanism that might have operated once the intensity of the crisis waned.

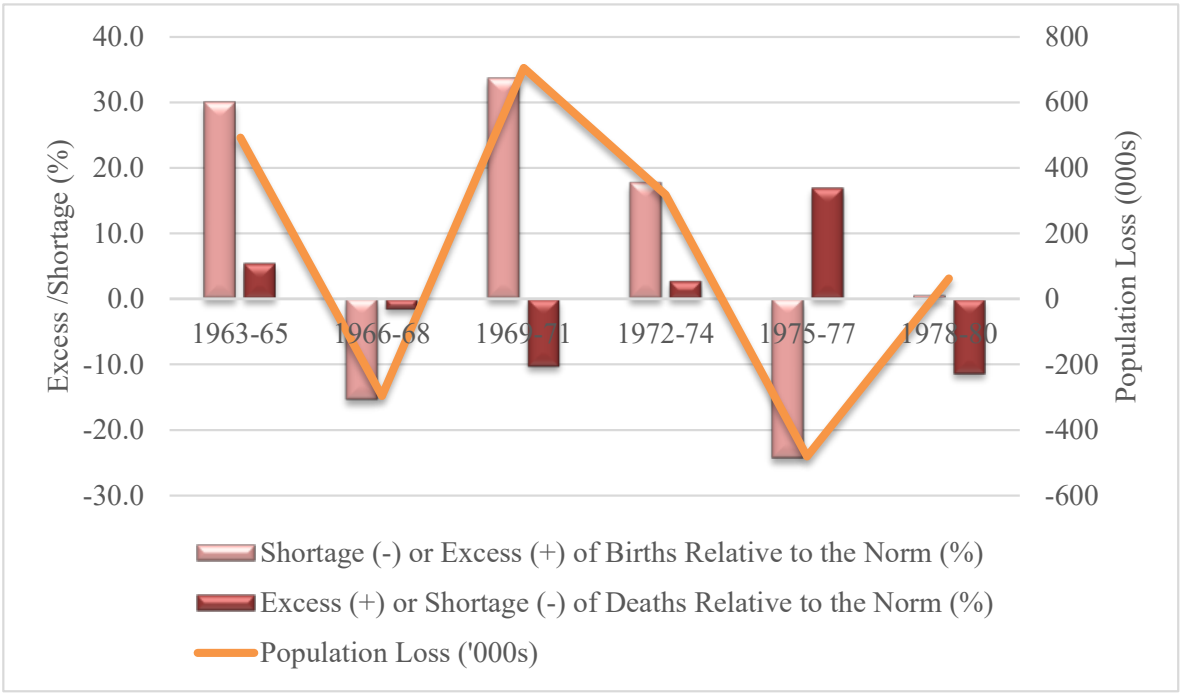
The significance of the Qiwu-ba Great Flood becomes more apparent when considered alongside other demographic crises in Mao’s China. The demographic crisis of 1975-77 was, by far, less severe than that caused by the Great Leap Forward (GLF) campaign from 1958 to 1961. Applying Del Panta and Livi Bacci's (1977) methodology, we found that over 80 percent of birth shortages, death excesses, and population losses in Mao’s Henan occurred during the GLF. Between 1959 and 1961, the total shortage of births exceeded 2.5 million, and ‘abnormal’ deaths reached 1.5 million, resulting in a total population loss of almost 3.5 million, consistent with Yang's estimation of 4.01 million from 1958 to 1961 (Yang 2012:411). These figures starkly contrast with those for the Qiwu-ba Great Flood Crisis, which, while substantial, are lower and less staggering than those of the Great Leap Forward catastrophe.

However, excluding the GLF, the Qiwu-ba great flood years emerge as the most significant demographic crisis in Henan province during Mao's China in terms of death excess and birth shortages combined. Figure 3a presents annual data, while Figure 3b indicates cumulative figures for periods of three years. These figures reveal that after the GLF, over the 1960s and 1970s, three periods of demographic crisis occurred. The first, in 1964, resulted from another flood, with approximately 78,000 'abnormal' deaths, primarily due to drowning, representing a deviation of nearly 15 percent from the norm. Despite this, our estimates indicate that no birth shortages relative to the norm resulted from this event (Zhumadian Gazetteers, Volume 2, Part 1: Natural Environment, Chapter 4: Climate).

Figure 3
Demographic crisis in Henan after the Great Leap Forward, 1960s-1970s
3a. Annual data



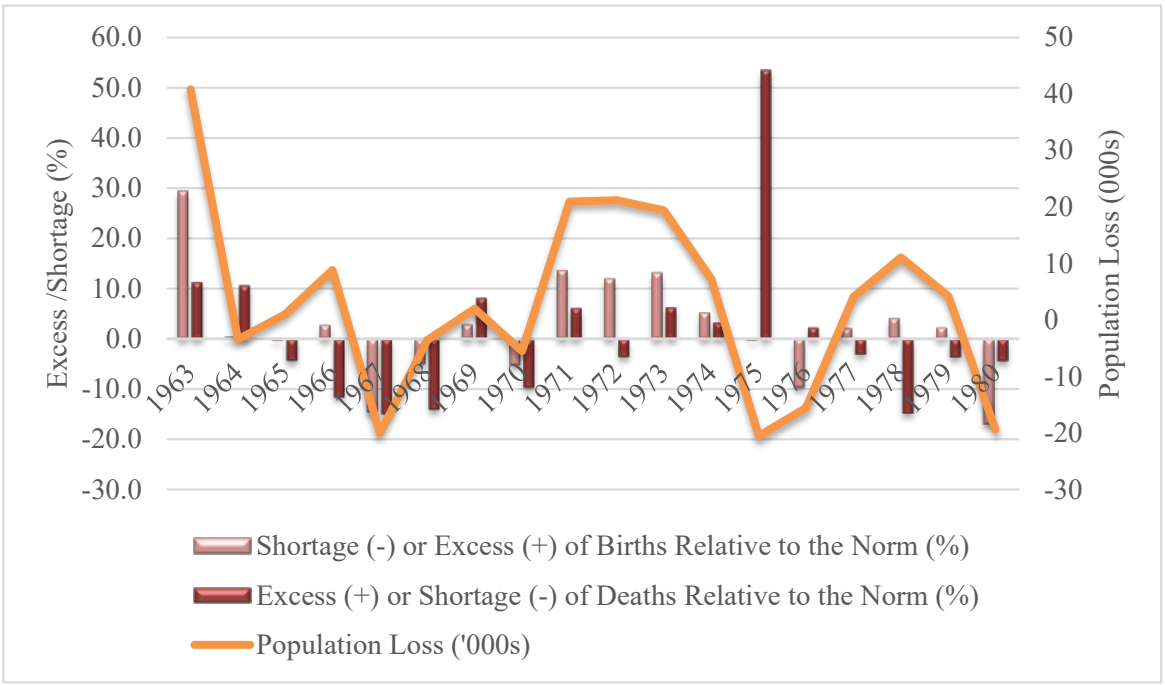
3b. Three-year cumulative data



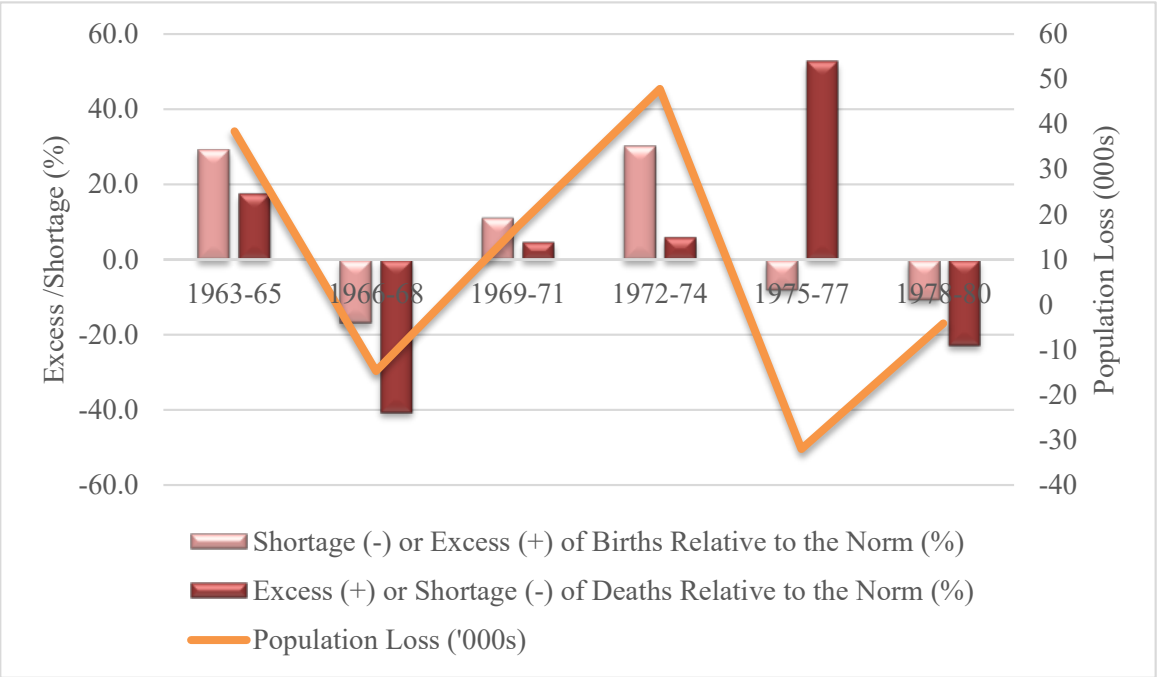
Notes and sources: See Table 1.

Figure 4
Demographic crisis in Zhumadian prefecture after the Great Leap Forward, 1960s-1970s

4a. Annual data



4b. Three-year cumulative data



Notes and sources: See Table 2.

The second crisis occurred in the period 1966-68, with its epicentre in 1967, corresponding to the initial stage of the Cultural Revolution. Although a minor flood occurred in 1968, we attribute this demographic decline mostly to the effects of political repression during the initial stage of the Cultural Revolution, which seem to be closely related to a rapid increase in the number of unborn (Zhumadian Gazetteers, Volume 2, Part 1: Natural Environment, Chapter 4: Climate). In 1966-68, the shortages of births increased by 15 percent relative to the norm. Over-mortality also increased in 1966 and 1968, though it remained below 5 percent relative to the norm. The final consequence of birth shortages and excess deaths was that population loss amounted to almost 300,000 people.

The third crisis was associated with the Qiwu-ba great flood. In the year the flood occurred, over-mortality was less intense than in 1964. Similarly, under-natality was also more moderate relative to 1967. However, and contrary to 1964 and 1967, the 1975 flood led to a combination of under-natality and over-mortality which, in addition, lasted for three years. When the period 1975-77 is considered together, the Qiwu-ba great flood crisis emerges as the most devastating crisis after the Great Leap Forward, as our estimates in terms of population loss make clear. Prefectural estimates, such as those for Zhumadian, support this conclusion (see Figure 4).

To conclude, our estimates of birth shortages, death excesses, and population loss in Mao's Henan reveal a greater severity in the Qiwu-ba Great Flood crisis than acknowledged in the official narrative. While our figures likely represent a conservative estimate, the excess mortality we calculated is three times higher than the number of deaths acknowledged by Chinese authorities. When considering this crisis in a broader context, the Qiwu-ba Great Flood crisis emerges as the most catastrophic event following the Great Leap Forward in Henan Province.

4. Agricultural modernisation and caloric intake on the eve of the Great Flood

There is no doubt that the flood's intensity led to fatalities from destruction and drowning immediately after the dams collapsed and the consequent development of the flood. However, deaths also occurred in the aftermath once the initial impact of the flood subsided. The following sections aim to address a crucial question that, in addition to being complex, intersects with issues of definition, causality, and identification, as discussed in Section 1: Was famine one of the causes of death in the disaster's aftermath?

We address these complex issues by investigating the presence of a famine crisis in 1975 Henan. Our approach involves three distinct strategies. First, in this section, we present evidence on trends in agrarian production as a preliminary step to understand the nutritional situation of the population before the Qiwu-ba flood. This is crucial in discussions about the presence of famine in Henan, as famines are more likely to occur in populations already facing undernourishment. Next, in section 5, we briefly examine qualitative evidence concerning the causes of disease in the Henan prefecture of Zhumadian. Finally, in section 6, we introduce indirect proxies using contemporary parameters to assess and confirm famine in catastrophic events.

Assessing the nutritional status of the population of Henan on the eve of the disaster requires acknowledging the process of agricultural modernization that occurred in Mao's China. This process accelerated after Mao called for regional grain self-sufficiency in the mid-1960s, leading peasants across China to focus on meeting physical grain targets (e.g., Lardy 1983, Kueh 1995; Shapiro 2001).

Table 3
The modernisation of agriculture in Henan, 1952-1974

Item	Units	1952	1957	1962	1966	1970	1974
Panel 1. Area and population							
Total sowed area	1,000 hectares	13,888	14,084	11,754	11,299	10,757	10,881
Agrarian population	1,000 people	41,330	44,200	45,710	49,580	55,700	61,280
Panel 2. Irrigation, fertilisation, and mechanisation (absolute numbers)							
Irrigated area	1,000 hectares	615	973	1,081	1,199	2,520[1]	3,027
Chemical fertilisers	1,000 kg	800	23,400	14,400	99,700	156,100	282,800
Machine power	1,000 Kw	220	3,300	36,800	67,620	189,600	564,920
Panel 3. Irrigation, fertilisation, and mechanisation (per 100 hectares of sowed area)							
Irrigated area	hectares	4	7	9	11	23	28
Chemical fertilisers	kg	6	166	123	882	1,451	2,599
Machine power	Kw	2	23	313	598	1,763	5,192
Panel 4. Irrigation, fertilisation, and mechanisation (per 1,000 agrarian population)							
Irrigated area	Hectares	15	22	24	24	45	49
Chemical fertilisers	Kg	19	529	315	2,011	2,803	4,615
Machine power	Kw	5	75	805	1,364	3,404	9,219

[1] 1971

Source: Authors' elaboration based on Department of Comprehensive Statistics of National Bureau of Statistics (1999), and Henan Tongji Nianjian 1985 [Henan Statistical 1985] 1986. Henan Province Agricultural Economic Data 1949-76 (1979).

Furthermore, since agriculture was the primary pillar of Henan's economy, the provincial government showed clear concern by placing significant emphasis on modernizing the sector. Therefore, following the implementation of the new economic model during the Great Leap Forward (1958-1962) and its subsequent negative consequences, Henan's government prioritized recovery through agricultural intensification. This involved initiatives such as irrigation, fertilizer and pesticide application, and mechanization, with the latter two being key components of the Green Revolution alongside improved seed varieties (e.g., Federico 2010 for an overview; Stone 1988, 1990, 1993; Schmalzer 2016; Eisenman 2017, 2018 for China).

To boost food production amidst recurring droughts and floods, the provincial government initially prioritized improving the irrigation system. This entailed optimizing water usage from the Yellow River and constructing hydraulic engineering projects, as noted in Section 2. Building on previous efforts, in the latter half of the 1960s and especially during the 1970s, numerous reservoirs were constructed and refurbished (Harrell 2023:107-08; Li 2007: 365-66, 369; Sun 2012:154-57), expanding the existing hydraulic infrastructure. This included new dams and reservoirs alongside existing ones,

such as the Banqiao Dam and the Shimantan Dam. The enhanced irrigation system was anticipated to positively impact agricultural productivity and yield, while also alleviating potable water shortages, thereby enhancing social welfare in the North China Plain, including major cities like Kaifeng and Zhengzhou (Harrel 2023:147-48; Sun 2012:156).

Furthermore, between 1966 and 1978, a drainage irrigation system was implemented, requiring the construction of electromechanical wells and other mechanized systems to pump water to the surface (Sun 2012:157-59). Thanks to these constructions, there was a concurrent steady rise in the water-irrigated area in the province: the irrigated area as a percentage of the total agricultural sown area increased from 9 percent in 1962 to 28 percent in 1974 (Table 3).

Finally, the construction of dams and reservoirs also facilitated the increase in electricity production and consumption. In Henan, a significant hydropower station was the Sanmenxia station, situated in the western part of the province (Figure 2b, in section 2), inaugurated in 1957 (Sun et al., 2019: 566; Ding, 2022). Consequently, between the early 1960s and the early 1970s, electricity consumption surged in Henan from less than two hundred million kWh to over one billion kWh (Department of Comprehensive Statistics of National Bureau of Statistics, 1999).

In addition to irrigation and water infrastructure, the application of chemical fertilizers and mechanical power were crucial factors in the agricultural modernization of the province. Concerning the former, chemical fertilizer usage in Henan was minimal before the mid-1960s, averaging below 2 kg per hectare. However, by the mid-1970s, it had increased to 26 kg per hectare, representing a more than 470% increase in just one decade (Table 3).

Table 4
Number of working animals in Henan province, 1950-1974
(annual averages)

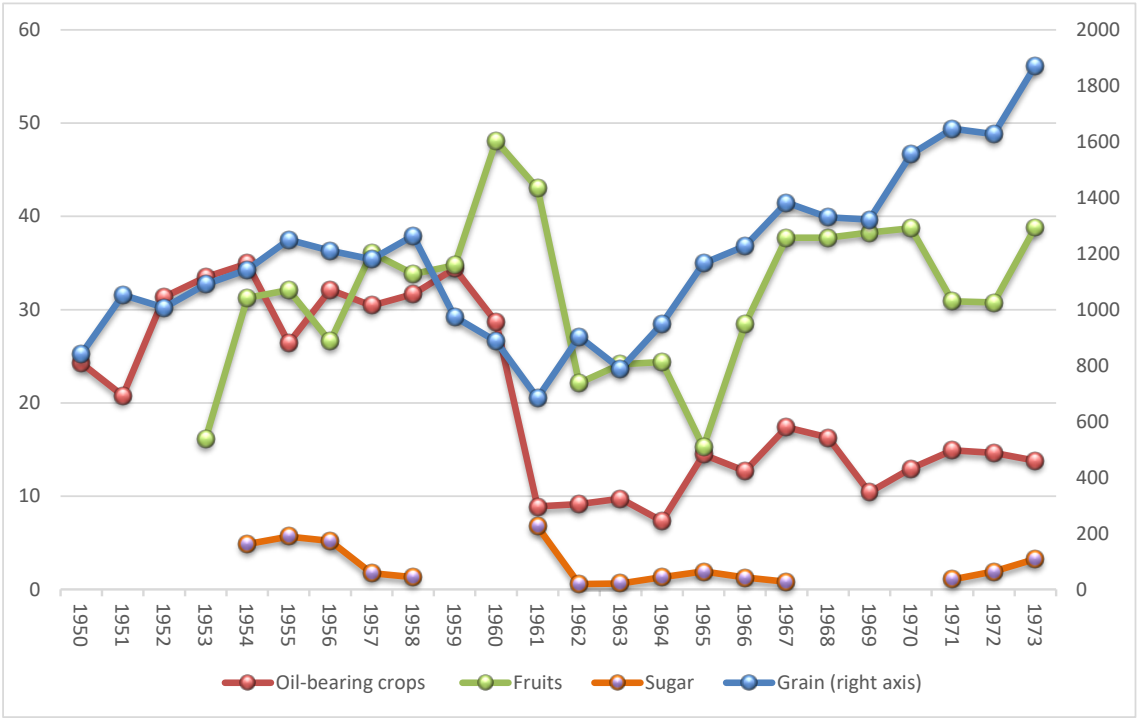
Period	Horses	Mules	Donkeys	Total	Horses	Mules	Donkeys	Total
	In 10,000 units				**In percentages**			
1949-52	11	14	178	204	5.6	6.6	87.8	100.0
1953-57	15	17	98	209	7.2	8.0	84.8	100.0
1958-62	15	15	76	128	11.6	11.8	76.6	100.0
1963-65	15	15	93	106	14.0	13.8	72.2	100.0
1966-70	23	19	98	134	16.8	14.3	69.0	100.0
1971-74	37	32	82	166	22.0	19.2	58.8	100.0
1975-78	47	45	117	174	26.8	26.0	47.2	100.0
1979-83	59	61	61	238	25.0	25.8	49.2	100.0

Source: Authors' elaboration based on (Department of Comprehensive Statistics of National Bureau of Statistics 1999; Henan Tongji Nianjian 1985 [Henan Statistical Yearbook 1985] 1986)

As far as mechanisation is concerned, during the Cultural Revolution, there was a significant introduction of new machinery into agriculture, marking a period of mechanisation. Mechanized field ploughing was rare in the 1950s and remained limited in the mid-1960s. However, from the early 1970s onwards, there was a gradual increase in the adoption of medium and large-sized tractors, as well as mechanized walking tractors. For instance, according to provincial statistical records, in 1960, there were 2,206 units of medium and large-sized tractors and 48 units of mechanized walking tractors. By 1974, these numbers had surged to over 23,000 units and around 22,000 units, respectively (Henan Province Economic and Planning Bureau 1979). Additionally, mechanisation for processing agricultural products like grain, cotton, and oil intensified during this period.

One might anticipate that this mechanisation process would lead to a reduction in working animals used in agriculture and rural transport. However, available data indicate that this was not the case before the mid-1970s (see Table 4). After overcoming the impact of the Great Leap Forward, the number of working animals actually increased, especially in the case of horses and mules.

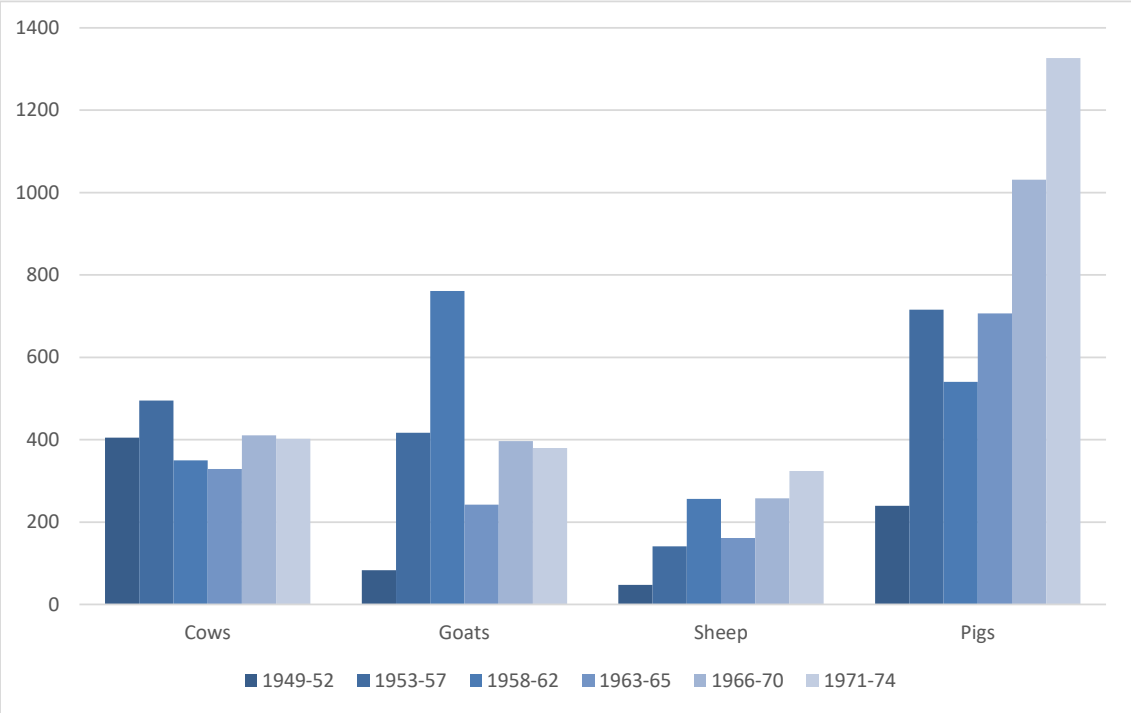
Figure 5
Annual agricultural output by selected crops, 1950-1974
(10.000 metric tons)



Source: Authors' elaboration based on (Department of Comprehensive Statistics of National Bureau of Statistics 1999; Henan Tongji Nianjian 1985 [Henan Statistical Yearbook 1985] 1986)

In terms of agricultural output, the modernization process yielded clear benefits, especially evident in grain production. Figure 5 illustrates long-term trends in agricultural output for selected crops in Henan province. While significant variation exists, the data suggest substantial growth in aggregate agricultural production since the mid-1960s, following the negative impact of the Great Leap Forward (1958-1962). Grain production notably doubled within a decade, surpassing the production levels achieved in the late 1950s by the early 1970s. However, this growth was not mirrored in other agricultural products; for example, in 1971-1974 the output of oil-bearing crops, fruits, and sugar remained below the 1953-1957 levels.

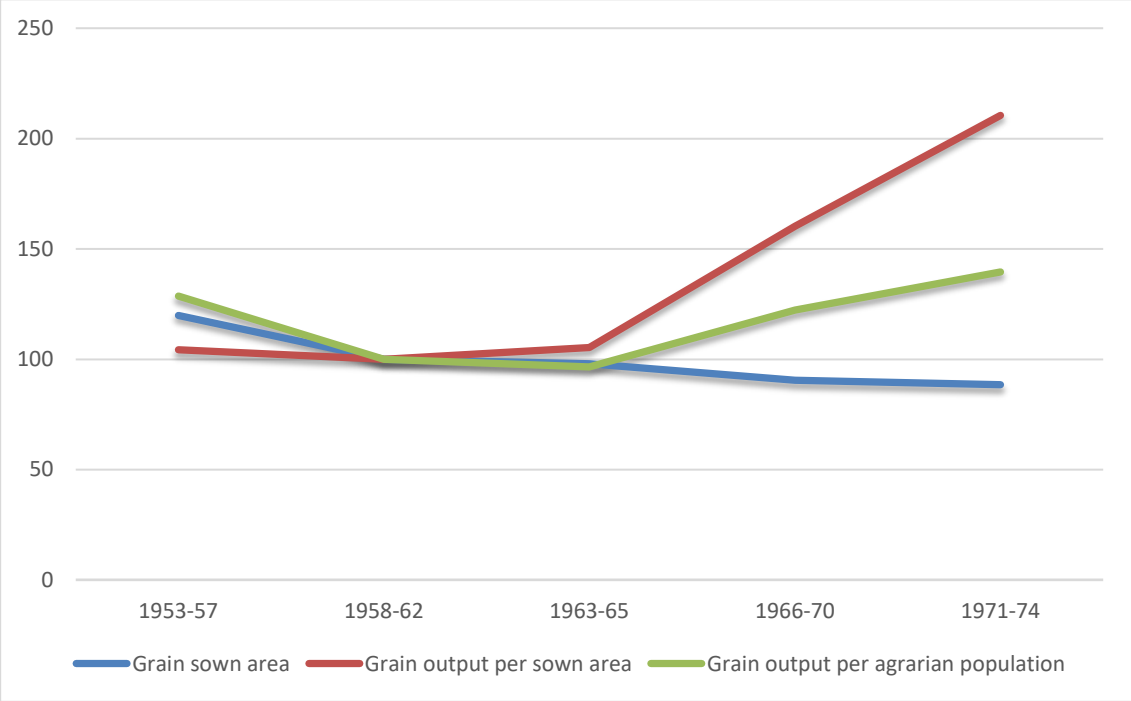
Figure 6
Number of livestock animals in Henan
(annual averages, in 10.000 units)



Notes: Prior to 1965, the available data for goats and sheep refer only to 1952, 1957, and 1962. For pigs, data correspond to the following years: 1952, 1957, 1960, 1962, 1965-1967, and 1970, and, therefore, the annual average for the period 1971-74 has been estimated by data interpolation.
Source: Authors' elaboration based on (Department of Comprehensive Statistics of National Bureau of Statistics 1999; Henan Tongji Nianjian 1985 [Henan Statistical Yearbook 1985] 1986)

Regarding livestock, evidence suggests a generally positive trend from the early 1960s onwards (Figure 6), although recovery patterns varied across species. Sheep populations increased by over 20 percent, while pig numbers more than doubled between the Great Leap Forward and the early 1970s. Aquatic animal production also experienced an upward trend from the mid-1960s to the mid-1970s. Conversely, goat populations declined, and although cow numbers rose, they remained lower in the early 1970s than in the mid-1950s.

Figure 7
Grain sown area, grain sown output per sown area, and grain output per agrarian population in Henan Province, 1950-1974
(Annual averages and index numbers 1958-1962=100)



Source: Authors' elaboration based on (Department of Comprehensive Statistics of National Bureau of Statistics 1999; Henan Tongji Nianjian 1985 [Henan Statistical Yearbook 1985] 1986)

Grain, as the most significant agricultural commodity, warrants further discussion. Long-term output growth underscores the positive impact of modernisation: while arable land and grain sown area decreased between 1963-1965 and 1971-1974, land yields doubled, and grain output per agrarian population, a rough proxy for labour productivity, multiplied by 1.5 (Figure 7). Improved agricultural methods, such as chemical fertilization, were instrumental in achieving grain intensification, without which production expansion would likely have been more modest.[10] Additionally, in the 1970s, Henan, along with other Chinese provinces, increasingly utilized improved seed grain varieties (Stone 1990: 56-57, 1993: 335).

[10] Walker (1977: 562-567) also discussed the role of product substitution as a source of increased land productivity. Wheat, a low-yielding crop, was replaced by high-yielding crops like rice, maize, and potatoes. According to Walker, "extending the areas of rice, maize, and potatoes has been important in accounting for a significant proportion of the rise in grain output" (Walker 1977: 567). However, by the late 1970s, wheat still accounted for 43.4 per cent of total grain output, more than 10 percentage points higher than in 1952-57 (Walker 1977: 563, Piazza 1983: 118). Another potential contributor to rising output per hectare of land was multiple cropping of grain land (Walker 1977:561-562).

The performance of grain output was also influenced by political and geo-strategic decisions that prioritized regional and national grain self-sufficiency (Ash 2006:968), thus constraining agricultural transformation in post-Great Leap Forward Maoist China. By the mid-1960s, the *san ziyi bao* (三自一包) program, established during the recovery years after the Great Leap Forward (1962-1965), was effectively abolished during the Cultural Revolution. This program had expanded private plots, facilitated rural trade fairs, and encouraged sideline activities managed privately. However, new policies during the Cultural Revolution reversed these measures, re-organising rural markets, reinstating price and production planning, and discouraging contracts between individual farm households and production teams. Consequently, peasants focused solely on meeting physical grain targets, neglecting economic diversification within the agricultural sector. Institutional changes, resembling the commune system, promoted large-scale labour mobilisation and equal distribution of farmland, resulting in demotivated peasants and inefficient farming practices, adversely affecting non-grain sectors (Kueh 1995:20-22).
While political and geo-strategic decisions shaped the impact of the Green Revolution, limiting non-grain production, the broader agricultural modernization process itself requires further qualification. Agricultural intensification led to mid and long-term challenges, including ecological soil degradation. In the mid-1960s, the use of nitrogenous fertilizers aimed at achieving high grain yields in the short term, overlooking long-term concerns such as nutrient requirements, soil types, and application techniques (Ash 2006; Kueh 1995). Hydraulic initiatives resulted in soil salinization and alkalinization, rendering vast areas unsuitable for agriculture and delaying agricultural recovery. For example, in Henan productive recovery relative to pre-Great Leap Forward levels occurred only in the latter half of the 1960s (Walker 1977: 560-561, Riskin 1991: 29). Furthermore, poorly executed state-driven hydraulic projects since the 1950s culminated in the catastrophic collapse of dams in Henan during the mid-1970s, and in enduring economic and environmental repercussions nationwide, including deforestation, erosion, and population displacements (Ding 2022).

How did agricultural modernization, with all its achievements and limitations, affect food and nutrient availability in Henan on the eve of the Qiwu-ba flood of 1975? Grain constituted the staple diet of the Chinese population, significantly influencing food consumption levels and the availability of energy and protein (Walker 1977: 582, Smil

1981: 72, Piazza 1983: 18, Riskin 1991: 25). In the case of Henan, earlier estimates indicated a stagnation, and at best, a modest growth of 0.3 percent per year in per capita grain production between the early 1950s and the mid-1970s, alongside consistently low levels of per capita grain output throughout this period (Walker 1977: 569-570). In the early 1970s, production of unhusked raw grain was estimated to be 263 kg per person (Walker 1977: 568). More recent data sourced from official statistics suggest slightly higher rates and increased per capita production levels, though they remain modest. Between 1950 and 1974, annual growth rates ranged between 0.5 and 0.6 percent, while for the period 1970-1974, output levels spanned from 272 to 296 kg of grain per person (raw weight), depending on whether the total provincial population or only the agricultural population is considered.[11]

Yet, in Maoist China, per capita grain output at the provincial level is only part of the equation. The other aspect concerns per capita grain availability and consumption, which necessitates consideration of imports and exports, including also provincial procurement rates—specifically, the grain delivery quotas mandated by the state, which must be deducted from regional grain production. Walker (1977: 574) estimated the amount of grain per head potentially available from output and net imports in Henan for 1970-1971, which amounted to 267 kg. Ash (2006: 998-999) approached to this issue by estimating the availability of grain per head of the agricultural population at the provincial level by subtracting procurements. His findings are illuminating. For 1971-75, in Henan province, it averaged 270.35 kg of raw weight per capita, indicating that per capita grain availability in this province was below the national average, with Henan ranking among the provinces with the lowest availability levels. If the entire provincial population were considered instead of just the agricultural population, per capita grain availability would be substantially lower, possibly around 250 kilograms per head.

Rural food self-sufficiency in China has been estimated at 275-300 kg of raw grain per head (Walker 1984: 3, also accepted by Ash 2006: 968, 972, and Ash, Du, King 2018: 319).[12] The available estimates indicate that by the early 1970s, per capita grain

[11] These figures refer to the period 1970-1975 and come from the Henan Tongji Nianjian 1985 [Henan Statistical Yearbook 1985]. For the period 1971-1975, grain output per total population and per agricultural population was 275 and 299 kg, the latter figure being the same as that provided by Ash (2006: 997).
[12] Walkers' estimated figures are set after deducing seed, feed, grain for industrial use, and waste (Walker 1984: 1).

availability in Henan may have hovered around the threshold of self-sufficiency, varying depending on the data and timeframe considered, but keeping a potentially fragile equilibrium.

Assessing trends and levels of grain per capita output and availability provides an initial perspective on food consumption. However, it is through personal caloric intake that we can more accurately evaluate the nutritional status of the population. (e.g., Smil 1981, Piazza 1983, 1986, Wang, Jensen, and Johnson, 1993). Piazza (1983, 1986) estimated per capita nutrient availability for the period 1978-79 at the provincial level, net of processing, waste, and all other non-human food end uses, but excluding interprovincial and international trade in food crops. While Piazza's calculations may underestimate true nutrient availability in some cases, they still shed light on the situation in Henan. According to Piazza's estimates, per capita daily energy availability in Henan province was 2,110.5 kcal, per capita daily protein availability amounted to 60.1 g, and per capita fat availability resulted in 37.1 g. These levels are modest compared to both the Chinese average and those achieved by other provinces. For example, on average, per capita energy in China amounted to 2,333.5 kcal in 1979-80 (Piazza 1983: 114-119).

To the best of our knowledge, comparative data on nutrient availability on the eve of the Great Flood in Henan have not been published. The only data available to us relies on grain consumption, excluding the consumption of other vegetables and animal food. This data was again estimated by Walker (1977: 575-576) from the gross grain output once deduced grain for seed, livestock feed, stocks, and losses of potatoes in storage. According to his estimates, during the period 1970-74, per capita daily caloric intake in Henan was 1,885 kcal, falling below the levels achieved in other provinces such as the northern neighbouring provinces of Hubei (2,063 kcal) and Shandong (1,979 kcal). However, it was likely similar to the Chinese average: calories derived from grain can be estimated at 1,891 kcal per capita per day in 1970-74 (Piazza 1983: 65-69). Nevertheless, in 1974, grain caloric intake was 1,733 kcal per day per person in Henan, compared to 1,973 kcal in mainland (Walker 1977: 576, Piazza 1983: 68). [13]

[13] Due to variations in estimation methods and underlying assumptions, it is essential to regard comparability between Henan and Chinese data as an approximation rather than an exact representation of true relative levels. Additionally, it is worth noting that in the period 1970-74, the Chinese average has been estimated to be around 2,014 kcal per capita per day if we only consider the intake of vegetable products, and 2,120 kcal if we consider all food intake (Piazza 1983: 26, 29). Alternative estimates on daily per capita

Table 5
Estimates of per capita output of food products in Henan in the 1970s
(annual averages, in kilograms and index numbers 1978-79=100)

Product	1978-1979 (kg)	1972-1974 (kg)	1978-1979 (Index)	1972-1974 (Index)
Grain	295.9	274.8	100	93
Peanuts	2.6	n/a	n/a	n/a
Edible Vegetable Oil	2.6	2.3	100	90
Sugar	0.1	0.1	100	81
Fruit	6.7	5.5	100	82
Pork, Beef and Mutton	7.2	7.7	100	107
Aquatic products	0.3	0.3	100	95

Notes and sources: Grain per capita production for 1978-79 and food per capita production for 1972-74 were calculated using data from the Department of Comprehensive Statistics of the National Bureau of Statistics (1999) and the Henan Statistical Yearbook, 1985 (1986). Per capita production of edible vegetable oil was derived through a backward projection of the 1978-79 estimates on the total output of edible vegetable oil, utilizing information on seed output of oil-bearing crops. A similar methodology, as explained in the main text, was employed for pork, beef, and mutton meat.

Unfortunately, evidence regarding caloric intake based on total food consumption for the early 1970s is unavailable. Yet, Walker (1977: 581-583) offered again an initial insight into this matter. Based on various reports, he estimated that the daily caloric requirement in China was 2,100 per person, although cautioned that this figure should be seen as a conservative standard. Moreover, he indicated that 83 percent of these calories came from grain, suggesting that grain needed to provide approximately "1,743 calories per head per day for the maintenance of bodily health and strength" (Walker 1977: 582). Considering this information, along with a daily caloric intake in Henan of 1,885 kcal per person in 1970-74 and 1,733 kcal per person in 1974, it is reasonable to conclude that Henan's population was in a vulnerable nutritional state on the eve of the Great Flood of 1975.

Table 5 aims to supplement Walker's analysis of caloric intake in Henan by incorporating additional and updated data. We calculated levels of per capita food output for specific products and compared them with figures from the 1978-79 period, during which available estimates suggest that per capita daily energy availability in Henan province was 2,110.5 kcal. (Piazza 1983: 114-119). Compared to the 1978-79 period, per capita

Chinese caloric intake in the early 1970s differentiating by nutrient sources correspond, among others, to those provided by the FAO (1977) for 1972-74 (2,073 kcal from grain and other vegetable nutrients, 2,278 kcal from all nutrients), by Smil (1981) for 1974 (1,902 kcal from grain and other vegetable nutrients, 2,045 kcal from all nutrients), and by Wang, Jensen, and Johnson (1993: 407) for 1970-74 (2,014 kcal from grain and other vegetable nutrients, 2,114 kcal from all nutrients). See also Jamison, Ho, and Trowbridge 1981: 8, and Piazza 1983: 29, for a summary and for the distinction between energy from vegetable and non-vegetable products.

grain production and per capita production of edible vegetable oil were 7 and 10 percent lower, respectively, during 1972-74. Moreover, per capita sugar and fruit production were between 17 and 18 percent lower, respectively, during the same period. Concerning animal products, our estimates indicate a more favourable situation in the early 1970s compared to the late 1970s: per capita production of aquatic products was 5 percent lower, but meat production was 7 percent higher. However, these data on animal food should be interpreted with caution. Per capita meat production has been derived from a backward projection of official meat output data for 1980-82 to 1972-74, utilizing official data on the number of pigs, sheep, and cows between these two periods (Piazza 1983: 115).

The conclusion drawn from the previous data seems clear: daily per capita caloric intake in Henan likely barely met 2,000-2,100 kcal on the eve of the Great Flood in 1975. As mentioned earlier, this is primarily because most calories depended on grain availability, which is unlikely to be balanced by potentially higher levels of per capita animal production. In late 1970s China, grains provided more than 88 percent of the total energy availability (Piazza 1983: 17), compared to 83 per cent in 1958 (Walker 1977: 582). With such a modest level of per capita caloric intake, the Henan population was at the limit of per capita energy requirements, estimated to have been 2,160 kcal per day in 1979 China (Jamison, Ho, and Trowbridge 1981: 10), a similar level to that of the early 1970s (Walker 1977: 281-282). It is noteworthy that guidelines from the World Food Programme and the United Nations High Commissioner for Refugees set 2,100 kcal/day/person as a minimum during a humanitarian crisis (United Nations High Commissioner for Refugees and World Food Programme 1997).

Protein availability in Henan during the early 1970s may have been slightly higher than in the late 1970s, reaching a daily per capita level of 60.1 g, slightly above the Chinese average. While this level surpasses the safe level of protein intake estimated for 1979 (between 35.4 and 41.3 g), it is important to note several limitations in drawing conclusions about dietary requirements (Jamison, Ho, and Trowbridge 1981: 12, Piazza 1983: 23-24). Firstly, comparing protein availability with safe levels of protein intake is an imperfect measure of average protein adequacy (Piazza 1983: 23). Secondly, our estimates on meat per capita production for the early 1970s would require further refinement, which prevents definitive conclusions. Thirdly, even if our estimates on per capita animal production are confirmed, most protein availability in China also stemmed

from grains, accounting for between 82 and 85 percent of total protein availability in the early 1970s (Piazza 1983: 18).

In summary, agricultural development during the Cultural Revolution did not result in exceptional food sufficiency among the rural population. On the contrary, the Qiwu-ba flood of 1975 occurred within a broader context of fragile per capita food intake, rendering survivors more vulnerable to potential famine conditions in the following months.

5. Diseases in the aftermath of the Qiwu-ba great flood: the case of Zhumadian

Caloric intake levels in the early 1970s suggest that in absence of external support, catastrophic events, such as the Great Flood of 1975, could rapidly evolve towards a famine. Excess mortality (Section 3) and pre-catastrophe food fragility (Section 4) might suggest that this was the case. However, deaths are not always directly caused by hunger and starvation but by infectious diseases, which interact with each other in a complex process. This puzzle was introduced at the beginning of section 4. As a preliminary strategy to explore the presence of a famine crisis in 1975 Henan, we now present fragmentary evidence on the causes of disease in the prefecture of Zhumadian, the epicentre of the catastrophe.

While categorizing diseases based on their causal connection with famine has its limitations, it is, nevertheless, important to recognize the impact of poor food conditions on morbidity and mortality. Infectious diseases are exacerbated by decreased physical energy output resulting from severe malnourishment (Centers for Disease Control 1992, Mokyr and Ó Gráda 1999, 2002, Yip 1997).

Table 6
Per capita output in selected food products in Zhumadian Prefecture, 1970-1979
(annual data and five-year annual averages)

Year/Period	Grain	Sesame	Pigs	Cows	Sheep
	(Kg per capita)		(Kg per 1,000 inhabitants)		
1970	307.3	5.1	218.5	86.6	46.1
1971	313.6	2.8	253.4	81.8	46.0
1972	271.6	2.7	256.0	79.1	51.0
1973	303.4	3.6	234.0	74.5	58.5
1974	285.8	4.0	223.3	73.2	78.4

1975	215.9	0.6	176.8	66.4	88.5
1976	354.8	3.3	226.8	62.8	103.4
1977	270.0	2.4	320.1	61.2	120.1
1978	285.9	4.3	259.2	60.2	153.1
1979	262.9	4.4	217.6	60.3	190.6
1970-1974	296.3	3.6	237.0	79.1	56.0
1975-1979	277.9	3.0	240.1	62.2	131.1

Notes and sources: Zhumadian Prefecture Gazetteers (1970-1979).

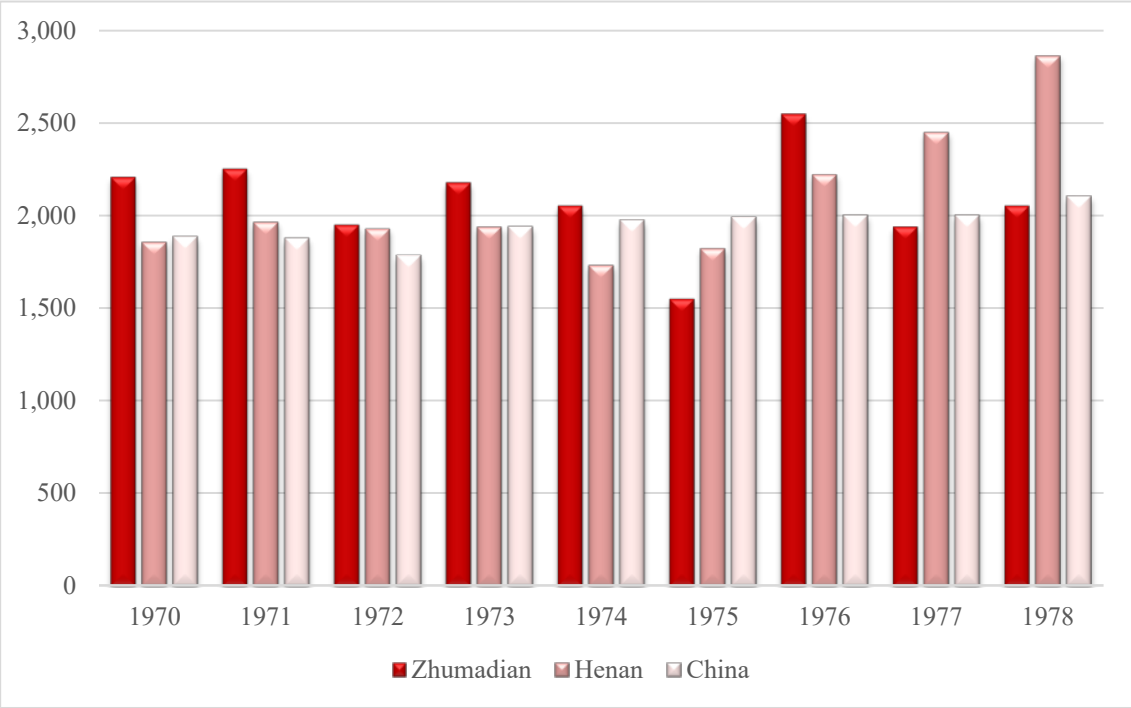
Because of the 1975 catastrophe, total and per capita agrarian output declined in Zhumadian Prefecture between 1974 and 1975. For example, the number of pigs and cows per 1,000 inhabitants, reduced by 21 and 9 per cent, respectively, and per capita grain and sesame production dropped by 24 per cent and by 85 per cent, respectively (Table 6). The flood also destroyed the granaries primarily located near the railroad (Zhumadian Gazetteers, Volume 1, Section 12, Chapter 4.2 Flood Damage). Alongside food decline, and although we cannot offer quantitative evidence, the supply of clean water also reduced due to the damage suffered by water provision infrastructures.

In addition, and due to the flood, 370,000 people remained trapped in water for weeks, and the rescue efforts continued until September 26th of that year. For almost 50 days, a significant portion of the population was inaccessible due to major damage to transport infrastructures, such as railroads and highways, rendering markets inaccessible to the affected population for almost two months.[14] As a response, food aid from other provinces was dispatched in response to the incident. However, in inaccessible areas, between 50 to 60 percent of the parachuted food supply ended up in water (Yi Si 1998).

Regarding caloric intake, the ultimate repercussion of the flood was that in 1975, Zhumadian's caloric supply had to depend mainly on the diminished prefectural domestic production. Consequently, the estimated daily per capita grain caloric intake in Zhumadian also underwent a significant reduction between 1974 and 1975 (Figure 8).

[14] The Guangzhou-Beijing railroad line going through the affected area was completely destroyed, 50 per cent of roads were and 20 per cent of constructed bridges were washed away. Also 90% of the total communication pole length disappeared, alienating over one hundred communes (**Zhumadian Gazetteers, Volume 1, Section 12, Chapter 4.2, Flood Damage**).

Figure 8
Estimated grain caloric intake in Zhumadian, Henan, and China 1970-1978
(kcal per person per day)

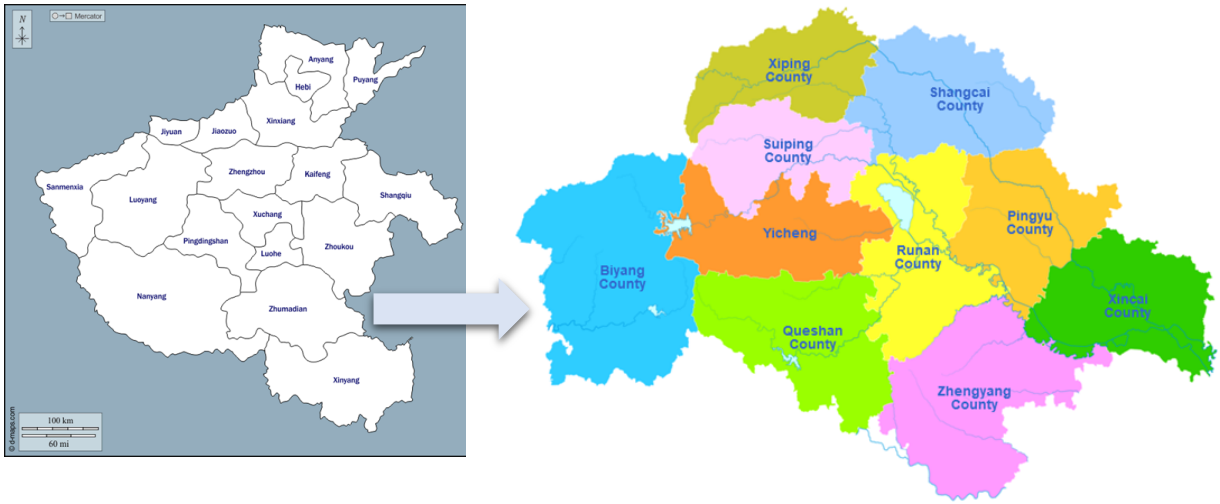


Notes and sources: Tables 5 and 6, Walker (1977) and Piazza (1983). For Zhumadian, grain caloric intake has been estimated by applying the coefficient of 7.2 kcal per kg of gross grain output derived from data for Henan in the period 1970-75. For Henan, data have been taken directly from Walker (1977: 568 and 576), while 1976-1978 data are forward projections using per capita gross output production in Henan. For China, figures have been elaborated from Piazza (1983: 65-69)

The decline in caloric intake in Zhumadian contrasts with what occurred in Henan province and mainland China. In these instances, daily per capita caloric intake derived from grain remained relatively stable between 1974 and 1975, although total per capita daily energy in China slightly increased (e.g. Piazza 1983: 26, Food and Agriculture Organization of the United Nations (FAO), https://www.fao.org/faostat/en/#data/FBSH, see Wang, Jensen, and Johnson 1993: 407, for an alternative view). Furthermore, as a consequence of Zhumadian's negative trend, by 1975, grain caloric intake in Henan and China relative to this prefecture had increased by 15 percent and 25 percent, respectively. Interestingly, estimates for the years preceding 1975 suggest that per capita caloric intake in Zhumadian might have slightly surpassed that of the province and the nation, although in 1974, caloric intake in Zhumadian (around 2,000 kcal per capita per day) was not far from the minimum required for bodily maintenance, namely 1,743 grain calories per person per day, rendering it vulnerable to any external shock, such as the Qiwu-ba flood.

This flood not only hindered the arrival of food, but also impeded the provision of adequate medical aid to the affected population. Moreover, prefectural gazetteers indicate that the flood had destroyed all hospitals in the affected areas (Zhumadian Gazetteers, Volume 1, Section 12, Chapter 5.4 Disease Prevention and Treatment). Compounding the situation, the National Bureau of Statistics document a clear decline in healthcare investment during the Cultural Revolution in the province, [15] which may have exacerbated constraints during the rescue period (Alvarez-Klee 2019, 2022).

Figure 9
Map of Zhumadian counties



Sources: For the map of Henan Prefectures, see Figure 2. For the map of Zhumadian counties, Wikipedia. The Free Encyclopedia. https://en.wikipedia.org/wiki/Zhumadian

Mortality and morbidity experienced a sharp increase. A survey conducted on August 13th, 1975, in Zhumadian indicated that four out of nine counties in this prefecture were afflicted by disease. Among a total population of 2,068,843 inhabitants in Xincai, Pingyu, Runan, and Suiping counties (which accounted for 34.6 percent of the prefecture's total population), 52.2 percent were affected by disease. Figure 9 illustrates the locations of these counties within Zhumadian prefecture. Table 7 outlines the types of diseases reported in selected counties. The data pertain to those accessible to rescue teams and, while imperfect and fragmentary, contribute new evidence to understanding the role of

[15] （**Department of Comprehensive Statistical Data… 1999, C16-27:538**）.

famine in the demographic crisis in Henan (Zhumadian Prefecture Gazetteers, Volume 1, Section12, Chapter 5.4.2, Types of Disease).

Table 7
Population affected by disease in Zhumadian Prefecture, 1975

Disease	Affected population	% of total population affected
Enteritis	336,285	33.6
Dysentery	162,494	16.2
Conjunctivitis	96,306	9.6
Trauma	94,205	9.4
Cold	92,442	9.2
Indigestion	38,770	3.9
Malaria	23,967	2.4
Fever	21,172	2.1
Oedema	1,130	0.1
Japanese Encephalitis	1,000	0.1
Typhoid	892	0.1
Other	132,301	13.2
TOTAL	**1,000,964**	**100.0**

Notes and sources: The files used in this study also indicate that 922,096 people were injured in the disaster. **Zhumadian Prefecture Gazetteers, Volume 1, Section12, Chapter 5.4.2, Types of Disease**.

Among the illnesses affecting flood-rescued populations, some cannot be directly linked to food shortage. This includes conjunctivitis, Japanese encephalitis, colds, and trauma, which collectively accounted for 28.3 percent of the sample. Another group of illnesses, comprising fever, typhus, and malaria (4.6 percent of the sample), may be attributed to declining hygiene standards resulting from the destruction of housing infrastructure. With three million houses washed away in Henan, hundreds of thousands were left without shelter, exposing them to microbial environments to which they lacked immunity areas (Zhumadian Gazetteers, Volume 1, Section 12, Chapter 5.4.1, Causes of Disease)

A third group of illnesses, such as enteritis, dysentery, indigestion, and oedema, is closely linked to famine conditions (Mokyr and Ó Gráda 1999: 23-27, 2002: 343-347; Malilay 1997: 315-321). Notably, 54 per cent of the population affected by disease suffered from gastrointestinal syndromes, which in the case of Zhumadian seems to have been partly associated with caloric decline in an already vulnerable caloric context, and, as a result, the consumption of deteriorated or contaminated food and water.

6. Searching for the last forgotten famine

In this section, we adopt the methodology developed by Devereux and Howe (2004), designed to identify famines, particularly to facilitate famine prevention and/or the response of governmental and non-governmental agencies to avert major catastrophes. These scholars addressed a fundamental concern: the challenge of establishing a universally agreed-upon definition of famine. Consequently, they devised a methodology to operationalize the concept of famine under contemporary parameters at the international level. They defined a set of indicators and threshold levels, structured as scales or categories, *empirical insights of the early warning and the coping strategies literatures, to the diagnosis and classification of actual cases, and thereby to introduce a degree of rigor to what has hitherto been left vague and intuitive*" (Devereux and Howe 2004: 360). Until relatively recently, this methodology has been utilized by, among others, the Integrated Food Security Phase Classification (IPC) Global Partners, comprising key international organizations focused on enhancing food security analysis and decision-making (IPC Global Partners 2012).[16]

Devereux and Howe (2004) advocated the use of two distinct scales for assessing famine conditions: the intensity scale and the magnitude scale. These scales are designed to complement each other. The intensity scale addresses the severity of a crisis at a specific point in time, utilizing mortality indicators and food security descriptors. The scale ranges from 0 to 5. For mortality indicators, a situation with a Crude Death Rate (CDR) below 0.2 deaths per 10,000 inhabitants per day, a cohesive social system, stable prices, and negligible adoption of coping strategies is assigned a value of 0. In contrast, situations with a crude mortality rate exceeding 15 deaths per 10,000 inhabitants per day, complete social breakdown, widespread mortality, and the affected population identifying food as the dominant problem at the onset of the crisis receive a value of 5. Values in between are as follows: 1 for food insecurity conditions, 2 for food crisis conditions, 3 for famine conditions, and 4 for severe famine conditions.

Second, the magnitude scale assesses the overall impact of the crisis on the affected population, focusing on mortality in absolute numbers. This scale consists of five levels, starting with level A, characterized as a minor famine, encompassing a death toll from 0 to 999 deaths. It progresses to level E, identified as a catastrophic famine, with an absolute

[16] See **IPC Global Partners (2021)** for the most recent update.

mortality of one million or more. The other defined levels include level B, representing a moderate famine with 1,000–9,999 deaths; level C, denoting a major famine with 10,000–99,999 deaths; and level D, indicating a great famine with 100,000–999,999 deaths. The authors do not differentiate based on period or the size of the affected territorial area in evaluating the demographic crisis.

We applied this methodology to determine if the Qiwu-ba great flood catastrophe could be classified as a famine crisis and, if so, to what extent. Among other evidence, this involved utilizing data on the number of deaths that occurred in the aftermath of the flood crisis—specifically, mortality not directly caused by the dams' collapse. Unfortunately, these data were either unavailable or unreliable, necessitating estimation. The resulting estimates are presented in Table 8.

Table 8
Estimates on the Qiwu-ba great flood immediate deaths and in the aftermath in the province of Henan and the prefecture of Zhumadian, 1975

Source of estimates	Year	Immediately	In the aftermath	Total
Henan province				
Our estimates (Lower-bound A)	1975	17,609	29,705	47,314
		(37.2%)	(62.8%)	(100.0%)
Our estimates (Lower-bound B)	1975	26,000	21,314	47,314
		(55.0%)	(45.0%)	(100.0%)
CPPCC estimates (Upper-bound)	1975 [?]	85,600	144,400	230,000
		(37.2%)	(62.8%)	(100.0%)
Officially accepted figures	1975	26,000	n.d.	n.d.
		(n.d.)	(n.d.)	(n.d.)
Zhumadian prefecture				
Our estimates (Lower bound A)	1975	7,421	12,519	19,941
		(37.2%)	(62.8%)	(100.0%)
Our estimates (Lower bound B)	1975	18,595	1,346	19,941
		(93.3%)	(6.7%)	(100.0%)
Our estimates (Upper bound)	1975	21,058	35,523	56,580
		(37.2%)	(62.8%)	(100.0%)
Gazetteers' data	1975	22,564	1,633	24,197
		(93.3%)	(6.7%)	(100.0%)

Notes and sources: See Henan Tongji Nianjian 1985 [Henan Statistical Yearbook 1985]; Zhumadian Prefecture Gazetteers, Table 2, and text.

The calculations are initially based on our lower-bound estimates of total excess mortality for Henan province and Zhumadian prefecture, as presented in Section 3. However, these estimates do not differentiate between victims killed by drowning and deaths occurring

in the disaster's aftermath. To determine aftermath mortality, we assumed that either the immediate or aftermath mortality followed the same distribution estimated by the National Committee of the Chinese People's Political Consultative Conference (CPPCC) in the 1980s. According to these Committee's data, 62.8 per cent of the total mortality caused by the Qiwu-ba great flood took place in the aftermath of the crisis, with the remaining deaths attributed to destruction and drowning after the dams' collapse (Referred to as Lower-bound A, Henan province, and Lower-bound A, Zhumadian province, respectively, in Tables 8 and 9).

While the National Committee of the CPPCC provides the highest casualty numbers known for Henan Province, making their figures upper-bound estimates, their distribution of mortality appears more reliable when compared to the data from the Zhumadian Prefecture Gazetteers. These chronicles indicate that only 6.7 per cent of casualties should be considered aftermath deaths, a notably low percentage even when considering the potentially higher direct impact of the dams' collapse in this prefecture compared to the whole province (Zhumadian Gazetteers, Volume 1, Section 12, Chapter 4.1.2 Casualties). A potential challenge to this low percentage of aftermath deaths is the fact that a substantial part of the flood-affected population in this prefecture remained isolated for weeks, as explained in Section 5. Consequently, we have estimated that 62.8 per cent of the total excess mortality in both Henan province and Zhumadian prefecture was aftermath mortality. However, for the latter, we have also produced estimates using the percentage provided by the Zhumadian Prefecture Chronicles as a lower-bound control (Referred to as Lower-bound B, Zhumadian province, in Tables 8 and 9).

As a supplementary check and to complete our calculations, we considered the following. For Henan province, we generated supplementary lower-bound estimates by assuming the government's official figure of 26,000 killed by drowning and subtracting it from our total excess deaths estimate in 1975 (47,314). This resulted in 21,314, the number of aftermath deaths representing 45 per cent of the total deaths (Referred to as Lower-bound B, Henan province, in Tables 8 and 9). For Zhumadian prefecture, in addition to lower-bound estimates, we also estimated upper-bound aftermath mortality figures by considering that one-quarter of the aftermath deaths reported by the National Committee of the CPPCC for the province of Henan corresponded to the prefecture of Zhumadian. This percentage is derived from our estimates of total excess mortality presented in

Section 2, indicating that 19,941 out of 47,314 Henan's excess mortality occurred in the prefecture of Zhumadian. We believe this percentage is likely more reliable than that obtained from officially accepted data, which claim that this prefecture accounted for 87 per cent of the total immediate provincial deaths directly caused by the dams' collapse. Although Zhumadian was the epicentre of the tragedy, a percentage close to 90 per cent seems too high, considering that the Henan prefectures of Xuchang, Luohe, Nanyang, alongside Fuyan prefecture in Anhui province, were also negatively affected by the flood (see Section 2) (Zhumadian Gazetteers, Volume 1, Section 12, Chapter 4).

In addition to aftermath mortality, the methodology proposed by Devereux and Howe (2004) also necessitates the estimation of daily aftermath mortality rates. To achieve this, we have considered various durations for the occurrence of mortality excess in 1975, as the specific time frame in which the excess death toll occurred is not precisely known. The minimum duration considered was 48 days, which was the period during which the affected population was trapped in water. Subsequently, we also examined a duration of 145 days, spanning from the first day after the disaster to the last day of the calendar year. Finally, we estimated durations of 365 and 548 days, respectively. The rationale for these maximum durations is to provide our upper-bound estimates the potential to encompass aftermath deaths associated with the 1975 great flood that might have occurred in 1976. As information is not always precise, we aim to account for the possibility that the figures from the National Committee of the Chinese People's Political Consultative Conference (CPPCC) also included post-1975 mortality figures.

A final step in the methodology proposed by Devereux and Howe (2004) for the identification and assessment of a famine crisis involves providing quantitative and qualitative information on livelihood features and food conditions. This encompasses, among other factors, the presence of specific diseases, the price of food, the market situation, and whether food is identified as a predominant problem. We have gathered as much information as possible from the Henan Province and Zhumadian Gazetteers, and a variety of other Chinese sources, primarily in the form of qualitative evidence.

Table 9
Intensity and magnitude scales of the Qiwu-ba great flood in the province of Henan, 1975

Panel 1: Intensity scale (dimension 1): Crude Death Rates (CDR) in Henan province and Zhumadian prefecture in the aftermath of the flood

	Population ('000s)	*Deaths (no)*	*Daily Crude Deaths Rates (CDR)*				
			‰ Total	*‰ 48 days*	*‰ 145 days*	*‰ 365 days*	*‰ 548 days*
Henan province							
Lower-bound (A)	67,580	29,705	4.40	0.07	0.02	---	---
(DH's designation)				(Food Security)	(Food Security)		
Lower-bound (B)	67,580	21,314	3.15	0.09	0.03	---	---
(DH's designation)				(Food Security)	(Food Security)		
Upper-bound	67,580	144,400	21.37	0.45	0.15	0.06	0.04
(DH's designation)				(Food Insecurity)	(Food Security)	(Food Security)	(Food Security)
Zhumadian prefecture							
Lower-bound (A)	5,980	12,506	20.94	0.44	0.14	---	---
(DH's designation)				(Food Insecurity)	(Food Security)		
Lower-bound (B)	5,980	1,346	2.25	0.05	0.02	---	---
(DH's designation)				(Food Security)	(Food Security)		
Upper-bound	5,980	60,690	101.77	2.12	0.70	0.28	0.19
(DH's designation)				(Famine)	(Food Crisis)	(Food Insecurity)	(Food Security)
Chronicles data	5,980	1,633	2.73	0.06	0.02	0.01	0.00
(DH's designation)				(Food Security)	(Food Security)	(Food Security)	(Food Security)

Panel 2: Intensity scale (dimension 2): Food descriptors in Zhumadian prefecture during and in the aftermath of the flood

Presence of oedema	*Social system situation*	*Market Situation*	*Coping strategies*	*Survival strategies*	*Food identified as a dominant problem*
• Yes	• Widespread of social breakdown	• Markets are inaccessible to affected population. • Destruction of granaries in affected areas. • Decline in food supply	• Food aid • Sell of livestock	• Eating rotten grain and dead animals	• Yes

Panel 3: Magnitude scale in Henan province and Zhumadian prefecture in the aftermath of the flood

Location category	*Total number of deaths*	*DH's magnitude classification*	*DH's designation*
Henan province			
Lower bound	29,674	Category C	Major famine
Upper bound	144,400	Category D	Great famine
Zhumadian prefecture			
Lower bound	12,506	Category C	Major famine
Upper bound	60.690	Category C	Major famine
Gazetteers' data	1,633	Category B	Moderate famine

Notes and sources: See Tables 2 and 3 and text.

Table 9 presents all the estimates and information gathered for Henan province and Zhumadian prefecture, meeting the criteria outlined in the methodology developed by Devereux and Howe (2004). Upon comprehensive consideration, the collective data suggests that the aftermath mortality resulting from the 1975 great flood aligns with the characteristics of a famine. This alignment is particularly evident in terms of magnitude, as the figures consistently fall within the famine thresholds defined by Devereux and Howe (2004), even when considering only lower bound estimates.

Regarding the intensity of the famine, estimates of daily Crude Death Rates (CDR) present an ambiguous picture, particularly dependent on the chosen figures. Upper-bound estimates suggest that in the initial month and a half after the dam collapse, residents of Zhumadian prefecture might have encountered food deprivation that could have escalated into famine. Similarly, these estimates imply that the hydrological catastrophe may have induced episodes of food insecurity at the provincial level. On the other hand, lower-bound estimates offer a less dramatic situation in terms of food security.

While daily CDR estimates for Zhumadian are inconclusive, food descriptors unequivocally indicate famine conditions. Ultimately, livelihood features serve as a determining factor for identifying famine. As emphasized by Devereux and Howe (2004: 364, 362), "*food crisis conditions may result in mortality, but the crisis associated with these deaths will not be classified as famine unless the intensity of conditions reaches* [level 3 in the scale, namely] *CMR >=1 but < 5/10,000/day, and/or wasting > =20% but < 40%, and/or prevalence of Oedema, and clear signs of social breakdown appear; markets begin to close or collapse; coping strategies are exhausted and survival strategies are adopted; affected population identify food as the dominant problem in the onset of the crisis*".

In the Qiwu-ba flood, all food-security descriptors are classified at level 3. This means that, despite the daily CDR classifying famine conditions only when considering the upper-bound mortality rate and the shortest time framework, we can categorize the crisis overall as famine when we combine all the available information. Firstly, based on the gazetteers in Zhumadian prefecture, we identified the presence of oedema, a fluid retention associated with suboptimal nutrient intake (See Section 5, Table 7).

Secondly, we also found evidence of widespread social breakdown. Many communes lost between 33% and 80% of their entire population; over one million people lost their homes; and weeks after the failure of the 62 dams, at least 370,000 people were still trapped in water (Zhumadian Gazetteers, Volume 1, Section 12, Chapter 4.1 Disaster; 4.1.3 Material Losses).

Thirdly, concerning food, we have identified adverse market conditions, the emergence of coping and survival strategies, and a major food problem in the period following the August 1975 dams' collapse. As detailed in Section 5, these adverse market conditions included the destruction of granaries, declines in production and food caloric value, and population isolation in a precarious situation.

Food aid functioned as a coping mechanism in such adverse conditions. As described, authorities parachuted food supplies to the isolated population, albeit with limited success. Similarly, livestock sales also served as coping mechanisms when food stress persisted, albeit 'trading short-term gain for potential long-term problems' (Devereux and Howe 2004: 358).[17] At the beginning of 1976, due to the ongoing difficulties in the disaster-affected areas, the population sold hogs in certain counties of the Zhumadian prefecture to obtain money (Henan Gazetteers, Volume 2, Chapter 2).

In addition to coping mechanisms, people also developed survival strategies. Following the 1975 great flood, and as suggested in Section 5, individuals resorted to consuming rotten grain and dead animals, and drinking contaminated water in the prefecture of Zhumadian (Zhumadian Gazetteers, Volume 1, Section 12, Chapter 5.4.1 Causes of Disease). These practices underscored the severity of the situation.

The qualitative information on adverse market conditions, the emergence of coping and survival strategies, provides compelling evidence of food as a pervasive problem. This information also complements the estimates and evidence on mortality. Taken together, it leads to the conclusion that the Qiwu-ba great flood resulted in a famine according to the methodology and categories established by Devereux and Howe (2004).

[17] For a recent review of the literature on livestock as a coping mechanism discussion, see, for example, Acosta, Nicolli, Karfakis (2021).

7. Conclusions

This article addressed the significant questions of whether there were evidence of demographic crises and famine episodes in Maoist China following the Great Leap Forward (GLF). This catastrophic event, which has been the subject of extensive research, headed towards relevant changes in the country for the following years, including demographic, agricultural, and natural disaster prevention and response policies (Li 2007: 365, Harrel 2023: 149). The implementation of these new strategies since the mid-1960s resulted in overall improvements in grain production, yet economic inefficiencies and ecological damage (Li 2007: 350-5, Harrel 2023: 140-4), leading to the general acceptance that famine episodes were successfully alleviated during the Cultural Revolution (Harrell 2023: 148).

However, the findings in this article suggest otherwise. Far from this common acceptance, it demonstrates that there were remarkable episodes of demographic crisis after the Great Leap forward and that the last famine in China might have taken place in the mid-1970s, only a few years previous to the new economic reforms. Indeed, by analysing the Qiwu-ba Flood, this research shows that episodes of famine were still present at the end of the Maoist period. While the famine that developed after the flood of 1975 was a very localized event, if measured in terms of demographic crisis, its severity was only second after the GLF crisis in Maoist Henan.

These are relevant finding that contributes to broader discussions, on the achievements of Mao's economic policies in terms of agricultural modernization and economic development and on demographic crises and famines, in general. First, they tend to temper the more optimistic assessments of Chinese agricultural transformation after the Great Leap Forward, while aligning with approaches that highlight the continued struggles of peasants in certain regions, who faced malnutrition and precarious subsistence levels during the late Maoist years. Although agricultural modernization in the province during the Cultural Revolution boosted grain production, food availability and caloric intake remained below national average, giving evidence of enduring malnourishment in the region. Second, they also urge for further research on demographic crises in the country from a provincial, prefectural, and county levels. It is apparent that great famines nationwide were eradicated after the GLF; yet this article puts into question

to whether localized and minor famine episodes were still persistent in underdeveloped areas where populations were still susceptible to exogenous shocks, supporting previous publications claiming that despite some economic and health advances during the Maoist period, wellbeing dimensions, such as nutritional intake, remained low among some populations. In addition, poor nutritional intake may have limited stronger and more consistent improvements in biological living standards (e.g., Morgan 1998; Schwekendiek and Baten 2019; Álvarez-Klee 2021a), while also contributing to episodes of hunger and malnutrition in some provinces.

The results of this research not only contribute to the literature on human development and wellbeing in Maoist China, but also to the literature on famine. While information and knowledge sometimes play a crucial role by constraining the state's capacity to act, we have not found evidence about its relevance as an explanation for the famine in 1970s Henan, although more research is needed. In fact, local and national governments made significant efforts to alleviate the situation, and the swift response from authorities and the community likely prevented a major crisis. However, the unprecedented scale of the flood, the underdeveloped technological infrastructure in the province, and the refusal to accept foreign aid hindered efforts to prevent what has now become a largely forgotten famine in Henan, China (Álvarez-Klee 2021b). This suggests that other factors also contributed to a famine which *a priori* might be thought to be solely associated with a 'natural' disaster.

In this vein, our findings also clearly illustrate the impact of famine on already vulnerable societies, in what can be interpreted as Mao's limited policies in terms of economic development. Based on secondary sources, the evidence we present indicate that Henan's population were already vulnerable to abnormal distress even before the Qiwu-ba Flood. The dam's breakdown only aggravated a situation of endemic poverty, undermining also Mao's hydrological policies.

Finally, by using a well-known and widely-used methodological approach to identify demographic crisis, our findings contribute to the debate on the consequences of the Qiwu-ba flood. Our estimates indicate at least 500,000-life loss between 1975 and 1977, including 80,000 unnatural deaths and 420,000 shortages of births. Such results threefold the official figure accepted by the Chinese government today, where cause of death has

been explained only by immediate drowning. While determining death causation in demographic crises tends to be challenging, in this article we have shown that the presence of intestinal and infectious diseases, low caloric intake, and the breakdown of the market, due to scarcity and full destruction of infrastructure, contributed to the increase of excess mortalities and postponing childbearing. Therefore, our results are more aligned to the figures given by the local government and the CPPCC in the 1970s and 1980s than the official figures accepted by the government since the 1990s.

The findings in this study must be seen in light of some limitations. First, the official Chinese sources must be put into scrutiny, especially when treating sensitive topics such as demographic crises and famine. While this is a general limitation in this type of research (Arrizabalaga 2002, Ravallion 1997, Maxwell and Hailey 2021, Ó Gráda 2011), additional burden must be put into historical records composed during the Maoist period (Frost and Li 2024, Alvarez-Klee 2019). Still, while this constraint may interfere with the real magnitude of the crisis as a consequence of the flood in 1975, our findings provide substantial records that offer evidence of demographic and subsistence crises through well-founded methodological strategies. The second limitation concerns the geographical scope of this research. While our findings are based on provincial and prefectural records, the delimitations of the flood were beyond Zhumadian prefecture and, even, Henan province. Zhumadian was the most affected area in terms of the flood, but also the prefecture receiving greater aid as a governmental response to the disaster. This puts into question to whether other prefectures ended up suffering more the consequences in terms of wellbeing. To address this issue, further research must be conducted for the other affected areas, both at a prefectural and county levels. Finally, previous studies show that it is extremely difficult to unravel death-causation in humanitarian crisis. This research has not been exempted from this challenge. However, by using a holistic approach and analyzing different aspects of wellbeing, both at the eve and the aftermath of the flood, we are able to pinpoint the diverse factors that contributed to the loss of half a million lives between 1975 and 1977 in Henan province. That is, not only drowning, but also endemic malnutrition, the spread of infectious and gastrointestinal diseases, and food entitlement decline.

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