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Source: *Harvard Journal of Asiatic Studies*, Vol. 69, No. 1 (Jun., 2009), pp. 1-36

Published by: Harvard-Yenching Institute

Stable URL: <https://www.jstor.org/stable/40213690>

Accessed: 11-11-2018 22:17 UTC

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Changing with the Yellow River: An Environmental History of Hebei, 1048–1128

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EARLY IN THE SIXTH LUNAR MONTH of 1048, the Yellow River broke its northern bank at a site called Shanghu 商胡, in modern Puyang 濮陽 of northern Henan Province, nearly four hundred kilometers west of the river's mouth.¹ Creating a breach more than seven hundred meters long, the river's torrent surged northward into central Hebei and exited into the North China Sea, in the vicinity of present Tianjin. Turning its back on the course that it had taken through northern Shandong during the previous millennium, the Yellow River opened up a "northern course" (*beiliu* 北流), which made its torturous way for nearly five hundred kilometers through central and northeastern Hebei. Everywhere it coursed in the two circuits that made up the Hebei region during the Northern Song—Hebei donglu and Hebei xilu—it caused havoc. This change in the river's direction introduced a half-century of further floods and shifts in the river's course, in particular in 1056, 1068, 1081, and 1099. It inflicted great long-term damage on the prefectures that,

I wish to thank the Chiang Ching-Kuo Foundation for International Scholarly Exchange for supporting the completion of this essay. I am indebted to Dr. Joseph McDermott, who gave his time unstintingly to make incisive comments on the drafts, and to Dr. Fan Hua, Dan Zhang, and David W. Goodrich for their help in drawing the maps in this essay.

¹ Li Tao 李燾, *Xu zizhitongjian changbian* 續資治通鑑長編 (Beijing: Zhonghua shuju, 1985) [hereafter XCB], 165.3965. The breach was reported to be 557 paces (*bu*, 步) wide; in the Tang-Song period 720 paces were equal to one kilometer.

for much of the first millennium of Chinese imperial history, had been the grain basket region of North China.

The human cost of these floods was enormous. In the wake of the 1048 flood, some one million people died in or fled from Hebei. In 1056, many of the three hundred thousand laborers engaged in Yellow River dike repairs were drowned by flood waters; and in 1068, up to a million or so died or were seriously injured. The Yellow River's destruction must have seriously obstructed Hebei's demographic growth just when south China was experiencing a dramatic increase in population. Understandably, during the Northern Song the number of registered households in Hebei dropped below its mid-Tang peak (falling from 1,408,530 in 754 to 1,232,649 in 1078 and 1,163,780 in 1102). Hebei's share of the empire's overall population also plummeted; in 754, it had 15.7 percent of the total number of households, but in 1078 it had just 7.44 percent, and in 1102 a mere 5.74 percent.² The area's economy suffered as well: before 1048, after some stability had been restored to the area with the 1005 peace treaty of Shanyuan 澶淵, Hebei's harvests had shown considerable improvement. After 1048, according to harvest records, Hebei was ravaged by famines and food shortages more frequently than ever before, and by 1127 it was consistently underproducing the grain needed to satisfy its own demand and was regularly dependent on imports of grain from other parts of the empire.

These disasters degraded Hebei's natural environment and agriculture, making them more vulnerable to future natural disasters. This essay will focus not on the great loss of life, but on the environmental impact of these floods between 1048 and 1128, when Song government officials deliberately redirected the Yellow River southward for military reasons.³ It will first discuss patterns in the occurrence and distribu-

² The statistics here are based on the collections of household and population in Liang Fangzhong 梁方仲, *Zhongguo lidai hukou, tiandi, tianfu tongji* 中國歷代戶口, 田地, 田賦統計 (Shanghai: Shanghai renmin chubanshe, 1980), pp. 86–95, 141–49, 152–60. See Ge Jianxiong 葛劍雄, ed., *Zhongguo renkou shi* 中國人口史, 6 vols. (Shanghai: Fudan daxue chubanshe, 2000–2002), 2:200–203, 3:432–35.

³ In 1128, in order to halt the Jurchen invasion, the Northern Song general Du Chong 杜充 broke the Yellow River's bank to provoke a flood. Thereby the river shifted southward into Henan and reached the Huai River drainage area. Christian Lamouroux has made a detailed study of the river's 1128 shift, in his "From the Yellow River to the Huai: New Representations of a River Network and the Hydraulic Crisis of 1128," in Mark Elvin and Liu Ts'ui-jung, eds., *Sediments of Time* (Cambridge: Cambridge University Press, 1998), pp. 545–84.

tion of these floods and their short-term and long-term impacts on Hebei's environment, in particular the problems of salinization, sandization, and deforestation. During this period, Hebei's local water bodies (rivers and lakes) were seriously disturbed by the Yellow River and their own drainage areas were subjected to repeated floods.

The environmental history of Hebei during the Song dynasty casts considerable light on the economic trends of this part of China during the Tang-Song transition period. On the basis of south China's experience during the period between 700 and 1200, historians have viewed Song economic development positively, using phrases like "medieval economic revolution."⁴ Without denying the validity of such claims for south China's progress, this paper will seek to explain the decline of Hebei's traditional agricultural economy in terms of natural disasters and their impact on the natural environment.

An examination of long-term issues like soil deterioration and deforestation will illuminate the roots of problems that plagued Hebei's environment from the eleventh century on. Some historians have claimed that the Song laid the basis for China's subsequent economic development, but the case of Hebei shows that its experience during the Northern Song marked a significant turning point in its environmental and economic history.

The Floods between 1048 and 1128

The Yellow River's entry into Hebei between 1048 and 1128 was significant in two respects. First, it disrupted the Hebei area on a much larger scale than in any previous historical period; second, it was the first time in two thousand years that it passed through the core prefectures of Hebei, becoming the principal cause of Hebei's flooding problems.

Surrounded by the Taihang Mountains 太行山 in the west, the Yan Mountains 燕山 in the north, and the North China Sea (Bohai 渤海) in the east, Hebei is a vast low-lying plain. Its terrain descends sharply from mountain slopes, which are several hundred meters above sea level, to hilly tablelands, which on average are about one hundred meters above sea level. Its central plain is on average no more than fifty meters above sea level, and its eastern coastal area is just several meters

⁴ Mark Elvin, *The Pattern of the Chinese Past* (London: Eyre Methuen, 1973).

high. Hebei's local rivers pour down from mountains onto the low, flat plain, and flow southeastward or northeastward to the lowest point in the vicinity of present Tianjin. In pre-imperial times, the Yellow River had once or twice flowed northward into this area and, as a part of the local river system, had entered the sea near Tianjin. Yet, according to scholars of the river's history, these early floods inflicted limited damage on Hebei's thinly populated plain.⁵

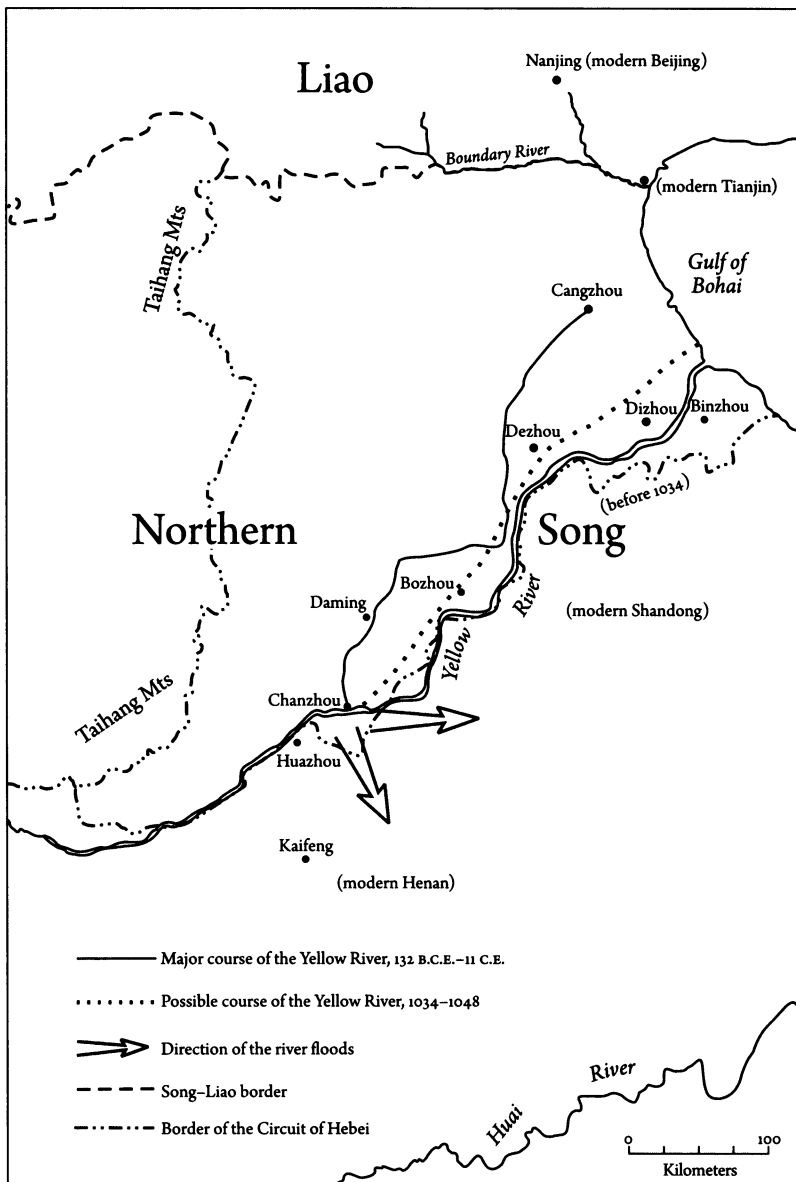
Between 132 B.C.E. and 11 C.E., the Yellow River's course shifted into Hebei. Even so, this change caused the Yellow River to flow through only a small portion of Hebei (see map 1). The river's flooding occasionally created problems in this area, but more frequently in Henan, to the south. For the next thousand years, after the river shifted to its more southern course between Hebei and Shandong provinces in 11 C.E., the river's floods were infrequent and rarely entered Hebei.⁶

From the late Tang dynasty on, harbingers of future trouble appeared. Throughout the ninth century, small-scale flooding occurred repeatedly in the area of Huazhou 滑州 (present-day Hua County) in northern Henan.⁷ In the tenth century the frequency of floods escalated: floods were recorded in forty separate years; the affected areas broadened to include territory of Hebei along the northern bank of the river, and some of these floods stretched some forty kilometers eastward from Huazhou to Chanzhou 澶州 (present-day Puyang). The flood waters themselves tended to flow in an easterly direction into

⁵ Various opinions about the lower course of the Yellow River in pre-imperial times and in the Han dynasty are reviewed and argued by Tan Qixiang 譚其驤 in his "Shanjing heshui xiayou jiqi zhiliu kao" 山經河水下流及其支流考 and "Xihan yiqian de Huanghe xiayou hedao" 西漢以前的黃河下游河道, in Tan Qixiang, ed., *Huanghe shi luncong* 黃河史論叢 (Shanghai: Fudan daxue chubanshe, 1986), pp. 1–16, 17–45.

⁶ Tan Qixiang, "Heyi Huanghe zai Donghan yihou hui chuxian yige changqi anliu de jumian" 何以黃河在東漢以後會出現一個長期安流的局面, in Tan Qixiang, *Huanghe shi luncong*, pp. 72–101.

⁷ In 813 half of the exterior wall of Huazhou city was engulfed by the Yellow River's flood. In order to tame the river, two military commanders on each side of the river cooperated to open a short river course to diverge the water. Yet, the river again inundated this area in 863. This time, the river's course here was moved westward, again by human force, four *li* away from Hua city; see Liu Xu 劉煦, *Jiu tangshu* 舊唐書 (Beijing: Zhonghua shuju, 1975), 15.448, 172.4482. In 896, when the river was going to break the city walls of Huazhou, Zhu Quanzhong (i.e., Zhu Wen 朱溫), subsequently Emperor Taizu of the Later Liang dynasty, breached the Yellow River's southern bank to create another river course to the south and so protect the city. An unexpected result of his action was to make the river's flood extend over "a thousand *li*," especially in the Henan area; see Xue Juzheng 薛居正, *Jiu wudai shi* 舊五代史 (Beijing: Zhonghua shuju, 1976), 1.17.



MAP 1 Hebei and the Yellow River's lower reaches before 1048. The geographic information for the maps in the present essay was extracted from Tan Qixiang, ed., *Zhongguo lishi ditu ji* 中國歷史地圖集 (Beijing: Zhongguo ditu chubanshe, 1991–1992), 2:26–27; 6:16–17.

Shandong or, on three occasions, southward into the Huai River.⁸ Thus, even though the first half of the eleventh century saw some disastrous flooding along the northern bank of the Yellow River (for instance, in 1015, when Dizhou 棣州's prefectural seat was inundated, and in 1034, when the river's course shifted a few kilometers northward near Chanzhou), the river's floods troubled Henan and Shandong far more seriously than they did Hebei.⁹

The precise, immediate reasons for the break in the banks at Shanghu are unclear. The Kaifeng court, which was worried mainly about defending its own vulnerability to a flood from the Yellow River, was caught off-guard and was slow to seek the cause of this flood. It was many days after the event that the court first sent inspectors out. The inspection, which left no records about its result, did not seek to investigate the causes of the flood but simply to "look at the Yellow River."¹⁰ A month or two later the court sent out another group of officials. The information we have on the flood from their brief report is mainly on the width of the river's rupture.¹¹

Although information about the flood of 1048 is scarce, two factors emerge as critical causes of the flood. First, the rising level of silt, sand, mud, and rocks on the downstream riverbed of the Yellow River was exceptionally high in the eleventh century, as Ouyang Xiu 歐陽修 (1007–1072) observed in southern Hebei in the 1040s and the first half of the 1050s.¹² The heavy silt might have pushed back the accumulated flow of water to a vulnerable point in the river's upstream defenses, at

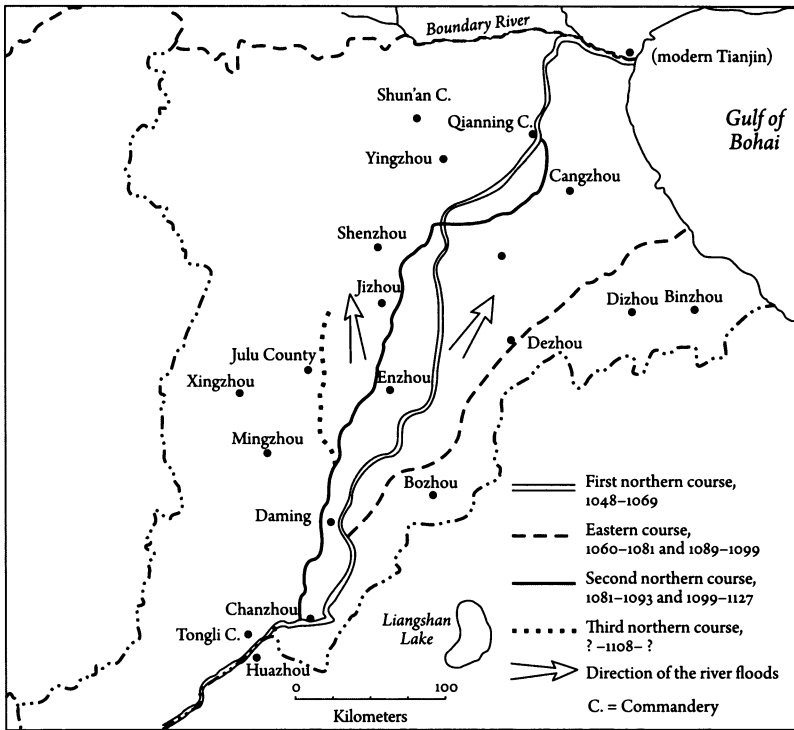
⁸ In 981, 954, and 983; see *Jiu wudai shi*, 28.391, Sima Guang 司馬光, *Zizhi tongjian* 資治通鑑 (Beijing: Guji chubanshe, 1956), 292.9519, and Tuo Tuo 脫脫, *Song shi* 宋史 (Beijing: Zhonghua shuju, 1977) [hereafter SS] 91.2259.

⁹ The river flooded near Dizhou in 1011, 1012, 1014, and 1015; see SS, 91.2260, and XCB, 77.1750, 83.1893, 84.1914. In 1034, the river burst at the site of Henglong 橫隴, so the surging water spread over Weizhou, Bozhou, and Dezhou; see XCB, 115.2691. According to Zou Yilin 鄒逸麟, a new river course created after this burst flowed slightly north of the previous course, along the border between Dizhou-Bingzhou and Cangzhou; see "Songdai Huanghe xiayou Henglong beiliu zhudao kao" 宋代黃河下游橫隴北流諸道考, in Tan Qixiang's *Huanghe shi luncong*, pp. 131–45.

¹⁰ SS, 91.2267.

¹¹ XCB, 165.3965.

¹² Ouyang Xiu, "Lun xiuhe di'erzhuang" 論修河第二狀, in *Ouyang wenzhong quanji* 歐陽文忠全集, *Sibu beiyao* edition, 109.3a–5b. Wu Chen 吳忱 and his co-researchers suggest that the Northern Song period was one of the periods with the highest silt content in the Yellow River; see Wu Chen et al., "Huanghe xiayou hedao bianqian de gu hedao zhengju ji hedao zhengzhi yanjiu" 黃河下游河道變遷的古河道證據及河道整治研究, *Lishi dili* 歷史地理 17 (2001): 1–28.



MAP 2 The Yellow River's courses and the direction of the floods in Hebei: 1048-1128

Shanghu. Second, at Shanghu and for much of the central plain stretch of land along the Yellow River the defenses on the northern bank were less well prepared against floods than those on the southern bank: most of the forty-five fascine dikes that had been established to protect the riverbanks before the 1040s were located on the river's southern side.¹³

By the end of 1048, 70 percent of the Yellow River's water reportedly had surged into this agricultural heartland of Hebei while roughly 30 percent remained in the old river course.¹⁴ Flowing northward through the fields of Daming 大名, Enzhou 恩州, Jizhou 冀州, and Yingzhou 瀛洲 in central Hebei, it then turned northeastward into Qianning Commandery 乾寧軍 and northern Cangzhou 滄州 before it converged with the Juma River 巨馬河 or the Boundary River 界河 along the Song frontier with the Liao and headed due east into the sea near Tianjin (see map 2).

¹³ SS, 91.2266.

¹⁴ XCB, 165.3977.

For the next eighty years the Yellow River followed first this and then other courses through Hebei. During these years, the area of southern and central Hebei suffered a much higher incidence of flooding—roughly once every two years—than it had either before 1048 or after 1128, when the river again shifted its course to Henan and Shandong. The severity of these floods also increased. Serious floods, some even exceeding the scale of the 1048 flood, struck southern and central Hebei in 1056, 1068, 1081, 1099, and 1108. These destructive floods occurred in such rapid succession that the residents of Hebei had insufficient time to recover their population, labor force, and other resources to prepare against the subsequent onslaughts of the Yellow River.

The flood-control efforts of the Song government were often inappropriate and only aggravated conditions in Hebei. In response to the problems created by the Yellow River, hydrotechnology developed greatly during the Northern Song period. Still, it was far from adequate to help the Song government and its technocrats in their fight against floods in the eleventh century. Indeed, it took the government eight years to agree on how to respond to the crisis brought on by the 1048 flood. In 1056, it sought to block the northern course and return its flow to a more eastward-flowing course in southeastern Hebei. But this solution—a new course close to and parallel to the pre-1048 course—proved too narrow to accommodate the river's high volume of water. The northern bank soon ruptured; the resulting flood in central and eastern Hebei destroyed much of the assembled construction materials and drowned a great number of the civilian and military laborers who had been brought in to complete these works.¹⁵

In the remaining seven decades of the Northern Song, further shifts in the course of the Yellow River would spread flood damage throughout much of the rest of Hebei. For virtually all these years the great portion of the river's water would continue to flow through central Hebei. Over time, the embankments occasionally broke unleashing floods onto adjoining prefectures in Hebei. This break from the north-

¹⁵ Zhao Bian 趙抃 (1008–1084), “Zouzhuang qi bachu Li Zhongchang Zhang Huai'en deng” 奏狀乞貶黜李仲昌張懷恩等, in *Qingxian ji* 清獻集, *Siku zhenben siji* edition, 8.11b. Exact numbers of laborers employed and killed in the 1056 project are unknown. According to Ouyang Xiu's memorial against this project which was presented to the court shortly before 1056, the laborers-to-be would have numbered three hundred thousand. See Ouyang Xiu, “Lun xiuhe diyizhuang” 論修河第一狀, in *Ouyang wenzhong quanji*, 108.5b–7b.

ern course first came about in 1060, with the formation of an “eastern course” (*dongliu* 東流), or the Second Branch River (*Ergu he* 二股河), which shifted some of the river’s flow eastward through southern Hebei in a more direct route to the sea (see map 2).¹⁶ Some officials, such as Sima Guang (1019–1086) and Hebei’s Commissioner of Transport Han Zhi 韓贇 (fl. 1030s–1070s), thought that the strategy of dividing the river’s water volume into two courses would reduce the chance of serious flooding in the late 1060s. Others, especially Wang Anshi 王安石 (1021–1086) and technocrat Cheng Fang 程昉 (fl. 1070s), soon realized that the redistribution of the Yellow River’s water brought its own dangers.¹⁷ The division into two river courses increased the likelihood that floods from the Yellow River would spread to other areas. Moreover, as modern scientific research has pointed out, the division into two courses reduced the speed of the currents and the water’s power to discharge the heavy silt; consequently silt deposits accumulated and settled on the two riverbeds.¹⁸ The two courses then posed an increasing flood threat to the surrounding prefectures in Hebei.

One result of the build-up of the siltage in the river’s northern course was the great flood of 1068. Bursting the banks in Enzhou and Jizhou, the flood waters spread northward, inundating Shenzhou 深州 and Yingzhou as well.¹⁹ Soon thereafter a series of intense earthquakes hit central, northern, and southern Hebei. Understandably Sima Guang judged the flood of 1068 to be more destructive than that of 1048.²⁰ Yet, he could not have been aware that long-term damage from the 1068

¹⁶ XCB, 192.4638.

¹⁷ The debates on the strategies of river management in the 1060s and 1070s are recorded in the “Hequ zhi,” SS, 91.2274–2278. Also see Christian Lamouroux’s analysis of these debates in “From the Yellow River to the Huai: New Representations of a River Network and the Hydraulic Crisis of 1128,” pp. 545–84.

¹⁸ Hydrologists have made great efforts to explore the relations between water and silt in the Yellow River’s current, which are largely published in the journals *Nisha yanjiu* 泥沙研究 and *Shuili xuebao* 水利學報. For example, Xu Jiongxin 許炯心, “Renlei huodong yingxiang xia de Huanghe xiayou hedao nishayiji hongguanqushi yanjiu” 人類活動影響下的黃河下游河道泥沙淤積宏觀趨勢研究, *Shuili xuebao* 2 (2004), online version: <http://www.chinawater.net.cn/Journal/slxh/>, accessed on September 30, 2007.

¹⁹ Huang Yizhou 黃以周, *Xu zizhi tongjian changbian shibu* 續資治通鑑長編拾補 (Beijing: Zhonghua shuju, 2004) [hereafter XCBSB], 3.102–5.

²⁰ According to Institute of Geophysics et al., *Zhongguo lishi dizhen tuji* 中國歷史地震圖集 (Beijing: Zhongguo ditu chubanshe, 1990), pp. 125–26, these earthquakes in central, northern, and southern Hebei are judged to be of an intensity of 8 degrees on the modern seismic scale. Sima Guang’s comment is in XCBSB, 3.xia.125.

flood would also affect most of central Hebei and even some parts of western Hebei.²¹ In central Hebei, its legacy was persistent waterlogging and repeated, small-scale river bursts, and floods at various places over the next nine years—just when the northern course's share of the river's water flow in Hebei was in decline.

A new northern course, flowing to the west of the previous northern course, emerged in 1081. In the next two or three decades, floods erupted all along this new route, particularly on its western side.²² In 1084 a severe rupture of the riverbanks at Daming led to the inundation of the prefectural seat, and in both the city and the countryside hundreds of thousands of people cried for relief.²³ Then, in 1086, 1087, 1093–1094, and 1099, either siltage deposits or heavy rainfall in the summer produced flooding in the area to the west of the new northern course. By the close of the eleventh century, this new northern course had absorbed all of the Yellow River's water, because the eastern course had dried up. One consequence of the river's tendency to flow westward was that, when the Yellow River broke its western bank along this new northern course in 1108, it formed a branch stream that penetrated farther west into Hebei than any water of the Yellow River had done before.²⁴ Flowing into Dalu Lake 大陸澤, its nearby marshes,

²¹ Even people in western Hebei, where the river's flood did not directly reach, were motivated to migrate out of Hebei and resettled permanently in Henan or farther south, very likely because they worried about potential floods from the Yellow River. See XCBSB, 3xia.141. Also see Fu Bi (1004–1083), “Shang Shenzong lun Hebei liumin dao Jingxi qi fenji tiantu” 上神宗論河北流民到京西乞分給田土, in *Song mingchen zouyi* 宋名臣奏議, *Siku quanshu zhenben erji* edition, 106.12a–14b. As Han Qi and Fu Bi observed, emigrants came either from the northern frontier (*yanbian* 沿邊), central Hebei (*cibian* 次邊, next to the frontier), or the southern part (*jinli* 近裏)—a geographical stratification determined by their distance from the political center in Kaifeng. Some of them came from western Hebei which, due to its high elevation, was apparently not directly affected by the Yellow River's floods. These families brought along the old and the young, drove large carts, and carried all their possessions, thus implying a permanent move from Hebei. Although Song officials held different opinions about these emigrants, Fu Bi insisted that most of them were of poor, low-ranking families who were forced to emigrate by the Yellow River's disasters in Hebei. But Zheng Xie 鄭獬 (1023–1072) argued that many emigrants were not poor or harmed by the river's floods but instead were lured there by local officials of Tangzhou 唐州, in western Henan, who wished to enlarge colonies and thereby win grants and awards from the central government; see “Lun Hebei liumin zhazi” 論河北流民割子, in *Yunxi ji* 鄧溪集, *Siku quanshu zhenben sanji* edition, 13.8b–11b.

²² SS, 92.2286.

²³ SS, 92.2287.

²⁴ Wu Chen et al., “Huanghe xiayou hedao bianqiao de guhedao zhengju ji hedao zhengzhi yanjiu,” *Lishi dili* 17 (2001): 1–28.

and some tributaries of the western Hebei river system, this 1108 flood caused considerable damage in Mingzhou 洺州 and Xingzhou 邢州 in western Hebei. More than six meters of mud buried the county seat of Julu 巨鹿, in Xingzhou (see map 2). According to archaeological excavation work done in 1919, Julu appears to have been totally unprepared for the flood: next to tables laid for a feast, skeletons were found.²⁵

This brief summary of the frequency and severity of the Yellow River's floods does little to suggest the despair and frustration expressed by Ren Boyu 任伯雨 (1047–1119?). Writing about this unpredicted turn of events in Hebei, he makes clear the enormous toll of these floods on Hebei's population and production:

Hebei had floods in the past that drove its people to emigrate. In Yongjing Commandery and to its north, 30 to 40 percent of the residents survived. In northern Cangzhou, 10 to 20 percent survived. The situation in other prefectures is generally the same. So desolated are these districts that for the span of a thousand *li* there was little sign of human activities. Despite a good harvest last year [Ren is here perhaps referring to the entire country], few people farmed [in Hebei], and the [actual] harvested crops were less than 10 or 20 percent [of what its lands should have yielded].²⁶

Environmental Changes in the River Disasters

The frequent floods and the shifts of the Yellow River's course that took place between 1048 and 1128 had a great impact on three key aspects of Hebei's natural environment: its water, its vegetation, and its soil. An examination of each of these will in turn show how the Yellow River intersected and merged with various rivers and lakes, thus greatly disrupting Hebei's network of local waterways. First, wherever it flowed, the Yellow River deposited heavy silt that blocked up many local rivers. Consequently some waterways were forced to change their courses and others dried up altogether. Second, to tame and repair the ruptures of

²⁵ SS, 93.2312. See Shi Nianhai 史念海, *Heshan ji* 河山集 (Beijing: Sanlian shudian, 1981), 2:64; Zou Yilin, "Huanghe xiayou hedao bianqian jiqi yingxiang gaishu" 黄河下游河道變遷及其影響概述, in Tan Qixiang, *Huanghe shi luncong*, pp. 221–42.

²⁶ Ren Boyu, "Shang Huizong lun Yueyun wei Maobi" 上徽宗論月暈團扇, in *Song mingchen zouyi*, 45.3a–8b.

the Yellow River and the local rivers, Hebei residents cut down trees, branches, bushes, and grass to produce fascine embankments. Therefore, although they to some extent achieved their own physical security against the floods, they ended up deforesting their province. Third, soil conditions deteriorated: decades of excessive flooding and water-logging salinized the soil in central Hebei, and the heavy deposits of the river's silt (mainly sand, mud, and debris of stone and other materials) and the depletion of vegetation cover exposed a considerable portion of Hebei's land to the air. Erosion followed, making sandization the severe environmental problem that would characterize Hebei from the eleventh century up to modern times.

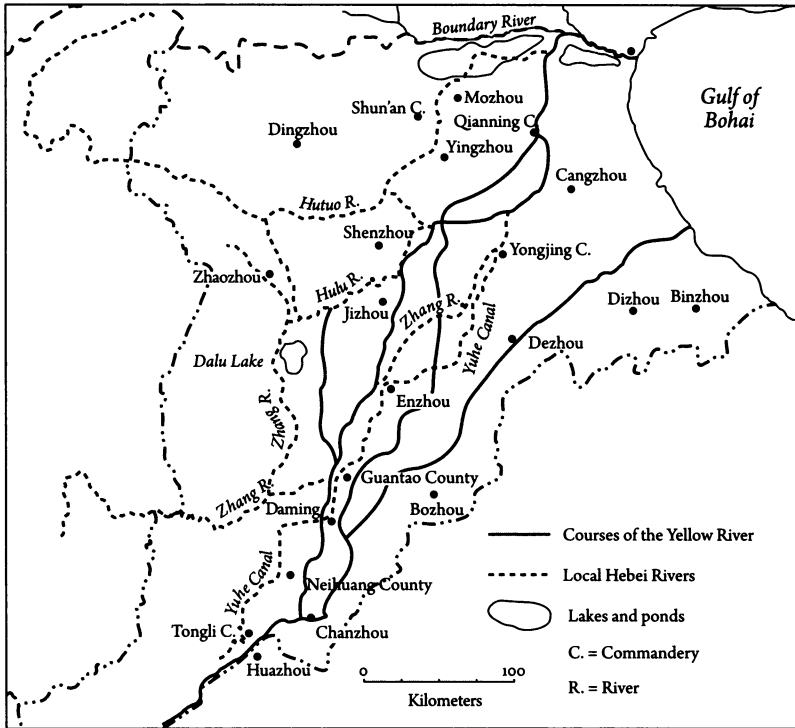
The Merger of the Yellow River and Hebei's Rivers

A remarkable result of its shifting course was that the Yellow River merged with Hebei's local river system, including the Hutuo 滹沱, Hulu 葫蘆, and Zhang 漳 Rivers, the Yuhe 御河 Canal, and their tributaries (see map 3). Originating in the Taihang Mountains in western Hebei, these rivers flowed eastward or northeastward to the low-lying Tianjin area along the Bohai Gulf. When the Yellow River cut through central Hebei in 1048, its northern course appropriated some sections of the Yuhe Canal and the Zhang River and intersected with other local rivers, thus initiating its merger with these water systems. After the Yellow River shifted its course in 1081, 1099, and 1108, it directly absorbed water from the Zhang, Hulu, and Hutuo rivers, whereupon the merger became more evident.²⁷

The merger of these rivers had profound and negative consequences. The most immediate one was that the water volume in local rivers increased dramatically. Almost simultaneously or soon afterward, these rivers overflowed and ruptured their banks. Thus ended the long period of stability in these waterways.²⁸ Over the long run, their flooding waters then produced a series of water catchments in the tableland prefectures of Shenzhou and Zhaozhou 趙州 in the west and

²⁷ According to the "Hequ zhi" 河渠志 (SS, 95.2351, 95.2364), after the Yellow River's 1048 shift, these rivers' lower reaches "entered the Great River [i.e., the Yellow River]." As a 1081 field survey by officials also reported, the Yellow River "converged with the Yuhe Canal and the Hulu and Hutuo rivers"; XCB, 313.7588. Such information suggests that these local rivers' courses were taken over by the northern current of the Yellow River.

²⁸ SS, 95.2352; XCB, 333.8015, 323.7790, 324.7810.



MAP 3 Hebei's water systems: 1048–1128

in the low-elevated plain prefectures of Yingzhou and Mozhou 莫州. A swampy landscape was thus formed.²⁹

Even worse was a long-term consequence: the deposit of the Yellow River's heavy silt in these local rivers. Considering the eleventh century as one of the periods with the heaviest load of silt in the Yellow River's history, modern historical researchers have—perhaps with a degree of exaggeration—estimated that, during this century, the downstream deposit of the Yellow River's silt pushed both its river mouth and Hebei's eastern coastal line eastward at an average annual rate of 333 meters.³⁰ Hence, within one year after the river burst in 1110, the accumulated siltage reached more than one meter high at the site that burst in southern Hebei.³¹ For the same reason, whereas Hebei's local rivers

²⁹ XCB, 421.10204.

³⁰ Xu Hailiang 徐海亮, "Lishi shang Huanghe shuisha bianhua de yixie wenti" 歷史上黃河水沙變化的一些問題, *Lishi dili* 12 (1995): 32–40.

³¹ SS, 93.2310.

had carried less silt and had little difficulty in discharging their water before the mid-eleventh century, muddy inflows of the Yellow River now quickly silted up their riverbeds, reducing the water-load capacity of their channels. Inevitably, their courses, banks, and dikes became more vulnerable to floods. Because of heavy siltage, the Zhang River, for instance, had great difficulty in discharging water and therefore suffered serious flooding, especially in the 1070s.³²

Measures to stop the build-up of silt deposits, such as the “iron dragon-claw” (*tielongzhua* 鐵龍爪) and, later, the “river-deepening harrow” (*junchunpa* 浚川耙), were created and used in the 1070s by hydraulic specialists to dig silt from the Yellow River’s riverbed.³³ But these devices apparently were ineffective and were criticized by contemporaries for being costly and expensive. “Even very stupid men living along the riverside all know that the river-dredging harrow does no good,” complained Minister Wen Yanbo 文彥博 (1006–1097) in 1076.³⁴ In the eleventh century, on the central Hebei plain where the terrain was so flat that all river currents naturally slowed down, barely carrying away their silt, residents could prevent river floods only by constructing high dikes along the Yellow River’s northern course and Hebei’s local rivers. However, these dikes, consisting of wooden fascines, stone, sand, and mud, were fragile in the face of surging waters. A small break paved the way for a violent break or even a shift of the river’s course—as when in 1077 a rupture in the Yellow River’s southern bank pushed its current southward, and thus abruptly terminated its northern course. This retreat of the Yellow River’s northern course from central Hebei might have brought about a reduction in the Yellow River’s silt deposit in the local rivers, but most of these rivers failed to recover their pre-1048 courses. In southwestern Hebei, for instance, the Xiaozhang River (literally, small Zhang River 小漳河) and the Sha 沙 River (found, in 1074 and 1075 respectively, to have become too silted to allow the flow of water; their courses’ locations are not identified in available documents) dried up almost completely.³⁵

³² SS, 95.2351.

³³ SS, 92.2282–83. The technical aspects of these devices are carefully explored in Joseph Needham’s *Science and Civilisation in China*, vol. 4, *Physics and Physical Technology, Part III: Civil Engineering and Nautics* (Cambridge: Cambridge University Press, 1971), 335–36; Klaus Flessel, *Der Huang-ho und die historische Hydrotechnik in China* (Tübingen: University of Tübingen Press, 1974), pp. 63–66.

³⁴ XCB, 278.6800; SS, 92.2282–83.

³⁵ SS, 95.2352, 2354, 2356.

The fate of the thousand-*li*-long Yuhe Canal provides an even clearer example of the harm caused by the Yellow River's siltage. Ever since it had been dug in the early seventh century, this canal had acted as Hebei's lifeline, linking the transport of goods between the central plain of North China and the empire's northeast frontier in Hebei.³⁶ In the eleventh century, it became even more important as the main route for transporting military supplies to Song troops stationed in Hebei along the Song-Liao border. When the number of troops there expanded rapidly to nearly a half million in the early 1040s, the shortage of provisions from Hebei itself became striking. This canal became particularly crucial for the importation of food from outside Hebei, as was realized by officials like Fan Zhongyan 范仲淹 (989–1052).³⁷

After merging with the Yellow River in 1048, the canal ceased to be protected from Yellow River floods. Consequently, not only did it overflow and flood more frequently than before, but its waterbed quickly silted up. By 1076, its upper reaches in southwestern Hebei had silted up for a stretch of fifty-five kilometers.³⁸ Its waterbed in the southern Hebei section rose so high that boats went aground and could not move.³⁹ Ten years later, the canal was fully blocked by siltage and "entirely useless for transporting things."⁴⁰ Unable to dredge this long canal with human labor, the Song government and Hebei's residents accepted the canal's decline as irreversible. The loss of Hebei's major inland water route impeded the delivery of grain and other supplies

³⁶ See relevant sections in Quan Hansheng 全漢昇, *Tang Song diguo yu yunhe* 唐宋帝國與運河 (Shanghai: Shangwu yinshuguan, 1946); Aoyama Sadao 青山定雄, *Tōsō jidai no kōtsū to chishi chizu no kenkyū* 唐宋時代の交通と地志地圖の研究 (Yoshikawa kōbunkan, 1963); Shi Nianhai, *Zhongguo de yunhe* 中國的運河 (Xi'an: Shaanxi renmin chubanshe, 1988).

³⁷ In 1034, the financial minister reported that the tax income from Hebei's economic production could support only three-tenths of the expenditure demanded by Hebei's troops (XCB, 114.2675), suggesting that the remaining seven-tenths relied on imports. This reliance was much strengthened when in the early 1040s the Song-Liao political tensions intensified and the number of Hebei's soldiers, according to Ouyang Xiu, suddenly increased to 477,000, the largest number of Hebei troops found in extant Song documents; see his "Lun Hebei caichan shang shixiang shu," in *Ouyang wenzhong quanji*, 118.12a. Under such extraordinary demand for military supplies, the eminent reformer of the time, Fan Zhongyan, considered that the government had to fully use the canal to transport military grain. See *Fan Wenzheng gong wenji* 范文正公文集, in Li Yongxian 李勇先 and Wang Ronggui 王蓉貴, comps., *Fan Zhongyan quanji* 范仲淹全集 (Chengdu: Sichuan daxue chubanshe, 2002), 14.349.

³⁸ SS, 95.2356.

³⁹ XCB, 278.6810.

⁴⁰ XCB, 393.9583.

within Hebei during the rest of the Northern Song; grain transportation had to rely primarily on such laborious overland means as draught animals and carts. Following the fall of the canal, the market towns and cities along it also declined. As Li Xiacong has argued, the city of Daming, the Song rulers' Northern Capital, declined from the late eleventh century on, both economically and ecologically; gradually it was buried beneath the Yellow River's silt.⁴¹ The canal would not enjoy a renaissance until two centuries later: the Yuan dynasty, keen on securing a reliable grain transport route to its capital of Dadu (present-day Beijing) in Hebei, had the Yuhe, which served as the northern section of the Grand Canal, repaired and dredged.

Impact on Lakes and Ponds

After the Yellow River shifted into Hebei, Hebei's lakes and ponds also changed.⁴² One example is Dalu Lake, in western Hebei (see map 3). The largest of the ancient lakes on the Hebei plain, it had a circumference of about eighty-three *li* at the end of the tenth century.⁴³ During the Yellow River flood of 1108 it became heavily silted. The sediment that collected at the lake's bottom caused the water to rise and overflow onto neighboring lowlands and swamps to form another lake. Dalu Lake started to shrink; in the early nineteenth century there remained only a small pool, which then vanished in the early twentieth century.⁴⁴

⁴¹ Li Xiacong 李孝聰, "Gongyuan shi—shi'er shiji Huabei pingyuan beibu yaqu jiaotong yu chengshi dili de yanjiu" 公元十—十二世紀華北平原北部亞區交通與城市地理的研究, *Lishi dili* 9 (1990): 246.

⁴² According to Zou Yilin, lakes and ponds on the North China Plain had remained little changed from the sixth to the tenth century; it is in the eleventh century that they started changing remarkably, although, unlike Hebei's lakes, not all of them changed due to the impact of the Yellow River. See Zou, "Lishishiqi Huabei dapingyuan huzhao bianqian shulüe" 歷史時期華北大平原湖沼變遷述略, *Lishi dili* 5 (1987): 25–39.

⁴³ According to Yue Shi 樂史 (930–1007), *Taiping huanyu ji* 太平寰宇記, ed. Wan Tinglan 萬廷蘭, Hongye Shanfang cangban 紅葉山房藏板 (preface 1793), 59.11a, the east-west length of the lake was twenty *li* and the south-north thirty *li*.

⁴⁴ Zou Yilin, "Lishishiqi Huabei dapingyuan huzhao bianqian shulüe," *Lishi dili* 5 (1987): 32. Also see Zhang Xiugui 張修桂, *Zhongguo lishi dimao yu guditu yanjiu* 中國歷史地貌與古地圖研究 (Beijing: Shehui kexue chubanshe, 2006), p. 404. Of course, the Yellow River's siltage may not have been the only cause of the shrinkage of Dalu Lake. Human factors might have contributed, such as poldering the lake and reclaiming the arable—similar to what happened to Xiang Lake in northern Zhejiang; see R. Keith Schoppa, *Xiang Lake—Nine Centuries of Chinese Life* (New Haven: Yale University Press, 1989). But, in the case of Dalu Lake in the Northern Song period, I have not found much evidence about human activities that were related directly to the lake's shrinkage.

Although no records survive with regard to the fate of Hebei's other natural lakes, it is known that man-made lakes in central Hebei also suffered great destruction. The eight hundred-*li*-long stretch of frontier ponds, which the Song government had dug and connected to form a watery Great Wall to thwart an invasion by Khitan cavalry from the north, were silted up by the infusion of the Yellow River's muddy water, especially in the 1070s and 1080s.⁴⁵ Inflows from the Yellow River most likely also damaged the extensive underground tunnels that had been built for military defense in the same area.⁴⁶ The damage to the ponds and the tunnels seriously threatened the security of the state, whereupon conflicts among officials over whether to maintain or abandon these ponds became intense. In the 1070s, Wang Anshi and his fellow reformers received imperial backing to reclaim land from some ponds by allowing the Yellow River's muddy water to pour silt into them.⁴⁷ Such land was used for rice paddies and rented out to peasants in order to increase government revenues.⁴⁸

During Wang Anshi's reforms, calls to restore the ponds for strategic purposes persisted; perhaps this was because the harvests from Hebei's paddies were poor.⁴⁹ The calls became even louder from the mid-1080s

⁴⁵ In his 1087 memorial, Wang Di 王覲 stated: "The establishment of the ponds is for the purpose of separating the south and the north. Once the muddy water flows over, [the ponds] soon become a flat plain"; XCB, 396.9661. Similar accounts of the Yellow River's damage to Hebei's frontier defense frequently appear in documents from the 1070s and 1080s; see, for example, XCB, 248.6053, 399.9733; SS, 95.2362.

⁴⁶ Hebei's underground tunnels (called *zhandao* 戰道 by modern scholars) are not mentioned in any extant Song-period document, probably because the government wished to keep them secret. According to recent studies, the tunnels located in present Yongqing 永清, Ba 霸, and Xiong 雄 counties—the most strategically crucial places along the Song-Liao frontier—were built to serve the Song-Liao war in the late tenth and early eleventh centuries. The overall scale of the tunnels is unknown because they have not yet been fully excavated and inspected. However, on the basis of their construction material—large quantities of identically sized gray bricks that are of high quality—researchers believe that the tunnels were built under government orders rather than through private initiative. The discovered sections of the tunnels border the land where the Song-period strategic ponds were located; not far away to their east lay the northern current of the Yellow River. About these tunnels, see Wang Shumin 王樹民, "Yongqing de Liaodai didao" 永清的遼代地道, in Chen Shu 陳述, ed., *Liao Jin shi lunji* 遼金史論集 (Beijing: Beijing wenji chubanshe, 1991), 5:332–34; Liu Pujiang 劉浦江, "Hebei jingnei de gudidao yiji yu Song Liao Jin shidai de gushi" 河北境內的古地道遺跡與宋遼金時代的故事, *Dalu zazhi* 大陸雜誌 101 (2000): 27–42.

⁴⁷ XCB, 260.6350, 280.6852, 501.11935; SS, 95.2371; Xu Song 徐松, *Song huiyao jigao* 宋會要輯稿 (Beiping: Beiping Tushuguan, 1936) [hereafter SHY], "Shihuo," 63.44a.

⁴⁸ XCB, 254.6206. 501.11935.

⁴⁹ In 1071, the Commission of Military Cultivation in Hebei reported that, even during

to the late 1090s, when, as Nagase Mamoru has correctly observed, the contradiction between the military and agricultural functions of the ponds became increasingly evident.⁵⁰ As a result of the increased attention paid to the ponds, it seems very likely that the practice of planting paddy rice was discontinued by the government in the late 1080s. Yet, because the government repeatedly insisted that regular maintenance of the ponds was strategically necessary, the ponds remained.⁵¹ Not only did the policy of Wang Anshi and his fellow reformers to “enrich the dynasty” (*fuguo* 富國) by promoting grain production in Hebei’s ponds fail to remove the threat of an invasion by Khitan nomads, but also their efforts to transform the Yellow River flooding into something positive came to naught. The Yellow River continued to discharge mud into ponds along the low-lying Song-Liao frontier, and Hebei’s water managers and officers remained committed to channeling clear water from surrounding local streams and springs into the ponds just to maintain this marshy land.⁵² Wang Anshi’s agricultural measures were stopped; fishing and wild-food gathering replaced settled agriculture in this area. As the official and poet Su Song 蘇頌 (1020–1101) observed in the 1080s, “the livelihood of ten thousand families benefits from wild rice and aquatic plants.”⁵³

Deforestation Hastened by Flood-Resisting Efforts

To repair ruptured riverbanks and build new embankments to resist these Yellow River floods, the government and people of Hebei were forced to make huge numbers of fascine rolls out of wooden sticks,

good harvests, the income from the paddy planting could not repay its operating cost; SHY, “Shihuo,” 63.44a. The *Song shi* therefore concludes that “annual income (from these paddies) is not much; it benefits merely the water reservation for the purpose of halting (the Khitan’s) cavalry and horses”; see SS, 176.4266.

⁵⁰ Nagase Mamoru 長瀬守, *Sōgen suirishi kenkyū* 宋元水利史研究 (Kokusho Kankō-kai, 1983), pp. 176–78.

⁵¹ In 1083, the government again emphasized the ponds’ maintenance by measuring their water with a water measure (*shui ze* 水則), and requested a quarterly submission of reports about the water depth in these ponds to the central court; see XCB, 333.8022. For more about the reporting system and protection of the ponds, see XCB, 494.11748; SHY, “Shihuo,” 63.50a.

⁵² XCB, 248.6053; SHY, “Shihuo,” 63.46a.

⁵³ Su Song, “Xingci tangdi” 行次塘堤, *Su Weigong wenji* 蘇魏公文集 (Beijing: Zhonghua shuju, 1988), 8.91.

grass, reeds, bamboo strips, earth, and stone. As the river's course and floods shifted northward into Hebei, the need for raw materials from within Hebei grew dramatically, thereby depleting much of Hebei's local tree and plant cover.

According to a calculation in the Yuan-dynasty *Hefang tongyi* 河防通議—if one assumes that this measurement method had been employed from the mid-eleventh century on—one fascine roll (*juansao* 卷埽), twenty *bu* 步 long and one *zhang* 丈 high (that is, about 230 cubic meters), consisted of 3,850 bundles and pieces of raw materials (that is, 1,100 bundles of wooden sticks, 2,625 bundles of grass, and 125 pieces of large timber).⁵⁴ Fascine sites (*sao* 埽) along the riverbanks required many such rolls, for the length of each site was between two and three hundred—or even one thousand—*bu*, and the height of accumulated rolls was between one and four *zhang*.⁵⁵ Thus, the different sizes of fascine sites determined the amount of rolls and raw materials required, and the latter would vary from 38,500 to 770,000 bundles and pieces—from 2,300 to 46,000 cubic meters—depending on the site, with a mean figure of 404,250 bundles. However, these figures do not represent the actual raw materials used to construct the fascine sites. According to the *Hefang tongyi*, except for the large timber, more than half of the materials were flushed away while the fascine rolls were placed at the riverbanks.⁵⁶ Thus, the actual amount of the sticks and grass used was on average 808,500 bundles and pieces for each fascine site—which was double the figures given above.

Although the fascine sites were constructed out of a huge amount of raw materials, they wore out rapidly and were frequently torn apart by the Yellow River's torrents. They thus required constant maintenance and replacement. Before the river burst in 1048, the Song government had set up a ministry for managing the Yellow River, regulating that officers on duty had to collect, buy, or levy more than ten million

⁵⁴ See *Hefang tongyi* 河防通議, which was based on the writing of a Northern Song hydraulic expert and edited by the Yuan figure Shakeshen 沙克什 in the fourteenth century, *Congshu jicheng chubian* edition, *shang*.12–13.

⁵⁵ Shakeshen, *Hefang tongyi*, *shang*.10. "Sao" originally referred to the fascine roll made up of various materials to block the Yellow River's bank ruptures; it was then adopted as the name of the hydraulic site along the river where such fascine rolls were placed, laborers stationed and raw materials stored.

⁵⁶ Shakeshen, *Hefang tongyi*, *shang*.9.

fascine bundles a year, to be distributed to various fascine sites along the river's banks for normal maintenance.⁵⁷ The demand for materials was so large and continuous that the requirement was soon transmuted into part of the compulsory annual taxes collected from the commoners in various North China circuits.⁵⁸ In the 1020s and early 1030s, forty-five fascine sites were set up along the lower reach of the Yellow River, mostly on the southern side in Henan; thus, on average each site would have received 222,222 bundles of raw materials per year.⁵⁹

The actual amount of raw materials that were required for the fascines increased year after year. According to Wen Ji 文洎 (fl. 1020s–1030s), the wooden branches collected from mountain forests were packed into anywhere between one and two million bundles per year. The number of bundles increased to 3,760,000 in 1029 and then skyrocketed to 7,800,000 in 1030. As Wen observed, materials like bamboo, wooden sticks, and other bits of wood were easier to collect than mountain lumber and were therefore collected in far larger amounts.⁶⁰ Furthermore, at important fascine sites and on particularly trying occasions, the demand for raw materials could rise to many times more than the normal annual provision.⁶¹ Not all of the fascines were used effectively and immediately. Often, a considerable portion was flushed away, especially whenever torrents breached the riverbanks; and, because of poor conservation, enormous stocks of raw materials rotted and wasted away.⁶² The extraordinary demand for and consumption of these raw

⁵⁷ SS, 91.2265. Such raw materials were used for normal maintenance in the spring, and were thus called “spring materials” (*chun liao* 春料); accordingly, corvée laborers employed specifically for collecting these spring materials were called the “spring-material men” (*chun liao fu* 春料夫). As reported in 1028, in Chanzhou alone such corvée laborers numbered ten thousand per year; see SHY, “Fangyu,” 14.13a.

⁵⁸ SHY, “Shihuo,” 140.8b.

⁵⁹ SS, 91.2266. It is hard to identify the exact period this record refers to, although it seems to describe the situation before 1048. It might refer to the situation in the 1020s because, although it is the only passage in the “Hequ zhi” that summarizes the Song government’s regulations for controlling rivers, it is put in front of all pre-1023 records instead of at the beginning or end of the chapters on the Yellow River. Furthermore, most of the fascine banks mentioned in this record were located in Henan and the rest in southern Hebei; clearly, at that time the river’s floods had not yet spread into central Hebei.

⁶⁰ SHY, “Fangyu,” 14.14b–15a.

⁶¹ In the fifth lunar month of 989, 1.7 million bundles of raw materials at a fascine site in Huazhou were burnt by a fire; from this one deduces that each significant fascine site like this one stored an enormous number of raw materials in the late tenth century; see SHY, “Fangyu,” 14.3a. In 1036, the fascine site of Henglong was said to have stored more than 1.9 million bundles of various materials; see XCB, 119.2809.

⁶² According to Wen Ji, more than twenty-five million such bundles had not yet been

materials had a harmful effect on the mountains of Henan, Shanxi, and Shaanxi. Noting the continuous cutting of the trees in these provinces, Wen Ji wrote in the early 1030s: "Forests in the mountains have gradually thinned out."⁶³

After 1048 Hebei replaced Henan as the nearest and most important provider of materials for river repairs. Of the forty-seven or more fascine sites newly recorded in documents between 1048 and 1128, all but four—that is, 90 percent—were located in central and southern Hebei. By contrast, nearly thirty-five of the forty-five pre-1048 sites in Henan and southeastern Hebei are rarely mentioned in post-1048 documents. This suggests that the government had shifted its flood-resistance efforts and facilities northward into Hebei.⁶⁴ Assuming that each of these Hebei sites—the forty-three new and the ten old—required an annual amount of 222,222 bundles for normal maintenance, as had been the case in the 1020s and 1030s, the total number of fascines required by these fifty-three sites would have come to nearly twelve million bundles per year after 1048, with the vast majority of them coming from the prefectures of Hebei.⁶⁵

Yet, this figure underestimates the amount of resources used for the fascines, and not only because the count of the fascine sites is incomplete. Over time, as flooding from the Yellow River spread and grew severe, many of the fascine sites that have been documented split into several subsites, each requiring a large quantity of raw materials.⁶⁶ In

used by 1030, of which nearly three million rotted due to poor conservation; see SHY, "Fangyu," 14.14b–15a.

⁶³ SHY, "Fangyu," 14.14b–15a.

⁶⁴ The names of these fascine sites are collected from "Hequ zhi," in SS, *juan* 91–93.

⁶⁵ As the official Sun Sheng 孫升 commented in the 1080s, once a river-repair plan was brought up, Hebei was the first one to suffer, as it had to provide enormous numbers of corvée laborers and raw materials; see XCB, 434.10460.

⁶⁶ The number of fascine sites fluctuated through the Northern Song period and the records about them are inadequate. According to Su Shi 蘇軾 (1037–1101), there were forty-five abandoned fascine sites along the old course of the Yellow River (probably the northern current generated by the 1048 river burst) by 1088; before being abandoned, they required five million bundles of raw materials annually. See XCB, 414.10056. According to Wang Cun 王存, there were five thousand fascine sites along the Yellow River's old northern current in 1089 and every year the maintenance of each site required an enormous amount of raw materials. See XCB, 421.10192.

Throughout the eleventh century, some large fascine sites were divided into upper, middle, and lower sites, for example, the splitting of the Guangwu site into the Guangwu upper site and the Guangwu lower site (SS, 92.2285). Some of these sites were subdivided into an even lower level of sites—stations (*pu* 鋪), for example, the fifth and fifteenth *pu* of the upper fascine site of Yangwu (SS, 93.2311). There was probably a lowest level of sites,

the late eleventh century some subsites annually required much more raw material than major sites had received on average in the period before 1048.⁶⁷ Furthermore, during the eighty years after 1048 the Yellow River often diverged into two or more courses, each of which tended to be unsettled. Conceivably the proliferation of river courses doubled or even tripled the total demand for raw materials at all the fascine sites. Finally, the Yellow River inflicted the problems of siltage, floods, bank ruptures, and course shifts of Hebei's local rivers. To repair these rivers required additional bundles of raw material from local areas. For instance, in order to repair the Zhang River's bank in southwestern Hebei in the early 1070s, reportedly more than a hundred thousand bundles of elm and willow wood were cut from its riverbanks as well as from nearby government horse pastures.⁶⁸ Furthermore, after 1048 the frequent occurrences of very severe floods drove the figures of the bundles to an exceptionally high level. In comparison with the employment of sixteen million bundles during the nine years following a serious river rupture in 1019, to repair the rupture in 1048 required eighteen million bundles.⁶⁹ In 1056, when water-controlling efforts caused a riverbank rupture, the flood destroyed and flushed away between one and two million bundles.⁷⁰ In 1077, when the Yellow River suddenly shifted southward into Henan, in order to protect the capital Kaifeng, 12,890,000 bundles were employed to block the rupture and move the river back into Hebei.⁷¹ In the 1080s the annual demand for millions of bundles was common, not only to repair single bank ruptures or establish fascine sites, but also to shift the river from its northern course to its old eastern course, in line with government wishes. In the late 1080s the government anticipated the need for twenty million bundles or

called *jie* 節; see XCBSB, 10.428–29. Such multilevel divisions of the fascine sites drove the demand for raw materials to increase.

⁶⁷ In the 1093 record about the seventy-*li*-long river course from the fascine site of Gancun to the lower fascine site of Neihuang, each ten-*li* section was provided with four hundred thousand bundles of raw materials; see XCBSB, 10.428–29. Assuming that these seven stations belonged to the two fascine sites of Gancun and Neihuang, these two fascine sites would have each required 1.4 million bundles, a number much greater than the average one in the 1020s and 1030s.

⁶⁸ XCB, 223.5421.

⁶⁹ XCB, 105.2455, and Ouyang Xiu's remarks in 1055, in XCB, 179.4327.

⁷⁰ Zhao Bian, "Zouzhuang qi bachu Li Zhongchang, Zhang Huai'en deng," *Qingxian ji*, 8.11b.

⁷¹ XCB, 289.7072.

units of various raw materials for just this shift; this number soon rose to thirty million and, in 1089, even to fifty million.⁷² If the amount of fifty million bundles was not fully attained in 1089, in 1087 and 1088 at least twenty-four million bundles were collected from Hebei and other provinces for use in southern Hebei.⁷³

The growing need for prodigious amounts of raw materials placed an exceptional financial burden on the Song government and Hebei residents. More importantly it imposed a burden on north China, rapidly depleting its forests and vegetation. Even if the government could afford to purchase the materials from the commoners, the natural renewal of wood and grass was too slow to meet the demand. Thus, in 1088, when the project to return the Yellow River to its old eastward course required 58,848,082 bundles or units of raw materials, the government could obtain merely 49,000 bundles—or 0.8 percent of the amount requested—after three months of purchases.⁷⁴ This huge gap between the plan and the actual acquisition of resources undoubtedly stemmed from the accelerated depletion of forests and plants.

“Cutting down trees at the wrong time and destroying what was created by heaven and earth” happened frequently in Hebei, leaving the plain with few trees.⁷⁵ As early as the 1020s, it was said that most human settlements in Hebei were “largely not close to mountains and valleys”; so few trees remained around towns and villages that Hebei residents often had to cut down their garden plants to make tools or satisfy the government’s demand for wood.⁷⁶ The projects to control the Yellow River in subsequent decades made it even harder for this province to supply wood and grass for the residents’ pressing domestic needs. In the 1070s and 1080s, when the state imposed a levy of raw materials on Hebei’s residents, they had to purchase these items at high cost from

⁷² According to Zhao Zhan 趙瞻, before the plan to shift the Yellow River’s course was fully worked out, the government had already engaged twenty million bundles of wooden branches into the construction; see XCB, 415.10096. Su Zhe 蘇轍 (1039–1112), however, remarked in 1088 that the government had already accumulated more than 30 million bundles of raw materials (XCB, 416.10113). Fan Bailu 范百祿 (1030–1094) and Zhao Junxi 趙君錫 discussed this issue, claiming that about fifty million bundles were to be used (XCB, 420.10179, 421.10198).

⁷³ See Wang Cun’s report in 1087 (XCB, 415.10087) and Fan Chunren’s 范純仁 report in 1088 (XCB, 416.10110–11).

⁷⁴ XCB, 420.10179.

⁷⁵ XCB, 434.10459.

⁷⁶ SHY, “Shihuo,” 1.21b–22a.

other places, cut down the mulberry trees that customarily supported silk production, or fell trees that were intended for the protection of ancestral graves.⁷⁷

Not surprisingly, the natural forests in the remote Taihang Mountains on Hebei's western periphery increasingly came under the fall of the axe. Since the early Song, the government had set up timber workshops near these mountains in order to collect materials for construction and firewood for such government monopolies as iron mining and smelting.⁷⁸ Information about the amount of wood these workshops collected is lacking, but in all likelihood wood from these western mountains was also transported to central and southern Hebei for river-repair projects. By the mid-1070s, because of the large-scale collection of wood, the Taihang Mountains, it was said, lost much of their pine forests and become largely bald.⁷⁹

Apart from the natural forests and trees of economic value, the trees originally planted to protect Hebei's riverbanks were also destroyed for the sake of repairing rivers. From the late tenth century on, the Song government ordered that elms and willows be planted along the Yellow River and various rivers in Hebei to supply timber for shoring up riverbanks against erosion and rupture.⁸⁰ These trees were officially protected and managed; and private parties who damaged or stole them

⁷⁷ XCB, 223.5421, 416.10110–11, 434.10460. As Prime Minister Fan Chunren observed in 1087, it was easier to obtain grass materials (such as fresh grass, hay, crop straw, and reeds) in years of good harvests, when crop straw was abundant. But, whether the harvests were good or bad, woody materials (such as lumber, tree branches, and sticks) were always hard to get because the Hebei plain lacked forests, and residents cherished the cash trees planted in their gardens and would cut them only in extreme hardship. According to Fan, the river-repair projects forced Hebei residents to cut down their cash trees even during years of relatively good harvests.

⁷⁸ Ever since the late 980s, the Song government started to run a Panyang workshop (*panyang wu* 礪陽務) in southwestern Hebei; this workshop conducted lumbering in nearby mountains between the second and the tenth month yearly. See *Zhangdefu zhi* 彰德府志, ed. Lu Songxiu 盧修 and Jiang Dajian 江大鍵, *Zhongguo fangzhi congshu* edition (photolithographic reprint of a 1787 edition), 4.17b–18a. About the same time, the government also established an important iron mine, the Panyang mine (*panyang ye* 礪陽冶) in this part of Hebei (SHY, “Shihuo,” 33.3b). Song records show more iron mines were set up in western Hebei during the eleventh century.

⁷⁹ Shen Kuo 沈括, *Mengxi bitan* 夢溪筆談 (Beijing: Zhonghua shuju, 1958), 24.233–34.

⁸⁰ The earliest order to plant trees to protect the Yellow River's dikes was given in 962 (SHY, “Fangyu,” 14.1a). It was reissued and practiced in 972 (SHY, “Fangyu,” 14.1b), 1000 (SHY, “Shihuo,” 1.17b), 1016 (XCB, 87.1997), and 1049 (XCB, 167.4019). In the 1070s, the government further encouraged planting trees along the course of the Yellow River and the frontier ponds for similar purposes; see XCB, 215.5234, 246.5987, 254.6206.

faced severe punishment.⁸¹ As the damage inflicted by river floods increased, and as these riverside trees thus gained importance for protecting the rivers, Hebei's local governments were prohibited from cutting and using them even to construct city walls.⁸² Nevertheless, after the Yellow River shifted in 1048 and Hebei suffered a severe shortage of raw materials, riverside plants were hewn by hydraulic specialists and the corvée laborers they employed to repair ruptured banks, in particular during the 1070s and 1080s.⁸³

Modern studies have shown that deforestation and land erosion in the Yellow River's upper and middle reaches resulted in a sharp increase in silt accumulation in the riverbeds and the plain along the Yellow River's lower reaches, leading eventually to the river's disastrous bank ruptures and floods.⁸⁴ Song contemporaries were aware that trees and vegetation coverage along the river helped to secure the sandy soil and thus to protect the riverbanks from ruptures. Yet, lacking alternatives in the face of increased flooding, Hebei's residents cut down trees and other vegetation. The removal of trees and grass had the unintended consequence of hastening the erosion of riverbanks. The long-term lack of vegetation cover inflicted serious soil deterioration, especially sandization, on many parts of Hebei.

Soil Salinization and Wang Anshi's Land-Improvement Measure

The dense interlacing of Hebei's river courses, their frequent flooding, and their prolonged waterlogging of the surrounding landscape suggest

⁸¹ In 1029, some corvée soldiers serving at various fascine sites in Huazhou cut down the river-protecting trees and were punished with exile far away (SHY, "Fangyu," 14.13b). In 1084, it was reported that in Hebei gangs of various sizes frequently stole trees from riverbanks; the central government ordered to arrest them and requested monthly reports of the arrested numbers (XCB, 345.8280).

⁸² XCB, 259.6323.

⁸³ In 1071, Liu Zhi 劉摯 (1030–1098) reported that, for repairing the Zhang River in Hebei, hydraulic specialists cut down enormous elms and willows along this river, as well as willows on the government's horse pasturages in western Hebei (XCB, 223.5421). The reports on the damage of these trees come also from Su Shi's memorial in 1088 (XCB, 414.10056), and the 1089 memorial jointly written by Liang Tao 梁燾 (1034–1097) and Liu Anshi 劉安世 (1048–1125) (XCB, 421.10204). The trees along the Yellow River's 1048 northern course, for example, were said to be completely felled by 1089 (XCB, 421.10204).

⁸⁴ See Tan Qixiang, "Heyi Huanghe zai Donghan yihou hui chuxian yige changqi anliu de jumian," in Tan Qixiang, *Huanghe shi luncong*, pp. 72–101; Shi Nianhai, *Heshan ji*, vols. 2–3 (Beijing: Renmin chubanshe, 1988).

that Hebei became a very wet place after 1048.⁸⁵ The excess surface water, however, did little to relieve the frequent droughts on the semi-arid Hebei plain in the eleventh century. Worse, because the terrain was flat and the elevation low, its land soaked in water for long periods and consequently became seriously salinized.⁸⁶

Before the Yellow River shifted into Hebei, the soil in some parts of central Hebei had already suffered from salinization because of poor water drainage and could not sustain agricultural cultivation.⁸⁷ The infusion of the Yellow River only made the situation worse. In the words of the late eleventh-century official Chao Shuo^{zhi} 晁說之 (1059–1129), “In places where river water stagnates, not an inch of grass grows; instead, white saline is generated.”⁸⁸ Some highly salinized lands allowed only “saline grass” (*yancao* 鹽草) to grow. Some Hebei people in the eleventh and twelfth centuries managed to survive harvest failures by extracting salt from the earth or the saline grass. Nevertheless, the soil was deteriorating and the harm of salinization on local agricultural production soon became evident. Vast stretches of once-arable land could no longer produce farm crops. The government not only lost tax revenue but also had to feed Hebei residents and soldiers by shipping in bulky cargoes of grain from other provinces. These difficulties prompted Wang Anshi’s land-improvement measure in the 1070s and early 1080s.

Wang’s “measure for silting fields” (*yutian fa* 淤田法) sought to create new fertile topsoil on salinized land by allowing the muddy waters of the Yellow River and other Hebei rivers to flood over the land and deposit their silt.⁸⁹ This idea, although it has routinely been practiced successfully on the flood plains of various rivers throughout the

⁸⁵ Even the abandoned riverbeds of the Yellow River’s northern currents, according to modern scientific research, contain strata of abundant water resources. See He Naihua 何乃華 and Zhu Xuanqing 朱宣清, “Huabei pingyuan qianmai guhedao dai de fenbu he chenji tezhen” 華北平原淺埋古河道帶的分佈和沉積特徵, in Wu Chen 吳忱, ed., *Huabei pingyuan guhedao yanjiu lunwenji* 華北平原古河道研究論文集 (Beijing: Zhongguo kexue jishu chubanshe, 1991), pp. 64–77.

⁸⁶ The concept of salinization used here accords with the interpretation in Richard Louis Edmonds, *Patterns of China’s Lost Harmony: A Survey of the Country’s Environmental Degradation and Protection* (London: Routledge, 1994), pp. 124–25.

⁸⁷ XCB, 159.3853.

⁸⁸ Chao Shuo^{zhi}, “Shuowen xia” 朔問下, in Chao Gongshuo 晁公溯, *Songshan wenji* 嵩山文集, *Sibu congkan xubian* edition, 2.29a–b.

⁸⁹ XCB, 262.6400, 263.6443, 290.7085.

world and is believed by some students of Song history to have been beneficial to eleventh-century north China's agriculture,⁹⁰ in effect, proved problematic for much of Hebei for three reasons. First, in the eleventh century, most places in Hebei were densely settled agricultural communities. Any man-made flooding and silting of fields by breaking a riverbank—without simultaneous preparations to control the floods—inevitably inflicted great damage on human settlements, as was predicted and frequently claimed by Wang's critics in the 1070s and 1080s.⁹¹ Second, water drainage was a persistent problem on the low-lying Hebei plain, where the water table was merely two to four meters deep in the alluvial plain and less than two meters deep in coastal areas.⁹² The Yellow River's flooding had already overburdened Hebei's poor drainage system, and the flooding introduced by the silting-fields measure only made matters worse. As a result, the soil in many parts of Hebei would have suffered salinization.

Third and most importantly, because the siltage from the Yellow River was sandy and coarse, it did little to improve Hebei's soil fertility. Recent analyses show that the Yellow River's silt consists of rocky debris, fine sand, and mud; only the last of these contains abundant organic matter, which is physically and chemically capable of becoming arable soil.⁹³ In the eleventh and twelfth centuries, the frequent river

⁹⁰ The case of the ancient Nile floodplain is a typical example of successful use of a river's fertile silt. The Nile's siltage was fine and nutritious, and its flooding occurred at regular intervals on the plain where human inhabitants were few and usually evacuated during flood seasons, and where the water drainage was smooth. In the high-elevated southwest part of Hebei, too, water from the Zhang River was introduced to irrigate and enrich fields during the Warring States; see Du You 杜佑, *Tong dian* 通典 (Beijing: Zhonghua shuju, 1982), 2.12. Song history scholars evaluate positively the silting-fields practice; for example, Higashi Ichio 東一夫 believes that "the organic components in the Yellow River's silt, in particular, have great benefits to agricultural production." See his *Ō Anseki shinpō no kenkyū* 王安石新法の研究 (Kazama shobō, 1970), pp. 434–79.

⁹¹ For example, the release of water from the Hutuo River to silt up fields was blamed for bank ruptures, extensive floods, and severe damage to crops in 1074 (XCB, 249.6073). Also see Su Shi's memorial about the damage caused by the silting-fields practice in the 1080s, in *Dongpo zhilin* 東坡志林 (Shanghai: Huadong shifan daxue chubanshe, 1983), 4.24.

⁹² Fereidoun Ghassemi, Anthony John Jakeman, and H. A. Nix, *Salinisation of Land and Water Resources: Human Causes, Extent, Management, and Case Studies* (Sydney: University of New South Wales Press, 1995), pp. 226–27.

⁹³ According to modern hydrologists, when a river flows smoothly, heavy coarse matter in the water deposits quickly on the riverbed, while fine matter suspends in the water and deposits slowly. As the water slows down and tends to evaporate, such suspending fine sand will deposit on the surface to generate smooth and fertile topsoil. But when the

bursts, bank ruptures, and floods undoubtedly deposited relatively large materials, such as rocks, stones, and broken fascines, onto the silt. Such debris would hardly have provided rich topsoil.⁹⁴

Even the fine, smooth silt of the Yellow River provided little fertility. As the “Hequ zhi” in the *Song shi* comments: “After the [Yellow River’s] water recedes, the sediment is a fertile glutinous soil in the summer. It then becomes a yellowish dead soil (*huangmietu* 黃滅土) in the early autumn which is quite loose [in structure]. Next it becomes a whitish dead soil (*baimietu* 白滅土) in the deep autumn. After the first frost, it becomes sand completely.”⁹⁵ This rare, concrete account

river scours, ruptures its banks, and creates floods, the heavy matter will be raised up by the current and become suspended in the water, leading to the creation of coarser and less fertile topsoil. This general water-silt mechanism can perhaps be also used to explain the circumstances of the Yellow River in the Northern Song period. Consult Han Peng 韓鵬 and Ni Jinren 倪晉仁, “Shuitu baochi dui Huanghe zhongyou nisha lijing yingxiang de tongji fenxi” 水土保持對黃河中游泥沙粒徑影響的統計分析, *Shuili xuebao* 8 (2001), online version: <http://www.chinawater.net.cn/Journal/slx/200108/>, and Zhang Xiaohua 張曉華 et al., “Huanghe zhongyou ganliu nisha zucheng guilü” 黃河中游幹流泥沙組成規律, *Nisha yanjiu* 4 (1999), online version: <http://www.chinawater.net.cn/Journal/SediRes/journalcontent.asp?str1=http://www.cws.net.cn/Journal/SediRes/199904/13.html&str2=2071>, both accessed on September 30, 2007.

⁹⁴ Song records do provide some positive reports on the silting-field practice, for example, the praise expressed by Emperor Shenzong (r. 1067–1085) for the nutritious topsoil created by silting up fields (XCB, 221.5370). These reports make many historians of the Song dynasty believe that the silting-field practice offered universal benefits for the entire country; see, for example, Higashi Ichio, *Ō Anseki shinpō no kenkyū*, p. 479. Without further examination, we cannot respond to these reports to evaluate the practice in Hebei, because almost all positive reports came from Henan rather than from Hebei. The Henan reports cannot explain the silting-field practice in Hebei for two obvious reasons. First, the execution of the practice in the two regions must have differed in terms of the government’s supervision and provision of labor and materials. Second, each of the two regions employed water from different sources—in Henan from the Bian Canal and in Hebei from the Yellow River. The hydrological differences of the two streams must have led to different results of the silting-field practice in the two provinces. Henan’s success could not have been enjoyed equally by Hebei. Because Henan was the metropolitan region of the state, it was under the careful protection and control of hydraulic specialists whenever the silting of fields was carried out. It therefore suffered less damage from flooding than did Hebei. Moreover, the silting-field practice in Henan employed the water from the Pacific Bian Canal, whereas in Hebei it used the much more violent Yellow River—a hydrological contrast that must have led to very different results of the two regions’ silting-field practices.

⁹⁵ SS, 91.2265. The expression *mietu* exists perhaps only in this SS text and another Yuan Dynasty writing, *Hefang tongyi*, and attracts limited attention from most Yellow River scholars. In her recent article, Ōkawa Yūko 大川裕子 glosses the term as *jiantu* 滅土. See “Koga shitaryūike ni ogeru sachi riyō no rikishi deki henshen” 黃河下流域において沙地利用の歴史的變遷, in Tsuruma Kazuyuki 鶴間和幸, ed., *Koga shitaryūike no rikishi to kankyō* 黃河下流域の歴史と環境 (Tōhō shoden, 2007), p. 167. The character *jian* 滅 has a similar shape as the character *mie* 滅, but it does not bear the meaning of the

describes the changing nature of the Yellow River's silt as its water content evaporated and its fertility decreased over the seasons, indicating that land on which silt had been deposited could support agriculture for only a brief period of the year. Consequently, although some peasants cultivated these silted lands and the government tried to recruit migrants to till them,⁹⁶ no evidence indicates that the siltage increased the river's fertility. On the contrary, as some contemporaries noticed, peasants who planted wheat on these lands could "barely get one harvest to relieve their poverty."⁹⁷ Not surprisingly, the government had trouble attracting farmers to this land.

For these reasons, I believe that, contrary to the aims of Wang Anshi and his fellow reformers, the silting-fields measure neither reversed the problem of soil salinization in Hebei nor improved the land's fertility.⁹⁸ Rather, it expedited the soil's deterioration. By the mid-twelfth century, for example, the land of Yingzhou, which the Yellow River's northern course had repeatedly flooded with silt between 1048 and 1128, was judged to be sterile.⁹⁹

Sandization: A Long-Term After-Effect

To most of Wang Anshi's contemporaries, and to many modern students as well, the most unexpected effect of the Yellow River's floods in Hebei was soil sandization.¹⁰⁰ According to the evidence quoted above from the "Hequ zhi," the Yellow River's deposits of silt seem to have ended up as sand after an annual cycle. This information is sup-

latter, which I tend to interpret as similar to *si* 死, suggesting the state of the loss of (or losing) fertility, nutrients, and water in soil. In the hydraulic treatise *Hefang tongyi*, the author also describes the *mie* soil as a type of "dead soil" (*situ* 死土) in riverbeds.

⁹⁶ For example, SHY, "Shihuo," 1.27a, 63.183a–b; XCB, 450.10821, 518.12337; and, Chao Buzhi 晁補之, "Zhang Dong zhuan" 張洞傳, *Jilei ji* 雞肋集, *Siku quanshu* edition, 62.918.

⁹⁷ XCB, 374.9078.

⁹⁸ XCB, 263.6440, 265.6499. Wang Anshi insisted that the fields silted artificially with river floods in Hebei brought along "not a little" increase annually in grain harvests.

⁹⁹ Tuo Tuo 脫脫, *Jin shi* 金史 (Beijing: Zhonghua shuju, 1975), 73.1683.

¹⁰⁰ According to Richard Louis Edmonds, "'sandization' is a beginning stage of desertification which includes massive soil erosion and vegetation cover destruction by humans but does not reach a fully desert-like landscape." See *Patterns of China's Lost Harmony*, p. 101. Ōkawa Yūko has clearly pointed out that the Yellow River's floods and silt have led to serious sandization in the drainage area of the river's lower reaches. See "Koga shitaryūike ni ogeru sachi riyō no Rikishi deki hensen," in Tsuruma Kazuyuki, ed., *Koga shitaryūike no rikishi to kankyō*, pp. 153–75.

plemented by a more detailed description of the river's siltage in the *Hefang tongyi*, which was written probably shortly after the occurrence of the 1048 river burst by a water-management expert who personally took charge of the fascine embankment at Shanghu around that time.¹⁰¹ His description of the silt classifies its changing nature and colors. A significant group of these soil types is classified as "sand," including "active sand," "floating sand," and "running sand." "These three types," he comments, "are active and movable, so it is hard to succeed [in building flood-control facilities on top of them]."¹⁰² Both of these records are strongly confirmed by modern hydrogeological research in southern Hebei, where most Song-period river bursts took place. This research shows that in the remnant stratum of the Yellow River's eleventh-century riverbed, the siltage was actually full of fine, floating sand, rather than of solid earth.¹⁰³

It is impossible today to measure the exact ratio of such sandy matter to the whole volume of silt. But some Song officials found the ratio very high, claiming that on the shoals along the Yellow River's banks after the flooding water had receded, sand constituted 80 percent of the silt's body and the remaining solid earth only 20 percent.¹⁰⁴ The preponderance of sand in the composition of the river's silt made it difficult for the soil to retain water and nutrients and to prevent its erosion; agriculture on such soil was thus impossible.¹⁰⁵ Exposed to the air, the land naturally underwent serious sandization. By 1088 some fascine embankments were being called "sand dikes" (*shadi* 沙堤) in documents.¹⁰⁶

¹⁰¹ In the preface, the Yuan compiler Shakeshen said that the book was originally written by Shen Li 沈立 in 1048, and then became fragmented in later periods. In 1321, Shakeshen recompiled the book based on one edition printed in Kaifeng during the Northern Song period and another edition stored in the Water-managing Bureau of the Jin dynasty.

¹⁰² Shakeshen, *Hefang tongyi*, shang.6.

¹⁰³ Xu Hailiang, "Huanghe gudao Hua Chan duan de chubu kaocha yu fenxi" 黄河古道滑澶段的初步考查与分析, *Lishi dili* 6 (1988): 28–29.

¹⁰⁴ Reported in 1078, in SHY, "Fangyu," 16.12a.

¹⁰⁵ About agriculture's impact on land erosion in the Yellow River's middle and lower reaches, see Tan Qixiang, "Heyi Huanghe zai Donghan yihou hui chuxian yige changqi anliu de jumian," in Tan Qixiang's *Huanghe shi luncong*, pp. 72–101, Zou Yilin, "Huanghe xiayou hedao bianqian jiqi yingxiang gaishu," in Tan Qixiang, *Huanghe shi luncong*, pp. 221–42, and Shi Nianhai, *Heshan ji*, vols. 2–3.

¹⁰⁶ XCB, 421.10205.

Sandization caused by the river's silt became even more evident in twelfth-century sources. In 1169, when the Southern Song official Lou Yue 樓鑰 (1137–1213) traveled to southern Hebei and northern Henan, he saw extensive sandbars amid the water of the Yellow River.¹⁰⁷ Along his journey, there were places bearing names like “Sand Store” (*shadian* 沙店), indicating the surrounding landscape. In Huazhou, which was located between Henan and Hebei and had been a repeated victim of the Yellow River's floods since the ninth century, the circumstance was particularly striking: “There are earthen hills lining both sides of the road, where the dust is extremely heavy and where it is so unclear that one cannot see things even from a very short distance.” Locals called this place the “Small Dust Cave” (*Xiaohuidong* 小灰洞), a name that suggests the existence of additional dusty places, perhaps with a name of “Big Dust Cave,” along the road. After entering Xiangzhou in southwestern Hebei, Lou Yue journeyed along a tributary of the Zhang River, which had gained the name “Small Yellow River” (*Xiao huanghe* 小黃河) due to its heavy silt. By 1169, this small river's deposited siltage had produced a landscape that made him think he was “traveling in sand.” In other parts of this province—for example, in Yingzhou where the Yellow River and various local rivers had coursed—the land was judged infertile in the mid-twelfth century.¹⁰⁸ And in Shenze County (in Qizhou during the Northern Song and Baozhou during the Jin dynasty), two-thirds of the thirty thousand *mu* of military fields suffered from waterlogging, sand-cover, and salinization in the early thirteenth century.¹⁰⁹

The next two centuries appear to provide few records on Hebei's sandization. Nonetheless, I suggest that the sandization process continued or even accelerated in the subsequent centuries. The problem was commented upon even by foreigners, such as the Korean Ch'oe Pu 崔溥, who was traveling in Hebei in the third lunar month in the late fifteenth century.¹¹⁰ In Dezhou in southern Hebei, and in Tianjin and Beijing in the north, he observed that the sand and dust blown

¹⁰⁷ Lou Yue, *Beixing rilu* 北行日錄, *Congshu jicheng chubian* edition, *shang*.14–16.

¹⁰⁸ *Jin shi*, 73.1683.

¹⁰⁹ *Jin shi*, 106.2332.

¹¹⁰ Ch'oe Pu, *Phyohae rok* 漂海錄, in Makita Tairyō 牧田諦亮, *Sakugen nyūminki no kenkyū* 策彦入明の研究 (Kyōto: Hōzōkan, 1959), 2:304, 310, 322.

about by winds was so thick that he could hardly open his eyes—just as if he were in a spring sandstorm in modern Hebei. Upon arrival in nearby Tianjin where most of Hebei's rivers (including the Yellow River's northern courses in the eleventh and early twelfth centuries) converged and entered the sea, Ch'oe further observed that "the white sand extends without end. In the wildness grass appears scarce, various crops do not grow, and human settlements are few." To this, his Chinese interpreter commented, "Sandy soil is abundant in the north." In the third and fourth lunar months in 1549, the Japanese monk Sakugen 策彦 made similar observations during his second journey from south China into Hebei.¹¹¹ In southwestern Hebei (Huaizhou in the Song), he came upon strong winds and a dull sky that was thick with sand and dust. At various places in central Hebei, his boat could not proceed because of "winds fierce with whirling sand."

Similar descriptions are frequently found in Chinese writings of the Ming Dynasty and later periods.¹¹² A relatively comprehensive comment on the problem was given by Lan Dingyuan 藍鼎元 (1680–1733), a Qing official, in his document on hydraulic benefits in central and northern Hebei in the 1720s: "There is no solid earth in the north, and sand is eroded along with flowing water." He concluded, "river-banks [here] cannot be consolidated."¹¹³ He found the banks of the Yellow River in particular to consist of floating sand.

Transformed from the river's silt, floating sands became a significant source of Hebei's local sandstorms then as now.¹¹⁴ Consider the

¹¹¹ Makita Tairyō, *Sakugen nyūminki no kenkyū* (Kyōto: Hōzōkan, 1954), 1:251–52.

¹¹² In Yingzhou of central Hebei, a 1499 survey reported that among 1120 *qing* of fields, only 418 *qing* were arable, while the others were covered by sand and saline. See Li Guoxiang 李國祥 and Yang Chang 楊昶, eds., *Ming shilu leizuan* 明實錄類纂, volume on Hebei and Tianjin (Wuhan: Wuhan chubanshe, 1995), p. 774. Also according to Gu Yanwu 顧炎武, western Shandong and central and southern Hebei "had an abundance of floating sand," and Neihuang County and Kaizhou of southern Hebei had a sandy and salinized soil during the Song dynasty; see *Tianxia jinguo libing shu* 天下郡國利病書, *Sibu shanben congshu chubian* edition, 2.9b, 12b.

¹¹³ Lan Dingyuan, "Lun Beizhi shuili shu" 論北直水利書, in *Jifu tongzhi* 畿輔通志 (Shanghai: Shangwu yinshuguan, 1934), 91.3652a.

¹¹⁴ Traditionally, the rapid desertification on the Mongolian steppe or in the farther northwest has been considered the major cause of sandstorms in present Beijing. However, recent "investigations [of the composition of sand and dust matter] suggest that the majority of wind-blown dust which can darken the sky in Beijing several times during the year comes from local river bed sand." See Richard Louis Edmonds's *Patterns of China's Lost Harmony*, p. 110, quoting Song Jinxi 宋錦熙, "Beijing diqu shawuzhi de zhongkuangwu chengfen, jiegou tezhen yu fengsha de shawuzhi laiyuan" 北京地區沙物質

case of Guantao 館陶 County in southern Hebei and the extensive damage from sandization there. Located in southern Hebei (see map 3), Guantao was crossed by the northern courses of the Yellow River, the Yuhe Canal, and the Zhang River in the eleventh century and suffered repeatedly from their floods. In 1051, the Yellow River burst one fascine embankment in this county; afterward, extensive embankments were constructed there to prevent floods.¹¹⁵ Despite such protection, twenty years later, in 1071, the river's flood again inundated the county seat.¹¹⁶ For the next ten years, the county seat was encircled by various river courses and their embankments; in 1083, it was finally moved to a higher place nearby to "escape the water."¹¹⁷ Nevertheless in 1103 the Yellow River's torrents engulfed the new county seat, inflicting severe damage.¹¹⁸ After the river shifted out of Hebei in 1128, its beds and embankments in this county were left high and dry, with heavy deposits of silt as a reminder of its Northern Song tragedy.

For centuries the topic of the Yellow River's silt on Guantao's land (probably together with silt from other local rivers) did not appear in historical records. Then, in 1724, when its county magistrate learned that enormous stretches of land were under the threat of sandstorms and becoming unsuitable for cultivation, the problem gained attention.¹¹⁹ The source of these sandstorms, surprisingly to this magistrate but not to us, was found to be the Yellow River's abandoned riverbed, which had been encircled by dikes built in the first century B.C.E. and then rebuilt in the eleventh century C.E. The locals' ignorance of when these sandstorms had begun suggests that they started well before the early eighteenth century. Year after year, sand was blown by strong spring winds into neighboring areas. As a consequence, "the sites of manors and buildings, covered with sand, cannot be discerned. Occasionally, there are some surviving buildings whose roofs merge into the sand.

的重礦物成分，結構特徵與風沙的沙物質來源，*Zhongguo shamo* 中國沙漠 7 (1987): 24–33.

¹¹⁵ XCB, 170.4096.

¹¹⁶ SS, 92.2281.

¹¹⁷ XCB, 335.8084.

¹¹⁸ SS, 95.2357. This was the last time that Guantao was reported to suffer the Yellow River's flood.

¹¹⁹ Zhao Zhixi 趙知希, "Xiaoping shabo jianze ji" 孝平沙薄減則記, in Liu Jiashan 劉家善 et al., *Guantaopian zhi* 館陶縣志, photolithographic reprint of the 1893 edition, *Zhongguo fangzhi congshu* edition, 6.303–10.

The sands spread over more than ten *li*, undulating up and down and forming hills and gullies.”¹²⁰ The area affected by these annual sandstorms was large: “for over seventy or eighty *li*, from Zhangsha in the south to Xuedian in the north, the land was in a similar situation.”¹²¹ The survey by this magistrate shows that Guantao’s sand-covered land totaled at least a thousand *qing*. These sterile lands were abandoned by peasants unwilling to fight sandstorms; the population was quite thin, and agriculture in these parts of Guantao often proved a failure.

Such a long-lasting environmental and social tragedy was not unique to Guantao County but happened in other parts of Hebei as well. In the northeastern section of Daming County, which the Yellow River’s northern course flowed through in the eleventh century, “along both sides [of the abandoned riverbed] there remain no remnants of dikes, only the widely diffused yellow sand.”¹²² In the southeast of the county, the Yellow River burst its banks in 1060, creating the eastern course. Over the next few decades, the river kept depositing a massive volume of sand at the burst site, eventually forming sand dunes that exceeded ten meters in height. It is reported that, until the government’s land reclamation efforts of the 1960s, these sand dunes had provided sand for storms as frequent and as destructive as those in Guantao. The sands in this area severely inhibited the growth of vegetation, and the local economy languished.¹²³ In other places, such as Neihuang in southern Hebei, sand-covered land that had been formed by the northern course of the Yellow River is immediately visible to the naked eye.

Conclusion

The shift in the course of the Yellow River into Hebei that occurred in the mid-eleventh century initiated eight decades of progressive environmental degradation there. Even in those parts of Hebei that escaped much or all of the environmental destruction, the impact of the river’s flooding is evident. For instance, in Hebei’s southeast corner, popula-

¹²⁰ Zhao Zhixi, “Shu ‘Taoshan ji’ hou” 書陶山記後, in Liu Jiashan et al., *Guantaoxian zhi*, 2.85–87.

¹²¹ Zhao Zhixi, “Xiaoping shabo jianze ji,” in Liu Jiashan et al., *Guantaoxian zhi*, 6.304.

¹²² Shi Nianhai, *Heshan ji*, 2:43.

¹²³ Wu Chen et al., “Huanghe xiayou hedao bianqian de guhedao zhengju ji hedao zhengzhi yanjiu,” *Lishi dili* 17 (2001): 18.

tion growth, agricultural prosperity, and the expansion of silk production occurred mainly after 1048—that is, during the eight decades after the Yellow River ceased to pass through this area. The flooding also had an indirect impact on western Hebei, along the Taihang Mountains. After 1048, migrants flocked to this area for work and refuge from the flood-ridden prefectures of central Hebei, where agriculture had given way to foraging for wild food, fishing in marshes, and extracting salt from land. Timber felling, pottery making, and iron and coal mining all flourished here as commercial industries.

Viewed from an empirewide perspective, the Yellow River floods in Hebei and their attendant environmental disasters prove highly instructive in at least two ways. Firstly, the repeated occurrence of these problems in a key area of north China suggests that the treatment of the Tang-Song transition as a largely southern Chinese phenomenon is inadequate. Although the dredging of waterlogged lowlands and the clearing of mountain forests in the lower Yangzi valley fostered the expansion of population and rice cultivation, the regular flooding of the downstream reaches of the Yellow River led to similarly dramatic modifications of the landscape in Hebei, but it did so at great cost to its environment, population, and agricultural production during the last half of the Northern Song. The environmental and economic problems experienced at that time by this ancient grain basket of north China need to be considered as an essential part of the Tang-Song transition. In hindsight, the shift of the empire's economic center from north to south seems inevitable, especially since the rice crops favored by the south tended to be more productive than the wheat and millet commonly grown in the north. Yet, the timing of this shift—that is, its role in the Tang-Song transition—was not inevitable; therefore a more complete, more northern, focus on the history of agricultural production during these centuries of transition promises a deeper, more accurate understanding of the economic dynamics of this great change in Chinese history. In fact, once the historian's focus falls on the eleventh-century crises of economic development and political rule, the north's experience surely must assume a greater role than the relatively successful south in the discussion of Song history.

Secondly, the problems of controlling the Yellow River downstream in Hebei were closely linked to persistent military and environmental problems along the Yellow River over a thousand miles inland

from Hebei. For most of the eleventh century the Yellow River's middle reaches in the Ordos region were by and large under the control of nomadic states north of the Song border. After the Xixia incursions into Song territory during the 1040s the defeated Song paid even less attention than before to this area's economic and social needs and more to its own strategic needs along this border, specifically, how it could exploit this area's land, forests, and other material resources for its military defense. Such a blinkered, if understandable, Song response to its political and military struggles in the northwest neglected the serious environmental problems that were then arising in the middle reaches of the Yellow River, such as the exacerbation of soil erosion and loss of control over water currents. Downstream, however, the consequences of these problems were less readily ignored. Centuries of soil run-off from the hillsides of the middle reaches had raised the bed of the Yellow River in its lower reaches, exerted greater pressure on the surrounding embankments, and eventually led to frequent bursts, floods, and course shifts in the Hebei area. The Song government, lacking the military power to deal with the problem at its source, responded with a series of policy shifts, the use of innovative hydraulic technology, and novel if unproductive uses of land within Hebei that resulted in great expenditures but few solutions. Thus, the environmental causes and consequences of the 1048 shift of the Yellow River, in addition to having great significance for the development of Hebei, lie at the heart of many of the broader issues of economic transformation and dynastic rule that have rightly concerned studies of the Northern Song for the last century.