The cradle for the Heaven-Human Induction idealism: Agricultural intensification, environmental consequences and social responses in Han China and Three-Kingdoms Korea

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Abstract:

Han China (206 BC – 220 AD) witnessed significant population growth, pronounced technological development, intensified agricultural practices, and the construction of large-scale hydraulic engineering projects in the Yellow River. These processes coincide with increased frequency and intensity of major floods along the Yellow River. The interactions between flooding and social-technical developments fundamentally reshaped politics of the Han and stimulated the formation of the so-called Heaven-Human Induction idealism. This Confucian environmental ethic gradually became a powerful orthodoxy that shaped political and economic behaviours and society's perspective on and actions towards utilising environmental resources and transforming landscapes. Similar processes played out in Three-Kingdoms Korea (300 – 668 AD). The Korean case exemplifies how, as in China, this idealism was a product of the long-term interplay between state formation and the environment through the development of intensive agriculture.

Key words

Han China, Heaven-Human-Induction idealism, agricultural intensification, Yellow River floods, Three-Kingdoms period Korea

Introduction

Archaeology, especially geoarchaeology, plays an increasingly important role in the study of how ideas and knowledge about soil, water and agriculture were intricately intertwined with social and economic developments (e.g., Lucero 2006; Scarborough 2006; Wingard and Hayes 2013). This can lead to a deeper understanding of critical issues such as sustainability and the formation of environmental ethics. 'We are all in this together' is a saying frequently used by researchers and public media to refer to the urgent need to develop an environmental ethic that accommodates the increasing dilemma our society faces with concerns about sustainability and environmental degradation. Whilst environmental ethics have been a great inspiration in many fields such as philosophy, ecology and geography (e.g., Crosby 2004; Morton 2009), there is considerable concern about the responsibilities of individuals and those of the community (Gudorf and Huchingson 2010). Since individuals and the community sometimes have different needs, they often compete with each other over economic resources and create tensions within society. To better understand how interest conflicts (e.g., on land ownership) between individual and community help to shape certain kinds of environmental ethics, we need to look deeper in history to illustrate the complicated and dynamic relationship between technologies, economic subsistence, collective or individual decision making, and political structure. Early imperial China, otherwise known as the Qin (221-206 BC) and Han period (206 BC to 220 AD) (but only the latter is discussed here, Table 1)[1] presents an ideal case for such research as (1) it was a period of dramatic political changes with the emergence of centralized governance with huge resources at its disposal; (2) it witnessed pronounced technological advancement, including, notably, the popularity of iron tools in agriculture and the development of irrigated agriculture (Bai 2005; Chen 2002); and (3) these changes, along with many other forces such as the intensifying cultural and political interactions along the Silk Roads, triggered fundamental shifts in philosophical thinking, and ideology, and thus altered the politics of the Han period. While historical studies have illustrated the social consequences of intensified agriculture due to population growth during Han period (Wang 2007), very little research has examined the environmental background of such economic behaviours and their social and political outcomes. More importantly, the degree to which this important interaction between environment and society helped to shape a new type of environmentalism has been overlooked.

This article focuses on the formation of what we may tentatively consider an early form of environmentalism, often called Heaven-Human Induction idealism (Huang 1988), and how it profoundly influenced political, social, and economic discourses in Han China. Stemming from interpretations of astronomical phenomena by scholars from the Warring States period (Table 1) onwards (e.g., Liu 2010), Dong Zhongshu (179-104BC) further articulated this Confucian idealism (Dong 2012; also see Du and Cui 2012). According to him, the universe (Heaven) was composed of five elements (gold, wood, fire, water and earth) which were in a constant equilibrium. Heaven has a will that regulates everything in the universe. Humans and their ideas, emotions and virtues are thus all created by Heaven. Abnormal astronomical phenomena and natural disasters rise once this balance is broken (Dong 2012). As a consequence, rulers, as representatives of Heaven on earth, should always follow the will of Heaven. In this new type of Confucian idealism, environmental disasters were regarded as a punishment enforced by Heaven on the mundane world because of human wrongdoings. Promoted by the Han court, this theory gradually became a powerful orthodoxy that influenced political and economic behaviours, and consequently the society's perspective and actions towards utilizing environmental resources and transforming their landscapes. At the same time, this theory was contested by Legalists[2], and pragmatic government officials who had an interest in advancing the state's interests (Huan 1967). Thus while a prominent ethical position, it was in practice often not adhered to by government agents.

In contrast to the predominant focus on the philosophical dimension of this influential Confucian idealism (Huang 1988; He 2000), this paper examines the agricultural foundation of the evolution of this idealism. We use archaeological, environmental and historical evidence. First, we use environmental evidence to present a preliminary reconstruction of the ecological context of agricultural development during the Han. We then cross-check these different lines of evidence. Archaeological discoveries not only provide supportive evidence to textual information on the Heaven-human Induction idealism, but demonstrate that soil, water and agriculture were all integral parts of Han agricultural development. Developments during the Han provided the foundation for the evolution of the Heaven-Human idealism, as attested by various textual-based evidence. The primary textual records that were written during Han and were transmitted later on by different generations, on the other hand, provide significant insights to the attitudes towards the Heaven-Human Induction Idealism in the Han society. Drawing on the discussion of this evidence, we present a summary of agrarian and water-use history and the degree of landscape transformation based on crop choices and changing agricultural regimes, environmental conditions and political structures in the two most developed regions of the Han empire: the Guanzhong Plain in the Wei River (tributary of the Yellow River) where the capital was located, and the Lower Yellow River. We aim to disentangle the close and intricate intertwining between environmental contexts, economic foundations and political discourses in the evolution of this Heaven-Human Induction Idealism. We argue that the fostering of this idealism coincided with dramatic population growth, rapid agricultural development and imperial expansion. Because the development of these three aspects are often associated with increasing environmental risks, more frequent natural disasters and shifting political outcomes, we contend that it was such a co-evolution of these factors that helped to shape the new idealism. We then use a Korean case to assess how the society, under different environmental, economic and political settings, responded to population growth and agricultural intensification with the strong influence of this Confucian idealism.

Monsoons, alluvial histories and ecology of the Yellow River

Much of East Asia is controlled by oscillations of the Asian summer and winter monsoons (Clift and Plumb 2008; An 2000). One of the direct consequences resulting from the monsoonal changes in much of East Asia is the concentration of rainfall in summer. Climates of the Han era were highly variable, and were characterised by significant variability with documented shifts between wet (flood) and dry (drought) periods (Wang 2010, 34; Chu 1973; Wang 1995; Chen 2002)[3]. Short-term but severe climate anomalies occurred seasonally or annually, imposing a serious threat to the agrarian economy. The instability of the Han-era climate limited predictability of rain and droughts and placed great strain on government resources because repeated and frequent climate crises reduced resilience and increased the vulnerability of the agrarian producers.

Vast areas of the North China Plain are the product of the ongoing alluvial activities of the Lower Yellow River, whose riverine landforms are much flatter than the Middle Yellow River, with large-sized terraces and floodplains. The Lower Yellow River channel, particularly the section in its lower reach, frequently changes its course at centennial scales (Chen et al. 2012; Xu et al. 1996). Frequent river avulsions and massive floods are documented from the late Holocene onwards (Chen et al. 2012). The floodplains of the Lower Yellow River are generally broad, with little vertical relief. This means that arable lands for agriculture and other related economic activities are abundant. The river carries large amounts of eroded materials from the easily eroded Chinese Loess Plateau. These suspended sediments are subsequently re-deposited after floods recede (Bridge 2003, 268; Yang and Li 2007, 42). As a consequence of high sediment loads and relatively low water levels, the Yellow River flows in a braided pattern across the North China Plain. As channels switch the floodplain topography becomes complex, with lakes, relict channels, and underfit drainages marking the landscape. Floodwaters often follow a seemingly random pattern that is really the result of a complex historical process of floodplain evolution (Wang 1998). In other words, water management in these areas is not static, but rather a dynamic response to challenging conditions.

Population growth during the Han

Population growth during Han period was very rapid[4]. Evidence of Han population trends is drawn predominantly from primary historical records including *Records of the Grand Historian* (Sima 1959), *Book of the Han* (1964) and *Book of the Late Han* (Fan 1973). Ge (1997, 47) claims that the average population growth rate from 202-134 BC reached as high as 10-12 ‰ (but cf. Bielenstein (1987) for a more modest assessment). In the first hundred years of Eastern Han (Table 1), the population grew close to the highest level seen in Western Han. A census carried out in 140 AD suggested a figure near 50-53 million (out of 9,689,630 households, Loewe 2006, 142), and eventually in 157 AD, the population surpassed the 60 million threshold (Ge 1997) Apart from the Guanzhong Plain, the Lower Yellow River was the most densely populated area in the country (Figure 1). Most large cities that had a population greater than 20,000 were located in this area. Some counties in what is today eastern Henan, western Shandong, and southern Hebei provinces had population densities of 190 to 260 persons/km^2 (Ge 1986).

The scale of population changes during Han was extraordinary and the potential problems they caused were unprecedented too. Large scale and frequent migration was both the crucial factor that influenced population change and the re-distribution of population, and a key solution to deal with population pressure. For example, when the Guanzhong Plain and many areas along the Lower Yellow River were overly crowded, the conflict between population and land became increasingly pronounced such that the Han court often had to move the immigrants out of these crowded areas that were reaching the carrying capacity threshold for feeding more people (Ge 1986; 1997). These migrations often coincided with periods of imperial expansion that, to some extent, was also driven by the crisis resulting from the increasing conflict between population growth and shortage of resources (Huan 1967; Wagner 2001). Another solution, however, was to pursue the reclamation of lands that were either previously unoccupied or ecologically unsuitable for cultivation.

Technological developments during the Han

The Han period witnessed technological advancements in metallurgy, agricultural practice and irrigation. While iron technology had appeared some several hundred years before Han, it was not until Western Han that iron tools began to be abundantly produced and used extensively in economic production. Different kinds of iron tools were produced by the state and private foundries and supplied or sold to farmers for tilling, ploughing, weeding, harvesting and other related activities (Bai 2005). However, the popularity of iron tools for agriculture varied in different regions. The spread of iron ploughshares is a good example of how the adoption of iron tools was not a straightforward process. Iron ploughshares began to be used by middle Western Han (Table 1) as evidenced by increasing pictorial evidence of farming scenes and archaeological discoveries of iron ploughshares (Liu 2010, 2014). Despite the obvious efficiency of iron ploughshares and being promoted by the Han court as a top down process to enhance intensification, they were not commonly used by farmers in the area around the Guanzhong Plain and the Lower Yellow River initially until late Western Han (Yang 1988). Only several dozens of iron ploughshares dated to middle Western Han have been found in the two regions (Liu 2005a; Zhang 1985; Bai 2005, 198-199) (Figure 2a), which is in great contrast with other types of iron farming tools such as spades, hoes, axes and sickles that are discovered in abundance all over China (Yang 1988). The archaeological evidence for iron ploughshare usage during Han revealed is further elaborated in historical documents. As recorded in the *Discourses on Salt and Iron* (Huan 1967), to some farmers, not only were the state-produced iron ploughshares expensive, many were also of poor quality and too fragile to work on hard soils. Farmers simply resisted the adaptation of these unproven technologies (Wagner 2001). The spread of animal-draft ploughing provides a similar story. For most farmers, it was just simply too risky to own a domesticated cattle and use it in ploughing because cattle were expensive to purchase and the investment was so high that the farmers were putting their financial situation at a great risk (Wagner 2001). It was not until new policies introduced at the end of Western Han or the beginning of Eastern Han (Table 1) that the state could either rent cattle or subsidise the cost of purchase that animal-draft ploughing was quickly adopted in different regions (Yang 1988) (Figure 2b). In addition, manuring was now widely applied to improve soil conditions (Hsu 1980, 246, 253; Gong 1995; Tan 2010). This has been confirmed by ceramic models of pigsties and houses and pictorial evidence in Han tombs (Figure 2c) and the excavation of the Sandaohao settlement in Northeast China where pigsties were connected with toilets for the collection of manure (Northeast Museum 1957). Farming fields were sometimes located close to pigsties where animal dung was piled up and ready for used as fertiliser (Luo and Chen 1985).

Irrigation projects during Han period

Already in the Warring States (475-221BC), many large-scale irrigation facilities were built by regional rulers in the Lower Yellow River (Yao 1987; Ye and Zhang 1990). These facilities were continuously used in early Western Han when the philosophy of Daoism Quietism was adopted during Emperors Wen and Jing's reigns (180-141 BC) (Huo and Li 1985; Zhang 1981; also cf. Loewe 2008, 652 and 693-697 and Sima 1959). Advocating doing nothing, this idealism was to give the people a chance to recover from the devastation of the Qin-Han wars (c. 221-180 BC). However, quickly after the re-consolidation of the state economy, many large-scale hydraulic projects that required enormous investment in labour and resources were constructed beginning in Emperor Wu's reign in the mid 2nd century BC (Yao 1987, 50-84; Hsu 1980, 254-277). These facilities were mainly located in the Guanzhong Plain. Most of the irrigation canals were connected with major rivers such as the Wei River. Zhengguo canal was built around 246BC during the Warring States period. It was continuously used during the early Western Han (Lu 1995). When the Zhengguo canal gradually lost its function, the Bai canal was dug during Emperor Wu's reign in around 95BC. This was to make sure the fertile land in the Guanzhong Plain would be continuously irrigated (Lu 1995). Recorded in the Records of the Grand Historian, (Sima 1959, 1405-1415), the most daunting task completed during this time was the construction of the Longshou (Dragon Head) canal (also see Sadao 2008, 554; Zheng 1996). To reach the Yellow River, this canal had to pass through a mountainous area. As well as digging a horizontal tunnel, they also dug vertical wells joining the tunnel (Liu 2007; Zhang and Gao 1981). Guanzhong was for the first time connected with the Yellow River; this connection became essential for the transportation of people and goods. None of these canals have been excavated. However, many surface surveys in the upper Jing and Wei Rivers have enabled the identification of the locations of the headwaters of these canals (Zheng 1996). Interestingly, canals dating to later periods were often located further upstream than those of earlier periods. This might be to do with the ongoing bank erosion and downcutting processes of the river (Lu 1995). At the headwater of the Zhengguo canal, gravels from the river floodplain and timber were used to build the dam (Zheng 1996), while the headwater at the Bai canal had a structure very similar to the Longshou canal just described (Qin 1974). These irrigation projects were of enormous scales. For example, according to Records of the Grand Historian, the Zhengguo canal alone, was at least 300 *li* (c. 150km) in length (Sima 1959, 1405-1415). In the vast areas of the Lower Yellow River, where agriculture was most developed, smaller scale, but more widely distributed irrigation projects were constructed as suggested by the *Book of Han* (Ban 1964; also see Ma 1997, 22-27 for a good summary of the relevant records). Extensive areas of arable lands were irrigated by these projects (e.g., the Zhengguo canal alone would have irrigated >40,000 hectares, Lu 1995); and in most times, these irrigation facilities were crucial in flood protection in North China (Tan 1962).

Though there is limited archaeological evidence, the abundant ceramic models and rich historical sources suggest a different attitude toward the construction of irrigation projects during Eastern Han. Unlike the ambitious Emperor Wu, the Eastern Han court was not interested in the construction of massive-scale projects as clearly stated in official document such as the Book of the Later Han (Fan 1973, 184). Instead, an increasing number of medium to small-scale irrigation facilities were built in the Lower Yellow River and in South China (Ma 1997; Wang and Zhang 1990, 105-119). Numerous ceramic models of such small-scale irrigation facilities have been discovered in Han period tombs in the Upper Han River and Sichuan of South China (Guo 1983; Luo 2003; Qin 1976), as a recreation of 'underground homes' of the decreased (cf. Selbitschka 2015). Although making the assumption that these models were straightforward reflections of historical conditions is problematic, they provide important glimpses of Han daily life and economic activities when archaeological excavations of Han villages are limited. These models provide vivid depictions of how these small irrigation systems functioned: located on important landforms connecting arable lands with natural water bodies, they mainly consisted of two parts: the small ditches for water diversion and even smaller ditches located on the sides of or across the farming fields to control and supply water during farming seasons (Guo 1983; Liu 2009) (Figure 3a; Figure 6). In addition to the economic needs they served, expanded construction of small-scale irrigation facilities by local communities has deeper social and environmental reasons. First, many natural lakes existed during Han period. In the Shandong Peninsula in the Lower Yellow River alone, there were more than 140 lakes recorded in the *Book of Han* (Ban 1964; but also see Ma 1997, 10; Wang 1998). As revealed in regional geomorphological surveys, these lakes were mainly remnants of oxbow lakes formed during the avulsion of the Yellow River (Wang 2007, 107-116; Zou 1987). These lakes continued to receive surface runoff and became a major source of water for irrigation. Some even became private assets. Discovered in tombs belonging to mid to lower class elites, ceramic models illustrate ponds were dug next to fields, either close or far away from courtyards (Luo 2003; Figure 3c and 3d). They were sometimes shallow, suggesting that these ponds and fields were used on rotation. But some were large and deep and must have been owned by rich families (Ma 1997). Inside or adjacent to courtyard buildings, wells and small ditches were dug and connected with water bodies via small outlets or holes that pierced the courtyard walls (Ma 1997, 26; Liu 1983; Luo 2003). Such wells and ponds located next to both farming fields and house compounds have been revealed during excavations at Sanyangzhuang (HPICRA and NICRC 2010; Figure 5). These small irrigated features were shared by these courtyards in the newly reclaimed land on the Yellow River floodplain. Unlike the Warring State periods, the expansion to new lands was allowed or encouraged by the Han court (Sun 2011). These features indicate that the irrigation system was the result of complicated water management planning for residential and agricultural use. Even today in rice farming regions, such small but robust irrigation systems still play a crucial role (Figure 3b).

Development of irrigated agriculture

A variety of crops were planted during Han times, including rice, millets, wheat, and beans. These were recorded in one of the earliest surviving manuals on agriculture from Han, the *Book of Fan Sheng Zhi* (Shi 1956; also see Wang 2007, 22-33), and also found as carbonised seeds from archaeological excavations (Li 2014, 37-33 and Chen et al. 2010 for wheat; Liu 2005b for rice; Wu et al. 2013 for beans; and Zhao 2009 for millets). Wheat farming was relatively new to the Han farmers and its promotion in many parts of the Han Empire was not a smooth process. In the Guanzhong Plain, according to the *Book of Han* (Ban 1964), wheat was not liked by most farmers and the royal court had to spend considerable effort in promoting wheat farming (Hui 2007). For the farmers, the reluctance came mainly from the consideration that wheat required more labour input for soil preparation and irrigation than millets even though this could potentially lead to increase in yields, whereas the royal court were keen to see production increase so they could reap more tax from expanding wheat farming (cf.Peng 2010). To some extent, this mixed attitude, and a delay in adopting wheat farming recorded in historical documents is testified by archaeobotanical evidence. Zhao (2009) examined plant remains stored in ceramic models of granaries found in 23 Han tombs in Guanzhong, datable from middle-late Western Han to Eastern Han. Only four (all dated to late Western Han period) out of 45 ceramic granaries contained wheat and barley (33 contained millets and nine contained beans). These tombs belonged to commoners (Liu 2004 in Zhao 2009) and might indeed reflect the still relatively minor role of wheat farming in the subsistence of the society in Guanzhong. Compared to the Guanzhong Plain, wheat farming was more popular in the Lower Yellow River. The idea that the eastern part of the Han empire was suitable for wheat farming was articulated in primary texts of the time, such as *Huai Nan Zi* (He 1998). However, these texts were vague as to why wheat farming was popular in the east. Ecological factors (e.g., seasonality of rainfall) have recently been emphasized by some scholars (Hui 2007) as one of the reasons why wheat farming was more important in this region. In the Lower Yellow River, the majority of rainfall falls in the summer (July to August), often causing floods and therefore rendering a severe threat to harvesting if the floods coincide with the ripening of the crops (Peng 2010). There was an urgency for changing the seasonality of farming in relation to these environmental conditions. Winter wheat farming provided an important opportunity to shift the production calendar. Planted in the winter, the crop reaches its crucial stage of growth before June and can be harvested before the flooding season (Hui 2007). The local communities in this region would have appreciated this ecological advantage of winter wheat and gradually promoted its cultivation. This new crop pattern ensured more reliable crop yields in these densely populated areas, which was vital to social stability. In addition, the life cycle of winter wheat from September/October to June meant that the fields could be planted with other crops after harvesting, which further increased yields and the productivity of land. With these advantages, winter wheat farming quickly spread across the Lower Yellow River and in some places over took millet farming as the primary subsistence strategy. The ecological and historical evidence described above is in line with archaeological findings. Texts recorded on bamboo slips discovered at Yinwan in present northern Jiangsu provide first-hand information concerning the scale and season of wheat farming in the Lower Yellow River. *Ji Bo* (one of the official documents surviving at Yinwan) says: by the end of Western Han (27-7 BC), the amount of arable lands in this county constitutes 512,092 hectares and about one fifth (c. 107,300) was cultivated with winter wheat, increased by 1.79% from the previous years (Zhang and Zhou 2011, 5). The fact that only figures regarding wheat cultivation were mentioned in the Yinwan bamboo slips reveals the importance of wheat cultivation to the local government. Overall, wheat cultivation was more important in the eastern part of the country, benefiting from the developed local, small-scale irrigation systems, than that in the western part by the end of Western Han. Also in the Lower Yellow River and parts of the Guanzhong Plain, rice was grown in places such as river floodplains that had better hydrological conditions. In wetlands in central Henan Province, rice was already cultivated during the Warring States period. By the Han period, more rice species were bred and varieties became adapted to local environments (Wang 2007, 22-25). For example, rice grains were found inside a bronze basin in a Han tomb in Xi'an (Cheng et al. 2004, 699) and in a tomb belonging to a state leader in northern Jiangsu (but details not clear, see Liu 2005b). An awnless rice species with very full seeds was commonly grown near Luoyang City. Some of the seeds were as large as 8 cm in length and 4 cm in diameter, benefiting from favourable growing conditions (Wang 2010, 52 and 85). According to textual sources such as the *Book of Fan Sheng Zhi* (Shi 1956), rice was also widely cultivated in Shandong (also see Yang 2007 for a summary of relevant historic sources). Benefiting from the springs and ponds in the Xindan River to the north of the Lower Yellow River, rice also grew well here and was praised as a good species (Wang 2010, 85). In other places of North China, the distribution of rice farming was much more sporadic. Rice remains have been discovered at more than 10 locations to the south of the Yangtze River, but the actual number would have been much bigger (Liu 2005b). As a whole, although the proportion of rice farming in the Han agricultural system was lower than both wheat and millet farming, rice was progressively gaining an important role (Zhang 1991), partly due to the imperial expansion to South China which promoted cultural and technological interactions between the North and South, including more culinary traditions from the South being brought into the North (cf. Liu 2016).

Socio-environmental consequences of agricultural development

Population growth and expansion of irrigated agriculture during Han resulted in an increasing shortage of arable lands. Conflicts between different interest groups gradually emerged. One of the solutions was to allow farmers to reclaim lands that were not cultivated previously. The government would even provide free seeds to farmers who wanted to cultivate on these newly-claimed lands (Ma 1997, 60-61). This policy gradually became popular. In densely populated areas like the Guanzhong Plain and the Lower Yellow River, a potential increase in arable lands came from the reclamation of river floodplains. States had already begun to build levees on the floodplains of major rivers during the Bronze Age as has been confirmed by a recent geoarchaeological survey along the ancient river channel of the Lower Yellow River (around 3000 BP) (Kidder and Liu 2014). These levees not only were efficient in mitigating small-scale floods, but also served as an important territorial boundary demarcating the inhabited domain and the uncultivated landscape. Building houses on the levees and cultivating on the floodplains were strictly banned by the states. In much of Western Han, levees were continuously built on the edges of river floodplains; lands on river floodplains were still under state protection as these were also strategically important places for flood protection. But by the end of Western Han, restrictions on floodplain use collapsed. First came the encroachment of human settlements on the edge of river floodplains. Levees were then occupied by human settlements and lands on the river floodplains were cultivated (Wang 2014; Sun 2011). Excavations at Sanyangzhuang, a well-preserved settlement located in central Henan province on the ancient river channel of the Yellow River, provide unambiguous evidence for the beginning of large-scale river floodplain occupation and cultivation (Kidder, Liu, and Li 2012; Kidder et al. 2012). These excavations capture a rare moment when farmers were retreating from their new lands on the river floodplain due to rising floods. Here more than 15 building compounds have been found. Each compound consists of one to several courtyard buildings and was surrounded by farming fields. Evidence for silk production and food processing was also discovered. Local farmers were practicing dry-land farming on the river floodplain (Wang 2014). The preservation of ridges and furrows indicates that fields were cultivated on a rotational basis, indicating the farmers were farming on fixed fields with significant labour investment and intensive practices. The latter rapidly turned alluvial sediments into anthrosols. At the same time or even earlier, similar development of reclaiming lands from river floodplains was also seen in the Middle Yangtze River.

From the Warring States period onwards, the frequency of Yellow River floods became closely related with land use along the river channel. Land use activities that caused significant erosion in the Upper Yellow River had a significant impact on the pattern of alluvial activities in the Middle and Lower Yellow River. Major floods from the river occurred increasingly frequently from middle Western Han onwards and the Yellow River became China's 'tribulation' (Zhuang and Kidder 2014). According to the three primary Han period texts*, Records of the Grand Historian, Book of Han and*

Book of the later Han, , amongst the 18 major floods on the Yellow River during Han, 13 of them happened during Western Han (Duan 2005, 12-16)(but see Table 2 for a more complete account). One of the main causes for this increased frequency of floods was improper land use in the central part of the empire and also in the peripheries where, from Emperor Wu's era (141-87 BC) onwards, large numbers of immigrants settled or were settled by the government (Ge 1997). In the northwest, for example, farmers migrating from central China cut trees and cleared land for to be economically self-sufficient. These activities significantly accelerated surface erosion and the eroded sediments were flushed into rivers, resulting in dramatic increase in river sedimentation rate as river channels were quickly silting up because of these sediments (Shi, Dian, and You 2002). As the base of the river rose because of siltation the river rose above the floodplain increasing the risk of catastrophic flooding in the alluvial North China plain. In addition to the aforementioned case-study at Sanyangzhuang, deposits of 'destructive floods' during Han due to long-term agricultural intensification have also been found in Rosen et al.'s (2015) survey in the Qufu area of Shandong.

But another reason for more flooding was the reclamation of lands on river floodplains which significantly reduced the capacity of the river channel to absorb flooding water (Zhuang and Kidder 2014). The Han government already noticed this problem. In the Records of the Grand Historian and other contemporary or later historical documents, statements about the tension between farming, water and land appear frequently. While government officials who had seen this ongoing problem on the ground proposed numerous solutions, the Han court's response was limited (Fu 2013, section 3.4.1). At the same time, large-scale irrigation canals suffered similar problems: silt-laden water quickly accumulated in the canal beds limiting their utility; the government's financial limitations and under investment in public works also meant there was a lack of proper maintenance leading to their increasing dysfunction (Ma 1997). These irrigation canals gradually played a less important role in flood prevention, which was one of their original functions. By the end of Western Han many of these canals were abandoned and became part of the flooding problem because they now served as channels for floodwaters. The frequency of severe floods along the Yellow River was lower during Eastern Han[3] (Tan 1962; Yang 1999). This coincided with the rise of small-scale irrigation facilities. This transformation suggests that well-functioning, small-scaled irrigation facilities play a more robust role in buffering the flooding risk than large-scale ones that are essentially more difficult to manage.

Natural disasters and social solutions in Han China

Besides the consequences of these human modifications of the environment, Han China was further plagued by periodic natural disasters. Droughts, for example, often alternate with floods. Compared to millets, which were the main crop in the later Bronze Age, wheat and soybean, which were now major staples, consume much more water and would be more vulnerable to droughts (Hsu 1980, 102; Luo 1989, 125). This increasing need for water in agriculture clashed with the uneven temporal and spatial distribution of water across the country and thus called for state actions. While the aforementioned Western Han irrigation projects were impressive in their sheer scale some large irrigation channels did not function well. In contrast, making use of optimal hydrological conditions, small-scale irrigation systems functioned much better and played a crucial role in the development of irrigated agriculture during Eastern Han. Droughts remained a main concern for the Han society (Table 2), with the number of recorded droughts in Eastern Han doubling from Western Han times. What is worse was that plagues of locusts often happened subsequent to droughts. Famine prevailed, forcing farmers to leave their homelands and become vagrants. A series of policies were adopted by the government for disaster relief, including, for example, providing loans and bestowing state lands to landless farmers and allowing them to exploit resources from forests and rivers which had been forbidden previously (Luo 1989, 125). Although most of these natural disasters have yet to be confirmed archaeologically, geoarchaeological investigations at Sanyangzhuang and Qufu (Kidder et al. 2012; Rosen et al. 2015) attest to the scale and magnitude of floods during Han.

As natural disasters became an increasingly serious threat to agriculture, food storage became more important. State granaries were set up during Han under the direct management of an official governmental department, Dasinongsi, which included associated offices for managing local granaries (Duan 2005, 72). These state granaries were located either immediately next to royal palaces or concentrated in cities or towns outside the capital. The Jingshi Granaries, located in an important strategic location outside the capital Chang'an, were built during Emperor Wu's reign and were used until the collapse of Western Han. Archaeological excavations have confirmed their enormous scale (SPIA 1990). The importance of granaries for local counties and communities were equally emphasized. Compared to the state granaries, these local resources played an even more crucial role in stabilizing food supplies when natural disasters occurred.

Birth and consolidation of the Heaven-Human-Induction idealism during Han

The close relationship between heaven and humans was discussed by Confucian intellectuals before Han (Huang 1988; Li 2003). Dong Zhongshu incorporated different ideas and further expanded this idealism According to him, the way Heaven responded to human society's failings was to visit abnormal astronomical and environmental phenomena on the society. In addition to auspicious or calamitous signs in the sky, floods, droughts, other kinds of climatic/environmental disasters and subsequent famines and social turmoil were all important ways heaven signalled its displeasure with human society for their wrongdoings. Emperor Wu often asked Dong's opinions about political affairs (Huang 1988); Dong's vision gradually entered into mainstream political philosophy. But there were other social, political and economic reasons why Heaven-Human-Induction idealism became a powerful principle in the political movements and philosophical thinking of the Han. First, the Daoist philosophy of Quietism that prevailed in early Western Han did not suit to the new situation of rapid imperial expansion during and following Emperor Wu's era. Because he saw himself as the Son of the Heaven, Heaven-Human-Induction idealism catered to the urgency of Emperor Wu's ambitious expansion as now every inch of land was under the Heaven (Du and Cui 2012). Second, agriculture became the main source of state revenue. This new idealism served to foster the growth of this new political and economic community; but at the same time, it also used to 'rationalise' the disastrous consequences brought about by expanding agriculture, and the social and political solutions to 'pacify' these disasters Third, this vision fit into the expanding necessity of improving the imperial bureaucracy.

Apart from disaster relief policies, which indeed triggered the establishment of a balanced Han welfare system, this emerging idealism also had a significant effect on many aspects of the political sphere. Fearing punishment from the Heaven, when natural disasters occurred, or even worse, persisted, Han Emperors would often not only decree a rescript of penitence, which were recorded repeatedly in historical documents (An 2012), but they would also voluntarily cut down expenses on sumptuous rituals and related activities (Liu 2001). These savings could then be used in disaster relief projects and to promoting agricultural production. Knowledge about floods and decision making surrounding them were also fundamentally shaped by this new idealism. Jia Rang (around 1st century BC), for example, proposed the famous three policies of river regulation and water control. The best solution, according to him (Fan 2007), was to let the river channels flow in their natural way. Floods occurred because society was not following the instruction of Heaven. The Yellow River should eventually flow into the sea from the North, which was the position water should be in the universe (Fan 2007).

Through increasing interactions between politicians and intellectuals and many successful experiments and failures, the Heaven-and-Human-Induction Idealism further gained such a prestigious status in the political and intellectual domains in the society that it became a main avenue for climbing the ladder of success in late Western Han.

Spread of the Heaven-Human-Induction idealism beyond Han China

This idealism gradually spread into other parts of East Asia. A representative case is ancient Korea, which highlights the influence of Heaven-Human Induction idealism as the main environmental ethics that were becoming closely related to the development of state-managed agricultural economy. The reasons behind the adoption of this philosophy in Korean peninsula echo what happened in Han China. With the presence of walled citadels, mountainous fortresses, large royal tombs, and distinctive pottery assemblages, all revealed by recent archaeological research (Yi 2012; Kim, Ahn, and Jeong, 2013), the Three-Kingdoms period (300 – 668 AD) is marked by the establishment of centralized kingship supported by hierarchical social class and bureaucratic administration for the first time in this region (Kwon 2008). This is dramatically different from the statelet-like confederacies developed in the previous Proto Kingdoms period (Yi 2012). The Three-Kingdoms period also witnessed great increases in agricultural productivity following the deployment of advanced iron technology and large-scale, state-controlled irrigation schemes. Because of geographic limitation of arable lands, increasing per capital productivity was vital to feed a growing population. The latter is suggested by the presence of large rice grains discovered in archaeological contexts dating to the proto Three-Kingdoms and the Three-Kingdoms periods (Yi 2012; Kim, Ahn, and Jeong 2013).

Despite their appearance in elite burials from the 1st to 3rd century AD, iron agricultural tools were only commonly used in daily life from the 4th to 5th century AD, as demonstrated by growing numbers of iron workshops and excavated iron tools. A wide variety of tools were produced, including those specially used in farming practices (Kim 2009) such as weeding, deep planting and draining. The application of animal-drawn ploughing also became popular, promoting the expansion of arable lands (Yoon 2013). The crop system was mixed, with rice, wheat, barley, millets and legumes all being cultivated. Though there was an emphasis on rice, there was not a sole reliance on rice or any other crop (Ahn 2010). The Korean peninsula is situated at the boundary of the rice agriculture ecotone defined by temperature and annual precipitation; planting other crops was therefore important to subsidize the low productivity of rice farming. These diverse crops buffered the potential risk of agricultural failure. In particular, though rice was already cultivated in the Bronze Age (Kim 2015), archaeobotanical research indicates that rice appeared to have become a luxury food, less available to commoners, around 0-300 AD, and its importance was further strengthened when it became one of the main tax items during the Three Kingdoms Period (Kim 2015; Lee 2010). It is not entirely clear why rice became a prestige crop apart from its high nutrient value and relatively higher productivity. Unlike the suggested connection between the changing social and ritual status of rice in parts of South Asia (e.g., Morrison 2001; Shaw and Sutcliffe 2003), rice became important as part of a broader socio-cultural interaction between ancient China and Korea and between different classes of the ancient Korean society. Religious institutions may form only a single component in this process; and indeed this new pattern of rice farming and consumption occurred before the adoption of Buddhism as the state religion by central governments of the Three Kingdoms during the late 4th to 6th Century AD. Nonetheless, it is clear from archaeological evidence described above that the increased perception of rice both as a staple crop and as luxury food appeared to have contributed to the restructuring of agricultural economy, with the construction of more rice fields and large-scale irrigation facilities. The implementation of rice farming thus created a tension in this otherwise unfavourable environment for rice farming which required substantial amount of water to the field system.

Historical texts like the *Samguk Sagi* (Kim 2012) and *Samguk Yusa* (Ilyeon 2012), which were compiled later than Three-Kingdoms periods in 12th-13th centuries AD, record information of large-scale hydraulic works decreed by the king for levee construction. Stele discovered at Cheongie (the Cheong lake), which was erected in either 5th or 6th century AD provides further information regarding the organization and scale of the construction and management of large reservoirs for water management that were operated by the government. According to Kang (2006), the Cheongje stele is thought to have been constructed in 476 AD (though the exact construction of it remains controversial) and it was repaired in 789 AD (Figure 4). Kang estimates that 7,000 people were drafted in the initial construction, while in the later phase 60 days of work by 136 axe-men and at least 14,140 soldiers was required to undertake repairs. The reservoir is currently 5km in circumference and has a capacity of up to 590,000,000m^3 of water (Kang 2006: 202). This would have been enough water to irrigate 460,000-510,000m^2 of land and to sustain a water supply against droughts that occurred every ten years according to early Joseon dynasty (14th to 19th century AD) records (Jang, Kim and Sung 2015). Beokgolje, another Three-Kingdoms period reservoir, is estimated to have held 124,250,000m^3 of water, enough to water 90,000,000-100,000,000m^2 of land and support 50,000 people based on Joseon dynasty records (Jang, Kim, and Sung 2015). In recent archaeological excavations, remains of the Gayari and Yaksadong reservoirs were found, with levees being built to retain water (Kim and Son 2015). The former is dated to the Three-Kingdoms periods based on the associated pottery sherds and AMS dating results (Sung 2015). There are a few more reservoirs such Uirimji, Susanje, Youngji and Gongeomji, that were built in the same or earlier periods according to historic documents, including *Samguk Saki*, *Samkuk Yusa* and *Goryeosa* (History of the Goryeo Dynasty) (Sung 2015).

The scale of the reservoir construction described above strongly suggests the presence of state-run irrigation systems with massive investment. In addition, possible innovations in irrigation technologies for higher yields in rice farming such as the use of wooden pipes for water supply to the field drainage facilities, and multiple irrigation schemes, are attested in recent research by Jeon (2010) and Noh (2010) who reconstructed ancient farming practices by revisiting historical texts including Samguk Saki and Samkuk Yusa; and remains of ridges and furrows preserved at recently excavated paddy field sites suggest crop rotation to replenish soils (Jeon 2010; Noh 2010; Yoon 2013) A geoarchaeological survey has confirmed the development of anthrosol due to intensive hydrolysis caused by repeated irrigation at a Three-Kingdom period paddy field (Lee et al. 2014). The excavated features related to rice farming at the site reveal the burgeoning rice agriculture supported by advanced techniques and state controlled irrigation schemes during the Three-Kingdoms and the succeeding Unified Silla (7th to 9th Century AD) periods. This new development also points to an extensive modification of local landscape for rice farming (Yoon 2013).

With large-scale irrigated agriculture becoming the backbone of the state economy, a new idealism was needed to rationalise the establishment of related state polices, especially when dealing with natural disasters, some of which threatened society by diminishing agricultural yields. Confucian Heaven-Human-Induction idealism was introduced to Korea during this period. A series of changes in the King's attitude towards natural disasters reflects the profound influence of this new idealism after 490 AD. When a drought occurred, the king would dispatch delegates to the regions affected and reduce the number of dishes in his meal as a manifestation of self-punishment. Often, new officials were appointed to rectify the king's mistakes (Jeon 2013). This is fundamentally different to the activities in the proto-Three-Kingdoms period (0-300 AD) when shamanistic regicide and performance of rituals were applied to pacify spiritual beings at the time of natural disaster (Jeon 2013). Prevention and mitigation of natural disasters, when harmful to agricultural production, became a duty of the bureaucratic organization by adoption of this idealism in Three Kingdoms' period.

Discussion and conclusions

With its deep roots going back to at least the Warring-States period, when different schools of thought articulating human-environment relationships were being formulated, Confucian interpretations of environmental realities and their interaction with the human society became important during Han. This philosophy was closely related to technological innovation and agricultural intensification during Han when population growth increased astronomically. Ironically, once agriculture is established as a state primacy, it often loses its robustness and adaptability when dealing with crises. Han society was particularly vulnerable when coping with natural disasters and the situation became even more complicated when these events were intertwined with political turmoils (Kidder et al. 2016**.** Expansion of agriculture by clearing uncultivated land in the Yellow River floodplain to produce more food came with costly ecological and environmental consequences. The most serious problem was the increasing frequency of floods as land that used to be inundated by floods was converted to arable. On the other hand, heavier reliance on water-intensive crops increased social vulnerability following catastrophic droughts. These natural disasters not only prompted governmental implementation of disaster relief programs, but also stimulated great debate in the Han court on how to better respond to these disasters. Because these events were interpreted as punishment from Heaven, the Confucian intellectuals' suggestion of living a frugal and humble life was adopted by the emperor. This new philosophical perspective promoted the formation of an environmental ethic that treated the physical environment and its behaviour as the agency that sits at the interface between the Heaven and the human society. Letting flooding water take their natural path to the sea was considered as the best solution to tackle floods. While there were superstitious beliefs which at times delayed flood prevention during Han (Fan 2007), the idea of letting river water choose a natural course coincided with the advanced geomorphological knowledge developed later on in Tang and Song periods (around 10th Century AD) (Dotterweich 2013). In addition, though it is not an environmental protection in a strictly modern sense, in their compiling and re-interpreting of Confucian classics, the Warring States and Han Confucian scholars stated explicitly the importance of harmony between society and nature and emphasized the conservation of natural resources (Zhao and Fang 2008). Many chapters in the three Confucian canons, namely The Book of Rites, The Rites of Zhou and the Book Etiquette and Rites, advocate allowing natural lives to recover and not cutting trees and hunting animals in the wrong season (He 2000). But how strong this ecological ethics was remains unclear and it was probably not until the Northern Song Dynasty (960-1127 AD) that it was further developed and strengthened by the new Confucianists (He 2000). This Confucian idealism on environmental ethics share some resemblance with environmental ethics that grew out of other religions in ancient China such as Buddhism and Daoism from the 3rd Century AD onwards (Liu 2007). For instance, centered on *Pratityasamutpady* (the theory of Origination in Dependence), Chinese Buddhism also stressed the interconnectedness of nature and human society, (Zhang 2010). But how this Confucian idealism interacted with other idealisms in ancient and modern China and becomes a great inspiration for the development of environmental protection in later historical and contemporary China is an important issue that warrants more scholarly effort (Hou 2014; Jenkins 2002; Zhang and Ren 2003).

Through tax policy, the central government exercised considerable control of agricultural and other economic resources (e.g., mountains and lakes for forestry and fishing). Whilst there was an awareness of the often negative environmental outcomes of rapid agricultural expansion (see section 5), the government, which set economic policies, was concerned with short-term, more urgent problems such as the shortage of arable lands. Even though floods were a constant threat, they were willing to trade relatively high-frequency but low-amplitude floods for increasingly highamplitude but low-frequency floods (Zhuang and Kidder 2014). However, 'agriculture cannot continue indefinitely without an environmental ethic' (Thompson 1995, 15), especially during Han when the economic growth was at an unprecedented scale. To a large degree, while it is true that the peasants were indeed all in this together when floods occurred, such was not always the case with the nobility and the court. Farmers lost their harvest and their homes and become vagrants. In response, the Han court would exercise self-restraint (cf. Nash 1989), not only to pacify the Heaven, but also to show to its people that the Court was not exempted from such socio-economic consequences. These actions, however, neither pacified Heaven nor satisfied the people.

But the popularity of this idealism encountered resistance. For example, despite realising that the best way of flood protection was to let water flow its natural way, the government continued to sponsor the construction of levees and other flood control devices. Gaining more agricultural tax was an important economic motivation as agriculture was now the main source of state revenues, but there was also influence from the Legalist view, which emphasized order and the government's role in controlling the natural and human world. Indeed, tensions between the emerging Confucian idealism, the legalist view and other philosophical thoughts existed throughout the early Western Han. The King of Huainan (179-122 BC) in the South, for example, gathered intellectuals from different backgrounds and compiled a book called *Huai Nan Zi*, which detailed ideas of many schools of thoughts still popular at the time (He 1998; also see Loewe 2008). The Discourse on Salt and Iron, compiled by Huan Kuan in 71 BC, 10 years after the debate between the Confucianists and the Legalists, provides a compelling story of such tensions and especially the government's sense of need to be parent to the people and to prevent disasters from happening. In 51 BC, Emperor Xuan had to host another meeting, during which Dong Zhongshu's vision was established as the accepted Confucian idealism was recognized by the government, whereas other philosophical thoughts were prohibited. Heaven-Human-Induction idealism went beyond just being an environmental ethic. Omens images depicting auspicious animals and astronomical signs, for instance, appeared commonly in Han tombs of different classes as a way of communicating with Heaven (Wu 1989). Confucian idealism was now deeply rooted in society. In further testament to its importance, Heaven-Human-Induction idealism gained its orthodox position in both the political and intellectual domains of not only Han China but its neighboring states such ancient Korea.

Indeed, the ancient Korean case exemplifies how such an idealism became a product of the long-term interplay between state formation and the environment through the development of intensive agriculture. This further illustrates the power of this new idealism among the Confucius-influenced societies of East Asia. More research is required to investigate how this philosophy was adopted and further development and how it has changed the historical discourse in these emerging states.

Notes

1: Chronology of the Qin and Han period

The Qin dynasty was extremely short-lived. Due to the lack of archaeological evidence for agricultural developments during this period, it is not dealt with in this paper

2: Scholars who advocated the establishment of *fa* (standards and laws) to form an 'anti-ministerial' 'monarchic despotism' (Pines 2014).

3: Whilst interdisciplinary research has contributed greatly to the reconstruction of palaeo-climate and palaeo-environment during Han, the resolution of such research is still quite crude. Information recorded in historical documents is still crucial for palaeo-climatic and palaeo-environmental reconstructions. A heavy reliance on historical documents, however, will also be problematic as these records are often biased and out of context.

4: Thanks to the detailed census conducted in AD 2, we know that the population almost tripled, from about 15-18 million in 202 BC (Ge 1997, 47) to nearly 60 million in 2 AD (Ge 1986, 6; Loewe 2006, 140-142). Some cities grew into huge ones. Linzi City, for instance, in Shandong during this time had a population of about 650,000, outnumbering by 150,000 that of the capital Chang'an in the Guanzhong Plain (Ge 1986, 30).

5: Controversy about the frequency and magnitude of Han period floods persists in scholarship. Generally speaking, there were more floods documented in Eastern Han records. But as many have argued (e.g., Tan 1962), this might be due to the society's awareness of floods and increasing attention paid to recording them. The magnitude, and disastrous outcomes, of Eastern Han floods was actually much smaller than that of Western Han floods, arguably due to the successful flood prevention work by Wang Jing in the first century AD(Tan 1962; Luo 1989; Yang 1999; and Zhou 2010).

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Period	Emperor
Qin 221-206 BC	The First Emperor and the Second Emperor
Early Western Han 206-141 BC	Emperor Gao, Emperor Hui, Emperor Wen and Emperor Jing
Middle Western Han 141-49 BC	Emperor Wu, Emperor Zhao and Emperor Xuan
Late Western Han 49 BC – 24 AD	Emperor Yuan, Emperor Cheng, Emperor Ai and Wang Mang
Eastern Han 25-220 AD	

Table 1 Chronology of the Warring States period and Qin-Han periods

Periods	Disasters					
	Floods	Droughts	Locust plagues	Other extreme weathers	Earthquakes	Epidemics
Early Western Han	8	7	3	5	3	0
Middle Western Han	8	14	10	10	6	1
Late Western Han	14	7	1	9	13	2
Xing Mang periods	5	1	4	10	2	1
Early Eastern Han	10	17	16	5	2	5
Middle Eastern Han	28	28	13	24	54	3
Late Eastern Han	25	10	11	11	39	9

Table 2: Frequencies of natural disasters during Han, after Luo 1989[5].

It is important to note that, even though the absolute numbers of floods and droughts in Eastern Han are bigger than that of Western Han, it does not necessarily mean that latter was faced with less problems. In fact, as demonstrated by many studies, society in Western Han suffered tremendously from frequent floods and this problem was much more mitigated after early Eastern Han when Wang Jing, a famous hydraulic engineer was sent the emperor to tackle the floods (Yao 1987). The smaller numbers of natural disasters during Western Han might be simply because the omission in historic records or indeed, as some have pointed out (Luo 1989, 124-125), due to corruption and the concealing of information by local authorities.

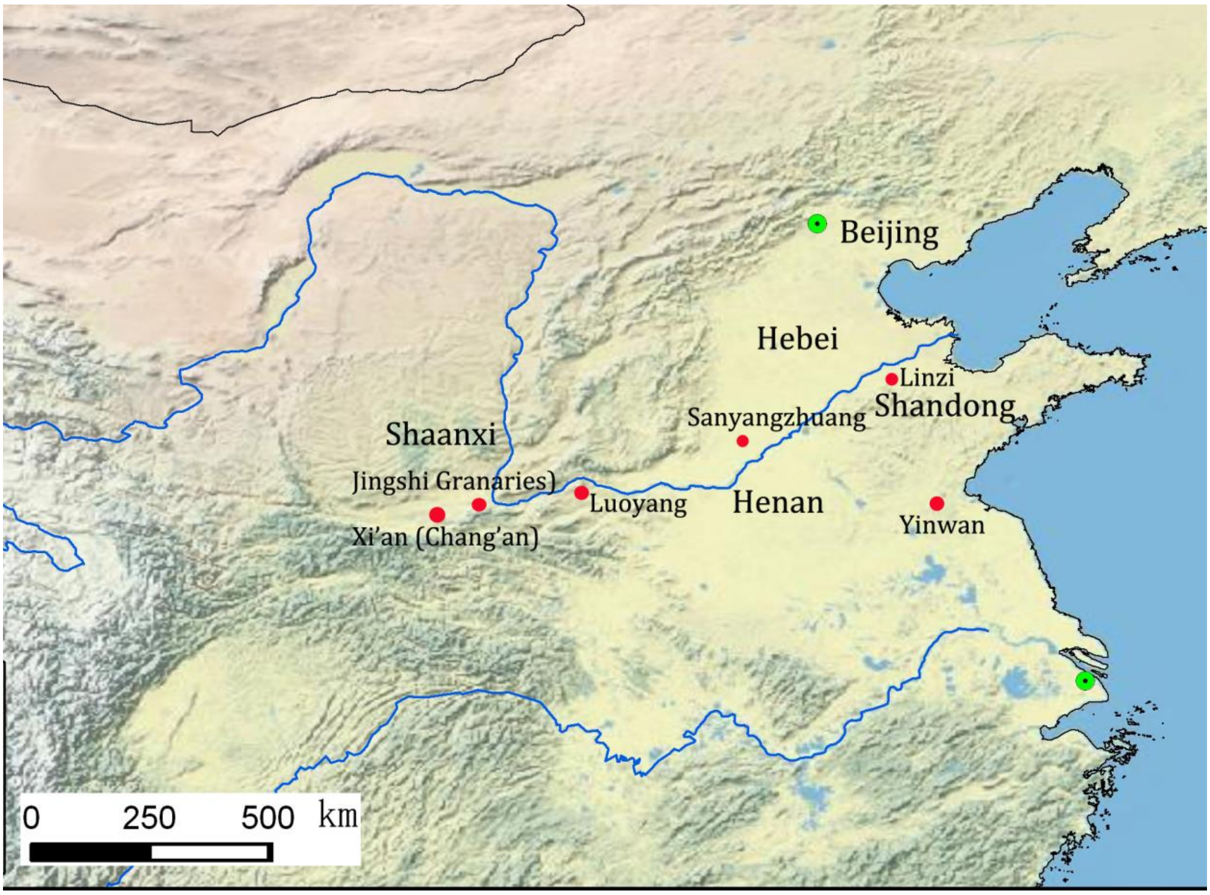


Figure 1: Regions and sites mentioned in the text.

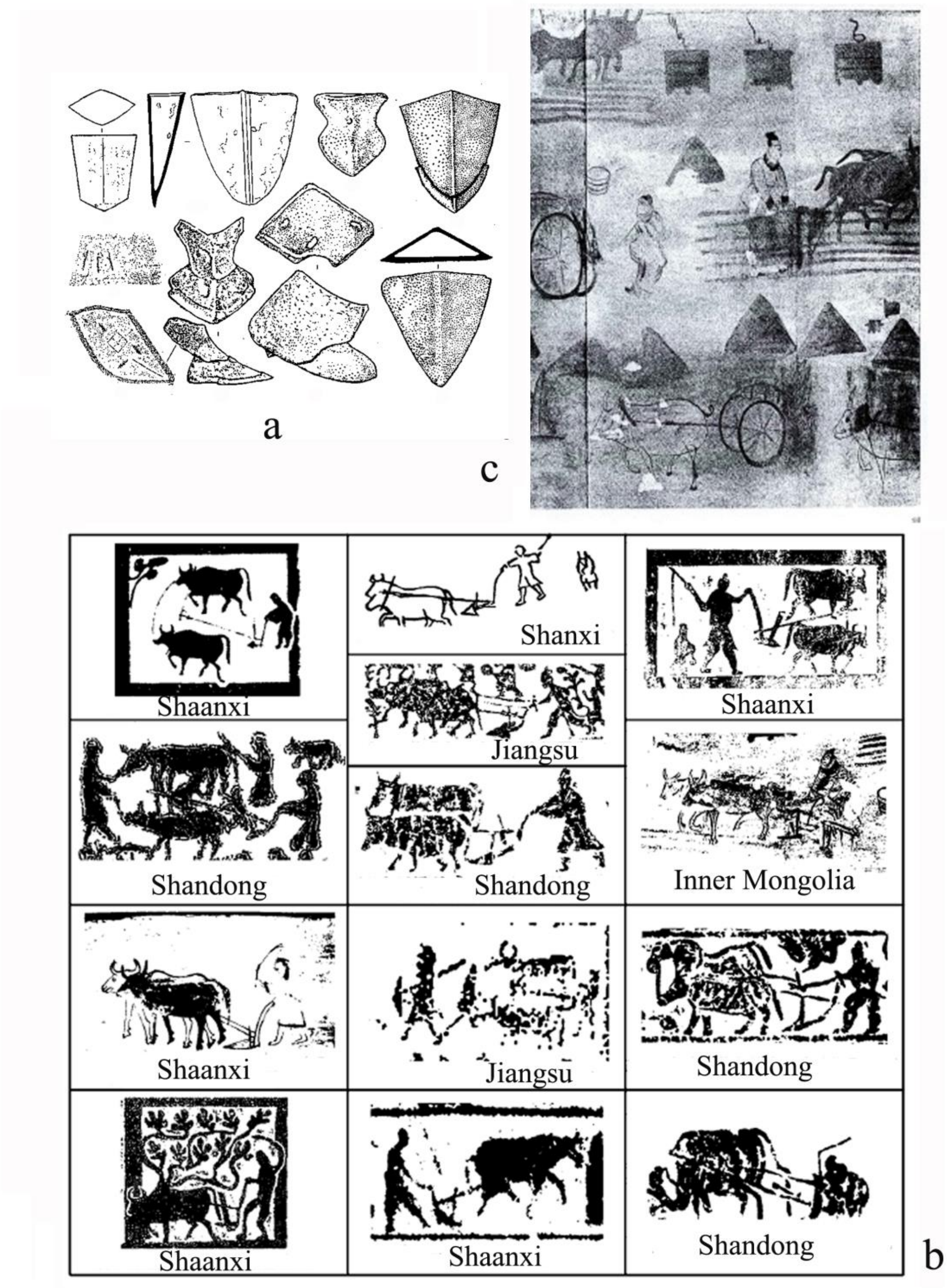
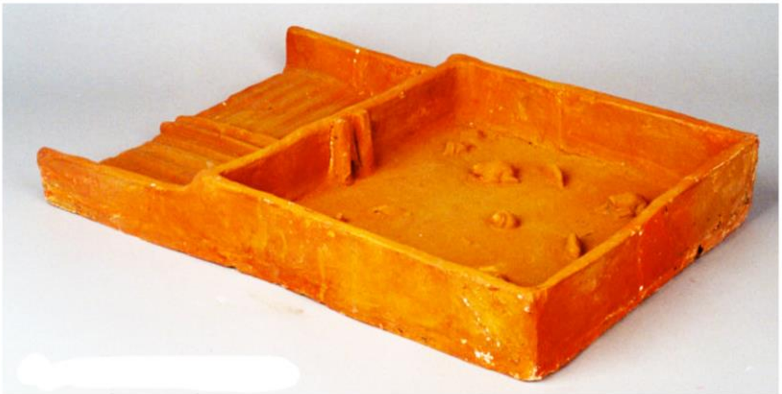


Figure 2: a: Han period iron ploughshares discovered in China. Note they are of various forms and of different thicknesses, after Bai 2005, 199; b: pictorial evidence of animal-drought ploughing in China. Mostly of Eastern Han periods and discovered in North China, after Liu 2014; c: mural painting from the Helinger Han tomb, Inner Mongolia, showing piles of crop chaff possibly used for manuring, after Li 2012.



a

b

Figure 3: a: ceramic model of Han farming fields discovered in Mian County, Shaanxi, connected with a small reservoir or pond, after Luo and Chen 1985. b: pipes used in modern polder field in Jiangsu province, China, as a micro-management of the water system in the field.

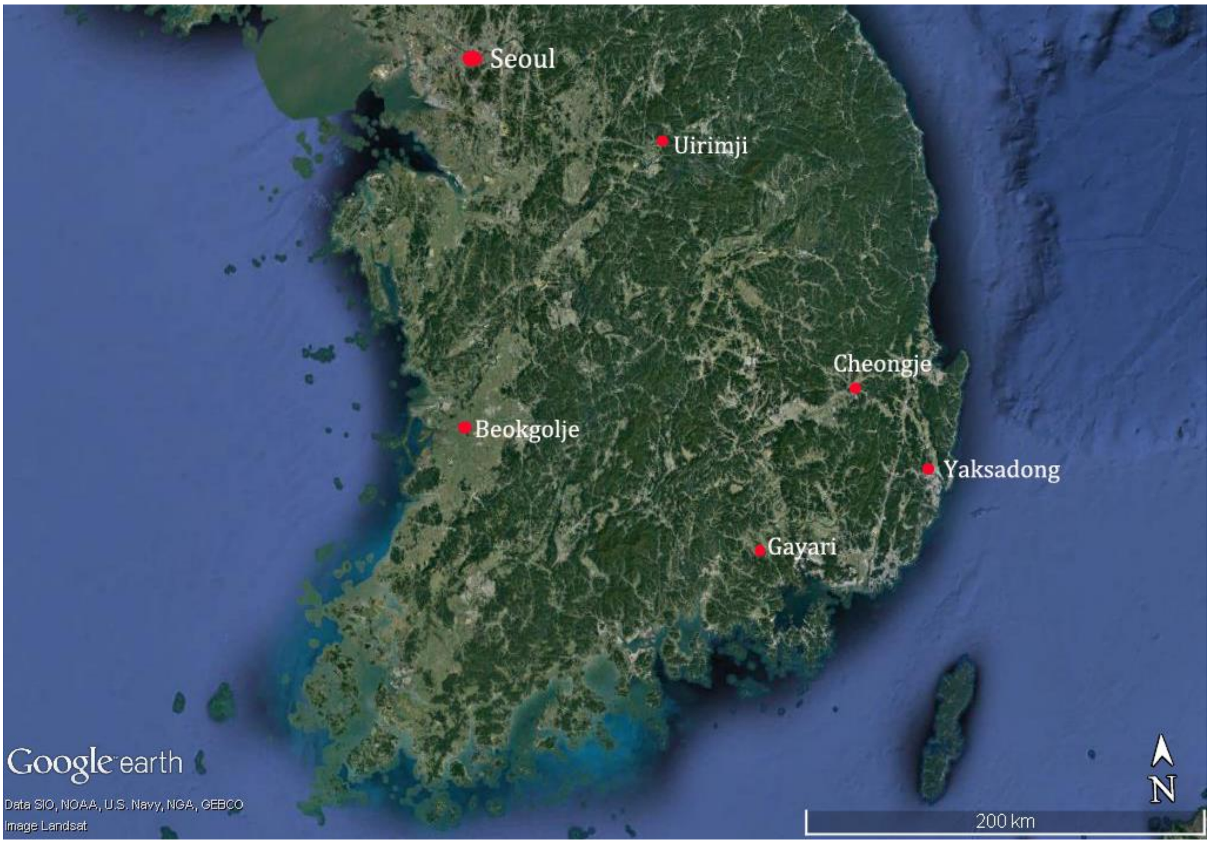
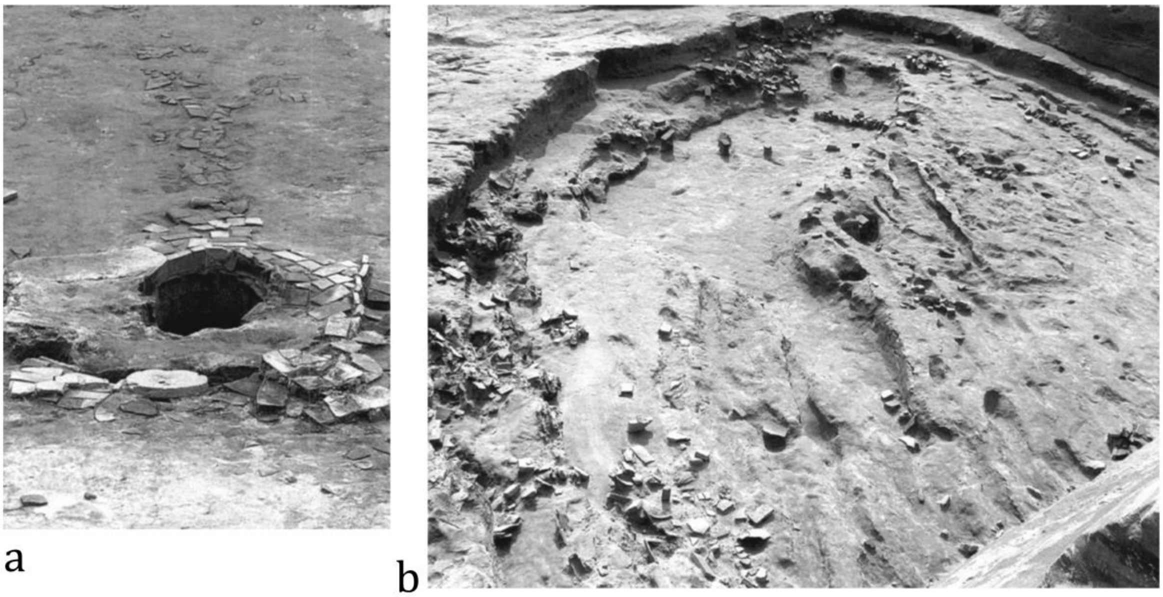


Figure 4: Locations of Three-Kingdoms period reservoirs in ancient Korea mentioned in the text.



a b

Figure 5: a: well excavated at the courtyard number 2 at Sanyangzhuang, Neihuang County, Henan Province. The well is located outside the courtyard; b: pond excavated at the same courtyard, note that there are marks at the bottom of the pond, which look like furrows and ridges of Han farming fields. This might be that the pond was previously (or on a seasonal rotation basis) a farming field. After HPICRA and NICRC 2010.

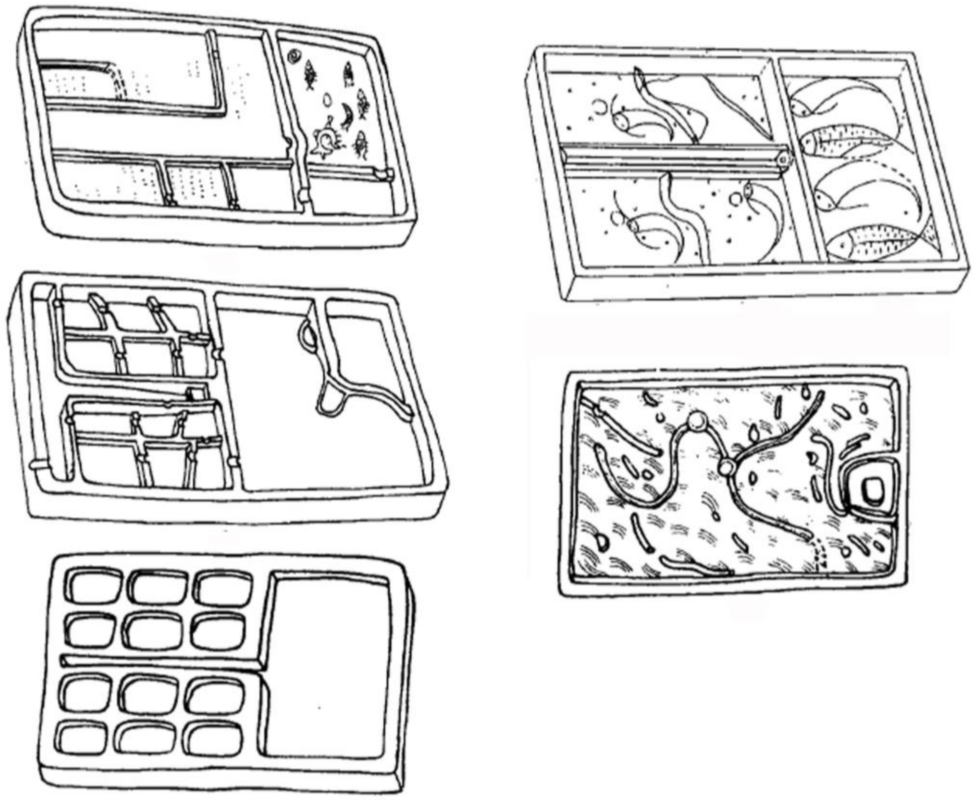


Figure 6: Ceramic models of Han farming fields. left column: well-planned small-scale farming fields of various shapes, connected to ponds through small water outlets. right column: similarly small-scale farming fields but less well-planned, note the lower right hand one shows the small holes in the field which probably served to connect and divert water. After Luo 2003.