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978-1-107-07156-8 - The Ecology of War in China: Henan Province, the Yellow River, and Beyond, 1938–1950
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Introduction

The Second Sino-Japanese War (1937–1945) began in July 1937 when a skirmish between Chinese and Japanese armies at Marco Polo Bridge (*Lugouqiao*) outside of Beiping (known today as Beijing) escalated into full-scale warfare. The incident ignited tensions that had been mounting since 1931, when the Japanese army occupied Manchuria (China's northeastern provinces) to secure Japan's economic privileges in the region. China's Nationalist government initially pursued a policy of appeasement, while preparing for a future confrontation with Japan's more formidable military. This non-resistance stance enraged many patriotic Chinese, who viewed Japanese aggression as a national humiliation. Instead, the Nationalist regime and its leader Chiang Kai-shek made exterminating the insurgent Chinese Communist Party (CCP) first priority. Only after Chiang was kidnapped by his own troops, who favored resisting Japan over fighting the CCP, did he agree to form a united front with the Communists. With the eruption of conflict in 1937, the Nationalist regime decided it could make no further concessions and the two countries entered into total war. Japan launched a full-scale invasion southward into China marked by fierce battles and horrific violence, including the Nanjing Massacre of December 1937. After less than a year of fighting, Nationalist China stood on the brink of annihilation.

In June 1938, Nationalist armies under the command of Chiang Kai-shek broke the dikes on the south bank of the Yellow River (*Huanghe*) in northern China's Henan Province in a desperate attempt to block the Japanese assault. The river's turbid waters, not yet swollen by yearly summer rains, moved slowly at first. But floodwaters rolled steadily out of the dike opening and advanced southeast, cutting off the Japanese army's path. Only people living in the immediate vicinity received any sort of warning from the Chinese authorities. Yet the flat, alluvial plain of eastern Henan was densely covered with farm villages and fields. As rains fell and the river cascaded onward, its waters spread across the landscape. The flood coincided with the peak agricultural season, when wheat stood ripe in the fields or lay newly harvested,

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ready for threshing. Hesitant to abandon crops and fields, rural residents left their farms only reluctantly. Some villagers tried to build or strengthen dikes to protect their land and homes, but when waters actually came, many people decided to flee. Those not caught completely by surprise stacked their possessions on wheelbarrows and ox-carts or carried them on shoulder poles, joining the long lines of refugees. People tried to rescue young children and the aged. They tried to save tools, livestock, grain, and other belongings but there was not enough time to salvage everything. Many people drowned in the flooding; far more would succumb to illness or hunger in the difficult months and years that followed. To the east, however, the river's diversion halted the invading Japanese, who abandoned their westward march. The vital railroad junction at Zhengzhou was safe for the time being. The city of Wuhan, China's provisional wartime capital after the fall of Nanjing, won a temporary breathing spell.[1]

Perhaps the most environmentally damaging act of warfare in world history, the Yellow River's strategic diversion threw long-established water control systems into disarray, leading to floods that persisted until after World War II had come to an end. In China's Henan, Anhui, and Jiangsu provinces, wartime flooding killed hundreds of thousands of people and displaced millions.[2] Even greater catastrophe struck Henan Province in 1942–1943, when war-related floods, an El Niño event, transport disruptions, and the food energy demands of Chinese and Japanese armies stationed in the province precipitated a famine of terrific magnitude. The Henan famine of 1942–1943 led to nearly as many deaths – approximately two million – as the famous Bengal famine that occurred at nearly the same time, and millions more Henan residents migrated to escape this subsistence crisis.[3] Grappling with the consequences of flood and famine, as this book shows, became a point of contention and competition among various regimes that controlled parts of Henan at different times during the war years: the Chinese Nationalists, the Chinese Communist Party, the Japanese, and their Chinese collaborators. By exploring the history of war-induced disasters and their consequences, this book adds significantly to our understanding of the interplay between military conflict and natural environment.

Studies linking war and the environment have grown into a flourishing subfield of environmental history. Examining the ecological consequences of

1 Perry O. Hanson, "A History of UNRRA's Program Along the Yellow River, Chapter I. – Background" (1947), 1–2: UN S-1021 Box 55 File 3.

2 Dutch (2009). Several works examine the 1938 Yellow River flood primarily from the perspective of military history. See especially, Lary (2001): 191–207; Qu (2003); Lary (2004). For an illuminating cultural interpretation of the disaster, see Edgerton-Tarpley (2014).

3 The oldest and most influential account of the Henan famine is in White and Jacoby (1980). For more recent scholarship, see Lary (2004); Wou (2007). For an effort to quantify the famine's causes and consequences, see Garnaut (2013). On the Bengal famine, see Sen (1981); Greenough (1982).

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military conflict as a central element in evolving human relationships with the natural world, this scholarship captures war's importance as a distinctive force shaping environmental change, as well as the environment's role in shaping warfare. Environmental factors mold the experience of war for soldiers and civilians alike, while war and militarization transform people's relationships with the environment in enduring ways.[4]

Historians have likewise highlighted the formative significance of war and militarization in modern China's politics, economy, and culture.[5] The Sino-Japanese conflict that raged during World War II, or the "Anti-Japanese War of Resistance" (*Kang Ri zhanzheng*) as it is known in Chinese, has garnered a great deal of attention.[6] But as Ruth Rogaski points out, research on the environmental impact of the Sino-Japanese War of 1937–1945 is "long overdue."[7] This observation applies even more to the Chinese Civil War (1946–1949) between the Nationalists and Communists, which historians have written far less about.

Military and political histories of wartime China invariably mention the breaching of the Yellow River's dikes in 1938 and the Henan famine of 1942–1943, if only in passing. This book offers new perspectives on these events, and the conflicts in which they occurred, by taking an in-depth look at them through the lens of environmental history. What were the effects of warfare on China's environment and people's interactions with it? What direct impacts did fighting and the dislocations that it caused have on flora, fauna, and the land? What were the environmental effects of wartime mobilization of resources? How did war's ecological consequences shape the military and political context? How enduring were the environmental effects of war? The history that follows addresses these questions.

Given China's vast geographical scale and ecological diversity, any meaningful investigation of the environmental history of World War II and its aftermath must start from the regional or even sub-regional scale. Accordingly, this book centers on the interplay between World War II and the environment in Henan Province. The war-induced ecological disasters that Henan endured from 1938 to 1945 vividly illustrate the vulnerability of human-engineered hydraulic infrastructure and agro-ecosystems to disruption during periods of

[4] Tucker and Russell (2004); McNeill (2004); Bennett (2009); Closmann (2009); Pearson (2009); McNeill and Unger (2010); Pearson et al. (2010); Biggs (2011); Brady (2012).

[5] Perhaps because of a tendency to see war and transformation of nature as distinct categories, little has been written about war's environmental history in China. Notable exceptions include Elvin (2004): chapters 5, 8; Perdue (2005).

[6] Lary and MacKinnon (2001); Coble (2003); van de Ven (2003); Waldron (2003); Westad (2003); MacKinnon (2008); Lary (2010); MacKinnon et al. (2007); Peattie, Drea, and van de Ven (2010); Flath and Smith (2011); Schoppa (2011); Mitter and Moore (2011). The most authoritative overview is Mitter (2013a).

[7] Rogaski (2002): 401. Yue (2008) catalogues damage caused by the Japanese invasion in Shanxi rather than presenting a coherent environmental history.

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violent conflict. Examining how Henan's rural populace lived through these massive perturbations also adds to our understanding of the complex, multifaceted experiences of military conflict in twentieth-century China by demonstrating their inextricable connections to the war's ecological impact. The Yellow River and other parts of the environment, as much as Chinese and Japanese armies, shaped the wartime experiences of Henan's rural populace. The environmental history and the social history of war illuminate one another, while making it necessary for us to rethink the boundaries between them.

As a hotly contested territory in the military struggle between Chinese and Japanese forces, Henan suffered as much human disruption and environmental damage as anywhere in China during World War II. Due to the combined trauma of Japanese invasion and war-related floods and famine, Henan had a larger refugee population than any other province. From 1937 to 1945, an estimated 14,533,200 people in Henan (43 percent of the province's total prewar population) lived as refugees for a least a time.[8] This book assesses the far-reaching consequences of Henan's wartime ecological disasters, as well as the displacement that they generated.[9] Spatially, the book focuses on the localities in eastern Henan that bore the brunt of wartime floods as well as famine. While other counties are given passing attention, most of the study centers on Henan's Zheng, Zhongmu, Weishi, Yanling, Taikang, Fugou, Xihua, Huaiyang, and Luyi counties, which from 1938 until the river's re-diversion in 1947 were the heart of the province's Yellow River flooded area (*Huangfanqu*). At the same time, the narrative moves with displaced people from these counties to Shaanxi Province to the west, where hundreds of thousands of flood and famine refugees from Henan migrated during the war years.

THE ENERGETICS OF MILITARIZED LANDSCAPES

To tie together warfare, flood, and famine, this analysis of Henan's wartime ecological catastrophes and their aftermath employs an approach that traces energy flows through and between societies and environments.[10] Metabolic processes transform energy and materials, enabling biological systems (whether organisms or higher-level ecosystems) to maintain life, grow, and reproduce. Socioeconomic systems also depend on throughputs of energy and

[8] MacKinnon (2001): 122; Zhang (2006): 128–135. Refugee migration from Anhui, another province seriously affected by the 1938 Yellow River flood, is usefully covered by Zhang (2004).

[9] Xia Mingfang (2000a: 59–78) argues that for China's rural populace, ecological disasters that emerged as second-order effects of war were an important catalyst for refugee migration. Postwar damage estimates for Henan support this point (Chen 1986: 69).

[10] This framework draws inspiration from Fiege (2004) and Laakonnen (2004).

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materials to maintain their internal structures. Exploiting various energy sources, human societies modify and manipulate land, water, plants, and animals to fulfill their needs. The concept of "social metabolism" likens this dependence to the biological metabolism of a living organism. Unlike the biological notion, this socio-ecological concept links energy and material flows to social organization. The quantity of resources used, their material composition, and sources are a function of socioeconomic production and consumption systems that vary greatly across time and space. This approach analyzes socio-metabolic patterns at different spatial, functional, and temporal scales, while also tracing their environmental consequences.[11] By seeing human societies as embedded in larger organic systems, an energy-centered approach renders legible connections between phenomena that historians conventionally see as discrete. Rather than artificially separating socioeconomic and biophysical processes, this framework highlights multifaceted interrelationships and interdependencies among societies, military systems, and environments.

Like all socioeconomic systems, militaries have metabolisms. Nature's energy makes warfare possible. Fighting and preparing for war, like all work, requires appropriating and exploiting energy. Militaries consist of agglomerations of humans, animals, machines, raw materials, logistical networks, engineering works, and many other components. No military systems can survive without energy inputs from the environment. They take in food, fuel, building materials, and other resources; they emit wastes. This book analyzes the redirection of energy flows that occurred in Henan during World War II, and recounts the massive ecological disturbances that it caused. A focus on energy and its transformations allows for a better understanding of war–environment connections than any interpretation premised on a division between the "human" and "natural." Thinking in terms of energy also makes it possible to integrate the Yellow River as an actor into the history of military conflict, for the same energy that propels rivers drives all human activities – including the waging of warfare.

Most environmental histories that employ the metabolism approach try to measure and quantify flows of energy and materials for entire societies, particularly during the industrial age. By contrast, this history offers the notion of metabolism as a conceptual apparatus to help us better comprehend environmental dimensions of war and militarization. Pivoting on the notion of energy and energy flows, the study argues that the metabolism of militaries and societies shapes the choices of commanders, the fates of communities, and the course of environmental change. Hopefully, this analytical framework can be applied to environmental histories of wars fought in other times and places. Even though specific details will differ considerably, recognizing the

[11] Weisz (2007): 291–292. My approach has also benefited greatly from Martinez-Alier (1987); Martinez-Alier (2007); and Fischer-Kowalski and Haberl (2007).

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primacy of nature's energy for all military conflicts should open up avenues for comparative inquiry.

We conventionally define energy as the capacity to do work. Work occurs when a force acts on a body, causing it to move some distance in that force's direction. Moving an object entails doing work and expending energy. The specific amount of energy depends on the object's size, how far it moves, and the resistance that it encounters. Energy assumes many forms, all of which have the potential to do work. Capturing more of that energy and using it more efficiently enables more work to be done. On this planet, the primary source of energy is the sun. Solar energy drives energy conversions at all levels. Photosynthesis, the process by which plants capture and store solar energy as chemical energy, is central to life on earth. As Edmund Burke III explains, "All complex life forms have devised methods for accessing the solar energy stored in plants. Human metabolism allows us to unlock this store of energy either directly, by consuming plants, or indirectly, by consuming animals. Alone among other complex forms of life, humans have been able to devise means of storing and using solar energy."[12]

Two laws govern the flow of energy. The first law of thermodynamics states that energy can change from one form to another, but cannot be created or destroyed. The same amount of energy exists before and after it is transformed.[13] The second law of thermodynamics dictates that whenever energy changes forms, part of the energy becomes heat. Energy conversion is never one hundred percent efficient. Some energy always becomes heat and dissipates into the environment. No energy transformations occur without some energy being degraded from a concentrated to a more dispersed form. The functioning of complex entities involves numerous energy conversions. As energy gets converted to do work, some changes into heat. Energy transferred as heat is still energy, but no longer useful for doing work. The total quantity of energy is definite, but its quality is not. As energy conversion chains progress, potential for useful work steadily declines. Entropy measures this dissipation of useful energy.

All complex structures require energy inputs from the environment to maintain their organization and keep functioning. In a closed system, energy dissipation due to entropy will lead to loss of complexity, greater homogeneity, and more disorder. In actuality, however, most energy conversions happen in open systems that interact with the surrounding environment. Complex entities temporarily defy entropy by importing and metabolizing energy. They arise in a balance between the usable free energy in the environment, which they put to work, and the entropy they throw off. Inputs of high-quality energy make it possible for complex structures to combat decay from within. In the process, they also dissipate large amounts of energy as heat,

[12] Burke (2009): 35. See also White (1995): 4–5.
[13] Marten (2001): 109; Pimentel and Pimentel (2007): 9; Smil (2008): 4–5.

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increasing entropy overall. As complex systems, living organisms maintain continuous energy inflows and outflows. Metabolism enables organisms to avert decay and stay alive by drawing energy from their environment, but they maintain their structures at the expense of increased contribution of entropy to the surrounding environment.[14]

To better grasp the environmental dimensions of war and militarization, we should therefore consider ways in which energy is converted for military purposes. Militaries can be thought of as organic systems that continuously interact with their environments, engaging in transfers of energy and materials. Militaries must constantly find new sources of useful energy and develop more effective mechanisms for handling large energy flows. As complex organisms, military systems extract free energy to do work and maintain their internal organization, while at the same time releasing low-level energy via entropy (waste).

The forms of energy that can support the "military metabolism" are strictly limited. Other complex systems – including agrarian ecosystems and hydraulic networks – draw on these finite energy sources as well. As it is transferred across different spatial scales, energy changes forms. But because the total amount of energy remains constant, appropriating energy in forms needed to fight or prepare for war necessarily entails losing it in others. Even when war and militarization lead economies to exploit new energy forms, they nevertheless render energy unavailable for other purposes. Militaries have to struggle for strategic advantage, as well as for energy sources that drive their metabolism. The better militaries gather, store, and deploy energy, the greater their potential for organized violence, coercion, and destruction. Military systems exploit finite sources of useful energy to maintain themselves, to do work, and expand. They also release heat, pollution, and other wastes. This waste, it should be noted, occurs at the level of ecosystems, as well as in the wastage of human bodies. Building complex military structures and expanding their realm of operations adds disorganization, chaos, and degradation to environments on which they depend.

The energy-centered approach employed in this book complements other ways of thinking about the war–environment nexus. Edmund Russell, for instance, has suggested that analyzing military supply chains as food chains "will help us uncover the indirect and hidden, but absolutely essential, links between armed forces and civilian, agricultural and natural systems." Thinking in terms of food chains, as Russell notes, demonstrates "that the area of militarized landscapes extends far beyond battlefields and bases, growing ever wider as the supply chain lengthens."[15] For ecologists, trophic pyramids represent roles of different organisms within food chains. In

[14] Smil (2008): 6–7; Marten (2001): 109–110; Pimentel and Pimentel (2007): 9–11; Christian (2005): Appendix II; Burke (2009): 34.
[15] Russell (2010): 237.

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terrestrial ecosystems plants anchor the bottom level, herbivores the next, and predators the level above them. "Species at each level depend not only on the level immediately below them, but on *all* lower levels – though their dependence becomes less apparent as the food chain lengthens."[16]

Though Russell does not dwell on the point, it is worth stressing that trophic pyramids map *energy transfers* between producers and consumers at each step in the food chain. As he explains, "The width of the pyramid represents biomass (the weight of organisms). Transforming energy from one form to another always comes at the cost of lost energy, so the biomass of each level must always be less than that of the level below it."[17] Russell usefully applies the model of a trophic pyramid to militarization's ecological effects: "Starting at the bottom, we can label the levels natural systems, agricultural systems, political, economic and technological systems, and armed forces." Armed forces depend on political, economic and technological systems for their sustenance. "Less apparently but just as much, they rely on the agricultural and natural systems that support the political and economic systems. Moreover, since each level must harvest greater biomass than itself to survive, the impact of military consumption widens as one goes down the scale. This means that militarization grows ever more pervasive as it becomes ever less visible."[18] Fully grasping the ecological impact of warfare and militarization requires investigating energy conversions at every level of the food-web pyramid.

To expand the environmental history of warfare "beyond the battlefield" to the "host of semiperipheral contexts where war etched its distant imprint on the land," Matthew Evenden analyzes commodity chains – "the linked labor and production processes involved in the making of a commodity from production to finished good."[19] As Evenden explains in his path-breaking research on aluminum production during World War II, "Far from dividing the environmental history of the Second World War into a series of national histories, commodity chains bridge the distance between places, point up the importance and irrelevance of international boundaries, and connect social and environmental change on several spatial scales. The commodity chain thus offers a useful angle of vision to help understand the dynamics of warfare and environmental change over distance."[20] Evenden's approach examines the development of new geographies of production, military efforts to defend vital commodity chains, and environmental repercussions of these strategically important processes. As Evenden shows, wartime expansion of aluminum production increased the character and the extent

[16] Ibid., 236. On energy transfer within food webs, see Smil (2008): 113–118.
[17] Russell (2010): 236.
[18] Ibid., 236–237.
[19] Evenden (2011): 70.
[20] Ibid.

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of environmental effects.[21] Commodity-chain analysis highlights the "unprecedented capacity of the Second World War to gather and scatter materials with untold human and environmental consequences, linking diverse locations with no necessary former connections."[22]

As a conceptual framework for investigating links between war and the environment, commodity chain analysis also melds nicely with the mode of analysis employed in this study of World War II and its aftermath in Henan, which focuses on energy transfers to understand the ecological dimensions of war and militarization. Most significantly, for our purposes, wartime expansion of aluminum commodity chains "required massive material and energy inputs" derived from multiple world regions, from extraction of tropical soils to the damming of rivers for hydroelectricity. What is more, "These critical links in the supply chain were bound together by a fossil-fueled, long-distance transportation system."[23] Commodity chain analysis, like the concept of metabolism, directs our attention to how military systems acquire the inputs of energy and materials they need to survive and function, as well as the environmental consequences of these flows. Taking a cue from the frameworks proposed by Evenden and Russell, this study explores the history of World War II through the lens of energy conversion to better understand its environmental dimensions.

TRANSLATING ENERGY AND POWER

One does not need to impose the language of thermodynamics and ecology on the historical record to engage in this type of analysis. More than anything, the specific language employed in sources from wartime Henan drew my attention to energy. Historical actors in the Sino-Japanese War of 1937–1945 engaged in constant discussion of topics that approximate what we now think of as forms of "energy." But they did so on their own terms, utilizing their own conceptual and semantic categories. None of the archival documents and other sources related to wartime Henan that I have consulted contain the Chinese word *nengyuan*, which contemporary dictionaries gloss as the translation for the English word "energy." Yet they make constant reference to *li*, a character that connotes power and capacity to do work. Wartime documents discuss *li* in a myriad of forms. They speak of *bingli* (military power), *renli* (human power), *minli* (common people's power), *caili* (financial power), *wuli* (material power), *chuli* (draft animal power), and *shengchanli* (productive power). All these terms can be understood as specific incarnations of energy and power. The documentary record presents vivid

[21] Ibid., 71.
[22] Ibid., 88.
[23] Ibid., 83.

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accounts of how Chinese and Japanese forces maneuvered to appropriate *li*, as well as the demands that warfare placed on finite energy sources.

The entry for *li* in the dictionary *Shuo wen jie zi* (Explaining Single Component Graphs and Analyzing Compound Characters), compiled during the Han dynasty (206 BCE–220 CE), explained the character's connotations. "*Li*: Muscle. It resembles human muscle's form. Effective governance is called *li*. It is able to defend against great disaster. Everything that is subordinate to *li* all follows from *li*."[24] This definition connected *li* with muscle power and its application to carry out work and accomplish tasks. All forms of *li*, moreover, were manifestations of a single generalized capacity. A later commentary on the entry for *li* in *Shuo wen jie zi* by the Qing dynasty (1644–1911) scholar Duan Yucai elaborated on the character's implications:

> *Li*: Muscle. Muscle is called flesh's *li*. The two seals are mutually explanatory. Muscle is its substance; *li* is its function. There are not two things. Extending this meaning, everything that vitality is capable of is called *li*. It resembles human muscle's form. It resembles its ordered pattern. Humans' pattern-principle is called *li*. Therefore, wood's pattern is called its grain. Earth's pattern is called terrain. Water's pattern is called weathering.[25]

A basic unity existed between muscle and *li*, which as substance and function were intrinsically related as ontological and functional aspects of the same entity. Muscle was original substance and *li* its function. *Li* referred to muscle put to use. *Li* flowed through human beings in the same way that physical features patterned landscapes, wood was patterned by its grain, and running water carved patterns in stone. This vital impetus underlay everything vigorous action could accomplish. *Li* was the animating force that ran through humans and the environment, constantly changing its character and manifestations, with greater and lesser concentrations appearing in different places and times.

These meanings persisted into the twentieth century, even as the character acquired additional ones. Like many other Chinese words, *li* was appropriated to translate Western scientific concepts that entered China in the late nineteenth and early twentieth century. This diffusion often occurred by way of Japan, which spearheaded translation of Western terms.[26] The entry for *li* in the dictionary *Ciyuan* (Source of Words), published in the 1930s, kept definitions contained in older dictionaries, while superimposing the newly introduced concept of "force" drawn from modern physics: "1) Muscle power. The effects of animal muscle accomplished by moving the limbs. In science, any influence that causes another object to move, rest, or change direction is called *li* . . . 2) Everything that vitality is capable of is called *li* . . . 3)

[24] Xu (121CE).
[25] Duan (1815).
[26] Weller (2006): Chapters 2–3.

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