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THE BURNING EARTH

An Environmental History of the Last 500 Years

SUNIL AMRITH

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THE BURNING EARTH

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ABOUT THE AUTHOR

Sunil Amrith is the Renu and Anand Dhawan Professor of History and professor in the School of the Environment at Yale University. He is the author of four books, and a recipient of multiple awards including a MacArthur 'Genius' fellowship and the 2024 Fukuoka Prize for outstanding achievements in the field of Asian studies. He grew up in Singapore and lives in Connecticut.

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For Ruth, Theodore, and Lydia

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THE HUMAN EXCEPTION
(1945–2025)

THE BURNING EARTH

Prologue

DREAMS OF ESCAPE

I had the most thoroughly urban of childhoods in an Asian metropolis that grew vertically. My memories are of harbor lights and darkened movie theaters and air-conditioned shopping malls. I paid little attention to the natural world, though nature seeped into my life unnoticed. To this day the rain I love is the rain that thrilled me then: rain that arrives abruptly and falls in sheets from stacks of inky afternoon clouds.

"I believe that whatever time you are born into shapes your perception of humankind vis-à-vis the natural world," writes novelist Annie Proulx.[1] And so my perception rested on separation. I grew up in Singapore, an island-city that imported almost all its food and even its water, a city as committed as anywhere on the planet to remaking nature for human ends. From the 1960s to the present day, Singapore's land area has grown by 25 percent. The country's engineers have conjured land from water—land made from sand dredged from river beds, held up with pillars drilled into the sea floor, and then sculpted into highways and parks and public housing and the world's best airport. Even the climate was molded to the nation's needs. In a 2009 interview, Lee Kuan Yew, first and longest-serving prime minister of Singapore, reflected that "air conditioning was a most important invention for us, perhaps one of the signal inventions of history." Lee believed that climate was destiny. Air conditioning had "changed the nature of civilization," Lee said, "by making development possible in the tropics."[2]

As a young person I was conscious of the idea of "sustainability," which entered common use in the 1980s. But I was drawn to study history by what seemed to be the more urgent struggles for political and social freedom that I saw unfolding all around me in the last two decades of the twentieth century.

When nature first touched my writing, it entered unbidden through the archives. Amid the bloody accounting of Malaysia's coroner's court records, I stumbled on detailed descriptions of the neat rows of trees that provided cover for the buried bodies of Indian migrant workers on the rubber plantations in the late nineteenth century. As I traveled through rural Malaysia to interview retired rubber tappers, I was surprised by how many of the stories they told me were about trees. Once I met a man who had spent his whole life on the plantations. His memories of the terrain were vivid as we walked together, his purposeful strides leading the way, his tall frame forcefully upright at the age of 80—"there used to be a tree there," he said, "it just refused to be cut down. We all believed a powerful spirit lived in it, so we left it alone." A line from the French historian of the Mediterranean Fernand Braudel came to my mind—"the land, like our skin, is bound to conserve the traces of past wounds."[3]

A few years later, in 2012, I spent time in Yangon, Bangkok, and Mumbai within the space of a few months. I have always been drawn to the port cities of the Indian Ocean. Their architecture and their many tongues still bear traces of an ancient commercial world, even as their youthful cultures embrace an optimistic future. The romance of sail and spices brought me to study the sea. On this visit, I became aware of new risks.

Within recent memory all three cities had faced extreme floods. A monsoon deluge in July 2005 submerged a substantial part of Mumbai. Cyclone Nargis leveled Yangon in 2008, with a toll beyond counting in lives and homes lost. The Bangkok floods of late 2011 broke the fortress of levees that surrounded Thailand's capital, which was no longer able to contain a Chao Phraya River swollen by a summer of unusually heavy rains. In all three cities, extreme

The busy life of the Chao Phraya River, vulnerable to increased flooding as a result of climate change.

weather cascaded into political disaster because of misrule. In Mumbai, decades of unregulated construction had paved over the city's natural drainage. In Yangon, a military government clung to power at any cost, denying the scale of the tragedy and shutting out international assistance. In Bangkok, rapid growth had wrecked the mangroves that once held back the waters. In all three cities the poorest people suffered most, those who lived in makeshift housing in precarious and low-lying settlements.

Walking by the banks of the Chao Phraya on a breezy evening after a day of intense heat, I struggled to connect the scene before me with fears that half the city could be underwater by the end of this century. The river was crowded with noisy pleasure boats festooned with lights. Silent barges pulled their loads upstream. Some of those barges carried sand, mined in Cambodia and Myanmar, to supply raw materials for new skyscrapers in cities that had doubled in size in a generation. Cranes stood watch like sentries over the half-built shells of luxury riverside apartments. The scars of the recent floods were confined to private grief. The life of this great city went on.

Was it resilience I was seeing—or blindness? I began to wonder

what these appearances of nature in every part of my research meant for the sort of history I wanted to write. It took me two books to begin to figure that out.[4] Now I understand, most of all, that I can no longer separate the crisis of life on Earth from our concerns with justice and human freedom that inspired me to become a historian in the first place.

The most compelling writing on nature often comes from deep feeling for the texture of a particular landscape and a sense of kinship with the other species that share it. This book rests on different foundations. It builds from a patchwork of attachments to many different places, distant from one another, most of them cities far from any wilderness. It is history for an urban, globalized, and divided planet, written from a position of empathy for the all-too-human dreams of fossil-fueled escape that now lie in ruins.

Introduction

NATURE AND FREEDOM

Once upon a time all history was environmental history. Life was governed by the seasons. When the weather gods were fickle, misery followed. Human societies used their ingenuity to wield fire, dam rivers, cut down forests: all to mitigate the risks of living. They harnessed the power of the animals they shared shelter with. Every culture had its gods of beneficence; every culture had dreams of plenty. A thousand years ago, those dreams grew more insistent. The scale of human impact on Earth expanded with the growth in human numbers. The range of possible futures inched wider. But the twinned foes of famine and epidemic never receded for long.

And then things changed. The most privileged people in the world began to think that the human battle against nature could be won. They believed that natural limits no longer hindered their quest for wealth and power. They believed that instant access to the prehistoric solar energy embedded in fossil fuels made them invulnerable. Their steam engines and lethal weapons conquered the world. In pursuit of freedom, they poisoned rivers, razed hills, made forests disappear, terrorized surviving animals and drove them to the brink of extinction. In pursuit of freedom, they took away the freedom of others. The most powerful people in the world believed, and some still believe, that human beings and other forms of life on Earth are but resources to be exploited, to be moved around at will.

ALMOST EIGHT HUNDRED YEARS separate the Charter of the Forest—issued by England's King Henry III in 1217—and the Earth Charter, published in fifty languages in the year 2001 by an international group of political leaders, scientists, and activists chaired by Mikhail Gorbachev, the final leader of the Soviet Union. The two charters are waypoints in a history of human freedom in relation to nature.

The medieval Charter of the Forest was a companion piece to the more famous 1215 charter of liberties (Magna Carta) decreed at Runnymede by King John of England to placate rebel barons resentful of overweening royal power. The forest charter "disafforested," or removed from the realm of Royal Forest, all the ecologically varied lands that the previous king, Henry II, had added to it. It affirmed the customary rights of commoners—rights to collect bracken and wood, turf for fuel, bark for tanning; rights to collect herbs and berries; the right to allow pigs to roam. As it gave, so it took: the charter recognized the property rights (the assarts) of lords whose domains encroached on the Royal Forest, easing fines for erecting structures or creating arable land. As forests became lucrative sources of timber, lords restricted public access to their woods—that is, they enclosed them as private property. Landscapes on the margins of settled cultivation, woods and uplands and wetlands, were at the leading edge of this enclosure movement. Soon, manor courts charged the provision of firewood or game from the enclosed lands as theft. Local people fought back, invoking royal promises of equal justice. To address these social conflicts, traveling forest courts, Eyres, became a feature of English law.[1]

In the year 1227 a group of peasants from Bilston, a manor south of Wolverhampton in the English Midlands, brought a case to the royal courts at Lichfield. They charged that Juliana, widow of Roger de Bentley, had put up unauthorized buildings and cut down trees in the Royal Forest, where the plaintiffs claimed rights of common.

The men of Bilston alleged Juliana and her son were blocking entry to the woods that remained. The court's verdict in this case is unknown, but there were many other judgments like it. People took action. They uprooted or burned fence posts. They filled ditches. They occupied land. Sometimes the courts brokered compromise by specifying limits to common rights: only alder and willow, thorn and holly could be used for fuel and fencing, for these were trees that lent themselves to coppicing—cutting low on the trunk so that the trees can grow back. The forests were not inexhaustible; demand for them was. People knew from hard experience that the health and survival of their small communities was consonant with the health of the forest.[2]

The Charter of the Forest arose from social conflicts that drove rapid changes in how human societies inhabited the planet around a thousand years ago—conflicts between rulers and ruled, elites and commoners, settled agriculture and nomadic life. Twinned with the charter of liberties, the Charter of the Forest acknowledged that human freedom and flourishing lay in the richness of human and more-than-human life that the soils and forests and waters sustained. The capture of those resources by people with power narrowed and impoverished the ways others could live, eroding what an archaeologist and an anthropologist together have called the "basic forms of social liberty": the "freedom to move away," the freedom to "ignore or disobey commands," and the freedom "to shape entirely new social realities."[3]

What relation does this capacious notion of human freedom—freedom within the affordances of nature—have to the narrower history of freedom as the foundational political concept that defines modernity? Modern ideas of freedom arose together with a step change in the scale and scope of the human imprint on the rest of the living planet, and together with the growing power of western European societies over the lives of others far away. Thomas Hobbes put it this way in his 1651 political treatise, *Leviathan*: "The NUTRITION of a Common-wealth consisteth, in the *Plenty*, and

Distribution of Materials conducing to Life." Over the centuries to come, the pursuit of "materials conducing to Life" would transform the planet; their "distribution" would create vast inequalities in different peoples' access to that plenty.[4]

Into the pursuit of freedom there crept, over time, a notion previously unthinkable: that true human autonomy entailed a liberation from the binding constraints of nature. The unshackling of fossil energy bolstered a way of seeing the world in which freedom defied any limits on what it was possible for human beings to do and to make—and for owners of capital to accumulate. "Freedom has been the most important motif of written accounts of human history of these [last] two hundred and fifty years," Dipesh Chakrabarty observes. The liberal freedom from arbitrary government, the capitalist freedom of markets, workers' freedom, anticolonial freedom, freedom from patriarchy, freedom from caste oppression, sexual freedom—hidden within these histories, until a belated twenty-first century reckoning, was their basic material underpinning: "the mansion of modern freedoms stands on an ever-expanding base of fossil-fuel use." That condition of possibility now exerts a new limit on the choices of future generations.[5]

In the human struggle to expand the possibilities of life on Earth, there is a surprising twist in the tale. From long before the Charter of the Forest, a fundamental human aspiration has been the dream of continuance: the dream that one's kin, one's name, one's works, one's community would outlast the vicissitudes of drought and flood, plague and famine, accident and disorder. In the second half of the twentieth century, that dream met with astonishing, unforeseen success, as early death and debilitating illness lost some of their power over a significant part of humanity. Economist Angus Deaton calls this the "great escape" of modern history. It is a signal and surprising achievement in a century otherwise characterized by its terrible innovations in mass killing.[6]

A child born in India in the 1940s could expect to live on average thirty-five years; had they been born in Indonesia or Nigeria, the

prospects would have been just as bleak, and if in Brazil only modestly brighter. Life expectancy at birth in each of those countries, and for most of the Global South, has doubled in less than a century. The survival gap between the wealthiest countries and the rest of the world has narrowed. Infant mortality has fallen rapidly, though unevenly along the gradient of wealth and social status. Nowhere in the world today are rates of infant mortality as high as they were in Britain in 1900, at the time when it was the wealthiest and most powerful country in the world.[7]

This vast expansion in human possibility could be credited to an increase in environmental control. Sanitary engineers disrupted the conditions in which water-borne and vector-borne diseases thrived. Oil refineries churned out the fractionated petroleum products that made fertilizers to boost crop yields and antibiotics to fight bacterial infections. Coal-fired power plants or diesel-powered generators kept the lights on in rural obstetrics wards that made childbirth safer, at least some of the time.

And then, in the year 2001, a further threshold was crossed in the human ability to understand, and potentially to manipulate, every form of life on Earth. That was the year when an international team of scientists announced that they had completed the initial sequencing of the human genome—the complete genetic information in an organism contained in sequences of DNA, consisting of twenty-three pairs of chromosomes in the cell's nucleus, and a small chromosome in the mitochondria. It came as a "capstone for efforts of the past century" to understand the building blocks of life. At the time, scientists had already deciphered the genome sequences of 599 viruses and viroids, 31 eubacteria, a fungus, and 2 animals. This was different. The team's first claim for the significance of the human genome was its complexity—it was twenty-five times as large as any genome previously sequenced. Only then did they add: "And, uniquely, it is the genome of our own species."[8]

There was no triumphalism in the genome team's announcement, which conveyed a sense of wonder that "the more we learn about

the human genome, the more there is to explore." They acknowledged obstacles in the way of their scientific advances being deployed "broadly and equitably." But still there was an exhilarating sense of a barrier broken. Working together across borders, scientists had finally found the key to "long-sought secrets" of life, with "profound long-term consequences for medicine."[9]

The initial sequencing of the human genome was published the same year as the Earth Charter. In 2001, at a "critical moment in Earth's history"—amid "environmental devastation, the depletion of resources, and a massive extinction of species"—the Earth Charter insisted that human well-being, and ultimately human freedom, depended on "preserving a healthy biosphere with all of its ecological systems, a rich variety of plants and animals, fertile soils, pure waters, and clean air." The relationship between human liberty and ecological vitality had become toxic. But unlike the medieval Charter of the Forest, the 2001 declaration contained no enforceable provisions. There would be no world court for the Earth, no global Eyre. The statement articulated principles that could only be enacted, if at all, by an interlocking architecture of administrative states, national courts, international organizations, and multilateral agreements.[10]

Scientists' breakthrough in assembling the genome coincided with awareness that all forms of life, including human life, were threatened by the destabilization of the core conditions that had made Earth a hospitable home. An expanding horizon of possibility collided with a closing-in of constraints. The publication of the charter marks a moment when people around the world began to ask: At what cost has this basic freedom, the freedom to live, been won? In the "great escape," were there also seeds of future imprisonment?

THE DREAM OF HUMAN freedom from nature's constraints is under assault by viruses, burned by wildfires, drowned by floods, scorched by extremes of heat. Many still cling to it, but an awakening has come to people around the world: "we cannot and will

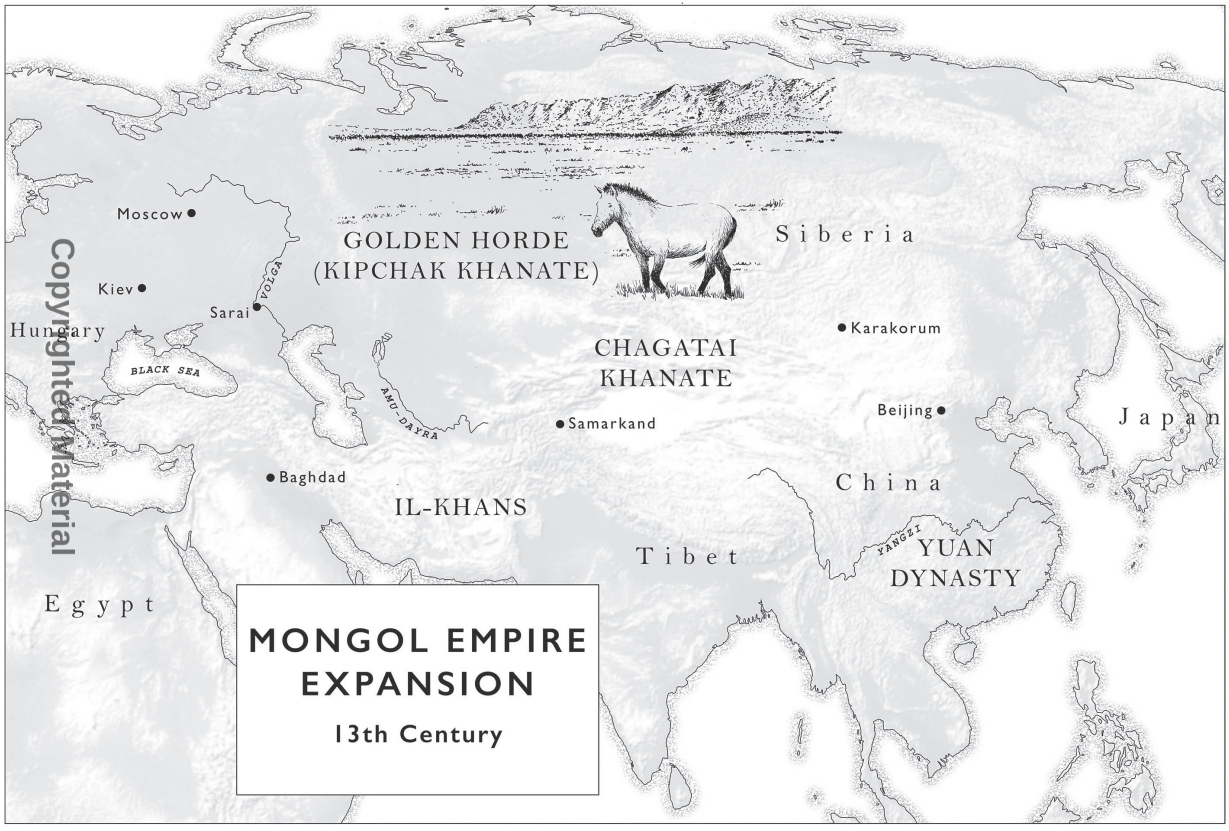
not escape the constraints that constitute the parameters of our mortal existence," writes essayist and critic Maggie Nelson in *On Freedom*—"nor do I see why we would want to." In the wealthy part of the world, and in the context of the past seventy years, the last part of Nelson's statement is bracing and radical. In the broader sweep of human history, it was the norm. Egyptologist J. G. Manning puts it this way: "We have, some say, achieved an existence outside of nature, . . . and in control of our own destiny. But that of course, is an illusion, and one limited to those living in a handful of lucky nations." The real question, then, is how it ever became possible for a small minority, a minority-within-a-minority, to believe in the illusion of mastery.[11]

How have we reached this point of planetary crisis? It is the outcome of our creaturely quest for survival—the long and continuing struggle for food and shelter that still drives a large part of the human impact on the rest of nature. It is, conversely, the outcome of the elite pursuit of luxuries—animal, vegetal, and mineral—that has spanned ever more of the world, ever more relentlessly, over the last five hundred years. It is the outcome of energy-hungry economic systems, capitalist and socialist alike, that turned living nature into lifeless commodities, sometimes with the liberatory intention of expanding human freedoms. It is the outcome of our inability to imagine kinship with other humans, let alone with other species. It is the outcome of the mutating hydra of militarism, armed with the power to destroy every form of life on Earth. Over time, those roads to ruin have twisted together: "The planet is shaped by the sheer amazing force of human want, which has changed everything," observes novelist Samantha Harvey. To have any hope of undoing the densely woven braid between inequality, violence, and environmental harm, we need to understand its origins.[12]

Part I

SEEDS OF CHANGE

1200–1800



Chapter One

HORIZONS OF DESIRE

In the year 1218, Yelü Chucai (1189–1243), scholar and administrator from the nomadic Khitan people of inner Asia, made a political pilgrimage to the West. He delighted in the varied landscape of steppe and mountain. He expressed grudging admiration for Mongol military prowess under the leadership of Chinggis (Genghis) Khan. Yelü's description made Mongol armies seem like they, too, were a force of nature:

> Mountains and rivers crisscrossed; how lush was the verdant land! The covered wagons were like clouds; the army, like rain drops. Horses and oxen covered the plains; foot soldiers and troops in armor emblazoned the sky. Fire and smoke viewed each other from afar; fortified camps stretched for thousands of miles. Never has there been such magnificence throughout all history!

With a gardener's eye, Yelü observed new plants ("The flowers of the *pa-lan* are like those of the common apricot tree, but somewhat lighter in shade"), and he relished new tastes: the pomegranates of Khojend were "sweet with a tinge of sourness" and "excellent for quenching thirst"; the watermelons were "sweet, cool, and delicious." Yelü delighted in every sign of cultivation. He praised the gardens of Samarkand watered with "fountains, square ponds, and

Przewalski's horses, which played a vital role in the Mongol Empire's military strength.

round pools," and marveled that "every third acre of land is irrigated with over two hundred gallons of water."

In his audience with the Khan, who had summoned the sage from his Buddhist hermitage to share his reputed wisdom, these "impressive scenes," were what Yelü told Chinggis to encourage. The ruler should turn his back on the nomadic life, Yelü advised. He urged Chinggis to stop harassing settled villages and to let their agriculture flourish. The Mongol treasury would bulge with the taxes that flowed in.[1]

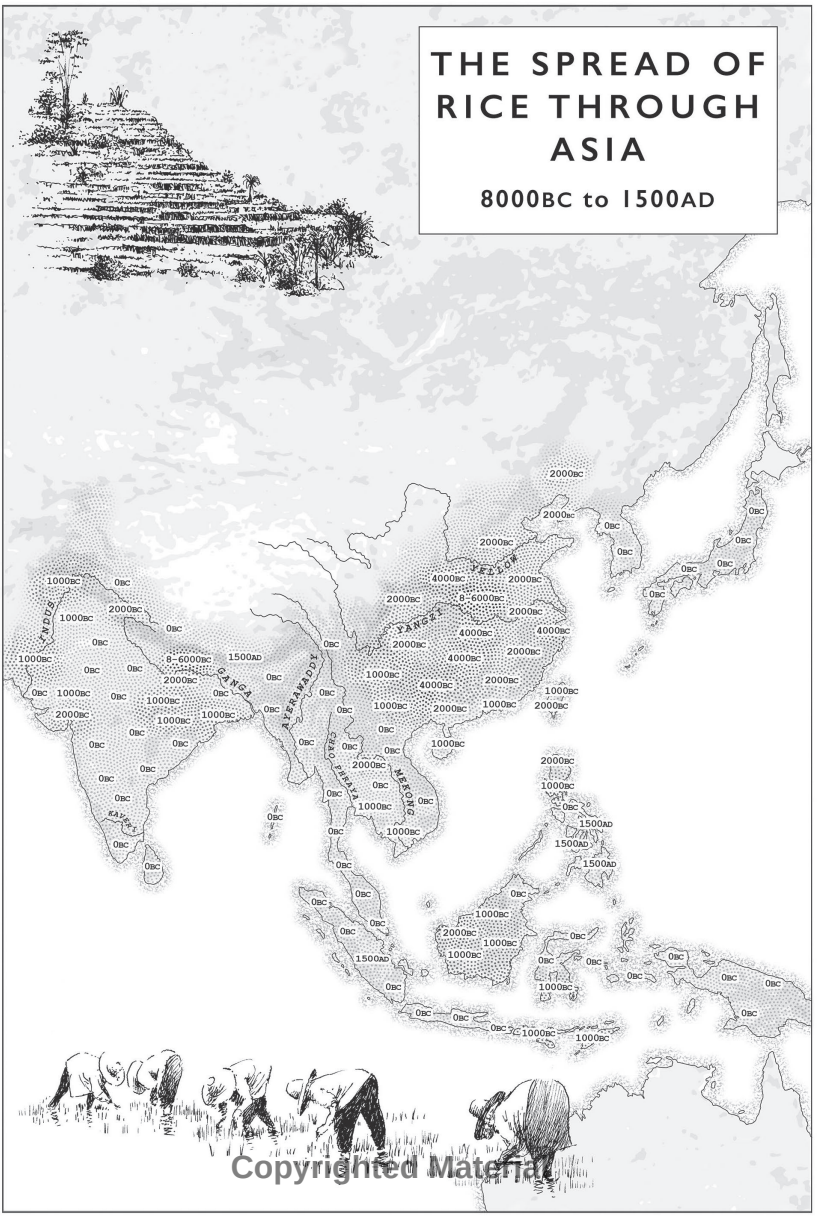
By contrast, Mongol soldiers and advisors saw nothing of value in the cultivated agricultural landscape that they moved through at such speed. They urged their ruler to demolish fields and let grass take over, to make new pasture for the roving camp's horses and sheep. The Mongols' power was rooted, quite literally, in steppe grass. Each of the estimated 102,000 men in the Mongol army had at least five horses. Perhaps half of all of the horses on Earth in the thirteenth century were in the Mongol Empire. Horses' milk and meat, at times their blood, furnished mobile soldiers with calories, even in winter, when the horses foraged for grass under snow. In the words of archaeologist Barry Cunliffe, the "partnership" that

humans established with horses on the steppe—a relationship of domination, to be sure, but also one of intimacy, care, and mutual dependence—"empowered humans, increasing out of all proportion their creative, and destructive, power."[2] The years from 1211 to 1230, immediately following Chinggis's fratricidal accession, were unusually wet. Rain made the grass grow faster: the Mongols' horsepower became their superpower.[3]

The Mongols' supreme god, Tengri, was the sky personified: the limitless sky sheltering the high, flat steppe. Under the umbrella of Tengri lived a range of natural and animal spirits: the wolf, the bear, and the eagle harbored special spiritual force. Chinggis's own mythology of origin held that he was descended from a union between the Blue Wolf and a wild doe. Before such wild and awesome power, what use could there be for agriculture?[4]

Few empires in history have faced as sudden and stark an ecological dilemma as the Mongols faced on their lightning sweep through the heart of the Eurasian continent. As the Mongols broke out of the niche that had sustained their way of life and their military power, the world of pasture and grass, they had to choose among fundamentally different ways to use land, find food, raise animals, manage forests, and rule people. They had to choose between competing visions of human life on Earth.

IN THE DECADES FOLLOWING Yelü's pilgrimage, Mongol forces pushed south through China, leaving a trail of death behind them. The debate that Yelü had tried to adjudicate remained unsettled. When Chinggis's grandson, Kublai, began the final advance against the southern Song Dynasty of China in the 1260s, he confronted the largest, most populous, and wealthiest agrarian state the world had ever known. He had to learn to rule over a landscape, and a society, that was the antithesis of the Mongols' own. By the end of the eleventh century, more than twice as many people lived in southern as in northern China—a reversal of a long historical pattern. China's



population reached around 115 million people by the start of the thirteenth century: a third of all the people alive in the world. Such stunning growth was possible because of the spread of rice.[5]

Rice sustained more human lives than any other crop until the advent of industrial agriculture. Compared with most grains, its properties are miraculous. Rice draws nutrients directly from water. Soil planted with rice improves rather than deteriorates over time. Only around 5 percent of the harvest needs to be kept for seed, whereas wheat demands a much larger proportion. Wet rice cultivation was the most productive and the most labor-intensive agriculture in the world. In China under the southern Song, the productivity of rice reached new levels.[6]

China's rice revolution began along the old trading route between southern China and Champa, a coastal kingdom on the Indochinese peninsula bordering Cambodia—it was the prodigal return of a Chinese crop that, through the uncoordinated efforts of Asian farmers over millennia, spawned more than one hundred thousand varieties. Almost all the rice grown in the world belongs to a single species, *Oryza sativa*, first cultivated in the middle stretches of the Yangzi valley as early as ten thousand years ago. From there it began a winding, prolonged, journey south and west: a journey we can trace through genetic, linguistic, and archaeobotanical fragments. Wet rice cultivation reached Taiwan, Korea, and Japan by 2500 BCE; rice arrived in Southeast Asia shortly afterward, likely taken by migrants from southern China. In India, rice cultivation may have developed independently, adapting strains of Gangetic wild rice; over time, rice grown in India appears to have hybridized with shorter-grained *japonica* varieties from East Asia, hinting how early the continual movement of knowledge and seeds had begun. By the second millennium, BCE, rice cultivation supported large sedentary populations along the Ganges Valley and eastern India, as well as in southern India and Sri Lanka.[7]

Sometime in the tenth century, one of those artisanal varieties of *Oryza sativa* returned to Chinese shores. "Champa rice"—an

early-ripening variety that was more tolerant of drought—arrived on merchant ships in Fujian. It passed between family farms by word of mouth and power of example. Its revolutionary possibilities grabbed official attention. In the year 1012, the Song emperor, Zhenzong, sent to Fujian for thirty thousand bushels of Champa seed to be distributed to other southern provinces. Government agricultural officers demonstrated the new technology and offered villagers incentives to adopt it. Within decades, the area planted with rice in southern China doubled. A second annual crop was added. Rice cultivation moved up hills and seized brackish swamps. By the 1300s, Guangdong was exporting rice back to Champa.[8]

The jeweled green surface of lowland paddy fields, bunded and cut with sluices; the chiseled, stepped terraces that ascended steep mountains—they were so ordered and so expansive as to seem an eternal feature of the landscape. But paddy fields, too, were the result of human conflict over different ways of inhabiting the Earth.

Kublai Khan had reasons to turn China's agrarian world upside down. The most pressing of them was a simmering conflict with his brother Arigh Boke about how far to adapt to settled society. Arigh Boke spoke for traditional Mongolian ways; he feared that his brother had caved to the temptations of sedentary luxury. But Kublai chose a different path, and provoked his brother into open rebellion. The wisdom of two women in Kublai's life—his mother, Sorghaghtani Beki, and his wife, Chabi—appears to have convinced him to make peace with Chinese agrarian society. When Kublai was a child, Sorghaghtani had held a personal realm in northern China. She was at pains not to interfere with its agriculture and had encouraged toleration of Chinese cultural norms. Her son took that lesson to heart. Chabi, too, urged Kublai not to allow his camp followers to turn agrarian land into pasture. Kublai prevailed over his brother, in the end, by denying Arigh Boke's forces the agrarian resources they disdained but could not do without.

In 1261, Kublai's government opened the Office for the Stimulation of Agriculture: this was a fundamental change of approach. The

bureaucrats who worked at the office produced detailed reports on growing rice and on the cultivation of silkworms. It is because of the Yuan Dynasty's efforts to create a permanent archive of agricultural innovation that a record still exists of two twelfth-century scrolls by Lou Shu—scholar, administrator, painter, and poet—that bear witness to every step in the making of China's "carpet of green." The original works have been lost, but not before Kublai's Office for Agriculture had copied and transcribed them.

Lou Shu came from a long line of scholar-officials in Ningbo, in coastal eastern China. Disappointed but undeterred after he failed the imperial civil service examination, which would have been a ticket to secure employment for life, he served instead as a local magistrate in Lin'an, near the southern Song capital at Hangzhou. In his spare time he turned to art to express his vision of a harmonious agrarian society. Lou Shu "diligently attended to people's affairs" and "consulted with farmers and sericulturalists," his grandson recorded. Lou Shu's work is ethnographic in spirit, humble and observant. He depicts lives of toil with empathy; he pays as much attention to women as to men. Lou Shu insists that the wealth of China is built on the hard work of its farmers, and he admonishes the wealthy to remember this: "The couple in damask silk gauze, / Should think of the one who wears coarse hemp." Lou Shu celebrates the productive beauty of the landscape vivified by the farmers' labor. A sense of hope suffuses the sixth tilling poem, "Planting Seeds," with its vision of nature and human hands working in concert.

The old grains send out new shoots,
    Plums ripen, and rains make plentiful.
Down in the fields, begin to plant the seeds,
    When walking slowly, the arms swing continuously
        back and forth.

Next morning, look at the level fields,
    Green, needle-like spikes ripple in the wind.

Carefully watch these one inch roots,
So the rows will have the space needed for ripening.

The poet observes and instructs, he praises and advises: "carefully watch these one inch roots." The skill of planting lives in muscle memory: in the swing of the arms, in measured movement through the fields. The man in the scroll looks concentrated but also loose, fluid. The seeds tumble from his hand like spray. "This is how we obtain every grain of food," Lou Shu writes, and, moving from the single farm to the known realm, he concludes thereby that, "The whole world is properly fed." Lou Shu hoped that, over time, improvements in irrigation would provide farmers a measure of freedom and leisure—even a chance to find love. "The setting sun shines on young willows, / The farmers, with laughter and songs, relax / with young maidens."[10]

In choosing to preserve the scroll, Kublai's officials endorsed this late-Song idyll of a harmonious society. A decision had been made about the future shape of China. By 1262, just a year after opening the state Office for Agriculture, Kublai passed an edict prohibiting nomads from allowing their animals to roam on farmland.[11] Upon

Yuan dynasty copy from Lou Shu's twelfth-century *Pictures of Tilling and Weaving*, showing the planting of a rice field.

Terraced rice fields in Guizhou, China.

becoming the emperor of a unified China, Kublai styled himself as a successor to previous holders of the Mandate of Heaven and not as a conquering cultural outsider. His reign achieved a new fusion of nomadic power and settled resources.

THE TRANSFORMATION OF THE world began with desire, even as most human lives scrabbled for subsistence: the desire of powerful rulers for symbols of rank and distinction—for pearls and pepper; for gold and silver and sugar. Already by 1300, the products of distant places were arrayed in hoards within Eurasia's royal treasuries. The harder they were to find, the more they were worth. The Mongols built an empire on ecological contrast: traders along the overland routes across Eurasia "had access to the produce of utterly different climatic zones, from desert to tundra." In centuries to come, the pursuit of spices and precious metals would compel millions of people to move across oceans and continents.[12]

In 1300, in the midst of a pan-Eurasian exchange of knowledge and plants, Rashid al-Din—Jewish convert to Islam; cook, physician, and vizier of the Il-khan branch of the Mongol Empire in

Persia—set up his House of Healing on the outskirts of Tabriz. It was a hospital, a medical college, a publishing house, and a botanical garden all in one. Rashid and his polyglot group of students of surgery translated Chinese medical texts into Persian. They investigated the properties of medicinal plants. They hoarded the dried root of Chinese rhubarb, native to Gansu and northern Tibet, for its cathartic and astringent properties; they procured cinnamon, exclusive to the island of Sri Lanka, as a painkiller and a tonic. Caravan and seaborne routes converged. The transmission of knowledge through written and printed texts enhanced the search for what was new and exotic. Paper was among the most revolutionary of all China's technologies, and the Mongol Empire spread it to many parts of the world where it was previously little or never used.[13]

The immediate region around the House of Healing was heir to the legacy of a tricontinental Islamic Empire, which had created pockets of irrigated agriculture from a profusion of plants from across Eurasia and the Indian Ocean. To the east of Tabriz was the Mongol highway to China, which the Moroccan intercontinental wanderer, Ibn Battuta, described as "the safest and best country for the traveller," where "a man travels for nine months alone with great wealth and has nothing to fear."[14] To the west lay Europe, where an agricultural efflorescence unfolded in parallel with China's embrace of rice. Between 800 and 1300, farmers and their lords had wrested large parts of western and central Europe from forest and marsh into arable land and planted endless fields of wheat. The most palpable effect of these changes was to sustain more people and more domesticated animals on Earth. Between 900 and 1200, the population of China more than doubled, from around 60 million to 140 million people; over a longer period, from 800 to 1300, Europe's population grew from 25 to 70 million. It took the Mongol empire's fusion of steppe, field, and ocean to force these agrarian worlds into a newfound proximity, which, for all its uniqueness, the House of Healing embodied. The pulse of human life on Earth quickened.

"Few other events in the history of European civilization," French

historian Marc Bloch wrote, "have had such weighty consequences" as the growth in human numbers that peaked in the twelfth century. The same was true for China, and across rice-cultivating regions of Asia. Social density allowed the "greater ease and frequency of exchange," Bloch observed. The Franciscan Bartholomew the Englishman published his *De proprietatibus rerum* ("On the Properties of Things") around 1240, part encyclopedia and part travelogue. In his writing, the adjective "populous" was used as the highest praise, along with "fertile." Italy, he observed, had "the most populous cities" (*civitates populosissime*); Paris "receives people coming from all parts of the world"; Picardy was "abounding in peoples." The horizons of his world expanded; Bartholomew wrote of places few Europeans had seen, but which now entered the consciousness of the literate elite. India, he said, was "amongst all the regions of the earth . . . the most populous." Human density brought a new sense of possibility. It also brought new kinds of desire, and among them the desire for spices loomed large.[15]

In the imagination of European consumers, spices came from distant and mythical lands to the east, all known vaguely as "India." The spices that arrived in Venice from Alexandria, dried and packed in bales or boxes, grew on plants unknown. They called forth fevered fantasies. Isidore of Seville, seventh-century philosopher, had imagined India's pepper forests "guarded by serpents." He speculated that "the natives burn the trees when the pepper is ripe and the fire drives away the snakes. It is the flame that blackens the pepper. . . ." Isidore's image of snake-vines coiled around pepper trees inspired manuscript illustrations well into the sixteenth century. The myth held that these substances were hard to procure because they had to be wrested from the menace of wild and faraway forests by the hands of unfamiliar people. Stories like these gave western Europeans the notion that to find the source of spices would be a heroic quest, pitting men against a hostile nature—and Christians against infidels.[16]

After 1250, European travelers began to fill out their knowledge of the spice route as they traveled through the vast Mongol Empire.

Europeans adjusted their perception of where India was in relation to China; for the first time, they understood that a major source of spices lay beyond "India," in archipelagos to the south and east. Marco Polo brought "Java" into European literature, though he never traveled there and his account fused Java with other islands of Indonesia. South-south-east from the kingdom of Champa, he said ("according to the testimony of good seamen who know it well") lay "the biggest island in the world . . . ruled by a powerful monarch and paying no tribute to anyone on earth." "It is a very rich island," Polo wrote, "producing pepper, nutmegs, spikenard, galingale, cubebs, and cloves, and all the precious spices that can be found in the world." He was sure that "it is from this island that the merchants of Zaitoun and Manzi in general have derived and continued to derive a great part of their wealth." His revelation was a siren: "this is the source of most of the spice that comes into the world's markets," he speculated. A young Christopher Columbus pored over the travel accounts of Marco Polo and Pierre d'Ailly, tantalized by the treasures that awaited the intrepid traveler. In margin notes, he scrawled: "great treasures," "much incense," "pepper, cinnamon, nuts"—and in Japan, "gold in the greatest abundance."[17]

The quest to monopolize the traffic in luxuries—luxuries chased by a small minority at first, and slowly widening their social reach—would affect soils and mountains and forests, airs and waters, mammals and birds and fish. But not yet. For within the whirlwind of the Mongol exchange of goods, plants, and knowledge, lay hidden the catastrophes that would bring it to a sudden end.

With the dawn of the fourteenth century came a change in the weather. With a change in the weather came acute pressure on the margins of viability of human and animal life. China experienced not only a marked shift toward cooler conditions, but also a slew of superstorms and an unrelated upsurge in seismic activity. Two earthquakes, in 1303 and 1305, caused an estimated 270,000 deaths. The

snowstorms that struck the Mongolian heartland led thousands of people to seek shelter in the vicinity of the Great Wall. The official Yuan chronicle noted that, by 1308, "the refugees from the north totaled 868,000 households, and everyone lived on disaster relief from the court." As part of the Yuan Dynasty's adaptation to traditional ways of rule in China, the state had conceded relief to its subjects in times of hardship. Now China's rulers faced desperate claims from their own Mongol kin. Between 1307 and 1310, Helin province alone distributed 36 million kilograms of grain, and 40,000 *ding* of paper money, to people fleeing the freezing Mongolian steppe.[18]

The following decade, Europe faced a similar string of catastrophes. Between 1315 and 1317, torrential rains flooded the fields, ruining the harvests. To a German observer, the rain was a portent of biblical catastrophe: "there was such an inundation of waters that it seemed as though it was *the* Flood." When an English poet described the weather as "so cold and unkynde," he used "unkynde" in the sense of uncharacteristic: weather behaving at odds with its own nature.[19] The English clergy walked barefoot in penitence after the failed harvest of 1315. The following season, grain yields were 43 percent below the annual average. The crisis continued into 1317, when "a thusent winter / ther bifore com nevere / non so strong" (never before had there been a winter so harsh as this). Across Europe, millions died. The poor suffered most as the price of grain rose sharply amid the crisis. A memorial in the German town of Schmidtstedt is devastating in its simplicity: "In the year of the Lord 1316 here were buried 100 × 60, 33 × 60, and 5 humans, who have died in the year of dearness. God have mercy on them." After the rains came a cattle plague. Half of the cows in England died.[20]

Things in China were about to get even worse. Between 1314 and 1320, after a "super snowstorm of the vast steppe," further disasters followed: "sheep, horses, camels, and all other animals died, people scattered and sold their children into slavery." While inland areas suffered from cold, the coasts drowned. Between 1319 and 1332, repeated typhoons and storm surges caused devastation. The

Yuan Shi, the official chronicle, observed: "typhoon and tsunami, houses in the Run, Chang, and Jiangyin prefectures washed away and people are hungry"; "The sea overflowed and broke the dikes and drowned over 17,000 people."[21]

The repeated onslaught of disasters eroded the authority of a Yuan state that was already overstretched, already riven with conflict between the Mongol ruling elite and Han Chinese, already printing too much money. Historian Li Tana argues, "climate [was] a major factor in the downfall of the Yuan dynasty," which "had had the misfortune to found their dynasty in an age of great climatic instability."[22]

The biological entity that did more than anything else to halt the expansion in human numbers and prosperity in the fourteenth century was *Yersina pestis*, the bacteria that infects human beings with the plague. The emergence of the plague pandemic that would come to be known as the Black Death—a name it acquired in Europe in retrospect, centuries later—owed everything to the environmental reshaping of the medieval world. *Yersina pestis* is endemic to wild rodents on the Central Asian steppe. Once before, almost a millennium earlier, it had caused a pandemic in Mediterranean Europe: the Plague of Justinian (541–49 CE). The development of a new strain through genetic mutation, sometime in the middle of the thirteenth century, made the germ more virulent and easier to spread. The ecological disruption unleashed by Mongol expansion—the rapid movement of people, animals, plants, and pathogens across ecological zones—created prime conditions for the mutation to develop. A fateful transition took place when *Yersina pestis* found a home among rodent populations that lived close to densely settled human populations; fleas transmitted infection from rodents to people. The trade in grains and furs carried the plague far and wide.[23]

Intermittent outbreaks of plague in China are recorded in the 1330s. It reached the cities of the Golden Horde, in southern Russia, by 1345–46. From there, the epidemic followed overland trading routes to the Crimean coast; it traveled in the holds of Genoese

merchant ships to the Black Sea and to Italy. The plague arrived in Constantinople in 1347, and from there it burned through Europe and the Middle East. The catastrophe was sudden and all-consuming. "In the face of its onrush, all the wisdom and ingenuity of man were unavailing," wrote Giovanni Boccaccio, Italian man of letters, who lived through it. Neither earthly nor divine power were of any use: "all sick persons were forbidden entry, and numerous instructions were issued for safeguarding the people's health, but all to no avail"; the "countless petitions humbly directed to God by the pious" proved just as futile.[24]

The Arab writer, Abu Hafs Umar Ibn Al-Wardi, observed the plague's devastation of Palestine and Syria—until he, too, succumbed to the illness in 1349. In Damascus, "the plague sat like a king on a throne and swayed with power, killing daily one thousand or more and decimating the population."[25]

For al-Wardi, the plague takes on human characteristics of a conquering army. In other accounts, by contrast, the plague represents nature alive and awry. An account from a monastery in southern Austria found portents of the plague in a mythic succession of disasters: "in the country where ginger comes from, a deadly rain fell, mixed with serpents and all sorts of pestilential worms . . . Not far from that country dreadful fire descended from heaven and consumed everything in its path; in that fire even stones blazed like dry wood." Widespread was the sense that the plague was a form of divine punishment: "this is surely caused by the sins of men who, while enjoying good times, forget that such things are the gifts of the most high giver." Everywhere, preachers called for repentance. In many parts of Europe, beginning in Germany, Jews became a scapegoat: they were accused of poisoning wells and rivers; they faced expulsion and murder.[26]

As the plague moved through western Eurasia, it squeezed the thin margin of security hard won by those who had cleared land and planted new crops. "Our former hopes have been buried with our friends," the Italian poet Petrarch wrote. He skewered the

presumptions of his generation, which had grown complacent in prosperity. "How transient and arrogant an animal is man! How shallow the foundations on which he rears his towers!" The great monuments to human power that adorned the cities of Eurasia looked different, now. There is sarcastic fury in his conclusion: "Go, mortals, sweat, pant, toil, range the lands and seas to pile up riches you cannot keep; glory that will not last."[27]

For what was Eurasia's agrarian transformation, if not a bet on the future? Now that future lay in ruins. A chronicle from Rochester, in England, observed in 1348: "The shortage of labourers and of workers . . . was then so acute that more than a third of the land throughout the whole kingdom remained uncultivated." Before his death from the illness, John Clynn, one of the Friars Minor of Kilkenny, left some pages blank in his notebook as a gesture of hope: "I leave parchment for continuing the work, in case anyone should still be alive in the future. . . ."[28]

The Black Death was the most lethal pandemic ever to affect human society. The numbers only hint at the scale of suffering, pieced together from local archives, and available only where births and deaths were recorded. Somewhere between seventy-five and two hundred million people died across Eurasia during the Black Death. The plague took the lives of between 30 and 60 percent of the population of Europe and the Middle East, following the forward march of conquest, connection, and expansion that had allowed for a leap in the scale and density of human habitation. French historian Emmanuel Le Roy Ladurie, pioneer of climate and demographic history, observed that the Black Death marked the beginning of an alteration in the conditions of life—"the unification of the world by disease."[29]

In recent decades, the computer-driven statistical power of the natural and social sciences has newly made visible patterns of long-term change. Today, analyzing these patterns drives the field of

climate history, as we urgently want to know how anomalous our current trajectory of anthropogenic climate change might be compared to previous eras of climatic variability. (The short answer is: highly anomalous.) The data that climate historians use comes from written traces of human experience—travel accounts, administrative records, manorial account books, sermons—but it also comes from a natural archive of tree rings and ice cores. These are called "proxy" data. The testimony of wood and ice stands in for the silence of human voices.

Beginning in the 1960s, the research of historical geographers suggested that medieval Europe had experienced a run of four centuries of warmer, wetter weather: a "medieval warm period." With an expanding natural archive, historians of different European regions added detail and nuance to this picture. Developments in economic and social history seemed to be driven by causes previously obscure: "It was the benign climatic and biomedical environment that was most responsible for the rise of European power and wealth, the clearing of land, the revival of cities, and above all the expansion of the population base fourfold from 900 to 1300."[30] Warmer weather extended the growing season; plentiful rains boosted the harvest. At first the evidence for warming was primarily European; and then new data from other continents hinted it was widespread, and nothing less than a global Medieval Climate Anomaly that affected Mesoamerica, India, and China as well as Europe. The timing, intensity, and synchronicity of this pattern admits many regional variations, and uncertainty remains: Iran, for instance, does appear to have experienced warming, but it began and ended earlier than in neighboring regions.[31]

If there *was* a worldwide climatic shift, this would explain why so many societies, so far apart and so different from one another, simultaneously expanded cultivation, built cities, and erected monuments. It would explain why so many states and empires came to the point of collapse in the fourteenth century, again more or less synchronously. The circulation and borrowing of new ideas and

The Hindu epic *The Churning of the Ocean of Milk,* carved into the walls of the south gallery of Angkor Wat, Siem Reap, Cambodia. Once among the largest cities on Earth, with a sophisticated infrastructure of water control, Angkor's decline in the fifteenth century is sometimes attributed to climate shocks, though recent evidence suggests a gradual retreat rather than a sudden collapse.

technology; the binding as well as destructive effects of conquering empires—these go some way to accounting for the highs and lows of prosperity and disaster, but they also leave much unexplained.[32]

Abrupt changes in climate, volcanic eruptions, and earthquakes acted upon a world on the move; they acted on a world being molded, imperfectly, to serve human needs. Unseasonal rains defeated dikes made to control them. Floods washed through soils unimpeded after whole forests had been burned or pulled up by their roots. Prolonged frosts slowed the growth of grass that fed horses that carried warriors over vast distances. Plague-carrying fleas stowed away amid animal furs in the holds of merchant ships. Cycles of unaccustomed cold and rain affected a profusion of life forms, stimulating new kinds of inquiry by botanists and physicians, travelers, and pilgrims. Curious observers of nature wrote in new genres, inscribed on a medium that spread across Eurasia: paper, wrought from cellulose fibers taken from wood, beaten in water, pressed on screens