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Chinese Environmental History: Past, Present, and Future

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I'm tempted to throw out this whole talk because I've learned so much from the morning sessions, and there are so many things that I could comment on or respond to or resonate with, and then Greg Clancey, to my complete surprise, delivered a stunning message about environmental history and the history of technology, which I can rip out of this one. No need to try out that polemic here. Greg has done it far more eloquently than me, so he's a very hard act to follow. These comments, I regret to say, are more backward-looking than forward-looking.

I just wanted to use this opportunity to express my appreciation to Roe Smith and the history and STS programs at MIT for all the collegiality and inspiration they've given me over 40 years, and at the risk of being self-indulgent, I will just sketch out the development of my own research interests, which have been centered on China, shaped by the MIT experience and the history of technology. It is a rather long and winding road that now leads me through my interests in Chinese environmental history with technological and other aspects added.

So this is a tribute to you, Roe, and here's a quick outline of the path here: First, "The Needham Question," second, technological determinism and how that gets us to Chinese environmental history, with a little mention in memoriam of Mark Elvin, who died last year, and then a couple of examples of recent studies in Chinese environmental history that I just want to call to your attention.

I. The Needham Question

When I came to MIT from Harvard to give my job talk in 1980, someone on the Search Committee asked me the famous Needham question, "Why did Imperial China not have a scientific revolution, like the one that occurred in the West?" In the Chinese history field at Harvard, nobody really focused on this question, but I did know that, before coming to MIT, I should be prepared for it, and I did know that Nathan Sivin, who preceded me at MIT, in STS, had collaborated with Needham on one of the volumes of Science and Civilization in China.

So I had an answer, though I can only roughly remember it now, but I think it was to the effect that we all greatly respected Needham for the massive amount of information he'd collected about Chinese science and technology, but the formulation of the question and the efforts to solve it were not really the center of most research on Chinese science. Even today, many people think, automatically, Chinese science equals the Needham question, as if that sort of sums up the story, which it does not.

More than 40 years later, I might give almost the same answer. Needham's encyclopedic learning, reflected in over 25 large volumes, spanning millennia of Chinese history, still has incredible value to be consulted, but he never solved his central problem. He promised to provide an explanation of factors impeding modern science in China, but the results were only published posthumously in Volume 7, Part 2, of Science and Civilization in China, in 2004.

When I reviewed this volume in *Technology and Culture*, I noted that it's not a systematic exposition of social and cultural factors affecting the development of science and technology. It's a disparate collection of chapters, some by Needham, some by collaborators, on a range of very interesting topics. [1] There's a great chapter on the Chinese classical language and why it was not an obstacle to scientific language and a study of probability by Mark Elvin, but Needham himself stuck to his basic argument from the 1940s that, despite the great creativity of Chinese scholars and craftsmen, the bureaucratic feudalism, as he called it, of the Chinese imperial state blocked science and technological development. He never strictly defined what he meant by bureaucratic feudalism, but in general, it referred to the Chinese imperial literati elite: the emperor, his clan, the

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[1] Peter C. Perdue, “Joseph Needham’s Problematic Legacy: Science and Civilisation in China, Volume 7, Part 2,” *Technology and Culture*, vol. 47, Jan. 2006, p. 175-178.

officials, the degree-holding scholars. These are the bad guys in the story, overall, generally summed up by Confucianism.

Needham was much more sympathetic to Taoism than Confucianism. He claimed Taoist origins for many of China's most famous inventions, including gunpowder and the compass, and he has a plausible case for both of those, but he had to admit that large-scale engineering projects, like the Grand Canal or the Great Wall, were not built by Taoists. They were built by officials in the service of the imperial state.

Needham also strongly believed in organicism and emergent processes. Interestingly, these processes were also the center of his scientific work. He believed that they dominated in Chinese thought much more than the mechanistic Newtonian concept of nature. This organic ideal was loosely analogous to Taoism, but he also applied this to civilizations, and he in fact viewed civilizations as coherent organic wholes. So he had no hesitation in opposing Eastern and Western conceptions of nature.

A question I have often been asked at conferences on history of technology is: What is the Chinese conception of nature, as opposed to the Western? I've always answered "the same, the same." Let's start with similarity. Today, we're much more skeptical of these large-scale civilizational generalizations. At least I hope so. We recognize that any large cultural formation has contradictory elements. It developed some interactions with global processes in unpredictable ways. Needham himself stressed only certain elements of the Chinese cultural heritage and neglected others.

As I said, he didn't like Confucianism very much. Buddhism and Islam didn't get much attention, either. Military and environmental factors were played down in favor of an ideal of cosmopolitan, organic cultural sensibility. He asserted priority of invention for China for hundreds of technologies, from equal temperament tuning in music to the conversion of rotary to oscillating pistons. I think we all accept Chinese priority in many major developments, like paper, the compass, and gunpowder, but a lot of the others, frankly, are much more speculative and haven't been confirmed.

I don't want to go on bashing Needham. I would rather ask, "Well, what survives from Needham?" There are recent articles in ISIS and in *Technology and Culture* that show that many people still think Needham provides valuable inspiration, but like me, I think they mainly respect his aspirations to explain global scientific progress comparatively, in which China had an important

role. We would all like to stress that, but we avoid the question of why China did not have a modern scientific revolution. [2]

In Benjamin Elman's phrase, we study science and societies on their own terms, rather than seeking priority for one over the other. Elman, unlike Needham, also denies that Chinese scientific progress stopped in 1600 or so. He finds significant advances in adapting Western technology and scientific terminology all the way from the first contact with the Jesuits through the end of the nineteenth century. [3]

As an outstanding example of recent work, I can recommend to you a new book by He Bian, professor at Princeton.[4] She argues that, in pharmacology and medicine, Chinese scholars continued to make new discoveries and devise new treatments from the sixteenth through the eighteenth century, in the Qing dynasty, as seen the imperial sponsored and private herbal manuals known as *Bencao*. These are one of the sources for Greg's project on animal sources of medicine, as they include not just plants but animals as medical treatments.

These were printed in commercial editions and sold widely on markets. The consumers themselves added popular medicinal knowledge about the healing properties of plants and animals and the expansion of the Qing empire into Central Eurasia brought in knowledge of other medical traditions, including those of Tibet.

So, in a time when leeches and humoral theory dominated in Europe, China's pharmacological tradition, based on very different understandings of the body, stands out for equal effectiveness and sophistication and pervaded both elite and popular medical understanding. I recommend that you look at He Bian if anyone ever asks you about, "What is the history of science beyond Needham?" – that is one good example.

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[2] H. Floris Cohen, ed., "Joseph Needham's SCC: A Second Look," *Isis* vol.100, no. 1, 2019. Mei Jianjun, et.al. *Technology and Culture*, vol. 60 no. 2, April 2019.

[3] Elman, B. A. (2005). On their own terms : science in China, 1550-1900. Cambridge, Mass., Harvard University Press.

[4] Bian, He (2020). Know your Remedies: Pharmacy and Culture in Early Modern China. Princeton, Princeton University Press.

II. Technological Determinism

The second issue that caught my attention after arriving at MIT was technological determinism, and this debate over technological determinism still thrives, as you all know, in the history of technology, and the remarkable popularity of Yuval Harari's truly terrible books. That's a provocative statement, but you can look at the devastating review by David Nye of Harari's books in *Technology and Culture*.[5] But it's a fact that crude versions of technological determinism attract attention from readers who want big-scale, simplistic explanations of long swaths of human history and the future.

I learned about technological determinism mostly from the conference held at the Dibner Institute that resulted in the book that Roe Smith and Leo Marx edited, entitled "Does Technology Drive History?" [6] I went back and re-read it for this talk, and I found it still full of insights. I had a chapter in it comparing the agrarian systems of ancien régime France, Russia, and China, and this in turn referred to Lynn White's famous argument for the decisive impact of the three-field system of agriculture on European development.

The main goal was to conceive of agriculture as a system of interacting elements, including fields, tools, animals, plants, humans, climate, and social institutions and, in line with Thomas Hughes' idea of technological momentum, decide how much the history of agrarian systems depended on the specific technologies of their formation.[7] Broadly speaking, I argued that Russian agrarian development, as described in a brilliant book by the French scholar Michael Confino, was locked into a pattern of low-yield extensive production and serfdom, while Chinese agriculture, in my view, was a much more loosely connected system with opportunities for reform and change.[8]

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[5] David E. Nye, "Harari's World History: Evolution toward Intelligence without Consciousness?" *Technology and Culture*, vol. 62 no.4, Oct. 2021 pp. 1219-1228.

[6] Smith, M. R. and L. Marx, Eds. (1994). Does Technology Drive History?: The Dilemma of Technological Determinism. Cambridge, Mass., MIT Press.

[7] Hughes, T. P. (1983). Networks of power : electrification in Western society, 1880-1930. Baltimore, Johns Hopkins University Press.

[8] Perdue, P. C. (1994). "Technological Determinism in Agrarian Societies," in Does Technology Drive History?: The Dilemma of Technological Determinism. Eds. M. R. Smith and L. Marx. Cambridge, Mass., M.I.T. Press**:** 169-200.

III. Environmental History

From that analysis of agrarian systems, we can move to Chinese environmental history, which is a relatively new sub-discipline in Chinese history. Beginning in the 1990s, some historians of China in the U.S. took up themes from the French Annales School -- at least I did, as I was a great admirer of the French historical tradition -- and others followed William Cronon and Donald Worster in the American Frontier School. We could also look back to the pioneering work of Owen Lattimore and his Chinese colleagues, and now the field has hundreds of valuable academic studies and graduate students spanning the globe.

Mark Elvin, who died last year, deserves special recognition for his remarkable book, "The Retreat of the Elephants: An Environmental History of China." [9] Elvin, like Needham, was another Cambridge man, who picked up the Needham question and turned his focus mainly toward Chinese economic development. The economic version of the Needham question asks why China did not have an industrial revolution. Unlike the science question, the economic question is still a subject of vigorous debate, for obvious reasons, since we can plausibly ask whether the spectacular economic growth of China in the last 50 years had its roots in earlier economic formations, or did it really depend on a complete rejection of traditional Chinese agriculture and commerce?

There's plenty of contention on the subject, but I think the best studies, simply put, converge on the question of the environment. Measuring aggregate economic variables on the basis of extremely unreliable data, which is popular among economists, doesn't help very much. We should look at specific regional ecosystems over extended periods of time. Elvin pointed this way to this in his first book, "The Pattern of the Chinese Past," describing the medieval economic revolution of the tenth to thirteenth century in the Yangtze Valley region, where China developed a commercialized economy, high-yield rice agriculture, extensive currency flows, including the world's first paper money, intensive iron industries for military purposes, and an overseas fleet that brought merchant traders to Japan and Southeast Asia.[10]

Why then did economic growth sputter out in the nineteenth century? Elvin invoked the concept of technological lock-in, which is the macroscopic version of what historians of technology

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[9] Elvin, M. (2004). The retreat of the elephants : an environmental history of China. New Haven, Yale University Press.

[10] Elvin, M. (1973). The Pattern of the Chinese Past. Stanford, Stanford University Press.

call the QWERTY phenomenon.[11] Initial conditions that are set up for anything from a typewriter keyboard to an agrarian system become so constraining that the system is unable to break through to a more efficient formation. Elvin named this “the high-level equilibrium trap.” In this model, population growth forces more intensive agricultural labor and raises productivity, but this in turn creates a surplus that stimulates further demographic growth, and resources ultimately are exhausted.

It really combines the demographic theories of Parson Malthus and Esther Boserup, which I'll mention later. Stevan Harrell calls it the “Malthus-Boserup Ratchet Effect.” The terminology is wonderful here. This isn't really an environmental model. It's about resources in a very general way, but it points toward it, and that's what Elvin did in his second great book, "The Retreat of the Elephants," which is kind of like Needham in that it is a huge array of fascinating primary sources with a series of chapters on a wide variety of topics, discussing deforestation, animals, hydrology, military defense, with sources ranging from quantitative ecological data to classical poetry. What runs through it is a theme of relentless exhaustion of all potential products of nature by the juggernaut of Chinese peasant agriculture, which Elvin summarized as "three thousand years of unsustainable growth."[12]

The Chinese military and the Chinese farmer alike feared wild animals, swidden agriculture, and mobile hill peoples. The Chinese cultivator liked to have individual trees around his grave but hated forests. By 1800, the Chinese empire had expanded to unprecedented size but showed signs of severe environmental stress. This powerful declensionist narrative has set the agenda for future studies of Chinese environmental history.

The intersections of Chinese environmental history with history of technology, include, to list a few, the history of water conservancy and hydrology, of course, from rice paddies to large hydropower dams, terraforming of the landscape by the Chinese state for security purposes, great walls, and deforestation. The PRC has announced with great fanfare a turn to an “ecological civilization” based on sustainable technologies, but mainly for the purpose of economic growth rather than system stability. Instead of describing a whole lot of specific studies, I recommend to

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[11] David, P. (1985). "Clio and the Economics of QWERTY." American Economic Review: Papers and Proceedings 75(2): 332-337.

[12] Elvin, M. (1993). "Three Thousand Years of Unsustainable Growth: China's Environment from Archaic Times to the Present." East Asian History 6: 7- 46.

you this one, a recent stunningly impressive book by the anthropologist Stevan Harrell, entitled "An Ecological History of China."[13]

The central concept is resilience, defined as “the magnitude of disturbance that a system can absorb without flipping into an alternative stable state in which the variables that control the system are fundamentally altered.” China's rapid economic development came at the cost of declining resilience, which meant vulnerability to natural disasters. The most spectacular one is the famine that followed the failure of the Great Leap Forward from 1959 to 1961. During the Great Leap, Mao and the Communist Party mobilized millions of laborers to attempt simultaneous, unprecedented advances in both agricultural and industrial production, aiming to surpass British steel production in fifteen years. The outcome was a mountain of worthless backyard steel, a huge drop in food output, a famine in which tens of millions of farmers starved, and a near collapse of the collective economy. Modern China has also experienced many smaller-scale natural crises, such as flooding, loss of biodiversity, toxic waste, deforestation, and air pollution, also derived from a monomaniacal focus on development at the expense of resilience.

For most of the twentieth century, China has lurched forward heedlessly into environmental crises, driven by the “ratchet effect” of growing population and ecological pressure, followed by “recursive interventions”, in which the state applied temporary fixes, whose inadequacy required further “fixes to fix the fix,” etc. in an endless cycle. Only with the advent of new concepts of “eco-civilization” around the 2000s have Chinese planners shown some awareness of the need to think more deeply about the ecological impact of development on China’s future.

Harrell gives plenty of credit to the technological advances that the PRC has achieved as well, but his systemic analysis exposes the dire consequences of environmental devastation. He uses the adaptive cycle metaphor derived from the ecologist, C.S. Holling.[14] The “adaptive cycle” metaphor centers on the biophysical impact of economic development, and it outlines a systemic analysis of the underlying forces driving ecological change. The adaptive cycle has four phases: in phase one [labeled “r”], a system mobilizes resources and builds more complex structures; in phase two [labeled “K”], a time of conservation, resources are directed into more

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[13] Harrell, S. (2023). An ecological history of modern China. Seattle, University of Washington Press.

[14] Gunderson, L. H. and C. S. Holling (2002). Panarchy : Understanding transformations in human and natural systems. Washington, DC, Island Press.

rigid institutions, and it loses resilience. A shock causes the system to collapse into the destructive phase three [“omega”], which produces chaos and dissipation of energy. Finally in phase four [“alpha”] the system reorganizes itself and returns to the growth of phase one in a different form. [p.19-20]. Originally developed to explain the explosive outbreaks of the spruce budworm in American forests, the adaptive cycle also works well to explain many processes of social and economic development. In Harrell's model, all of China lurches forward heedlessly into crises driven by the ratchet effect. Their inadequacy requires further “fixes to fix the fix”, my favorite phrase in the book, in an endless cycle, very much like Elvin’s high-level equilibrium trap. Maybe, with the idea of eco-civilization, beginning around the 2000s, Chinese planners, the state, and the population have gained some awareness of the need to think more deeply about the ecological impact of development on China's future. Harrell takes this commitment seriously and doesn't just brush it off. We all know about electric vehicles and solar panels and certain parts of the Chinese ecological commitment, but how much will that matter in a systemic sense? That is the key question.

Harrell’s model, in many ways, echoes that of Elvin. The K phase, in particular, of the adaptive cycle is a time of rigidity, involutionary growth, or technological lock-in. The pre-modern analogy to this is the management of the Yellow River, where the heavy silt load of the Yellow River caused the river to rise. In the K phase, the officials desperately built up its banks till, in the disastrous Omega Phase, the river broke its dikes and flooded millions of farmers, and then the cycle began again, as farmers cultivated the newly silted land.

Harrell, however, adds a lot of nuance to Elvin's model and, I think, does not endorse hard technological determinism. Elvin borders on that kind of argument and Needham maybe even more. For Harrell, the constant investment in new fixes is a choice of political leaders and their subjects, but a different ideological orientation could bring different results. I began my research under the influence of the French Annales School, as a longue durée guy, and part of the Annales School approach is to remove the short-term impact of the state. Now I think this needs reconsideration. We can never, I have concluded, kick out the Chinese state from our story, nor, unfortunately, the impact of the leadership of the Chinese state. Xi Jinping's new slogan of ecological civilization could signal a genuine change towards sustainable growth, but he has produced another slogan called "Productive Forces." This is a classic phrase of orthodox Marxism, which just offers us more of the same dead-end policy of industrial growth. I don't see many signs of “ecological Marxism” in current Chinese ideology. China’s environmental future remains unclear.

This is my little trip down memory lane. Here I wanted to pay tribute to Roe and his colleagues, and offer some new perspectives on Chinese history. So I hope that was informative and thanks, Roe for your inspiration.