Comparative Studies in Society and History (2024), 1–28
doi:10.1017/S001041752400029X

CAMBRIDGE UNIVERSITY PRESS

RESEARCH ARTICLE

The Significance of Small Things: Small Hydropower in the People's Republic of China, 1949–1983

Arunabh Ghosh

History Department, Harvard University, Cambridge, MA, USA
Email: aghosh@fas.harvard.edu

Abstract

From less than three dozen in 1949, the number of small hydropower stations in the People's Republic of China grew to nearly ninety thousand by 1979. By the early 1980s, these stations were distributed across nearly 1,600 of China's 2,300 counties. In 770 counties, small hydropower was the primary source of rural electricity generation. This article offers a history and assessment of these developments, unsettling our traditional emphasis on large-scale hydroelectricity. The article begins by reconstructing the PRC's enormous investments in small hydropower from the 1950s to the early 1980s. This reconstruction, the first of its kind in the English language, not only helps reassess key periods and events in the history of the PRC but also establishes the position of small hydropower in the hydraulic history of the twentieth century. The article then turns to a discussion of the claimed impacts of small hydropower. As electricity became available for the first time in many parts of the Chinese countryside, it affected patterns of economic and social activity for hundreds of millions of people. Finally, the paper explores what the case of small hydropower can offer to conceptual and theoretical problems surrounding development, innovation, and the environment. Returning to the long-standing debate over scale and development, China's experience with small hydropower reminds us of the important role played by smaller-scale, appropriate, and self-reliant technologies in global energy history.

Keywords: environmental history; hydropower; dams; China; scale; energy; rural development; twentieth century; political economy

In late 1969, 150 representatives from thirty work units located across fifteen provinces and autonomous regions of China[1] gathered in Yongchun county (永春县), in the hilly southeastern province of Fujian. Their principal task was to discuss how best to promote small hydropower throughout the People's Republic of China

[1]These were: Sichuan, Guizhou, Yunnan, Hubei, Hunan, Guangdong, Guangxi, Fujian, Jiangxi, Zhejiang, Anhui, Jiangsu, Shaanxi, Henan, and Shandong. Liang Tiancheng, chief ed., *Yongchun xianzhi* (Yongchun County annals) (Beijing: Yuwen chubanshe, 1990), 327.

(PRC). Officially called the "Symposium on Small Water Conservancy and Hydropower in the Southern Mountainous Areas" (南方山区小型水利水电座谈会), the meeting was split into two parts. After a fortnight in Yongchun, the participants relocated for the next two weeks to the national capital of Beijing.[2] At the end of the month-long affair, the participants returned to their home provinces and work units to put in motion developments that would make 1969 a watershed year in the hydraulic history of modern China.

During the ensuing decade the PRC experienced a "high tide" of small hydropower construction. Over seventy thousand small hydropower stations were built across the country.[3] This was more than the total number of small hydropower stations in the rest of the world (the United States, by comparison, had a little over one thousand, and India a little over one hundred). Their construction represented a near fivefold increase in the number of stations—from 18,935 to 89,669—and meant that by the early 1980s, two out of every three counties in China (nearly 1,600 out of 2,300) had access to hydropower. In nearly one-half of these counties (770), small hydropower was the primary means of electricity generation. Most of these newly built stations generated as little as 50 kilowatts, and the largest among them rarely exceeded several megawatts in capacity.[4] By 1979, total small hydropower generation capacity stood at 6,329 megawatts, representing a ninefold increase from a decade earlier (729.5 megawatts) and accounting for about one-third of the total installed hydropower capacity in the country. Three hundred million people in the countryside were affected by these developments.[5]

Identifying 1969 as a watershed year and the 1970s as the decade of peak (small) hydropower confounds common and deeply held impressions about the history of hydropower and China's place within that history. After all, for most of us, it is the

[2]Details of the conference are drawn from: Zhao Jianda and Wu Hao, "Zhongguo xiaoshuidian dashiji (1904–2019 nian) (zhi yi)" (China's small hydropower: chronicle of events, 1904–2019, part I), *Xiao shuidian* (Small hydropower) 6 (2020): 1–11, at 11; Liang Tiancheng, *Yongchun xianzhi*, 327; and Hangzhou Regional Centre, *Small Hydro Power in China: A Survey* (London: Intermediate Technology, 1985), 43–45.

[3]Based on data compiled from Zhao Jianda and Wu Hao, "Zhongguo xiaoshuidian."

[4]A megawatt is 1,000,000 watts, and a kilowatt is 1,000 watts. A watt is a unit of power "which in one second gives rise to energy of 1 joule." A joule (a unit of energy or work) "is the work done when the point of application of 1 meter-kilogram-second unit of force [i.e., 1 newton] moves a distance of 1 metre in the direction of the force." For these definitions and others, see Bureau International des Poids et Mesures, *The International System of Units (SI)*, 9th ed. 2022[2019], 127; https://www.bipm.org/documents/20126/41483022/SI-Brochure-9-EN.pdf (accessed 21 June 2024). One kilowatt supplied for one hour translates to 1 kilowatt hour of energy. In simple terms, this is the amount of energy expended by running an average microwave for one hour. For reference, average residential utilities in the United States in 2020 accounted for a little less than 1 megawatt hour (893 kilowatt hours) per month. The capacity of large coal-fired power plants or hydropower stations is frequently over 1,000 megawatts. For more, see https://www.eia.gov/tools/faqs/faq.php?id=97&t=3 (accessed 2 Oct. 2022).

[5]Sang Huo, "Woguo de xiaoxing shuidianzhan" (China's small hydropower stations), *Diangong jishu* (Electric engineering) 8 (1985): 30–31. For similar numbers, see also Li Ying, "Zili gengsheng jianku chuangye de shuoguo: Woguo xiao shuidian jianshe de chengjiu" (The fruits of self-reliance and hard work: the achievements of my country's small hydropower construction), *Nongtian shuili yu xiao shuidian* (Agricultural water conservation and small hydropower) 4, 6 (1984): 41–45; Bai Lin, "Woguo xiao shuidian de fazhan qianjing" (Development prospects for small hydropower in my country), *Shuili shuidian jishu* (Water resources and hydropower engineering) 4 (1981): 55–59; and Hangzhou Regional Centre, ed., *Rural Hydropower and Electrification in China* (Hangzhou: Zhongguo shuili shuidian chubanshe, 2004), 8.

enormity of dams that is immediately resonant, not their diminutiveness or ubiquity. Furthermore, given that China arguably more than any other country in the recent past, has pursued massive, mostly state-led projects of technological and social transformation, such confusion is not surprising. Fascination with superlatives abound: the "longest bridge," the "fastest train," the "greatest capacity," and, most apropos here, "the largest dam." We can trace this fascination to a young Sun Yat-sen, who wrote passionately of the promise of hydropower as early as 1894.[6] Decades later, Sun would make damming the Yangzi River the centerpiece of his plan to rapidly industrialize China.[7] Following a checkered history involving Soviet, American, and international advisers, and supervision by key leaders such as Premier Li Peng, himself a hydraulic engineer, that ambition was eventually realized in 2012. In that year, the Three Gorges Dam on the Yangzi River became the world's largest power station, capable of generating 22,500 megawatts.[8] Between 1894 and 2012 was built a series of other mega-hydropower projects, headlined by Sanmenxia (on the Yellow River) in the 1950s and 1960s and Gezhouba (on the Yangzi, a short distance downriver from the Three Gorges) in the 1970s and 1980s. Today, China is home to five of the world's ten largest dams.[9] Totemic projects aside, since the 1990s China has indeed transformed itself into a global leader in large-scale hydropower; so much so that today it accounts for nearly 40 percent (a little over twenty-four thousand) of the world's large dams.[10] With a combined installed capacity of 341 gigawatts by 2017, China's capacity dwarfs that of the next four nations put together.[11]

[6]Sun Yatsen, *Sun Zhongshan quanji (di yijuan)*: *Shang Li Hongzhan shu (yibajiusi nian, liu yue)* (Complete works of Sun Yatsen [volume one]: Letter to Li Hongzhang, June 1894) (Beijing: Zhonghua shuju, 1981), 12, cited in Huang Quansheng and Yang Jichao, "Shilongba dianzhan xiujian jiqi shimo lishi diwei yingxiang," *Changjiang shifan xueyuan xuebao* (Journal of Yangzi Normal University) 30, 2 (2014): 14–23, at 15.

[7]Yat-sen Sun, *The International Development of China* (Shanghai: Commercial Press, 1920).

[8]For key moments in this history, see chapter 5 in Tan Ying Jia, *Recharging China in War and Revolution, 1882–1955* (Ithaca: Cornell University Press, 2021); Covell Meyskens, "Building a Dam for China in the Three Gorges Region, 1919–1971," in Filippo Menga and Erik Swyngedouw, eds., *Water, Technology and the Nation-State* (London: Routledge, 2018), 207–22.

[9]The list includes dams under construction. The five Chinese dams are the Three Gorges (三峡) on the Yangzi, the Baihetan (白鹤滩), the Xiluodu (溪洛渡), the Wudongde (乌东德), and the Xiangjiaba (向家坝), all on the Jinsha River (金沙江). This is based on a panel at the National Water Museum in Hangzhou that I visited in January of 2019.

[10]International Commission on Large Dams (ICOLD), "World Register of Dams," https://www.icold-cigb.org/GB/world_register/world_register_of_dams.asp (accessed 21 June 2024); https://www.icold-cigb.org/GB/world_register/general_synthesis.asp); https://www.hydropower.org/region-profiles/east-asia-and-pacific (accessed 21 June 2024). The challenge, as Patrick McCully noted in 1996, is how one classifies what is large. The International Commission on Large Dams (ICOLD) provides the following definition: "A dam with a height of 15 metres or greater from lowest foundation to crest or a dam between 5 metres and 15 metres impounding more than 3 million cubic metres"; https://www.icold-cigb.org/GB/dams/definition_of_a_large_dam.asp (accessed 24 Sept. 2021)." Patrick McCully, *Silenced Rivers: The Ecology and Politics of Large Dams* (London: Zed, 1996), 24. If a 30-meter standard is used, then China has 6,539 large dams, more than the combined number in the United States (1,533), Japan (1120), India (592), Spain (512), Turkey (475), and Brazil (256). See Jinsheng Jia, "A Technical Review of Hydro-Project Development in China," *Engineering* 2, 3 (2016): 302–12, at 303.

[11]Xingsong Sun et al., "Development and Present Situation of Hydropower in China," *Water Policy* 21, 3 (2019): 565–81, at 577. The next four nations are the United States, Brazil, Canada, and Japan. A gigawatt equals 1,000 megawatts.

https://doi.org/10.1017/S001041752400029X Published online by Cambridge University Press

The dissonance identified here between commonplace impressions that privilege large hydropower and the overwhelming ubiquity of small hydropower construction in the 1970s is also reflected in the scholarly literature, where China is a historiographical outlier not once, but twice. In the first instance, it remains an outlier in twentieth-century histories of energy and economics. Although there exist excellent global surveys of the history of energy and power and monographs on the expansion of hydroelectricity in the United States and elsewhere, the locus of scholarship on Asia tends to cluster around what environmental historian Elizabeth Chatterjee labels "fossil developmentalism," with an attendant focus on steam power at the expense of electricity.[12] Recent works in the China field have largely followed this pattern, exploring the histories of coal and oil and their central role in industrialization during the late Qing (ca. 1860–1911), Republican (1912–1949), and Socialist (1949–) eras.[13] By contrast, histories of hydropower receive relatively little attention and are typically subsumed under larger studies of water conservation, river management, and the environment.[14]

To the extent that the history of hydropower is acknowledged, the focus is almost exclusively on tracing the construction and impact of large projects, emblematic among which are the aforementioned Sanmenxia, Gezhouba, and Three Gorges dams.[15] This fascination with size is not limited to China. The United States was the first nation to build mega-dams. The Soviet Union under Stalin is notorious for

[12]Elizabeth Chatterjee, "The Asian Anthropocene: Electricity and Fossil Fuel Developmentalism," *Journal of Asian Studies* 79, 1 (2020): 3–24, at 12. Among global surveys, exemplary are John R. McNeill and Peter Engelke, eds., *The Great Acceleration: An Environmental History of the Anthropocene since 1945* (Cambridge: Harvard University Press, 2014); and Vaclav Smil, *Energy in World History* (Boulder: Westview, 1994). On the United States and the West, see Andrew Needham, *Power Lines: Phoenix and the Making of the Modern Southwest* (Princeton: Princeton University Press, 2015); Thomas P. Hughes, *Networks of Power: Electrification in Western Society, 1880–1930* (Baltimore: Johns Hopkins University Press, 1993[1983]); Carolyn Marvin, *When Old Technologies Were New: Thinking about Communications in the Late 19th Century* (Oxford: Oxford University Press, 1988); and David E. Nye, *Electrifying America: Social Meanings of a New Technology, 1880–1940* (Cambridge: MIT Press, 1990). Donald Worster's *Rivers of Empire: Water, Aridity, and the Growth of the American West* (New York: Pantheon, 1985) remains a classic history of American hydropower. An important exception is Sunil Amrith's more recent history of water in Asia, *Unruly Waters: How Rains, Rivers, Coasts, and Seas Have Shaped Asia's History* (New York: Basic Books, 2018).

[13]Hou Li, *Building for Oil: Daqing and the Formation of the Chinese Socialist State* (Cambridge: Harvard University Asia Center, 2018); Victor Seow, *Carbon Technocracy: Energy Regimes in Modern East Asia* (Chicago: University of Chicago Press, 2021); Shellen Xiao Wu, *Empires of Coal: Fueling China's Entry into the Modern World Order, 1860–1920* (Stanford: Stanford University Press, 2015); and Shellen Wu, "The Search for Coal in the Age of Empires: Ferdinand von Richthofen's Odyssey in China, 1860–1920," *American Historical Review* 119, 2 (2014): 339–63. A notable exception is Tan's *Recharging China*.

[14]For instance, David A. Pietz, *The Huai River and Reconstruction in Nationalist China, 1927–1937* (London: Routledge, 2002); David A. Pietz, *The Yellow River: The Problem of Water in Modern China* (Cambridge: Harvard University Press, 2015); Judith Shapiro, *Mao's War against Nature: Politics and the Environment in Revolutionary China* (Cambridge: Cambridge University Press, 2001); and E. B. Vermeer, *Water Conservancy and Irrigation in China: Social, Economic and Agro-technical Aspects* (The Hague: Leiden University Press, 1977).

[15]For a history of Sanmenxia, see Xiangli Ding, *Hydropower Nation: Dams, Energy, and Political Changes in Twentieth-Century China* (Cambridge: Cambridge University Press, 2024). On Gezhouba, see Covell Meyskens, *Mao's Third Front: The Militarization of Cold War China* (Cambridge: Cambridge University Press, 2020). China built just under eight hundred dams taller than 40 meters during the three decades preceding the 1980s. Chinese National Committee on Large Dams, *Large Dams in China: History, Achievement and Prospect* (Beijing: China Water Resources and Electric Power Press, 1987), appendix.

pursuing "gigantomania,"[16] and Nehru is famously supposed to have referred to large dams as "the new temples" of modern (post-independence) India.[17] Dwarfing the historical works is the much larger contemporary social science literature on recent dam construction in China. Here, the focus is on the ecological and socio-economic impacts that such construction has already had and may have in the future, and on the ability of people to mobilize against the state to alter the conditions under which large dams are built.[18] Finally, there is also a large and vocal discourse at the more popular level, which includes works by prominent Chinese activists and journalists, such as Dai Qing (who has written and campaigned against the Three Gorges Dam) and Ma Jun (who has written more generally about China's impending water problems), to name just two.[19] It is this focus—both scholarly and popular—on large hydropower that has rendered the history of the construction, use, and impact of small hydropower in China an outlier yet a second time.

This paper represents a first step in redressing some of these imbalances. I first reconstruct the history of the PRC's enormous investments in small hydropower from 1949 to the early 1980s. Such a reconstruction, the first of its kind in the English language, helps reassess key periods and events in the history of the PRC. For one, we may have to reconsider our long-standing view of the Great Leap Forward (1958–1962) as the pinnacle of (hydraulic) infrastructural mobilization in the early PRC.[20] Further, by shifting attention from urban centers to the countryside, and from political and cultural affairs to the political economy of energy, this history expands our understanding of the years of the Cultural Revolution (1966–1976).[21]

[16]Victoria Khiterer, "Gigantomania," in James R. Millar, ed., *Encyclopedia of Russian History* (New York: Macmillan Reference, 2004), 557–58.

[17]Nehru referenced dams in religious terms on several occasions in the 1950s, albeit never in the way in which his words are evoked in popular memory. For representative discussions, see Amrith, *Unruly Waters*, 198; Daniel Klingensmith, *One Valley and a Thousand: Dams, Nationalism, and Development* (New Delhi: Oxford University Press, 2007), 263; Kathleen D. Morrison, "Dharmic Projects, Imperial Reservoirs, and New Temples of India: An Historical Perspective on Dams in India," *Conservation & Society* 8, 3 (2010): 182–95, esp. 192–93. By the end of the 1950s, Nehru had tempered his enthusiasm, cautioning against what he called the "disease of giganticism"—the "idea of doing big undertakings or doing big tasks for the sake of showing that we can do big things." Ramachandra Guha, "Prime Ministers and Big Dams," *The Hindu*, 18 Dec. 2005, https://ramachandraguha.in/archives/prime-ministers-and-big-dams.html (accessed 21 June 2024).

[18]This is a vast field; exemplary monographs include Bryan Tilt, *Dams and Development in China: The Moral Economy of Water and Power* (New York: Columbia University Press, 2015); and Andrew Mertha, *China's Water Warriors: Citizen Action and Policy Change* (Ithaca: Cornell University Press, 2008). Geographer Darrin Magee has also authored several important essays on the subject, including "The Politics of Water in Rural China: A Review of English-Language Scholarship," *Journal of Peasant Studies* 40, 6 (2013): 1189–208.

[19]In addition to Dai Qing's writings in Chinese, see also her book *The Red River Dragon Has Come! The Three Gorges Dam and the Fate of China's Yangtze River and Its People* (Armonk: M. E. Sharpe, 1998). Ma Jun's *Zhongguo shui weiji* was translated by Nancy Yang Liu and Lawrence R. Sullivan and published as *China's Water Crisis* (Norwalk: Eastbridge, 2004).

[20]On the Great Leap Forward as an infrastructural campaign with significant environmental costs, see Shapiro, *Mao's War against Nature*, especially chapter 2, 67–94; and Robert B. Marks, *China: An Environmental History*, 2d ed. (Lanham: Rowman & Littlefield, 2017), especially chapter 7, 307–91.

[21]Recent scholarship on the Cultural Revolution effectively uses political economy as a lens through which to understand those tumultuous years. See, for instance, Yiching Wu, *The Cultural Revolution at the Margins: Chinese Socialism in Crisis* (Cambridge: Harvard University Press, 2014), particularly ch. 3; and Laurence Coderre, *Newborn Socialist Things: Materiality in Maoist China* (Durham: Duke University Press, 2021).

https://doi.org/10.1017/S001041752400029X Published online by Cambridge University Press

I next turn to a discussion of the claimed impact of small hydropower. As electricity became available for the first time in many parts of the Chinese countryside, it affected patterns of economic and social activity for hundreds of millions of people. The rural and mountainous sites in the east, south, and southwest that emerge as new geographic loci for hydropower activity are also distinct from the traditional sites of fossil fuel-dependent heavy industrialization, which are typically found in the industrialized northeast (Fushun, Anshan, and Daqing) or in zones associated with Third Front Construction (1964–1980).[22] Finally, I explore what the case of small hydropower offers to conceptual and theoretical problems surrounding development, innovation, and the environment. Returning to the long-standing debate over scale and development, China's experience with small hydropower reminds us of the important role played by smaller-scale, appropriate, and self-reliant technologies in global energy history. Taken together, these three parts enhance our understanding of dam building across the twentieth century, situating small hydropower as an important parallel development to the better-known story of big hydropower.[23]

Defining Small

Although small hydropower has been a constant feature in the history of the PRC since 1949, a precise definition of smallness has been anything but constant. Instead, classificatory schemes have undergone repeated revisions to keep pace with the construction of increasingly ambitious projects. Since there are various ways to measure a dam, including height, surface area, volume of reservoir, and power generation capacity, it is not surprising that multiple classifications co-exist. Such multiplicity notwithstanding, a technocratic definition based on generation capacity is the standard classificatory metric for small hydropower. During the 1950s, all stations with a total rated capacity of 500 kilowatts or less were classified as small. In the 1960s, this standard was raised to 3 megawatts. It was further raised to 12 megawatts in the 1970s, before eventually settling at 25 megawatts in the 1980s.[24] PRC standards co-exist with various other national and international standards (a sampling is provided in table 1).[25] With the upper bound for small hydropower established at 25 megawatts, medium and large projects are accordingly classified as between 25 megawatts and 250 megawatts and greater than 250 megawatts, respectively.[26] In practice, these

[22]On the industrialized northeast, see Seow, *Carbon Technocracy*; Koji Hirata, "Made in Manchuria: The Transnational Origins of Socialist Industrialization in Maoist China," *American Historical Review* 126, 3 (2021): 1072–101; and Li, *Building for Oil.* On the Third Front, see Barry Naughton, "The Third Front: Defence Industrialization in the Chinese Interior," *China Quarterly* 115 (1988): 351–86; and Meyskens, *Mao's Third Front.*

[23]For representative discussions on the growth of big hydropower, see Sanjeev Khagram, *Dams and Development: Transnational Struggles for Water and Power* (Cornell: Cornell University Press, 2018), 6–9; and Nicholas J. Schnitter, *A History of Dams: The Useful Pyramids* (Brookfield: Balkema, 1994), 230. For a discussion of China's place in that history, see Arunabh Ghosh and Covel Meyskens, "The Contradictions of Dam Building in the People's Republic of China," May 2024 (currently under journal review).

[24]Sang Huo, "Woguo de xiaoxing shuidianzhan," 30–31.

[25]As is evident in table 1, in the twenty-first century the category of "small" has been deconstructed into three further subcategories: micro, mini, and small.

[26]"Shuidianzhan jiben zhishi," (Basic knowledge on small hydropower), Hangzhou Regional Centre (Asia-Pacific) for Small Hydropower, at http://www.hrcshp.org/aboutshp/aboutshp.asp?docId=01 (accessed 30 June 2024).

Table 1. Classifications of small hydropower projects today (in kilowatts)

	Micro	Mini	Small
	(微型)	(小小型)	(小型)
International Conference on Small Hydropower 国际小水电有关会议	<100	101–500	501–10000
Latin American Energy Association 拉美能源组织	<50	51–500	501–5000
People's Republic of China	<100	101–500	500–25000

distinctions are useful only up to a point. The overwhelming majority (over eighty-eight thousand) of the nearly ninety thousand stations in existence by the end of 1979 were rated less than 500 kilowatts each. And in effect, average capacity was 80 kilowatts per power station, itself somewhat inflated because of the 964 stations classified larger than 500 kilowatts.[27]

The eventual choice of generation capacity as the parameter of distinction may lull us into thinking that there is little that distinguishes large and small hydropower functionally—after all, they both use the potential energy of water to power turbines that are connected to dynamos, which produce electricity. As the following sections demonstrate, this functional similarity can mask richer and more variegated technological, economic, and social processes and outcomes than can be captured by a focus on large dams alone. The result is a more nuanced appreciation of China's place in the global history of dam building, one that acknowledges—as much recent scholarship does—not only its leading role when it comes to large hydropower but also the limits of such a focus. In other words, the "small" in their vast numbers may be just as significant as the "mega" is in its individual size.

The Early Years

Hydropower was not initially a key feature of the PRC's hydraulic policy. In this, it echoed a pattern set over the preceding decades, wherein, despite interest from leaders like Sun Yatsen and attempts at building a hydropower infrastructure, progress was slow.[28] When the Communists came to power in 1949, total installed hydropower capacity stood at 163 megawatts, contributing less than 9 percent of energy generation capacity in the country.[29] In the years that followed, socialist China pursued a two-pronged hydraulic strategy. Major rivers became sites of large-scale projects that drew upon the latest technologies. Smaller rivers and waterways were the sites of water conservancy projects that typically relied upon the labor of the

[27] Ministry of Water Conservancy, "Small Hydropower in China: Paper for Study Tour on Small Hydropower Stations in China," United Nations Archive (hereafter cited as UNA), S-1913-0017-0004-00002, 1.

[28] For hydropower construction during the late Qing and Republican years, see Arunabh Ghosh, "Multiple Makings at China's First Hydroelectric Power Station at Shilongba, 1908–1912," *History and Technology* 38, 2–3 (2022): 167–85; Covell F. Meyskens, "Dreaming of a Three Gorges Dam Amid the Troubles of Republican China," *Journal of Modern Chinese History* 15, 2 (2021): 176–94; and David A. Pietz, *Engineering the State: The Huai River and Reconstruction in Nationalist China, 1927–1937* (London: Routledge, 2002).

[29] Sun *et al.*, "Development and Present Situation," 566, 568.

https://doi.org/10.1017/S001041752400029X Published online by Cambridge University Press

masses.[30] The primary goal in these early years was to increase irrigation for arable land.[31] By 1959, the Ministry of Water Resources was claiming that a nearly fourfold increase in irrigation had been achieved. The guiding principle followed the slogan of the "three priorities" (三主), which emphasized the "smallness of scale, local manufacture, and local management" (小型为主、地方群众自办为主、设备地方自制为主).[32] Water conservation at this time primarily referred to the building of reservoirs. By one estimate, as many as forty thousand reservoirs were built during the PRC's first decade.[33] It also entailed the construction of canals and waterways so that more land could be irrigated. Such labor-intensive water conservation projects reached a peak during the years of the Great Leap Forward.[34]

Within this scheme, hydropower was of marginal importance, identified in the early 1950s only as an emerging area. It began to receive greater attention due to the influence of Soviet advisers, who emphasized large-scale projects on major rivers. But "huge dams, required large amounts of concrete and steel, material which China did not yet produce in sufficient quantities."[35] The shift to focusing on smaller-scale solutions emerged partly from a disaffection with these large-scale methods. In particular, the poor performance of two key Soviet-advised projects—Foziling dam (on a Huai River tributary) and Guanting reservoir (on the Yongding River)[36]—gave Chinese water-management authorities greater confidence in "some of the more traditional Chinese techniques—such as use of corvee [*sic*] labor in labor intensive, technologically primitive, low cost, small-scale projects."[37] In March 1955, Minister of Agriculture Liao Luyan stated that the government did not have the ability to foster many large-scale projects. Keeping in mind the importance of agriculture, and therefore the importance of water conservancy, Liao indicated that emphasis would be placed on energetically developing small-scale projects.[38] These plans included the building of hundreds of small dams to produce electricity.[39]

[30]Bureau of Farmland and Water Conservancy, Ministry of Agriculture, *Shinian lai nongtian shuili jianshe chengjiu: 1949–1959* (Achievements in farmland and water conservancy construction in the past ten years: 1949–1959) (Beijing: Nongye chubanshe, 1959), 2.

[31]These works no doubt drew upon China's millennia-long tradition in river and water management. There is a large body of scholarship that explores this history. Exemplary recent works include Ling Zhang, *The River, the Plain, and the State: An Environmental Drama in Northern Song China, 1048–1128* (Cambridge: Cambridge University Press, 2016); and Ruth Mostern, *The Yellow River: A Natural and Unnatural History* (New Haven: Yale University Press, 2021).

[32]Bureau of Farmland and Water Conservancy, *Shinian lai nongtian shuili jianshe chengjiu*, 41.

[33]Department of Agriculture, Government of India, *Report of the Indian Delegation to China for Study of Irrigation and Water Conservancy Projects during January–February 1959* (New Delhi, 1959), 61.

[34]For a discussion on how such conservation projects played out at the local levels in the 1950s, and especially their implications for gendered work, see Micah S Muscolino, "'Water Has Aroused the Girls' Hearts': Gendering Water and Soil Conservation in 1950s China," *Past & Present* 255, 1 (2022): 351–87.

[35]Michel Charles Oksenberg, "Policy Formulation in Communist China: The Case of the Mass Irrigation Campaign, 1957–58," PhD diss., Columbia University, 1969, 30.

[36]In Oksenberg's original: "Futse-ling and Kuan-t'ing dams and reservoirs."

[37]Oksenberg. "Policy Formulation," 31.

[38]Ibid., 32.

[39]Tan characterizes 1955 as the starting point in a "Great Acceleration" of China's electrical industries, in *Recharging China*, pp. 5, 177–78.

The possibilities of small hydropower were recognized precisely due to the existence of the vast numbers of new small reservoirs that were being built.[40] By the late 1970s, their number would increase from forty thousand to well over seventy thousand.[41] Reservoir construction entailed creation of "innumerable navigation locks and dams," a common byproduct of which was a head of water (i.e., water amassed at a height from which it can be released).[42] With a slight rearrangement and at minimum expense, many of these reservoirs could be used to produce electricity.[43] As a short 1954 primer on hydropower notes, the idea was to "make water do the work." The primer explains that in the past, people could only harness a small portion of water's hydraulic power. Traditional devices, such as the watermill (水磨), the water roller (水碾), and the waterwheel (水车) used an extremely small share of the true potential of water. Hydraulic power, in contrast, had nearly limitless power. But to realize that potential, the power had to be converted into electricity.[44]

In the 1950s, there were three principal types of small hydropower projects that a county could build. The first type relied on a dam to create a head of water. Electricity generation could take place at the top of the dam or at its base. A second type of project relied on the run of the river, and it could be located along a canal, irrigation channel, or ditch. Finally, there were designs that were a hybrid of the first two, combining run of the river features with the existence of a dam (see figure 1).[45] By the late 1970s, this three-fold schema had expanded to seven; the four new categories of plants exploited natural rapids or waterfalls, were located on irrigation channels, exploited mountain springs, or used tidal power.[46]

Elements of technology popularization accompanied the expansion of small hydropower construction. The 1954 primer explains that in order to convert waterpower into electric power, one had to build a machine room (机器房) inside of which there would be two devices: a water turbine (水轮机) and a generator (发电机). Variations in these devices were explained using language and imagery that immediately resonated across peasant households unaccustomed to hydroelectricity. For instance, a water turbine could have different types of blades (轮片). Some might resemble the earlobes of a cow (牛耳朵), others iron ladles/spoons (铁勺子), and still others a propeller (螺旋桨; lit.: a paddle attached to a screw).[47] The generator was

---

[40]Claims to newness almost certainly obscure the fact that in many instances these were not new constructions but rather the outcome of repairs, restorations, or expansions of pre-existing imperial-era constructions, a process that is evocative of Judd C, Kinzley's layered model of state formation, in *Natural Resources, and the New Frontier: Constructing Modern China's Borderlands* (Chicago: University of Chicago Press, 2018).

[41]This was in addition to two thousand large- and medium-scale reservoirs. James E. Nickum, "The Organisation of Water Resource Development in the People's Republic of China," *Agricultural Administration* 6, 3 (1979): 169–86, at 170.

[42]Ministry of Water Conservancy, "Small Hydropower in China," 2.

[43]Anhuisheng shuiliting kance shejichu shuidian zubian (Hydropower Group of the Survey and Design Division of the Anhui Provincial Water Resources Department), eds., *Jianshe nongcun xiaoxing shuidianzhan de jiben zhishi* (Basic knowledge on building small hydropower stations in rural areas) (Hefei: Anhui renmin chubanshe, 1958), 3.

[44]Chang Yu, *Shuili fadian: Gongye changshi xiaocongshu, diyiji* (Hydropower, miniseries on industrial knowledge, first collection) (Beijing: Tongsu duwu chubanshe, 1954), 3.

[45]Anhuisheng shuiliting kance shejichu shuidian zubian, *Jianshe nongcun*, 4–8.

[46]Robert P. Taylor, *Rural Energy Development in China* (London: Routledge, 2016[1981]), 168.

[47]Chang Yu, *Shuili fadian*, 7.

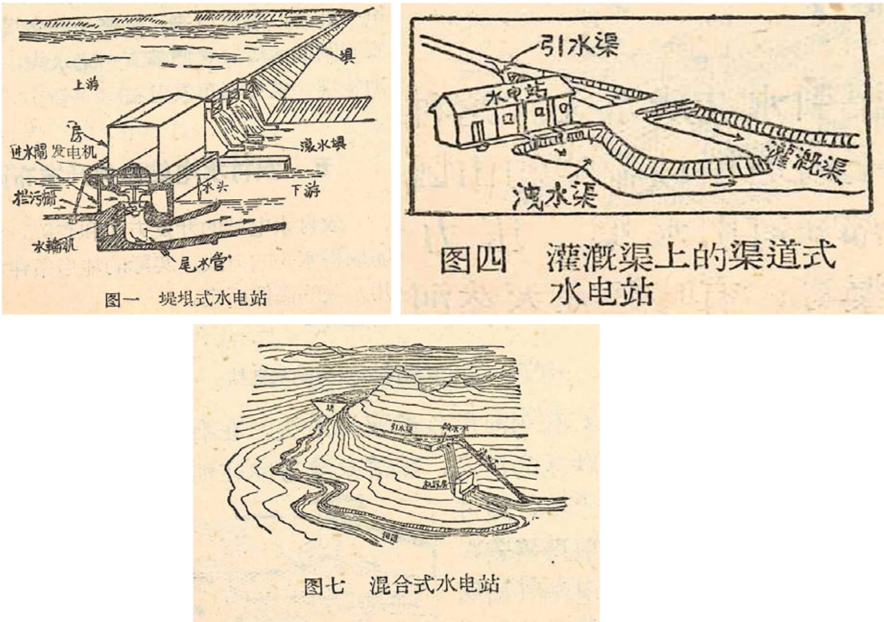


Figure 1. Three types of small hydropower projects: on a dam (top left), run of the river/canal (top right), and a combination of a dam and run of the river (bottom). Source: Anhui Department of Water Resources, Jianshe nongcun xiaoxing shuidianzhan de jiben zhishi (Basic knowledge on building small hydropower stations in rural areas) (Hefei: Anhui renmin chubanshe, 1958), 4–8.

trickier to explain, since it required a grasp of how moving a magnet rapidly through a coil of copper wire could produce electricity. Often, a simple experiment was used to demonstrate the scientific principle. A wire was connected to an ammeter and moved between the two prongs of a horseshoe magnet. In the case of a hydropower plant, the primer clarifies, instead of the wire being moved, it was the magnet that would move. It would be connected to a water turbine, and as the turbine moved, the magnet would, in turn, move around copper coils, thereby generating electricity.[48]

Didactic homilies notwithstanding, adoption of small hydropower during the 1950s was a gradual affair. Records indicate that total installed capacity was only 5 megawatts in 1949. It grew gradually to reach 20 megawatts by 1957. By the start of the following year, there were 589 small-scale hydropower projects spread across twenty-six provinces and autonomous regions, with a total installed capacity of just under 30 megawatts. The leading province was the southwest province of Sichuan, where 173 such projects had a total capacity of 8.4 megawatts. Next was Fujian province in the southeast, whose ninety-two projects could produce up to 3.5 megawatts. At the other extreme, provinces such as Jiangsu, Anhui, and Inner Mongolia reported as few as two or three such projects.[49] The year 1958, which coincided with the start of the Great Leap Forward, witnessed a significant increase,

[48]Ibid., 8–12.

[49]"Quanguo xiaoxing shuidianzhan gaikuang" (Overview of small hydropower stations in the country), *Dianye jishu tongxun* (Electrical industry technical newsletter) 7 (1958): 45–52.

https://doi.org/10.1017/S001041752400029X Published online by Cambridge University Press

as another 130 megawatts of installed capacity was added. An additional 430 megawatts was planned for the following year, but it appears that as of 1960 only a total of 251.4 megawatts of installed capacity had been achieved.[50] Even so, the number of stations had grown to just under nine thousand.[51]

The 1970s: The Decade of Peak Small Hydropower

By the time the 150 delegates to the Symposium on Small Water Conservancy and Hydropower in the Southern Mountainous Areas gathered in Yongchun county (in October 1969), the number of stations had doubled to 18,935 and installed capacity had nearly tripled to 730 megawatts. Growth during the 1960s was likely spurred on by a national meeting on small hydropower that took place in February 1960 in the Jinhua area (金华地区) of Zhejiang province, immediately north of Fujian.[52] Following the meeting, participants divided into two groups. One traveled to Sichuan and the other to Yongchun, where they spent five days learning about the county's small hydropower projects.[53] The selection of Yongchun as host of the 1969 conference nearly a decade later thus was not coincidental but rather the result of a long-standing reputation for developing small hydropower.[54] Both a picture book and a booklet summarizing the county's experiences were published as early as 1958.[55] In the following year, Yongchun was hailed as an "advanced flag bearer" for hydropower-based rural electrification.[56] Even the nation's top political leaders got into the act, offering words of recognition and praise. The most prominent among them was Premier Zhou Enlai, who in 1969 called Yongchun a small hydropower "red flag" (一面红旗).[57]

As noted, the October 1969 "Symposium on Small Water Conservancy and Hydropower in the Southern Mountainous Areas" consisted of two phases. From 20–31 October the attendees met in Yongchun county in what was called the "National Small Hydropower On-the-Spot Meeting" (全国小水电现场会).[58] Among the meeting's highlights was the adoption of new policies guaranteeing that financial profits and material benefits of small hydropower construction

[50]Bureau of Farmland and Water Conservancy, *Shinian lai nongtian shuili jianshe chengjiu*, 5.

[51]Zhao Jianda and Wu Hao, "Zhongguo xiaoshuidian dashiji," 9.

[52]The "National Conference on the Exchange of Experience on Rural Hydroelectricity and Hydropower" was held in February 1960 and was attended by representatives from fifteen provinces and autonomous regions. Zhejiangsheng Jinhuashi shuidianju (Hydropower Bureau of Jinhua City in Zhejiang Province), *Jinhuashi shuilizhi* (Jinhua Water Conservancy chronicles) (Beijing: Zhongguo shuili shuidian chubanshe, 1996), 261–62.

[53]Liang Tiancheng, *Yongchun xianzhi*, 327.

[54]On hydropower in Yongchun during the Great Leap Forward, see Ding, *Hydropower Nation*, particularly chapter 3. Yongchun and Jinhua are not alone in enjoying this special distinction. Other leading hydropower counties include, among others, Xianju (Zhejiang), Nanping (Sichuan), Changbai (Jilin), Tongcheng (Hubei), Tengchong (Yunnan). Ministry of Water Conservancy, "Small Hydropower in China," 3.

[55]*Xiang dianqihua jinjun de Yongchun xian* (Yongchun County marching toward electrification) (Shanghai: Shanghai renmin meishu chubanshe, 1958); *Fujiansheng Yongchunxian nongcun xiaoxing shuili shuidianzhan jianshe jingyan* (The construction experience of rural small hydropower stations in Yongchun County, Fujian Province) (Beijing: Shuili dianli chubanshe, 1958).

[56]Bureau of Farmland and Water Conservancy, *Shinian lai nongtian shuili jianshe chengjiu*, 37.

[57]Liang Tiancheng, *Yongchun xianzhi*, 300.

[58]Liang Tiancheng (ibid.) lists the dates of the conference as 20–28 October.

https://doi.org/10.1017/S001041752400029X Published online by Cambridge University Press

would remain local.[59] To meet this goal, the central government agreed to provide financial resources and material support (such as supplies of iron, aluminum, and silicon steel sheets[硅钢片], etc.) to local factories to alleviate existing supply issues, with the understanding that the manufacture of turbines and other necessary equipment would be local affairs. The second phase was held from 1–19 November in Beijing. A major outcome included adoption of a policy that emphasized the "three priorities" of smallness of scale, local manufacture, and local management.

Yongchun would remain at the heart of propaganda campaigns to accelerate adoption of small hydropower through the 1970s. The county's achievements were featured in provincial newspapers like *Fujian Daily*, in national newspapers like *People's Daily*,[60] and in sympathetic foreign newspapers such as Hong Kong's *Ta Kung Pao*. The highwater mark came in 1970, when three major venues—the Chinese-language *China Pictorial* (中国画报), the English-language *People's China* (人民中国), and the Hong Kong–based *Weekend Daily* (周末报)—each carried photo features on Yongchun (see figures 2 and 3).[61] This fame also extended

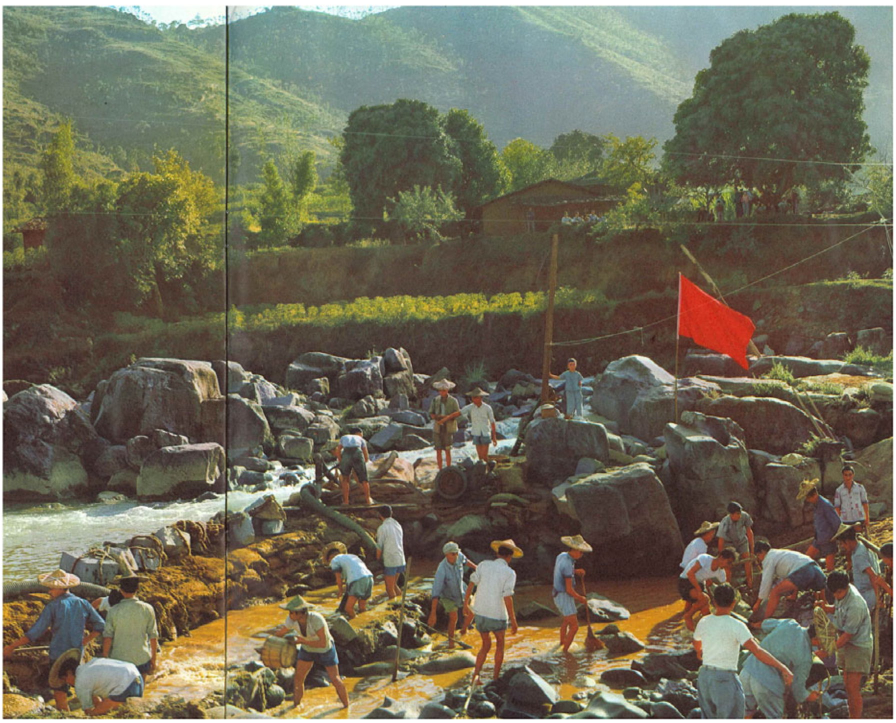


Figure 2. "Yongchun's Small Hydropower Stations Are All Built Using the Labor of Commune Members," China Pictorial (March 1970): 34–35.

[59]Known as the policy of "who builds, who manages, who possesses, who benefits" (谁建、谁管、谁有、谁受益).

[60]See, for instance, 28 Jan. 1970, 3; 17 Mar. 1970, 3; and 15 Nov. 1971, 3.

[61]Liang Tiancheng, *Yongchun xianzhi*, 329.

https://doi.org/10.1017/S001041752400029X Published online by Cambridge University Press

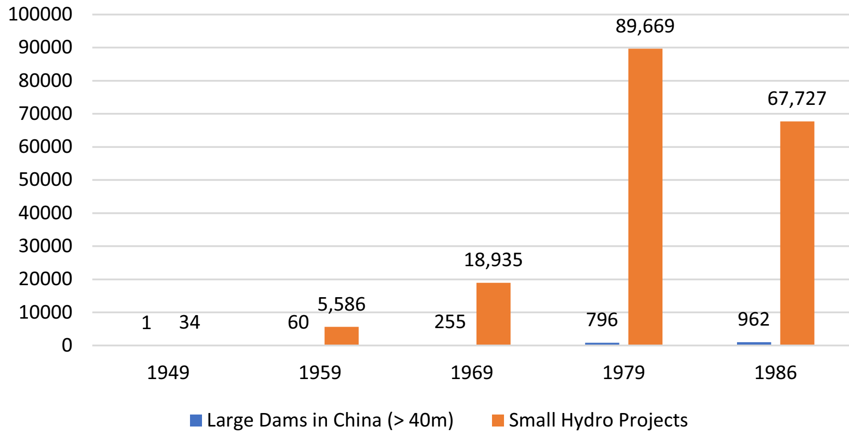
Figure 3. "All the People's Communes in the County Have Small Hydropower Stations," China Pictorial (March 1970): 34.

farther afield: Yongchun's achievements were exhibited in Algeria, Canada, Egypt, France, Romania, Syria, Tanzania, Turkey, the United Arab Emirates, the United States, and Zambia.[62]

[62]Ibid., 333.

https://doi.org/10.1017/S001041752400029X Published online by Cambridge University Press

Table 2. Total Large and Small Hydropower Projects



The official imprimatur, granted in late 1969 in Yongchun and Beijing, unleashed a flurry of construction activity that made the 1970s the decade of peak small hydropower. Seasonal labor, estimated at 150 million during the slack winter season, was utilized in a range of water conservation projects, including small hydropower.[63] The result was construction of nearly seventy thousand new stations.[64] Table 2 summarizes this growth, contrasting it with the growth of large dams (defined by the Chinese National Committee on Large Dams as taller than 40 meters).[65] Data for total installed capacity added make a similar case, with 6,057 megawatts installed in the 1970s, compared to 543.8 megawatts in the 1960s and 297.7 megawatts in the 1950s (see table 3).[66]

Similar to the number of projects, small hydropower's share of installed hydropower capacity peaked in the 1970s, at a little over 43 percent.[67] Not surprisingly, a large portion of this added capacity was located in southern and southwestern China, where the mountainous terrain favored hydropower. For instance, of the 770 counties that relied almost exclusively on small hydropower for their electricity needs by the early 1980s, nearly 70 percent (563) were located in the more mountainous eastern, southern, and southwestern parts of China (see figure 4).[68]

[63]Nickum, "Organisation of Water Resource Development," 177–78.

[64]These data and the estimates that follow are compiled from these sources: Li Ying, "Zili gengsheng jianku chuangye de shuoguo"; Zhao Jianda and Wu Hao, "Zhongguo xiaoshuidian dashiji (1904–2019 nian) (zhi yi)"; and Zhao Jianda and Wu Hao, "Zhongguo xiaoshuidian dashiji (1904–2019 nian) (zhi er)" (China's small hydropower: chronicle of events, 1904–2019, part II), *Xiao shuidian* (Small hydropower) 1 (2021): 1–17.

[65]The data on large dams are compiled from the appendix to Chinese National Committee on Large Dams, *Large Dams in China*.

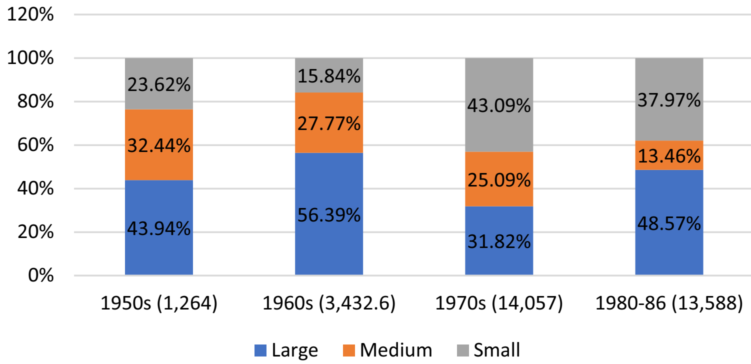
[66]Sun Baomu, *Zhongguo shuili shi jianming jiaocheng* (A concise course on the history of Chinese water conservancy) (Zhengzhou: Huanghe shuili chubanshe, 1996), 134. The data from the sources in note 64, above, provide a slightly lower estimate of 5,600 megawatts.

[67]Ibid., 134.

[68]Data on the map are compiled from Li Ying, "Zili gengsheng jianku chuangye de shuoguo," 41–45.

https://doi.org/10.1017/S001041752400029X Published online by Cambridge University Press

Table 3. Share of Hydropower Capacity Added by Decade (total installed capacity in MW)



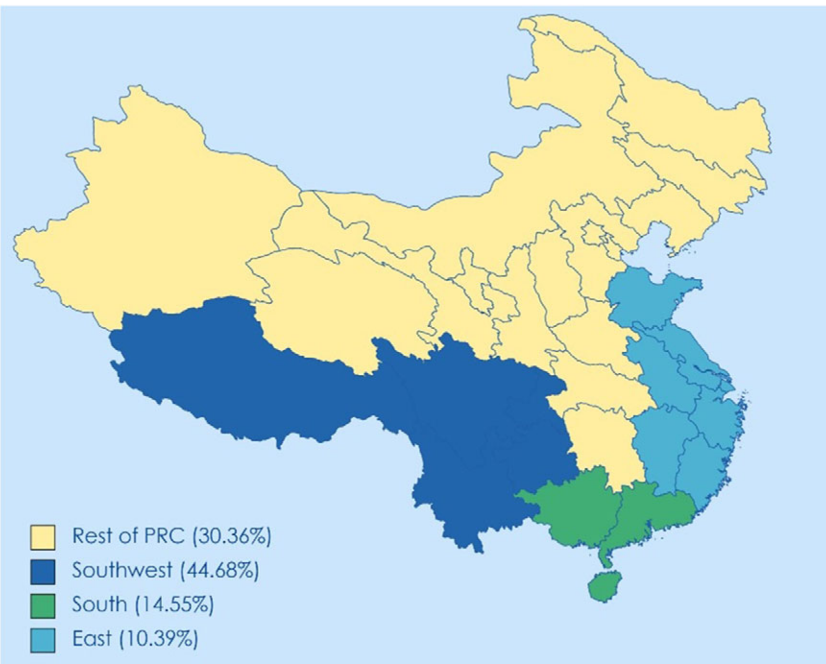


Figure 4. Regional distribution of counties that rely primarily on small hydropower (n = 770). Author's map.

Claims: Transformative Impact at the Grassroots

In 1981, the Ministry of Water Conservancy of the PRC offered an assessment of China's small hydropower landscape. It noted, "Full utilization of decentralized hydropower potential in China and a combination of SHP [small hydropower] … could hastily meet the requirement of electrical energy in decentralized rural areas

https://doi.org/10.1017/S001041752400029X Published online by Cambridge University Press

and has promoted the development of agriculture."[69] Total rural electricity consumption stood in excess of 28 terawatt hours in 1979.[70] One-third of this consumption was supplied by small hydropower. Contemporary reports asserted that the rapid expansion of small hydropower ensured that all counties, 87 percent of communes, 62 percent of production brigades, and 52 percent of production teams had access to electricity.[71] This electricity was consumed for a variety of purposes: "… in rural areas, 43% is for drainage and irrigation, 16% for commune and brigade-run industries, 22% for processing agricultural and sideline products and 19% for home lighting."[72]

Assessments made both contemporaneously and more recently indicate that the expansion of small hydropower had a large impact on rural electrification.[73] It gave peasants greater control over the storage, channeling, and drainage of water, which in turn was helpful in times of both drought and flood.[74] Small hydropower also promoted the mechanization and electrification of agriculture. In the 1950s, the Anhui Department of Water Resources took the trouble to break down what 1 kilowatt hour of electricity could achieve at the village level, thereby translating an abstract unit of energy into easily relatable rural activities. In agriculture, 1 kilowatt hour could drain an area of 40 square meters. It could also thresh 200 *jin* (100 kilograms) of grain or grind 50–60 *jin* (25–30 kilograms) of grain. If rice was the main staple, then 100 *jin* could be husked. In terms of manufacturing, 1 kilowatt hour could help weave 27 *chi* (~ feet) of cloth, roll 30 *jin* of steel, or make ten thousand cigarettes. It could also shear three hundred head of sheep, boil 30 kilograms of water, extract approximately 15 *jin* of oil, or produce 0.5 *jin* of nitrogenous fertilizer.[75] By the early 1980s, in counties with total installed capacities equal to or greater than 10 megawatts, over 60 percent of the production teams used electricity for diverse activities.[76]

In many places, the labor released from agriculture was redirected to local industries, which began to develop a capacity to manufacture agricultural implements and various commodities such as cement, fertilizer, paper, cotton, and calcium carbide. Revenue from the sale of small hydropower further bolstered industrial activity. At operating costs of 2–3 fen per kilowatt hours and sales at 5–6 fen per kilowatt hours, small hydropower was the cheapest source of energy in rural areas and it ensured a steady revenue stream for local communities.[77] In hilly

[69]Ministry of Water Conservancy, "Small Hydropower in China," 3.

[70]A terawatt-hour is a unit of energy equal to outputting one trillion watts for one hour.

[71]Bai Lin, "Woguo xiao shuidian de fazhan qianjing," 55. Slightly different estimates—81 percent, 62 percent, and 50 percent, respectively—are provided in Ministry of Water Conservancy, "Small Hydropower in China," 3.

[72]Ministry of Water Conservancy, "Small Hydropower in China," 4.

[73]Lin Xiaoliang and Chen Peizhen, "Woguo nongcun xiaoshuidian de fazhan fenxi" (Analysis of the development of small hydropower in China's rural areas), *Keji xiaoxi* (Science information) 5 (2006): 215, 198.

[74]Li Ying, "Zili gengsheng," 42.

[75]Anhuisheng shuiliting kance shejichu shuidian zubian, *Jianshe nongcun*, 19–20.

[76]Bai Lin, "Woguo xiao shuidian de fazhan qianjing," 57.

[77]A unit of currency, one fen is equal to 1/100 of a yuan, or 1/10 of a Chinese jiao. Between 1978 and 1981, annual per capita personal income in communes ranged between ¥ 75 and ¥ 98. For more, see Nicholas R. Lardy, "Consumption and Living Standards in China, 1978–83," *China Quarterly* 100 (1984): 849–65, at 851. James Nickum provides similar estimates of electricity fees in Huadong Commune and Red Flag Canal. The electricity, generated through both hydropower and thermal means, was charged using a graduated fee

https://doi.org/10.1017/S001041752400029X Published online by Cambridge University Press

counties and communes, in particular, small hydropower was at the center of industrial activity.[78] Data from Sichuan for 1979 indicate that the profit margins of small hydropower were nearly double those of small thermal power. In the face of a limited supply from the national grid (108 megawatts compared to small hydropower's 296 megawatts), it was thus a crucial source of electricity for rural industry in the province.[79]

One result of small hydropower expansion was an improvement in rural material standards of living. At one extreme, and undoubtably a non-representative level, was a model county like Yongchun, where it was claimed that every village and 92 percent of rural households had electricity by 1979. Applications included lighting, radio, television, and cinema, significantly expanding educational and cultural possibilities. Over six thousand households had electric rice cookers, ten thousand households had electrically driven fuel-saving bellows for use with ovens, and over two thousand households had electric kettles. A range of other household appliances also began to be widely used.[80] The reduced need for manual labor freed up time for other activities, and electric lighting made it possible to read and study into the night.[81]

Yongchun's numbers stand in stark contrast to Vaclav Smil's 1979 assessment that average household electricity consumption in the rural areas across China remained very low, with households typically restricted to one or two low wattage (15 watt or 40 watt) light bulbs.[82] We can safely assume that the reality for most rural Chinese hewed closer to Smil's assessment than to Yongchun's claims. Nonetheless, for a countryside where electricity was a novelty well into the 1970s, even a much more sober assessment signals a noteworthy achievement.[83] Nor should it be surprising that significant regional variations existed, not least because of China's varied geography. And although environmental concerns may not have driven the expansion of small hydropower, certain ecological benefits did also accrue. Among these was conservation of local forests, since wood constituted the principal source of cooking fuel prior to the availability of hydroelectricity.[84] At the same time, thus far we have no data that show whether these benefits were offset by new forms of hydropower-induced industrial activities, which, we know from other sources, in

structure, with higher rates for industrial and household use. Nickum, "Organisation of Water Resource Development," 175.

[78]Bai Lin, "Woguo xiao shuidian de fazhan qianjing," 56–57; Li Ying, "Zili gengsheng jianku chuangye de shuoguo," 42; Hangzhou Regional Centre, *Small Hydro Power*, 23.

[79]Although small hydropower stations were more expensive to run than medium and large ones, the deficit was made up by their being 50 percent cheaper in terms of total investment. Ministry of Water Conservancy, "Small Hydropower in China, 5–6.

[80]Hangzhou Regional Centre, *Small Hydro Power*, 44–45.

[81]Li Ying, "Zili gengsheng jianku chuangye de shuoguo," 43; Bai Lin, "Woguo xiao shuidian de fazhan qianjing," 57.

[82]Vaclav Smil, "Intermediate Energy Technology in China," in Neville Maxwell, ed., *China's Road to Development*, 2d ed. (Oxford: Pergamon Press, 1979), 279–88, at 282–83. An eponymous expanded version of this article was originally published in *World Development* 4, 10/11 (1976): 929–37.

[83]Xiujie Wu, "Men Purchase, Women Use: Coping with Domestic Electrical Appliances in Rural China," *East Asian Science, Technology and Society: An International Journal* 2, 2 (2008): 211–34, notes the novelty of electricity across the North China Plain as late as the 1970s.

[84]Li Ying, "Zili gengsheng jianku chuangye de shuoguo," 43; Lin Xiaoliang and Chen Peizhen, "Woguo nongcun xiaoshuidian de fazhan fenxi," 198, 215.

Figure 5. "A Small Coal Mine in Yongchun County, Fujian. Part of the Small Hydropower-Fueled Growth in Local Industry," People's Daily, 28 January 1970: 3.

some instances included the establishment of new small-scale coal mines (figure 5).[85]

To the extent that data about material improvements at the local levels are reliable, and especially once we set aside obvious outliers such as Yongchun and other model counties, they provide an interesting counterexample to the distributional effects of large-scale hydraulic engineering. For instance, in their study of large hydroelectric dams in India, Rohini Pande and Esther Duflo show that the distributional effects tended to favor those who lived farther away from the dam.[86] These districts benefited from the reliable supply of electricity, water for irrigation and consumption, and foodstuffs (fish, etc.). In contrast, in districts where large dams were built, Pande and Duflo find increased poverty, greater volatility in agricultural production, and vulnerability to climate events. The case of small hydropower, where both the good and the bad effects are local, suggests a different logic at play.

Adaptive Governance, Devolution, and Global Leadership

In his recent history of the Chinese Communist Party, Tony Saich notes that a key feature of Chinese governance since 1949 has been the "struggle between local adaptation and central imposition."[87] This adaptation frequently involved experiments on the margins—at specific factories, work units, and communes—which, if successful, would be promoted on a wider scale.[88] In the case of hydraulic

[85]On small-scale coal mining, see Vaclav Smil, "Intermediate Energy" [1979], 279–81; see also Smil, "Intermediate Energy" [1976], 929–31.

[86]Esther Duflo and Rohini Pande, "Dams," *Quarterly Journal of Economics* 122, 2 (2007): 601–46. On the uneven distributional impact of the Tennessee Valley Authority in the United States and of the Damodar Valley Corporation in India, see Klingensmith, *One Valley.*

[87]Tony Saich, *From Rebel to Ruler: One Hundred Years of the Chinese Communist Party* (Cambridge: Harvard University Press, 2021), 451.

[88]For a more extensive discussion of adaptive governance in the Chinese context, see Elizabeth Perry and Sebastian Heilmann, eds., *Mao's Invisible Hand: The Political Foundations of Adaptive Governance in China*

https://doi.org/10.1017/S001041752400029X Published online by Cambridge University Press

implementation, the first person to point to the adaptive nature of Chinese practices was Michel Oksenberg. In his dissertation on the 1957–58 mass irrigation campaign, he notes: "China responded to the pressures upon them by making gradual or incremental adjustments in water policy. Moreover, it suggests that the total pattern of their responses to various pressures arising from different parts of a complex society did not always form a coherent whole."[89]

While broadly in accordance with this adaptive-governance pattern, in which counties such as Yongchun and Jinhua played a leading role, small hydropower also signaled a significant devolution of fiscal, managerial, and technical expertise from the central to the local levels. Financed largely through local means, small hydropower was designed around the use of local skills sets, local materials, and local technologies. As such, it offers an important lens through which to explore the changing political economy of center-local relations from the founding of the PRC to the 1980s. The cost of small hydropower construction ranged widely on account of the considerable variation in local conditions across the country. The minimum specific cost per kilowatts was estimated at 600–800 renminbi (RMB), and the maximum for the larger but much rarer plants might surpass 2,000 RMB. Central funding typically constituted at most one-third of the total. Between 1975 and 1979, it averaged 350 RMB per kilowatts and was used chiefly to source electro-mechanical equipment and principal construction materials.[90] The remaining funding, including funds from banks, was obtained locally.[91]

Design and managerial oversight were left to the counties and communes. The larger ones, with their extensive networks of small hydropower stations, often set up dedicated corporations to oversee these tasks. Only when a plant was rated 500 kilowatts or higher did the provincial government also become involved.[92] In some cases, counties marketed their excess capacity to others. Yongchun's General Machine Works, for instance, sold many of the more than eight hundred hydropower turbines it manufactured and the generators it produced to neighboring counties. In time, it also began offering repair and maintenance services, which led local farmers to dub workers from the General Machine Works "iron doctors."[93] "Through practice, ranks of technical staffs [*sic*] including planning, exploration, designing, construction, installation, operation, and maintenance have already been trained up in China," the Ministry of Water Resources summarized in 1981.[94]

This buildup of local capacity helps us understand the dynamism that was displayed after 1978, when Deng Xiaoping's wider policies of reform and opening led to the dissolution of the communes and the return to household farming.[95]

(Cambridge: Harvard University Press, 2011); and Sebastian Heilmann, *Red Swan: How Unorthodox Policy-Making Facilitated China's Rise* (Hong Kong: Chinese University Press, 2018).

[89]Oksenberg, "Policy Formulation," 1.

[90]The dividing line is capacity. Units below 500 kilowatts were local affairs, with only silicon steel sheets and copper offered by the state at subsidized rates. Units over 500 kilowatts were manufactured and distributed under a national plan. Ministry of Water Conservancy, "Small Hydropower in China," 7.

[91]Ibid., 4–5, 7.

[92]Ibid., 8, 9.

[93]Hangzhou Regional Centre, *Small Hydro Power*, 44.

[94]Ministry of Water Conservancy, "Small Hydropower in China," 9.

[95]For standard histories of the reform era, see Barry Naughton, *Growing Out of the Plan: Chinese Economic Reform, 1978–1993* (Cambridge: Cambridge University Press, 1995); Carl Riskin, *China's Political Economy: The Quest for Development since 1949* (Oxford: Oxford University Press, 1996). For Deng Xiaoping's role, see

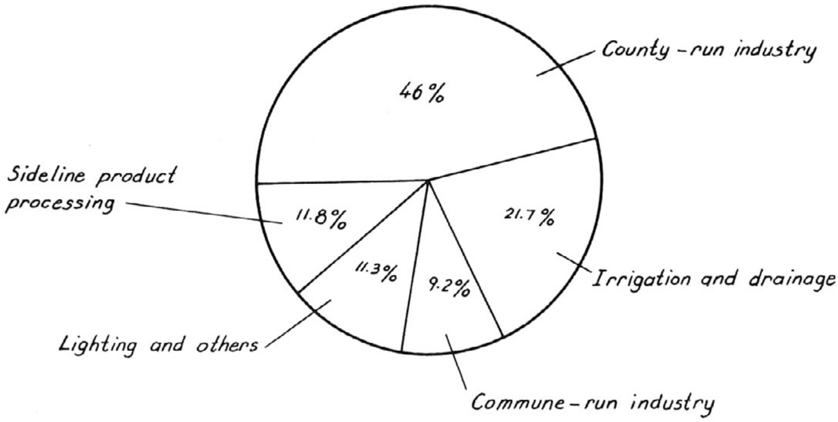


Figure 6. Electricity consumption in the rural areas, by sector, ca. 1983. Hangzhou Regional Centre, Small Hydro Power in China: A Survey (London: Intermediate Technology Publ., 1985), 9.

The "explosive growth of the township and village enterprises [starting in the mid-1980s] was not foreseen by the leadership," but it may, in part, be traced to the widespread availability of electric power and managerial and technical capacity that had been fostered by the expansion of small hydropower.[96] The trend was already evident by 1983, when commune- and county-run industries claimed over one-half (55.2 percent) of rural electricity production, up from a mere 16 percent just four years earlier (see figure 6). Tellingly, the corresponding share of drainage and irrigation dropped from 43 percent to 21.7 percent during the same period.[97]

The years after 1978, when Deng Xiaoping initiated the policy of reform and opening, are often viewed as the period when the PRC reconnected (even reintegrated) with a large part of the world. A key element in this reconnection consisted of seeking out and mastering the most advanced ideas in science, technology, and statecraft.[98] In terms of economic knowledge, some scholars, such

Ezra F. Vogel, *Deng Xiaoping and the Transformation of China* (Cambridge: Belknap Press of Harvard University Press, 2011).

[96]Saich, *From Rebel to Ruler*, 451. Township and Village Enterprises (TVEs) were market-oriented public or private enterprises under the purview of local governments based in townships and villages. Their key identifying feature was their location, not their ownership. Starting in 1983, the number of TVEs witnessed explosive growth, reaching nearly twenty million by the end of the 1980s. There is a large literature on TVEs. A good place to start is Zou Wei, "The Changing Face of Rural Enterprises," *China Perspectives* [online], 50 (2003), at http://journals.openedition.org/chinaperspectives/773 (accessed 17 Sept. 2021). For a discussion on the rural roots of the post-1978 reforms, see Odd Arne Westad, "The Great Transformation: China in the Long 1970s," in Niall Ferguson *et al.*, eds.,*The Shock of the Global: The 1970s in Perspective* (Cambridge: Belknap Press of Harvard University Press, 2010), 65–79. For the role of small industries in Chinese development, see Carl Riskin, "Small Industry and the Chinese Model of Development," *China Quarterly* 46 (1971): 245–73. Andrew Walder, in "Local Governments as Industrial Firms: An Organizational Analysis of China's Transitional Economy," *American Journal of Sociology* 101, 2 (1995): 263–301, ascribes the dramatic TVE growth after 1978 to the relative autonomy and firm-like behavior of local governments.

[97]The 1979 figures are from Ministry of Water Conservancy, "Small Hydropower in China," 4.

[98]This process began in 1971, when the PRC was admitted to the United Nations, but it picked up significantly after 1978.

https://doi.org/10.1017/S001041752400029X Published online by Cambridge University Press

as historian Julian Gewirtz, contend that this encounter was characterized by enthusiastic and uncritical assimilation by the Chinese.[99] Others, exemplified by economic historian Isabella Weber, suggest a much more measured and judicious engagement, one in which Chinese economists and reformers actively sought advice from worldwide economists of varying ideological persuasions, as they deliberated the best path forward for the Chinese economy.[100] Indeed, similar instances of Chinese reaching out to communities of global experts can be found in almost every domain of knowledge production.[101]

Small hydropower appears to invert the logic of the Chinese as merely seeking global best practices. Instead, by the early 1980s, it was the Chinese who were global leaders in the adoption and expansion of small hydropower technology. In their own words, they "were ready to render service at any time," on "river projects planning, exploration and surveying, designing, construction, installation, testing and, in fact, the whole engineering project from design to operation."[102] Global recognition came in late 1979 in Montreal at an international conference on long-term energy sources, at which several speakers on hydropower singled out the exceptional development in China.[103] Director of Projets de centrales Hydro-Quebec Toby Gilsig observed, "China represents a remarkable example of accelerating development. Her developed resources of 12,000 megawatts are comprised largely of local units of up to 500 kilowatts.… This is an extraordinary example of a developing country considering a heavy investment in hydroelectric generation as being a key element in its industrialization."[104] And Edward Wehlage, president of the International Society for Geothermal Engineering, noted appreciatively that "reports indicate that China has reversed the trend [of a global decline in small hydropower] … by installing over eighty thousand hydropower units during the last three decades, 60 percent of them less than 500 kilowatts in capacity."[105]

[99]See, for instance, his retelling of how Chinese economists learned about the latest developments in the world of American neoclassical economics. Julian B. Gewirtz, *Unlikely Partners: Chinese Reformers, Western Economists, and the Making of Global China* (Cambridge: Harvard University Press, 2017).

[100]Isabella Weber, *How China Escaped Shock Therapy: The Market Reform Debate* (London: Routledge, 2021).

[101]See, for instance, Wendy Leutert, "Sino-Japanese Engagement in the Making of China's National Champions," *New Political Economy* 27, 6 (2022): 929–43.

[102]Ministry of Water Conservancy, "Small Hydropower in China," 19.

[103]Organized in the shadow of the decade's two oil shocks, the conference, held from 26 November 26 to 7 December 1979, was convened by the United Nations Institute for Training and Research (UNITAR) and Petro-Canada, a state-owned Canadian oil company that had been formed just four years earlier in 1975. Cooperating agencies included the United Nations Development Program (UNDP); Canadian International Development Agency; Petroleos de Venezuela; Petroleos Mexicanos; Hydro-Quebec; and the Compaigne Française des Petroles. See R. F. Meyer, ed., *Long-Term Energy Resources: An International Conference*, 3 vols. (Boston: Pitman, 1981). See also Henry Giniger, "U.N. Conference Is Optimistic on World's Energy: A Course Is Proposed." *New York Times*, 9 Dec. 1979: 23, https://www.nytimes.com/1979/12/09/archives/un-conference-is-optimistic-on-worlds-energy-a-course-is-proposed.html?smid=url-share (accessed 22 June 2024) (also in UNA, S-0990-001 0-02-00001).

[104]Toby Gilsig, "The Development of Hydroelectric Resources," in R. F. Meyer, ed., *Long-Term Energy Resources: An International Conference*, 3 vols. (Boston: Pitman, 1981), vol. II, 1244. In the same volume, see Meyer's, "Introduction," vol. 1, xlii–iii.

[105]By contrast, of the nearly fifty thousand small dams in the United States, only about fourteen hundred were developed to produce hydroelectricity. Wehlage, "Hydro and Hydroelectric Power: Promise for a Long-

https://doi.org/10.1017/S001041752400029X Published online by Cambridge University Press

Within a year, the United Nations Department of Technical Co-operation for Development, in cooperation with the United Nations Industrial Development Organization (UNIDO) and the government of the PRC, set about to coordinate a "Study Tour on Small-Scale Hydropower Stations in China."[106] The letter of invitation to various UN resident representatives explained that the tour would "provide an opportunity for participants from developing countries with potential for small-scale hydropower development to examine the Chinese experience in meeting rural energy needs by using simple technology and local skills in the development of small hydropower schemes."[107] Held from 22 May to 4 June 1981, the tour had eighteen participants from sixteen countries.[108]

In that same year, the government of the PRC, with cooperation and financial support from the UNDP, the Economic and Social Commission for Asia and the Pacific (ESCAP), and UNIDO, established the Hangzhou Regional Centre (Asia-Pacific) for Small Hydro Power in the city of Hangzhou, in the coastal province of Zhejiang.[109] Operating under the Chinese Ministry of Water Resources, the Centre's aim was to "promote regional and international co-operation, including the adaptation and development of SHP [small hydropower] technologies, with the ultimate objective of encouraging the transfer of technology and application of SHP for rural electrification and industrialization."[110] According to the Centre's website, as of 2012 it had conducted sixty-three training workshops and had trained 1,332 individuals from 105 countries.[111]

Scale and Development

Acknowledging China's centrality in the history and implementation of small hydropower technology allows us to reassess several key debates in the history of development, none perhaps more important than the issue of scale. In 1973, economist E. F. Schumacher published a collection of essays that articulated a vision of economic development that, in the words of Theodore Roszak, took "scale of organization" as an "independent and primary problem."[112] Schumacher questioned the dominant idea of continuous growth as well as the reliance on large-scale projects to pursue such growth, seeking instead to re-envision an ideal of

term Resource," in R. F. Meyer, ed., *Long-Term Energy Resources: An International Conference*, 3 vols. (Boston: Pitman, 1981), vol. II, 1234–35.

[106]F. Knight to His Excellency Ling Qing, 9 Mar. 1981, UNA S-1913-0017-0004-00003. Similar tours by country-level delegations took place as early as 1979.

[107]John G. Ditchburn to Resident Representatives, 16 Mar. 1981, UNA S-1913-0017-0004-00003.

[108]The countries were Bolivia, Columbia, Costa Rica, Dominican Republic, Ethiopia, Ghana, Haiti, India, Kenya, Mozambique, Nepal, Nicaragua, Panama, Peru, Thailand, and Zaire. "Annexture: KF/80-11," UNA S-1913-0017-0004-00002.

[109]William H. Tanaka, "Foreword," in Hangzhou Regional Centre, *Small Hydro Power in China: A Survey* (London: Intermediate Technology, 1985) 2.

[110]The idea of setting up a center was first mooted at two workshops, in 1979 and 1980. For more, see Hangzhou Regional Centre, *Small Hydro Power in China*, 105–6.

[111]At http://www.hrcshp.org/en/about/training.html (accessed 18 Sept. 2021).

[112]Thomas Roszak, "Introduction," in E. F. Schumacher, *Small Is Beautiful: Economics as if People Mattered* (New York: Harper Perennial, 2010), 4, 70. Schumacher, of course, has his detractors, none perhaps more strident than economist Wilfred Beckerman, the author of *Small Is Stupid: Blowing the Whistle on the Greens* (London: Duckworth, 1995).

sustainability or of permanence, a status quo that did not destroy the one resource humans could not produce—the natural world.[113] Accordingly, he set forth four propositions that, in their framing, uncannily echo Chinese articulations of the logic of small hydropower. First, that workplaces be local, not metropolitan; second, that they be affordable so that many can be built; third, that production methods, organizational principles, material supply, financing, marketing, and so on be relatively simple so that even unskilled or semi-skilled people can execute them; and finally, that production rely upon local materials and be primarily for local use.[114] Schumacher went on to posit the need for a regional, subnational approach and for the adoption of appropriate intermediate technologies.[115]

Although the similarities between Schumacher's ideas and the logic of small hydropower in China have been noted by contemporary observers, there are important differences as well, most notably their distinct intellectual genealogies.[116] Schumacher's arguments were rooted in postwar debates on modernization theory and contention over contrasting modes of development—one defined by centralized, large-scale, top-down schemes and the other motivated by small-scale, decentralized, and community-based approaches.[117] To these Schumacher added a Gandhian sensibility and admiration for what he called "Buddhist" economics. The timing was also propitious —*Small Is Beautiful* was published in 1973, the year of the first oil shock.

By contrast, the Chinese emphasis on small hydropower had different origins, rooted in domestic discourses about self-reliance. As Long Yang explains, the term "self-reliance" in Chinese (自力更生) signifies not only a reliance on oneself but also "regeneration through one's own power and effort to attain economic and spiritual growth." Born during the Chinese Communist Party's struggle against the Japanese during World War II (1937–1945), the concept was refashioned during the Mao years to justify the era's "radical isolationist policies."[118] An instance of making virtue out of necessity, it is also widely regarded as having been economically debilitating. But in certain areas it had other important implications as well. Sigrid Schmalzer shows that in the realm of science and technology it reified a dichotomy between applied and basic science. An emphasis on the former connoted autonomy from the center and reliance upon local methods.[119] As demonstrated by the case of small hydropower from as early as the Great Leap Forward, the goal of self-reliance was not

[113]Schumacher, *Small Is Beautiful*, *inter alia*, 34.

[114]Ibid., 186.

[115]Ibid., 186–92.

[116]"The latter [Chinese articulations of indigenous technology] is similar to Schumacher's 'intermediate technology' in that it refers not to the traditional manner of doing things but to innovative technology appropriate to the village resources at hand." Nickum, "Organisation of Water Resource Development," 180. Smil identifies small hydropower as "perhaps the most meaningful application of intermediate energy technology in China," in "Intermediate Energy Technology" [1979], 281; and [1976], 931.

[117]See, for instance, Daniel Immerwahr, *Thinking Small: The United States and the Lure of Community Development* (Cambridge: Harvard University Press, 2015); Jeremy Adelman, *Worldly Philosopher: The Odyssey of Albert O. Hirschman* (Princeton: Princeton University Press, 2013).

[118]Long Yang, "Self-Reliance," in Christian Sorace, Ivan Franceschini, and Nicholas Loubere, eds., *Afterlives of Chinese Communism: Political Concepts from Mao to Xi*, (New York: Verso, 2019), 231–36, at 231.

[119]Sigrid Schmalzer, "Self-Reliant Science: The Impact of the Cold War on Science in Socialist China," in Naomi Oreskes and John Krige, eds., *Science and Technology in the Global Cold War* (Cambridge: MIT Press, 2014), 75–106.

environmental sustainability but rather a developed modern industrial future. This is confirmed by the shift in the term's meaning in the 1980s, when it came to signal "a means to an end in the struggle to ultimately reclaim China's rightful place on the world stage."[120]

Not surprisingly, therefore, the ecological costs (and benefits) of small hydropower are difficult to assess. Our contemporary understanding of dams is informed by the seminal final report of the World Commission on Dams (1997–2001), which focuses almost exclusively on large dams. It concludes: "Dams have made an important and significant contribution to human development, and the benefits derived from them have been considerable … [but] in too many cases an unacceptable and often unnecessary price has been paid to secure those benefits, especially in social and environmental terms, by people displaced, by communities downstream, by taxpayers and by the natural environment."[121]

Although some may contend that this verdict is applicable to dams of all sizes, small dams, in theory, offer specific advantages over their larger counterparts. They are cheaper to build, and their failures rarely lead to catastrophic losses of life or habitat. The benefits of construction and operation are more likely to be enjoyed by local communities, fewer of whom need to be relocated. One can build such dams in remote areas to cater to populations that are otherwise underserved.[122] As our discussion so far indicates, several of these benefits did indeed accrue in many parts of China. At the same time, their impact—especially in the aggregate—on the hydrological cycle, on ground water, soil quality, loss of species, and local ecological diversity has yet to be systemically assessed. In a recent article, Thomas Ptak calls for a more holistic assessment, combining qualitative and quantitative approaches to "critically analyze a range of effects resulting from SHP [small hydropower] based programs in a country as geographically, culturally and biophysically diverse as China."[123]

The absence of such a holistic and aggregate assessment is not limited to China, nor is it merely a historical problem. In a 2018 paper, ecologists Thiago B. A. Couto and Julian D. Olden observe that science has lagged behind the rapid rise of small hydropower, and that, although small hydropower "represents 91% of existing [global] hydropower installations," fewer than five percent of the publications they reviewed "explicitly investigated SHP [small hydropower]."[124] At the same time, the past two decades have witnessed a growing number of case studies, collectively complicating any straightforward positive or negative assessments. In the case of China, many of these studies focus on the province of Yunnan. For instance, in one case, the cumulative impact of thirty-one small hydropower projects along the Nu

[120]Yang, "Self-Reliance," 234.

[121]World Commission on Dams, *Dams and Development: A New Framework for Decision Making* (London: Earthscan, 2000), xxviii. For a brief summary of the pros and cons of large-scale dam construction, see J. R. McNeill and Peter Engelke, *The Great Acceleration: An Environmental History of the Anthropocene since 1945* (Cambridge: Harvard University Press, 2014), 33–34.

[122]McCully, *Silenced Rivers*, 24–26.

[123]Thomas Ptak, "Towards an Ethnography of Small Hydropower in China: Rural Electrification, Socioeconomic Development and Furtive Hydroscapes," *Energy Research & Social Science* 48 (2019): 116–30, at 117.

[124]Thiago B. A. Couto and Julian D. Olden, "Global Proliferation of Small Hydropower Plants: Science and Policy," *Frontiers in Ecology and the Environment* 16, 2 (2018): 91–100, at 93.

River in Yunnan was found to exceed that of four large hydropower plants.[125] Another study, also on the Nu River valley, finds that ethnic minority communities often experience further marginalization due to the expansion of small hydropower.[126] Other case studies from China, and from other parts of the world, point to the adverse impacts on freshwater biodiversity and fish migration, soil erosion, access to electricity for local communities, and much else.[127]

The history of small hydropower in China is significant also for debates about the sources of technological innovation. As a Schumacher-style intermediate technology, small hydropower in China drew upon local materials and local skills to adapt traditional techniques and innovate new ones. With ideological antecedents in the mass line approach of the Great Leap Forward, this involved the design and manufacture of a range of products that could cater to every specific combination of climate, topography, hydrology, soil, and skills. As the Ministry of Water Conservancy boasted, "We not only have equipment for high head operations up to 620 meters to suit mountainous region development but also those for large discharge low head operations in rivers and streams up to 2 m. head."[128] Such an approach involved devising creative solutions to problems as they emerged. One such problem, for instance, was corrosion within generators that were located in sub-tropical and moist climates, where the humidity reduced the efficacy of insulation.[129]

By 1981, factories in coastal and southern provinces such as Guangdong, Zhejiang, Fujian, Sichuan, Yunnan, and Hunan were producing eighty-five different types of hydraulic turbines and 121 types of generators. Total production of sets of hydroelectric equipment was estimated at two hundred thousand. These included a special series of "micro-unit-sets" designed especially for remote and mountainous regions. Many of these small, light, and easy to build and maintain units were rated as low as 0.25 kilowatts.[130] As instances of local innovation and bottom-up engineering, the history of small hydropower provides a powerful alternative to the standard

[125] Kelly M. Kibler and Desiree D. Tullos, "Cumulative Biophysical Impact of Small and Large Hydropower Development in Nu River, China," *Water Resources Research* 49, 6 (2013): 3104–18. Similarly, David Hardiman observes that when small dams exist in "chain" form, they may have deleterious effects. David Hardiman, "Small-Dam Systems of the Sahyadris," in David Arnold and Ramachandra Guha, eds., *Nature, Culture, Imperialism: Essays on the Environmental History of South Asia* (New Delhi: Oxford University Press, 1995), 185–209.

[126] Thomas Ptak, "Small Hydropower for Electricity and Modernity," in Jean-François Rousseau and Sabrina Habich-Sobiegalla, eds., *The Political Economy of Hydropower in Southwest China and Beyond* (Cham: Palgrave Macmillan, 2021), 147–70.

[127] For a representative sample, see Couto and Olden, "Global Proliferation," 97; Tyler Harlan, Rui Xu, and Jun He, "Is Small Hydropower Beautiful? Social Impacts of River Fragmentation in China's Red River Basin," *Ambio* 50, 2 (2021): 436–47, at 447; Thomas Hennig and Tyler Harlan, "Shades of Green Energy: Geographies of Small Hydropower in Yunnan, China and the Challenges of Over-Development," *Global Environmental Change* 49 (2018): 116–28; Ameesh Kumar Sharma and N. S. Thakur, "Assessing the Impact of Small Hydropower Projects in Jammu and Kashmir: A Study from North-Western Himalayan Region of India," *Renewable & Sustainable Energy Reviews* 80 (2017): 679–93.

[128] Ministry of Water Conservancy, "Small Hydropower in China," 16.

[129] Ibid., 18.

[130] Ibid., 16–17.

https://doi.org/10.1017/S001041752400029X Published online by Cambridge University Press

glorification of cutting-edge technological innovation as a means to devising low-carbon alternatives.[131]

Conclusion

Small hydropower has neither the charisma of mega-dams—with their masses of concrete, ingenious designs, and sheer power—nor their capacity with one failure to devastate thousands of lives and reshape ecologies. But in China, small hydropower by the early 1980s collectively had achieved a significance that merits our attention. Reconstructing that history, as I have done here, reminds us that a sole focus on large dams can obscure how foundational small hydropower was to rural development and local political economy in China. It may also conceal the central role of small hydropower in the global history of energy. Furthermore, this history can offer insights into questions of scale and development in a global comparative context and situate small hydropower as a crucial constituent of the larger history of hydropower in the twentieth century.

However, the growth of large dams since the 1980s has largely obscured the history of small hydropower outlined here. In this more recent growth, it is the countries of the Global South that are leading the way. At the start of the twenty-first century, the five countries with the most dams under construction were all in Asia: "India, with 700–900 new dams under construction; China, with 280; Turkey, with 209; South Korea, with 132; and Japan, with 90."[132] India may have temporarily outpaced China in about 2000, but for much of the past several decades, the Chinese were the greatest dam-building enthusiasts. Their near-missionary zeal means "no river is being left undammed."[133] As Robert Marks explains, "The scramble began in 2002 when the State Power Company of China was privatized and broken into five profit-making enterprises, most headed by people well connected to the ruling Communist Party,

[131]This obsession with innovation, especially at the expense of maintenance and repair, has been critiqued by Lee Vinsel and Andrew Russel and by Stefan Krebs and Heike Weber. James Scott wrote extensively on the value of local knowledge, which he called *metis*, and its relationship to universal technical knowledge, which he called *techne*. In a China-specific context, one can locate other examples that point to the significance of bottom-up, locally sourced, and small-scale approaches. Solar-powered water heating is a ubiquitous indigenous technology that was developed from the bottom up with limited central government support. Similarly, the province of Guizhou has utilized small-scale, low-skill economic opportunities to reduce poverty, even in the face of slow economic growth. On maintenance and innovation, see Lee Vinsel and Andrew L. Russell, *The Innovation Delusion: How Our Obsession with the New Has Disrupted the Work that Matters Most* (New York: Currency, 2020). On repair, reuse, and persistence, see Stefan Krebs and Heike Weber, eds., *The Persistence of Technology Histories of Repair, Reuse and Disposal* (Bielefeld: Transcript, 2021). On *metis*, see James C. Scott, *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed* (New Haven: Yale University Press, 1998). On solar heaters, see Frauke Urban, Sam Geall, and Yu Wang, "Solar PV and Solar Water Heaters in China: Different Pathways to Low Carbon Energy," *Renewable and Sustainable Energy Reviews* 64 (2016): 531–42. On Guizhou, see John A. Donaldson, *Small Works: Poverty and Economic Development in Southwestern China* (Ithaca: Cornell University Press, 2011).

[132]Pu Wang, Shikui Dong, and James Lassoie, *The Large Dam Dilemma: An Exploration of the Impacts of Hydro Projects on People and the Environment in China* (Dordrecht: Springer, 2014), 2.

[133]Wang Yongchen and Ye Xue, "Highly Controversial Hydropower Development in Western China," in Liang Congjie and Yang Dongping, eds., *The China Environment Yearbook (2005): Crisis and Breakthrough of China's Environment* (Leiden: Brill, 2007), 66, citing World Commission on Dams, *Dams and Development*; quoted in Marks, *China: An Environmental History*, 309.

unleashing a 'hydropower rush' as these companies sought to divvy up China's Rivers."[134] That trend has accelerated in recent years, as many of these enterprises have gone global. The number of dams in Latin America and on the African continent has exploded, and the greater Himalayan region is today rapidly becoming the most dammed space on earth.[135]

At the same time, global growth in renewable energy, including hydropower, continues to be dwarfed by growth in fossil fuel-based non-renewable energy. Coal demand by itself was projected to rise in 2021 by 60 percent more than all other renewables combined. Moreover, China, which became the world's largest consumer of power in 2010, was projected to account for 50 percent of that growth.[136] The result is a contradictory energy politics whereby ambitious renewable energy policies co-exist with massive investments in fossil fuels.[137] Given this state of affairs, it comes as no surprise that the relative share of small hydropower within China's total hydropower generation has declined since the heyday of the early 1980s.[138] But even into the early years of the twenty-first century small hydropower continued to constitute about 50 percent of electricity-generating capacity at the county levels and below.[139]

Within official rhetoric, small hydropower's significance and purpose have been rearticulated. According to the Hangzhou Regional Centre, we are now in the third phase of the history of small hydropower.[140] In the Centre's reckoning, the first phase lasted from the 1950s to the 1970s, during which time the emphasis was primarily on providing domestic lighting. The second phase continued during the subsequent two decades, prioritizing poverty relief in rural areas. In the ongoing third phase, ecological sustainability and boosting local economy are the governing principles. Elsewhere, such as in the United States, there is a new recognition that dams may be a required feature of a future threatened by climate change, population growth, and their attendant water risks. Researchers note that such risks raise "a debate as to whether we need dams more than ever, where and why, and how dams may need to be

[134]Marks, *China: An Environmental History*, 309. Marks relies here on the work of Mertha, *China's Water Warriors*, 45–48.

[135]"… plans are moving forward to harness Himalayan waters through the largest series of construction projects in human history." Kenneth Pomeranz, "The Great Himalayan Watershed: Agrarian Crisis, Mega-Dams and the Environment," *New Left Review* 58 (2009): 5–39, at 7.

[136]Tan, *Recharging China in War and Revolution*, 1; International Energy Agency, *Global Energy Review 2021*, at https://iea.blob.core.windows.net/assets/d0031107-401d-4a2f-a48b-9eed19457335/GlobalEnergyReview2021.pdf (accessed 21 June 2024).

[137]Jonas Nahm, "The Energy Politics of China," in Kathleen J. Hancock and Juliann Emmons Allison, eds., *The Oxford Handbook of Energy Politics* (Oxford: Oxford University Press, 2021), 507–32.

[138]The total number of power stations has stabilized at about forty-seven thousand, with a combined installed capacity of 55 gigawatts, suggesting the existence of many relatively large capacity (~5–25 megawatts) small hydropower projects.

[139]Jiahua Pan *et al.*, "Rural Electrification in China 1950–2004: Historical Processes and Key Driving Forces," Working Paper #60, Program on Energy and Sustainable Development, Stanford University, 2006. https://fsi-live.s3.us-west-1.amazonaws.com/s3fs-public/WP_60%2C_Rural_Elec_China.pdf (accessed 6 Oct. 2021).

[140]Hangzhou Regional Center (Asia-Pacific) for Small Hydro Power (HRC), "A Survey of SHP Development in China," http://www.hrcshp.org/en/rural/2.html (accessed 23 Sept. 2021).

designed and operated differently to meet social and environmental goals for rivers."[141]

In the face of new climate risks, including the cataclysmic flooding and droughts across large parts of China during the summer of 2022, the continued prevalence of small hydropower in China today demands greater systematic analysis of its long-term merits. Although evidence from case studies in China and elsewhere points to a mixed legacy, small hydropower still awaits a comprehensive study such as that by the World Commission on Dams at the end of the twentieth century.

Acknowledgments. I would like to thank the *CSSH* editors, David Akin, and the anonymous reviewers for their critical engagement and thoughtful suggestions. Aditya Balasubramanian, Divya Cherian, Rohit De, Partha Ghosh, Gal Gvili, Jeff Kahn, Bill Kirby, Brian Lander, Chris Nielson, Liz Perry, Emma Rothschild, R. Bin Wong, and Ling Zhang read early drafts in part or in whole and provided excellent feedback and welcome encouragement. Audiences at Harvard's Center for History and Economics, Harvard STS Circle, Harvard China Project, Duke University, Ashoka University, and the University of Trento raised helpful questions and offered valuable suggestions. Thanks to Zhou Ruohan for his energetic and excellent research assistance. I continue to remain indebted to Nancy Hearst for her meticulous editorial attention. Unless noted otherwise, all translations are mine. Part of the research and writing for this article was made possible by generous support from the Weatherhead Center for International Affairs and the Dean's Competitive Fund, both at Harvard.

[141] Michelle Ho et al., "The Future Role of Dams in the United States of America," *Water Resources Research* 53, 2 (2017): 982–98, at 982–83.

Cite this article: Ghosh, Arunabh 2024. "The Significance of Small Things: Small Hydropower in the People's Republic of China, 1949–1983." *Comparative Studies in Society and History*, 1–28, doi:10.1017/S001041752400029X