ICHM 2001 History of Meteorology

Climate Regionalization in China: A Historical Perspective on Scientific Development and National Building

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Introduction

Climate regionalization constitutes a foundational component of China's secondary school level geography curriculum. Through this framework, students can situate their lived climatic experiences within a broader climate zone, rapidly grasp national climatic characteristics, and—furthermore—comprehend global climate distribution patterns through comparison with China's climate.[1] In this process, China's climate is rendered both unique and universal.

The climate regionalization taught in this curriculum is not a product of contemporary China, but rather of early twentieth-century China. Taking this historical context into account, it may have exerted a far more profound influence on modern Chinese historical development than previously assumed. By the early 1900s, Chinese intellectuals were facing a foundational question: how could national redemption best be achieved? This discourse traced back to the 1840s, when imperial collapse and territorial losses defined China's trajectory. Key turning points included defeat in the 1895 Sino-Japanese War and the Boxer Rebellion in 1900, which symbolized China's subjugation to colonial powers.[2] Such narratives pervaded early Republican-era discourse, as seen in textbooks depicting China as a leaf consumed by imperialism.[3]

[1] Ministry of Education of the People's Republic of China, *Yiwu Jiaoyu Dili Kecheng Biaozhun (2022 Nian Ban)* [*Compulsory Education Geography Curriculum Standards (2022 Edition)*] (Beijing Normal University Press, 2022), accessed September 15, 2024, https://www.gov.cn/zhengce/zhengceku/2022-04/21/content_5686535.htm.

[2] John King Fairbank, *The Cambridge History of China: Volume 11, Late Ch'ing, 1800-1911, Part 2* (Cambridge University Press, 1980), 589–602.

[3] Xu Peng, "Qiuhaitang, Sangye, Xiongji yu Zhongguo" [Begonia, Mulberry Leaf, Rooster, and China], *Bolan Qunshu* [Chinese Book Review Monthly], no. 11 (2016): 111–16.

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Thus, amid national humiliation and a sense of responsibility, various proposals such as "industrial salvation," "educational salvation," and "scientific salvation" were successively put forward. The Chinese Science Society, founded in 1914 by Chinese students in the United States, aimed, among other things, to popularize science and enable China to become strong and respected in the international community.[4] The Chinese Science Society was the most influential non-governmental organization in Republican China, whose members included leading figures from various disciplines and served as the representative institution for Chinese science before the establishment of the Academia Sinica in 1928.[5] Reflecting the outsized influence of the Chinese Science Society on modern Chinese history, using science to change the country went on to become one of the central beliefs of modern China's scientific development.

To develop Chinese science, Ren Hongjun (任鸿隽), a leader of the Chinese scientific community, proposed that countries with weaker scientific foundations should actively develop local sciences rather than merely pursue the advancement of general sciences. Ren introduced a differentiated development strategy: nations with weak scientific bases should prioritize the development of disciplines with regional characteristics.[6] He emphasized that Chinese scientists bear an irreplaceable responsibility in advancing China's local sciences. Another scientific leader, the meteorologist Zhu Kezhen (竺可桢), adopted a similar stance and further noted that foreign scholars' research on China's local sciences might risk exceeding their boundaries, particularly when such studies directly involve the infiltration of foreign powers into China's border regions.[7] China's climate Regionalization research was fully aligned with Ren and Zhu's scientific objective and became one of the central focuses of Zhu Kezhen's work during the 1920-30s.

This scientific objective embodies the conviction that Chinese scientists, being more familiar with China's conditions than foreigners, could achieve effective scientific results in a shorter time frame. This confidence stems largely from their nationally relevant natural and cultural experiences. On the other hand, to achieve deeper scientific understanding, more data was required. Thus, it is evident that meteorologists of the era regarded meteorological data collection as an integral component of national sovereignty from both a nationalist and a technical perspective.[8]

In this context, "local science" is used to refer to the study of the natural environment and phenomena across China as a whole, focusing on the distinctive characteristics of its various regions. While in climatological terms "local" might refer to more narrowly defined areas, Ren and Zhu were advocating for the development of a scientific approach that emphasized China's unique, multifaceted natural environment. As subsequent research will demonstrate, one of their objectives was to establish the distinctiveness of "China" through scientific inquiry and elevate its national image and status. Initially, however, they framed the

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[4] Wang Zuoyue, "Saving China through Science: The Science Society of China, Scientific Nationalism, and Civil Society in Republican China," *Osiris* 17, no. 1 (2002): 291–322.

[5] Zhang, Jian. Sai Xiansheng Zai Zhongguo: *Zhongguo Kexueshe Yanjiu* [Mr. Science in China: A Study of the Chinese Science Society] (Shanghai: Shanghai Scientific & Technical Publishers, 2018), 1.

[6] Ren Hongjun, "Fan Taipingyang Guoji Xueshu Huiyi de Huigu" [A Review of the Pan-Pacific Scientific Conference],*Kexue*[Science]12, no. 4 (1927): 455–65.

[7] Zhu Kezhen, "Riben Qixiangxue Fada Zhi Gaikuang"[An Overview of the Development of Meteorology in Japan), *Kexue* [Science]12, no. 4 (1927): 455–64.

[8] Liu Xiao, "Understanding Sovereignty through Meteorology: China, Japan, and the Dispute over the Qingdao Observatory, 1918–1931," *Annals of Science* 81, no. 3 (July 2, 2024): 420–39.

survey of the nation's climate, flora and fauna, and mineral resources merely as scientists' responsibility. [9]

Although the Chinese focus has largely been on climatic regionalization, this is actually a term that emerged later. In the 1930s and 1940s, climatologists typically used the term climate classification for their research. It was not until the 1950s that the term climatic regionalization began to be used more widely. While the results presented on maps may appear similar for both terms, in the context of the Chinese language, climatic regionalization refers to the division of climate into different regions, similar to administrative divisions, which has become a part of government management of populations and their economic development.[10] However, Chinese climatologists' climate classification was initially regional in approach, exhibiting distinctive regionalized characteristics. Thus, this paper incorporates climate classification into its analytical framework, deploying specific terminology appropriate to each historical period and contextual scenario.

While regions are constructs blending natural and humanistic dimensions, regionalization analysis represents a rigorous scientific enterprise. Thomas Simpson's inquiry into Andrew Herbertson's "natural regions" theory—articulated in the early 1900s—highlighted the intricate interplay between climate and regional categorization.[11] Extending this line of research, Deborah R. Coen demonstrated how climate became the cornerstone of Austro-Hungarian natural regionalization, as Habsburg scholars employed systematic regionalization to map the empire into "natural regions" and "transition zones," thereby synthesizing climate models at an imperial scale. Moreover, Coen uncovered adaptive dynamics between cultural practices and climatic conditions, underscoring the reciprocal relationship between human societies and environmental systems. Martin Brückner's research highlights how geography in early American history transformed local experiences into national narratives[12]—a process that closely parallels the case under discussion here. Mark Frank argues that Chinese climatologists of the time constructed the concept of a "Chinese Climate" through meteorological observations and climate classification systems, thereby integrating the nation-state concept into meteorological knowledge production.[13]Whereas Qing Guo describes the evolution of climate regionalization methods in China during the first half of the twentieth century, constructing a technological model of introduction-integration-absorption.[14]

However, existing studies often focus on scientific processes while overlooking regions' unique natural and cultural contexts. In particular, China's climate regionalization is characterized by deep historical roots while also being aligned with the objectives of modern Chinese scientific development. This paper explores this uniqueness by examining how Chinese climatologists: (1) embedded regional boundaries—rooted in cultural traditions—with scientific legitimacy while adapting foreign climate theories to local conditions; (2)

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[9] Zhu, Kezhen, "Wo guo di xue jia zhi Zeren"[The Responsibilities of Chinese Geographers], *Shidi xuebao*(Journal of History and Geography) 1, no. 1 (1921): 44–45.

[10] Deborah R. Coen, "Imperial Climatographies from Tyrol to Turkestan," Osiris 26, no. 1 (January 2011): 47.

[11] Thomas Simpson and Mike Hulme, "Climate, Cartography, and the Life and Death of the 'Natural Region' in British Geography," *Journal of Historical Geography* 80 (April 1, 2023): 44–57.

[12] Martin Bruckner, "Lessons in Geography: Maps, Spellers, and Other Grammars of Nationalism in the Early Republic," *American Quarterly* 51, no. 2 (1999): 311–43.

[13] Mark E Frank, "National Climate: Zhu Kezhen and the Framing of the Atmosphere in Modern China," *History of Science* 62, no. 4 (December 1, 2024): 562–90.

[14] Guo Qing. Zhongguo Qihou Quhua Fazhan Yanjiu (1929–1966) [Research on the Development of Climate Regionalization in China (1929-1966)]. Master's thesis, University of Science and Technology of China, 2023.

universalized these studies to reconcile uniqueness with global scientific norms, thereby enhancing national scientific standing; and (3) operationalized their research in dynamic, practical contexts aligned with national needs, ultimately scientizing traditional perceptions of regions.

The Uniqueness of China and the Right to Climate Classification

In 1884, climatologist Wladimir Köppen proposed the first quantitative climate classification system.[15] This classification system, along with its subsequent revisions, has been widely adopted in academic research.[16] From 1913 to 1918, Zhu Kezhen pursued meteorological studies at Harvard University. By that time, the Köppen classification method had already been incorporated into American geography and meteorology textbooks.[17] To date, this system has remained the most widely utilized climate classification framework, maintaining its canonical status in numerous climatology textbooks worldwide.[18]

On a climate map of China classified according to Köppen's method, Zhu Kezhen found many discrepancies with his own understanding. For example, he observed that Köppen's Cfa climate zone (C for temperate, f for uniform humidity throughout the year, a for the hottest month averaging above 22°C) was confined to a narrow coastal strip from Fuzhou to Shanghai[19]. Zhu believed this zone should extend along the Yangtze River into the Chinese interior. However, doing so would divide the Cwa climate zone (warm, dry winters) into two parts: the lower Yellow River region (North China)[20] and South China. In reality, there is a significant difference in precipitation and temperature between the lower Yellow River region and South China. If these two regions were classified under the same climate zone, it would clearly not align with the actual observed climate conditions.[21] Here, Zhu Kezhen saw an opportunity to revise and improve the Köppen climate classification.

What gave Zhu Kezhen confidence was not abundant meteorological data; at the time, he had just proposed his own meteorological station network plan.[22] His greatest reliance came from his cultural, historical, and geographical expertise. This was closely linked to a critical demarcation line: the Qinling-Huaihe Line. Chinese people over two millennia ago had already recognized the agricultural and cultural differences caused by the contrasting environments north and south of this line, as evident in the famous fable *Master Yan Mission to Chu*:

> The king looked at Master Yan and said: "Do the people of Qi enjoy stealing things?" Master Yan got up from his mat and responded: "I have heard it said that when an orange tree is planted

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[15] Mark Stephen Monmonier, *Cartography in the Twentieth Century*, The History of Cartography, 6 1-2 (Chicago: The University of Chicago press, 2015), 227–29.

[16] Arthur A. Wilcock, "Köppen After Fifty Years," *Annals of the Association of American Geographers* 58, no. 1 (March 1, 1968): 12–28.

[17] C. W. Thornthwaite, "Problems in the Classification of Climates," *Geographical Review* 33, no. 2 (1943): 233–255.

[18] Michal Belda et al., "Climate Classification Revisited: From Köppen to Trewartha," *Climate Research* 59, no. 1 (February 4, 2014): 1–13.

[19] Zhu Kezhen, "Zhongguo Qihou Quyu Lun (Climatic Provinces of China)," Dili Zazhi(The Geographical Review), no. 2 (1930): 1–14.

[20] This is the core region of north China; thus, it can also be used to denote north China in climate. See Wang, E., Q. Yu, D. Wu, et al. 2008. "Climate, Agricultural Production and Hydrological Balance in the North China Plain." *International Journal of Climatology: A Journal of the Royal Meteorological Society* 28 (14): 1959–1970.

[21] Notwithstanding substantial climate changes over the past century, these regional disparities have persisted obvious both historically and at present, see Qian, W., and Y. Zhu. 2001. "Climate Change in China from 1880 to 1998 and Its Impact on the Environmental Condition." *Climatic Change* 50, no. 4 (201): 419–444.

[22] Zhu Kezhen, "Quan Guo Sheli Qixiang Cehou Suo Jihua Shu" [A Plan for Establishing Meteorological Observation Stations throughout the Country], *Zhongguo Qixiang Xuehui Huikan* [Journal of the Chinese Meteorological Society], no. 4 (1928): 7–10.

south of the Huai River it produces oranges as fruit, but if you transplant it north of the Huai River, it produces bitter oranges. The leaves are the same, but the taste of the fruit is completely different. What is the reason for this? It is because the water and the soil are different. Now a person who is born and brought up in Qi would never think of stealing anything, but when they move to Chu they become thieves. Perhaps this is because the water and soil of Chu makes people enjoy stealing things?" The king laughed and said: "It is impossible to play jokes upon a sage. I brought this humiliation on myself."[23]

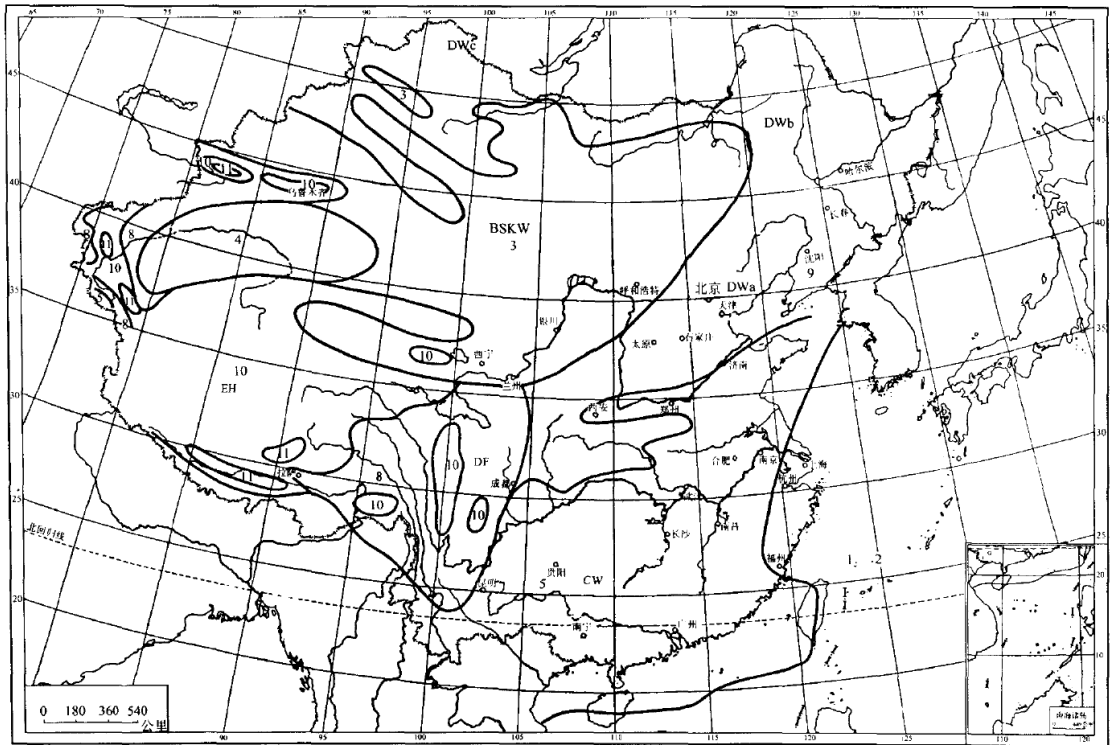


Fig. 1. According to the Köppen climate classification, parts of southern China and some northern regions are categorized under the same climate zone Cwa. A small portion of the southeast is classified as Cfa. Zhu Kezhen believed that the middle and lower reaches of the Yangtze River should be classified as Cfa. However, doing so would split the Cwa zone into two separate parts.[24]

This fable has been widely disseminated in Chinese culture, and its narrative of environmental differences across the Huai River has gradually become a cultural trope. Moreover, during periods of political fragmentation in Chinese history, the Qinling-Huaihe Line frequently served as the boundary between northern and southern regimes. Southern regimes in particular emphasized the strategic importance of the Huai River's defence, leading to the maxim: "[t]he key to defending the Yangtze is holding the Huai"[25]

In 1924, Zhang Xiangwen（张相文), the first president of the Chinese Science Society, explicitly identified the Qinling-Huaihe Line as China's north-south divide from a geographical classification perspective.[26] However, his rationale was rather tenuous—a

[23] Milburn, O. *The Spring and Autumn Annals of Master Yan*. Brill, 2015, 349–50.

[24] Zhu, "Zhongguo Qihou Quyu Lun."

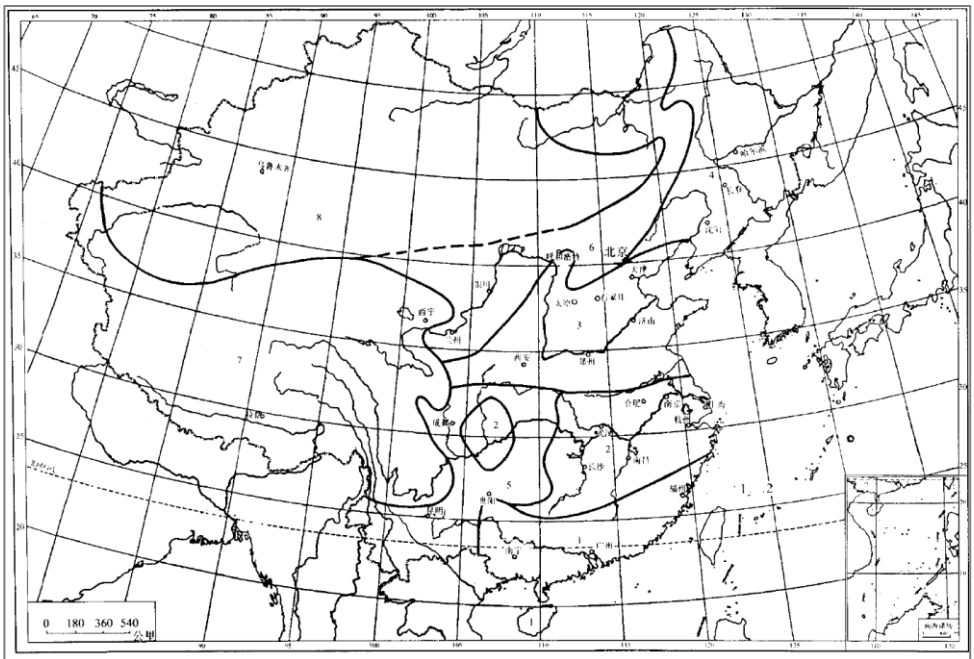
[25] Han Maoli. *Dadi Zhongguo* [The Land of China], (Wenhui Publishing House, 2023), 223–30.

[26] Shan Zhiqiang. "Nanbei Fenjiexian Shang de Miwu" [The Mist on the North-South Divide]. *Zhongguo Guojia Dili* [Chinese National Geography], no. 10 (2009): 34–51.

tenuousness likely shaped by the longstanding cultural tropes. This cultural trope also influenced Zhu Kezhen. Therefore, when Zhu Kezhen made the classification of climate, three very important principles were adopted:

> (a) Classification schemata must maintain concise and unambiguous categorical definitions;
>
> (b) Delineation boundaries should correspond to natural geographical boundaries within national regions;
>
> (c) Within China's cyclonic and anticyclonic systems, where meteorological impacts exhibit significant spatial heterogeneity, climatic regionalization must prioritize this dynamic framework as the primary determinant.[27]

Compared to the Köppen method, the principles proposed by Zhu Kezhen cannot be considered quantitative or as empirically precise. However, in Zhu's view, they more closely approximated the actual climatic conditions of China. These principles are simple, and we can observe a response to the Köppen method, especially in the second principle: that climatic classification should correspond to natural regions. Zhu divided China into eight climatic regions, with each named after a specific region in China. For example, the southern region is termed the "Middle China or Yangtze River Basin type," while the northern region is referred to as the "Northern China type." The boundary between these two regions generally coincides with the Qinling-Huaihe line, which is traditionally recognized as the dividing line between the north and south in China. This was also the first time that this boundary had been explicitly depicted on a Chinese climatic map.



附图 3 Climatic Provinces of China, A New Classification〔中国气候区域(一个新的分类)〕

Fig. 1. In Zhu Kezhen's climate classification map, northern China is largely within a single climatic region, while southern China is also characterized by a relatively unified climatic region.[28]

Zhu Kezhen did not attempt to challenge the Köppen classification method, but rather its outcomes. This constituted the core essence of Zhu's revision. Mark Frank argues that Zhu integrated the Köppen classification approach into a Chinese climatic framework—a pivotal

[27] Zhu, "Zhongguo Qihou Quyu Lun."

[28] Ibid.

step in asserting that any climate classification should align with China's actual climatic conditions.[29] The interpretive authority over what constituted China's climate, however, rested firmly in the hands of Zhu and his colleagues.

By the 1930s, Zhu Kezhen's meteorological station network plan began yielding results, providing him with data for regional climate research. Zhu sought to give scientific legitimacy to traditional cultural and geographical perceptions through such research. In 1934, while analysing drought conditions and causes in North China, he identified the Qinling Mountains as the natural boundary between the North China Plain and the Yangtze River Basin. He further argued that, except in Sichuan Province, the Qinling's climatic role primarily regulated rainfall rather than temperature, making it a critical factor in the region's scant precipitation.[30]

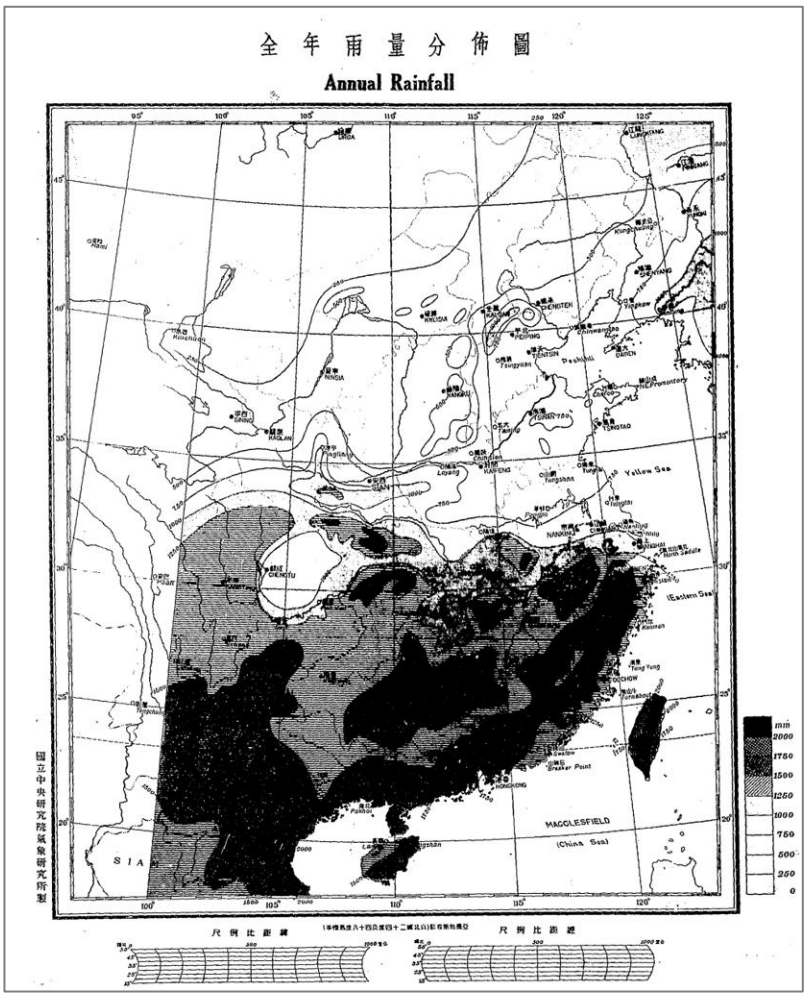


Fig. 3. A map of rainfall in China, in which Chinese climatologists use dark and light colours to clearly show the climate differences between northern and southern China.[31]

[29] Frank, "National Climate."

[30] Zhu Kezhen and Li Liangqi. "Huabei zhi ganhan ji qi qianyin houguo" [The Drought in North China and Its Causes and Consequences]. *Dili Xuebao*[Acta Geographica Sinica] 1, no. 2 (1934): 98–109.

[31] Zhu et al., The Chinese Rainfall, 49.

Concurrently, rainfall studies in China reached a milestone in 1936 when the Institute of Meteorology at Academia Sinica, led by Zhu, published *The Chinese Rainfall.*[32] Despite poor printing quality and blurry images, the Qinling-Huaihe Line remained conspicuously visible. This graphical representation clearly reflected contemporary climatologists' recognition of the line's climatic significance.

Zhu Kezhen and his colleagues' work brought international recognition to the Qinling-Huaihe Line's role as a major geographic divide. Prominent geographers, including the famous American geographer and Zhu's close friend George Babcock Cressey (1896–1963),[33]commented on the line's climatic and cultural significance.[34] As Zhu himself noted: "[n]umerous scholars, both Chinese and foreign, have studied the climatic disparities between North China and the Yangtze River Basin."[35]

We must reiterate the mindset of Chinese climatologists represented by Zhu Kezhen: even if they did not attempt to rival the classificatory power of Köppen's model, they believed their intimate familiarity with China granted them unique interpretive authority over its climate.[36] Thus, they leveraged their strengths to ensure that any climate classification framework respected China's indigenous climatic characteristics.[37] This conviction would manifest in subsequent classification schemes, regardless of their theoretical underpinnings.

In 1936, Tu Changwang （涂长望) and Lu Wu (卢鋈） claimed to have refined Zhu Kezhen's climate regionalization scheme by dividing his climatic regions into 8 primary zones (first-order divisions) and 22 subzones (second-order divisions).[38] Interestingly, while they employed different criteria for regional demarcation, their results broadly aligned with Zhu's original classification, most notably retaining the iconic Qinling-Huaihe Line. As colleagues of Zhu, Tu and Lu effectively carried forward his climatological work during the decade following Zhu's assumption of Zhejiang University's presidency in 1936, significantly advancing the climate regionalization project.

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[32] Zhu Kezhen, Tu Changwang, and Zhang Baokun. *Zhongguo zhi yuliang* [The Chinese Rainfall]. Nanjing: Guoli Zhongyang Yanjiuyuan Qixiang Yanjiusuo [Institute of Meteorology, Academia Sinica], 1936. http://read.nlc.cn/OutOpenBook/OpenObjectBook?aid=416&bid=8435.0.

[33] Theodore Herman, "George Babcock Cressey, 1896–1963," *Annals of the Association of American Geographers* 55, no. 2 (June 1, 1965): 360–64.

[34] Cressey, George B. "The Geographic Regions of China." *The Annals of the American Academy of Political and Social Science*152, no. 1 (1930): 1–9.

[35] Zhu and Li, "Huabei zhi ganhan ji qi qianyin houguo," 100.

[36] Zhu Kezhen And Lu Wu . "Zhongguo qihou zhi yaosu" [The Climatic Factors of China], *Dili Xuebao* [Acta Geographica Sinica] 2, no. 1 (1935): 1–9.

[37] Grace Yen Shen, *Unearthing the Nation: Modern Geology and Nationalism in Republican China* (University of Chicago Press, 2014), 46.

[38] Tu Changwang and Lu Wu, "Zhongguo Qihou Quyu" [Climatic Provinces of China], *Qixiang Zazhi* [Acta Meteorologica Sinica], no. 9 (1936): 487–518.

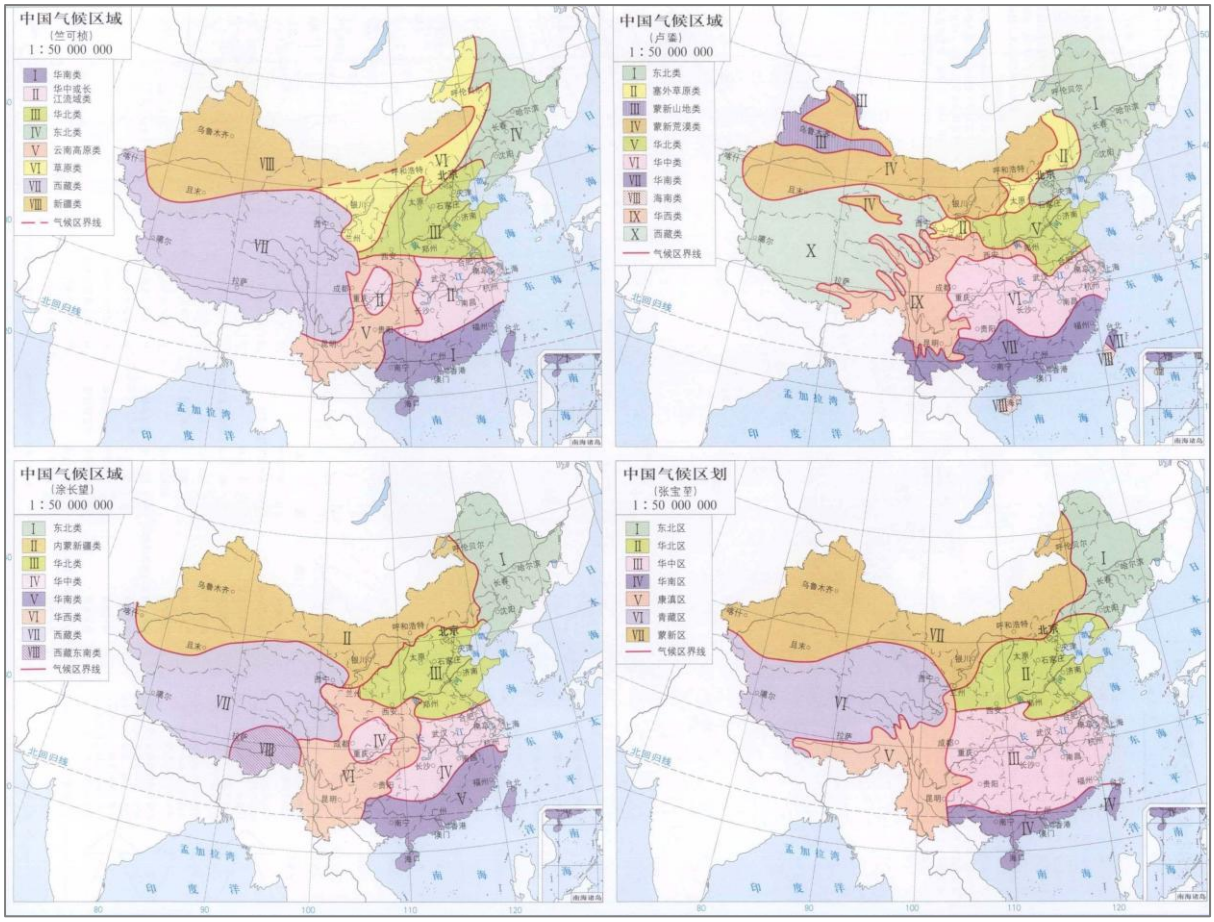

Fig. 4. The boundary between southern and northern China is consistently reflected in various climate classification systems.[39]

Dialogue with global science

Zhu Kezhen and his colleagues appeared to construct a vision of China's climate distinct from global standards, insisting that any climate classification scheme must align with this localized understanding. Such an approach risked rendering global climate classification systems irrelevant in China, potentially insulating the nation from international scientific discourse. This, however, was not their intention. On one hand, Zhu was acutely aware that atmospheric circulation knows no national boundaries, even as he sought to imbue meteorology with nationalist significance.[40] On the other hand, the Chinese scientific community's pursuit of localized climate science was fundamentally aimed at enhancing the nation's scientific reputation and standing.[41] In 1930, Zhu Kezhen exhorted his peers that scientific advancement could not rely solely on translating foreign works; it also required "speaking the Chinese language," meaning producing indigenous scientific contributions that would ultimately establish Chinese as a global 'lingua franca' of science.[42] Disseminating knowledge of China's

[39] Liu Mingguang, ed., Italicized: *Zhongguo ziran dili tuji* [Atlas of Physical Geography of China], 3rd ed. (Beijing: Zhongguo Ditu Chubanshe [China Map Press], May 2010),50.

[40] Zhu Kezhen. "Qingdao jieshou zhi qingxing" [The Retrocession of Qingdao: Context and Implications], *Shidi Xuebao* [Journal of Historical and Geographical Studies] 2, no. 2 (1923): 85–90.

[41] Ren, "Fan Taipingyang Guoji Xueshu Huiyi de Huigu."

[42] Zhu Kezhen, *Zhu Kezhen Quanji* [The Complete Works of Zhu Kezhen], vol. 2 (Shanghai: Shanghai Science and Technology Education Press, 2004), 55.

actual climatic conditions, he argued, should be an integral component of developing Chinese climate science.

In 1938, Tu Changwang and Guo Xiaolan （郭晓岚）published China's Climate Regions According to the Köppen Paradigm.[43] Köppen's steppe climate (BS) zone grouped areas from Kulun (present-day Ulaanbaatar, Mongolia) in the north to Zhengzhou in the south into a single unit, despite their vastly differing climates. To align China's regional boundaries with the Köppen system, the Tu-Guo scheme introduced the temperature-precipitation product (TR) as a criterion to subdivide the steppe zone into three smaller regions: the North China Plain, the Loess Plateau-Qinghai Highlands, and the Mongolian Steppe. For other boundaries, the scheme made adjustments where Köppen's system clashed with China's geography, most notably shifting the cool (D) climate zone—originally extending deep into North China—to the Rehe region. Other revisions were relatively minor.

In 1939, Xu Erhao （徐尔灏）, a young faculty member at National Central University, [44] published The Climatic Regions of China According to the Köppen Classification. [45] His revisionist approach resembled that of Tu and Guo, yet he focused on the humid and dry winter temperate zones previously identified by Zhu Kezhen. Xu's revisionist intensity surpassed the Tu-Guo scheme, a consequence of denser meteorological station coverage in temperate regions compared to arid zones.

Across these schemes, modifications to the Köppen classification system were consistently observed, yet these adjustments remained confined to China's specific context, thus leaving the core Köppen framework intact. While the classifications appeared to be derived from Köppen's methodology, they in fact adapted the system to China's unique climatic regions.[46] Given their China-centric starting point, these efforts can be interpreted as translating indigenous Chinese climatic regionalization into the Köppen framework. In Tu's paper, he pointed out that his purpose was to facilitate comparisons with the climatic characteristics of other regions around the world and to meet the needs of those familiar with Chinese place names.[47] Clearly, this was an effort to globalize local scientific knowledge to present China's "truth" to the world.

Such globalized practices still bear traces of nationalism. Xu Erhao expressed his nationalistic sentiments more directly. In the colonial context of the past, the temperate zone was considered the ideal environment for Europeans to live and develop, carrying positive and affirmative evaluations.[48] Xu accepted this narrative and believed that the temperate zone, especially the warm temperate and humid regions, were where world civilization flourished the most. After his modifications, China was depicted as having vast warm temperate and

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[43] Tu Changwang and Guo Xiaolan, "Koppen Fanshi de Zhongguo Qihou Quyu" [Climatic Regions of China According to Köppen's Classification], *Qixiang Zazhi* [Acta Meteorologica Sinica], no. 2 (1938): 51‑6

[44] It is necessary to introduce the relationship between the Institute of Meteorology, Academia Sinica, and the Department of Geography at National Central University. Before the Japanese occupation of Nanjing in 1937, the two institutions were located across the street from each other. Researchers from the Institute frequently taught courses and attended conferences at the university. Xu Erhao studied at National Central University from 1934 to 1938, thus we can infer he maintained close professional relationships with figures like Zhu Kezhen and Tu Changwang.

[45] Xu Erhao, "Keben Fenleifa Zhi Zhongguo Qihou Qu" [The Climatic Regions of China According to the Köppen Classification], *Kexue* [Science]23, no. 12 (1939): 728–46.

[46] Frank, "National Climate."

[47] Tu Changwang and Guo Xiaolan, "Koppen Fanshi de Zhongguo Qihou Quyu" (Climatic Regions of China According to Köppen's Classification], *Qixiang Zazhi* [Acta Meteorologica Sinica], no. 2 (1938): 51‑6

[48] Deborah R. Coen, "Imperial Climatographies from Tyrol to Turkestan," *Osiris* 26, no. 1 (January 2011): 47.

humid zones, thus possessing the climatic conditions to stand as an equal with Europe and the United States.[49]

Such modifications convey Xu's nationalistic sentiment. He was once outraged by the expression of "Independent Manchukuo" in an atlas. Eventually, he wrote a short essay beside it in the atlas to admonish himself not to forget the humiliation.[50] However, such modifications could at most serve as a form of psychological comfort. Therefore, like Tu before him the target audience of his article was still people outside of China. In this way, he articulaled China's strengths in a "scientific"[51] context to provide a basis for enhancing the nation's image and standing.[52]

In 1946, Lu Wu independently proposed his own climate regionalization scheme.[53] He categorized China's climate using two approaches: one global in scope (including China) and represented by Köppen, and another focused exclusively on China, exemplified by Zhu Kezhen. Regarding Zhu and Tu's classifications, Lu acknowledged their strengths in "aligning with natural and human regions," yet criticized their lack of systematic criteria and inadequate scientific explanatory power. Ultimately, Lu tasked himself with synthesizing the merits of both methods to create a hybrid framework compatible with both. His methodological approach was to "primarily follow Köppen's system while adapting to local conditions."[54]

Lu Wu's approach appears paradoxical, not as a personal inconsistency, but as a collision of two divergent paradigms among Chinese climatologists at the time. On one hand, they felt compelled to map China's climate using Köppen's global framework; on the other, they sought to safeguard the nation's distinct natural and human-geographic regions. Here, Lu's work can be interpreted as either adapting Köppen's system within a Chinese epistemological framework,[55] or rearticulating China's climatic identity through Köppen's terminology. Thus, the climate regionalization work of this period cannot be reduced to a mere introduction and adaptation of foreign classification methods, but actually included multiple processes of translating and promoting local scientific knowledge. Only through this path could the initially stated objective of fostering nationalist science be achieved.

Academic Independence and National Sovereignty

Following the founding of the People's Republic of China, the terminology of "climate regionalization" quickly supplanted that of "climate classification," signalling a shift in the function of climatic regionalization. In terms of identity and roles, Chinese climatologists transitioned from advancing national status through scientific development to more direct engagement in state governance.

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[49] Xu, "Keben Fenleifa Zhi Zhongguo Qihou Qu."

[50] Yang Zun, ed., *Xu Erhao Jinian Wenji* [Xu Erhao Memorial Volume] (Nanjing: Nanjing Normal University Press, 2000), XI (preface).

[51] If Xu were a geographical determinist, he would consider this scientific—though of course the theory has undergone significant revisions today， see : Anatolii Pavlovich Getman et al., "Geographical Determinism: History And Present," *Revista Notas Históricas y Geográficas*, November 17, 2023, 303–18.

[52] Stephen Frenkel, "Geography, Empire, and Environmental Determinism," *Geographical Review* 82, no. 2 (1992): 143–53.

[53] Lu Wu, "Zhongguo Qihou Quyu Xinlun" [New Study on China's Climatic Regionalization], *Dili xuebao* [Acta geographica sinica] (1946): 1‑10

[54] Indeed, Lu himself was a participant in this classification a decade earlier， see Tu and Lu , "Climatic Provinces of China".

[55] Frank, "National Climate."

The 1956 publication of the Draft of China's Natural Regionalization stated: "The purpose of this draft is to divide regions, not zones... Different objectives can lead to different results in regional division."[56] The goal of climatic regionalization is to provide reference materials for production and construction departments such as agriculture, forestry, animal husbandry, rural side-line production,[57] and mining.[58] However, the Chinese government of the time was dissatisfied with this draft, desiring a climate regionalization scheme more directly aligned with their imperatives for economic development.

In 1956, China formulated a 12-year plan to stimulate development in its Outline of the Long-Term Plan for Scientific and Technological Development (1956-1967).[59] The ranking of various fields in this plan reflects the government's national priorities. The plan proposed thirteen major areas and fifty-seven important tasks. The first area was natural conditions and natural resources, with the first task being the natural regionalization of China and economic planning. In addition to this, there were five tasks requiring surveys of natural resources.

State-organized natural resource surveys in China had begun as early as 1951. In 1955, the Chinese Academy of Sciences (CAS) established the Committee for Comprehensive Survey of Natural Resources, with Zhu Kezhen serving as its director. Half of the committee members were CAS researchers, many of whom were CAS academics, while the other half consisted of deputy leaders from natural resource-related national ministries.[60] During the 1950s and 1960s, the committee organized nationwide large-scale comprehensive natural resource surveys.[61] The 12-year plan imposed clearer requirements on the committee's mandate: to accept leadership from the State Planning Commission, undertake national tasks, conduct natural regionalization, and propose rational allocation of productive forces.[62]

During this period, regionalization efforts began to exhibit characteristics of Maoist science, where scientific tasks became aligned with political objectives, and science itself emerged as a tool for social revolution.[63] While this alignment was partially driven by scientists' proactive engagement,[64] subsequent research will demonstrate that just as scientists leveraged their activities to advance state-building, they could also pursue their own disciplinary goals through national construction and political processes.

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[56] Editorial Department of the Records of Chinese Geography, *Zhongguo Ziran Quhua Caoan* [Draft Natural Regionalization of China] (Beijing: Science Press, n.d.), 1.

[57] Rural sideline production refers to the other production activities that agricultural producers engage in in addition to their main production activities. Since 1993, the subdivision of sideline occupations has been cancelled, and the hunting of wild animals has been classified into animal husbandry, and the gathering of wild plants and commodity industry run by rural household have been included in farming. See National Bureau of Statistics of China, Explanatory Notes on Main Statistical Indicators, 2022, https://www.stats.gov.cn/sj/ndsj/2022/html/zbe12.pdf.

[58] Editorial Department of the Records of Chinese Geography, *Zhongguo Ziran Quhua Caoan*, 57.

[59] Department of Innovation and Development, Ministry of Science and Technology, PRC (eds), *Kexue Jishu Fazhan Guihua Gangyao* [Outline of the Program for Science and Technology Development] of the People's Republic of China (1956-2000) (Scientific and Technical documents Press, 2018), 6.

[60] Zhang Jiuchen. *Ziran Ziyuan Zonghe Kaocha Weiyuanhui Yanjiu* [Study on the Comprehensive Survey Committee of Natural Resources]. (Beijing: Science Press, 2013),74-76.

[61] Sun Honglie, Cheng Shengkui, and Feng Zhiming, "From Integrated Surveys of Natural Resources to Comprehensive Research of Resources Science over 60 Years," *Journal of Natural Resources* 25, no. 9 (2010): 1414–23.

[62] "Historical Evolution of the Institute of Geographic Sciences and Natural Resources Research, CAS." Website of the Institute of Geographic Sciences and Natural Resources Research, CAS. Chinese Academy of Sciences, n.d. Accessed [March 23, 2025]. https://igsnrr.cas.cn/skjs/lsyg/.

[63] Sigrid Schmalzer, *Red Revolution, Green Revolution: Scientific Farming in Socialist China* (University of Chicago Press, 2016), 5.

[64] Ibid., 28.

During the 1950s, China was undergoing a fervent movement to emulate the Soviet Union, and these above-mentioned undertakings were characterized by extensive Soviet involvement. In July 1952, V.T. Zaychikov, Deputy Director of the Institute of Geography, USSR Academy of Sciences, visited China to discuss collaborative compilation on the *Geography of China* with Chinese scholars.[65] At Zaychikov's suggestion, the Chinese Academy of Sciences established the Editorial Board for the *Geographical Annals of China*, marking the start of China's natural regionalization efforts. In April 1955, a Soviet scientific expedition led by Innokenty Petrovich Gerasimov arrived in China. During exchanges, Gerasimov criticized the natural regionalization section of the *Geographical Annals of China* for lacking proper theoretical guidance and singled out the climate regionalization maps as poorly executed and subservient to other regionalization frameworks.[66] In 1956, under the guidance of Soviet experts, the geography component of the 12-year plan was finalized, directing geographers to complete tasks accordingly. Led by the Soviet geographer Ivan Vasilyevich Samoylov (Самойлов，Иван Васильевич)—who would, in the years that followed, emerge as the leading figure among Soviet geographers working in China—more than fifty Soviet scientists provided direct or indirect guidance to China's natural regionalization.[67] By late 1958, after completing all components of the natural regionalization plan, Chinese scholars translated the scheme and its explanatory notes into Russian and sent them to the Soviet Union. The USSR responded with a 150,000-character written critique and dispatched a specialized expert group to China to provide feedback. The Soviet delegation engaged Chinese scholars in discussions spanning 17 issues, including the objectives of regionalization, zonal vs. non-zonal related problems, and methodological procedures.[68] Regarding climate regionalization specifically, the Soviet side convened 20 meteorologists from Kiev, Moscow, Leningrad, and Voronezh for deliberations and organized subgroup discussions at institutions such as the Central Geophysical Institute and the Meteorological Group of the Institute of Geography.[69] Amid these controversies, both eyewitnesses and Zhu Kezhen's biographers have concurred that the subtropical zone issue was a significant disagreement between Sino-Soviet climatologists at the time.

The subtropical zone issue perplexed Chinese scientists from the outset. As an imported concept, at the time its international definition remained ambiguous, as it inherently denoted regions ill-fitted to either temperate or tropical classifications.[70] In addressing this, Chinese climatologists chose to maintain continuity with previous approaches: on one hand, they downplayed foreign-defined subtropical boundaries within China, asserting superior access to localized data; on the other, they refrained from deviating excessively from the general concept to ensure acceptance by international peers.[71]

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[65] Zhu Kezhen, *Zhu Kezhen Quanji* [The Complete Works of Zhu Kezhen], vol. 13 (Shanghai: Shanghai Science and Technology Education Press, 2007), 659-661.

[66] Zhu Kezhen, *Zhu Kezhen Quanji* [The Complete Works of Zhu Kezhen], vol. 14 (Shanghai: Shanghai Science and Technology Education Press, 2008), 118.

[67] Working Committee of Natural Regionalization, CAS, *Zhongguo Qihou Quhua Chugao*[Climatic Regionalization of China (Preliminary Draft)] (Beijing: Science Press, 1959), II.

[68] Soviet Experts, "Comments and Summary on the 'Draft Comprehensive Physical Regionalization of China'," *Dili Xuebao* [Acta Geographica Sinica] 25, no. 3 (1959): 240–247.

[69] Kezhen, Zhu Kezhen Quanji [The Complete Works of Zhu Kezhen], 2008, 14:505，510.

[70] "Subtropics - Glossary of Meteorology," accessed April 2, 2025, https://glossary.ametsoc.org/wiki/Subtropics.

[71] Huang Bingwei. "Zhu Kezhen Tongzhi yu Woguo Redai he Hainan Dao de Kexue Yanjiu (Yi) Woguo Redai、Yaredai Jiexian Wenti" [Mr. Zhu Kezhen and China's Tropical and Hainan Island Scientific Research (Part 1): The Issue of China's Tropical and Subtropical Boundaries]. *Dili Yanjiu* (*Geographical Research)* 1, no. 1 (1984): 8–18.

The extensive involvement of Soviet experts introduced unforeseen complications. Soviet scientists' theoretical frameworks ceased to be passive tools awaiting Chinese modification and instead became proactive agents shaping China's climate regionalization process. Chinese climatologists could no longer afford to first establish domestic consensus on subtropical boundaries before applying foreign systems—as they had with Köppen's classification—but were now compelled into a dynamic, real-time negotiation with Soviet science.

Zhu Kezhen's diaries contain extensive records of this period. At that time, the Soviet Union had climate classification systems such as those developed by Berg, Alisov, and Selyaninov, with Alisov's classification being the most representative. Unlike Köppen, Alisov attempted to classify climates based on the movement of air masses, a tradition adopted from dynamic climatology.[72] In Alisov's climate classification, North China, Northeast China, and southern Xinjiang were categorized as subtropical regions.[73] Nevertheless, these areas are currently classified as temperate zones. Take Northeast China, for instance; it is well-known for its snowy winters and fertile black soil, which clearly do not match the characteristics of a subtropical climate. In 1956, the Soviet experts who had just arrived in China exhibited a rather assertive stance, indicating that the boundary of the subtropical zone in China should conform to the Soviet Union's will.[74] Perhaps unsurprising given that Samoylov, the representative figure guiding China's natural regionalization, was a colleague of Alisov's at Moscow State University.

Huang Bingwei (黄秉维), Zhu Kezhen's deputy, described the intellectual confusion of the time, noting that many Chinese scholars adhered to Soviet scientists' viewpoints and even advanced more persuasive indicators and phenomenological justifications than their Soviet counterparts.[75] Large-scale natural resource surveys provided Chinese academics with preliminary evidence, and accumulating climatic data suggested those regions should be classified as temperate zones.[76] Additionally, after conducting on-the-ground surveys in China, some Soviet experts working in the country began to shift or soften their previously rigid positions.[77] Some Soviet experts even expressed excitement at encountering tropical and subtropical regions for the first time.[78] This reinforced Chinese scientists' conviction that they possessed a superior understanding of China's climatic realities compared to foreign authorities, whether Köppen or Alisov.

China's climate regionalization also followed an implicit trajectory: translating locally specific research into universal scientific language rather than resorting to protectionist adjustments. Alisov's classification, based on air mass dynamics, could not be persuaded by so- called "Chinese climatic realities".[79] Meanwhile, by the late 1950s, Sino-Soviet tensions

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[72] Boris Pavlovich Alisov (Борис Павлович Алисов), *Klimaticheskie oblasti zarubezhnykh stran* [Климатические области зарубежных стран; Climatic Regions of Foreign Countries] (Moscow: Gos. izd-vo geogr. lit [Гос. изд-во геогр. лит], 1950), 37.

[73] Ibid., 79, 91.

[74] Zhu, Zhu Kezhen Quanji, 14: 374-375.

[75] Huang. "Zhu Kezhen Tongzhi yu Woguo Redai" 9.

[76] Zhu Kezhen, *Zhu Kezhen Quanji* [*The Complete Works of Zhu Kezhen*], vol. 3 (Shanghai: Shanghai Science and Technology Education Press, 2004), 420-429.

[77] Zhu Kezhen, *Zhu Kezhen Quanji* [*The Complete Works of Zhu Kezhen*], vol. 15 (Shanghai: Shanghai Science and Technology Education Press, 2008), 62-63.

[78] Zhu, Zhu Kezhen Quanji, 15:62–63.

[79] Huang. "Zhu Kezhen Tongzhi yu Woguo Redai, "12-13.

emerged. Accepting Soviet subtropical boundaries would have directly impacted China's agricultural restructuring, imbuing Chinese scientists' actions with additional political significance. This necessitated Chinese climatologists' entry into the previously unfamiliar field of dynamic climatology. Fortuitously, Chinese climatologists identified errors in Alisov's dynamic classification through their analysis of the East Asian subtropical highs and westerlies.[80] After synthesizing evidence from multiple disciplines, Zhu Kezhen definitively settled the debate with his landmark paper "Subtropics of China."[81]

Notably, the boundary between the subtropical and temperate zones eventually chosen by Chinese scientists is still the well-known Qinling-Huaihe Line. This boundary also closely aligns with the universally defined northern limit of the subtropical zone today.[82] In the *Climatic Regionalization of China (Preliminary Draft)*, this line has profound scientific meaning:

> It is advisable to use the accumulated temperature of 4500°C during the warm season (period with daily mean temperature ≥10°C) and the 0°C isotherm for the coldest pentad as boundaries. This line also corresponds to other climatic thresholds: a frost-free period of approximately 240 days, an aridity index of 1 (precipitation equivalent to evapotranspiration), and an annual precipitation of 750 mm. Geographically, this boundary lies at roughly 34°N, coinciding with the southern limit frequently influenced by the summer polar front, the southern edge of the upper-level westerly circulation during midsummer, and the southern margin of the typical east-west path of mid-path anticyclones.[77]

Gone are the simplistic rationales of 30 years ago: the Qinling-Huaihe Line is the dividing line between north and south, so it should be a climate regionalization boundary. Today, this represents the most significant boundary in Chinese geography, one that every middle school student is required to understand. In this sense, Chinese scientists have achieved academic independence on two levels: one in using academic independence to bolster national sovereignty; the other in interpreting existing cultural and geographical understandings through universal scientific discourse.

Conclusion

The case of China's climate regionalization presents intriguing dynamics. Early twentieth-century Chinese scientists adopted the development of "local science" as a strategy for a nation that was a relative latecomer to science. Natural geographic knowledge with deep indigenous roots, such as climate regionalization, became the focus of this strategy. National psychology served as the impetus for scientific development, while national culture provided its nourishment.

Thus, Chinese climatologists sought to reconcile Köppen's universalist framework with China's distinct climatic and cultural regions, creating hybrid systems that 'spoke Chinese' scientifically. However, the goal of developing local science remained to elevate China's scientific standing globally, ensuring Chinese science would be recognized internationally. Thus, we observe that Chinese climatologists have consistently demonstrated a general tendency—most notably by reinterpreting traditional boundaries through scientific lenses—endowing them with rich significance. This necessitated a dual task: explaining China through

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[80] Staff Members of the Section of Synoptic and Dynamic Meteorology, Institute of Geophysics and Meteorology, Academia Sinica, Peking, "On the General Circulation over Eastern Asia (I)," *Tellus* 9, no. 4 (1957): 432–46.

[81] Zhu Kezhen, "Zhongguo de Yaredai[Subtropics of China]," *Kexue Tongbao*, no. 17 (1958): 524–28.

[82] "Subtropics - Glossary of Meteorology."

globally dominant scientific languages while simultaneously preserving its uniqueness. Through this process, Chinese climatology also began to mature and achieve autonomy.

Climate regionalization represents a successful case, with its achievements closely tied to scientists' unique educational backgrounds. Most, possessed dual training in traditional cultural education and natural sciences, enabling them to draw insights from classical texts.[83] This approach was frequently adopted in the early development of certain Chinese disciplines, leading to a peculiar phenomenon: while historians debated the use of archives of nature versus social society,[84] scientists of that era transcended such limitations. This successful case also invites reflection: what role have unsuccessful or non-universalized natural-cultural concepts played in the history of Chinese science?

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[83] In China, they are called "Jing Shi Zi Zu", which means classics, histories, philosophers and anthologies.

[84] Fiona Williamson, "The 'Cultural Turn' of Climate History: An Emerging Field for Studies of China and East Asia," *WIREs Climate Change* 11, no. 3 (May 2020): e635.