THE ‘MYSTERY’ OF LOP NOR: EMPIRE, GEOGRAPHICAL ‘PROBLEMS’ AND CLIMATE CHANGE ON THE SILK ROADS

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ABSTRACT

In the late nineteenth century, rumours of a large lake in Central Asia provided the material for a vexing ‘problem’ in imperial geography. That Lop Nor existed – or at least once had – was indicated by information in Chinese chronicles. However, identifying the lake proved challenging, not least because it did not always appear to have been located in the same place. Attracting romanticised epithets like ‘mysterious’ and ‘wandering’, Lop Nor became an important site for imperial scientific speculations about climatic stability and change. This article considers investigations by Russian, British, Swedish and American geographers (as well as the key roles of Loplyk brokers such as Ördek, who located the ancient city of Loulan that had once graced the shores of the lake and been abandoned in the face of changing habitability). In turn, the article examines the way Lop Nor was bound up in the formation of imperial imaginaries of the ‘Silk Roads’, as well as incorporated by geographers like Peter Kropotkin and Ellsworth Huntington into theories of desiccation and climate change within recent human history. More widely, considering debates over Lop Nor allows for an examination of the role of imperial geographical ‘problems’ in the history of climate sciences and the development of geography as a discipline.

KEYWORDS

Central Asia; Climate Change; Desiccation; Empire; Environmental Determinism; Geography; Indigenous Knowledge; Lop Nor; Silk Roads

INTRODUCTION

The Lop desert is situated at the eastern end of the Tarim Basin in what is today Xinjiang, China. Bridging between the vast Taklamakan and Gobi deserts, it is classified as extremely arid, with almost no annual rainfall, though it is watered by snowmelt from the surrounding Tian Shan and Kunlun mountains, which feeds rivers, lakes and sometimes marshes. Formed largely of yellow-grey clay and sand sprinkled with gravel, it is part of an endorheic basin (i.e. drains nowhere into an ocean), as well as almost perfectly flat and subject to high winds, factors which all contribute to its complex and changeable hydrography. In the late nineteenth century, longstanding rumours of a large lake in this desert provided the material for a vexing geographical problem. This lake – Lop Nor – would go on to become a key site for imperial theories and speculations about climatic change and stability over a range of timescales.[1] In order to do so, however, it first had to be found. Despite expanding colonial interference in Central Asia and the filling in of the last 'blank spaces' on imperial maps around the turn of the twentieth century, pinning down Lop Nor proved far from straightforward. This was similarly true of the ancient city of Loulan (also called Kroraina or Krorän), which Chinese historical accounts indicated had been located on the shores of Lop Nor, but which had been abandoned more than 1,500 years previously. Fascination with Loulan was only increased by the fact it had apparently been an important site on the historical 'Silk Roads', imperial imaginaries of which were in the making in tandem with attempts to identify Lop Nor.

This article traces historical scientific and geographical debates about Lop Nor to examine late nineteenth and early twentieth century ideas of climatic stability and change. As well as a perplexing geographical 'problem', theories about Lop Nor, its peripatetic wanderings between the southern and northern parts of the desert, and the apparent demise of Loulan in the fourth century CE became important to questions about the habitability of Central Asia.[2] Here Philippe Forêt has argued for the importance of examining debates around historical climate change in Central Asia at the turn of the twentieth century, which present a 'vexing question: why was the need for stability reiterated when the data from the field proved that climate was anything but stable?'[3] Indeed, the itinerant characteristics of Lop Nor fed into

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[1] Also spelled Lob Nor and Lop Nur.

[2] Some settlement nevertheless continued in the area until the seventh century. On imperial ideas of habitability more widely, see Lachlan Fleetwood, 'Histories of habitability from the Oikoumene to the Anthropocene', *WIREs Climate Change* **14** (5) (2023): e840. https://doi.org/10.1002/wcc.840

[3] P. Forêt, 'Climate change: A challenge to the geographers of Colonial Asia', *Perspectives* **9** (2013): 21.

imperial theories that increasingly pointed to the topographical and hydrographical instability of the Tarim basin but, as Forêt notes, these were often downplayed.[4] The discovery of Loulan and other lost cities in the Tarim basin in places incapable of supporting similarly sized cities in the present nevertheless required explanation. It seemed that environmental conditions in Central Asia might have changed, not only on a geological timescale but also within recent human history. In turn, this led to wider concern that Central Asia was inexorably becoming more arid over time, with 'desiccation' potentially leading towards greater and greater uninhabitability. Whether these environmental shifts required changes of climate to be explicable, or were accountable for by other geological or physical mechanisms, became the subject of intense debates in this period. These reflected tensions between the regional and global scaling of apparent climatic changes, as Deborah Coen's work has shown, as well as pointing to the anxieties inherent in unstable definitions of both 'climate' and 'climate change' in this period.[5]

More widely, the eventual identification of Lop Nor also fed into an anxiety in imperial circles about the filling in of the globe's last 'blank spaces' at turn of the twentieth century. This brought concerns about a 'closed-world system,' with attendant imperial questions about demography and the limits of habitable space.[6] The discovery of dead cities and possible widespread desiccation only compounded these fears. In this context, debates about the limits of habitability, and how they might change – either decreasing through environmental variation, degradation and climatic change, or expanding through terraforming and technological expansion – thus took on heightened geopolitical and imperial resonance. Phillip Lehmann has shown how these anxieties were developed in North Africa where

[4] Forêt, 'Climate Change', 22. See also P. Forêt, 'Le changement climatique dans les cartes de la Route de la Soie: les contributions négligées de l'Expédition sino-suédoise de 1927–1935', *Annales de géographie* **722** (4) (2018): 401–26; J.A. Millward, 'Towards a Xinjiang environmental history: Evidence from space, the ground, and in between', in J.A. Millward, Y. Shinmen, and J. Sugawara (eds), *Studies on Xinjiang Historical Sources* (Tokyo: Toyo Bunko, 2010), pp. 279–304; D.C. Waugh, 'Richthofen's "Silk Roads": Toward the archaeology of a concept', *The Silk Road* **5** (1) (2007): 1–10.

[5] D.R. Coen, *Climate in Motion: Science, Empire, and the Problem of Scale* (Chicago: University of Chicago Press, 2018).

[6] A. Bashford, *Global Population: History, Geopolitics, and Life on Earth* (New York: Columbia University Press, 2014).

'the possibility of climatic instability added to the sense of "unreadability" of little-known and environmentally alien overseas landscapes', amidst wider concern over 'future climatic catastrophes that could destabilize colonial and even metropolitan economies and polities'.[7]

In addition to their importance to the history of imperial climatology, debates about the 'mystery' of Lop Nor also shed light on the attraction of romanticised geographical 'problems' to the practice of imperial geography. Here the 'Lop Nor problem', as it was referred to by contemporaries, echoes famous 'problems' of the nineteenth century, including attempts to locate the source of the Nile and find the Northwest Passage. In the case of Lop Nor, the 'problem' was framed not only around location, but also multifaceted questions of what physical or climatic processes could reconcile seemingly contradictory accounts of the lake and its movements. Tracing these 'problems' thus gives insight into the development and further codification of geography as both an imperial science and an academic discipline. As 'problems' waiting to be 'solved,' these geographical conundrums provided provocations and justifications for imperial exploration. They also played key roles in narratives of geographical 'progress' and advancement, as well as providing the possibility for individual fame and associated benefits to the geographers who went after them.[8] Relatedly, Andy Bruno has traced the role of 'mystery' in environmental history, focusing on the case of Tunguska where 'the centrality of mystery-solving presents a distinctive environmental story that overlaps with familiar narratives of exploration, exploitation, and conservation, but possesses a different underlying logic' in pointing to 'catastrophes' beyond the scale of 'human experiences and comprehension'.[9]

The evocative 'problem' presented by Lop Nor attracted attention from an eclectic range of imperial explorers, geographers and scientists in the late nineteenth and early twentieth centuries. These include the Russian officer Nikolay Przhevalsky, Swedish explorer Sven Hedin, Hungarian-born British archaeologist Aurel Stein and American geographer Ellsworth Huntington. While involving, at times, imperial, national and personal competitiveness, this also points to the transimperial nature of geographical knowledge-making in this period.[10]

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[7] P. Lehmann, *Desert Edens: Colonial Climate Engineering in the Age of Anxiety* (Princeton: Princeton University Press, 2022), pp. 2–5.

[8] F. Driver, *Geography Militant: Cultures of Exploration and Empire* (Oxford: Blackwell, 2001).

[9] A. Bruno, *Tunguska: A Siberian Mystery and Its Environmental Legacy* (Cambridge: Cambridge University Press, 2022), pp. 8–9.

[10] See J.M. Jacobs, 'Nationalist China's "Great Game": Leveraging foreign explorers in Xinjiang, 1927–1935', *The Journal of Asian Studies* **73** (1) (2014): 43–64.

While the geographers who hunted Lop Nor were primarily Anglo-American and European, it also attracted the interests of the Japanese explorer Zuicho Tachibana, who was particularly interested in the spread of Buddhism, as well as later by Chinese scholars including Parker C. Chen and Huang Wenbi, who initially worked with Sven Hedin and later independently, bringing a range of different – albeit still essentially imperial – interests.[11] More widely, these surveys were entangled in the Qing reconquest of Xinjiang and here, as Peter Lavelle shows, 'the late Qing state practiced a certain brand of colonialism in its own internal frontiers,' pursuing more efficient resource extraction and agricultural productivity amidst a growing recognition of 'just how suddenly environments could change'.[12] The mapping of Lop Nor thus remains a deeply imperial story, taking place at the intersection of the 'three empires' of China, Russia and British India, even if these empires did not necessarily impose the same geopolitical visions or seek to make Central Asian landscapes answer the same questions.[13]

Of course, however mysterious to imperial geographers and archaeologists, the Lop desert had long been known to the Loplyks (a Turkic-dialect speaking people) who lived in the area, as well as other Central Asian groups who frequented it, notably Uyghurs and Kazakhs. Much of the early imperial knowledge of the lake, and later theories about its peripatetic movements over time, relied heavily on local testimony about environmental change.[14] Indeed, as this article shows, from the discovery of the Loulan ruins by the Loplyk Ördek, to the theories of environmental stability that depended on the intergenerational oral knowledge of Tokhta Akhun, a diverse range of actors made knowledge about habitability around the turn of the twentieth century. In recent years, there has rightly been considerable interest in indigenous knowledge about climate change.[15] The story of Lop Nor illustrates the way that different traditions overlapped in the making of knowledge about climate and its stability over a range of timescales. Here, existing notions of habitability and change continued to

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[11] These expeditions were mostly archaeological and remain beyond the scope of this article, but see I. Galambos and K. Kōichi, 'Japanese exploration of Central Asia: The Ōtani expeditions and their British connections', *Bulletin of the School of Oriental and African Studies* **75** (1) (2012): 113–34; J.M. Jacobs, 'Huang Wenbi: Pioneer of Chinese archaeology in Xinjiang', *The Silk Road* **12** (2014): 122–31.

[12] P. Lavelle, *The Profits of Nature: Colonial Development and the Quest for Resources in Nineteenth-Century China* (New York: Columbia University Press, 2020), pp. 12, 17.

[13] See J.A. Millward, *Eurasian Crossroads: A History of Xinjiang* (London: Hurst, 2007).

[14] While used in colonial accounts, the designation of Loplyks (or Lopliks/Lopliqs/Loptuqs) as a distinctive ethnic group remains debated. See S. Ståhlberg and I. Svanberg, 'Loplyk fishermen: Ecological adaptation in the Taklamakan desert', *Anthropos* **105** (2) (2010): 423–39.

[15] See H. Mercer and T. Simpson, 'Imperialism, colonialism, and climate change science', *WIREs Climate Change* **14** (6) (2023): e851, https://doi.org/10.1002/wcc.851

inform and contest imperial categorisations of Central Asian deserts. At the same time, Loulan also saw geographers weighing natural and cultural factors in the abandonment of settlements with greater and lesser degrees of nuance, echoing a long and insidious history of environmentally determinist explanations for 'civilisational' success and decline.[16] Indeed, discussions of Lop Nor and Loulan inevitably echoed longstanding ideas about human potential in relation to climatic factors, and these deterministic explanations were expanded on by geographers around the turn of the twentieth century as justifications for imperial dominance.

The history of imperial interference in Central Asia in general, and the Tarim basin in particular, is far from untouched, though much existing scholarship focuses on archaeology and the histories of religious and cultural exchange.[17] This article is less interested in these archaeological debates, instead focusing on what the lost cities like Loulan reveal about imperial theories of climate. Recent research has nevertheless accorded Central Asia an important place in the history of climatology more widely, with focuses on the Habsburg empire and Russian attempts to colonise and govern Turkestan.[18] Lop Nor is likewise far from the only example of changeable hydrography in Asia, alongside contemporary investigations into changes to the Aral Sea as well as interest in the way the Amu Darya/Oxus, Indus and Tsangpo-Brahmaputra rivers historically shifted course.[19] Notable parallel cases globally include the Euphrates and Tigris in Mesopotamia, whose contemporary courses were sometimes quite far from ruined Sumerian cities that they had abandoned. Ultimately, what Lop Nor thus offers is a productive case study for bringing together these various debates, as global theories of desiccation jostled with imperial imaginaries of the Silk Roads and indigenous climate knowledges, allowing for a sustained reflection on imperial geographical 'problems' and their legacies.

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[16] See, among others, D.N. Livingstone, 'Changing climate, human evolution, and the revival of environmental determinism', *Bulletin of the History of Medicine* **86** (4) (2012): 564–95.

[17] See especially V. Hansen, *The Silk Road: A New History* (Oxford: Oxford University Press, 2012); J.M. Jacobs, *The Compensations of Plunder: How China Lost its Treasures* (Chicago: University of Chicago Press, 2020).

[18] Coen, *Climate in Motion*; Jennifer Keating, *On Arid Ground: Political Ecologies of Empire in Tsarist Central Asia* (Oxford: Oxford University Press, 2022).

[19] D. Gilmartin, *Blood and Water: The Indus River Basin in Modern History* (Oakland: University of California Press, 2015), p. 15; T. Simpson, 'Find the river: Discovering the Tsangpo-Brahmaputra in the Age of Empire', *Modern Asian Studies* **58** (1) (2024): 127–62.; M.K. Peterson, *Pipe Dreams: Water and Empire in Central Asia's Aral Sea Basin* (Cambridge: Cambridge University Press, 2019).

One other key concept ultimately indivisible from imperial imaginative geographies of Central Asia around the turn of the twentieth century requires some attention; namely, the so-called 'Silk Roads'. A flexible and evocative concept, the idea of the 'Silk Roads' has been applied in a variety of ways, sometimes referring to land trade routes through Central Asia, at other times to referring much more widely to economic and cultural interactions between the 'East' and 'West' or Europe and Asia.[20] These definitions are nevertheless important to the story of Lop Nor, not least because they dovetail the places, people and moments that saw the earliest formulation of the 'Silk Roads' as an imperial imaginary.[21] The German geographer Ferdinand von Richthofen is usually credited with inaugurating the term 'Silk Roads' – via the German '*Seidenstraßen*' in 1877 – even if he did not necessarily coin it.[22] Richthofen was a key interlocutor in the Lop Nor debates, and Sven Hedin's 1936 book *Sidenvägen* – translated into English as *The Silk Road* – contributed to the popularisation of the term.[23] Environmental factors also played a part in these imaginaries, and this article contributes to a growing body of scholarship on the environmental history of the 'Silk Roads'.[24] At the same time, it is important to remember that the idea of the 'Silk Roads' was popularised in tandem with imperial attempts to gain influence in Central Asia (and, as Justin Jacobs argues, particularly to 'impose economic and political claims upon the lands and peoples of Xinjiang').[25] These romantic visions of the 'Silk Roads' and connections in world history are thus inseparable from fraught political questions about the fate of the Uyghurs and other Turkic-speaking peoples of Xinjiang today.[26] The story of Lop Nor and Loulan shows that the Tarim basin has long been a multicultural space of lives and exchanges – perhaps one day it can be again.

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[20] For an overview, see J.A. Millward, *The Silk Road: A Very Short Introduction* (Oxford: Oxford University Press, 2013).

[21] Hansen, *The Silk Roads*, p. 6. See also J.M. Jacobs, 'The concept of the Silk Road in the 19th and 20th centuries', in D. Ludden (ed.), *Oxford Research Encyclopedia of Asian History* (Oxford: Oxford University Press, 2020).

[22] See Waugh, 'Richthofen's "Silk Roads"'; M. Mertens, 'Did Richthofen really coin "the Silk Road"?', *The Silk Road* **17** (2019): 1–9; T. Chin, 'The invention of the Silk Road, 1877', *Critical Inquiry* **40** (1) (2013): 194–219.

[23] See A.J. Andrea, 'The Silk Road in world history: A review essay', *Asian Review of World Histories* **2** (1) (2014): 105–27.

[24] See Waugh, 'Richthofen's "Silk Roads"'; L.E. Yang et al. (eds), *Socio-Environmental Dynamics along the Historical Silk Road* (Cham: Springer, 2019).

[25] Jacobs, 'The concept of the Silk Road'.

[26] For the wider history of Xinjiang, see Millward, *Eurasian Crossroads*.

SALT OR SWEET: NINETEENTH CENTURY SEEKERS AND DOUBTERS

In collating the various historical traditions that referenced Lop Nor, Sven Hedin reflected on the apparent extent of Ptolemy's knowledge in 150 CE, explaining that this was 'without the slightest doubt due to the great silk trade'.[27] He was thus bemused that a millennium later 'Marco Polo does not say a word about Lop-nor; he only speaks of the great Lop desert.'[28] Indeed, in imperial imaginaries of Central Asia, Marco Polo was a ubiquitous reference point, and his not mentioning the lake only added to the mystery. Ferdinand von Richthofen, meanwhile, noted that Lop Nor continued to be approximated on European maps, even if by the mid-nineteenth century 'the conclusive solution of all questions appeared to be very distant; for Lob-nor lay exactly in the centre of an extensive region of Asia entirely beyond the reach of the European explorer'.[29] Framed in this way, Lop Nor thus served as a provocation, a tantalising geographical 'problem' in want of empirical confirmation. Indeed, much as inscribing 'blank spaces' on imperial maps overwrote existing indigenous topographies, geographical 'problems' served to drive exploration, and ultimately imperial appropriation.

While European knowledge was sparse, Lop Nor was nevertheless far from unchronicled, especially in Chinese accounts. In summarising these records, George Macartney, the long-serving British Consul at Kashgar, noted a key piece of information which became central in debates over the identification of Lop Nor; namely, that it was a salt lake. As Macartney explained, 'the Tsien Han-shu [Book of Han] tells us that China began intercourse with this country in the reign of the Emperor Wu-ti' (141-87 BCE) and here the lake was referred to as 'Pú-cháng-hai (lit. Calamiferous lake), which is also called the Salt marsh'.[30] Similarly, in the monumental *Shiji* (Records of the Grand Historian) published around 100 CE, the lake was referred as 'Yen-tse' (which was translated as 'salt sea').[31] The English explorer and scholar Ney Elias meanwhile explained that it was not only ancient chronicles that were of value. Here he explained that the *Xiyu shui dao ji* (Records of the Waterways in the Western

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[27] S. Hedin, *The Wandering Lake*, trans. F.H. Lyon (New York: E.P. Dutton and Co., 1940), p. 235.

[28] Ibid., p. 234.

[29] Richthofen in N. Przhevalsky, *From Kulja, Across the Tian Shan to Lob-Nor*, trans. E.D. Morgan (London: Low, Marston, Searle & Rivington, 1879), pp. 137–38. See also Waugh, 'Richthofen's "Silk Roads"'.

[30] G. Macartney, 'Notices, from Chinese sources, on the ancient kingdom of Lau-Lan', *The Geographical Journal* **21** (3) (1903): 261.

[31] Hedin, *The Wandering Lake*, pp. 241–42; Z. Songqiao and X. Xuncheng, 'Evolution of the Lop Desert and the Lop Nor', *The Geographical Journal* **150** (3) (1984): 319.

Regions) produced around 1823 by Chinese administrator Xu Song claimed that 'the Lob-nor is 400 li long and 200 li broad' (approximately 220 kilometres by 110) and this allegedly vast scale was another key element in debates over the later identification of the lake.[32]

In the second half of the nineteenth century, imperial knowledge of Lop Nor remained dependent on an eclectic set of multicultural historical records, which were ultimately insufficient for the evolving aims of imperial geographical science. The 'problem' of Lop Nor was thus thrust into the spotlight by the attentions of Russian explorer Nikolay Przhevalsky, who believed he had found the lake in 1877.[33] In the account of his journey, Przhevalsky played up the growing imaginative resonance of Lop Nor with the claim that 'another successful step in the exploration of Inner Asia – the basin of Lob-nor, so long and so obstinate a *terra incognita* – has at length been revealed to science', though this announcement would ultimately prove not to be quite so straightforward.[34] Indeed, he actually identified two lakes, suggesting one of them must be the historical Lop Nor of the Chinese texts. Geographical observers, notably Ferdinand von Richthofen, quickly pointed out that Przhevalsky's identification of these with the historical Lop Nor did not seem to entirely add up. Indeed, the lakes identified by Przhevalsky were several hundred kilometres further south than the Chinese sources put them (see Figure 1). Adding to the doubts was also that Przhevalsky reported the water to be sweet rather than salty.[35]

[32] N. Elias, 'About the basin of Lake Lob-Nor', Royal Geographical Society Archives, London, NE/42, f3; f76.

[33] See A. Andreyev, M. Baskhanov and T. Yusupova, *The Quest for Forbidden Lands: Nikolai Przhevalskii and His Followers* (Leiden: Brill, 2018).

[34] Przhevalsky, *From Kulja*, p. 31.

[35] Richthofen in Przhevalsky, *From Kulja*, pp. 158–59.

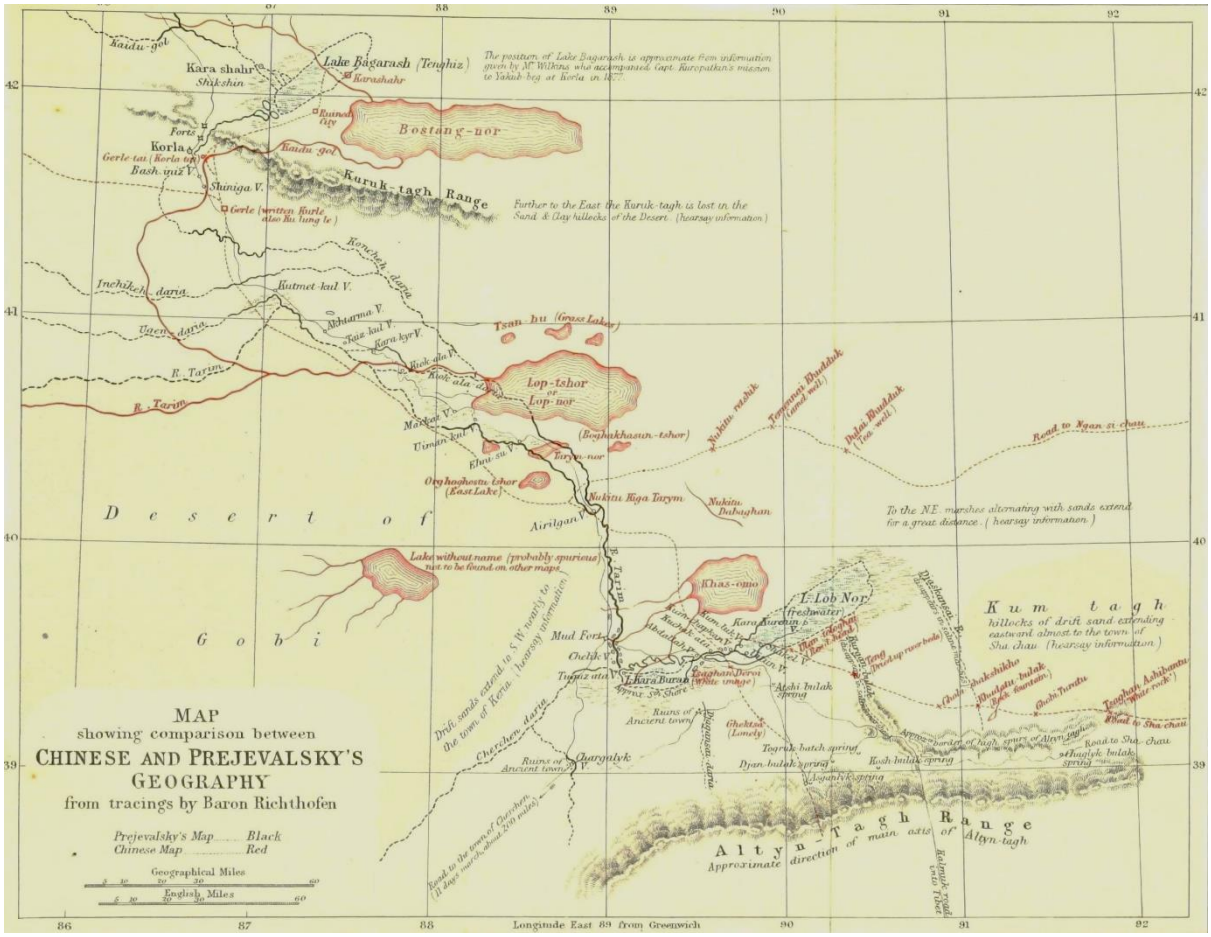

Figure 1. 'Map Showing Comparison between Chinese and Prejevalsky's Geography'. Here the Chinese map is reproduced in red, with Przhevalsky's overlaid in black. A whole degree of latitude separates the Chinese Lop Nor and Przhevalsky's Lop Nor (Kara-koshun), indicating the scale of the geographical conundrum. Source: Przhevalsky, *From Kulja*, pp. 144–45.

Przhevalsky quickly provided a response to Richthofen, critiquing the German geographer's alleged overreliance on the Chinese accounts. Przhevalsky also brought in discussions of indigenous nomenclature, insisting that 'the circumstance of the natives not knowing or rather not employing the term "Lob-nor" for these lakes' was not surprising.[36] As Przhevalsky explained, 'the name Lob-nor is applied by these very people to the whole inhabited district of Kara-kul and Kara-kurchin'. Here he also recounted an anecdote which implied very different ways of understanding the topography, claiming that 'when we arrived at the first Tarim village of Kutmet-kul, the chief of the place, in answer to my question,

[36] Przhevalsky, *From Kulja*, pp. 164–65.

"How far is it to Lob-nor?" answered, pointing to himself, "I am Lob-nor."'[37] Przhevalsky also relied on these informants to bolster his claim that there were no other extant lakes that could possibly be Lop Nor.[38] Even as it raised as many questions as it answered, Przhevalsky's identification of Lop Nor was thus based on a combination of scientific surveys, multicultural historical records and intergenerational oral testimony, indicative of the multifacetedness of imperial geographical knowledge production in nineteenth-century Central Asia.

SVEN HEDIN AND THE 'WANDERING LAKE'

Looking back in a popular account titled *The Wandering Lake* (published in 1940), Sven Hedin highlighted the contributions of Przhevalsky, whose 'discoveries on this journey created an extraordinary sensation in the geographical world'.[39] Indeed, Hedin went on to quote from Petermann's *Mitteilungen*, an influential geographical magazine, that 'in this respect Prjevalsky's journey ranks equally with the solution of such famous problems as the crossing of Australia, the reaching of the North Pole or Timbuctoo, the discovery of the sources of the Nile, and Stanley's journey down the Congo'.[40] This again indicates the importance of sensational – and sensationaliseable – geographical 'problems' both to European imperial geography, but also to the individual careers of those who sought fame and fortune in the last 'blank spaces' of the maps. Petermann went on to conclude that 'Prjevalsky's journey to Lop-nor is a model achievement in the geographical field', because even if not all of his conclusions might prove correct, this merely opened up new opportunities to drive imperial geography forwards.[41]

While Przhevalsky's and Richthofen's debates elevated Lop Nor to the upper strata of unsolved imperial geographical 'problems,' the name that would become most famously associated with the lake is undoubtedly that of Sven Hedin. Over a period spanning four decades, Hedin made multiple visits to the Tarim basin and, following Richthofen's critiques, argued that 'Prjevalsky had discovered not the historic lake Lop-nor, the P'u-ch'ang-hai or

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[37] Ibid., p. 165.

[38] Ibid.

[39] Hedin, *The Wandering Lake*, p. 240. See also S. Hedin, *Scientific Results of a Journey in Central Asia 1899–1902* (Stockholm: Lithographic Institute of the Swedish Army, 1904), Vol. 2, pp. 257–314.

[40] Cited in Hedin, *The Wandering Lake*, p. 241.

[41] Ibid.

Yen-tse ("salt sea") of the Chinese, but a newly formed lake', namely Kara-koshun.[42] Hedin went on to conclude that the Lop Nor 'problem' thus remained unsolved – opening up, of course, space for his own forthcoming denouement. Here Hedin proposed a theory that might explain all the difficulties and reconcile the historical and contemporary accounts – namely the idea of a 'wandering lake'. Essentially, he argued that the solution to the lake not being found where expected was that it had actually shifted – in fact, quite dramatically – between the northern and southern parts of the desert.[43]

Meanwhile, the Russian explorer Pyotr Kozlov also visited the lake and in 1898 published an article defending Przhevalsky, though he conceded to some of Hedin's 'objections, namely, that the grandfathers of the present inhabitants of the Lob-nor lived by a lake whose position was more to the north'. He ultimately concluded, however, that 'the Kara-koshun-kul is not only the Lob-nor of my lamented teacher, N.M. Prjevalsky, but also *the ancient, the historical, and the true Lob-nor* of the Chinese geographers' (adding some interpersonal friction to these scientific debates, Kozlov had studied with Przhevalsky, while Hedin was a former student of Richthofen).[44] Hedin in turn used this as an opportunity to argue that such questioning was important to geography, thanking Kozlov (with hindsight and the easy magnanimity of victory) for his critiques and claiming 'if he had not defended them with such warmth, I should never have returned to the Desert of Lop'.[45] Here 'problems' served as important framings for geographical competition, seen as driving exploration as well as the development of novel scientific theories. They also often become central to geographical careers, leveraged both within academic circles, to obtain opportunities and funding, and more widely to shape public perceptions of imperial exploration and appropriation.[46] As Thomas Simpson has shown in the case of the Tsangpo-Brahmaputra, the theories themselves could become the end goal, and the maintenance of unknowability could have particular utility such that 'practitioners of spatial sciences came to thrive on the proliferation of models and objects of discovery rather than seeking definitive closure'.[47]

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[42] Hedin, *The Wandering Lake*, pp. 241–42.

[43] S. Hedin, 'Summary of the results of Dr. Sven Hedin's latest journey in Central Asia (1899–1902)', *The Geographical Journal* **20** (3) (1902): 311. See also Hedin, *Scientific Results*, Vol. 2, pp. 257–314.

[44] P. Kozlov, 'The Lob-nor controversy', *The Geographical Journal* **11** (6) (1898): 658.

[45] Hedin, *Scientific Results*, Vol. 2, p. 306.

[46] See Driver, *Geography Militant*.

[47] Simpson, 'Find the river', 1.

While Hedin's theory indicated that Lop Nor could move locations on the scale of human history, shifts in the hydrography were also observable within human lifetimes. On his second trip to Central Asia in 1899–1902, Hedin had the opportunity to observe some dramatic changes since his first expedition and was thus 'convinced that in a few years' time the lake will be found in the locality where it was formerly placed by the Chinese cartographers' (that is, in the northern part of the desert).[48] Here Hedin insisted that scientific surveys might cut through the debates stemming from the challenges reconciling the historical sources (even if imperial surveying practices were themselves destabilised by attempting to measure terrain which refused to stay still, meaning that maps could only ever be snapshots in time). In 1901, Hedin took a series of levels, to confirm whether the elevational differences were small enough to allow for the lake's movement.[49] He went on to calculate that the height difference was only 2.28 metres across 82 kilometres, and explained that it was this 'remarkable horizontality' which – in combination with wind erosion – allowed the lake to migrate between the northern to the southern part of the desert (see Figure 2).[50] These changes within human history were nevertheless challenging to reconcile, as evident in contemporary comparisons such as the unexpected increases to the Aral Sea measured by the Russian geographer Lev Berg in 1899–1900. As Jennifer Keating shows, environmental knowledge-making was often far from a linear process, and 'the more exploration generated empirical knowledge, the more challenging some of Turkestan's environments became'.[51]

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[48] S. Hedin, *Central Asia and Tibet* (London: Hurst and Blackett, 1903), Vol. 2, p. 174.

[49] Hedin, *Scientific Results*, Vol. 2, p. 235. See also Forêt, 'Climate change', 23.

[50] Hedin, *Scientific Results*, Vol. 2, p. 330. For a later expansion of this theory, see N.G. Hörner and P.C. Chen, 'Alternating lakes. Some river changes and lake displacements in Central Asia', *Geografiska Annaler* **17** (1935): 145–66.

[51] Keating, *On Arid Ground*, p. 19.

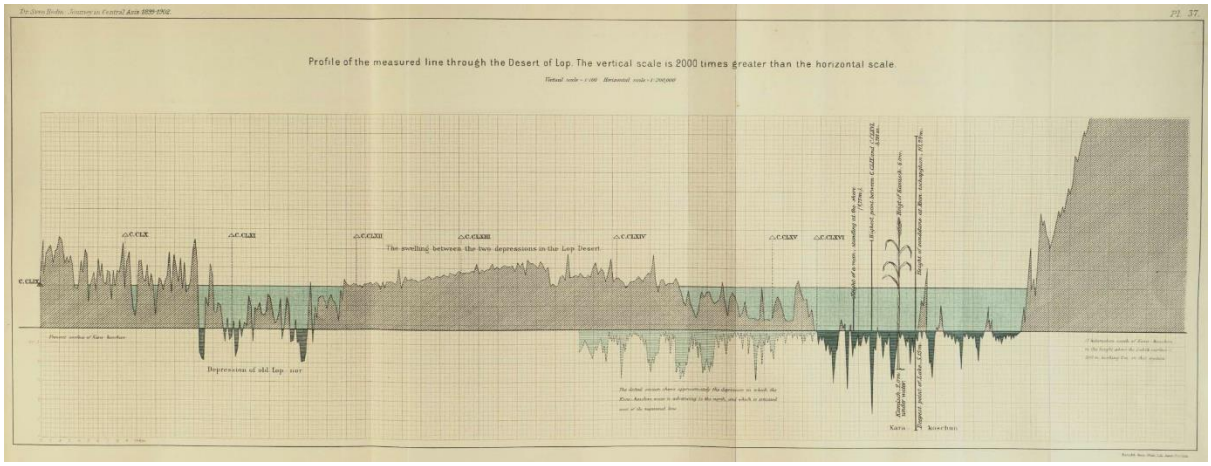

Figure 2. ‘Profile of the measured line through the Desert of Lop’. This showed two depressions in the nearly ‘horizontal’ Lop desert. Alongside indigenous oral knowledge about the relatively recent formation of Kara-koshun, these surveys were key to Hedin’s ‘wandering lake’ theory. Source: Hedin, *Scientific Results*, Vol. 2, Plate 37.

SERENDIPITY IN SPADES: THE DISCOVERY OF LOULAN

Closely associated with Lop Nor was the ‘Silk Road’ city of Loulan, which Chinese chronicles indicated had been founded on the shores of the lake as far back as the second century BCE. The discovery of the ruins of this city, an important archaeological desideratum by 1900, was ultimately made by accident. As Hedin recounts it, the actual discovery was made by a Loplyk named Ördek (see Figure 3). Hedin noted that ‘Ördek, a Lop-man, and a first-rate fellow, who had an exceptional knowledge of all that region, was engaged, amongst other things, to do labourer’s work about the camp.’[52] As Hedin explained, one day in 1900 his men realised that their spade was missing, and ‘Ördek, who was responsible for having left it behind, at once proposed to go back and fetch it’, eventually returning with the spade and ‘news of the very utmost importance.’[53] Hedin explains that a storm had come up and ‘he lost our trail and got astray, but finally came to a tora, or landmark tower, in the vicinity of which he discovered several houses’.[54] The way Hedin chooses to tell this story also indicates the complexity of the dependency on Central Asian labour and expertise in the pursuit of

[52] Hedin, *Central Asia and Tibet*, Vol. 1, p. 236.

[53] Ibid., pp. 381–82.

[54] Ibid., pp. 382–83.

European geography. Indeed, Hedin gives credit to Ördek as the discoverer of Loulan, and yet ensures his agency is undercut by emphasising the accidental nature of the find.

Figure 3. A stylised portrait of Ördek, the Loplyk who discovered the ruins of Loulan. The way Ördek's role in this discovery was rhetorically managed by Hedin in his accounts points to the complex dependency of European geographers on indigenous knowledge and labour. Source: Hedin, *The Wandering Lake*, pp. 18–19.

Hedin was ultimately excited by Ördek's finds not only for their own sake, but also because they represented 'a contribution towards the solution of the complicated Lop-nor problem'.[55] Indeed, Hedin knew that if the ruins of Loulan were found in the northern part of the desert – which indeed they were – then this would be further confirmation that this was where the historical Lop Nor had been located, and not Przhevalsky's Kara-koshun. In 1901, Hedin thus returned to investigate the ruins of Loulan more fully. Here he uncovered documents which helped to date the ruins, with Loulan flourishing from approximately 200 BCE until its

[55] Ibid. p. 386.

demise, which Hedin placed around 330 CE.[56] On reaching the deserted site, Hedin got characteristically carried away in evoking the drastic changes in habitability that had occurred: ‘look upon that picture and then look upon the picture of the scene as it is now! An endless array of cenotaphs!’ (see also Figure 4).[57] Hedin considered a mix of natural and cultural factors in the town’s initial abandonment, arguing that ‘even if military and political changes had been contributory causes of the evacuation of the town’ the movement of the lake ‘presented absolutely insuperable obstacles to the continuance of human life’.[58] Hedin went on to wax lyrical, writing that ‘in any case, it was a locality which awakened feelings of sadness at the perishableness of earthly things, and at the thought that cities and races are swept off the face of the earth like chaff before the wind’.[59] Loulan, a once thriving city that had been entirely abandoned, thus presented an illustrative and melancholy example of the consequences of changing habitability.

The Scene of Ördek’s Discovery—Photographed a Year Later.

Figure 4. ‘The scene of Ördek’s Discovery’. Stark photographs like this one contrasted with tales of a thriving Loulan and the imagined ‘Silk Roads’ it had served, reinforcing the

[56] Hedin, *Central Asia and Tibet*, Vol. 2, pp. 132–33; Hedin, *The Wandering Lake*, p. 275.

[57] Hedin, *Central Asia and Tibet*, Vol. 2, pp. 130–31.

[58] Hedin, *The Wandering Lake*, pp. 275–77.

[59] Hedin, *Central Asia and Tibet*, Vol. 2, p. 137.

tensions inherent in environmental theories around changing habitability. Source: S. Hedin, *Adventures in Tibet* (London: Hurst and Blackett, 1904), p. 135.

While Hedin conducted archaeological work at Loulan, this was mostly preliminary, and systematic investigations were left to his contemporary Aurel Stein. Stein too emphasised the contrasts, given that 'through this once habitable ground across the difficult salt-encrusted expanse of the dried-up sea beyond it' had once passed a key link on the 'Silk Roads'.[60] Reconciling the stunningly desolate site of Loulan with the emerging imperial imaginary that this ground had once hosted apparently one of the greatest trade routes in world history was thus not easy. Aurel Stein would later have the opportunity to discuss his findings at the Royal Geographical Society in London, which maintained itself as a focal point, stage and sometimes arbiter of imperial geographical 'problems' like that of Lop Nor. The RGS also sought to manage and police evolving practices in geography and, after a paper summarising Stein's expedition of 1906–08 the RGS President pointed to how tackling 'problems' like Lop Nor reflected changes towards systematisation which: 'should be the ideal in the future for every explorer, because we must recognize the fact that pioneer work is becoming less and less necessary' as 'there are fewer and fewer blank places on which maps remain to be filled'. Thus 'the explorer who wishes to make a name for himself in the future cannot do better than study Dr. Stein's methods'.[61] Indeed, in the period from the emergence of the Lop Nor 'problem' in the 1870s to its 'solution' by the 1930s, geography was itself being codified into a modern academic discipline, even as it remained an intensely imperial enterprise.

HABITABILITY, ENVIRONMENTAL CHANGE AND INDIGENOUS KNOWLEDGES

One of the most prominent imperial geographers drawn to Lop Nor was the American Ellsworth Huntington. In two journeys to Central Asia in 1903 and 1905–06, Huntington became interested in not only the movement of Lop Nor, but also its size. Following his first visit, he argued that 'there is reason to believe that in the Middle Ages Lop-Nor was

[60] M.A. Stein, 'Innermost Asia: Its geography as a factor in history', *The Geographical Journal* **65** (5) (1925): 394.

[61] G. Macartney et al., 'Explorations in Central Asia, 1906–8: Discussion', *The Geographical Journal* **34** (3) (1909): 266.

decidedly larger than now'.[62] In support of his theories about the lake's expansions and contractions, Huntington provided intergenerational oral knowledge from the Loplyks 'who once numbered thousands, but now are reduced to two hundred and fifty, the change, according to their own story, being due to the gradual drying up of Lop-Nor'.[63] While Huntington would go on to become infamous for his deeply racist and Eurocentric environmentally determinist theories, his notebooks reveal that he too relied heavily on Central Asian guides for the environmental knowledge that underpinned his theories.[64]

Indigenous knowledge was also applied to questions of nomenclature to trace environmental changes. In mapping the shifting hydrography, Hedin explained that 'the names of the natives are not without value geographically' and moreover 'they are also interesting as documents. I would almost venture to wager that within twenty years practically all the names which I have recorded … will have disappeared, even if they are not forgotten'. He continued that 'some of them would however still be in use, e.g. Usun-köl, or the Long Lake, Jangi-köl, or the New-Lake', being 'characteristic names', and 'yet they would then certainly be applied to different sheets of water from those they now indicate'.[65] Hedin went on that 'the names become, as it were, like the lakes themselves – overgrown with reeds; new basins come into existence and acquire new names'.[66] These studies of nomenclature thus revealed that the Loplyks maintained flexible topographical frameworks, further indicating that the changeable nature of the hydrography of the region had long been understood by those who lived there.[67]

In tracing the habitability of the Lop desert, European geographers also relied on intergenerational knowledge to map shifts over time. As Hedin explained, his observations of the formation of Kara-koshun in the southern part of the desert confirmed 'the information given me in 1896 … by Prjevalsky's old friend, the octogenarian chief Kunchekan Bek' who 'told me that his father, Numet Bek, had lived in his youth by a big lake situated north of

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[62] E. Huntington, 'Lop-Nor – a Chinese lake. Part II', *Bulletin of the American Geographical Society* **39** (3) (1907): 143.

[63] E. Huntington, 'Lop-Nor – a Chinese lake. Part I', *Bulletin of the American Geographical Society* **39** (2) (1907): 68. Here Huntington referred to Przhevalsky's Lop Nor, i.e. Kara-koshun.

[64] See E. Huntington, *Civilization and Climate* (New Haven: Yale University Press, 1915). See also J.R. Fleming, *Historical Perspectives on Climate Change* (New York: Oxford University Press, 1998).

[65] Hedin, *Scientific Results*, Vol. 2, p. 141.

[66] Ibid., p. 140.

[67] See Ståhlberg and Svanberg, 'Loplyk fishermen', 425; G. Jarring, *Central Asian Place-Names: Lop Nor and Tarim Area* (Stockholm: Sven Hedin Foundation, 1997).

Kara-koshun, and that the last-named had not been formed till 1720–30'.[68] Hedin and Przhevalsky, although they disagreed, both deployed intergenerational oral knowledge in support of their arguments and, in the case of Kunchekan Bek, they even relied on the same man. Ellsworth Huntington, Aurel Stein, Sven Hedin, Zuicho Tachibana and later the Swedish archaeologist Folke Bergman all also relied on a Loplyk named Tokhta Akhun, who was himself the son of Kunchekan Bek (see Figure 5).[69] Huntington, for example, relied on Akhun's knowledge to date both the formation of Kara-koshun and trace its changing dimensions, recording is his notebook of 1905 that 'Tokhta Akhun is 46 years old. His grandfather died 6 years ago at the age of 75. In the younger days of the latter's grandfather, so Tokhta Akhun says, that is about 1780–1790 the river followed the Kona Daria + lakes … to the Karakoshun which was much large than now.'[70] Aurel Stein meanwhile 'gathered interesting information from Mullah and Tokhta Akhun about the notable change which has taken place in the physical aspects of this dismal ground since Hedin saw it'.[71] Stein went on to explain how these men:

> Knew the Yangi-köl depression since their youth from hunting expeditions … and could recall having seen its western edge where it was marked by rows of dead Toghraks. Their fathers had told them that the basins had also formerly held water for certain periods … the total absence of vegetation in certain intervening depressions was attributed by my hunters to the depth of the water once held in them.[72]

Here they not only provided information about the changes that had occurred, but also offered explanations. While Lop Nor was a 'mystery' to European science, it had clearly long been explicable to those who lived by its whims. Stein would go on to rely on Tokhta Akhun over multiple expeditions, writing in 1913 to George Macartney 'for help in retaining in advance the services of two of my old Lop guides, Tokhta Akhun and Mullah Shah of Abdal' who 'have seen more of the desert with Hedin & myself than any other Lopliks' and were

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[68] Hedin, *The Wandering Lake*, p. 279.

[69] For Tachibana's employment of Akhun, see M.A. Stein, Papers, Oxford, Bodleian Libraries, MSS. Stein 303, f31. See also Ståhlberg and Svanberg, 'Loplyk fishermen', 425.

[70] Ellsworth Huntington Papers (MS 1), Archives and Manuscripts, Yale University Library, Series 1, Box 6, Folder 60, Notebook 05.I, f148.

[71] M.A. Stein, *Ruins of Desert Cathay* (London: Macmillan, 1912), Vol. 1, p. 360.

[72] Ibid., Vol. 1, pp. 360–61.

essential ‘for all the trying survey work I wish to get done around these dismal salt marshes, ancient & new’.[73]

Figure 5. ‘Natives of Abdall’. Both Kunchekan Bek and Tokhta Akhun were important sources of information about changes to the hydrography of the Tarim basin. At the same time, these sorts of ‘ethnographic’ photographs served to reinforce environmentally determinist stereotypes of the Loplyks as outside of time and ‘civilisational’ advancement. Source: Hedin, *Central Asia and Tibet*, Vol. 1, p. 449.

Tokhta Akhun developed a long career as a go-to expert and guide, one which ultimately spanned several decades. Indeed, in the 1930s Folke Bergman explained how ‘Tokhta Akhun … the faithful servant both of Hedin and Stein, accompanied me’.[74] Here Akhun had apparently continued searching out the ruins in the intervening years of his own volition, and offered Bergman objects he had collected after Stein’s previous expedition. Discussions of Akhun’s activities nevertheless often reflected a form of rhetorical practice, with European

[73] Stein to G. Macartney, 27 June 1913, Oxford, Bodleian Libraries, MSS. Stein 96, f145.

[74] F. Bergman, *Archaeological Researches in Sinkiang* (Stockholm: Bokförlags Aktiebolaget Thule, 1939), p. 225.

visitors insisting that their own archaeological investigations were essentially different from – and somehow superior too – existing local practices of Central Asian 'treasure-seekers'.[75] At the same time, Bergman acknowledged that Akhun's expertise was invaluable not only in locating the ruins, but also in keeping track of the many foreigners who had showed up with shovels before him.[76] Akhun's career indicates the way Central Asian people were not only subjected to imperial surveys, but might actively adapt to exploit economic and other possibilities. This reflects scholarly insights into other colonial contexts, for example Oceania and Australia, where sometimes indigenous actors 'made their own "strategic" and adroit uses of expedition parties', however violent the overarching imperial processes remained.[77] Ultimately, as factotum on an eclectic array of expeditions over several decades, Tokhta Akhun's contributions were far more fundamental than mere 'assistance' and he spent more time than any of Bergman, Stein, Hedin, Tachibana or Huntington investigating the desert sites. The most experienced expert in the ruins of the Lop desert was thus arguably not an imperial scientist or geographer at all.

THE LAKE WANDERS AGAIN AND DREAMS OF REVIVING THE 'SILK ROADS'

When Hedin proposed his 'wandering lake' theory and suggested its predictive capacity, it is unclear that he truly entertained the idea that the lake might 'wander' again in his lifetime. But it did. Beginning in 1921, the waters that had fed the southern depression, the Kara-Koshun of Przhevalsky, shifted northwards, resurrecting the Kuruk-daria ('Dry River') which had not flowed for a millennium and a half, and filling the old dried-up Lop Nor once more. Reflecting on these events in light of geographical 'problems', Hedin implied it was rare for them to be directly answered by 'Nature', but the reversion of the river was 'an answer to all unsolved questions, itself calling for no commentaries'.[78] The drama of these changes was only reinforced when Hedin made his final trip to Central Asia. Indeed, in 1934 Hedin travelled along the resurrected Kuruk-daria to the newly refilled Lop Nor. The contrast between his first trip in 1900, where he had travelled by camel along a completely barren and

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[75] See for example, Hedin, *Central Asia and Tibet*, Vol 2, pp. 132-3.

[76] Bergman, *Archaeological Researches*, p. 225.

[77] T. Shellam et al., eds., *Brokers and Boundaries: Colonial Exploration in Indigenous Territory* (Canberra: ANU Press, 2016), p. 5.

[78] Hedin, *The Wandering Lake*, p. 254.

dry riverbed, and this later journey by raft and canoe along a vast and flowing river could hardly have been starker (see Figure 6).

Figure 6. As Hedin explained 'my caravan in March, 1900, went along the bed of the Kuruk-daria, then dry for 1,600 years past – the same bed down which we passed in canoes in April and May 1934'. Source: Hedin, *The Wandering Lake*, p. 253.

When Hedin completed his descent of the resurrected Kuruk-daria and reached the reformed Lop Nor, flights of fancy took hold: 'I heard the splash of paddles on those old waterways, now recalled to life … and whose pure fresh water must have gladdened the hearts of travellers on the Silk Road.'[79] He went on in this vein, weaving in the key imaginaries and tropes that have come to be associated with the Silk Roads. While imagining the past, Hedin also had one eye on the future, and how the resurrection of the old Lop Nor 'prepared the ground for new life and new colonization … Lou-lan and its villages could blossom anew, and traffic on the Silk Road begin again'.[80] These visions had obvious geopolitical

[79] Ibid., p. 121.

[80] Ibid., p. 122.

implications and Hedin suggested that ‘a remarkable geographical and hydrographical event has put a means in the hand of the [Chinese] Government to open the old line of communication to traffic again’.[81] Hedin went on to leverage Lop Nor’s resurrection in preparing a ‘Plan for a Revival of the Silk Road’, which was later formally submitted to Chiang Kai-shek’s new Nationalist government in Nanking, as part of the complex web of obligations and permissions that had allowed the very deliberately monikered ‘Sino-Swedish Expedition’ access to Xinjiang.[82] Here, Tamara Chin has shown how, in popularising these imaginaries, Hedin and Richthofen ‘asserted the centrality of geological knowledge to geopolitical action. They used the Silk Road to reshape spatiotemporal beliefs about the inhabited and uninhabited Earth,’ but so too did the Chinese, albeit for different ends.[83] Indeed, these debates show how imperial imaginaries and theories of climate were developed in tandem in this period, and the way that scientific questions about shifts in habitability were ultimately always linked to wider imperial and political interests.

LOP NOR, CLIMATE CHANGE AND THEORIES OF DESICCATION

While the changeable hydrography of Lop Nor clearly had implications for habitability locally, it also raised larger questions about the climate and its stability. Turn-of-the-twentieth-century investigations into Lop Nor played out in tandem with questions about whether Central Asia – and perhaps even the Earth – was gradually becoming drier over time.[84] Indeed, in considering climate change within human history, one debate increasingly occupied geographers; namely, desiccation. These debates were global, with investigations in Central Asia compared, among others, to Australia, Southern Africa and the United States. These comparisons often centred anxious searches for mechanisms, including changes in wind patterns, temperature or evaporation, as well as how human activities like deforestation might be factors.[85] David Moon has shown that these questions were similarly crucial to

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[81] S. Hedin, *History of the Expedition in Asia, 1927–1935* (Stockholm: Elanders Boktryckeri Aktiebolag, 1943), Vol. 2, pp. 173–75. See also Chin, ‘The invention’.

[82] Jacobs, ‘The concept of the Silk Road’. See also P. Forêt, ‘Les frontières du *Central Asia Atlas* de Sven Hedin: Un exemple de dilemne politique’, *Le monde des cartes* **187** (2006): 51–64.

[83] Chin, ‘The invention’, 196.

[84] See especially Forêt, ‘Le changement climatique’.

[85] See D.K. Davis, *The Arid Lands: History, Power, Knowledge* (Cambridge, MA: MIT Press, 2016); G. Endfield and S. Randalls, ‘Climate and empire’, in J. Beattie, E. Melillo and E. O’Gorman (eds.), *Eco-Cultural Networks and the British Empire* (London: Bloomsbury, 2015), pp. 21–43.

Russian imperial expansion in Central Asia, coalescing around whether the steppes were becoming more extreme, 'and if so, whether change was progressive or cyclical', as well as whether changes had natural or anthropogenic causes.[86] Among the scientists and geographers who investigated Lop Nor, there were very different opinions as to whether the lake's changes demonstrated evidence of historical climate change, and whether this could be scaled up to the global, with both 'climate' and 'climate change' emerging as unstable categories.

Sven Hedin was firmly against the idea of changes within human history, and while he traced drastic local environmental shifts, cautioned that 'within historical times … that is at the most a period of 2,000 years, we can hardly suppose that any very great climatic changes have taken place'.[87] Hedin went on to conclude that 'the oscillations in the lake are entirely dependent upon chance hydrographical changes' driven by wind and 'it would be a grave mistake to attempt to harmonise these periodical variations either with the Brückner periods or with any other secular climatic changes in Central Asia'.[88] Aurel Stein was more ambivalent, explaining that, a 'shrinkage of the available water-supply has taken place in the Tarim Basin during historical times' which 'must be connected with a general desiccation period affecting the whole of Central Asia and probably most regions of the continent, if not of the whole earth'.[89] Stein nevertheless remained unsure about desiccation as a widespread trend. He acknowledged that 'these once cultivable areas have since the beginning of the fourth century A.D. become incapable of settled occupation' but that it would nevertheless 'be a mistake … to try and interpret developments in the history of the Tarim basin or of Central Asia in general, mainly by conjecturally determined changes of climate'.[90]

While Hedin opposed and Stein grappled with the complexities of climate change within recent human history, Ellsworth Huntington was meanwhile all in on encompassing deterministic explanations. Though he would later develop his grand (and deeply racist) environmentally determinist theories of 'energy', climate and 'civilisation' into a global vision, much of his formative work was done in Central Asia. Here Lop Nor was presented

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[86] D. Moon, 'The debate over climate change in the Steppe region in nineteenth-century Russia', *The Russian Review* **69** (2) (2010): 251.

[87] Hedin, *Scientific Results*, Vol. 2, p. 349.

[88] Ibid., p. 357.

[89] M.A. Stein, *Serindia* (Oxford: Oxford University Press, 1921), Vol. 1, p. 207.

[90] M.A. Stein, 'Innermost Asia: Its geography as a factor in history (continued)', *The Geographical Journal* **65** (6) (1925): 490.

by Huntington as a key piece of evidence in his apparent discovery of widespread desiccation. He argued that even 'Hedin, who utterly scouts the idea of any change of climate during historic times, recognizes that during certain periods Lop-Nor has been distinctly larger than it now'.[91] He went on to calculate that 'the fluctuations of Lop-Nor agree perfectly with the climatic pulsations of which we have found proof in other parts of the Lop basin and in Kashmir'.[92] Indeed, while Huntington had initially supported the idea of a progressive desiccation or drying up, he soon adopted a wider theory of climatic 'pulsations'. Here the varying levels of Lop Nor were presented as evidence, though Huntington did concede that 'the problem of its fluctuations is complicated' by the way the lake itself moved. He nevertheless went on to argue that 'from the third to the sixth century of our era, there seems to have been a time of intense aridity succeeding a period of relatively abundant moisture, during which the rivers and hence the population were much larger than at present'.[93] Huntington thus sought to place the variations of Lop Nor and the rise and fall of Loulan into a framework of 'civilisational' success and failure as determined by climate, which in turn could be expanded to a global picture that conveniently seemed to explain and justify European and Anglo-North American imperial dominance.

As well as among these imperial explorers, questions of desiccation were taken up by others, and Loulan and the many 'lost cities' of the Tarim basin became important to debates about climate change more widely – even as the weighting given to different mechanisms, from local shifts in wind patterns and humidity, to solar explanations and even the necessity of broader 'climatic' shifts to explain apparent changes remained in flux. Notable here was the polymathic Russian anarchist, scientist (and Prince) Peter Kropotkin, who presented a lecture at the RGS on 'The desiccation of Eur-Asia' in 1904. In this, after reflecting at length on the case of Lop Nor, he argued that 'recent exploration in Central Asia has yielded a considerable body of evidence, all tending to prove that the whole of that wide region is now, and has been since the beginning of historic record, in a state of rapid desiccation'.[94] Kropotkin went on to conclude in a deterministic vein that 'altogether it is quite certain that within historical times East Turkestan and Central Mongolia have not been the deserts they are now. They have had

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[91] Huntington, 'Lop-Nor – a Chinese lake. Part II', 142. See also Forêt, 'Climate change'.

[92] E. Huntington, *The Pulse of Asia* (Boston: Houghton Mifflin, 1907), pp. 292–93.

[93] Ibid., pp. 282–83.

[94] P. Kropotkin, 'The desiccation of Eur-Asia', *The Geographical Journal* **23** (6) (1904): 722. See also M. Davis, 'The coming desert: Kropotkin, Mars and the pulse of Asia', *New Left Review* **97** (2016): 23–43.

a numerous population, advanced in civilisation.'[95] Kropotkin also addressed parallel cases of hydrographical changeability including the Amu Darya, and here Lop Nor was drawn into broader debates, including the possible speed of desiccation and the local, regional and global character of alleged climatic shifts. Ultimately, at stake in these debates was the notion of climatic stability itself, and the attendant imperial anxieties this raised within the Russian Empire and beyond.[96]

Others would later be fiercely critical of these desiccation theories. For example, British officer Reginald Schomberg, who visited Central Asia in the 1920s and 1930s, insisted that natural variation in the rivers was responsible for the changing habitability, and hoped to lay to rest 'the ghost of the desiccation theory'.[97] The British geologist John Walter Gregory meanwhile remarked how 'that theory has been advocated by so many eminent Asiatic authorities' – in this list he included Kropotkin, Stein and Huntington – 'and it offers such a simple solution of many facts, and is so attractively interesting and dramatic, that it has naturally been popular and persistent'.[98] Gregory went on to note that it had, however, been rejected by other authorities, including Richthofen, Hedin and Berg, ultimately coming down against the idea that 'Central Asia is undergoing desiccation through a still progressive climatic change'.[99] Climatology would eventually move away from debates framed around cyclical and progressive desiccation, but the challenges of reconciling an insisted stability in the present with apparent changes in the past, and what this meant for stability in the future, would all play a key part in the new understandings of anthropogenic and planetary scale climate change that would eventually follow.

CONCLUSION

Towards the end of his life, Sven Hedin concluded that 'we have solved the Lop-nor problem, in so far as it can be solved at present, but the restless lake is no more permanently

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[95] Kropotkin, 'The desiccation', 723.

[96] For contemporary discussions, see J.W. Gregory, 'Is the Earth drying up?', *The Geographical Journal* **43** (2) (1914): 148–72. For these debates in the Russian context, see especially J. Oldfield and D. Shaw, *The Development of Russian Environmental Thought: Scientific and Geographical Perspectives on the Natural Environment* (London: Routledge, 2015).

[97] R. Schomberg, 'Alleged changes in the climate of Southern Turkistan', *The Geographical Journal* **80** (2) (1932): 140.

[98] C. Close et al., 'The climatic conditions of the Tarim Basin: Discussion', *The Geographical Journal* **75** (4) (1930): 321.

[99] Ibid.

established' than it had been at the time of Loulan.[100] He nevertheless demurred that 'as to the length of the period' of the pendulum swing: 'it is best to refrain from all prophecies'. At the same time, Hedin did not rule out human and technological intervention interrupting this cycle, reflecting that 'perhaps the Turkis will some day succeed in damming the river and forcing it back into its old bed'.[101] Indeed, Folke Bergman suggested that 'human activities' might have already been a factor in the resurrection of Lop Nor in 1921, and that new canals higher up the Tarim River 'were certainly not decisive but they may have accelerated the natural development, and in the eyes of the natives they have come to be regarded as the cause'.[102] Hedin meanwhile was happy to conclude that 'it will be reserved for a remote future to witness the next swing of the pendulum'.[103]

Here Hedin was wrong, and the story of Lop Nor has another twist in its tale: the lake over which so much imperial geographical debate and ink was spilt exists no more. Human interventions and exploitation of water resources – in particular, dams upstream – mean that Lop Nor no longer exists in either its southern or northern location. Indeed, the lake dried up again in the 1960s and has remained so since, with the diversion of water now exacerbated by the impacts of anthropogenic climate change shrinking the glaciers that feed the rivers of the Tarim basin.[104] Modern scientific work meanwhile continues to shed light on Lop Nor's peripatetic past, reconstructing the environmental conditions at the time Loulan thrived, as well as wider shifts across the Holocene. Here scholars have used paleoclimatic data to suggest 'that the Loulan kingdom flourished during a period of higher precipitation than today'.[105] Despite this apparently greater wetness, some scientists have argued that the drying up of Lop Nor and abandonment of Loulan was nevertheless a disaster caused mostly by humans.[106] The region has also been subjected to environmental degradation of another kind,

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[100] Hedin, *The Wandering Lake*, pp. 270–71.

[101] Ibid., pp. 271–72.

[102] Bergman, *Archaeological Researches*, p. 48.

[103] Hedin, *The Wandering Lake*, p. 272.

[104] Millward, 'Towards a Xinjiang environmental history', 298–99.

[105] K. Li et al., 'Oasis landscape of the ancient Loulan on the west bank of Lake Lop Nur, Northwest China, Inferred from vegetation utilization for architecture', *The Holocene* **29** (6) (2019): 1041.

[106] S. Mischke et al., 'The world's earliest Aral-Sea type disaster: The decline of the Loulan Kingdom in the Tarim Basin', *Scientific Reports* **7** (1) (2017): 43102, https://doi.org/10.1038/srep43102

with the Lop desert used for Chinese nuclear testing beginning in the 1960s. These tests have further altered the habitability of the region, albeit for different reasons.[107]

This article has traced some of the ways that romanticised geographical 'problems' like Lop Nor were leveraged by imperial geographers to a variety of ends. It has shown how these 'problems' were interpreted as provocations in propelling imperial investigations and the appropriations of land, landscapes and peoples. This was despite the way that knowledge of changing habitability around the turn of the twentieth century was made – and could only be made – by a diverse range of actors, drawing in multicultural historical records, intergenerational oral knowledge and contemporary Central Asian expertise and labour. These geographical appropriations were also heavily entangled with the development of imperial imaginaries of the 'Silk Roads'. All of these saw Lop Nor deployed as a key case study – alongside other regional hydrographical conundrums like the Aral Sea and Amu Darya – for questions of habitability and climatic stability, not only in geological time but also within recent human history. The Lop Nor 'problem' thus highlights evolving – and ultimately often irreconcilable – attitudes towards historical and future climate change at the turn of the twentieth century, and the way these definitions reflected geopolitical ambitions and anxieties, especially if stability could not be assumed. As in the stark imagery around the demise of Loulan, the Lop Nor case was also a reminder that habitability could be fragile, and the societal consequences of changing limits potentially catastrophic (even as imperial assessments continued to centre problematically deterministic explanations). Today, anthropogenic climate change increasingly threatens the habitability of Central Asia, and indeed many parts of the planet, in ways most early twentieth-century geographers could not have accounted for. Placing imperial debates about climatic stability into their historical contexts thus reveals that many of these questions are not new, but it is simultaneously a reminder of why their urgency is now greater than ever.

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[107] Ståhlberg and Svanberg, 'Loplyk fishermen', 436–37. On nuclear testing and habitability, see D.E. Nye and S. Elkind (eds), *The Anti-Landscape* (Leiden: Brill, 2014).