

The Riddle of the Sarasvati River

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In the *R̥gveda*, the Sarasvati is both a goddess and a river, and the only one to be deified in the Vedic hymns. Yet it disappeared in the post-Vedic era—the only major river to do so in northwest India. As it did, Sarasvati, the goddess of speech, knowledge and the arts, grew in stature and became one of the fountainheads of India’s classical civilization. Where was this river flowing and how did it come to occupy such a place in Indian culture?

Praised in the *R̥gveda* as a ‘mighty’ river flowing ‘from the mountain to the sea’ and listed in the *Nadī Stuti* hymn (10.75) between the Yamuna and the Sutlej, the Sarasvati is reported a few centuries later, in several Brāhmaṇas and the Mahābhārata (whose great war is waged in the Kurukshetra region watered by the river and its tributaries), to be disappearing in the desert at a point called Vinashana, a highly revered pilgrimage site. The river went on dwindling down, eventually becoming ‘mythical’, relocated at the confluence between Ganga and Yamuna as an ‘invisible’ river—a device that effectively preserved continuity of worship of the river-goddess, since from Vedic times Sarasvati had been turned into a goddess of inspiration and speech (Danino, 2010).

One persistent popular misconception is that the Sarasvati was ‘rediscovered’ by satellite imagery in the 1970s. As it happens, the date is wrong by over two centuries. As early as in 1760, a map from *The Library Atlas* (Bryce, Collier & Schmitz) showed a small stream, ‘Soorsuty’, joining the ‘Guggur’ in Punjab (Fig. 1). In 1778, James Rennell, a noted British geographer and cartographer, included in his *Memoir of a Map of Hindoostan or the Mogul Empire* the most detailed map of India then available; it showed ‘Sursooty’ meeting the ‘Caggar’ or ‘Kenker’. The Ghaggar, as it is spelt today, is a seasonal river flowing down from the Shivalik hills; one of its tributaries is indeed a small seasonal stream called ‘Sarsuti’. During strong monsoons (as in 2010), the Ghaggar still manages to flow well into Punjab; there is historical evidence that in the 19th century, it occasionally reached Anupgarh, close to the present Indo–Pakistan border (at which point the river’s name changes to ‘Hakra’).

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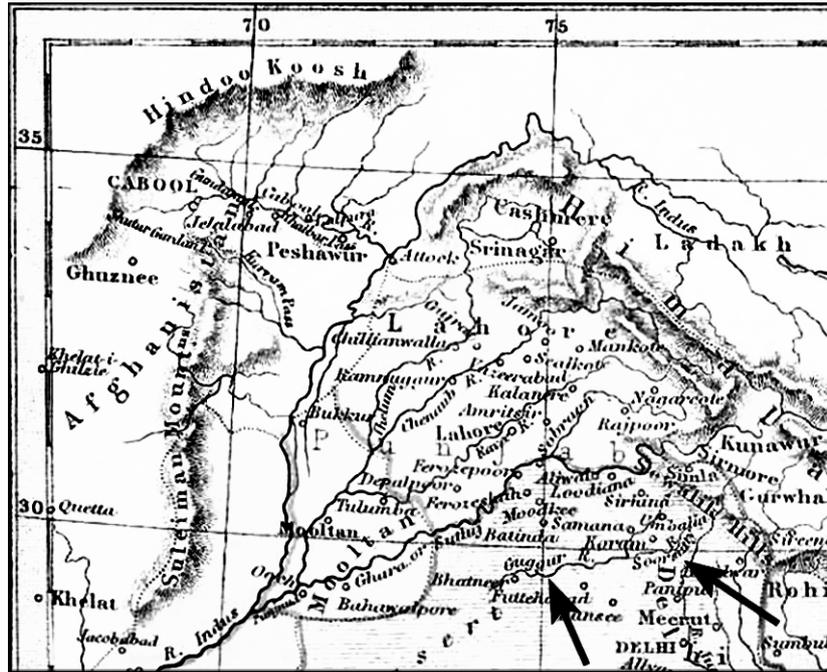


Fig. 1 The Sarasvati and the Ghaggar marked by the two arrows in this detail of a 1760 British map. (Courtesy Prof. Frances Pritchett of Columbia University, www.columbia.edu/itc/mealac/pritchett/00maplinks/colonial/india1760/india1760.html).

In the next century, British topographers—among them James Tod (in the 1810s), Major Colvin (in 1833) and Major F. Mackeson (in 1844)—surveyed the bed of the Ghaggar and found it far wider than the paltry waters it carried during monsoons would have required. Those early maps and reports soon reached the noted French geographer Louis Vivien de Saint-Martin, who noticed the corrupt spelling of Sarasvati as well as the Ghaggar’s location between the Yamuna and the Sutlej, as indicated in the *R̥gveda*; combining physical and literary evidences, he was the first scholar to propose, in 1855, that the Ghaggar-Sarasvati system was the relic of the Vedic Sarasvati:

The trace of the ancient riverbed was recently found, still quite recognizable, and was followed far to the west. [This discovery] confirmed the correctness of the tradition (Vivien de Saint-Martin, 1858: 23).

In the next few decades, nearly all Indologists, from H.H. Wilson and F. Max Müller to M. Monier-Williams, A.A. Macdonell, A.B. Keith or F.E. Pargiter, and more recently L. Renou, A.L. Basham or Jan Gonda, accepted Vivien de Saint-Martin’s thesis (Danino, 2010). Geologists such as R.D. Oldham (1886) joined in, followed by geographers such as Shamsul Islam Siddiqi (1944) or Herbert Wilhelmy (1969).

This broad scholarly consensus was reflected in nearly all British maps of the nineteenth century (Figs 2 & 3). Fig. 3 is a detail of a map in Alexander Cunningham's monumental *Ancient Geography of India*, in which he combined data from ancient Indian and Greek texts with the testimonies of Chinese pilgrims to India. The same year, 1871, Cunningham was nominated first director general of the ten-year-old Archaeological Survey of India. And it is indeed the discipline of archaeology that will give, seventy years later, an unexpected twist to the saga of the lost river.

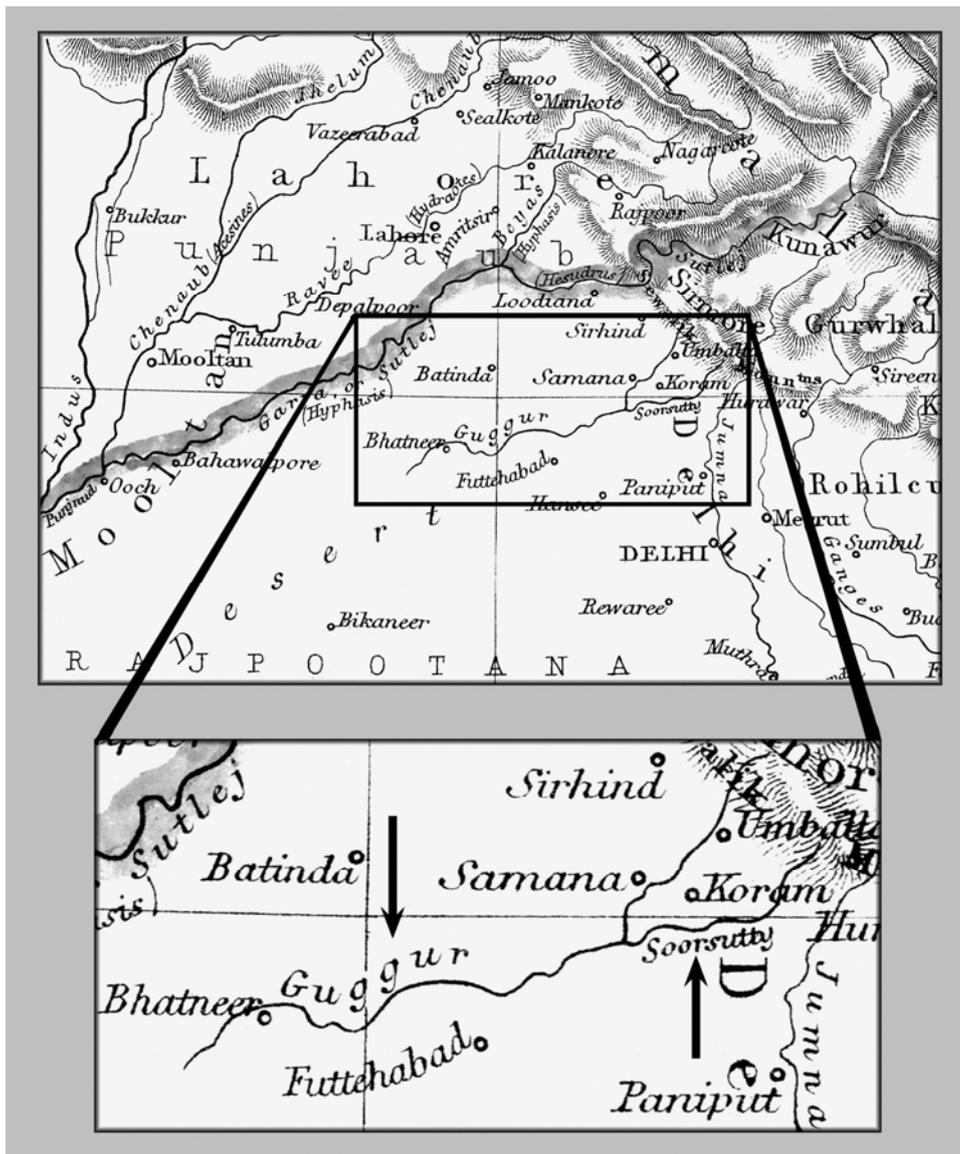


Fig. 2. Detail from a British map of India (from Henry Beveridge, *A Comprehensive History of India, Civil, Military, and Social*, Blackie & Son, London, 1862).

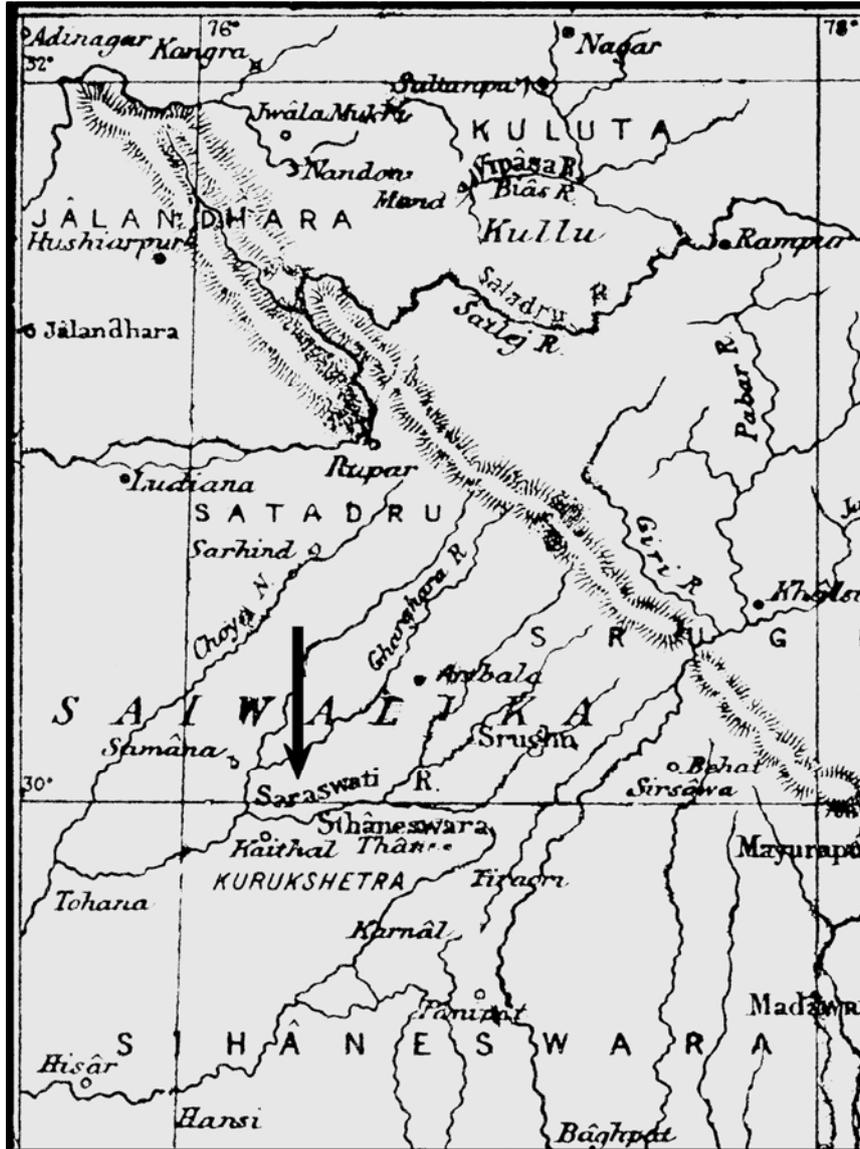


Fig. 3. Detail of Cunningham's map (1871) showing the Sarasvati and neighbouring rivers.

The Sarasvati and the Indus Civilization

The riddle of the Sarasvati would have been regarded as solved long ago if archaeology had not sprung a major surprise by redefining its role in antiquity. In the early 1920s, the Bronze Age cities of Harappa and Mohenjo-daro came to light, soon followed by more settlements of the same culture in the Indus Valley and Baluchistan. In 1941, the intrepid explorer and Sanskritist Marc Aurel Stein conducted at the age of 78 an expedition in the then Bikaner and Bahawalpur states; the former is now part of northern Rajasthan, while the latter, today's Cholistan, is an arid region of Pakistan and technically part of the Thar Desert.

Stein was keen to find out whether the Harappan civilization extended to this region anciently watered by the Sarasvati—for he was among those who had accepted the identification between the Vedic river and the Ghaggar (which continues into Cholistan under the name of ‘Hakra’), as an early paper of his makes quite clear (Stein, 1917). The region had long been known to be dotted with numerous ruined settlements, and, crisscrossing it on horse and camel back, Stein recognized Harappan culture in several of them (Stein, 1942, 1989): apart from similar pottery types, some of the pottery sherds displayed ‘incised characters which appear on many inscribed seals from Mohenjo-daro and Harappa’. The Ghaggar–Hakra, in Stein’s opinion, was home to ‘very numerous prehistoric mounds’ (Stein 1942: 180)—that is, going back to the Harappan age.



Fig. 4. A view of Kalibangan’s mounds from the Ghaggar’s bed (photo taken during A. Ghosh’s expedition of 1950, courtesy Archaeological Survey of India).

Indeed, in the following decades, further explorations (Fig. 4) took place both in India and Pakistan: in 1951, Amalananda Ghosh identified Harappan culture at Kalibangan and several other sites further upstream; among his followers are Katy F. Dalal, Suraj Bhan, Jagat Pati Joshi, M. Rafique Mughal, R.S. Bisht.... In Cholistan, M. Rafique Mughal identified 363 new sites in 1974, 171 of which belonged to the Mature (or urban) Harappan phase (2600–1900 BCE). All these surveys put together established that the Sarasvati basin was home to at least 360 sites of the Mature—almost a third of the nearly 1,200 known such sites in the totality of the Harappan sphere. Among the

larger Harappan cities found in the Ghaggar-Hakra basin are Bhirrana, Rakhigarhi, Kunal or Banawali (all in Haryana), Kalibangan (Rajasthan) or Ganweriwala (Cholistan) (Fig. 5 and Table 1; recent surveys by Vivek Dangi, Narender Parmar, Parveen Kumar and Raj Pal in Haryana, Punjab and northern Rajasthan have added a few dozens of sites since this table was prepared).

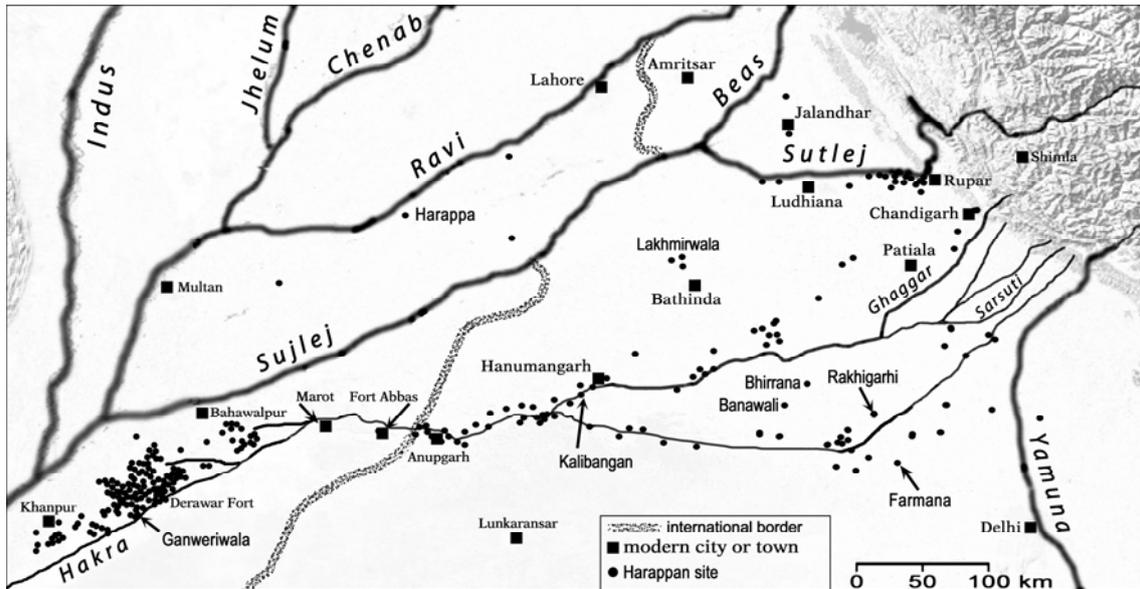


Fig. 5. Mature Harappan sites in the Sarasvati basin (map by Michel Danino).

Sarasvati Basin (east to west)	Early Harappan	Mature Harappan	Late Harappan	Total
Haryana	558	114	1168	1840
Indian Punjab	24	41	160	225
Rajasthan	18	31	0	49
Cholistan (Pakistan)	40	174	50	264
Total	640	360	1378	2378

Table 1. Distribution of Harappan sites in the Sarasvati basin (Michel Danino, adapted from a list compiled by S.P. Gupta, with inputs from G. Possehl and M. Rafique Mughal).

Since the Sarasvati, it was now clear, had nurtured the ‘Indus’ civilization as much as had the Indus, a few archaeologists, beginning with S.P. Gupta in 1989, have proposed the broader term of ‘Indus–Sarasvati civilization’. (It does not, however, cover

all Harappan sites, since Gujarat is also host to some 300 Mature Harappan sites, most of which cannot be said to be in the Sarasvati basin.) For reasons that will become clear in the next section, the term did not really catch on, but the Ghaggar-Hakra's identity as the Sarasvati's relic was accepted by most archaeologists after Stein, including the British M. Wheeler (1968), R. and B. Allchin (1997) and J. McIntosh (2002, 2008), the American G.L. Possehl (1999, 2002) and J.M. Kenoyer (1998), the French J.-M. Casal (1969), the Pakistani A.H. Dani (in Mughal 1997: 11, 12), the Indian A. Ghosh (1952), B.B. Lal (1997, 2002, 2009), S.P. Gupta (1996), V.N. Misra (1994) or Dilip Chakrabarti (2006, 2009).

The Sarasvati and the Aryan Issue

Despite the broad consensus, a few scholars such as Romila Thapar, Irfan Habib, Shereen Ratnagar, Suraj Bhan or the late R.S. Sharma started in the 1980s questioning this term and the identification between Ghaggar and Sarasvati. What prompted this *a posteriori* reaction? The pattern of settlements in the Sarasvati basin now revealed that in its central part—roughly southwest Haryana, southern Punjab and northern Rajasthan—most Harappan sites were abandoned sometime around 1900 BCE, a period coinciding with the end of the urban phase of the Indus civilization (Fig. 6). Clearly, the river system collapsed—which archaeologists now see as a contributing factor in the decline of the brilliant Indus civilization.

Why was this a problem? We must remember that the Sarasvati is lavishly praised, both as a river and a goddess, in the *R̥gveda*, a collection of hymns which mainstream Indology says was composed by Indo-Aryans shortly after their migration to India around 1500 BCE. However, by that time, the Sarasvati had been reduced to a minor seasonal stream: how then could the said Aryans praise it as a 'mighty river', the 'best of rivers', 'mother of waters', etc.? There is a chronological impossibility. Either the hymns were composed much earlier, contradicting mainstream Indology, or, as the objectors now asserted, the Ghaggar-Hakra was not, after all, the Sarasvati extolled in the *R̥gveda*.

While some of the objectors, such as Rajesh Kochhar (2000) tried to relocate the river in Afghanistan, others like Irfan Habib (2000–01) decided that the Sarasvati was not a particular river, but 'the river in the abstract, the River Goddess'—in other words, a 'mythical' river. But such theses ran against both the *R̥gveda*'s own testimony that the river flowed between the Yamuna and the Sutlej, and the realistic descriptions of the river's disappearance in the sands of the desert in subsequent literature such as the

Brāhmaṇas or the Mahābhārata, with Vinashana given great prominence among pilgrimage sites.

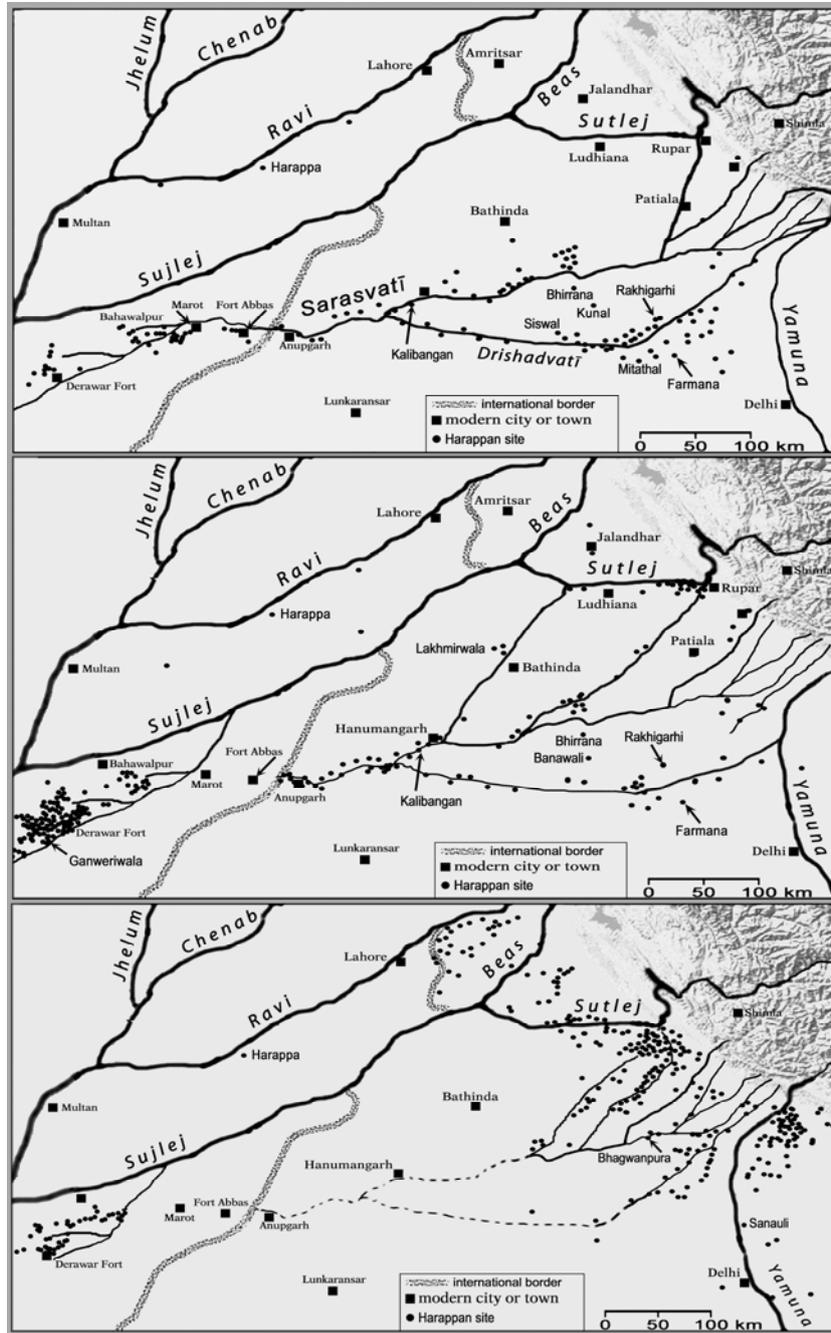


Fig. 6. Settlement pattern in the Sarasvati basin, clearly showing the abandonment of sites in the central basin from about 1900 BCE (maps by Michel Danino).

However, what should have remained a scholarly issue now turned into an ideological and often acrimonious battle: On the one hand, those who stuck to the

identity between the Sarasvati and the Ghaggar-Hakra concluded that the composers of the Rig-Vedic hymns must have lived in the region during the 3rd millennium BCE at the latest—but as the only settlements known of that period were Harappan ones, they often held that the Harappans were among the Vedic people; cultural evidence such as a Harappan swastika, yogic postures, figurines in *namaste* and more was pressed into service to bridge the Harappan and the Vedic worlds (Danino, 2010; Lal, 2002). On the other hand, scholars who continued to swear by an Aryan immigration in the mid-2nd millennium BCE, and therefore a pre-Vedic Harappan civilization, accused the former of ‘chauvinism’, ‘jingoism’, ‘false patriotism’ or worse, concealing that dozens of Western scholars had, for a century and a half, accepted the same location and identity for the Sarasvati river.

This negationist attitude is all the more bizarre as some of the above objectors (e.g. Thapar, Ratnagar, Bhan) had quite happily accepted the identity between the Ghaggar and the Sarasvati before the date of the latter’s desiccation became clear in the 1980s (see Danino 2010 for details).

Recent Research on the Sarasvati

Leaving aside the controversy, several scientific disciplines now have their say. Since the 1970s, satellite imagery has proved to be a very useful tool, although by itself it cannot date the numerous buried palaeochannels (ancient waterways) it has brought to light; anyone can today access websites such as Google Earth and view the well-marked bed of the Ghaggar, but this does not tell us when a perennial river last flowed through it, how large it was, and where it drew its waters from. Many satellite studies have been published (to mention only a few recent ones, Bhadra et al., 2009; Danino, 2010: 66–73; Gupta et al., 2011, Rajani & Rajawat, 2011) and I will not go over them again here.

I will instead focus on recent geology and river studies, several of which have thrown new light on the ancient river, though at times with contradictory findings. Thus, in a 2011 article published in *Science*, Andrew Lawler claimed that ‘the Ghaggar-Hakra was at most a modest seasonal stream ... from 2500 B.C.E. to 1900 B.C.E.’ (Lawler, 2011), that is, at the height of the Harappan civilization. This ran against the notion of a substantial and perennial Sarasvati flowing during mature Harappan times. Lawler referred to independent studies piloted by geologists Sanjeev Gupta, Peter Clift (both from U.K.), and Hideaki Maemoku (Japan), which appeared to suggest that the river had largely dried up long before Harappan times.

Lawler's verdict was hasty as well as inaccurate. Two years earlier, Clift had noted that 'between 2000 and 3000 BCE, flow along a presently driedup course known as the Ghaggar-Hakkra River ceased, probably driven by the weakening monsoon and possibly also because of headwater capture into the adjacent Yamuna and Sutlej Rivers' (Clift, 2009). Then, in 2012, Clift's multi-national team dated zircon sand grains from trenches and drilled cores at four sites in Cholistan (the U-Pb dating method they used is a standard one that measures variations in the ratios of isotopes of uranium and lead to date the formation of rocks over millions or even billions of years). By comparing the zircon grains with those from other regions, the geologists concluded that the Yamuna once flowed into the Ghaggar-Hakra, as had often been suggested since the late nineteenth century, but switched eastward tens of thousands of years ago; the Sutlej also contributed to the Ghaggar system but abandoned it 10,000 years ago or earlier. As a result, any drainage capture affecting the Ghaggar system 'appears to have occurred prior to human settlement and not to have directly caused the Harappan collapse' (Clift et al., 2012). Being limited to samples from Cholistan, the paper had to remain non-committal about the time when the Ghaggar itself dried up.

The same year, a study by a team of geoscientists under the direction of Liviu Giosan (with most of its members drawn from the previous study's team) reached slightly more precise conclusions. It rejected the possibility that 'large glacier-fed Himalayan river watered the Harappan heartland on the interfluvium between the Indus and Ganges basins'; rather, in its view, 'only monsoonal-fed rivers were active there during the Holocene' (that is, the last 10,000 years or so). In particular, 'rivers were undoubtedly active in this region during the Urban Harappan Phase'. Indeed, the geoscientists found 'sandy fluvial deposits approximately 5,400 [years] old at Fort Abbas in Pakistan [in Cholistan], and recent work on the upper Ghaggar-Hakra interfluvium in India also documented Holocene channel sands that are approximately 4,300 [years] old.' (Giosan et al., 2012) In a later comment on the paper, Giosan clarified, 'Our research points to a perennial monsoonal-fed Sarasvati river system with benign floods along its course' (Giosan et al., 2013). The Ghaggar-Hakra was thus active during the urban Harappan period, although apparently not (or no longer) fed by glacial sources; it was a monsoon-fed river, like rivers of central or southern India: 'Reliable monsoon rains were able to sustain perennial rivers earlier during the Holocene, [which] explains why Harappan settlements flourished along the entire Ghaggar-Hakra system without access to a glacier-fed river' (Giosan et al., 2012).

The last point remains an object of debate among geologists, with several Indian ones maintaining that the Ghaggar system did have contributions from Himalayan

glaciers (Puri & Varma, 1998; Valdiya, 2002, 2013; Puri, 2001, 2008). We must leave it to them—or, more likely, to the accumulation of new data—to settle the issue. What matters, for the moment, is the acknowledgement of a perennial Ghaggar’s role in sustaining numerous Harappan urban settlements, and the coincidence between its dwindling down and the withdrawal of Harappan sites from its central basin.

This is further supported by a 2009 study by H.S. Saini et al., which studied buried channels in the northwestern Haryana Plains and documented ‘the existence of channel activity during the mid-Holocene ... in a part of the Haryana plains’; by mid-Holocene is meant a ‘second fluvial phase ... represented by a palaeochannel segment whose signatures are dated between ~ 6.0 and ~ 2.9 Ka’ (Saini et al., 2009), after which a depleted Ghaggar was left. The dates bracket the Indus civilization.

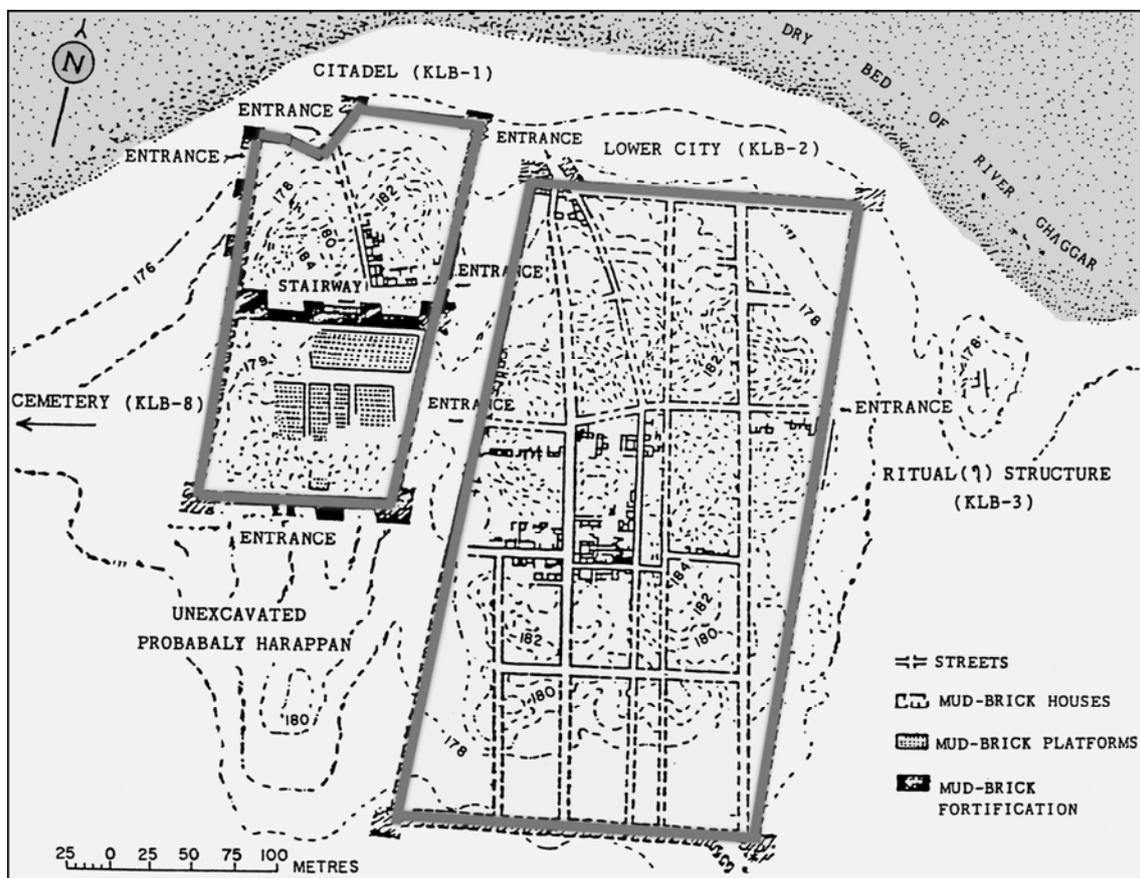


Fig. 7. Plan of Kalibangan (adapted from Archaeological Survey of India).

Finally, a 2013 study directed by the Indian geologist Rajiv Sinha, which mapped palaeo-river sedimentary bodies in the subsurface by measuring their electrical resistivity, since water-bearing sediments having a lower resistivity than dry ones. The

study offered ‘the first stratigraphic evidence that a palaeochannel exists in the subsurface alluvium in the Ghaggar valley. The fact that the major urban sites of Kalibangan [Fig. 7] and Kunal lie adjacent to the newly discovered subsurface fluvial channel body ... suggests that there may be a spatial relationship between the Ghaggar-Hakra palaeochannel and Harappan site distribution’ (Sinha et al., 2013).

Such a conclusion had been reached by archaeologists much earlier, since Kalibangan, for instance, shows no evidence of independent water supply; unlike Mohenjo-daro, it had very few wells, and unlike Dholavira, no reservoirs, yet it was continually occupied for several centuries: for its water supply through the year, it must therefore have depended on the Sarasvati, on whose left bank it lay, with entries into its fortified enclosures facing the riverbed. Banawali and Bhirrana, too, were built right on the river’s bank. Why should the technology-savvy Harappans have taken so much trouble to build cities right on the edge of dried-up rivers (Fig. 7)?

In fact, noticing a break in the settlement pattern in Cholistan, close to the international border (visible on Fig. 6 above, central portion), M. Rafique Mughal suggested in 1993 that the river, which was ‘a perennial river through all its course in Bahawalpur during the fourth millennium B.C. (Hakra Period) and the early third millennium B.C. (Early Harappan Period)’ (Mughal, 1993: 94), lost a channel from the Sutlej in the west and, in the east, the Chautang (or Drishadvati) to the Yamuna system. This, in his estimate, happened between the Early and Mature phases, that is, around 2600 BCE.

Archaeology and geological studies thus appear to converge in depicting an already depleted Ghaggar or Sarasvati during the Mature Harappan phase. Besides, palaeoclimatic studies have in recent years pointed to a weakening of the Indian summer monsoon from 2200 BCE onward (for a survey, see Danino, 2015). It seems clear that the long drought that followed contributed to the final break-up of the Sarasvati, although other causes such as river dynamics and tectonics cannot, at this stage, be ruled out.

As regards the ‘controversy’ surrounding the Vedic river, allowing for some metaphorical inflation in the Vedic hymns, nothing in the recent research contradicts the river’s break-up and gradual extinction as recorded in India’s ancient literature. We are thus back to the original problem: If we accept the Vedic hymns’ description of a river flowing from the mountain to the sea and located between the Yamuna and the Sutlej, the Ghaggar remains the sole candidate; but as we now know, this description can only

apply to the 3rd millennium BCE or earlier, an epoch that does not fit with the conventional scenario of a 2nd-millennium Aryan migration into India.

From Sarasvati to Ganga

In the meantime, two lessons flow from the river's disappearance. The first is that it forced migrations of Harappans in several directions, in particular eastward, crossing Ganga and mingling with agrarian communities long established in the Gangetic plains. The Late Harappans, as they are called, reverted to rural lifestyles but carried some of their culture with them, which explains the transmission of a host Harappan cultural features, symbols, practices and technologies to the later Ganga-Vindhya civilization. Besides, Indological studies have shown that the Sarasvati's sacredness and her attributes as a goddess were transmitted to Ganga in the course of centuries.

Secondly, it is now clear that climatic and environmental disruptions played a major part in the break-up of the Indus civilization. No one can deny anymore that we are now undergoing another major climatic change; a just published study predicts that at least 70 per cent of the volume of Himalayan glaciers in the Everest region may disappear by the end of this century. With human interference (deforestation, excessive damming, etc.) compounding the problem, there have been warnings that Ganga and the Brahmaputra may turn into seasonal rivers even before. This may spell the end of the 3,000-year-old Ganges civilization in its mother-region. We must hope that mitigating steps will be urgently taken to save Ganga from becoming another Sarasvati.

References

- Allchin, Raymond & Bridget, *Origins of a Civilization: The Prehistory and Early Archaeology of South Asia*, Viking, New Delhi, 1997.
- Bhadra, B.K., A.K. Gupta & J.R. Sharma, 'Sarasvati Nadi in Haryana and its Linkage with the Vedic Sarasvati River: Integrated Study Based on Satellite Images and Ground Based Information', *Journal Geological Society of India*, vol.73, February 2009, pp. 273-288.
- Casal, Jean-Marie, *La civilisation de l'Indus et ses énigmes*, Fayard, Paris, 1969.
- Chakrabarti, Dilip K., *The Oxford Companion to Indian Archaeology: The Archaeological Foundations of Ancient India*, Oxford University Press, New Delhi, 2006.
- Chakrabarti, Dilip K., & Sukhdev Saini, *The Problem of the Sarasvati River and Notes on the Archaeological Geography of Haryana and Indian Panjab*, Aryan Books International, New Delhi, 2009.

- Clift, Peter, 'Harappan Collapse', *Geoscientist*, vol. 19, no. 9, September 2009, pp. 18–22.
- Clift, Peter D., A. Carter, L. Giosan, J. Durcan, G.A.T. Duller, M.G. Macklin, A. Alizai, A.R. Tabrez, M. Danish, S. VanLaningham, & D.Q. Fuller, 'U-Pb zircon dating evidence for a Pleistocene Sarasvati River and capture of the Yamuna River', *Geology*, 40(3), 02/2012, pp. 212-215.
- Cunningham, Alexander, *The Ancient Geography of India*, Trübner & Co., London, 1871; 2nd revised edn, Calcutta, 1924 (reprint Munshiram Manoharlal, New Delhi, 2002).
- Danino, Michel, *The Lost River: On the Trail of the Sarasvati*, Penguin Books, New Delhi, 2010.
- Danino, Michel, 'Climate and Environment in the Indus-Sarasvati Civilization', in *Ratnaśrī: Gleanings from Indian Archaeology, Art History and Indology* (Papers Presented in Memory of Dr. N.R. Banerjee), Arundhati Banerji, (ed.), Kaveri Books, New Delhi, 2015, pp. 39–47.
- Ghosh, A., 'The Rajputana Desert: Its Archaeological Aspect', in *Bulletin of the National Institute of Sciences in India*, 1952, vol. I, pp. 37–42, reproduced in Stein, 1989, pp. 98–106.
- Giosan, Liviu, P.D. Clift, M.G. Macklin, D.Q. Fuller, S. Constantinescu, J.A. Durcan, T. Stevens, G.A.T. Duller, A.R. Tabrez, K. Gangal, R. Adhikari, A. Alizai, F. Filip, S. VanLaningham, & J.P.M. Syvitski, 'Fluvial landscapes of the Harappan civilization', *Proceedings of the National Academy of Sciences*, vol. 109, no. 26, E1688–E1694, published online May 29, 2012.
- Giosan, Liviu, Peter D. Clift, Mark G. Macklin, Dorian Q. Fuller. 2013. 'Sarasvati II', *Current Science*, 105(7), pp. 888–810.
- Gupta, S.P., *The Indus–Sarasvatī Civilization: Origins, Problems and Issues*, Pratibha Prakashan, Delhi, 1996.
- Gupta, A.K., J.R. Sharma & G. Sreenivasan, 'Using satellite imagery to reveal the course of an extinct river below the Thar Desert in the Indo-Pak region', *International Journal of Remote Sensing*, vol. 32, no. 18, 2011, pp. 5197–5216.
- Habib, Irfan, 'Imagining River Sarasvati: A Defence of Commonsense', *Proceedings of the Indian History Congress*, 61st session, Kolkata, 2000–01, pp. 67–92, reproduced in *Social Scientist*, V.29, no. 1–2, January–February 2001, #332–333, pp. 46 ff.
- Kenoyer, Jonathan Mark, *Ancient Cities of the Indus Valley Civilization*, Oxford University Press & American Institute of Pakistan Studies, Karachi & Islamabad, 1998.
- Kochhar, Rajesh, *The Vedic People: Their History and Geography*, Orient Longman, Hyderabad, 2000
- Lal, B.B., *The Earliest Civilization of South Asia*, Aryan Books International, New Delhi, 1997.
- Lal, B.B., *The Sarasvatī Flows On: the Continuity of Indian Culture*, Aryan Books International, New Delhi, 2002.

- Lal, B.B., *How Deep Are the Roots of Indian Civilization? Archaeology Answers*, Aryan Books International, New Delhi, 2009.
- Lawler, Andrew, 'In Indus Times, the River Didn't Run Through It', *Science*, vol. 332, 1st April 2011, p. 23.
- McIntosh, Jane R., *A Peaceful Realm: the Rise and Fall of the Indus Civilization*, Westview Press, Boulder, 2002
- McIntosh, Jane R., *The Ancient Indus Valley: New Perspectives*, ABC-Clio, Santa Barbara, 2008
- Misra, V.N., 'Indus Civilization and the Rgvedic Sarasvatī', in *South Asian Archaeology 1993*, Parpola, Asko, & Petteri Koskikallio, (eds), Suomalainen Tiedeakatemia, Helsinki, vol. II, 1994, pp. 511–525.
- Mughal, M. Rafique, *Ancient Cholistan: Archaeology and Architecture*, Ferozsons, Lahore, 1997.
- Mughal, M. Rafique, 'Recent Archaeological Research in the Cholistan Desert', in Gregory L. Possehl, (ed.), *Harappan Civilization: A Recent Perspective*, 2nd edn, Oxford & IBH, New Delhi, 1993, pp. 85–95.
- Oldham, R.D., 'On Probable Changes in the Geography of the Punjab and Its Rivers: An Historico-Geographical Study', *Journal of Asiatic Society of Bengal*, vol. 55, 1886, pp. 322–43.
- Possehl, Gregory L., *Indus Age: The Beginnings*, Oxford & IBH, New Delhi, 1999.
- Possehl, Gregory L., *The Indus Civilization: A Contemporary Perspective*, Altamira Press, Oxford, 2002; Indian edn, Vistaar, New Delhi, 2003.
- Puri, V.M.K. & B.C. Varma, 'Glaciological and geological source of Vedic Saraswati in the Himalayas', *Itihas Darpan*, vol. 4, no. 2, 1998, pp. 7–36.
- Puri, V.M.K., 'Origin and course of Vedic Saraswati river in Himalaya – its secular desiccation episodes as deciphered from palaeo-glaciation and geomorphological signatures', Geological Survey of India, Special Publication, 2001, no. 53, 175–191.
- Puri, V.M.K., 'Vedic Saraswati: Scientific Signatures on Its Origin from the Himalaya', in S. Kalyanaraman, (ed.), *Vedic River Saraswati and Hindu Civilization*, Aryan Books International, New Delhi, 2008, pp. 14–35.
- Rajani, M.B. & A.S. Rajawat, 'Potential of satellite based sensors for studying distribution of archaeological sites along palaeo channels: Harappan sites a case study', *Journal of Archaeological Science* 38 (2011), pp. 2010–2016.
- Rennel, James, *Memoir of a Map of Hindoostan; or the Moghul Empire*, London, 1788.
- Siddiqi, Shamsul Islam, 'River Changes in the Ghaggar Plain', *The Indian Geographical Journal*, vol. 19, no. 4, 1944, pp. 139–46.

- Saini, H.S., S.K. Tandon, S.A.I. Mujtaba, N.C. Pant and R. K. Khorana. 2009. "Reconstruction of buried channel-floodplain systems of the northwestern Haryana Plains and their relation to the 'Vedic' Saraswati," *Current Science*, 97(11), pp. 1634–43.
- Shea, J.M., W.W. Immerzeel, P. Wagnon, C. Vincent & S. Bajracharya, 'Modelling glacier change in the Everest region, Nepal Himalaya', *The Cryosphere*, 9, 2015, pp. 1105–1128.
- Sinha, Rajiv, G.S. Yadav, Sanjeev Gupta, Ajit Singh, S.K. Lahiri, 'Geo-electric resistivity evidence for subsurface palaeochannel systems adjacent to Harappan sites in northwest India', *Quaternary International*, vols 308–309, 2 October 2013, pp. 66–75.
- Stein, Aurel, 'On Some River Names in the Rigveda', *Journal of the Royal Asiatic Society*, 1917, pp. 91–99.
- Stein, Marc Aurel, 'A Survey of Ancient Sites along the "Lost" Sarasvatī River', *The Geographical Journal*, vol. 99, 1942, pp. 173–182.
- Stein, Marc Aurel, *An Archaeological Tour along the Ghaggar–Hakra River*, S.P., Gupta, (ed.), Kusumanjali Prakashan, Meerut, 1989.
- Valdiya, K.S., *Saraswati, The River That Disappeared*, Indian Space Research Organization & Universities Press, Hyderabad, 2002.
- Valdiya, K.S., 'The River Saraswati was a Himalayan-born river', *Current Science*, 104(1), 10 January 2013, pp. 42–54.
- Vivien de Saint-Martin, Louis, *Étude sur la Géographie Grecque et Latine de l'Inde and Mémoire Analytique sur la Carte de l'Asie Centrale et de l'Inde*, Imprimerie Impériale, Paris, 1858.
- Wheeler, Mortimer, *The Indus Civilization*, 3rd edn, Cambridge University Press, Cambridge, 1968.
- Wilhelmy, Herbert, 'The Ancient River Valley on the Eastern Border of the Indus Plain and the Sarasvatī Problem', in B.P. Radhakrishna & S.S. Merh, (eds), *Vedic Sarasvatī: Evolutionary History of a Lost River of Northwestern India*, Geological Society of India, Bangalore, 1999, pp. 95–111 (partial English translation of 'Das Urstromtal am Ostrand der Indusebene und das Sarasvatī Problem', in *Zeitschrift für Geomorphologie*, N.F. Supplementband 8, 1969, pp. 76–93).
