fishes. While the dolphin awareness programmes are already at work along Ganga river, we appeal to the Government and other concerned agencies to extend the programmes to tributaries of the Ganges in order to save the dolphins in these regions as well. Saving the life of a single dolphin, if it happens to be a female, can increase their numbers by 4–5 individuals.

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Sarasvati II

Current Science published an article by Valdiya[1] that is a long rebuttal of our study[2] published in *PNAS* in 2012 on the 'Fluvial landscapes of the Harappan civilization'. We will respond nevertheless to the challenge and its follow-up[3], although we were surprised that Valdiya did not submit his rebuttal to *PNAS* and would have preferred that his contributions focused on scientific issues only[4,5].

We thank Valdiya for his apology for his misattributions of text and opinion, but find his reply[3] to be insufficient as it is mostly dedicated to the perpetuation of an error, namely that we somehow ignored Indian contributions to the topic. Keeping in mind publication space restrictions, we did select relevant work but the selection criteria did not include the nationality of the authors! For the record, where Valdiya[3] finds only 3 papers by Indian authors we count 11 and these include a collection of 27 studies by Indian scientists.

In this letter we assess if Valdiya's article provides new and/or uncovers old evidence to seriously challenge our scholarship (Table 1). His critique primarily addresses one of the problems pursued in our original work: Did a glacier-fed Himalayan river, identified by some with the mythical Sarasvati, flow along the interfluve between the modern courses of Sutlej and Yamuna and, if yes, when?

For the sake of this discussion let us call the large perennial river system that was once active on the Sutlej–Yamuna (S–Y) interfluve Sarasvati, as we agree that this is the most likely location for the mythical river. Nobody would disagree with the need for more studies on the hydrogeology, eolian activity, tectonics, near-surface geology and geophysics, mineralogy, etc. of the S–Y interfluve and adjacent regions, as suggested by Valdiya, provided that such studies would have solid spatial and temporal information. For example, we see the high value of hydrogeological studies to expand pioneering work by, for example, Rao[6], and Geyh and Ploethner[7], which suggests that old groundwater on the S–Y interfluve and under the dunes of the Thar Desert has a probable lowland pluvial origin rather than Himalayan.

We also agree with Valdiya that climate is not the only forcing factor affecting rivers and people living along them, nor is it always dominant. However, for now, climate change provides a full and relatively well-supported explanation for disappearance of the Sarasvati, while no proposed theory for its capture that is based on either tectonic or morphodynamic causes has gathered enough evidence to be credible. Most importantly, these theories lack precise chronologies on well-documented outcrops and/or cores. So far there are no studies to link Himalayan rivers to their purported extension on the S–Y interfluve that have a reliable chronology for the time of interest (Holocene). References provided by Valdiya that we already consulted for our study do not unfortunately seem to change this state of affairs. Furthermore, where such chronologies exist or are being developed, downstream along the former palaeochannels of the S–Y interfluve, results are consistent with our data and interpretation. For example, luminescence dates presented by Gupta and colleagues indicate that the palaeochannel traced to the Sutlej[8,9] is much older than the Harappan era. New provenance work[10] supports our previous contention[11] that the other possible Himalayan source for Sarasvati, the Yamuna, has flown to the east during the Holocene. This is in accordance with our Cholistan data and upstream data from Saini *et al.*[12] and Saini and Mujtaba[13], which indicate that the river activity changed drastically on the S–Y interfluve well before Harappan times.

Our main geomorphological argument for a non-Himalayan Sarasvati is simple: the lack of wide incised valleys on the S–Y interfluve similar to the valleys of the Indus, Ganga, Yamuna and all Himalayan tributaries of the Indus, including Ravi, which is the smallest (see also Maemoku *et al.*[14]). Such large-scale features cannot be completely covered by wind along their entire course as argued by Valdiya; in fact, the much narrower Ghaggar incision (see figure 1 in our *PNAS* paper[2]) is still easily recognizable even at the edge of the Thar Desert. New data on dunes on both sides on the Ghaggar and Chautang courses show that they started to develop well before Harappan times, are continuing to do so today[14] and yet they leave intact channel traces visible on satellite imagery. A multitude of papers use interpretations of

Table 1. Valdiya's challenges, their relevance, and our main refutation arguments

Challenge	General relevance	Spatial scale relevance	Temporal scale/ chronology relevance	Water/ sediment source relevance	Relevant references	Refutation
Modern groundwater elevation	Somewhat	Yes	No	No	No	Composition of groundwater suggests non-Himalayan source
River capture/course changes	Yes	Yes	No	Yes	Yes	Lacks chronologies; adverse fluvial activity chronologies (see below)
Eolian filling of incised valleys	Yes	No	Yes	Yes	Yes	Contradicted by remnant incisions, dates on dunes, large-scale patterns
Large multiple-channel sand bodies	Yes	Yes	No	Yes	Yes	Chronologies and facies refutation; composition alone not diagnostic (Holocene deposits could be reworked using Pleistocene Himalayan sediments)
Multiple channels active at different times	Yes	Yes	Yes	Yes	Yes	Dates on multiple channels older than Holocene; typical incision for Himalayan rivers missing
Himalayan uplift causing incisions	Yes	No	No	n/a	No	Equally applicable to Himalayan rivers, including a 'Himalayan Sarasvati'
Tectonic aggradation	Yes	No	No	n/a	No	Different spatial pattern and scale; ignores tectonics of Sindh
Climate already arid	Yes	Yes	No	n/a	Yes	Fluvial hydroclimate complex and not fully equivalent to arid/humid

n/a, not applicable.

satellite images claiming to detect channels under the sands of the Thar Desert (including Valdiya[15]). We made perfectly clear in our paper[2] that we employed much stricter criteria than a simple interpretation of satellite images: 'To avoid misinterpreting the morphology due to post-Harappan alterations of the Indo-Gangetic Plain via natural and anthropogenic processes, especially over the past century, we only interpreted features that retain a clear, large-scale SRTM topographical expression.'

Valdiya also argues that the > 600 km long Indus mega-ridge that we detected in Sindh is a tectonic feature akin to what he describes as 'massive aggradation at the river bends, upstream of active faults that lifted up the downstream blocks in streams, rivulets and rivers'[1]. Such an explanation not only ignores the scale of the feature, the difference in rates between tectonic and fluvial processes and the complex tectonics of Sindh (see, for example, Harbor *et al.*[16]), but also the morphology of the ridge itself whereby the aggradation is evidently a channel-driven transversal feature.

We fully agree with Valdiya's view that climate was already arid before the Harappan civilization flourished and that people were accustomed with aridity. The northwest region of the Indian subcontinent has long been one of its most arid parts as demonstrated by the history of Thar Desert, but the climate of the subcontinent at centennial to millennial timescale is much more complex and less understood than Valdiya's compilation would suggest. For example, Ponton *et al.*[17] indicate a general drying after ~ 4000–4500 years BP of the peninsular India, while Berkelhammer *et al.*[18] and Anoop *et al.*[19] suggest that an intense 4.2 ka drying event may have affected the subcontinent. However, there is a strong regional character of climate at decadal to centennial scales across the subcontinent[20] with some regions getting wet while others dry out. As we proposed in our study, subtle changes in climate can make the difference between perennial rivers and seasonal flows on the S–Y interfluve. Consequently, new reconstructions from the Indus–Sarasvati domain that are more detailed than what is already available[21] are needed. Such research on lakes in Haryana for example[22] suggests that the climate may have become more arid than normal during the 4.2 ka event, but never fully recovered to wetter conditions afterwards. With the refinement of the climate reconstructions in the region, access to better archaeological chronologies for individual sites and sub-regions would become crucial to understand the nitty-gritty of the relationships of humans with the environment in the Sarasvati region[23].

Finally, our research points to a perennial monsoonal-fed Sarasvati river system with benign floods along its course, which could well be considered important for early agricultural civilizations such as the Harappan. A novel analysis of the *Rig Veda* (rather than later secondary sources) by Aklujkar[24] paints exactly such a picture of a benevolent river with multiple courses affecting a wide area, which would certainly explain the amazing density of settlements across the S–Y interfluve rather than only along definite river courses. This description conforms well to the model that is slowly emerging for the Sarasvati: a perennial monsoonal river with many feeding streams in its headwaters with mild and nourishing floods when compared to the Indus or its large Himalayan tributaries. This is a testament to the acuity of the *Rig Veda* composers who transmitted to us across millennia such an incredibly accurate description of a grand river!

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