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## **An Ancient Civilization, Upended by Climate Change**

By RACHEL NUWER

The Vedas, a collection of texts composed over 3,000 years ago in India, speak of a mythical sacred river called the Sarasvati from which the Hindu goddess of science and learning emerged. Hers was a river "surpassing in majesty and might all other waters." But around 4,000 years ago, all was lost when climate change kicked in.

That is the conclusion of a group of geologists, geomorphologists, archaeologists and mathematicians who joined forces to answer a question that has dogged scholars for centuries: what became of the Indus civilization?

This colossal civilization rose about 4,500 years ago, flourished for 600 years and then began a steady and relentless decline. Previous scholars hypothesized that regional strife or a foreign invasion led to its unraveling, while others suggested that environmental factors may have been to blame. The researchers who took part in the new study, published in the Proceedings of the National Academy of Sciences, had a hunch that the latter theory was correct.

"What we thought was missing was how to link climate to people," said Liviu Giosan, a geologist at the Woods Hole Oceanographic Institution in Massachusetts and the lead author of the study. "The answer came when we looked at the wide-scale morphology."

Using satellite photos and topographical data, the researchers prepared digital maps of the Indus River landscape. They collected field samples to determine the age of sediments in the region and whether their structure was shaped by rivers or the wind. The information was then overlaid across prior archaeological findings, yielding a compelling new chronology of 10,000 years of human history and landscape changes, and what drove them.

The story goes something like this:

Wild, untamed rivers once slashed through the heart of the Indus plains. They were so unpredictable and dangerous that no city could take root on their banks. As the centuries passed, however, the monsoons became less frequent and the floods less intense, creating stable conditions for agriculture and settlement.

Sprawling across what is now Pakistan, northwestern India and eastern Afghanistan, the Indus civilization encompassed more than 625,000 square miles, rivaling ancient Egypt and Mesopotamia in its accomplishments. In its bustling hubs, there was indoor plumbing, gridded streets and a rich intellectual life.

Unlike the Egyptians and Mesopotamians, who used irrigation systems to support crops, the Harappans relied on a gentle, dependable cycle of monsoons that fed local rivers and keyed seasonal floods.

But as later generations would discover, it was what the researchers call a "Goldilocks civilization." After about 2,000 years, the window for agricultural stability closed again.

As time passed, the monsoons continued to weaken until the rivers no longer flooded, and the crops failed. The surplus agriculture was longer there to support traders, artists, craftsmen and scholars. The Harappans' distinct writing system, which still has not been deciphered, fell into disuse.

People began abandoning the cities and moved eastward toward the Ganges basin, where rains were more dependable (though not dependable enough to sustain urban metropolises). The civilization dispersed, fracturing into small villages and towns.

"The cities became peripheral -- they didn't abruptly disappear," Dr. Giosan said. "But in the end, those cities were only a place for squatters."

The researchers found the dusty geologic remnants of the long-lost Sarasvati River in the sprawling desert surrounding the modern-day Ghaggar-Hakra valley. Rather than being fed by Himalayan runoff, as many scholars had assumed, the researchers uncovered evidence that her liquid sustenance came only from monsoons. As the climate became more arid, the weak rains could no longer sustain the river, it retreated into myth.

Dr. Giosan suggests that the Harappans' fate offers lessons for today. "We think about tomorrow -- we think of the lives of our children or maybe grandchildren," he said. "But these accumulating effects of climate that are so slow, they don't really enter our vocabulary or thinking."

Modern-day cultures and policy makers need to pay attention to "deep time," or the very slow changes that accompany the deterioration of climatic conditions and resources, for the benefit of third, fourth or fifth generations, Dr. Giosan said. But in some cases, he adds, the changes are not so slow -- for instance, the depletion of fossil fuels.

"Just as the Indus civilization did, we're depending on a resource that came and went," Dr. Giosan said. "That resource is oil."