

ENVIRONMENT

It's a small world after all, say scientists warning of sand scarcity

SURFACING MODELS OF THOUGHT Out of the complexity of the global sand trade has emerged something of a butterfly effect, in which an economic decision in one place can wreak social and environmental havoc on the other side of the world.





Rajesh Kumar Singh/AP/File | Caption



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SEPTEMBER 14, 2017 — If you're looking for a way to express something that's staggeringly hard to count, you won't find a more reliable metaphor than grains of sand.

There is indeed quite a bit of it – about 7.5 quintillion grains on Earth's beaches and deserts, according to one estimate. But if you think that this would be sufficient to supply an ever-expanding global economy with all the concrete, asphalt, glass, and semiconductors it could possibly desire, think again.

Our consumption of sand is outpacing our understanding of the economics and environmental impacts of extracting, transporting, and consuming it, finds research published last Thursday in the journal *Science*. Out of the complexity of the global sand trade has emerged something of a butterfly effect, in which an economic decision in one place can wreak social and environmental havoc on the other side of the world. Using a holistic, interdisciplinary approach called telecoupling, the researchers' analysis of the global sand trade opens a window into the global interconnection of human and natural systems.

“The demand is skyrocketing, and the supply is increasingly limited. And also the consequences, both the environmental and the socioeconomic impact, are enormous,” says Jianguo “Jack” Liu, director of Michigan State University's Center for Systems Integration and Sustainability and a co-author of the paper.

Sand mafias and vanishing islands

Modern society is literally built on sand. Most of our buildings and bridges are made with concrete, which consists mostly of sand and gravel. The same is true for the asphalt that covers our roads and parking lots. Glass, from window panes to eyeglass lenses to smartphone screens, is made by melting sand, and the semiconductors in our electronics come from heating silica sand. Another type of sand is increasingly used in hydraulic fracturing, where it is used to prop open cracks deep in the Earth for fossil fuel extraction. After air and water, sand is humankind's most consumed natural resource.



Brett Coomer/Houston Chronicle/AP | Caption

The profits of this easy-to-get, hard-to-regulate material, whose trade is valued at \$70 billion annually, have lured organized crime. In India and Bangladesh, “sand mafias” have been implicated in the murder of hundreds of people in recent years. In Indonesia, more than 20 islands have vanished since 2005 because of illegal sand mining for developments in Singapore. Illegal sand mining in Sri Lanka is thought to have worsened the effects of the 2004 tsunami. In addition to coastal erosion, sand mining is also fueling habitat destruction, water scarcity, and crop failures.

“This over-exploitation makes the local communities more vulnerable to natural hazards,” says Aurora Torres, a research fellow at the German Centre for Integrative Biodiversity Research and at Martin Luther University Halle-Wittenberg and the paper’s co-author. Dr. Torres cites storm surges, food and water shortages, and other events that she says could “increase or create sociopolitical conflicts, and eventually displace entire populations.”

She notes that she is amazed at how little attention this issue receives from the international research community.

In the past, most sand was mined locally, but regional shortages and rising demand, driven in part by a construction boom in Asia, have transformed it into a global commodity. Singapore, for instance, imports its sand from Indonesia, Cambodia, and Vietnam. India imports sand from Indonesia and the Philippines. And even the United Arab Emirates, having exhausted its sand resources on Dubai’s artificial islands, now buys its sand from Australia.

In February, members of Florida’s congressional delegation from both parties introduced a bill to repeal a law prohibiting the Sunshine State from importing sand from the Bahamas and other foreign sources.

A 2014 report from the United Nations Environment Programme found that the mining of sand and gravel “greatly exceeds natural renewal rates.”

“A large discrepancy exists between the magnitude of the problem and public awareness of it,” the report concludes. “The absence of global monitoring of [sand and gravel] extraction undoubtedly contributes to the gap in knowledge, which translates into a lack of action.”

A tragedy of the commons

Telecoupling, a way of looking at the interactions between human systems and natural systems and their effects around the globe, aims to fill this gap. Developed over the past decade by Dr. Liu, it examines and quantifies five interconnected components – systems, agents, flows, causes, and effects – so that it can address the socioeconomic and ecological impacts all at once. It has been used to gain insight into a number of complex issues related to sustainability, from explaining how increased demand for meat in Asia drives deforestation in Brazil, to how goat farming in the Bahamas can affect populations of Kirtland's warblers, North America's rarest songbird.

“What telecoupling is really about is human beings are becoming a major force in the world,” says Paul Ehrlich, the Stanford biologist whose 1968 book, “The Population Bomb,” sounded the alarm about humanity's impact on limited natural resources. “Can you imagine we've gotten to the point where really serious scientists are worrying about the supply of sand? I mean, give me a break.”

Telecoupling research also reveals what Liu sees as a vicious cycle in our resource consumption and development. “The more you consume, the more you want to develop even in distant places, until there is nothing left,” he adds in an email. “That leads to the tragedy of the commons.”

Sand may be a metaphor for abundance, but it is an equally powerful symbol of impermanence. Even Dr. Ehrlich, who has been warning of a population-driven societal collapse for the past five decades, sees potential alternatives to an economic mode of production that demands unrelenting growth.

“The world has had a very successful economic system for a couple hundred years. But we modern human beings have been around for 200,000 years,” he says. “We need to design a different economic system.”

“[Whoever] thought we’d run out of sand?” Ehrlich asks. “It’s just nuts.”

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