



IN DEPTH

ENVIRONMENTAL SCIENCE

Asia's hunger for sand takes toll on ecology

Scientists link species' declines to the mining of construction-grade sand

By **Christina Larson**, in *Kihim, India*

As a morning mist rolls in from the Arabian Sea, young men lead a couple of dozen ox-drawn carts onto a beach south of Mumbai, India's commercial capital. Using shovels and buckets, they pile their rickety wooden transports high with sand, which they will sell to cementmakers. Altering the shoreline is illegal in India, but enforcement of coastal protection zones is lax, says Sumaira Abdulali, a local environmentalist who was beaten up after confronting “sand miners” near here.

Across Asia, rampant extraction of sand for construction is eroding coastlines and scouring waterways. “For a resource we think is infinite, we are beginning to realize that it’s not,” says Aurora Torres, an ecologist at the German Centre for Integrative Biodiversity Research in Leipzig. “It’s a global concern, but especially acute in Asia, where all trends show that urbanization and the region’s big construction boom are going to continue for many years.” And it is taking an environmental toll that scientists are beginning to assess—and environmentalists hope to reduce.

Already, scientists have linked poorly regulated and often illegal sand removal to declines in seagrasses in Indonesia and in charismatic species such as the Ganges

River dolphin and terrapins in India and Malaysia. In eastern China’s Poyang Lake, dredging boats are sucking up tens of millions of tons of sand a year, altering the hydrology of the country’s largest freshwater lake, a way station for migratory birds. Conservation groups are urging governments to crack down. But the political clout of developers means it will be an uphill—and perilous—battle. Last Septem-

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ber, for example, two activists with Mother Nature Cambodia who were filming illegal sand dredging off the Cambodian coast were arrested and convicted of “violation of privacy.” They spent several months in jail before being released last month.

Used to make concrete and glass, sand is an essential ingredient of nearly every modern highway, airport, dam, window-pane, and solar panel. Although desert sand is plentiful, its wind-tumbled particles are too smooth—and therefore not cohesive enough—for construction material.

Instead, builders prize sand from quarries, coastlines, and riverbeds. “The very best sand for construction is river sand; it’s the right particle size and shape,” says David Shankman, professor emeritus of geography at the University of Alabama in Tuscaloosa, who studies the hydrology of Poyang Lake, a repository of sand deposited by Yangtze River tributaries.

Between 1994 and 2012, global cement production—a proxy for concrete use—tripled, from 1.37 billion to 3.7 billion tons, driven largely by Asian construction, according to a 2014 report from the United Nations Environment Programme (UNEP). Land reclamation projects, too, have a rapacious hunger for sand. Singapore, for example, has expanded its land area by 22% using sand primarily from Malaysia, Cambodia, and Indonesia as fill. All told, UNEP warned, sand mining—on an industrial scale and by individual operators—“greatly exceeds natural renewal rates” and “is increasing exponentially.”

Scientists are now tracing the collateral damage. In a paper under review at *Science of the Total Environment*, Richard Unsworth, an ecologist at Swansea University in the United Kingdom, and colleagues explain how sand mining has driven declines of seagrass meadows off of Indonesia. Sediment plumes stirred up by the dredging block sunlight, impeding photosynthesis,

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his team has found. The meadows nourish several species, including the dugong, which is in decline. “If they lose their food source, the dugong could eventually be gone,” Unsworth says.

Another sand mining victim is the southern river terrapin, a critically endangered turtle in Southeast Asia. Every year, Chen Pelf Nyok, a biologist with the Turtle Conservation Society of Malaysia in Kemaman, spends a few weeks patrolling sandy beaches near Malaysia’s Kemaman River during the terrapin’s brief egg-laying season; her team collects and incubates eggs to protect them from poachers. Three years ago, sand mining erased a nesting site they had monitored. “Terrapin habitat cannot be easily replaced,” Chen says, because female turtles return each year to lay eggs at the same beaches.

Also under siege, in Bangladesh and India, is the northern river terrapin. “Sand mining is one of the biggest problems and reasons why they are so endangered today,” says Peter Praschag, a biologist at the Conservation Breeding and Research Center for Turtles in Graz, Austria. “When the sand banks are gone, the [terrapin] is gone.” Other creatures directly affected by river sand mining, scientists say, are the gharial—a rare crocodile found in northern India—and the Gangetic River dolphin.

Poyang Lake, a key wintering ground on the East Asian-Australasian Flyway, hosts

Singapore is attempting to reduce its reliance on imported sand for its land reclamation projects. Much of the fill for a new container port in Tuas, on the island’s west coast, is from domestic dredging and excavation.

dozens of migratory species, including almost all of the 4000 or so surviving Siberian cranes. But sand dredging campaigns in the middle Yangtze Basin have expanded rapidly since the early 2000s, when such activities were banned on sections of the lower Yangtze. “Sand mining has significantly lowered the water level, especially in winter,” says Lai Xijun, an environmental hydrologist at the Nanjing Institute of Geography and Limnology in China. Falling lake levels can curtail the birds’ access to aquatic vegetation. And when lake bottom mud dries and hardens, the birds may not be able to pluck out nutritious tubers.

In grasslands near Poyang, the kind and amount of food the cranes consume “may no longer be enough to fuel egg laying” at the levels the birds managed in the past, says James Burnham, a conservation biologist at the University of Wisconsin in Madison. His group has documented a worrisome decline in the ratio of juvenile cranes to adults at Poyang between 2010 and 2012.

Scientists in China are calling on the government to curtail sand mining across the entirety of the Yangtze Basin. In a letter to *Nature* last October, Yushun Chen of

the Institute of Hydrobiology in Wuhan, China, and colleagues argued that sand mining there “has destroyed crucial spawning, feeding and rearing grounds for its aquatic organisms,” including the now-extinct Yangtze river dolphin and the endangered Yangtze finless porpoise. “We appeal to the Chinese government to clamp down on this wholesale destruction of aquatic organisms’ habitat,” they wrote.

“We are not saying we need to stop sand mining altogether. We are saying we need to minimize the impacts,” says Jack Liu, a biologist at Michigan State University in East Lansing who is spearheading an effort to assemble a comprehensive picture of the damage. Construction standards should be raised to extend building longevity, he says, and building materials should be recycled. Those sand grains on the beach may not be innumerable after all. ■

Christina Larson is a journalist in Beijing.

ASTRONOMY

Arecibo telescope saved by university consortium

University of Central Florida will take over operations of iconic radio dish

By Daniel Clery

After a dozen years of uncertainty about its future, the iconic Arecibo radio telescope in Puerto Rico finally found a savior last week: a consortium led by the University of Central Florida (UCF) in Orlando. The National Science Foundation (NSF) in Alexandria, Virginia, had been looking for another group to shoulder the burden of paying for the Puerto Rican observatory ever since a 2006 review suggested the agency ramp down its funding to free up money for newer projects. “We’re delighted that there are signatures on paper,” says Richard Green, director of NSF’s astronomical sciences division. “That’s a fabulous moment at the end of a long process.”

Astronomers, planetary scientists, and atmospheric physicists all use the 55-year-old, 305-meter radio dish, the biggest in the world until a 500-meter telescope in China surpassed it in 2016. But its importance has waned. NSF now spends about \$8 million a year to run Arecibo, with NASA pitching in an additional \$3.6 million. Under the agreement signed last week, NSF’s contribution will shrink to \$2 million by 2022, with UCF and its partners making up the difference. “There was not a moment’s hesitation. It’s a real opportunity,” says Elizabeth Klonoff, UCF’s vice president for research.

UCF will take over management on 1 April, although an agreement detailing the transfer of funds must still be finalized, says James Ulvestad, NSF’s chief officer for research facilities. NSF will retain ownership of Arecibo and will regularly review UCF’s stewardship of it.

UCF, founded in 1968 to provide technical staff for NASA’s burgeoning space program at the nearby Kennedy Space Center, has teamed up with the Metropolitan University in San Juan and Yang Enterprises in



Sand mining has wiped out nesting sites of critically endangered southern river terrapins in Southeast Asia.

Science

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