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SCIENCE NEWS BY AGU

A 1928 Dirigible Tragedy

Saving a Pagoda's Dome

How to Measure the World's Sand

SATELLITE RECON

Scientists are using remote sensing from orbit to hunt for underwater volcanoes, predict allergy seasons, and even plan better cities.

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Riazi and Vila-Concejo and their coauthors found that existing models typically underestimate the surface area of carbonate sands by over 30%, overestimate the transport of these rougher grains over the seafloor, and underestimate transport of sands when they are suspended. The researchers hope that their model will be implemented by coastal engineers and others who need to evaluate the way sandy beaches respond to ocean currents, waves, and the long-term impacts of sea level rise.

"The new model provides a more accurate description of the settling velocity, which is a primary input parameter for sediment transport calculations," said Cheung. "The better the input, the better the output."

Managing a Crucial Resource

Accurate accounting of the sand that makes up tropical beaches will become more important in the coming years. As sea levels rise, beach managers and coastal engineers will need to decide how best to preserve beaches as both a crucial coastal habitat and a natural coastal barrier. "When preparing for the impacts of climate change, the accuracy of our equations will mean that we don't need to overengineer and use more sand than strictly necessary," said Vila-Concejo. "This can directly translate [into] more accurate coastal management of eroding sandy coasts."

Better accounting is also important in light of sand mining's increasing intensity and the threat it poses to coastal and marine ecosystems. A construction boom in Asia and Africa has driven up the demand for sand in the past 2 decades, and the resource is expected to become much more sought after—and scarce—in the coming years.

"We need to better monitor changes in sediment transport, as we're seeing increasing human impact on natural systems," said Mette Bendixen, a research fellow at the Institute of Arctic and Alpine Research at the University of Colorado Boulder who commented on the phenomenon in *Nature* last year (bit.ly/sand-scarcity). "Despite the central importance of sand, we don't possess any clear global overview, or statistics, of the sand resources available or those being mined. If we don't have this overview of what we actually have available as a resource, we're putting sustainability of the environment, and people's livelihoods, at risk."

By **Rachel Fritts** (@rachel_fritts), Science Writer

The Rise of Zombie Fires

An image of northern Siberia taken on 5 May 2020 by NASA's Terra satellite with hot spots marked in red (enhanced here for visibility). Credit: NASA Worldview; bit.ly/NASA-zombie-fires

In early May, just as the spring thaw was beginning in the northern reaches of Siberia, Mark Parrington spotted something strange on images captured by instruments aboard NASA's Terra satellite. Red dots, indicating some kind of thermal anomaly, stood out on a vast white expanse.

Fueled by methane deposits and insulated by a layer of snow, zombie fires can burn all the way through the cold and wet Arctic winters.

Parrington, a senior scientist at the Copernicus Atmosphere Monitoring Service, posted one of the images (above) to his Twitter account @m_parrington: "Hotspots starting to appear in NASA MODIS & VIIRS [observations] as ice thaws in northern parts of Siberia. Hard to tell if these are fires yet…but it is probably just a matter of time."

Thomas Smith, an assistant professor of environmental geography at the London School of Economics, quickly noticed that the hot spots were located in areas that had burned in last year's epic Arctic fires.

"Whatever they are (land clearance? natural?) they were occurring at the same time last year," Smith wrote, posting a picture of the same location from 2019.

"Zombie fires?" Parrington replied.

Burning Between Fire Seasons

"Zombie fires" is a new and catchier name for an old and relatively rare phenomenon. Known among Arctic fire managers as holdover or overwintering fires, zombie fires transcend the typical fire season.

After flaming wildfires are extinguished on the surface, they can continue to smolder belowground, burning through peat and other organic matter. Fueled by methane deposits and insulated by a layer of snow, zombie fires can burn all the way through the cold and wet Arctic winter. In the spring, as temperatures begin to climb and soil dries out, the fires can reignite aboveground.

Although records of zombie fires go back decades, the phenomenon wasn't extensively studied until recently.

Researchers noticed that these early spring fires seemed to pop up more often after large fire seasons and often near the burn scars left by the previous fire. This couldn't be a coincidence, thought Sander Veraverbeke, an assistant professor at Vrije Universiteit Amsterdam. Veraverbeke and Rebecca Scholten, a Ph.D. student at the university, have carried out some of the first scientific studies on zombie fires.

The pair analyzed records from Alaska going back to 2005, showing empirically that zombie fires were more likely after large fire seasons (bit.ly/zombie-fires).

Fire managers in Alaska had noticed the trend. "We noticed clusters of these overwintered fires the spring after some of our big fire seasons in Alaska: 2004, 2005, and 2015," said Randi Jandt, a fire ecologist with the Alaska Fire Science Consortium.

"These fires can pop up early, while we're still trying to complete fire readiness and training activities, and before lightning season when we normally expect to be actively managing fires."

But Veraverbeke and Scholten's study was the first to attempt to detect holdover fires using satellites, according to Jandt.

Aerial photos of the Yukon Flats region in 2005, a year after the Lower Mouth Fire burned through the region, show trees "felled like toothpicks," said Jandt, "due to their roots and soil underneath burning out." That's where smoke first emerged in the spring of 2005.

A Record-Breaking Season

Last year's Arctic fire season was one of the biggest on record. In June and July 2019, more than 100 blazes burned in the Arctic circle. Millions of hectares of boreal forests across Siberia, Alaska, Greenland, and Canada went up in smoke. Clouds of soot the size of the European Union stretched across the sky.

Jandt and her colleagues at the consortium have already identified a few overwintered fires that are active now.

Without on-the-ground confirmation, it's hard to say for sure whether the fires Parrington identified in the Siberian Arctic were actually started by the remnants of last year's blazes. The satellite instruments can detect the fires only once they've reignited on the surface. But Parrington and Smith suspected they may have been burning there all winter long for a few reasons: Arctic fires are typically started by people or by lightning strikes, but these fires emerged in remote areas far away from human settlements, near the areas that burned last year, and before lightning strikes typically pick up in June.

Like all wildfires, zombie fires are sources of carbon emissions. In 2019, Veraverbeke and his team traveled to Siberia and camped out in the burn scars of past wildfires to study carbon combustion. They took soil core samples from burned and control plots to figure out just how much carbon Arctic fires are releasing.

Most people think that most of the carbon released during wildfires comes from burning trees, but that's a misconception, according to Veraverbeke. "Seventy to ninety percent comes from the organic soil," he said. "Trees contribute just a small fraction."

Veraverbeke thinks that the smoldering phase of these fires accounts for only a small portion of wildfire emissions. Though overwintering fires can burn through organic matter and methane stored in the soil, they also tend to stay put. The team's previous research shows that on average, zombie fires account for less than 1% of Alaska's burned land area each year.

They can still be a headache for fire managers. "These fires can pop up early, while we're still trying to complete fire readiness and training activities, and before lightning season (June–July) when we normally expect to be actively managing fires," said Jandt. The upside is that the tundra is usually still cool and wet in the spring, and the fires may be easier to control.

But the Arctic is changing rapidly, and patterns of the past may not hold in the future.

"We know that these large fire years in the boreal forests are already happening more often," Veraverbeke said. Temperatures in the Arctic are rising faster than almost anywhere else on Earth, thawing the permafrost, drying soils, and providing new fuel for blazes. Global warming is also leading to more thunderstorms and thus more lightning strikes—a common ignition source for fires in remote regions.

Veraverbeke and Scholten are currently working on a study to find out how climate change might affect Arctic blazes and zombie fires.

By **Kate Wheeling** (@katewheeling), Science Writer