Study shows unexpected expansion of rare earth element mining activities in Myanmar-China border region

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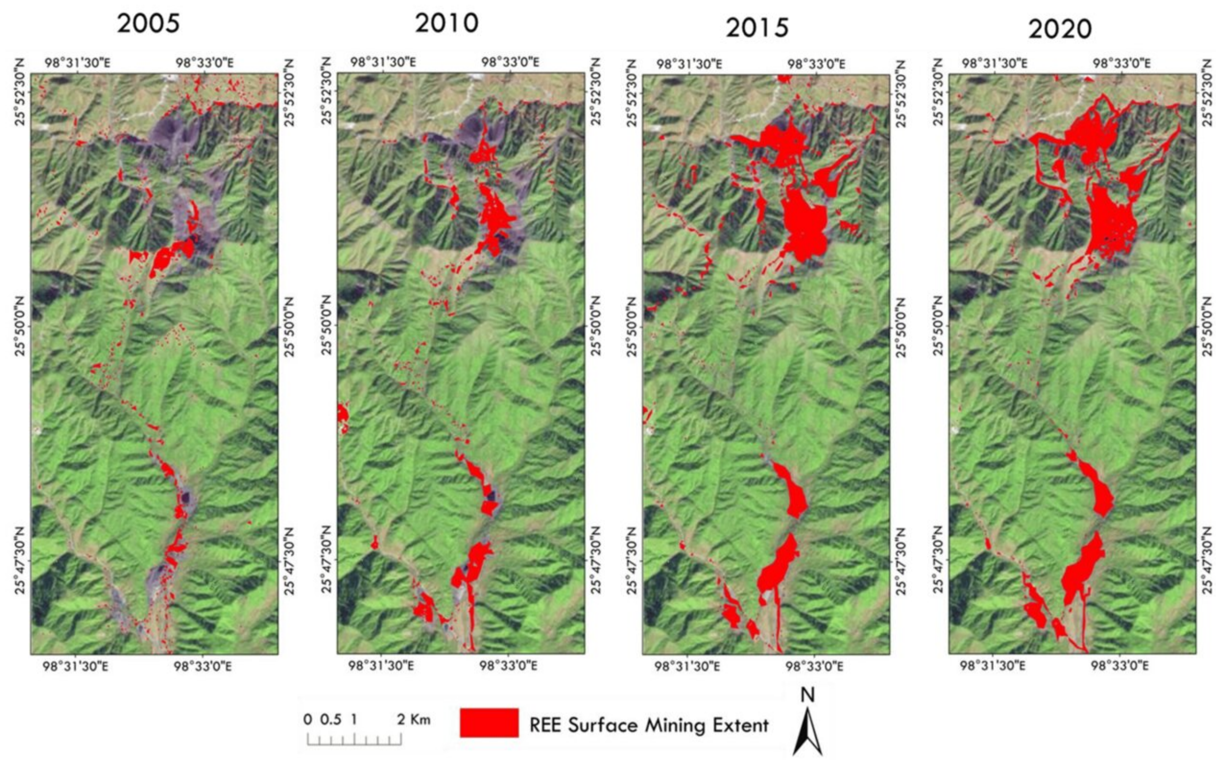

Surface mining extents for 2005, 2010, 2015, and 2020 draped on 2020 Landsat 8 OLI natural color imagery. Credit: *Remote Sensing* (2023). DOI: 10.3390/rs15184597

As the demand for rare earth elements increases world-wide, so too do the mining activities associated with rare earth element extraction. Rare earth elements are listed as 15 elements on the periodic table constituting what is known as the lanthanide series, ranging in atomic number from 57 (lanthanum) to 71 (lutetium), as well as scandium (Sc) and yttrium (Y), which serve as essential inputs for information and energy technologies, especially renewable energy technologies.

China is a country rich in rare earth elements and has dominated global rare earth mining and production since the 1990s. Its neighbor, Myanmar, is also a country rich in rare earth elements. In 2012, China's Central Government implemented a strategy to shift away from mining and focus on the processing of rare earth elements, which led primary extraction to increase in other parts of the world.

The prevailing thought has been that while mineral extraction has decreased in China following this declaration, and subsequently increased in Myanmar and other parts of the world, a new study by the University of Delaware shows that when it comes to the border regions of Myanmar and China, the dynamic is more complex.

The study, which was published in the journal *Remote Sensing*, used remote sensing techniques to look at changes in mining surface footprints between 2005 and 2020 in two rare earth mines located on either side of the Myanmar-China border, within Kachin State in northern Myanmar and Nujiang Prefecture in Yunnan Province in China.

The research was led by Emmanuel Chinkaka, a doctoral student in the Department of Geography and Spatial Sciences, who served as the lead author of the paper. Co-authors of the paper included Julie Klinger, assistant professor in the Department of Geography and Spatial Sciences; Kyle Davis, assistant professor in the Department of Geography and Spatial Sciences and the Department of Plant and Soil

Sciences as well as a resident faculty member with UD's Data Science Institute; and Federico Bianco, associate professor in UD's Joseph R. Biden, Jr. School of Public Policy and Administration.

Confirming rare earth mines

Chinkaka said the study focused on how the various energy material minerals are extracted and how they find themselves integrated into the global supply chain.

"Basically, we are trying to look at what is actually happening and what we can see from satellite images with regards to the expansion of the footprint in correlation to what the policies are saying," Chinkaka said. "Our main focus was to look at the correlation between the policy standpoint and what is actually happening on the ground. We found out that it's completely different."

Using satellite images and data from the NASA/United States Geological Survey (USGS) Landsat Program, the researchers looked at the two mines in resolutions up to 30 meters over a period of 15 years, from 2005 to 2020.

Because detailed geological and mineralogical survey data is not freely available in China and Myanmar, the researchers had to take an extra step to confirm that the mines were actually being used for rare earth elements.

To do this, they used satellite remote sensing and the USGS Spectroscopy Laboratory Library to determine the hyperspectral signature—basically a unique fingerprint left across the electromagnetic spectrum—by certain types of rare earth elements to verify their presence in these mines.

They indeed found amounts of neodymium in the mines, which is a rare earth element that is critical for permanent magnet productions used in wind turbines and hybrid fuel cell batteries, as well as components for military equipment.

"We wanted to be certain that we could see a reflector scale in the open pits of this specific mineral," Chinkaka said. "Then we were able to use satellite data and made comparisons with a field-based spectral reflectance of a neodymium sample from the USGS library. When you take that and you make a comparison of the image and the sample, we found that there was a 100% match."

Different border

Klinger, author of the 2018 Meridian Award-winning book "Rare Earth Frontiers: From Terrestrial Subsoils to Lunar Landscapes," said that there has been a lot of big-picture, public interest with regard to rare earth mining in Myanmar, especially since China has aimed to reduce mining within its own borders.

"Because of that, one of the things that we wanted to investigate is, "Well, how important is the border, actually?" along with determining whether or not mining activities are actually happening," Klinger said. "I think the significant finding from our paper is that the border is not necessarily a hard line."

They found that, despite the policy implemented by China, there's been mining expansion on both sides of the border. Over the 15-year period, the mining activity on the China side of the border increased 130%, and the mining activity on the Myanmar side increased 327%.

"We took images five years apart to be able to see the drastic increase and it was indeed a huge increase," Chinkaka said. "But then, when you look at the landscape of the area, there are no roads that lead from the boundary of Myanmar to the inside of Myanmar. The roads are going into the China side. So what does that tell us? That's the biggest question. There's a lot of influence on the Myanmar side because of the proximity to China and on the Chinese side, that's where the actual processing is taking place."

This finding is significant because of the efforts underway to try to control or further sanction the Myanmar regime, in particular, around potential mineral exports from areas where there are documented cases of human rights abuses. One of the big challenges with enforcing those sanctions is the traceability of the minerals.

"You can say that this border region is indeed different," Chinkaka said. "It just looks like whatever is happening on either side of this border is similar. And this method can be applied in many border areas where mining is happening."

Klinger agreed, saying that they are hoping the methods they used in this paper, which provide empirical clarity on an otherwise mysterious border region, can be applied to other research studies.

"There are a number of other border regions throughout the world, the U.S.-Mexico border, for example, where you have extractive and industrial activities occurring on either side of the border, two very different national-level policy regimes, and also potentially much more fluid relations on the ground," Klinger said.

"Because you're in two different political jurisdictions, there's two different information regimes and it can be difficult to verify what is going on without using these multiple methods to actually look at the place. This study is part of a larger project to use machine-learning and geospatial techniques and also qualitative research to map and model the interaction between licit and illicit energy critical material flows globally."

More information: Emmanuel Chinkaka et al, Unexpected Expansion of Rare-Earth Element Mining Activities in the Myanmar–China Border Region, *Remote Sensing* (2023). [DOI: 10.3390/rs15184597](https://dx.doi.org/10.3390/rs15184597)

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