

## Forest Loss in Mountains of Southeast Asia Accelerates at ‘Shocking’ Pace

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*Southeast Asia is home to roughly half of the world’s tropical mountain forests. These highland ecosystems support massive carbon stores and tremendous biodiversity, including a host of species that occur nowhere else on the planet. But new evidence suggests these havens are in grave danger. Conversion of higher-elevation forest to cropland is accelerating at an unprecedented rate throughout the region, according to findings published June 28 in [Nature Sustainability](#).*

By analyzing high-resolution satellite data sets of forest loss and state-of-the-art maps of carbon density and terrain, an international team of researchers quantified patterns of forest loss in Southeast Asia during the first two decades of this century. They found that during the 2000s, forest loss was mainly concentrated in the lowlands; but by the 2010s, it had shifted significantly to higher ground.

Between 2001 and 2019, the researchers calculated that Southeast Asia had lost 610,000 square kilometers (235,500 square miles) of forest — an area larger than Thailand. Of this loss, 31% occurred in mountainous regions, equivalent to 189,100 km<sup>2</sup> (73,000 mi<sup>2</sup>) of highland forest converted to cropland and plantation in less than two decades.

Moreover, the study reveals an accelerating trend. By 2019, 42% of total annual forest loss occurred at higher elevations, with the frontier of forest loss migrating upslope at a rate of roughly 15 meters (49 feet) per year.

Particularly prominent shifts to mountain forest loss were found in north Laos, northeast Myanmar, and east Sumatra and Kalimantan in Indonesia — the country that experienced the most overall forest loss.



Terraces are cleared on a hillside in Malaysian Borneo to make way for an oil palm plantation. Image by Rhett Butler/Mongabay

Decades of widespread clearing of lowland forests to make way for rice, oil palm and rubber plantations has led the conservation community to perceive forest loss as an issue only affecting the lowlands, said Paul Elsen, climate adaptation scientist at the Wildlife Conservation Society and co-author of the study.

“To see through this study that forest loss is increasing and accelerating in mountainous areas throughout the whole of Southeast Asia was pretty surprising,” he told Mongabay.

The expansion of agriculture into higher elevation areas, despite sub-optimal growing conditions due to lower temperatures and steep slopes, spotlights just how scarce undeveloped land now is in lowland Southeast Asia.

“Just because we found that there’s a lot of increasing forest loss in the mountains does not mean that we’re not still seeing forest loss in the lowlands ... we still have to worry about lowland forest loss,” Elsen said. “It is just shocking that [forest loss] is continuing to move up into places that we felt were safe by virtue of being rugged and remote and isolated.”



Slopes planted with maize ascend to the tops of hills where they have replaced secondary forest in Nan province, Thailand. Image courtesy of Zhenzhong Zeng

### **Natural hazards**

Worldwide, more than 1 billion people live in mountainous regions. Forest loss in these areas has far-reaching implications for people who depend directly on forest resources and downstream communities.

Clearing forests in steep headwaters where rivers originate can increase the risk of catastrophic landslides and flooding in lower areas. It also exacerbates soil erosion and runoff, causing rivers to clog with silt and agricultural pollutants, reducing downstream water quality and availability. In 2018, many people blamed the devastating floods that struck southeast Sulawesi in Indonesia, [displacing](#) thousands of people from their villages, on upstream forest clearing.

“These impacts can kill people, of course, but they also disrupt roads and transportation access so goods and services can’t reach communities,” Elsen said. “That’s hugely impactful when you have increased soil erosion and instability following the removal of trees.”

Elsen said communities dependent on mountain forests are hit with a “double whammy” when trees are cleared, since they lose the safety net the forest provides against diminished crop yields, which also suffer from diminished water availability and quality. “Now that the forest has been removed, you have fewer products available for communities to rely on, so it also reduces their adaptation potential,” he said. “If left unchecked, this could be a really big environmental problem for the communities living both in the mountains and in the lowlands.”

Furthermore, a 2021 [study](#) showed that deforestation in the tropics can increase local warming by up to 2° Celsius (3.6° Fahrenheit). “Local communities living in these frontier zones will suffer much stronger climate warming due to the biogeophysical feedbacks driven



by tree loss further compounding the effects of global warming,” Zhenzhong Zeng, associate professor at the Southern University of Science and Technology, Shenzhen, China and co-author of the new study told Mongabay.



A landslide in Indonesia caused by the removal of trees which has destabilized the steep slope. Image by Rhett Butler/Mongabay

## Nowhere to go

If the forest loss continues to march upslope, the consequences for wildlife could be equally devastating. [Recent studies](#) suggest many species are shifting their ranges to higher altitudes in response to warming temperatures.

“The mountains of Southeast Asia are one of the most biologically rich regions of the planet and it’s incredible how many species of mammals, of birds, of amphibians are living only in the mountains and rely on forested ecosystems for their survival,” Elsen said. “So the removal of any of those forests will most likely reduce their abundances at a minimum and could potentially cause local extinctions because species that live in mountains often are very isolated in particular spots.”

“While it’s not surprising, unfortunately, that forest loss rates are moving up elevation in Southeast Asia, this study importantly quantifies this upwards acceleration,” Tim Bonebrake, a conservation biologist at Hong Kong University who was not involved in the study, told Mongabay in an email. He said the rate of upslope shift in the frontier of forest loss is very concerning and might hamper species’ ability to adapt to climate change.

“Not only do these losses of forest cover amount to losses in habitat for species, but the incursion of this forest loss up elevation will also impair biodiversity resilience to climate change,” Bonebrake said. “Forest species that may have otherwise been able to shift their distributions in response to warming will have less space to do so.”

## Global carbon budget

As part of the study, the researchers investigated how forest loss is affecting carbon budgets by overlaying forest loss datasets on high-resolution carbon density maps. They found that carbon stocks in steeper, higher-elevation forests are much greater than in lowland forests. This contrasts with patterns in Africa and South America where lowland forests account for more carbon sequestration. The Southeast Asia pattern is most likely due to greater levels of primary production and organic soil content in the region's highland forests, say the researchers.

The team calculated that the total annual forest carbon loss across Southeast Asia was 424 million metric tons of carbon per year, which is equivalent to one-sixth of all the carbon absorbed by the world's [oceans](#) each year. Mountain areas accounted for nearly one-third of that loss.

Their findings suggest that assumptions used in global climate change models, which consider all forest carbon emissions as equal, could be inaccurate. Moreover, the Intergovernmental Panel on Climate Change's (IPCC) climate models incorporate predictions that tree-dominated land cover will persist in Southeast Asian mountains. Not only are those mountains losing their forest cover, but the fact that the region's mountain forests store comparatively more carbon than lowland forests means that their loss will disproportionately affect climate predictions.

The authors calculate that if the patterns of forest loss continue, annual forest carbon loss in the mountains will exceed that of the lowlands as soon as 2022. They also suggest that the continued loss of carbon-rich forests at higher elevations could eventually tip the scales, shifting Southeast Asia's forests from being a [neutral actor](#) in the global carbon cycle to a net carbon emitter.

Ultimately, the loss of higher-elevation forest will make it much harder to meet international climate objectives to limit global warming to below 2° Celsius (3.6° Fahrenheit) by the end of this century. This is, according to Elsen, "A very simple message that we need practitioners and policymakers to understand."

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## Sources

Feng, Y., Ziegler, A. D., Elsen, P. R., Liu, Y., He, X., Spracklen D. V., ... Zeng, Z. (2021). Upward expansion and acceleration of forest clearance in the mountains of Southeast Asia. *Nature Sustainability*. doi:[10.1038/s41893-021-00738-y](https://doi.org/10.1038/s41893-021-00738-y)

*Featured image: White-handed gibbons (Hylobates lar) are among the many species that may have to shift their ranges further up into mountain forests in response to climate change. Image by [JJ Harrison](#) via Creative Commons ([CC BY 3.0](#))*

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