Amazon rainforest splits along geological lines

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From above the Amazon rainforest may look like an endless, uniform sea of greenery, but it turns out there are sharp lines through it separating very different ecosystems with distinct inhabitants. And these lines are drawn by the region's geology.

An innovative study published in Journal of Biogeography and led by Mark Higgins of Duke University is the first to combine large-scale data from satellites with painstaking work on the ground, sampling the plant types found in particular areas.

It shows an abrupt boundary between two distinct kinds of forest, running some 300km through northern Peru. The method also reveals a similarly sharp disjunction in western Brazil, running from north to south for more than 1500km. The researchers suggest this effectively

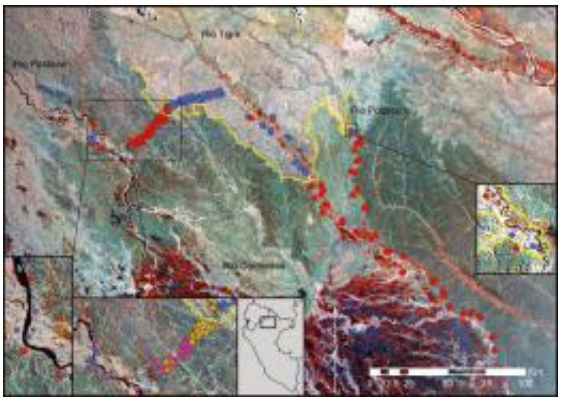
marks the boundary between western and central Amazonia.

The earth is very different on either side of these boundaries. On average the soil on one side contains 15 times as many cations - tiny particles that plants need for nourishment - as that a short distance away on the other side. The plant communities living in these different kinds of soil are almost completely distinct.

"It's a profound difference in soil and plant species," says Professor Oliver Phillips, a specialist in rainforest ecology at Leeds University and one of the paper's authors. "We used to think the ecology of the Amazon varied gradually with the climate across the whole basin. But now we can see that it's not a matter of gradual variation - there are really dramatic changes over a few hundred meters."

Scientists have known for some time that the Amazon isn't as uniform as it looks at first glance, and that it hosts many distinct regions with their own plant and animal communities. Before now, there have been various theories as to why this is - some have argued it's to do with rivers acting as barriers to species' spread, for example. But it now looks like the true causes may operate on an even larger scale.

The research suggests the Andes mountain range strongly influences the plants growing in the Amazon far away, by lifting the ground very slightly. The difference is so subtle you'd barely notice it at ground level, but it means water flows across the raised area more quickly, increasing erosion.



Map of soil properties, topography and plant species. The yellow line shows the boundary between geological formations in Peru. Circles are places where plants were sampled; red and blue circles show the distinct plant communities found on either side of the boundary.

Over hundreds of thousands of years this wears away the relatively nutrient-poor surface soil and exposes the much richer deposits buried underneath. So the areas that are raised up slightly by the distant Andes have more fertile soil and end up with a different mix of plants and animals.

"It's amazing to think that the Andes are driving the ecology of the Amazon forest more than a thousand kilometres away," says Phillips.

Satellite data meets fieldwork

The scientists looked first at the Peruvian rainforest. They took information from two satellites - Landsat, which senses the visible light and infrared radiation reflected by the forest canopy, providing information on the chemical activity there and how much moisture is present; and the Shuttle Radar Topography Mission (SRTM), which uses radar to create a very accurate picture of the contours of the landscape

below.

Combining these two sets of data - one showing different kinds of plant; the other revealing the fine details of the landscape - let the researchers see a line running through the forest that seemed to correspond both to a shift in topography and to a different set of plants.

To check this information against the facts on the ground, they drew both on fieldwork from the 1990s in Peru where Phillips' NERC Fellowship concentrated on sampling different species of forest trees and on newer research sampling ferns and another group of understorey plants called melastomes.

They focused on these plants because trees are so big and so varied that to get a representative sample you need to survey an extremely large area - and also because when they're not flowering or fruiting, rainforest trees can be hard to identify. The ground-level data came from 138 sites distributed along more than 450km of road and river.

The scientists applied the same remote-sensing methods to the rainforest of western Brazil, finding an even longer geological boundary that seems to have caused the forest on either side to diverge.

Phillips says it's striking that as so often, painstaking scientific research has ended up backing up the knowledge of the people who live in the area. "The locals are well aware of these differences - they know that some areas are much more suitable for farming, so they use various indicator species like particular understorey palms to identify the most fertile areas and clear the forest there," he says.

Indeed, a map of the results from Peru shows strong similarities to aerial images of local deforestation - the fertile areas are usually the ones cleared for farmland.

Phillips explains that these insights will be important in devising strategies to conserve the Amazon rainforests - it will be important to conserve both types of rainforest, as they are both unique ecosystems and if one is destroyed it won't be repopulated by the plants and animals that live in the other. More fertile areas may need more protection against clearance.

He adds that many of the areas these geo-ecological thresholds run through are so remote that biologists have never got there to do research on the ground. The study predicts that any who went and looked would find similar sharp ecological boundaries here to those described in the studies, but more fieldwork is needed to confirm this.

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