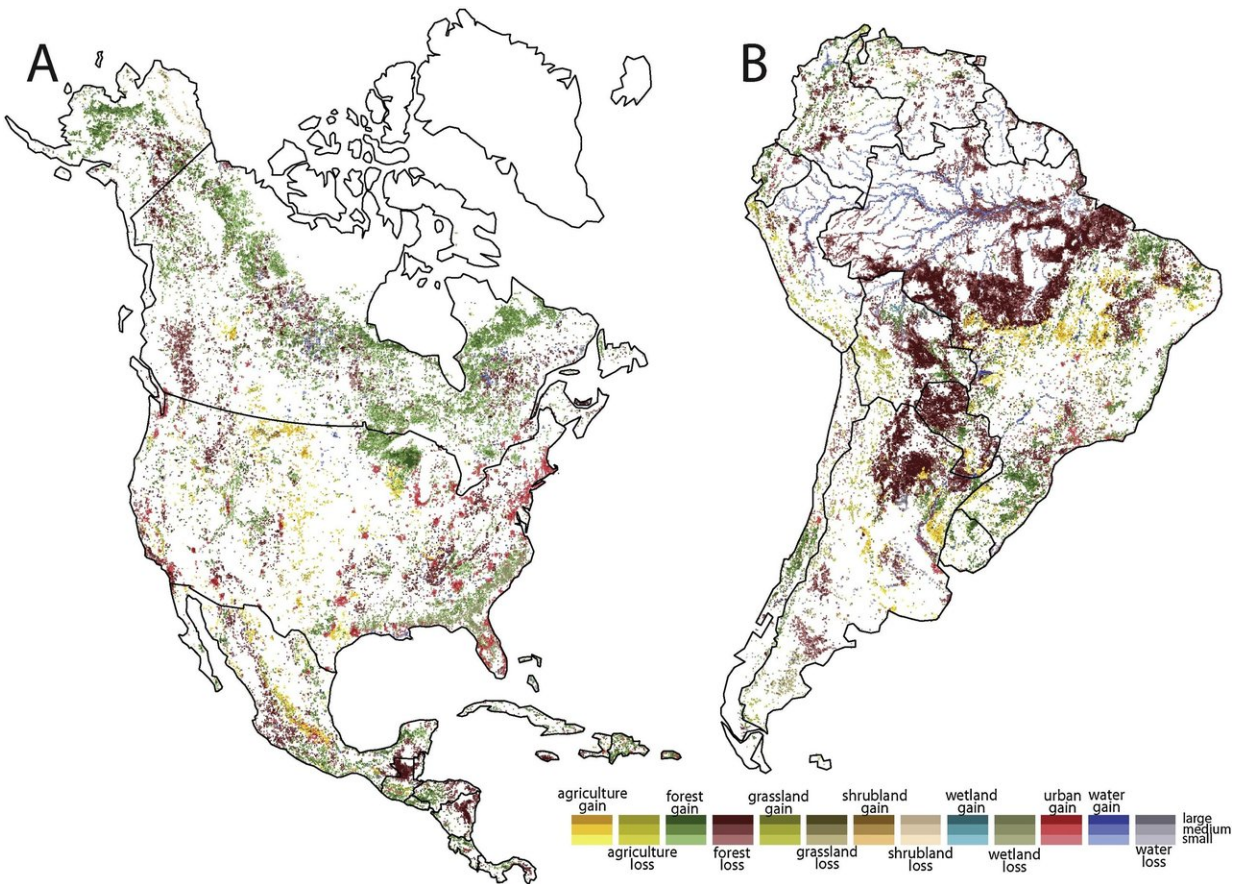


Powerful new map depicts environmental degradation across Earth

November 19 2018, by Michael Miller



UC used satellite images to track landscape change between 1992 and 2015. White reflects little change. Darker shades reflect the greatest rate of change in each category. Credit: Tomasz Stepinski/UC

A powerful new map by the University of Cincinnati illustrates one motivating force behind migrant caravans leaving Guatemala and Honduras to reach the United States.

UC geography professor Tomasz Stepinski created the new world map showing dramatic changes in land use over the last quarter century. Stepinski, a professor in UC's McMicken College of Arts and Sciences, turned high-resolution [satellite images](#) from the European Space Agency into one of the most detailed looks so far at how people are reshaping the planet.

"Right now there are caravans of people walking to the United States. Many of them are coming from Guatemala," Stepinski said.

News agencies such as The Guardian have called some of the Central American migrants "climate-change refugees" since many are fleeing successive years of crop failure. But Stepinski said climate change tells only part of the story. His map shows how Guatemala has seen widespread deforestation.

"And they've lost the forest because people use wood for fuel," Stepinski said. "It's one part of the refugee crisis."

The project was published in the *International Journal of Applied Earth Observation and Geoinformation*.

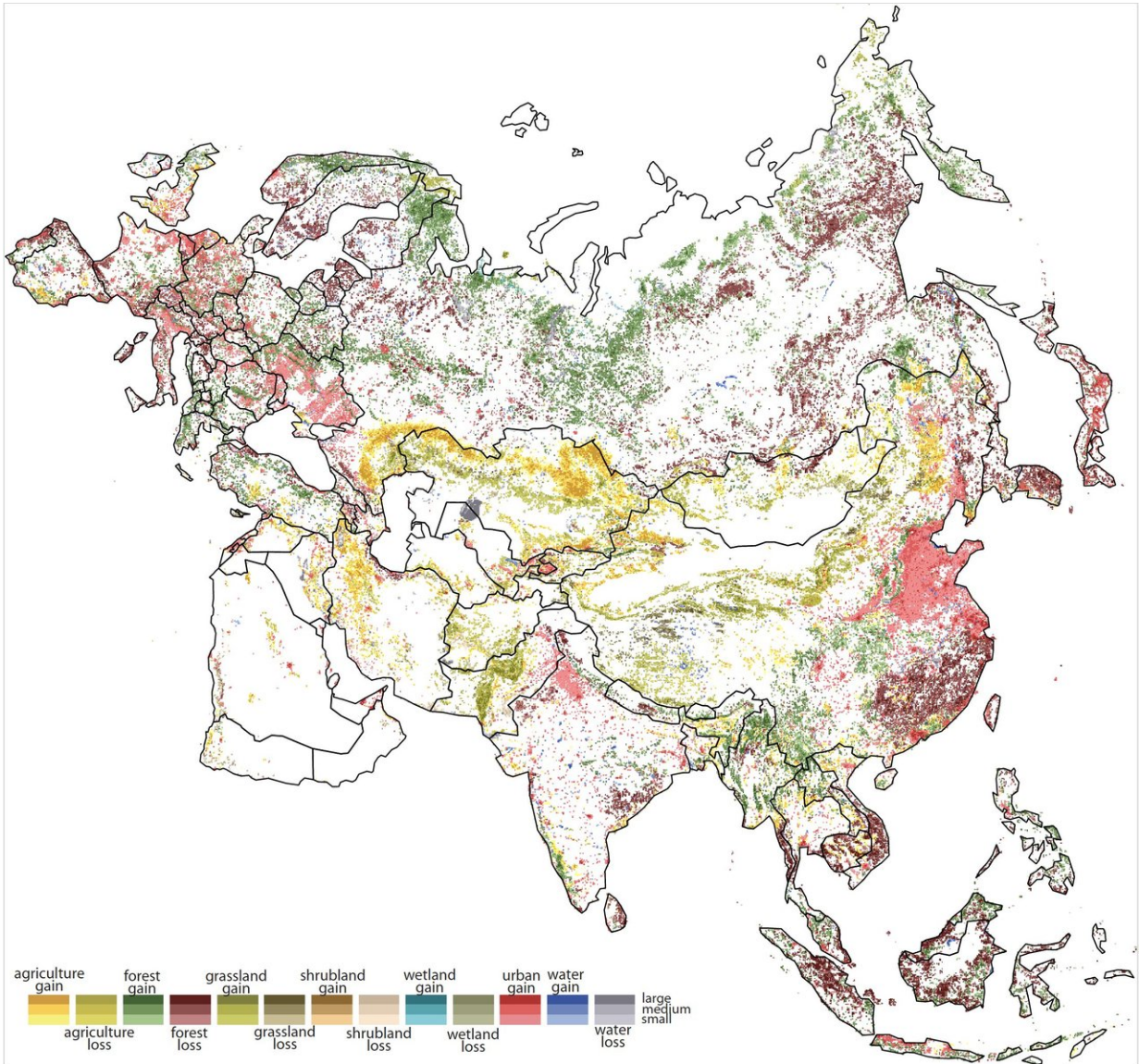
The digital map illustrates how 22 percent of the Earth's habitable surface has been altered in measurable ways, primarily from forest to agriculture, between 1992 and 2015.

"It's very informative. There is nothing else like it," Stepinski said. "There are maps of forest loss but no maps showing everything."

The map tells a new story everywhere you look, from wetlands losses in the American Southeast to the devastation of the Aral Sea to deforestation in the tropics and temperate rainforests.

"Of course, it raises alarm bells. But they're not new ones," Stepinski said.

"We already knew about deforestation or wetland loss or increasing urbanization. But now we can see exactly where all of that is happening," he said.



UC used satellite images to create a map tracking landscape changes between 1992 and 2015. White reflects little change. Darker shades reflect the greatest rate of change in each category. Credit: UC

The European Space Agency in 1992 began capturing satellite images of the Earth to study climate change, Stepinski said. Surface cover can dramatically influence temperature depending on whether it absorbs or

reflects sunlight. Likewise, forest cover absorbs more carbon dioxide than shopping centers.

"The great achievement for the European Space Agency was to make sure the satellite images were compatible from year to year so you could compare them," Stepinski said.

Stepinski said the map shows how finite natural resources are being exploited on a global scale.

"What makes this so depressing is that it's examining a timescale that is shorter than our lifetime," Stepinski said.

One of the most obvious examples of changing land use is found around cities, said the study's lead author and former UC postdoctoral fellow Jakub Nowosad.

"The direct impact of human actions is reflected in the patterns of urbanization. For example, you can see suburbanization and cities densification in North America and Europe," said Nowosad, now an assistant professor at Adam Mickiewicz University in Poland.

UC geography researcher Pawel Netzel also contributed to the project.

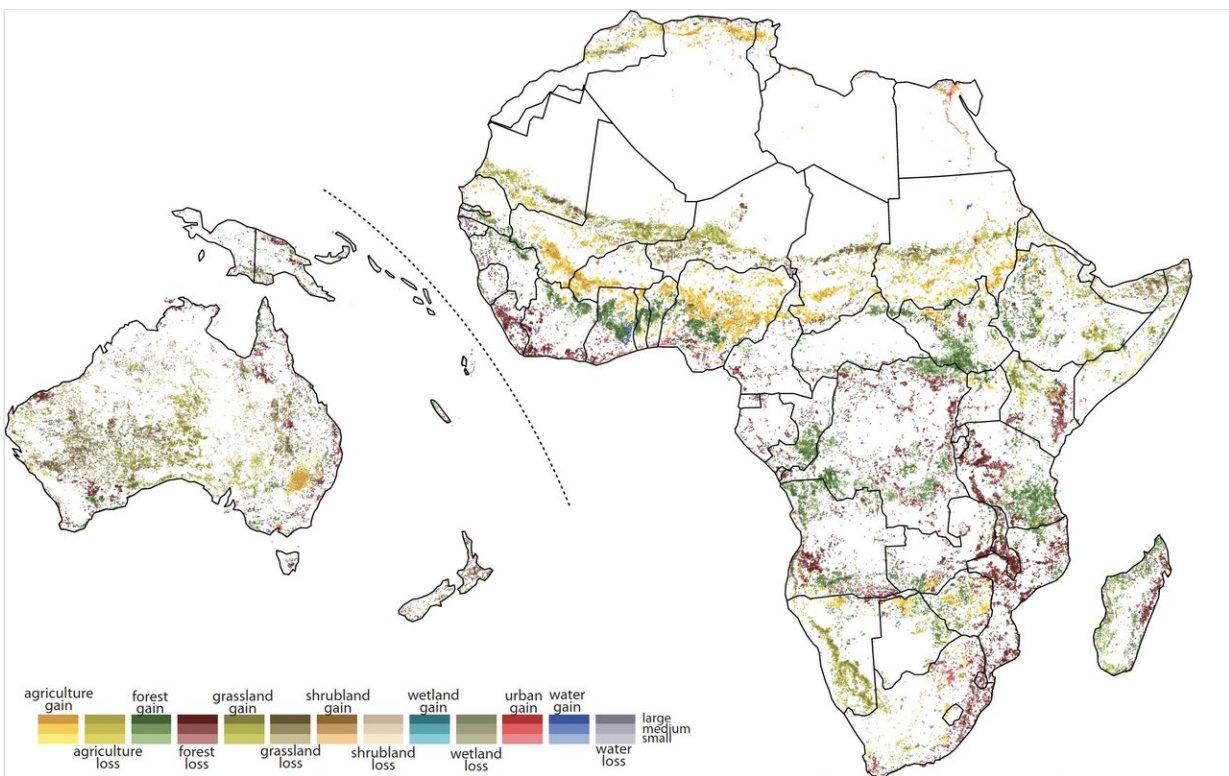
Nowosad said western China has seen vast urbanization while India's most obvious development has been in its smaller cities.

"I hope this map will make people more aware of the human impact on our planet," Nowosad said. "As a society, we need to be better informed of the scale of changes we make to the Earth, and in my opinion, this awareness can influence future changes in environmental policies."

Nowosad said his map does not draw any inferences about what the next

24 years might bring. But demographics suggest our footprint will only get bigger.

"Human population is still increasing, creating more demand for land and natural resources," Nowosad said. "Also, we know that societies in developed countries use more resources; therefore, with increasing development in poorer countries we can expect that pressure on land will be even larger than just predicted as an effect of population growth."



UC used satellite images to create a map tracking landscape changes between 1992 and 2015. White reflects little change. Darker shades reflect the greatest rate of change in each category. Credit: UC

The satellite images are so detailed, UC geographers could organize

them into 300-square-meter grids called pixels. Each pixel identified changes among 22 land-use categories describing various types of farmland, forest, wetlands, grasslands or urban development. But the tiny pixel sizes and large numbers of variables made a global analysis virtually impossible. In this incarnation, the map looked like a bowl of Fruity Pebbles.

So Stepinski organized the pixels into larger 9-kilometer squares and narrowed the number of land uses to nine types reflecting broader descriptions such as agriculture, forest or development. In comparing differences between the 1992 and 2015 maps, he used three shades of color to identify the extent of change from one [land use](#) to another.

Soon the story of the the past 25 years began to take shape. The map shows that the Sahara Desert in North Africa is growing.

"This is the transition area called the Sahel. And if you notice, you see grassland losses because of [climate change](#)—more desertification," Stepinski said.

The map of the United States shows huge losses of wetlands in the Southeast along with growing urbanization outside cities.

The map illustrates the dramatic disappearance of the Aral Sea, which dried up in the 1990s after farmers in Kazakhstan and Uzbekistan diverted its tributaries for cotton fields.

"It was a total disaster. This was a big saltwater lake fed by two rivers. They diverted water for cotton and the sea dried up into grassland," Stepinski said. "Today, you see huge boats sitting in the middle of fields."

Stepinski has used maps before to tell similar fascinating stories. News

website Quartz in 2017 called his map of racial diversity in the United States "insanely detailed." Earlier this year, he used WorldClim data to compare climates anywhere on Earth and project how the climate is expected to change over the next 50 years.

His latest project presented unique challenges.

Since many world maps tend to exaggerate the size of countries farther from the equator, Stepinski plotted his results using a projection map first developed in 1943 by Buckminster Fuller that shows the comparative size of continents. But this required UC to develop special software that would maintain the integrity of the data for the translation.

While the map tells the story of development in broad strokes, researchers can examine any portion of it in fine detail. The map presents data from each 300-square-meter pixel.

More information: Jakub Nowosad et al, Global assessment and mapping of changes in mesoscale landscapes: 1992–2015, *International Journal of Applied Earth Observation and Geoinformation* (2018). [DOI: 10.1016/j.jag.2018.09.013](https://doi.org/10.1016/j.jag.2018.09.013)

Provided by University of Cincinnati

Citation: Powerful new map depicts environmental degradation across Earth (2018, November 19) retrieved 25 April 2024 from <https://phys.org/news/2018-11-powerful-depicts-environmental-degradation-earth.html>

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