Artificial intelligence and big data provide the first global maps on key vegetation traits

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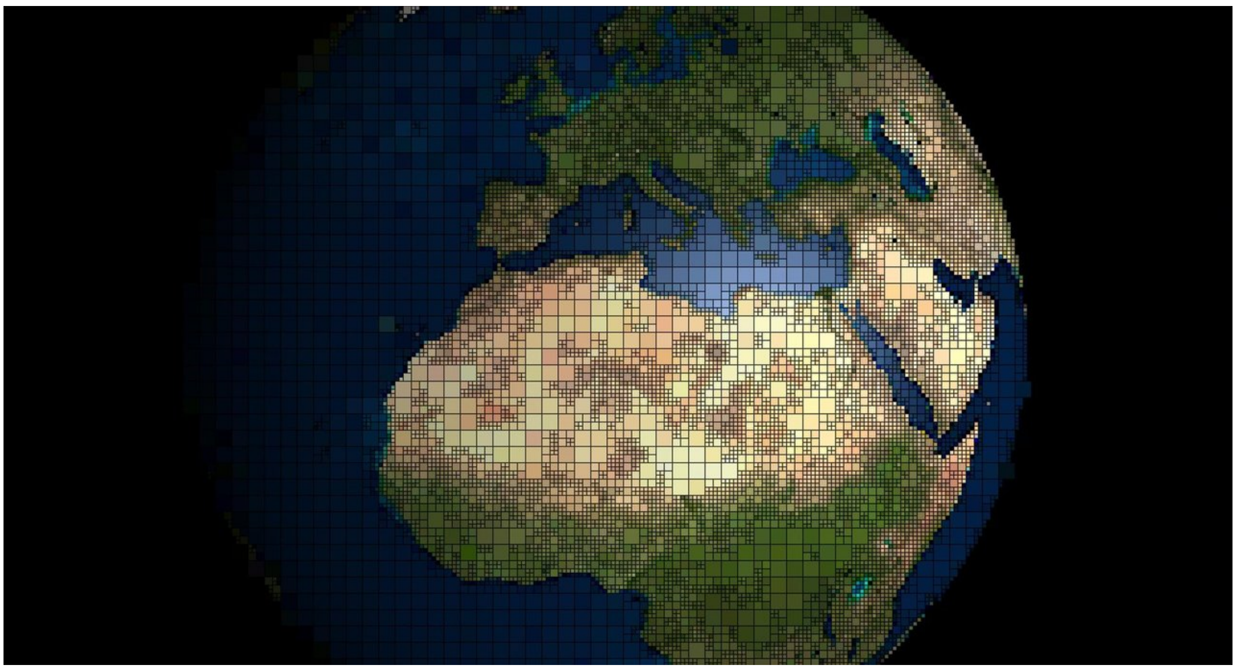

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Researchers of Valencia University (UV) have developed the first global maps of phosphorus and nitrogen content in vegetation, as well as efficiency in water use, via artificial intelligence and big data techniques. The application of these maps could benefit fields such as biodiversity, agriculture and the adaptation of species to climate change.

Artificial intelligence (AI) techniques and Google mass satellite observation data have made it possible to generate the first global maps on vegetation variables that until now were only available locally.

The research team has developed a methodology to generate global maps of key parameters, variables and features of the planet's vegetation. The AI technique works with Google's cloud to exploit thousands of images from the NASA and the ESA, enabling the generation and monitoring of global vegetation with high spatial and temporal resolution. The studies have revealed very interesting patterns in key parameters related to climate change, such as phosphorus or nitrogen content and plant foliage.

"Until now, it was impossible to produce these maps because the required conditions weren't available. We didn't have powerful and accurate machine learning statistical tools, nor did we have access to great bodies of data or cloud computing to process petabytes of satellite images in a fast and accurate way. Now, with the Google platform and AI techniques, we can make these calculations with data from the ESA or NASA quickly and on a planetary scale," says physician and electronic engineer Álvaro Moreno, leader of the study and current researcher of the IPL for the Image and Signal Processing (ISP) group.

"The mathematical tools are machine learning models that learn the relation between the images they receive from the satellites and the measurements taken from the Earth's surface. Once they have learned this relationship for numerous observation-measurement pairings, this knowledge can be extrapolated to any other location and time to generate estimation maps of the measure of interest," explains Manuel Campos-Taberner, researcher of the ERS. "The possibilities are tremendous, and now we can generate global maps from almost any variable of interest where there is in situ data, as we have the satellites orbiting and providing very good temporal and spatial observations. In our case, we generated global maps of biophysical parameters that are useful to monitor vegetation (how much vegetation we have, to what extent it's active, and what amounts of phosphorus and nitrogen there are), but they could very well be used for other variables of interest, not only on the ground, but also in water and as regards the quality of air," he says.

For over 15 years the team has been taking part in similar initiatives with the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) for the exploitation of data from current and future missions within a European programme called Satellite Application Facility on Land Surface Analysis (LSA-SAF). "It is the first European initiative dedicated to producing and distributing, in real time, variables of the status of the terrestrial environmental system, offering products of great value for the observation of the climate and the environment," says Javier García Haro, Principal Investigator of the ERS group.

Future applications

According to the scientists, the new maps will have implications in other fields such as precision farming, biodiversity and the adaptation of species to climate change. "The study is not only a conceptual test of what can be achieved by combining machine learning and remote sensing, but it also opens the door to future scientific studies that exploit these types of maps," says Gustau Camps-Valls, electronical engineering professor and researcher of the IPL. "The applications and implications are endless, and even more so considering the current pressure on food and biofuel production, for example, without underestimating the study of the impact on ecosystems and the adaptation of species."

Steven W. Running of the University of Montana, lead author of the fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), which earned him the Nobel Peace Prize in 2007, took part in these studies. "What Álvaro Moreno and his collaborators have done is impressive," he says. "Now, with a computer connected to the internet, you can do things that the ESA or NASA have never done in their 50 years of existence."

More information: Mingzhu He et al. Regional Crop Gross Primary Productivity and Yield Estimation Using Fused Landsat-MODIS Data, *Remote Sensing* (2018). DOI: 10.3390/rs10030372

Álvaro Moreno-Martínez et al. A methodology to derive global maps of leaf traits using remote sensing and climate data, *Remote Sensing of Environment* (2018). DOI: 10.1016/j.rse.2018.09.006

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