

# What's driving erosion worldwide?

December 3 2019, by Peter Rüegg

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The border between Haiti and the Dominican Republic is easily recognizable by the vegetation cover. Credit: UNEP—United Nations Environmental Programme

ETH Zurich researchers are reexamining the causes of soil erosion around the world—and have found that countries themselves have a surprisingly strong influence on their soil. This country effect was previously undetected.

Soil erosion is a global problem that threatens food security and the functioning of ecosystems. It has an adverse effect on water and air and, of course, on the soil itself. It also produces a number of harmful knock-on effects; farmers, for example, have to compensate for the loss of natural soil productivity by increasing their use of fertilizer. As things stand, soil is being lost at a significantly greater rate than it is being created. Given that the agriculture and forestry industries simply cannot function without soil, many governments are trying to combat the erosion in their countries.

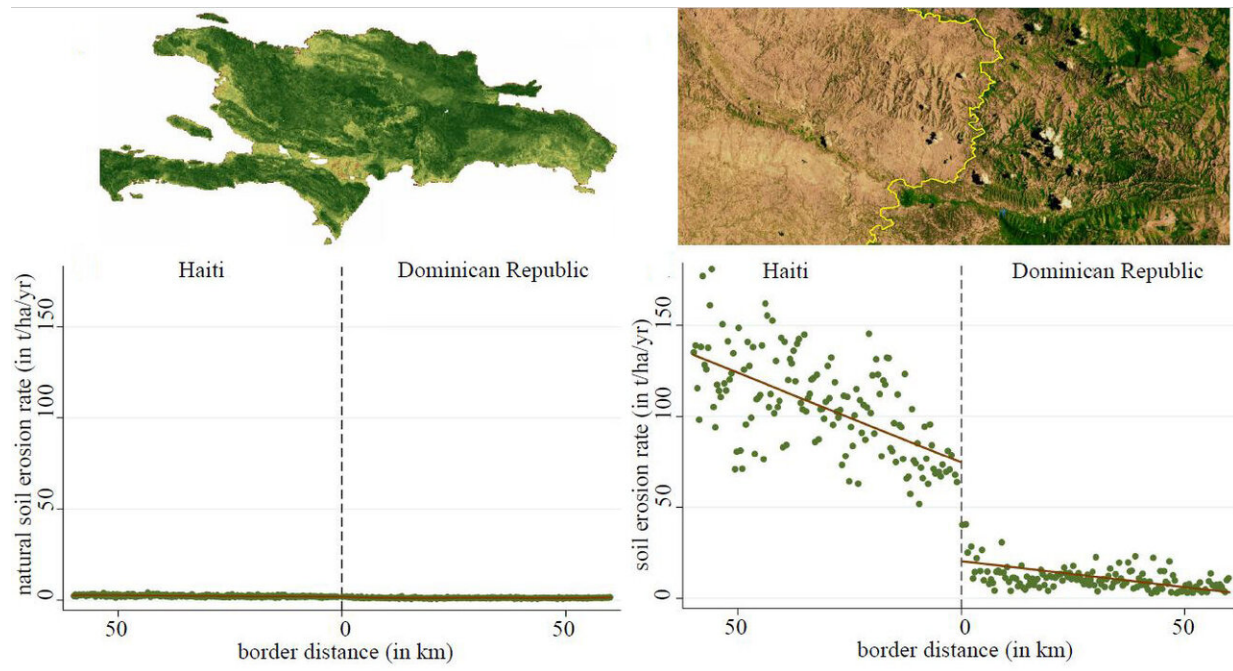
Soil erosion has a whole host of causes, many of which are still not well understood. We still don't know, for example, whether and indeed how different countries influence the erosion of their soils. Research so far has focused on identifying reciprocal relationships known as correlations, such as the fact that erosion is more severe in poor countries than in rich ones. Identifying causal effects, on the other hand, has been and remains very difficult.

## **Remote sensing and modeling of soil erosion**

David Wüpper and Robert Finger from the Group for Agricultural Economics and Policy at ETH Zurich and Pasquale Borrelli from the University of Basel have now employed satellite imagery and numerous other data sources to investigate the socio-economic causes of [soil erosion](#) around the world.

On the basis of high-resolution [remote sensing](#) data and numerous other data sources, the researchers created an erosion map of the world. With the help of a statistical model, the researchers then investigated whether the erosion rate is generally changing continuously through space but "jumps" abruptly at country borders. Such abrupt "jumps" at [political borders](#) reveal the influence of the countries that are left and right of the borders.

On a second map, the researchers also modeled the potential natural erosion rate. This enabled them to see how great the difference between current and natural erosion is and whether there are natural discontinuities in the erosion rate at the political borders.



The natural (left) erosion on the whole of Hispaniola would be almost the same. Currently the erosion is rising at the border. Credit: Wüpper et al., 2019, *Nat. Sustain.*

### National borders reveal where erosion is unnaturally high

It was through this approach that Wüpper and Finger were able to identify the "country effect" as a cause of soil erosion. The researchers present their findings in a study recently published in the journal *Nature Sustainability*.

This country effect is most visible along political borders as these areas offer the best basis for comparing observations. "The rate at which soils erode strongly depends on which side of a border, and accordingly, in which country the soil lies," says lead author David Wüpper.

To illustrate their approach, the researchers use the island of Hispaniola, home to Haiti and the Dominican Republic, as an example. In its natural form, Hispaniola would be uniformly covered with dense tropical forest and natural erosion would be very low because this vegetation would protect the soil from rain.

In reality, however, the researchers found that along the border, Haiti's soils lose 50 tonnes more per year and per hectare than those of the Dominican Republic. Wüpper explains that if Hispaniola had not been subject to human intervention and were still in its natural state, there would be no sharp increase in soil erosion along the border. "But the presence of such a rise points to political entities, not natural borders," he says.

The differential erosion along the border of the two Caribbean states is extremely high: 30 times higher than the global average, which—according to the researchers' calculations—stands at 1.4 tonnes per year and hectare of arable land. By comparison, the rate of erosion in Germany is 0.2 tonnes lower than that of neighboring countries. The researchers consider this to be very positive because it suggests that erosion is also fairly low in the countries that border Germany. "Our findings illustrate how inconsistent the pattern observed around the world is," Wüpper says. A country's strongest influence on soil erosion is its agriculture and the way that farmers cultivate the soil there. The income level in a particular country, however, has no influence.



The soil of this olive grove in Italy is exposed to erosion without any protection.  
Credit: Artemi Cerda

## **High potential**

In addition to highlighting failures and shortcomings in soil protection, the study also shows that there is clear potential for countries to improve their soil protection and how they go about it. Finger explains that before the study, nobody realized the huge leverage that the country effect would offer. In the past, soil erosion had been seen as a predominantly local problem. "Now we've shown that larger-scale factors also strongly influence erosion in a given country," he says.

In addition, the ETH Zurich researchers' method can be used to

determine whether measures that countries take to improve soil protection are effective or not. One such measure, for example, is introducing economic incentives to encourage greater [soil](#) cover or reduced tillage. However, measures to protect against [erosion](#) can also result in new conflicts of interest if, for example, reduced tillage leads to increased use of pesticides for weed control. "The basis for good policy-making in this respect is to identify and quantify these conflicting goals," Finger says.

Finger and Wüpper are already working on a follow-up study to investigate such trade-offs. They plan to use the same methodology to quantify the conflict of interest that all countries face between increasing their yields and conserving water.

**More information:** David Wuepper et al. Countries and the global rate of soil erosion, *Nature Sustainability* (2019). [DOI: 10.1038/s41893-019-0438-4](#)

Provided by ETH Zurich

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