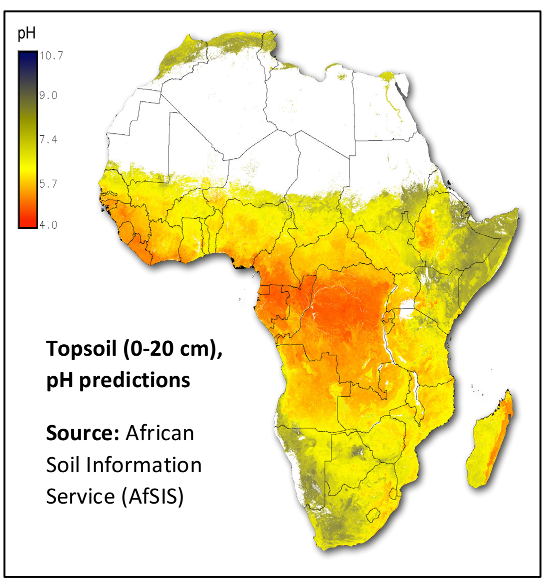
21st Century Explorers Seek Out New Riches in Africa

Scientists Use Technology to Shine a Light on Africa's Farms

Nairobi, Kenya – Portuguese explorers began mapping the African coastline in the 15th century in an effort to dominate the international spice trade. Those early maps, though crude, had a profound effect on Africa's history and the wellbeing of her people. Today, a new set of maps is under development that could well rival their importance.

Working from a small laboratory in Nairobi, Kenya, a group of modern day explorers is providing the data for a first-ever set of digital maps of African soils. Traditional maps, the scientists say, provide information on broad soil types but not on specific soil properties. The new maps provide direct information on soil properties at a level of accuracy once considered all but unachievable.

"It would have taken thousands of field workers and a multi-million dollar investment to develop the types of maps that are now being generated," says Keith Shepherd, the project's principal scientist. Shepherd is based at the World Agroforestry Centre, the world's leading research institution on tropical agroforestry.



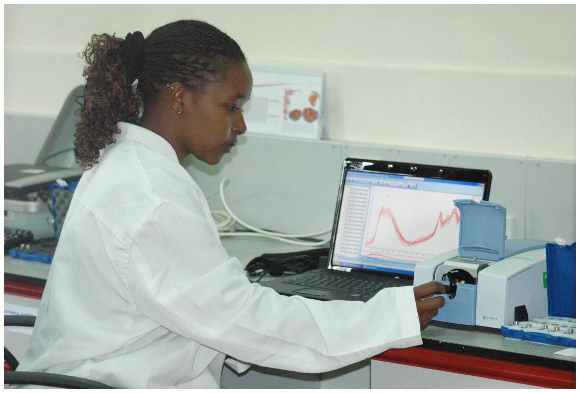
Topsoil (0-20 cm), pH predictions

Source: African Soil Information Service (AfSIS)

Detailed maps are now available that are helping thousands of subsistence farmers to maximize their production of basic food crops, an effort that many experts believe will also take the pressure off Africa's forests and marginal lands and help reduce global climate change.

"If you know what your soils can do and how to take care of them, that's an all-important first step to maximizing production," adds World Food Prize winner Pedro Sanchez. "Once farmers can produce enough to feed their families and produce surpluses, the back-breaking work of cutting down forests to grow crops will no longer be necessary."

A consortium of scientists is producing the maps using technologies known as infrared and x-ray spectroscopy. "It sounds complicated, but it's actually pretty simple," Shepherd says. "Basically what we do is shine light on a soil or plant sample and measure the amount of light reflected back at different wavelengths or energy levels, much in the same way that a digital camera records colour. The spectral signature, or fingerprint, tells us about the sample's mineral and organic composition. These characteristics determine a soil's functional capacity – for example its ability to retain and supply water and nutrients and to store carbon. With that information we can then determine the soil's potential and make highly accurate recommendations about what farmers need to do to improve the health of their soils and produce better crops."


Scanning soil samples with an infrared spectrometer

There are two parts to the system. The first part is the instruments used to read the samples – in essence to fingerprint them. Over the past decade, Shepherd and a small team of colleagues have developed a set of practical and affordable tools that enable researchers to rapidly and reliably analyse individual soil and plant samples.

Analysing a soil in a conventional lab requires highly sensitive equipment that depends on a reliable electrical supply and high-grade chemicals, both of which are often unavailable in developing countries, Shepherd says. It's also expensive. Even the most basic analysis can cost $50 and it can take weeks or even months before the results are delivered to farmers.

Using the new techniques, a soil sample can be analysed for about a dollar and the results made available within minutes. The entire instrument package costs less than $100,000, fits easily within a small shipping container, and is rugged enough to withstand the conditions found in rural Africa.

The second part of the system is a central library, a world soils fingerprint database if you will, against which samples can be compared and analysed. The database contains spectral information taken from tens of thousands of soil samples. Once collected, information is transmitted to the database in the Cloud and is instantly and automatically analysed. The entire process takes less than 30 seconds.

Thus far the results have greatly outpaced expectations. For example:

- In one of its first large-scale tests, the technology was used in a World Bank-funded project to begin reversing the damage caused to Lake Victoria from millions of tons of soil runoff from the small farms that surround the Lake. Using the new system, researchers were able to pinpoint the sources of soil erosion and advise local authorities and land users on where to focus conservation and restoration efforts.
- Last year the technology was used to map soil fertility problems in Ethiopia on about a third of the country's farmland – an area equivalent in size to the states of Kansas and Nebraska in the United States. The Government of Ethiopia is using the new system to guide their multi-million dollar investments in fertilizer imports and develop blending strategies that precisely target local conditions.

- Light-based methods are likewise being used to measure soil carbon stocks in the forests around Mount Kenya and in several large rangeland trust areas. As part of that effort, the Kenyan Government recently established its own spectral lab to track carbon emissions and removals as part of its commitment to the United Nations Framework Convention on Climate Change.
- In the near future, scientists plan to bypass conventional soil testing entirely. Next year, for example, project collaborators in Kenya, Rwanda, Tanzania and Uganda plan to analyse soil and plant tissue samples from thousands of on-farm maize trials using the new methods, the first time that such an effort has been done at scale.
- And in China, a phosphorus mining concern is now using the new methods to monitor heavy metal pollutants in soils and plants. The company is trying to identify what soil treatments are required, and to determine which trees to plant where to ameliorate heavy metal problems.

Looking forward, Shepherd and his colleagues are working to develop smaller, more portable instruments that can be used in farmers' fields. "Basically what we're looking for is a hand-held device that any extension agent can use to fingerprint a soil sample and instantly access our spectral libraries, in the Cloud, via cell phone, or to even use the cell phone itself to measure the sample."

Similarly, efforts are being made to develop new methods for directly analysing nutrient content in plants. The end result, scientists believe, will be a powerful set of diagnostic tools for crop nutrient management. If successful, that would give developing country farmers the same ability as farmers in North America and Europe to manage their soils and increase crop and livestock productivity.

"It's a big challenge, but it is now well within our reach", Shepherd predicts.

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Additional information about the World Agroforestry's Spectral Laboratory can be found on the Centre's website and publications list.

The Centre, is a partner in the African Soil Information Service, a Gates Foundation-funded project that combines remote sensing and predictive analytics to determine nutrient requirements and landscape management. The Centre welcomes others to join in supporting this critically important work is contributing to food security and poverty reduction across Africa and beyond.

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