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Digging in the dirt – ICTs and soil

As many other parts of the world, ACP countries have seen their soils severely degraded over the last 100 years, largely due to overcultivation, overgrazing, extensive fuelwood gathering, increased animal densities and inadequate natural resource management.

The result has been an ever-expanding catalogue of environmental deterioration: increased soil erosion and desertification; reduced soil fertility and the accompanying reduction in food production; critical losses of biomass and biological diversity; and the transfer of soil-based carbon into the atmosphere, polluting the air and contributing to global warming.

And all this is just when we consider 'normal' soil conditions. We can also add to this list pollution, oil saturation and salinization.

However, ICTs are playing a key role in overcoming each of these tribulations. Indeed, in some cases, without such technologies as GIS, GPS, remote sensing, computer modelling and decision support software, untying these tremendously knotty problems would be nigh on impossible. ICTs are part of strategies that, with luck, are set to radically transform agriculture in ACP countries, boosting crop production; arresting soil erosion and reversing desertification; and developing carbon sinks that, once emissions trading schemes are in place, will deliver substantial financial benefits as well.

These technologies are progressing at mercurial rates, and some are trickling down into the hands of agricultural stakeholders from developers in fields such as medicine, aerospace and defence. We cannot hope to cover all of them in *ICT Update*, but this issue includes a handful of projects that illustrate some of the key technologies that are now contributing to the improvement and conservation of soils in ACP countries.

One thread that seems to run through most of the projects we looked at for this issue is the issue of maps, or the lack thereof. Paper soil maps are rapidly being lost due to poor storage or the disappearance of institutions responsible for their maintenance. The problem is made worse by the fact that, for historical reasons, most soil maps are languishing in the archives of institutes in the North, largely inaccessible to users in the South. However, the internet, GPS and GIS are bringing an end to this knowledge divide and making such information much more widely available.

In the Q&A Dr Sjef Kauffman describes how his organization, ISRIC – World Soil Information, is attempting to combat this information decay with an extensive rescue operation. The European Digital Archive on Soil Maps of the World (EuDASM) project has digitized soil maps from around the world and made them available online and on CD-ROM.

One of the most exciting new developments is the use of infrared spectroscopy in concert with remotely sensed imagery. The application, developed in Kenya by Dr Keith Shepherd, is a 'soil lab in a suitcase' that will slash the cost of measuring soil moisture and many other properties. At the same time, it will turn what was once a very lengthy procedure into one that takes just 30 seconds.

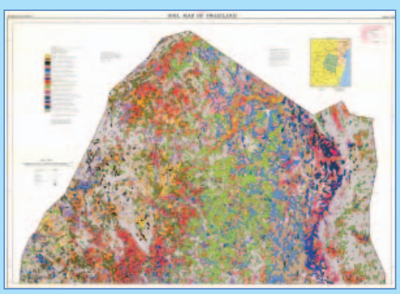
What is interesting about many of these technologies and the solutions being developed is their wide applicability and interconnectedness. The infrared spectroscopy technology would be equally useful to those involved in another project featured in this issue of *ICT Update* that investigated the extent of urban agriculture and the use of organic waste in Mali and Burkina Faso.

Meanwhile, in the Sahel, the Desert Margins Programme is attempting to combat desertification using a decision support system similar to that used by the urban agriculture researchers to plot the use of urban waste.

Damage to soils affects so many aspects of human life and the environment, not merely in the developing world, but everywhere on Earth. Nonetheless, as they are so central to agriculture, and agriculture is in turn so central to development, degraded soils afflict the developing world most especially. Development is hindered and undermined so markedly when we do not take soil into account.

And yet, apart from at the regional level, soil is rarely considered in agricultural planning. It is hoped that this issue of *ICT Update* will go some way towards ensuring that dirty old soil gets the recognition it deserves. ■

TechTip: European Digital Archive on Soil Maps of the World (EuDASM)



Soil maps may be vital to development and agricultural planning, but around the world, many are rapidly being lost due to poor storage or the disappearance of the institutions charged with their maintenance. The situation is particularly acute in developing countries where much valuable information has already been lost. Compounding the problem is the fact that the majority of soil maps are found in the archives of Northern institutes and are thus almost entirely inaccessible to users in the South.

Realizing the urgency of this problem, Dr Luca Montanarella of the European Joint Research Centre and Dr Otto Spaargaren of ISRIC initiated the European Digital Archive on Soil Maps of the World project in October 2004. The EuDASM translates soil information from paper maps and reports into digital format that is readily accessible anywhere in the world to anyone with an internet connection, and is available on CD-ROM.

The first steps in the project are largely complete. The translation of maps and data for Latin America, the last region to be digitized, was completed in December 2005. The next step is to develop a global digital information system on soil and terrain that could be used for an abundance of applications.

To access the archive, visit:
http://eusoils.jrc.it/esdb_archive/EuDASM/EUDASM.htm

The soils lab in a suitcase

Keith Shepherd describes how infrared spectroscopy and satellite imagery are helping African farmers boost crop production. With additional reporting from Tor-Gunnar Vagen and Ed Sulzberger.

A technique previously used by the pharmaceutical industry to ensure quality control in medicines is taking off as a tool that could deliver major increases in food production in developing countries. The process enables hundreds of soil samples to be analyzed in just one day for next to nothing, and, combined with GPS and satellite imagery, is set to radically transform soil mapping in Africa and beyond.

The technology employs infrared (IR) spectroscopy, a form of absorption spectroscopy that employs the infrared part of the electromagnetic spectrum to identify a compound and to investigate the composition of a sample. It provides precise information on soil conditions more cheaply and quickly than ever before.

'This is a technique that puts the equivalent of a million-dollar soils lab into a suitcase', says Dennis Garrity, director of the World Agroforestry Centre in Nairobi, Kenya.

Developed by the author at the Centre with support from the Rockefeller Foundation, the technique provides results that are equivalent to – and frequently better than – those available to farmers in industrialized nations. All that farmers and government agencies need is the same type of diagnostic surveillance used by public health systems for disease monitoring.

Identifying soil properties

The IR technique uses just light, and nothing else, in a non-destructive analysis of soil and plant materials. Working from a digital scan, technicians obtain a 'reflectance fingerprint' that can be used to identify multiple soil properties. The technique is fast, and does not require the costly chemicals normally used in conventional soil analysis. Once the equipment is up and running, the cost drops close to nil; previously the cost per sample sent to a conventional laboratory was more than €50.

First, an air-dried soil sample is placed in a petri dish and positioned on an optical window. IR light is then broadcast onto the sample and the reflected light is collected as a reflection spectrum on a computer. A range of soil properties for the sample is produced within 30 seconds using existing calibration models stored in the computer. The results are compiled in a report that can be transmitted to extension agents and other farm service providers via email or text messaging.

Until now, the absence of tools for rapid screening of soil and plant health has limited the completion of soil and plant nutrition surveys. Moreover, because land use in developing countries is changing so rapidly, soil conditions are in constant flux, which greatly limits the value of one-off surveys.

IR technology changes all this. For the first time, there is a tool that is extremely robust, has high levels of repeatability, and in a day can analyze hundreds of soil and plant samples for a variety of properties. Furthermore, IR technology could also help researchers apply diagnostic surveillance approaches to soil and plant health problems that until now have been used only in medical studies.

Soil fertility mapping

The technology also has the capacity to expand considerably national soil fertility mapping capabilities. Tests have shown that IR analysis can be effectively used in conjunction with GPS and satellite sensing to produce inexpensive maps pinpointing areas with soil and plant nutritional problems. Using existing soil maps and satellite images as guides, thousands of soil samples can be taken from geo-referenced point locations and analyzed for soil fertility constraints.

Depending on the density of sampling points, soil fertility constraints are usually mapped using either geo-statistical tools that provide spatial interpolation of point data, or by directly calibrating soil constraints to light reflectance bands on satellite images. The availability of affordable and accurate GPS equipment, and of freely accessible satellite imagery and processing software, has meant that the approach can now be widely applied in developing countries.

The technique not only provides higher resolution and more reliable data on soil fertility constraints than ever

before. It also allows uncertainties in the estimates of soil properties to be expressed in quantitative terms. This should help policy makers become more aware of the risks of basing decisions using data of this kind. The approach also permits researchers to provide quantitative estimates of the number of samples needed to obtain a high level of accuracy, and will help in identifying areas where additional sampling would improve accuracy.

Large-area diagnostic surveillance will increase the efficiency of scaling up soil and crop improvement practices by improving both the targeting of interventions as well as impact monitoring. The technique is also applicable in the assessment of the carbon sequestration potential of soils.

As small as the suitcase-sized device currently is, its developers believe that within a decade, versions the size of a mobile phone will be possible. The very first handheld IR units will be available in about three years, making soil analysis about as fast, easy and cheap as sending a text message. ■

Dr Keith Shepherd (k.shepherd@cgiar.org) is senior soil scientist at the World Agroforestry Centre, Nairobi, Kenya. For further information visit www.worldagroforestry.org/

Tor-Gunnar Vagen (Tor-Gunnar.Vagen@nlh10.nlh.no) is a research scientist at the Centre for Soil and Environmental Research in Jordforsk, Norway.

Ed Sulzberger (e.sulzberger@cgiar.org) is a fund raising and public awareness expert specializing in research and development issues for developing countries.

Carbon sequestration: pulling off an ecological hat-trick?

Dr Assise Touré explains how remote sensing and computer simulations are helping West Africa to take advantage of the Clean Development Mechanism.

Climate change presents perhaps the direst of threats to our world and the global economy. Without radical changes to our way of living and the development of clever new strategies to counter carbon accumulation in the atmosphere, the world is on course for more extreme climate events such as floods and droughts. In dry areas such as the Sahel, to this can be added severe land degradation, and irreversible desertification.

Carbon sequestration is one such clever new strategy. Carbon exists in five different locations – or 'pools' – on the planet: in the atmosphere, the oceans, the terrestrial biomass (plants and animals), geological formations and soils. Carbon sequestration is the facilitated transfer of carbon from the air to other pools, thus reducing the amount of atmospheric CO_2. This transfer, or 'flux', sees natural processes of photosynthesis take carbon from the air and transform it into organic material that enters the soil via plant roots, organic litter and crop residues. In this way, soils become a carbon 'sink'.

The process could achieve an 'ecological hat-trick'. Not only could it ameliorate carbon accumulation in soils, but it would also help to combat desertification, improve soil fertility, and enhance biological diversity. Better yet, as the Clean Development Mechanism (CDM) of the Kyoto Protocol allows developing countries to sell carbon credits to developed nations to offset carbon emissions, sequestration would also deliver substantial economic benefits to farmers and other stakeholders in Africa.

However, before such projects can be launched in a region, local stakeholders must first estimate its sequestration potential. This requires quantifying the dynamics of carbon sources and sinks over space and time, and modelling the major processes that control CO_2 exchange between the soil and the atmosphere.

The SOCSOM project

Sequestration of Carbon in Soil Organic Matter (SOCSOM) is a project launched by USAID and the EROS Data Center of the US Geological Survey to investigate this potential in Senegal. The project used remotely sensed imagery and biogeochemical computer modelling to develop carbon sequestration strategies that could eventually be applied across the country. The semi-arid and sub-humid regions of Africa have the highest potential for carbon sequestration in the world due to their severely degraded soils. But by increasing irrigation, reduced tillage, restoring grasslands and savannas, and extending fallow periods, coupled with applications of compost and organic waste and the adoption of erosion control strategies, countries could replenish their soil carbon stocks. In the process, this would benefit farmers through increased agricultural productivity.

In a pilot study in southern Senegal, SOCSOM researchers employed remote sensing to depict the trends and sensitivity of carbon stocks under various management and climate scenarios over a 200-year period from 1900 to 2100. They estimated the patterns of carbon stocks and fluxes in 1900 by setting up the General Ensemble Biogeochemical Modelling System (GEMS), a computer simulation, to run for 1500 years, based on actual vegetation, soil, drainage and climate data from 1961 to 1996.

Using a detailed timeline of remotely sensed imagery from the Landsat satellite taken in 1973, 1978, 1984, 1990 and 1999, and field-checked in 1984, 1996 and 2001, they were able to map the changes in land and carbon status across the country. The system was then used to simulate the impact of human activities on carbon dynamics by incorporating information on changes in land cover and land use. Additionally, data on crop composition, crop rotation patterns, grazing, fire, fertilizer use and irrigation from the literature and censuses were incorporated into the simulations. Finally, various possible future climate change scenarios were layered into the model.

The model results showed the actual and potential soil carbon gains, and the economic and ecological costs and benefits. Between 1900 and 2000 the total carbon stock in soils and vegetation went from 141 to 89 tonnes per hectare – a reduction of 37 per cent.

Carbon credit payments

That may sound bad, and it is, but in the world of carbon sequestration, this is actually great news, because it means that Senegal has that much more 'space' left to fill with carbon. And what does this signify financially to the country in terms of carbon credit payments from developed nations? Some €70 million a year, or just under €2.5 billion over the 35 years that it will take to reach a new carbon steady-state. In order for the carbon sequestration process to be maintained over that period, national capacities for monitoring and simulating soil carbon stocks using remote sensing, GIS and biogeochemical modelling must be improved. Thus, after the original SOCSOM pilot projects were completed, the effort to develop sequestration strategies for West Africa was split into two complementary programmes. The first, SEMSOC, is developing locally integrated project activities with partners in Burkina Faso, Ghana, Mali and Niger, to achieve a 'Sahel and West Africa-wide synthesis' of the region's carbon sequestration potential. The second programme, SOCSAB, based at the AGRHYMET Centre in Niger, focuses on training in the use of modelling technologies.

All of which brings great hope to the struggle against global warming and not insignificant financial benefits to Senegalese farmers. ■

Dr Assise Touré (assize@cse.sn) is the technical director of the Centre de Suivi Ecologique in Senegal. For further information visit http://edcintl.cr.usgs.gov/carboninfosheet.html

Waste not, want not: satellite soil mapping in West Africa

Recycling organic waste could benefit local authorities and urban farmers, reports Leo van den Berg

In cities across West Africa there are mounting concerns about the growing volume of waste. Bamako in Mali and Ouagadougou in Burkina Faso, for example, each generate 600–700 tonnes of solid waste per day, about a third of which is organic material. As these cities grow, local authorities urgently need to find ways to deal with the problem, but are faced with diminishing budgets for the collection, safe treatment and disposal of waste, and landfills are approaching capacity.

At the same time, farmers in and around these cities produce significant quantities of fresh food, but the municipalities tend to view them as economically unimportant and their farms as occupying potentially valuable real estate. Yet there has always been a strong symbiosis between the production of organic waste and its use by urban and peri-urban farmers to improve their land – it contains nutrients that replenish soil fertility, helps retain soil moisture, and assists in preventing erosion. In short, the cities need to get rid of the waste, while farmers need organic material as fertilizer for their fields.

APUGEDU

As part of a three-year EU-funded project to promote the recycling of organic waste for use in urban agriculture in Bamako and Ouagadougou, researchers set up a pilot study to establish whether farmers would use more organic waste if it were treated and made safe for use on their land. But before any action could be considered, they first had to ascertain the extent of urban farming, the location of farms, and the number of farmers who are currently using organic waste.

Researchers from the APUGEDU project, which was implemented by a consortium of local and international partners led by the Agricultural Economics Research Institute of Wageningen University, found that the authorities had little information except for a few maps showing the locations of farms in and around their cities. The farms varied enormously in size, from large fields to beds of tomatoes just 1 m^2, making it difficult for project staff to visit all of them.

In the past, researchers would use aerial photographs to select areas for study, but this was extremely labour intensive. The APUGEDU researchers decided to use some modern mapping techniques that would save a lot of time and effort. They acquired imagery from Ikonos 2, a new high spatial resolution satellite that delivers near-photographic quality imagery of anywhere in the world, but they didn't come cheap. The two sets covering Bamako and Ouagadougou cost around €12,000. In fact, they had wanted to survey a larger area, but that would have pushed up the price to almost €18,000.

A multi-spectral approach

The researchers applied formulas to the Ikonos imagery to identify reflections on the Earth's surface, and translated the results into descriptions of the various land types using a 'multi-spectral approach'. With these formulas they were able to identify irrigated land, dry areas of sand, and areas with nutrient-rich soils due to the addition of organic matter, i.e. farms using urban waste.

The resolution of an image is a function of the size of the area represented in each pixel. With the previous imagery one pixel represented between 20 and 30 m^2, if you were lucky. With the higher spatial resolution of the Ikonos imagery – about 4 m^2 per pixel – the researchers thought they would be able to categorize land types much more precisely.

In irrigated areas, plant growth occurs in stages, each of which reflects light differently, and in turn gives a different average value per pixel. This minute level of differentiation was what the researchers were after, but when they analyzed the results, they found that due to the multiple stages of plant growth, there was simply too much variation to be useful, and the data no longer averaged out. In the end, they decided that the Ikonos imagery was not the blessing they had expected, and that lower-resolution imagery was probably much better suited to this sort of analysis. In an earlier project in Nigeria, they had used SPOT-XS and Landsat images and found that the elements that were averaged out in each pixel produced quite distinctive results. And they were considerably cheaper – just €200 each!

The project then developed a hybrid approach using a GIS, and combining the satellite imagery with ordinary maps obtained from the local authorities, including maps of urban horticulture, waste collection sites, a digital land register and even a tourist map. After scanning the maps and merging them with the satellite data into one database, they then played with different imagery values from the two satellites and treated them as variables in the GIS analysis. A year after obtaining the satellite images, the researchers confirmed the data at 279 locations, using a GPS to register geographic coordinates.

Ultimately, remote sensing combined with ground truthing proved to be a cheaper and less labour-intensive method of mapping urban agriculture and the use of organic waste. You don't always need a hammer – in this case, near-photographic quality high-resolution satellite imagery – to crack the proverbial nut. ■

Dr Leo van den Berg (leo.vandenberg@wur.nl) was project coordinator/researcher at at Alterra, Wageningen UR, the Netherlands, and now works at Wageningen University. For further information visit www.lei.dlo.nl/apugedu.

feature

Battling desertification with decision support software

Sibiry Traore explains how decision support tools and GIS are being used to develop new, targeted agricultural techniques for Africa's desert margins.

Far from being part of the 'natural cycle' of things, desertification is fundamentally about land degradation – the decline in the quality of soil, water or vegetation caused by human activities such as over-cultivation, and climate change.

Desertification affects over a third of the Earth's surface and more than a billion people. In recent decades there has been a substantial decrease in precipitation in many parts of Africa, but particularly in countries on the margins of the Sahara known as the Sahel.

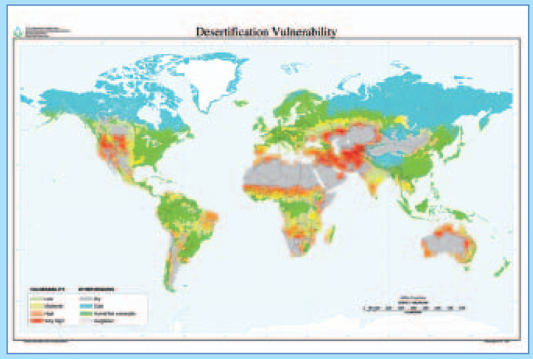
The soils of the region are sandy, coarse and retain very little water, so that very few plants can grow in them. Such poor, dry soils contain very little biomass and organic matter, and are highly susceptible to wind erosion. With the decreasing vegetation cover, there are fewer plant roots to hold the soil together. It's a vicious cycle, made worse by the increasing population pressure and poor agricultural practices.

Desert Margins Programme

The Desert Margins Programme, initiated by the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), brings together national scientists from five Sahelian countries, as well as Botswana, Kenya, Namibia, South Africa and Zimbabwe. The programme is working to tackle land degradation in these countries by raising awareness of the problem and by organizing training in the use of decision support software or tools for national scientists.

At the desert margins, soil properties can vary enormously over a small area, requiring different agricultural techniques. For example, farmers need to apply different amounts of fertilizer to millet and other crops, or to sandy soil as compared with a clayey soil.

The interactions between various elements of farming systems are extremely complex. These are: the nutrients applied to soils, the differing rates at which these nutrients break down, the yields of different crops and crop varieties, livestock movements, and geography. Understanding these interactions requires the use of decision support tools. They provide information that is then coupled with a GIS, allowing the development of targeted techniques or cropping systems that can be rolled out in different situations and locations.



DSSAT

Two crop modelling systems that are applicable to West Africa are the Decision Support System for Agrotechnology Transfer (DSSAT) and APSIM.

DSSAT is a suite of programs for PCs that combines soil and weather databases with crop models and application programs that can simulate multi-year outcomes of crop management strategies. DSSAT allows users to ask 'what if' questions and obtain in minutes results that would otherwise take years of real-world experimentation.

The researchers chose DSSAT rather than APSIM, a similar set of programs, even though APSIM is especially strong on the soil side, because it was produced by Australian research teams for Australian farmers. APSIM's rigid intellectual property protection means that it would not have been possible to access and change the source code.

If we run into a problem and we want to understand what's not right in the model, we need to access the source code. Very few models have been produced for developing countries and so do not represent the local constraints we have here. Thus it is important to have access to the code to ensure that decision support is adapted to the conditions under which researchers are working. We have tried to convince the developers of APSIM to open up the source code, but we have little leverage. They have to make money out of it. This is a problem for international research institutes, which are mandated to produce non-proprietary work that is accessible to the largest number of people.

With DSSAT, however, we have flexibility in that we can change the code, make recommendations to the development team, who can then incorporate those suggestions into upcoming releases. With DSSAT we can do whatever we want. It's not quite open source, but all parts of the model are accessible, and it's cheap – less than US$200 – so even our national partners can afford it.

However, DSSAT is more of a research tool that we can use to develop new technologies or cropping methods. We have found that the target group for this tool is not the farmers, but national scientists. ICRISAT brings together scientists from the programme countries for workshops on DSSAT and other modelling tools. We also organize follow-up workshops, where the scientists work on real problems affecting their own regions. We then work with them to expand their skills in modelling appropriate farming systems, and to enhance capacities at the national level. The next step is to pass on to farmers this information and advice on cropping systems that will arrest or reverse land degradation.

The struggle against desertification requires new agricultural techniques that are applicable to conditions at the desert margins, as well as national capacities to use the decision support software that will help develop such techniques. Software tools need to be more appropriate to ACP countries, and developers need to be more flexible, because conditions in countries such as Niger are rarely comparable with those in Australia or the American Midwest. ■

Dr Pierre Sibiry Traore (p.s.traore@cgiar.org) is the head of GIS at ICRISAT. For more information, visit www.dmpafrica.net. DSSAT software can be ordered from www.icasa.net/dssat/.

Web resources

This section lists key resources in the field of soils
Additional information is available from the web magazine at http://ictupdate.cta.int

Madagascar, Sudan: ICS
ICS is a French company that supplies agricultural equipment to farmers in Africa and the Middle East. In arid areas where soils are fragile and water resources are limited, high-performance agriculture relies on effective irrigation water management. ICS supplies electronic sensors that measure either the soil moisture content or soil water potential, indicating when the plants need water, so that the farmer can adjust the timing and the amount of irrigation accordingly. The Watermark® sensor, for example, and is suitable for arid regions where the soil moisture content fluctuates greatly during the period of crop growth. A series of these sensors may be connected to a data logger (a device resembling a PDA), for automatic soil moisture monitoring, linked to an irrigation system.
www.ics-agri.com/index.htm

Cuba: Computer simulation models of water use in irrigation, esp. in regard to sugar cane production
Computer simulation models may be a key component of the agricultural decision-making process, but too few models are adapted for developing country conditions. Specialists from the Agrarian University, Havana, and national irrigation and drainage institutes have developed the first software for modelling Cuban soil and water conditions. According to Dra. Maria Elena Ruiz, these models facilitate 'what-if' experiments, with no need for expensive, and sometimes impossible, field tests.
www.isch.edu.cu/

Mali and Senegal: Decision Aids for Integrated Nutrient Management
Soil acidity and nutrient deficiencies limit crop yields in most developing countries, but once these constraints are overcome, new cropping strategies are possible. The Decision Aids project, a collaboration of the North Carolina State University and institutes in Mali and Senegal, seeks to develop and disseminate integrated decision aid tools that will facilitate the process of diagnosing soil constraints and selecting appropriate management practices for location-specific conditions.
http://intdss.soil.ncsu.edu

Southern Africa: Soil Fert Net
This multidisciplinary network aims to improve the management of soil fertility resources in the maize-based smallholder farming systems of Malawi, Zambia and Zimbabwe. The network members support research to identify suitable new technologies for maintaining and enhancing soil fertility, and deploy them in trials involving thousands of farmers. The results are disseminated to farmers and farm advisers via the website and a series of booklets, 'Best Bets'. The network also provides training, and economic and policy support to ensure that farmers can access technologies.
www.soilfertnetsouthernafrica.org/

Namibia: Agro-ecological Zoning Programme
The Namibian Ministry of Agriculture has used the latest crop modelling technology, Decision Support System for Agrotechnology Transfer (DSSAT), to assist planners, managers and researchers. The DSSAT system can be used to identify the 'best' farming systems for specific conditions, including crops/cultivars, planting dates, fertilizer applications, etc. This information can be integrated with the database and GIS system being developed as part of the programme.
www.icasa.net/applications/namibia.html

FAO/IAEA: Optimization of Fertilizer Application for Irrigated Wheat Systems using crop simulation models and nuclear techniques
This joint project aimed to find ways to improve management of soil water and fertilizer applications in order to maximize resource use. Using neutron probes and the CERES-wheat model (part of the DSSAT suite of simulation models), the project was able to explain differences in crop and soil information collected in different environments. This information is now being applied to refine management strategies and recommendations for specific conditions in the participating countries.
www.icasa.net/applications/fertilizer.html

FAO Africover Initiative
The FAO launched the Africover Initiative in response to the many national requests for assistance in the development of reliable, geo-referenced information for decision making, planning and natural resources management in Africa. Africover aims to establish a freely accessible digital geo-referenced database on land cover for the whole of Africa, and to develop tools appropriate to the continent. Data, maps and software tools can be downloaded free from the site.
www.africover.org

FAO Land and Water Development Division
The Plant Nutrition Management Service is responsible for programmes and activities related to integrated planning and management of land and plant nutrient resources, enhancement of soil fertility and land. The site offers access to a vast range of information resources, databases related to soils, as well as portals devoted to soil fertility and plant nutrition, and Pro-Soil, a multimedia kit including a database and electronic archive on how to deal with soil problems. The Division also publishes a Digital Media Series, a set of 31 CD-ROMs on land and water issues.
www.fao.org/ag/agl/agll/index.stm

FAO Global Assessment of Human-induced Soil Degradation (GLASOD)
In 1990, ISRIC and UNEP produced a world map of human-induced soil degradation in three sheets at an average scale of 1:10M, which has since been digitized and stored in GIS format with a database and supplementary statistics. The GLASOD map is now also accessible online. For each country the extent of each severity class of soil degradation and associated population numbers in the area mapped are given.
www.fao.org/landandwater/agll/glasod/glasodmaps.jsp

World Overview of Conservation Approaches and Technologies (WOCAT)
WOCAT is a consortium of national and international institutions that serves as a clearinghouse for soil and water conservation specialists to share knowledge on land management, soil fertility and soil resources. Tools, results and outputs are accessible online, in the form of books, maps or on CD-ROM. WOCAT recently asked national experts to provide information on the conservation technologies used in their country, which will be compiled in a world map.
www.wocat.net/worldmap.asp

Decision Support System for Agrotechnology Transfer (DSSAT) version 4
DSSAT is a software suite combining crop, soil and weather databases, and programs to manage them. Is also includes crop models and application programs, to simulate multi-year outcomes of crop management strategies. DSSAT has been in use for more than 15 years by researchers in over 100 countries.
www.icasa.net/dssat

Q&A: ISRIC, soils and ACP farmers

Sjef Kauffman explains how ISRIC – World Soil Information, is improving access to the world's soil maps for everyone.

What are the key problems relating to soils for farmers in ACP countries?

For the majority of small farmers in ACP countries the three major factors limiting production are low soil fertility, shortages of water in the root zone soil, and soil degradation. Soil fertility is often low because many soils are strongly weathered or sandy. Moreover, many farmers do not add adequate fertilizer to compensate for the nutrients that their crops take from the soil. Agriculture in ACP countries, particularly in sub-Saharan Africa, is predominantly rainfed. In semi-arid and sub-humid areas, shortages of water in the root zone of the soil may limit crop growth during the rainy season. Over-cultivation may lead to enhanced wind and chemical degradation, which will reduce the production potential of the soil, unless appropriate soil and water conservation approaches have been adopted.

How do these problems relate to agricultural and rural development?

These three factors often lead to low production levels, making it difficult for many small farmers to escape a life of subsistence. Governments need to create better production conditions by: (i) making fertilizers more affordable for all farmers (e.g. fertilizer prices inland can be four to five times those at the port); (ii) providing financial support for farmers to invest in soil and water conservation; and (iii) promoting the development of agricultural training and information facilities for farmers.

Most uses of ICTs in relation to soils seem to be confined to surveys of land cover, soil moisture, etc. Do you feel that GIS and GPS technologies could take over the role of the surveyor?

GIS and GPS are tools for the surveyor that make it possible to offer fast, location-specific, and tailor-made information on soils and other natural resources to support land owners and policy makers in making decisions about, for example, necessary investments. GIS and GPS are not taking over, but rather enhancing the role of the surveyor. Moreover, GIS applications are always dependent on the quality of the available data, and new field surveys are needed in many ACP countries to expand and improve current datasets.

What activities is ISRIC involved in that you are excited about?

ISRIC, in collaboration with the FAO and various national partner institutions, is currently involved in the global and local monitoring of land degradation based on semi-automatic interpretation of satellite images. This will be the first objective quantitative assessment of land degradation worldwide that can be used to underpin policy decisions, and will supersede existing qualitative assessments.

ISRIC is a leading partner in the development of the European Digital Archive on Soil Maps of the World (EuDASM), which allows anyone with an internet connection to access soil maps. What is the next step in accessibility?

Many of the maps that are now accessible through EuDASM were deteriorating in the archives of Northern institutes, and were inaccessible to individuals in the developing world. Now, no one has to trek all the way to a library in the UK, say, in order to access a soil map. Every user of soil information can access ISRIC's soil collections online or on CD-ROM. This is a great leap forward, but the challenge now is to convince other national and international soil map holders to join this innovative venture.

ISRIC is making soil maps available online and on CD-ROM, but is this sufficient?

It is a first step, but in practice users ask various questions that require an interpretation of soil information combined with other biophysical and socio-economic information. ISRIC and its partners are exploring a number of ICT tools that will allow us to do this. For example, we have recently formulated a proposal for a Green Water Information and Learning Network, which would include an easy-to-use question-and-answer facility for users in the field and at government level. The proposed network would include national partners in ACP countries and leading international institutions concerned with the development of sustainable agro-ecosystems.

What sort of applications could follow from the creation of this comprehensive soil map archive?

Linking the global EuDASM collection with the digital Soil and Terrain Database (SOTER) will open up an array of applications in the fields of climate change, food production, biodiversity, water, and other environmental assessments at global, regional and national levels. ISRIC looks forward to contributing to all of these ventures in the coming years. ■

Sjef Kauffman (sjef.kauffman@wur.nl) is Deputy Director of ISRIC – World Soil Information, Wageningen, the Netherlands. For further information, visit www.isric.org.

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