Feeding the 9 billion

An ever-expanding population is forcing agricultural producers to up the ante, requiring improved monitoring measures to ensure expansion is environmentally sustainable. Here, **Lieven Bydekerke** and his partners **John Latham**, **Olivier Leo** and **Wu Bingfang** discuss how they have come together to address this issue

Can you describe some of the potential long-term impacts of insufficient global monitoring of agriculture?

JL&OL: Food is a basic human need and low agricultural yields may lead to shortages. Obtaining information on agricultural production in order to plan and regulate food supply and demand is essential. In past decades, these data have become increasingly critical in light of the growing global population; competition between food, feed and energy; as well as rising levels of global food trade. What we find in our shops is grown in many different parts of the world. As such, failures in national supply chains may have a global effect, possibly with severe consequences. For this reason, accurate, transparent and timely information is required to enable countries to take appropriate mitigating actions – both in the short- and long-term – that can lessen the impact on a country's food security status.

What measures have been taken to address the situation, and how can these be improved upon?

JL&OL: In 2008, food prices spiked, pushing millions of people into extreme poverty and hunger. This was caused by uncertainty in food supply, with market speculation and export bans aggravating the situation. As a result, in 2011 the G20 agreed to increase transparency on agricultural commodities on a global scale. The resulting Agricultural Market Information System (AMIS), managed by the Food and Agricultural Organization of the UN (FAO), collects and provides information on agricultural markets worldwide. The Group on Earth Observations' Global Agricultural Monitoring (GEOGLAM) initiative, managed by the Agriculture Community of Practice of the GEO, uses remote sensing-based technologies to increase accuracy, transparency and timeliness on agricultural production as an input to AMIS. The FAO and EC Joint Research Centre has such systems operational, but needs to intensify international cooperation and harmonise with other systems in the world.

The need for global monitoring of agriculture is critical to ensure that stakeholders have accurate, transparent and timely information which both improves their capacities to stabilise and improve food security at the national level, while helping to inform governments of the appropriate policies that they can implement in response to the potential regional and global implications.

Information on agricultural dynamics is vital in the long term. Many studies indicate that, with current practices, crop yields may be flattening or even declining over longer timescales, providing an additional challenge to meet the dietary needs of the global population. Frequent scientific data that shed light on this area are needed to ensure sustainable food production and effective management.

Lieven, you have spent a lot of time working for environmental organisations in Africa. How did this experience develop your interest in agricultural monitoring?

LB: My work at the UN Environment Programme in Africa focused on the effects of human activities on ecosystem health through a multidisciplinary approach that addressed both the environment and agriculture. Remote sensing was one of the key technologies that we used to map and monitor changes, so this was how I came into contact with the monitoring and early warning communities, and learned about the benefits and operational usage of remote sensing.

Greater than the sum of its parts

Bringing together world-leading expertise in agriculture, remote sensing and modelling, **SIGMA** is a multilateral project that will explore new technologies to assess the impacts of changes to farming practices

The SIGMA project involves 22 partners from 17 countries. Are there particular challenges that arise from working as part of such a large collaborative network?

LB: Partners are located in different parts of the world, and therefore the agricultural systems and related challenges to map, analyse and forecast agricultural production, are very different. As such, partners have their own understanding of information needs and priorities. The main challenge of this set-up is communication – not only in physical terms across different time zones, but in speaking the same language and creating a common understanding in order to translate local or regional needs in a global frame.

How important is a multidisciplinary approach for achieving the project's aims and objectives? Can you highlight some of the different disciplines working on the project and the importance of their roles?

LB&WB: The multidisciplinary approach of SIGMA is crucial to the success of the project. It brings together environmental, agricultural and remote sensing experts. Remote sensing is being used to map the actual and past state of the environment; agriculture experts are needed to enable characterisations of agricultural systems; and modellers help to assess crop state and environmental impacts under various scenarios. Only through close interaction between these different areas can the project's objectives be achieved.

FOR MANY PEOPLE, food is a source of great pleasure as well as a necessary means of nourishment. Yet the UN's World Food Programme estimates that around one in eight people worldwide are currently malnourished, and thus suffer from a gamut of related social issues including ill health, poor economic performance and political volatility.

On top of the staggering number of people already hungry, it is widely held that the world's food supply will continue to be challenged in decades to come. According to a Food and Agriculture Organization of the UN (FAO) report, our planet's population is set to swell to over 9.7 billion by 2050. Not only will this growth mean more mouths to feed, it will put further pressure on natural resources, with food, feed and energy all vying for agricultural land.

THE NEED FOR ACCURATE PREDICTIONS

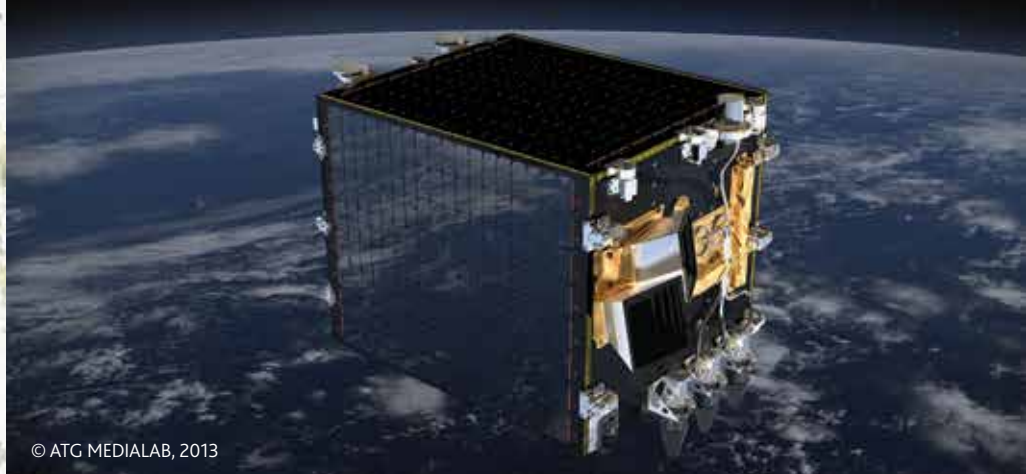
The FAO report forecasts that, in order to feed this exponentially growing population, global food production will need to increase by between 70 and 100 per cent – a major task that will depend upon the intensification of current agricultural practices, as well as the expansion of existing farming sites. To achieve this production target sustainably, a deeper understanding of the environmental impacts caused by changes to farming is required. Earth observation-based information systems – widely used to produce short-term forecasts – will need to be adapted in order to provide value in the longer-term, to pinpoint the dynamics of different practices, and their impacts on productivity and the environment.

The international scientific and agricultural communities have responded to this issue by establishing a number of working groups and programmes including: the Group on Earth Observations (GEO), that aims to build a system of systems that will bring together and harmonise global monitoring efforts; the Agricultural Market Information System (AMIS), an aggregator of information on agricultural markets around the world; and the Global Agricultural Geo-Monitoring (GEOGLAM) initiative, set up to boost AMIS by improving crop yield forecasts.

BUILDING BETTER SYSTEMS TOGETHER

Funded by the EU's 7th Framework Programme (FP7), the Stimulating Innovation for Global Monitoring of Agriculture (SIGMA) project is a collaborative venture between a consortium of 22 partners from 17 countries that aims to add to this work by supporting the R&D component of GEOGLAM through a mix of local, regional and national activities. The project will feed into GEOGLAM by developing the methods and tools necessary to generate information on how changes to cropland distribution and agricultural practices impact upon the environment and ecosystems, as well as boosting efforts to integrate effective new methods into existing global monitoring infrastructure.

SIGMA is coordinated by Lieven Bydekerke at the Flemish Institute for Technological Research (VITO); an organisation with considerable experience of building and fine-tuning innovative agricultural monitoring solutions. Bydekerke himself has a background in geographic



SIGMA

STIMULATING INNOVATION FOR GLOBAL MONITORING OF AGRICULTURE

OBJECTIVES

To actively develop methods and products that will allow policy makers and decision makers to know how ecosystems and agricultural sustainability is affected by changes in cropland distribution and cultivation practices. This will help ensure integration of developed methods for global monitoring systems.

PROJECT PARTNERS

Instituto Nacional de Tecnologia Agropecuria, Argentina • **International Institute for Applied Systems Analysis**; **GeoVille Gmbh**, Austria • **Université Catholique de Louvain**; **Joint Research Centre – EC**, Belgium • **National Meteorological Centre**; **Institute of Remote Sensing and Digital Earth**; **Chinese Academy of Science**, China • **GISAT S R O**, Czech Republic • **GeoSAS Consulting Service PLC**, Ethiopia • **Agricultural Research Institute for Development**, France • **EFTAS Fernerkundung Technologietransfer GmbH**, Germany • **Food and Agricultural Organization of the UN**, Italy • **Regional Centre for Mapping Resources for Development**, Kenya • **Stichting Dienst Landbouwkundig Onderzoek - Alterra**; **University of Twente**; **SarVision B V**, The Netherlands • **Centre Regional AGRHYMET**, Niger • **Space Research Institute of Russian Academy of Sciences**, Russia • **DEIMOS Imaging SLU**, Spain • **Sarmap SA**, Switzerland • **Space Research Institute of the National Academy of Sciences of Ukraine**, Ukraine

FUNDING

EU Seventh Framework Project (FP7)

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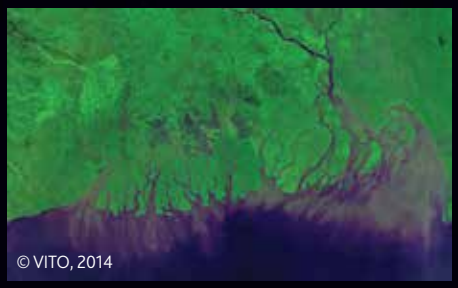
LEIVEN BYDEKERKE has a Master's degree in Bio-Engineering from the University of Ghent, Belgium; following which he worked as a Junior Professional Officer for the UN Environment Program (UNEP) in Nairobi, Kenya. He has since worked in other areas of the UNEP including the Division of Early Warning and Assessment, the Net initiative and the World Conservation Monitoring Centre. Bydekerke has been employed at VITO since July 2003, where he is currently responsible for the Remote Sensing Applications group.



PROBA-V image of the mouth of Ganges, 333m resolution.

information systems (GIS) and environmental data, having worked on UN Environmental Programme projects around the world, as well as developing technologies for industry.

LEVERAGING COLLECTIVE EXPERTISE

Working alongside Bydekerke and his colleagues at VITO is a group of internationally renowned experts in the environmental, agricultural and remote sensing fields. SIGMA's consortium includes major organisations such as FAO and the EC's Joint Research Centre, in addition to a host of national research institutes and universities that span the globe.

The mix of stakeholders involved will serve to strengthen the project, as Bydekerke explains: "The diversity in terms of opinions, experience and issues faced enables an enriching environment to contribute to solutions at global scale". Partners will be able to benefit from the opportunity to exchange ideas, results and best practices with fellow colleagues from around the world during regular face-to-face meetings and teleconferences, and it is hoped that this cross-fertilisation of unique perspectives will lead to improvements to local and regional activities.

METHODOLOGY

Research conducted as part of SIGMA will fall into three key categories, each of which is broken down into smaller projects overseen by a designated expert in the relevant field. The first focuses on agricultural expansion, in which farming land will be mapped to study how the growing or shrinking of cultivation affects a particular area. Intensification of agricultural practices forms another area, with the researchers looking at gaps between potential and actual crop yields, and investigating how different systems – such as single or multiple cropping, or irrigated or non-irrigated methods – have an impact.

The environmental impacts associated with both changes will also be explored. This aspect of the project is what really makes SIGMA unique, since this kind of effect is rarely picked up by the agricultural monitoring systems currently in place. The variety of environmental impacts to be studied will depend on each given site, but could include greenhouse gas emissions, biodiversity, pollution and water-related issues, as well as socioeconomic factors.

BUILDING CAPACITY IN DEVELOPING COUNTRIES

On a project of this breadth and complexity, with stakeholders across the world, sensitivity to scale is particularly important. "The main challenge will be to thoroughly understand the dynamics, interactions and validity of the methods we develop at various levels," asserts Bydekerke. The researchers will initially monitor at global and regional levels, before following-up by homing in on particular sites to verify whether a specific approach is effective, or whether local improvements could be made. Any innovations at national or regional levels can then be scaled-up.

Along the way, the SIGMA team will also seek to build the agricultural monitoring capacity of developing countries through training and outreach work, which represents a secondary benefit from the project. Not only will findings be used to establish remote sensing systems in these countries, but the research programme's global nature sets out to facilitate knowledge exchange and transparency between developing and developed countries, something that can be sustained after its completion.

PROGRESS TO DATE

Since SIGMA's official launch at VITO in November 2013, the team has set about gathering remote sensing and field datasets for analysis. The project will start with the GEOGLAM Joint Experiment for Crop Assessment and Monitoring sites, which are located in China, France, Belgium, Africa, Argentina, Ukraine and Russia, and several other countries are being considered for inclusion.

Specific outcomes of the project will include enhancing understanding of global agricultural practice on cropland expansion and intensification; as well as determining their impact on the environment using maps and statistics. Educational materials on remote sensing-based agricultural monitoring will also be developed.

By the end of the project's 42-month term, it is hoped that its network of research and monitoring bodies will be fully operational and harmonised, and will have collaboratively generated information and methods that can be used and shared by the GEOGLAM community to underpin a robust international agricultural prediction strategy.

SIGMA AT A GLANCE

TITLE: Stimulating Innovation for Global Monitoring of Agriculture and its Impact on the Environment

DURATION: 42 months

START DATE: November 2013

CONSORTIUM: 22 partners from 17 countries

PROJECT COORDINATOR: Flemish Institute for Technological Research (VITO)

PROJECT WEBSITE: www.geoglam-sigma.info