FSIN-AUC Technical Consultation
Food and Nutrition Security and Resilience Analysis

Are we effectively using the right data?

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PANEL 4
Background Discussion Paper

Filling the gaps by exploiting innovation around data production, data collection and data sharing

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Table of Contents

Accurate, objective and timely information is needed for improved food and nutrition security policies and interventions. Panel 4 of this workshop intends to explore the opportunities of innovative data collection sources, technologies and methods for **filling existing gaps in data availability and quality.** In times of rapidly increasing volumes of data and with a general trend towards open data, the panel will also address issues of data management and governance. In particular, it will be important to understand how these innovations can benefit African governments, and what the role and approaches of national and regional centers might be in making available the new data and using innovative technologies.

1. Introduction

People are considered food secure when they have - at all times - the availability of and adequate access to sufficient, safe, nutritious food to maintain a healthy and active life. The relative complexity of this definition provides an idea of the difficulties of measuring food security in its different dimensions (availability, access and utilization). Food security cannot be assessed as a simple quantitative indicator but requires an integrated analysis of many different indicators that need to be assessed on the ground.

Strategies for analysis and monitoring of food security applied by international, regional, and national institutions raise many challenges to be dealt with. Data should meet some specific information needs defined within implementation frameworks. The needs are mainly related to:
- early warning systems;
- prevention and management of food crises;
- support to rural development;
- analysis of household vulnerability; and
- actions to help decision-making, communication and dissemination of the value added products to the stakeholders at all levels including actors at the local level.

The complex nature of food security assessment and monitoring calls for inter-sectoral and interdisciplinary approaches. Therefore, most of the existing activities stem from integrated systems which draw on diverse types of data at different scales – e.g. climate, meteorology, land cover, soils, economy and trade, population census, household statistics, etc. The challenge is not only to meaningfully integrate those data, but – in the first instance - to have access to them through a coordinated spatial data infrastructure (SDI). In the absence of accessible SDIs, there is a need to support (and sometimes a tendency to substitute) essential information by alternative data captured through innovative methodologies.

Data collection by using mobile phones, for example, was defined as the most easy to implement strategy for improving information availability during the IMAAFS conference discussions, but at the same time the need for data standardization and validation protocols and for strengthening national infrastructures were also emphasized. This means that although many new data sources and innovative technology are increasingly available, there is still a strong need for understanding how they need to be integrated in order to best support food and nutrition security related decision making.

Also it was noted during IMAAFS that food security related data especially in the spatial domain and related capacity building is often producer driven, and not sufficient attention is paid to countries' real needs, nor to the coordination between data producers.

2. Definition of key actions at different geographic levels

The required actions for the analysis and monitoring of food security can be structured according to the different levels:

Level	Type of Action
Continental	Coordination of programs of continental interest: - climate change impact on agriculture and food security; - Prevention, management and monitoring of drought and soil degradation; and - Prevention and control of locust invasion and other trans-boundary risks.
Regional	Regional Program set up: - seasonal meteorological forecasts; - coordination of early warning systems - management system for water resources Development of programs for decision-makers and support to the producers; Development of information system and vulnerability mapping; and Reinforcement of the capacities of the actors in all the fields concerned.
National	Implementation of actions to support data producers: - Biophysical and socio-economic data delivered reliably and in real time; - Tools to support decision-makers; and - Early warning and assistance systems for affected populations. Implementation of programs to support decision-makers for: - agricultural investment; - rural planning; - land tenure; - project interventions in the regions facing structural risks; - assistance to vulnerable populations; and - land and conflict management between farmers and pastoralists.
Local	Support to users and local communities: - Short term meteorological forecasts; - Advice to local communities for implementation of their agricultural, pastoral and commercial activities; and - Sustainable management of land (soil conservation and restoration).

adapted from: GAAP vers. 0 (2009)[1]

3. Trends and rationale

Spearheaded by initiatives such as the Group on Earthobservation (GEO), free and open access to geospatial data is on the rise. Following the opening of access to Landsat data by the USGS, the data policy of the European Copernicus Program stipulates a full, open and free access in the respective regulation adopted by the European Parliament in 2014. Access to space data alone however does not provide the necessary resources to assess and monitor e.g. land cover and its change. Equally important is the availability of up-to-date observational data from the field or in-situ data, which falls under the responsibility and mandate of national institutions. The coordinated access to those data (National Spatial Data Infrastructure) is a pre-requisite for the effective and efficient geospatial information support to e.g. food security.

[1] Samba A., Massart M., Khamala E., Leo O. (2009): Food Security and Rural development. GMES & Africa, Action Plan GAAP, Version 0; http://gmes-africa.iict.pt/images/pdf/GMESandAfrica_ActionPlan_Version0.pdf

In this new era of free and open satellite data access, a policy framework which facilitates sharing of in-situ data and information will provide benefits for public, private and research sectors. With the 'raw materials' available, activities can then be focused on the development and provision of operational services involving the private sector predominately through small and medium-sized enterprises (SMEs). Experience in other regions (e.g. North America, Europe) has shown that needs of public institutions are best met by innovative solutions delivered by SMEs supported by research institutions.

The sharply increased data volumes for especially the free and open data flow from high resolution sensors require alternative processing approaches that are based on evolving "Big Data" technologies. One of the key principles of the latter is to co-locate processing logic close to the data repositories and integrate with scalable computing resources for on-demand data analysis.

The main advantage of these hosted or cloud-based solutions is the reduced need for network bandwidth and local storage space for raw and intermediate products. The most advanced solutions, for instance those offered by Google Earth Engine, allow the sharing and re-execution of the data analysis logic instead of requiring full processed results to be downloaded. Thus, users can join in participative analysis and data sharing via low bandwidth solutions.

Developments in cloud-based solutions are developing fast, and typically integrate solutions which are based on open data standards (e.g. data formats, metadata standards) and open data access standards (e.g. REST web services), many of which are implemented as open source solutions (e.g. GDAL, Apache components). This means that country-scale processing solutions are, in principle, also configurable with low cost hardware and open source components, although these would imply the necessary network capacity to receive the raw data products. Hybrid solutions that integrate local cloud solution providers are feasible as well.

The rapidly increasing availability of new data sources and the enlarged data flow and processing potentially represent vast opportunities for policy makers to get more rapid access to high quality analysis outputs of large data volumes. While on the other side these trends also require good access to technical knowledge and continuous updates of existing systems. To effectively support food security and sustainable rural development decisions, the capacities of the experts, engineers and technicians in the use of new technologies for collection, treatment, transmission, management, analysis and dissemination of the biophysical and socio-economic data & information must be continuously reinforced. This will allow them to improve the quality of the analysis and to better tailor their decision-making support products to the various users.

The area of innovative data and approaches for food security is very vast and we therefore decided to refer to the strategy definition and prioritization exercise carried out at the end of the IMAAFS conference. According to the conference conclusions the key challenges regarding priority strategies in the **development of new approaches to data collection are**:

- Continue to reinforce infrastructure and support sustainable collection of good quality data;
- Develop and use common field data validation protocols/metrics;
- Promote the use of mobile phones for field data collection; and
- Establish an inventory/catalogue of field data collection activities.

In preparation for this FSIN consultative workshop, the authors have selected a number of case studies connected to the priority strategies of innovative data collection mentioned above.

For data collection we mainly look at innovations linked to new data becoming available from remote sensing, as reflected in the case studies on Sentinel data and STARS.

The GEOWIKI case study illustrates a well-known example of the development of a common data validation framework. This does not answer all aspects of the full strategy for developing common field data validation protocols and metrics, but is interesting for discussion in this context due to its crowdsourcing aspects.

Concerning the use of mobile phones for field data collection, we included a description of WFP's market price data collection efforts using mobile phones.

The STARS study case in addition is interesting not only from a data collection point of view but also for data sharing, since it includes ways of providing information directly to the farmers.

At the global and continental scale, some on-going and future innovative approaches can be mentioned, such as the Group on Earth Observation's (GEO) Global Agricultural Monitoring Initiative (GEOGLAM) and Global Monitoring for Environment and Security & Africa (GMES &Africa, African Union Commission, supported by European Commission).

On a global scale, GEOGLAM is mandated and adopted by the G20, with the purpose of informing decisions and actions in agriculture through the use of coordinated and sustained Earth observations. GEOGLAM leverages expertise in remote sensing to create (mostly) MODIS -derived products to aid in crop outlook forecasting: monthly precipitation, temperature, and NDVI anomalies. The innovative aspect is that these information products are then shared with regional and commodity experts to comment upon the anomalies. The experts provide commentary grounded in regional expertise, which is then synthesized into an evidence and consensus-based report of the actual status of global productivity.

GEOGLAM links the global – regional – national levels for monitoring, forecast, anomalies detection and analysis by feedback from regional experts. Comments are synthesized and delivered to the G20 Global Agriculture Market Information System (AMIS) () with the intent of stabilizing commodity price shocks by grounding estimates in earth-observed evidence. Now the challenge is how to link these information systems to local farmers.

The GMES & Africa initiative establishes a long-term partnership between Europe and Africa, working together on the development and implementation of Earth Observation (EO) applications tailored to African requirements. This process is implemented in the wider context of the Africa-EU partnership aimed at sustainable development and scientific cooperation. GMES & Africa strengthens Africa's capacity and ownership of EO activities and acknowledges the importance of past and present African programmes, recognising the need to coordinate actions to avoid duplication, increase synergies and enhance complementarities. Approaches developed in the European Commission's (EC) Copernicus will be applied to the implementation of GMES & Africa, notably by: adopting a free and open data policy, focusing on operational services and involving the private sector in service development. Funded under the EC Pan-African Facility (PanAF), the first three thematic areas (Long-term Management of Natural Resources, Water Resources Management, Marine & Coastal Environment Monitoring) will start to be implemented in 2016. As one of the next areas to be validated for service development, Food Security and Rural Development is planned to be addressed during an expert workshop in early 2016.

4. Requirements

Needs and gaps in terms of Earth Observation data useful for food security and the possible impact of Sentinel data (*commercial data providers in italic*)

Category of Data	***Sensor***	***Acquisition strategy***	***Identification of gaps***
Low Resolution	MSG	Daily acquisition for crop monitoring	Lack of validated products (indicators still under development with different processing chain)
Low Resolution (300 m -1 km)	NOAA METOP SPOT-VGT MODIS ASAR **Sentinel 3**	Daily acquisition for crop monitoring and cropland mapping	Lack of clear inter-comparability of the data, lack of a standard, well-documented pre-processing strategy, lack of program continuity **continuity, full, open, free access**
Medium Resolution (10 -50 m)	LANDSAT *SPOT* *DMC* CBERS *IRS* ASTER **Sentinel 2**	Complete coverage yearly for cropland and land use mapping, for agriculture statistics stratification	Lack of satellite possibilities for complete acquisition **continuity, full, open, free access**
High resolution (2 -5 m)	*SPOT, RapidEye, DMC-2, UrTheCast, PlanetLabs*	Complete coverage 3-5 years for agriculture statistics and land use mapping	Lack of satellite possibilities for complete acquisition; lack of receiving stations or on-board recording. Many new capacities (and lower costs)
Very High resolution (< 1 m)	*DigitalGlobe* (*GeoEye, Worldview 1-3*) *Pleiades, SkyBox airborne data (incl. UAV)*	Sampling for agriculture statistics applications and products validation Ad hoc acquisition for specific projects on land administration	Prohibitive cost and poor acquisition strategy in Africa
Radar high resolution (1-50 m)	*RADARSAT TerraSAR-X, CosmoSkymed, ALOS-2* **Sentinel 1**	Specific areas, ad hoc request, multiple acquisition coverage yearly for land use mapping. All weather, day/night image capability	Lack of complete acquisition strategy Lack of validated and thus operational products **continuity, full, open, free access**

adapted from: GAAP vers. 0 (2009)

Needs and gaps in the availability of complementary data useful for food security:

Biophysical parameters		**Existing and planned capacities**	**Gaps**
Meteorological	Rainfall, temperature, radiation, wind speed, ...	Synoptic stations	Poor reporting, low coverage in Africa, poor data accessibility
Soil	Structure, water holding capacity, erosion, soil moisture...	Global FAO map, IIASA-HWSD database, JRC-FAO-ISRIC initiative on soil atlas of Africa	Local knowledge, harmonization of soil definition and procedure for extracting the key parameters
Crop	Crop cycles, varieties, crop phenology,	Local knowledge exists and partial information	No real and consistent network of phenology information collection
Hydrology	River network and attributes		Need to be harmonized, complemented and validated
Land-cover	LC maps and attributes	Some local, national and regional information	Lack of uniform classification, legend and scale, lack of validation, old information
Crop Production	Agriculture statistics (area, yield and	Reinforcement of agriculture statistics by FAO in many countries	Lack of reliability of the data, aggregation level
Socio-economic parameters		**Existing and planned capacities**	**Gaps**
Population	Density, characteristics, structure...		Generally not available in adequate resolution and format
Infrastructure	Road network, exploitation , markets, ...	Information exists	Lack of consistency and harmonization
Land tenure	Large scale parcel mapping, land use rights and	On-going FAO and World Bank projects	Nearly inexistent

adapted from: GAAP vers. 0 (2009)

5. Case Studies

Case 1: Mobile-based food security monitoring systems

1.1 Mobile Vulnerability Analysis and Mapping (mVAM)

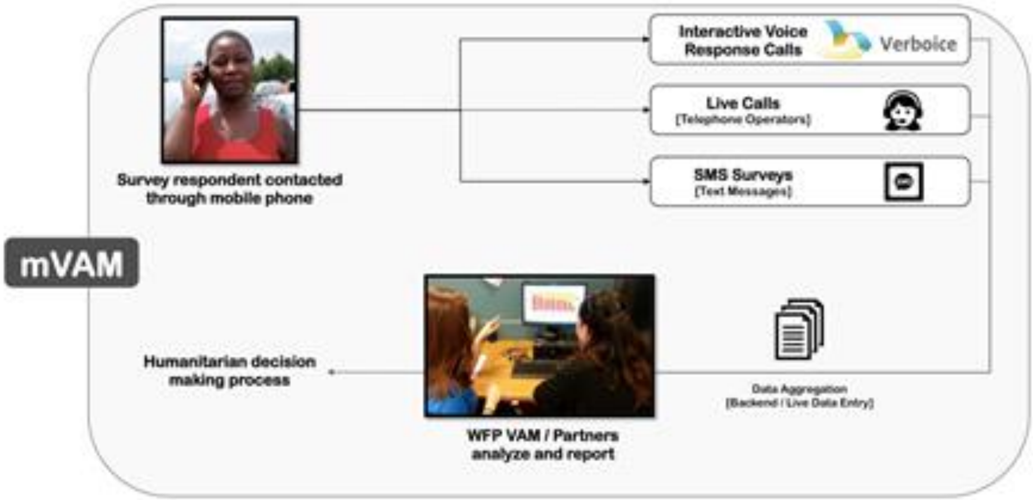
Project implemented by the World Food Programme (WFP) with funding from the Humanitarian Innovation Fund, USAID, Google.org and Cisco Corporate Responsibility.

a. Application field

mVAM offers near-real time, affordable information for food security monitoring, overcoming the obstacles that primary data collections frequently faces. The mobile Vulnerability Analysis and Mapping (mVAM) project collects data through short mobile phone surveys, using SMS, live telephone interviews and Interactive Voice Response (IVR) systems. mVAM works through the phones people already own, and no smartphones or data plans are required. mVAM has been used to track household food security indicators, food prices, and to generate qualitative analysis in near-real time.

b. Methodology used / workflow

As shown in the figure below, mVAM involves contacting survey respondents by SMS, IVR or through a call placed by an operator. The availability of free and open source software offers user-friendly interfaces that allow non-specialists to design and implement IVR and SMS surveys. Private third party providers also offer SMS and IVR surveying services worldwide. The information collected by cell phone is aggregated in an database that WFP and partner analysts query. Reports and aggregated data are made available to the public on an open-access basis, supporting the humanitarian decision-making process.



c. Key results

- An external review of the project carried out in 2015 found that 'mVAM is a very successful prototype' and 'a proof of concept for the application of mobile technology for food security monitoring'. The review has confirmed that 'mVAM demonstrates that inexpensive data collection in difficult contexts is possible and that high frequency monitoring can be efficiently achieved.'

- The approach is scalable: from a small pilot in 2013, the approach has been used in 12 countries, as of late 2015. An entirely automated SMS-based food security monitoring system was put into place for the Ebola response, delivering data in a matter of weeks.

- mVAM has allowed WFP to understand the methodological challenges and limitations of mobile surveys, including the trade-offs and biases they involve. Learning is helping judiciously deploy these tools and analyse the data they generate.

mVAM has used SMS and IVR for 2-way communication with communities in the deep field, allowing IDPs in conflict-affected communities to obtain food prices and other food security information on demand.

- All mVAM information products are made available on a dedicated project website and UNOCHA's Humanitarian Data Exchange (HDX) website. WFP's has developed an application programming interface (API) to make its food security data machine-readable, and therefore accessible to other information systems outside of WFP. As data is provided in open access, anyone, particlarly local governments, have access to the data.

d. Innovative impact

The project's impacts have been wide ranging, and have been documented in articles for the Overseas Development Institute's Humanitarian Exchange magazine. The innovation has led to cost and time savings, and enhanced security for staff. The project also allowed new analytics:

- Cost per questionnaire: Face to face surveys usually cost USD 20-40. SMS surveys are currently being conducted at a cost of USD 5, while live calls are made at USD 7-9.
- Time: traditional face-to-face household surveys usually require 4-6 weeks of fieldwork. mVAM tools have reduced that time to 1-2 weeks, offering more timely analysis.
- Security: mVAM allowed data collection from Ebola affected zones that were under quarantine. mVAM enabled weekly market monitoring in areas of Iraq held by armed opposition groups. WFP has been able to collect a sample of over 2,400 household questionnaires each month from Yemen, delivering critical information in a highly insecure environment.
- Advanced analytics: the cost-effectiveness of SMS surveys has enabled WFP to crowdsource food price data (ongoing in Dadaab, Kenya). The project has also led WFP to explore natural language processing and pattern sentiment analysis to triangulate other findings.

The Active Learning Network for Accountability and Performance in Humanitarian Action (ALNAP) will be publishing a case study of the innovation process in early 2016.

e. Status of the application

The application is currently being rolled out to more WFP operations. mVAM has demonstrated its impact and has benefited from an external review conducted by Development Services International in 2015. A learning lab is being put into place to allow WFP to continue implement a learning agenda on mobile data collection.

f. Area/region of application

The mVAM project began as a pilot project in the Democratic Republic of Congo and Somalia in 2013. It has been deployed in Level 3 emergencies, including the Ebola crisis, Iraq and Yemen. WFP is in the process of rolling out mVAM to countries affected by chronic food insecurity.

g. Data used/provided

mVAM provides monthly estimates of the Food Consumption Score and the Coping Strategies Index, aggregated at the admin 2 level. In some cases, food price data is also collected with the same frequency. Data series and analytical reports are available on an open-access basis on the project website and Humanitarian Data Exchange. A public API also exists.

1.2 Geo-Wiki

a. Application field

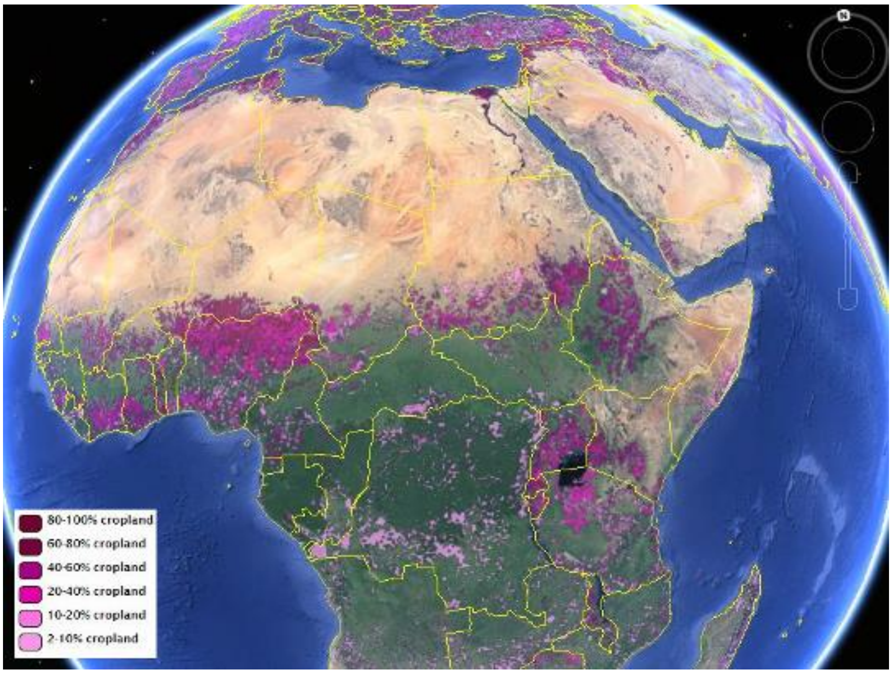
Geo-Wiki is tool for visualization, validation and crowdsourcing to improve the reliability and coverage of information on global land cover. The crowdsourced data have been used along with many different land cover products to create different hybrid land cover products. These include a generic land cover map, a global cropland map, a map of field sizes and a map of forest cover. The global cropland map is used by the International Food Policy Research Institute (IFPRI) to create maps of crop type distribution.

b. Methodology used / workflow

Crowdsourced data are collected through campaigns, which are run on a regular basis, or through "serious games" (a citizen science gaming approach[2]), which run for a set period of time. The hybrid map methodology involves using geographically weighted regression, existing land cover maps such as GlobCover 2005, MODIS v.5, regional maps such as AFRICOVER and national maps from mapping agencies and other organizations, to create a cropland probability layer. National and sub-national statistics are then used to allocate cropland to the most likely areas until the cropland total match the statistics. In this way the global cropland map reflects the official figures published by the Food and Agriculture Organization of the United Nations (FAO). The first ever global field size map was produced at the same resolution as the global cropland map, which was based on interpolation of the field size data collected via a Geo-Wiki crowdsourcing campaign.

c. Key results

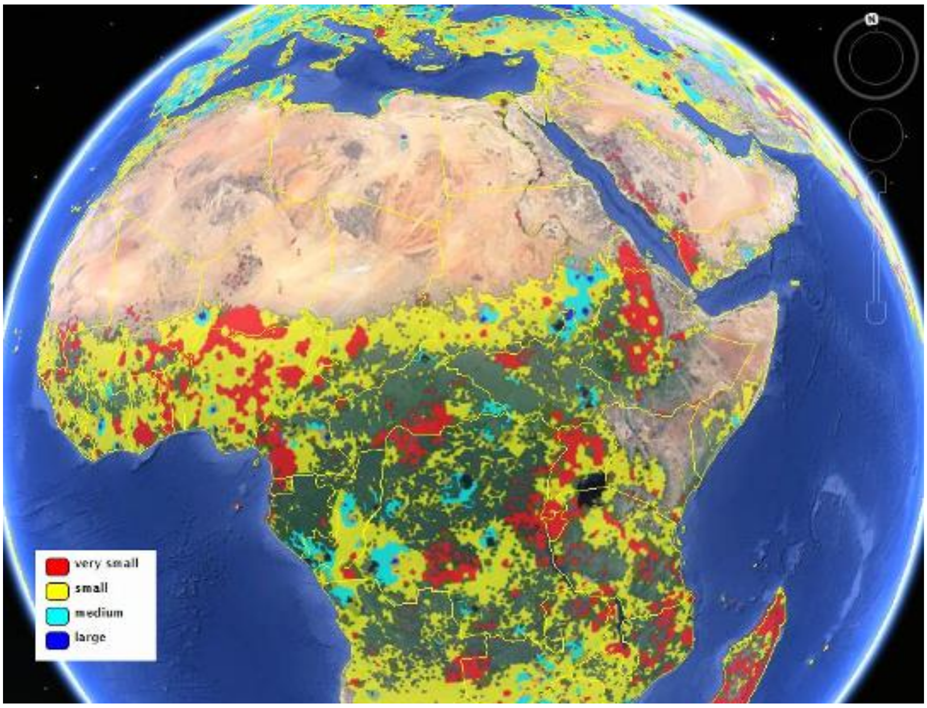
The **global cropland product** (referred to as the IIASA-IFPRI cropland map) has been validated using very high-resolution satellite imagery via Geo-Wiki and has an overall accuracy of 82.4 percent. It has also been compared with the EarthStat cropland product and shows a lower root mean square error on an independent data set collected from Geo-Wiki.



[2] Cropland Capture is a game version of our citizen science project Geo-Wiki, which has a growing network of interested experts and volunteers who regularly help us in validating land cover through our competitions.

Global Cropland Map

A validation exercise of the **global field size map** revealed satisfactory agreement with control data, particularly given the relatively modest size of the field size data set used to create the map.



Global Field Size Map

Both of these maps can be viewed on Geo-Wiki and downloaded from the website. Other products such as the map of tree cover are also available. IIASA is currently working on a new global cropland map for the year 2010, which will use the crowdsourced data (around 5 million classifications) collected from the Cropland Capture serious game.

d. Innovative impact

The hybrid approach combines existing maps to produce a more spatially accurate product than any of the individual global base maps currently available. The first ever global field size map was based entirely on crowdsourced data collected during one of many Geo-Wiki campaigns. The campaigns involve many interested citizens, who look at thousands of very high-resolution images to identify the type of land cover present, including cropland. Both the global cropland and field size maps are critical inputs to global agricultural monitoring in the framework of the GEOGLAM initiative; they also serve the global land modelling and integrated assessment community, in particular for improving land use models that require baseline cropland information.

e. Status of the application

The application is always evolving and under development because it is largely a research-based tool. More recently, two serious games have been developed, i.e. Cropland Capture and Picture Pile. Geo-Wiki tools could be part of an operational workflow if there was a demand for it.

f. Area/region of application

Global but with specific regional and national applications, e.g. the AusCover branch for validation of Australian land cover; the hackathon branch which dealt with cropland mapping of Ethiopia; an offline version for wall-to-wall cropland mapping of Tanzania, etc. These Geo-Wiki branches are developed for specific use cases as and when required.

g. Data used/provided

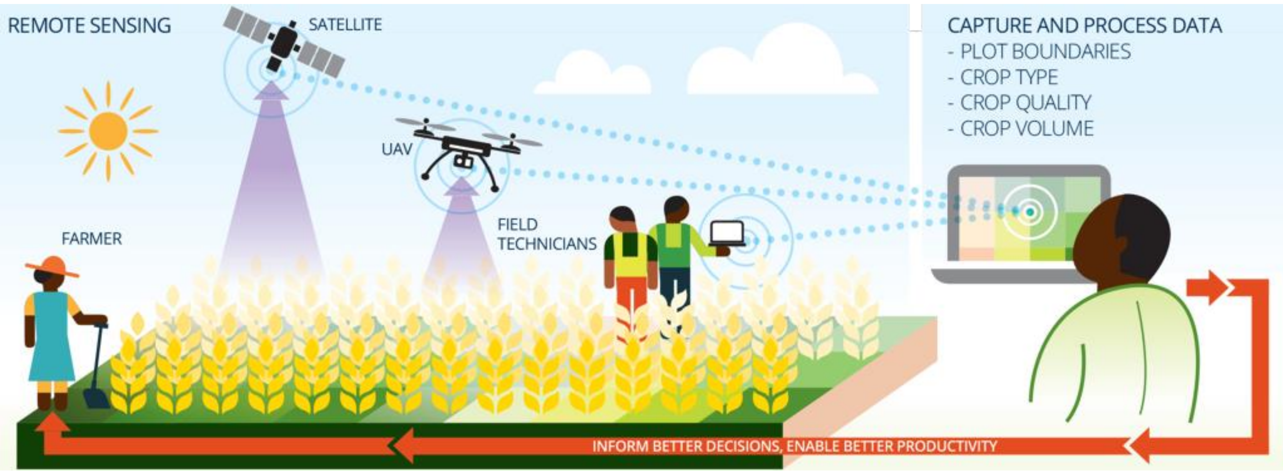
Existing land cover maps of various resolutions served as Web Map Services for visualization via Geo-Wiki. High resolution (i.e. Landsat) and very high-resolution satellite data (from Google Earth and Bing imagery). Data collected through crowdsourcing, which is either point-based or at various resolutions from 30 m to 1 km^2.

Case 2: STARS: Spurring a Transformation for Agriculture through Remote Sensing
Project coordinated by ITC, the Netherlands, funded by the Bill & Melinda Gates Foundation

a. Application field

High-income countries have seen recent improvements in their agricultural management systems through modern remote sensing technology, such as satellites, aircraft and the information they collect. Out of the vast amount of data collected, advice can be provided to farmers on the ground to help inform their decisions about farming methods. This leads to better crop yields, higher quality produce and possibly more sustainable practices for the farming communities. This data can also inform higher-level decisions to manage national food supply needs more effectively.

b. Methodology used / workflow



Out of the vast amount of data collected by remote sensing technology, advice can be provided to farmers on the ground to help inform their decisions about farming methods.

c. Key results

If ways can be found to use remote sensing effectively in Sub-Saharan Africa and Southern Asia, the potential benefits include:

- Smallholder farmers may have access to better advice, allowing them to make better and more sustainable decisions about the types of crops they plant, when to plant them and how to manage them once they have been sown. This may lead to better yields, higher quality produce and increased wealth for some of the world's poorest communities.

- More accurate and transparent spatial information about crops and fields will enable smallholder farmers and their communities to secure land usage rights. Lack of information about land rights is often the subject of dispute and can lead to land access being lost by the smallholder.
- The STARS project comes at no cost to the local farmer and aims to provide education and training to help put this free information to effective use. Furthermore, it will seek to create pathways to greater development and investment in remote sensing technologies for emerging economies.
- Emerging economies will be able to more accurately forecast yields at a national level and make informed decisions about the state of food security for their populations.
- Food production processes in emerging economies will be more secure as local markets thrive when farmers are able to produce sustainable and reliable crops. Better export opportunities may also arise from more sustainable farming practices, potentially contributing to a stronger economy.

STARS' ambition is to determine whether remote sensing technology can bring some of these benefits to fruition. In doing so, the aim is to increase the quality, volume and understanding of food production in emerging economies and to improve the farming activities and livelihoods of some of the world's poorest people.

d. Innovative impact

Smallholder farmers often use small cropland plots with variable boundaries, and often grow multiple crops and crop varieties on the plot at the same time. Thus, there is a rich variety of farm practices in place that adds to the heterogeneous mosaic that often characterizes African and Asian farmland. These conditions make it hard to discriminate cropping systems, crops and cropping practices from the skies; this presents a fundamental barrier to accurate information, timely crop monitoring and forecasting, and improved agricultural advisories. In recent times, technological advances have led to improved satellite image resolution, improved revisit frequency that allow better monitoring during the growing season, and improved spectral characteristics in those data products.

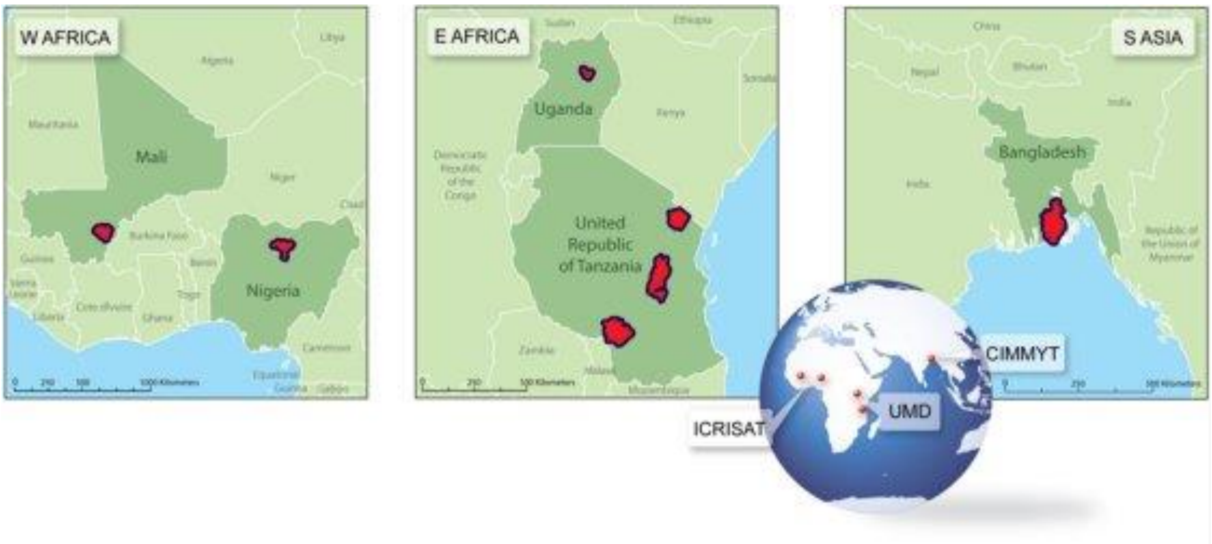
e. Status of the application

Under development/research

f. Area/region of application

The STARS project has three use cases:

1. In Mali and Nigeria, concurrent remote sensing of land tenure in 20+ communities, and 150 individual farmer fields explores ways in which data can lead to the emergence of smallholder-friendly advisory services.
2. In Tanzania and Uganda, the STARS consortium is monitoring four separate, large blocks of cropland to provide data to the National Food Security Agency to support monitoring of crop conditions.
3. The third project is in Bangladesh, where remote sensing data is used to analyse the floodplain of the Bengal Delta to determine whether farmers can be allowed to use surface water to grow a second crop in the dry season.



Complementary to the regional experimental use cases, a technical and institutional landscaping study of remote sensing investment opportunities aims to identify the entry points in agro-information systems where remote sensing can help to transform agricultural development. It will provide guidance on potential future investments and the pathways to do so. The landscaping study takes a broader perspective of the reasoning behind the regional experiments, looking at the full gamut of stakeholders and technological offerings.

g. Data used/provided

Satellite data medium to very high resolution; UAVs, mobile devices

Case 3: Sentinel 1 & 2

a. Application field

1. The introduction of Sentinel-1 and Sentinel-2 high resolution image time series (i.e. with 10-30 m spatial resolution) will facilitate a significant "scale-step" in the use of Earth Observation (EO) data in agricultural mapping and monitoring applications. This expectation is based on 3 major aspects of the Copernicus programme, each of which contrasts markedly with previous EO scenarios: the unprecedented technical quality of the sensors, in each of the following aspects: radiometric (relevant channels), spatial (resolution and swath-width) and temporal (revisit frequency);
2. the "Full, Free and Open" data policy /licensing scheme; and
3. global coverage of land with a guaranteed continuity (> 10 years) of observations.

b. Methodology used/workflow

Sentinel-1A (S1A) is the first Copernicus sensor operationally providing imagery since October 2014. A systematic coverage of several African countries is already part of the operational phase. With the launch of Sentinel-1B in 2016, a doubling of the operational capacity will allow a further expansion of coverage. S1A acquires C-band Synthetic Aperture Radar (SAR) imagery over land at 10 m resolution (IW mode).

Sentinel-2A (S2A) was launched on 23 June 2015 and will provide wide area optical imagery with 10 m (visual and near-infrared), 20 m (red-edge, near and short-ware infrared) and 60 m (visual to short-wave infrared for atmospheric correction) resolutions from November 2015 onwards. Large areas in Africa have already been covered in the pre-operational phase. A Sentinel-2B twin to be launched in 2016 will double revisit.

The S1A and S2A both have wide swath widths (185 and 290 km, respectively) and a 12 and 10-day revisit frequency. S2A coverage will be global (land masses). Since S1A is an active microwave sensor, with all-weather day and night acquisition capacity, a combination of descending (morning) and ascending (late afternoon) passes may be used to create denser time series in areas where these passes overlap.

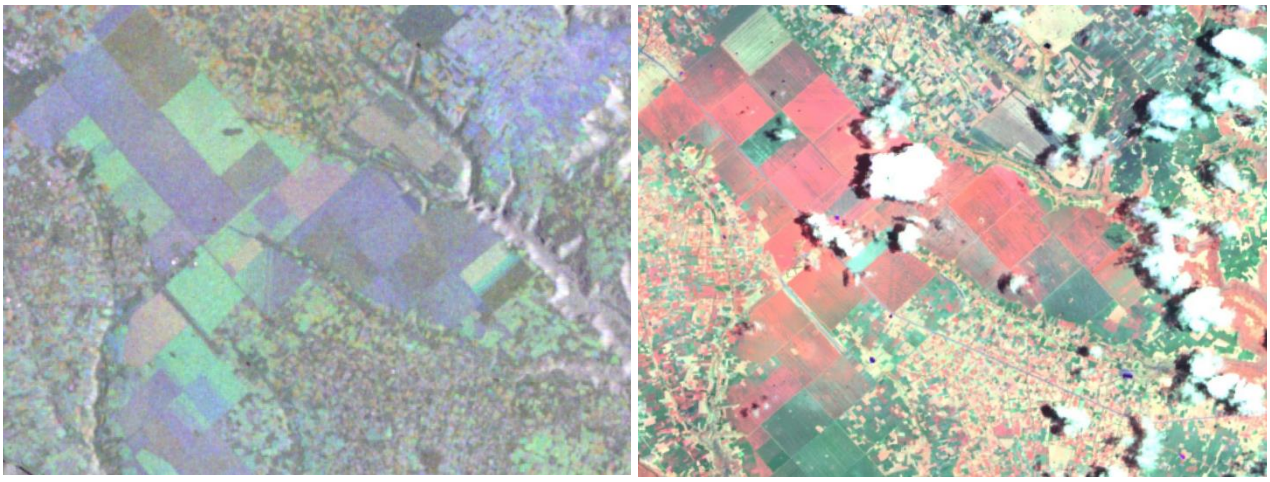
Data from both sensor platforms are freely downloadable from a central data hub, and possibly via other platforms in the near future. The open interfaces of these platforms support scriptable scheduling and downloading. Furthermore, tools to process the data into Geographic Information System (GIS)-ready imagery are made available as open source software. Thus, low cost solutions for wide-area agricultural mapping and monitoring can be setup relatively easily. As an alternative, cloud-hosted data and processing may be considered to minimize data transfer, especially in situations where internet bandwidth is limited. Cloud solutions for high volume Sentinel data-like workflow are rapidly evolving.

c. Key results

The technical quality of the sensors will significantly enhance the separation of land cover classes in agricultural land use, both for arable land (i.e. crop types) and the complex domain of grassland and pastures. The 10-20 m spatial resolution of S1 and S2, combined with 10-12 days (5-6 days when the B units are operational) revisit frequency will resolve crop specific development status and crop area delineation at parcel level detail, at least for the larger arable crop and grassland production systems. Slower changes to land use, in particular agricultural land abandonment, changes to irrigated areas, forest conversion and agro-forestry benefit from the high spatial details and the possibility to select the most relevant seasonal acquisitions.

d. Innovative impact

The greatest innovative impact of Sentinel-1 and -2 data availability is the full, free and open availability of large volumes of frequent coverages at 10-20 m resolution. The all-weather capacity of the Sentinel-1 SAR sensors allows consistent time series to be developed, which can be cross-correlated to (intermittent, due to cloud cover) time series of Sentinel-2 optical and infrared channels. Detailed mapping of agricultural areas (scales 1:25,000 – 1:50,000) are core inputs into yield prediction and food logistics.



A multi-temporal composite of Sentinel-1A VV intensity in April, May and June 2015 (left) compared to a, partially cloud covered, Sentinel-2A multi-spectral composite of 14 September 2015 (right). The images highlight mixed cropping practices near Robe (Oromia), Ethiopia. Both sensors are complementary, spatially and radiometrically, to support crop area measurement and delineation of crop type and terrain variation.

e. Status of the application

Applications of Sentinel-2 data are similar to those of Landsat and SPOT-like resolution data, except that the 10 and 20 m channels of Sentinel-2 are considerably more detailed than 30 m Landsat, especially for African agricultural landscapes. Furthermore, the lack of cost constraints allow for the widest possible selection of imagery of the right quality, rather than budget-limited sub-optimal selection. The operational use of Sentinel-1 SAR is much less developed in (African) agricultural mapping applications, but will rapidly develop in areas where these data are consistently and reliably acquired. In specific cultivations (e.g. rice), SAR is already used operationally.

f. Area/region of application

Africa. For Sentinel-1, repetitive coverage is for a selected area only. For Sentinel-2, full coverage is foreseen. The B-units to be launched in 2016 will double the acquisition capacity, allowing a wider and more frequent coverage.

g. Data used/provided

Sentinel-1 intensity (backscattering coefficient) or interferometric images at 10 m resolution; Sentinel-2 optical and infrared reflectance at 10 and 20 m resolution.

6. Overall considerations and key questions

The case studies are not systematically addressing all questions about data gaps in terms of availability and quality in food security monitoring and analysis, but provide a selected number of interesting innovative data sources or new approaches to collection and validation. New data is mainly available in the geophysical sector thanks to earth observation, while new collection and validation methods are enabled by the diffusion of mobile phones and access to internet. The STARS approach shows an interesting example of providing information based on innovative data and techniques not only to analysts or decision makers, but directly to the small scale farmers.

Based on the selected case studies and in order to expand the discussion and look more broadly at data gaps and challenges for improved food security analysis we would like to propose the following questions to be further addressed in the panel discussion:

a) New data sources are available mainly in the geospatial domain, while new collection and validation methods are interesting also for the socio-economic aspects of food security. How can these new sources and approaches contribute to reduce gaps in data availability and quality for food security analysis and what major problems do still need to be addressed?

b) Do you think that the gap between early warning and early action is linked to data availability and quality and if yes, what kind of data and at what frequency do we need to improve early action?

c) How can local farmers fully benefit from new technologies/new data? And how can decision makers? And more specifically, how can high resolution Sentinel derived crop area and biophysical parameters benefit the full range of actors in the agri-food chain (farmers, farm services, food processing, government)?

d) What actions can be taken to stimulate the private sector to offer operational services with new data and technologies in support of public institutions?

7. References

Case 1: Mobile-based food security monitoring systems
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Case 1.2: Geo-Wiki
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The hybrid products are freely available for downloading from different branches of Geo-Wiki. For example, the hybrid cropland map is available from http://cropland.geo-wiki.org while the hybrid forest map can be found on http://biomass.geo-wiki.org. The crowdsourced data can be downloaded from http://www.geo-wiki.org.

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