Crop and Yield Monitoring Activities

MARS Stat Action of the European

For implementation of the Common Agricultural Policy, the European Commission needs timely information on the agricultural production expected in the current season. This is the main concern of the MARS (Monitoring Agriculture with Remote Sensing) Stat Sector of the Agriculture and Fisheries Unit, part of the Institute for the Protection and Security of the Citizen of the Joint Research Centre (DG-JRC EC).

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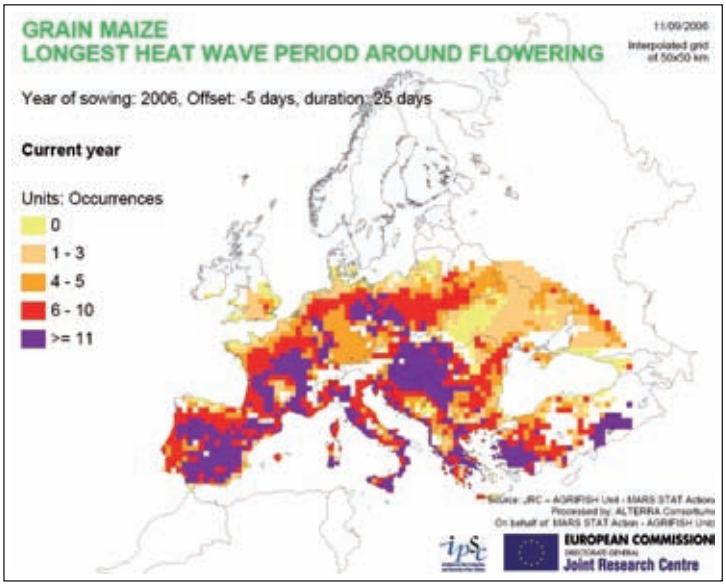

Flowchart of crop simulation.

The need of DG Agriculture for early European figures on harvests led to the development of the MARS Stat activities. A crop yield forecasting system was put in place to supply early information to DG Agriculture on the development and growth conditions of crops during the campaign. After several years of research in co-operation with Member States and a pre-operational phase, the MARS Stat action is now operational, running what is called the MCYFS (MARS Crop Yield Forecasting System) in accordance with a European Parliament and Council decision (see framed text). Besides this main activity, research is done on crop area estimates, and ongoing surveys are also supported, e.g. LUCAS.

MARS Crop Yield Forecasting System

The core of the MARS Crop Yield Forecasting System (MCYFS) is a geospatialized agro-meteorological crop growth model (CGMS) monitoring crop behaviour by means of decadal crop growth indicators. The crops covered are: wheat, spring barley, grain maize, rape seed, sunflowers, potatoes, sugar beets, field beans, rice and pasture. This system can be considered as having three levels:

1. Management of a meteorological database (level 1 – weather monitoring);
2. Management of an agro-meteorological model and DB (level 2 – crop simulation);
3. Statistical analyses of data produced and crop yield forecasting at the European level (level 3 – yield forecasting).

It is rounded off by the management of low-resolution satellite information supporting the CGMS at each level. Results are published in a bulletin containing analysis, forecasts and thematic maps on crop yield expectations. This is done approximately monthly, in paper and on a public access internet site (http://agrifish.jrc.it/marsstat/Bulletins/2006.htm). The following sections briefly describe the system components.

On May 22, 2000 the European Parliament and Council adopted Decision no. 1445/2000/EC on the application of aerial survey and remote sensing techniques to the agricultural statistics for 1999-2003. The period of coverage was later extended to 2004-2007 (Ref. PE/CONS 3661/1/03 OJ L 309 of November 26, 2003). The current legal basis for research activities related to the system is in the JRC multi-annual working program (FP6 2003-2006 action 1121 MARS Stat).

Weather Monitoring

Based on daily meteorological data coming from more than 2000 EU-25 stations, weather phenomena are monitored throughout the season. The data, processed daily and quality checked, is interpolated to a 50 kilometer by 50 kilometer grid. The derived grid weather comprises 10 agro-meteorological parameters like temperature, rainfall, snow cover, radiation etc. The grid weather is used for crop yield evaluations in two ways. In the first it serves as input for the crop growth model, and in the second as weather indicators for direct evaluation of alarming situations such as drought or extreme rainfall during sowing, flowering, harvest etc. (see Figure 1).

Crop Simulation

The agro-meteorological model uses the daily interpolated grid weather to simulate biomass accumulation and crop development showing the effect of recent weather on crop growth. Crop growth is simulated by the point model WOFOST (version 6.0) on a regional basis by means of geospatialized input data like soil parameters, weather information and crop parameters. The work is divided into three operational activities regional crop simulation; spatial aggregation; and production of crop indicator maps. Besides regional monitoring of crop conditions, this component of MCYFS issues warnings in the case of abnormal conditions. The outcome of the crop monitoring portion is also one of the inputs for yield prediction.

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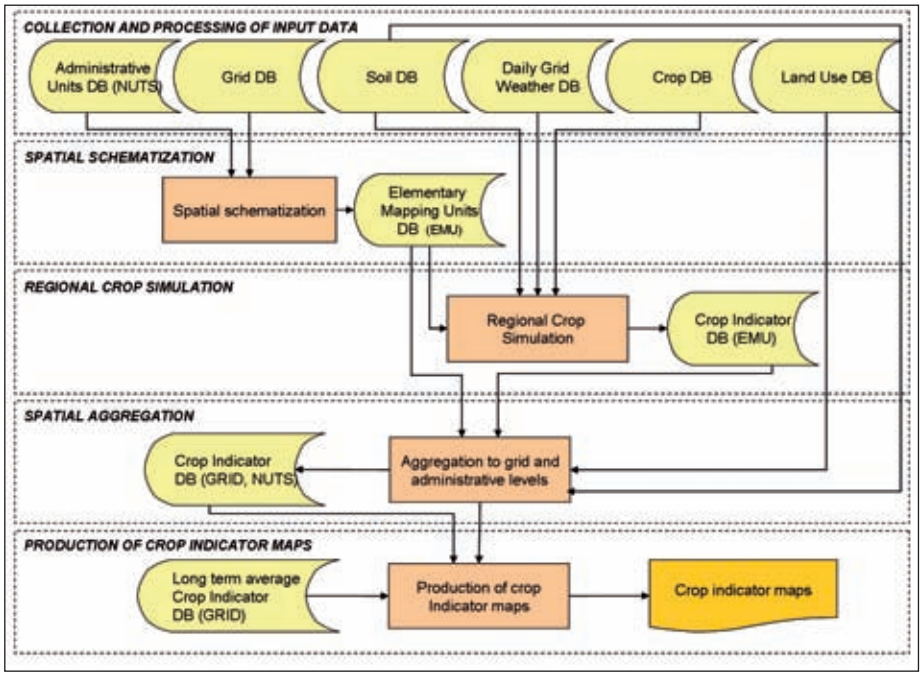

Flowchart of crop simulation.

Crop Yield Forecasting at the European Level

The main role of the third level of the MCYFS is to provide yield statistics for major crops at the EU and national levels, in as accurate and timely a fashion as possible, while ensuring independence from all external sources of estimates including national statistical systems. To achieve this, different statistical tools are used. At the end of the process different possible forecasts are available, often 'statistically' acceptable. The 'most performing result' is then individuated and selected according to statistical tests. Results at the national level are published in our bulletins approximately monthly throughout the season.

Low-Resolution Satellite Information

Remote sensing data is used as an independent source of information to confirm crop growth indicators and forecasts with the help of vegetation state indicators and weather indicators. As well, an integrative approach will be followed by direct ingestion of derived parameters into the Crop Growth Monitoring System. Derived phenology or crop phasing parameters in level two and quantitative crop cycle parameters in level three are also under development.

As real-time crop monitoring is performed throughout the season, there is high demand for the timely availability of remote sensing data products. Operational chains are put in place to regularly produce 10-daily and monthly vegetation state parameters covering EU-25 and neighboring countries. All data is mosaiced to a pan- European extent and compiled with the same spatial extent and projection.

A variety of different sensors is used to support the MCYFS, starting with data from 1987: a time series with almost 20 years of NOAA–AVHRR (Advanced Very High Resolution Radiometer) which is the cornerstone of the remote sensing database with pan-European coverage. In addition, spot vegetation data is available from 1998 on. The apparent overlap of the two similar sensors increases the chances of permanent data availability. Mainly vegetation state parameters are derived from these two sensors, like NDVI, VCI, VPI, SAVI and fAPAR. They are currently the main remote sensing information used in the context of the MCYFS. They allow interpretation of vegetation conditions, biomass development etc. At present the data is used as an independent source of information to check convergence of results. These products are widely used by our analysts, as they allow vegetation conditions to be evaluated in an historical context. This low-resolution data with 1 kilometer pixel size is completed by MODIS data at 250 meter spatial resolution. As well, MSG – SEVIRI data with 5 kilometer spatial resolution is used. The derived meteorological products are distributed by the LSA SAF (Land Surface Analysis Satellite Applications Facility [http://landsaf.meteo.pt/]) and adapted to MCYFS requirements throughout an operational processing chain. They support weather monitoring and crop simulation.

MARS Stat ImageServer.

Data Access and Distribution

In order to allow our users to access information, two main tools have been put in place: the MARS-OP website showing a comprehensive picture of the agricultural campaign; and all the information derived from the MCYFS and the MARS Stat ImageServer giving access to the full-resolution vegetation state parameters derived from low-resolution satellite imagery.

MARS-OP Website

The MARS-OP website offers a wide variety of information about the current agricultural season in Europe and other important agricultural areas of the world. Available products include maps of weather indicators based on observations and numerical weather models, maps and time profiles of crop indicators based on agro-meteorological models, and maps of vegetation indices and cumulated dry matter based on remote sensing images. The extranet site can be freely accessed under www.marsop.info/ upon login request through the web site.

MARS Stat ImageServer

The MARS Stat ImageServer is a Web mapping application that allows searching for vegetation state parameters using various search fil-

ters like sensor, product and time period (see Figure 3). The identified datasets can be previewed interactively by zooming and panning to the area of interest. Additional thematic map layers, like country borders, NUTS (Nomenclature of Territorial Units for Statistics) regions or municipalities, allow better navigation on the map. The selected datasets can be downloaded in full resolution, either as the full dataset or clipped to an area of interest. Administrators can predefine reusable user-specific areas of interest that make it easy for users to clip the downloaded datasets to the same area every time. In addition, users can define the area interactively or insert the bounding coordinates manually. Image formats provided for download are GeoTIFF and ERDAS Imagine (HFA). As well, the interactive map with the selected image product and geographic extent can be printed out as HTML or downloaded as a PDF file.

The Image Server is based on the OpenSource Web mapping framework of UMN MapServer (http://mapserver.gis.umn.edu) and uses the PHP MapScript interface of MapServer. The advantage of UMN MapServer is its flexibility and extendibility for working with various kinds of data sources and integration into an existing application framework. The built-in support of a large number of raster formats permits direct access to image products in their native storage format ENVI Labeled Raster without the need for pre-processing or conversion.

The processed images are uploaded by the contractor into a pre-defined directory structure. An automated task scheduler checks for new data and references them with their required metadata in a PostgreSQL database. Directly afterwards the images are available for visualization and download: users select the product parameters and the time frame they are interested in; a request is sent to the metadatabase; and the identified image data is offered as dynamic layers in the Image Server application.

Visualization including printing and PDF creation is available to everybody. Downloading imagery data requires registration. Upon registering in the database, users are permitted a certain download quota.

Outlook

The MARS Stat activities will continue under the 7th Framework Programme of the EU and expansion of crop yield forecasts to additional countries is envisaged. The MCYFS itself will be enhanced in terms of spatial resolution, and direct ingestion of remote sensing data into the model is foreseen. Moreover, climate-change scenarios will be developed and implemented into the MCYFS to study the impact on crop production systems at the EU level.

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References

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