Crop Monitoring as an E-agricultural tool in Developing Countries

# CGMS ADAPTATION MOROCCO

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# ACRONYMS & CLOSSARY

| | | |
|---|---|---|
| CGMS | - | Crop Growth Monitoring System |
| DMN | - | Direction de la Météorologie Nationale |
| DSS | - | Direction de la Statistique |
| DSSF | - | Down-welling Short-wave Surface Flux (from MSG satellite) |
| EMU | - | Elementary Mapping Unit |
| IDW | - | Inverse Distance Weighting |
| INRA | - | Institut national de la recherche agronomique |
| MSG | - | Meteosat Second Generation |
| NDVI | - | Normalized Difference Vegetation Index |
| NUTS | - | Nomenclature des unités territoriales statistiques |
| OGC | - | Open GIS Consortium |
| SMU | - | Soil Mapping Unit |
| WMO | - | World Meteorological Organization |
| WOFOST | - | WOrld FOod STudies |

# 1. Introduction

The overall goal of the E-Agri proposal to support to the uptake of European ICT research results in developing economies. The objective can be realized by setting up an advanced European E-agriculture service in two developing economies, Morocco and China, by means of crop monitoring and yield forecasting. In the work package 2 of the E-Agri project, the focus is on the implementation of the European Crop Growth Monitoring System (CGMS) for wheat monitoring and yield forecasting in two target regions: Morocco and the Huaibei region in Anhui province in China.

This deliverable describes the adaptations made for the CGMS implementation in Morocco. The results described here basically reiterate over what has already been reported in deliverables D22.1, D22.2 and D25.1 due to overlapping content of the deliverables that were defined in the project proposal.

# 2. Adaptations to CGMS Morocco

## 2.1. Spatial Schema

The spatial schema of CGMS-Maroc consists of several layers (Figure 1):

1. The basis for the spatial schematization of the CGMS-Maroc is a uniform grid with cells of 9.14x9.14 km size covering the entire Morroccan territory.
2. The 1:1,000,000 soil map of Europe which was combined with a more detailed soil map that was available only for the agriculture zone in the northern part of Morocco. Moreover, the soil hydraulic properties were estimated for the spatial units in the Moroccan soil map.
3. The land cover mask derived from the GlobCover project. From this map, the classes related to arable land were derived in order to calculate the percentage of arable land per CGSM grid. This land cover mask was later replaced by more detailed (high resolution) crop mask made available by INRA.
4. The administrative regions for Marocco consisting of four levels: districts (1450), provinces (45), agrozones (6) and whole country.

All layers of information were combined and loaded into the CGMS database and the database for the CGMS Statistical Toolbox.

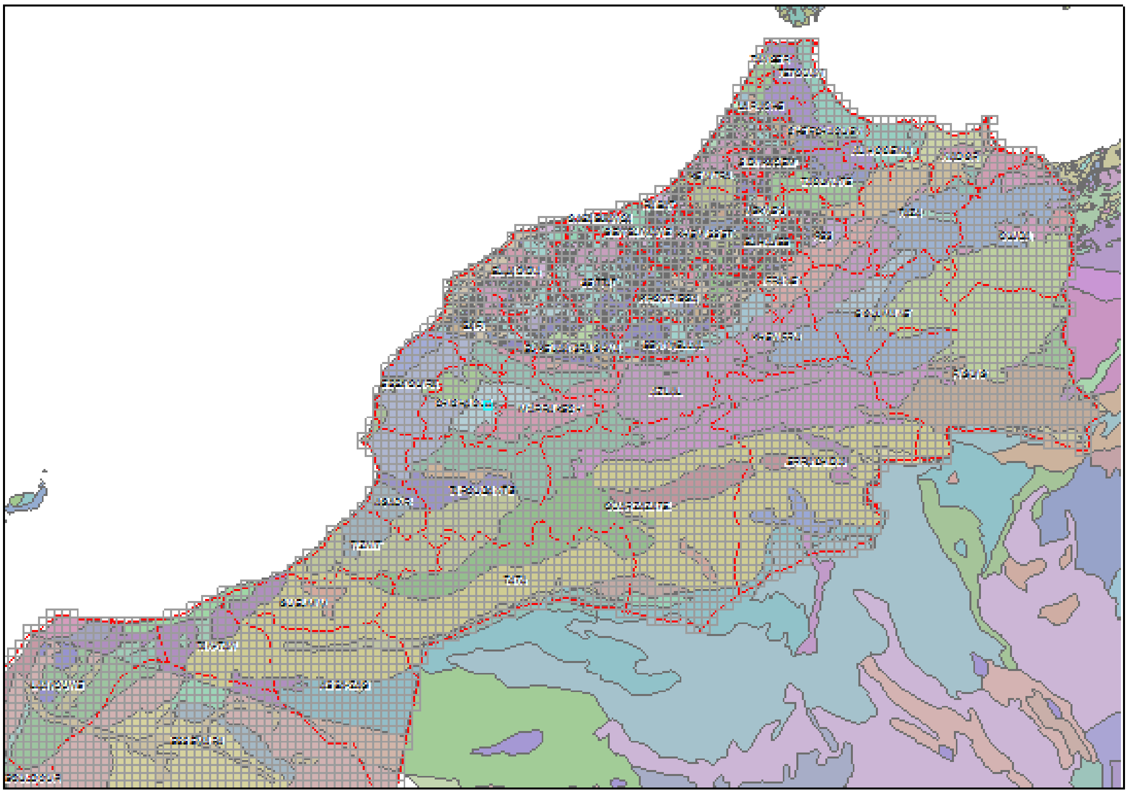

*Figure 1. Overview of the CGMS-Maroc spatial schema for the Northern part of Morocco, including the province boundaries (red), the soil map (coloured polygons) and the CGMS grid (grey rectangular boxes). Labels are province names.*

## 2.2. Crop parameterization

Crop experimental data for calibration of WOFOST were provided by INRA and consisted of crop calendars and yields for several cultivars of soft-wheat and durum-wheat over the period 2000-2005 for several experimental stations in the country, located in sub-humid and semi-arid environments. These data were derived from previous monitoring projects. For a better description, see section 2.4 in the Usability Report (D22.1).

The calibration involved the WOFOST parameters TSUM1 and TSUM2 which define the temperatures sums to go from emergence to flowering and from flowering to maturity. The value of 110 degree days for TSUMEM (sowing to emergence) was copied from existing datasets for spring-barley, as we expected to gain very little from calibrating this parameter. In the crop growth simulations done for Europe, the TSUMEM is normally set to zero in order to compensate for fact that emergence that occurred in the previous calendar year is neglected. Furthermore, initial total biomass for Europe - as reflected by parameter TDWI - is normally set to 210 kg per ha - much higher than the actual amount of seed used for the same reason. For Morocco, TDWI was set to 60 kg per ha.

The results of the optimization demonstrate that the optimized TSUM1 and TSUM2 parameters (Table 1) are quite different from the ones used in the MCYFS for Morocco where values of TSUM1=800 and TSUM2=1100 are used. The parameter values differ somewhat between wheat cultivars and the three durum wheat cultivars tend to have a slightly smaller total TSUM (average: 2100 degree days) compared to the soft-wheat cultivars (average: 2170 degree days).

Finally, the average values for the cultivars for soft wheat and durum wheat where implemented in the CGMS database for running the crop simulation for soft-wheat and durum-wheat.

*Table 1. Optimum values for selected parameters.*

| Cultivar | Cultivar name | TSUM1 | TSUM2 | TSUM1 + 2 |
|---|---|---|---|---|
| 1 | Karim durum wheat | 1400 | 750 | 2150 |
| 2 | O.Rabia durum wheat | 1300 | 750 | 2050 |
| 3 | Tomouh durum wheat | 1350 | 750 | 2100 |
| | *Average durum wheat* | *1350* | *750* | *2100* |
| 4 | Achtar soft wheat | 1450 | 775 | 2225 |
| 5 | Kanz soft wheat | 1375 | 875 | 2250 |
| 6 | Massira soft wheat | 1375 | 800 | 2175 |

| | | | | |
|---|---|---|---|---|
| 7 | Arrehane soft wheat | 1325 | 825 | 2150 |
| 8 | Mehdia soft wheat | 1325 | 725 | 2050 |
| | *Average soft wheat* | *1370* | *800* | *2170* |

## 2.3. Cropping calendar

For setting up CGMS a spatially distributed sowing date must be defined. In practice, the sowing dates will vary as a result of weather, logistics and local practices. Moreover, in Morocco there is north-south gradient in rainfall pattern and therefore a N-S pattern in sowing dates may exist. In order to observe this pattern, we made a small analysis whether we could discover any trends with latitude in the observed sowing dates from the experimental data. Our conclusion was that such a trend cannot be proven with the currently available data.

Therefore, the CGMS-Morroco was implemented using a fixed sowing date for all years of simulation which was originally set to 1 December but which was adjusted to 15 November after discussion with the Moroccan users.

## 2.4. Waterbalance initialization

We tested whether we could initialize the soil water balance in a way that isappropriate to the Moroccan situation. The results demonstrated that even when starting the water balance 6 months before the crop sowing (June 1), the soil moisture levels will not converge towards a stable soil moisture level. In fact around sowing ($1^{st}$ of December) the variability in the available soil moisture is still large. Similar tests at other sites and soil types reveal the same pattern.

Therefore, the Moroccan CGMS was implemented by assuming a dry soil profile at the end of the growing season and to let the water accumulate in the months before crop sowing rather than assuming a completely wet profile at the crop start as is done in Euroe. The assumption presupposes one crop per year under rainfed conditions.

In terms of implementation, the initial soil water in the CGMS-Morocco was set to a low value (around 5 cm of water) because it was found that the system can become unstable when there is zero soil moisture available at the start of the crop simulation.

## 2.5. Processing chain

The complete CGMS level 1 processing chain was implemented at DMN and carries out the following steps for automatic retrieval and processing of weather data:

1. Metdata is updated daily by processing Synop and Metag Messages at 11h00.
2. A FORTRAN executable checks automatically the last day from the table GRID_WEATHER and compares it with the last available day in METDATA. If the date in GRID_WEATHER is earlier than the date in METDATA, the program updates SYSCON table with the related current_year.
3. The program generates automatically the configuration file for running CGMS in batch mode. The configuration file contains the last day.METDATA as the begin and end date of interpolation, the calculated weather option is also activated for global radiation and PET calculation.
4. The program runs CGMS in batch mode, then the table GRID_WEATHER is updated by the real time values at 13h00.

The operational implementation of the CGMS level 2 is currently still a manual process where an operator is needed to run the CGMS executable, start the aggregation of crop simulation results to grid and regional level and finally export the aggregated results to the CGMS-Maroc viewer and CST database. As this process has to be performed on decadal time-steps, this is not problematic. Nevertheless, an automated procedure can be implemented easily by updating the CGMS configuration file and running the CGMS executable using a scheduled procedure.

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## 2.6. CGMS Maroc Viewer

A Web viewer, called CGMS-MAROC and available at www.cgms-maroc.ma (Error! Reference source not found.), has been developed by the project in order to visualize data and make preliminary analyses of status of the cropping season. It is managed autonomously by a consortium composed of three national institutions involved by the project in Morocco (INRA, DMN, DSS) and which are bound by a mutual official agreement.

The general functionalities have been inspired from "MARSOP3" Web viewer (http://www.marsop.info/marsop3/) developed by Alterra. The Moroccan Web viewer is hosted on a server located at INRA and supplied by daily climatic data (rainfall, maximum and minimum temperature, reference evapotranspiration) coming from all synoptic stations of DMN, by main outputs derived from WOFOST crop model, as well as by satellite imagery products (NDVI and DMP, coming from both SPOT-VEGETATION and MODIS) delivered every 10 days by VITO. All data are aggregated at common uniform grid cells of 9.14x9.14 km size. The size of the grids was decided as a compromise between needed accuracy for crop monitoring and forecasting and the error generated when interpolating weather data coming from the 43 available synoptic stations. It is intended to reduce the size of the grid when new synoptic stations will be available for CGMS-MAROC.

# 3. Conclusions

The overall conclusion that can be drawn is that the adaptation of CGMS for Moroccan conditions was very successful:

- The phenological parameters of WOFOST were calibrated on the Moroccan experimental data. The results demonstrate that the parameter values differ considerably from the parameters used in the MARS Crop Yield Forecasting System for Morocco. This is a strong indication that the current MCYFS setup is not appropriate for Morocco.
- It was demonstrated that the assumption of soil moisture being at field capacity at the start of the crop simulation is inappropriate for Morocco. Instead, it is more realistic to assume that the soil profile is completely dry by June 1 and to start the water balance several months before the crop starts in order to let the rainfall accumulate during the months before the cropping season.
- The adapted CGMS using the new crop calendar, new WOFOST phenological parameters and adapted water balance initialization performs considerably better than MCYFS in explaining the yield variability for Morocco over the period 1999-2010 for soft and durum wheat.
- A processing chain was developed in WP2 for running CGMS level 1 in an automated way at the premises of DMN. The processing chain of CGMS level 2 and 3 were also implemented but still require an operator. However, as the CGMS level 2 and 3 are executed every 10 days this is not critical.
- A web-based viewer was developed that displays results from the CGMS-Maroc system for analysis by end users.