# A COMPUTER PROGRAM INTEGRATING GIS, SPATIAL WEATHER GENERATOR AND SIMULATION MODELS FOR THE DEVELOPMENT OF AGROMETEOROLOGICAL ADVICE

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## INTRODUCTION

The bulletins currently published by various agrometeorological services mainly contain meteorological information. The use of simulation models at a regional scale to provide quantitative information on crop growth and development, or on infection levels of crop diseases and pests, is still not widespread.
The objective of this study, carried out within the project SEM 04/204/028 of Direction de la Météorologie Nationale of Morocco and supported by the European Union, has been to develop a computer program that allows regional simulation of crop development and yield by integrating various types of applications, such as databases, spatial weather generators, simulation models of crops and of crop diseases, and geographic information systems. The output of this system facilitates the production of agrometeorological bulletins.

## SYSTEM DESCRIPTION

Historical meteorological data of synoptic and climatic stations of Morocco and daily weather forecast grids.

**ORACLE 8i**

- METEOROLOGICAL DATABASE
- AGROMETEOROLOGICAL DATABASE
  - Reference grid
  - Geographical data
  - Morphological data
  - Soil data
  - Species and cultivar characteristics
  - Spatial weather generator output
  - Model output

The program combines stochastically generated, site-specific weather series based on grid maps of generator coefficients with data from deterministic forecast maps as produced by weather forecast models to create various hypothetical weather scenarios. The generator coefficient grids are estimated from meteorological station data using topography-guided spatial interpolation techniques.

**SPATIAL WEATHER GENERATOR**

The models are used to simulate phasic development and yield of wheat, barley, sugar beet and olive. The original user interfaces have been eliminated and selected options and parameters are passed to the models both from the main user interface and the ORACLE database.

**CROP MODELS**
- Cropsyst model
- Olive model

This module, developed in VisualBasic, calculates average, minimum, maximum, mode, median, quartiles and standard deviation of crop model output.

**STATISTICAL ANALYSIS**

All stored information is linked to geographical grids with resolutions of 2', 1' and 30". ORACLE tables are managed by several modules developed in the Avenue language of ArcView©.

Main menu of ORACLE table management module

The gridded output of statistical analyses, as well as other data archived in the ORACLE database, can be loaded into ArcView GIS 3.2© of ESRI to produce final maps for agrometeorological bulletins.

**GEOGRAPHICAL INFORMATION SYSTEM**
- Map production
- Management of model output

**PEST AND DISEASE MODELS**

**AGROMETEOROLOGICAL ADVICE**

The models included in the system forecast development stages and infection pressure of vine downy mildew, olive fly, wheat brown rust and sugar beet cercospora. For these models, the original user interfaces have been maintained. They use as input hourly weather data collected by automatic meteorological stations.

### PROGRAMMING LANGUAGE USED

Since the different models included in the system are written in different programming languages, the various components of the system have been interconnected by modules developed in Microsoft® VisualBasic 6. These modules handle the automatic creation of input files in the formats demanded by the various models and the management of output files.

User interface and modules for general system management have also been developed in VisualBasic 6.

### MAIN USER INTERFACE

In the main user interface, the user first selects working area and spatial resolution of the working grid. Then he chooses crop and crop model, the number of weather scenarios to be created by the Spatial Weather Generator, and the starting date of the simulation. After this, he has to activate the generation of meteorological data by selecting the menu option "Building SWG files."

## DATA FLOW AND STEPS INVOLVED IN RUNNING CROP MODELS

Automatically, the system creates input files for the Spatial Weather Generator by extracting data from the ORACLE database (one set of files for each working area), runs the program, and stores the SWG output files (one file for each row of the working grid) back into the ORACLE database.

In the main user interface, the user then activates crop simulation by choosing the option "Launch System."

For each grid cell and each weather scenario produced by the Spatial Weather Generator, the system automatically creates all input files necessary to run the selected crop model, launches the model, and transfers its output files to the statistical analysis module for further processing. The output files of the statistical analysis module are automatically saved in the ORACLE database from which they can be exported to GIS software for further elaboration and/or the creation of maps.

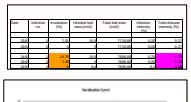
## DATA FLOW AND STEPS INVOLVED IN RUNNING PEST AND DISEASE MODELS

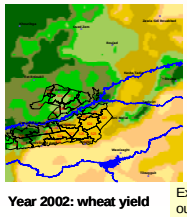
The user selects the desired model in the main user interface and specifies the name of the meteorological station whose data are to be used.

Automatically, the system creates input files in the format demanded by the model and launches the model which brings up its own user interface.

The user then enters any additional data requested by the model and activates simulation.

Example downy mildew model output





Year 2002: wheat yield

Example of map output