

CLIMAGRI – Climate Change and Agriculture Activities of the third year and conclusions

Development of a regional network on climate change and agriculture for the countries in the Mediterranean region

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ABSTRACT

In 2001 a three-year research project named **CLIMAGRI** started, funded by the Italian Ministry of Agriculture and Forestry Policies (**MiPAF**) and coordinated by the Central Office for Crop Ecology (**UCEA**). The main objective of the project was to get a wide-ranging and in-depth technical and scientific overview of the various interconnections between agriculture and climatic variations in Italy. In order to widen the potentialities of the project outside the national border, in February 2002, a partnership agreement was reached between UCEA and the Food and Agriculture Organization of the United Nations (**FAO**) within the framework of CLIMAGRI. Due to its geographical context, this topic was named **CLIMAGRI_{med}**. Following is a brief description of the activities carried out during the three years of the project, conclusions and future perspectives.

INTRODUCTION

At the beginning of 2001 a three-year research project named **CLIMAGRI** started, funded by the Italian Ministry of Agriculture and Forestry Policies (**MiPAF**) and coordinated by the Central Office for Crop Ecology (**UCEA**). The project had as its main objective a wide-ranging and in-depth technical and scientific overview of the various interconnections between agriculture and climatic variations in Italy. In order to widen the potentialities of the project outside the national border, in February 2002, a partnership agreement was reached between UCEA and the Food and Agriculture Organization of the United Nations (**FAO**) within the framework of CLIMAGRI.

The above-mentioned partnership is an integral part of CLIMAGRI and is listed as topic 4.3 under Sub-topic 4: Information and the dissemination of data. Due to its geographical context, this component was named **CLIMAGRI_{med}** and the coordination was led by the Agrometeorology group of the Environment and Natural Resources Service (**SDRN**), within the Research, Extension and Training Division of the Sustainable Development Department. SDRN is FAO's focal point for all activities connected with International Environmental Conventions (Climate Change, Desertification, and Biological Diversity) and because it provides infrastructures, regional information on the environment and training.

GENERAL OBJECTIVES OF THE RESEARCH

The final objective of the technical support services provided by FAO under topic 4.3 was to obtain an ideal synergy between UCEA, the Italian research institutes and FAO for the application of the methodologies elaborated in the framework of CLIMAGRI in order to be adapted and applied

in some developing countries in the Mediterranean area. To reach this goal it was needed, first of all, to establish a virtual network among all participating countries and the Italian research institutes, and to define the fields that qualified for the transfer of methodologies. To this aim, the following activities have been realized: (i) organization of an international workshop; (ii) design and creation of the multilingual Internet website for CLIMAGRI*med*; (iii) drafting of a long-term project proposal.

The international workshop has allowed the scientists from other countries (mainly from National Agronomic Research Institutes and National Meteorological Services) to meet the coordinators of various topics of the CLIMAGRI project. About 50 experts on the impact of climate change on agriculture met in Rome, at FAO's headquarters, in September 2002. The participants came from 8 Mediterranean countries (Algeria, Cyprus, Egypt, Lebanon, Libya, Morocco, Syria and Turkey) and from Italy. There were also representatives from UCEA and FAO. The Mediterranean area experts represented the National Meteorological Services and the National Agronomic Research Institutes.

During the meeting, the following themes were discussed:

- i) Goal of CLIMAGRI and of CLIMAGRI*med*.
- ii) Research topics of CLIMAGRI.
- iii) Activities carried out by the scientists of Mediterranean countries and linked to the various topics of CLIMAGRI.
- iv) Bilateral discussions.
- v) Proposals for cooperation.

On the grounds of the proposals for collaboration discussed during the international workshop in Rome and of the budget for CLIMAGRI*med*, it has been possible to define a protocol of collaboration of a duration of two years and having the general objective of creating a network among Italian scientists and those from Mediterranean countries participating in CLIMAGRI*med* in order to establish a common scientific structure for the study of the impact of climatic change on the agricultural sector. Besides Italy, the countries participating in the collaboration were: Cyprus, Egypt, Morocco and Turkey.

The second activity concerned the design and creation of the multilingual Internet website for CLIMAGRI*med* in English and in French managed by FAO under the portal of the Department for sustainable development (http://www.fao.org/sd/index_en.htm).

A final mission of the Italian scientists in Cyprus, Morocco and Turkey allowed the collection of useful information and a consensus for drafting a long-term project proposal including all Mediterranean countries.

METHODOLOGY

The protocol for collaboration targeted four main specific objectives:

1. The institution of an inter-regional network for the exchange of information and mutual access to data and research outcomes through the realization of the CLIMAGRI*med* website.
2. Formulation of a project proposal which includes all of the Mediterranean countries, worked out on the basis of information acquired during the execution of technical activities.

3. Acquisition, analysis of the quality and homogeneity of the historical series of the meteorological data to construct future climatic scenarios. Coordinator: Dott. Maurizio MAUGERI (Institute of General Applied Physics, University of Milan). Participating countries: Cyprus (Dr. Stelio PASHIARDIS, Meteorological Service), Egypt (Dr. Emad ATTIA, Meteorological Service), Morocco (Dr. Abdelaziz EL OUALI, Meteorological Service).
4. Development of a *Land Evaluation* system useful to assess climatic risks in agriculture due to both variability and climate change in the Mediterranean area on a local and national scale. Coordinator: Dott. Pierpaolo DUCE (CNR-IBIMET, Institute of Biometeorology, Agroecosystem Monitoring Laboratory, Sassari), Dott. Franco ZINONI (ARPA-SMR Meteorological Service, Regional Agency for the Prevention and the Environment of the Emilia-Romagna Region). Participating countries: Morocco (Dr. Mohammed KARROU, National Agronomic Research Institute), Turkey (Dr. Ulfet OZSOY, Menemen/Izmir Soil and Water Research Institute of Rural Services, Dr. Yildirim KAYAM, Menemen/Izmir Agrohydrology Research and Training Center).

During the second and third year of the CLIMAGRI project, under objectives 3 and 4 above, some technical missions were planned, either to Mediterranean countries for Italian scientists or to Italy for others. The institution of an inter-regional network was coordinated by FAO while the formulation of a project proposal was given to a team of Italian scientists with the technical-logistic support of FAO.

RESULTS AND DISCUSSION

Despite some logistic problems that delayed the work plan, the technical activities have progressed as planned. It must be noted the high degree of professional performance of all scientists, both from Italy and from other Mediterranean countries, in carrying out their duties. The following are the results regarding the four objectives.

1. Realization of an Internet Website

An Internet website concerning cooperation within the framework of CLIMAGRImed has been designed, realized and managed by FAO. The website is in English and in French and it includes four main sections: (i) activities, (ii) projects, (iii) research, (iv) cooperation. Furthermore, a protected area which is used by participants of CLIMAGRImed only is used to exchange data and information. Besides the documents regarding CLIMAGRImed activities, the website also includes most of the documents of the Italian CLIMAGRI project. A special budget allocation given by FAO has allowed the website to be translated into Arabic as well. The website is accessible at the address <http://www.fao.org/sd/climagrimed/>.

2. Drafting a Project Proposal for the Mediterranean Region on Climate Change and Agriculture

During the various missions performed during the two years of activities of CLIMAGRImed, the scientists from Mediterranean countries have confirmed the lack of methodologies to assess the impact of climatic change on the agricultural sector and then the need to acquire such applications.

The activities under CLIMAGRI*med* have created an initial linkage with some developing countries. Italian scientists have collected, during their missions abroad, important elements to draft a long term project proposal in order to consolidate this linkage which has to allow a complete transfer of the methodologies. At the end of the second year, a team of Italian scientists performed a final mission to synthesize and to structure in a coherent way, under a project proposal, the objectives, activities and outputs required to establish a permanent regional network among the developing countries in the Mediterranean region to adapt and apply the various methodologies.

3. Acquisition, analysis of quality and homogeneity of the historical series of meteorological data to construct future climatic scenarios

- Mission of Dott. Maurizio MAUGERI to **EGYPT** at the National Meteorological Service (December 2003).

The aim of the mission was to evaluate the existing meteorological situation as regards availability of data, methods of analysis, logistical infrastructures and identification of a potential counterpart for the transfer of methodologies. The Meteorological Service was found to qualify because it had computer archives containing about 40 years of information (quality to be evaluated) and hard copy archives for a longer period. The personnel and logistics have an excellent technical level judging from studies made on the climate in Egypt with the publication of a Climate Atlas. As regards studies on climatic variability and change, research is still in the preliminary phase.

A work plan for future activities was set out:

- i) Collection of data and meta-data.
- ii) Checking the quality and homogeneity of data.
- iii) Analysis of data.

It was agreed that the first mission of the scientists from Egypt to Italy would take place once the collection of data and meta-data was completed. An application for participation in the CLIMAGRI*med* activities has been sent by FAO to the General Director of the Meteorological Service, making the collaboration official. The proposal has been rejected.

- Mission of Dott. Maurizio MAUGERI to **CYPRUS** at the National Meteorological Service (January 2004).

The objective of the mission was to evaluate the existing meteorological situation as regards availability of data, methods of analysis, logistical infrastructures and identification of a potential counterpart for the transfer of methodologies. The Meteorological Service was found to qualify because it had computer archives containing 80/90 years of rainfall data and hard copy archives for a longer period. For the daily temperature data, the archives go back 40/50 years. The personnel and logistics have an excellent technical level judging from the studies made of the climate in Cyprus, some of which on climatic variability and change.

A work plan for future activities was set out:

- i) Collection of data and meta-data.
- ii) Separation of observed data from estimated data, filing away of rainfall data prior to 1916, checking of missing data, identification of stations to be used for the monitoring of homogeneity;
- iii) Checking of quality and homogeneity of data.
- iv) Analysis of data.

The first mission of the scientists from Cyprus to Italy would take place once collection of data and meta-data has been completed.

- Mission of Said EL KHATRI, Driss BARI, Amine CHENNOUFI from the National Meteorological Service of Morocco, Stelios PASHIARDIS and Elenitsa STAVRIKKOU from the National Meteorological Service of Cyprus to **BOLOGNA** (Italy) at the Institute of Atmospheric Sciences and Climate (ISAC) of the National Research Council (CNR) (May 2005).

The objective of the mission was to attend the training session on “**The quality and homogeneity of meteorological data to build up scenarios of climatic change**”. The session was aiming to explain its approach toward the use of homogenisation methods for the analysis of time series of meteorological data. Homogeneity tests, methods, limits and benefits of homogenizing meteorological records were discussed, and a demonstration of the homogenisation of real time series was given. The training session was held at the Institute for Atmospheric and Climate Sciences (Istituto di Scienze dell'Atmosfera e del Clima, ISAC) of the National Council for Research (Consiglio Nazionale delle Ricerche, CNR) in Bologna, Italy. The teachers were Maurizio Maugeri (Milan University) and Michele Brunetti (ISAC CNR). The contents of the training session are available at http://www.isac.cnr.it/%7Eclimstor/hom_training.html.

It is planned to realize and publish a CD-ROM including all materials of the training session, as well as the software for the homogenisation of time series of meteorological data.

4. Development of a *Land Evaluation* system useful to assess climatic risks in agriculture due to both variability and climate change in the Mediterranean area on a local and national scale.

- Mission of Dott. Pierpaolo DUCE (CNR-IBIMET), Dott. Andrea MOTRONI (SAR-Sardinia), Dott. Lucio BOTTARELLI (ARPA-SMR) to **TURKEY** at the Agrohydrology Research and Training Center (ARTC) and the Soil and Water Research Institute of Rural Services (MRI) in Menemen/Izmir (November 2003).

The objective of the mission was to evaluate the situation of the meteorological and agronomic sectors in terms of availability of data, methods of analysis, infrastructures and identification of the most suitable partners for an efficacious transfer of methodologies. Both ARTC and MRI appeared to be able to make use of the transfer of CLIMAGRI methodologies efficaciously. Between 1999 and 2003 work groups of the two institutes conducted studies on the Impact of the Climate and the Agro-technological and Socio-economic factors on wheat and cotton crops and they recently started a new research project regarding the Impact of Climatic Variability and Change on Agricultural Production in western Turkey. Moreover, the institutes confirmed the ready availability or possibility of collecting most of the data (climatic, morphological, pedological, soil usage, Agricultural Land Capability, etc.) needed to evaluate the climatic risk in agriculture in the crop areas identified by the ARTC-MRI work group for the transfer of *Land Evaluation* methodologies. The two Institutes have set up an interdisciplinary research group for the realization of CLIMAGRImed activities and they guarantee they are well equipped with services and infrastructures for analysis of the data and execution of the activities foreseen.

- A work plan for future activities was set out:
- i) Selection of the agricultural areas for application of *Land Evaluation* analysis of climatic risks in agriculture (Aegean coastal area of about 30,000² km characterized by a Mediterranean-type climate) and description of the region selected in terms of meteorological, climatological, pedological and agronomic characteristics.
 - ii) Inventory of available data and selection of climatologic historical series (temperature, rainy precipitations, at least 20-30 years of daily data).
 - iii) Discussion in detail of the methods to be used for the calculation of bioclimatic indexes. Using a 30-year historical series provided by ARTC and MRI researchers, calculations of the bioclimatic indexes were made, mainly based on degrees per day and on simplified models of hydrological balance, and on analysis of climatic variability by means of the procedure elaborated within CLIMAGRI.
- Mission of Dott. Andrea MOTRONI (SAR-Sardinia), Dott. Simona CANU (SAR-Sardinia), Dott. Gabriele ANTOLINI (ARPA-SMR) to **MOROCCO** at the National Institute of Agronomic Research (INRA), (December 2003).

The objective of the mission was to evaluate the situation in the meteorological and agronomic sectors in terms of availability of data, methods of analysis, infrastructures and identification of the most suitable partners for an efficacious transfer of methodologies. The INRA Centres in Rabat, Settat and Meknès appeared to be able to make efficacious use of the transfer of the CLIMAGRI methodologies. During the last five years the INRA work groups have conducted studies on the impact of the climate and agro-technological and socio-economic factors on the production of wheat, barley and on pastures. The area of greatest experience is the modelling of crop cultivation and various models have been developed and used to estimate potential crop production, also in relation to climatic variability. Moreover, early warning systems of drought have been developed.

The Centres confirmed the ready availability or possible collection of most of the data (climatic, morphological, pedological, soil usage, Agricultural Land Capability, etc.) needed to evaluate climatic risk in agriculture in the agricultural areas identified by the INRA work groups for the transfer of the *Land Evaluation* methodologies. The INRA researchers involved in the project have set up an interdisciplinary research team for the realization of CLIMAGRI^{med} activities. They guarantee a good level of competence in using Geographical Information Systems (GIS) and that they are well equipped with services and infrastructures for analysis of the data and execution of the activities foreseen.

- A work plan for future activities was established:
- i) Selection of the agricultural areas for the application of *Land Evaluation* analysis of climatic risk in agriculture (the region of Settat, about 6,000² Km., 150 km south-east of Rabat, as it is the most important area for the cultivation of wheat and barley in Morocco; the region of Meknès, approximately 3,600² Km., 150 km. east of Rabat, characterized by a more humid climate than Settat);
 - ii) Description of the region selected in terms of meteorological, climatological, pedological and agronomic characteristics.
 - iii) Inventory of available data; selection of the climatologic historical series (temperature, rainy precipitations, at least 20-30 years of daily data) to be used in the calculation of the bioclimatic indexes; identification of the historical series and data to be collected.
 - iv) Analysis of data and methods to be used for the calculation of the bioclimatic indexes (using a 30-year historical series provided by the INRA researchers, calculations were made of the bioclimatic indexes, mainly on the basis of degrees per day and on a simplified model of

hydrological balance, and climatic variability was analyzed by means of a procedure elaborated within CLIMAGRI.

- Mission of Orhan ODEN, Dilek KAHRAMAN (Agrohydrology Research and Training Center, ARTC), and Ulfet OZSOY (Soil and Water Research Institute of Rural Services, MRI) of Menemen/Izmir (Turkey), to **ITALY** at the Institute of Biometeorology, Agroecosystem Monitoring Laboratory (CNR-IBIMET) in Sassari (June 2004).

The first meeting with international consultants from Italy was held in November 2003 in Menemen/Izmir (Turkey), it was noted that:

- The agricultural areas where Land Evaluation analysis for climate risk in agriculture would be applied were approximately 30 000 km²;
- The methods that should be used to calculate Bioclimatic indexes based mainly on growing degree days and a simplified water balance model have been discussed.

The Turkish team in the CLIMAGRI_{med} project had enough experience on establishment of meteorological data sets and calculation of bioclimatic indexes at that point. However, the main problem for the team was the lack of experience of Geographic Information System (GIS) and the software to manage and analyze data. After the first meeting, 44 meteorological stations were selected in the project area. The meteorological data were obtained from the State Meteorological Works. The soil data of the project area were obtained from the General Directorate of Rural Services. The growing degree days and a simplified water balance model were calculated and maps were produced by using ArcMap software.

The meeting was very useful for comparing the methodology that we used to complete missing data to calculate bioclimatic indexes and to produce climatological and pedological maps with those of the CLIMAGRI project. The Turkish team presented the results of the works that have been done between the first and second meeting. A detailed discussion on pedological LCA maps, Climatic LCA classification and reconstruction of meteorological data took place. The Italian scientists transferred the methodology of the CLIMAGRI project to the Turkish team. Before the meeting the Turkish team had had some difficulties in data spatialization using the ArcMap software. The explanations given during the meeting made this process clearer.

At the end of the meeting, the following activities to be concluded were defined:

- i) The meteorological stations in the project area will be re-evaluated to confirm whether the data from meteorological stations used in the previous analysis are available for the work.
- ii) The meteorological data will be reconstructed by using an optimum interpolation which is called the minimum variance method. The interpolation will be based on the altitude, distance from the sea and distance between stations. To reconstruct the data set a Digital Elevation Model (DEM) of the project area will be obtained (250 m or 1000 m).
- iii) After reconstruction of the data set, bioclimatic indexes will be calculated for each grid cell.
- iv) Climatic LCA classification and Cluster Analysis will be done
- v) Pedological LCA classification map will be produced.
- vi) Climatic LCA classification will be produced before the third meeting in Turkey.

- Mission of Mohammed KARROU, Hassan BENAOUA, and Riad BALAGHI (National Institute of Agronomic Research, Morocco) to **ITALY** at the Meteorological Service, Regional Agency for the Prevention and the Environment of the Emilia-Romagna Region (ARPA-SMR) in Bologna (January 2005).

This mission was a follow up of the visit to Morocco, of the Italian counterparts in December, 2004. During that visit, it was decided that the Moroccan partners (Department of Agronomy) prepare the required data for testing the methodologies mentioned above. These data concerned the climate, soil, topography and land use. The objectives of the visit were the following:

- i) Exchange of information on methodologies used in Morocco and in Italy in the domains of Agrometeorology.
- ii) Presentation, by the Moroccan team, of collected available agroclimatic data concerning Settat and Meknès provinces.
- iii) Discussion of the possibility of using, by Moroccan partners, some tools developed within the framework of the Italian CLIMAGRI project.
- iv) Discussion of the possibility of preparing a Mediterranean project on climatic change and risk management in agriculture.

During the visit, INRA-Morocco scientists presented some tools and methodologies developed by their agrometeorology and GIS laboratories. They also presented the available data collected within the network taking into consideration the terms of references of the first meeting in Morocco. As outputs of their work, they presented different maps and indices (maps of Morocco describing the spatial distribution of average rainfall, land capability, synoptic weather stations, all climatic stations network, NDVI, land use, length of growing period and some indices like SPI). In addition, the group visited the Micro-meteorology, Physiology and Tissue culture laboratories of the CNR, Bologna.

At the end of the mission, it was concluded that INRA-Morocco, ARPA-Bologna and CNR-Sassari have to continue the collaboration in the field of the management of risks on agriculture due to climatic change. INRA-Morocco showed interest in testing, in Morocco, the tools developed in the CLIMAGRI Project and the partners expressed interest in improving some tools and methodologies developed in the CLIMAGRI Project. However the partners recognized that the test of the tools in Morocco and their improvement required financial support and this issue will be reported to FAO. The partners supported the idea of developing a larger project for the Mediterranean region on the aspects related to the management of risks in agriculture due to climatic change and a team of Italian scientists will visit Morocco during 2005 to draft with their counterparts a project proposal.

CONCLUSIONS

From the FAO point of view, the CLIMAGRI research project had two main objectives: to create, as a first in Italy and probably as a first in Europe, a coordinated structure on the researches of the impacts of climate change on agriculture; to transfer to developing countries in the Mediterranean region the methodologies elaborated by the Italian Institutes.

Without any doubt, after three years of activities, the CLIMAGRI project has certainly attained the first objective. Research, data and methodologies obtained so far will serve to get a very detailed analysis of the Italian territory, to underscore anomalies and current or future climatic changes, with specific reference to the impact on the Italian agricultural sector.

Furthermore, the topic developed under CLIMAGRI^{med} has established a first attempt at a regional network on climatic changes and agriculture for Mediterranean countries. The CLIMAGRI^{med} activities have clearly demonstrated that, given the geographic and geomorphological situation of Italy, the results of the CLIMAGRI project can be applied with success to other agricultural systems of the Mediterranean region. FAO, who coordinates this topic, is fully

aware that a closer and more fruitful technical-scientific cooperation is needed among Italian research scientists and those from the Mediterranean countries. For this reason, the current collaboration must continue and, in this respect, a project proposal has been drafted for the establishment of a regional and permanent network among the developing countries of the Mediterranean region to adapt and apply the various methodologies.

It is strongly desirable that all research carried out by Italian Research Institutes under the CLIMAGRI project can continue so as not to lose the knowledge acquired and the multi-disciplinary conscience established so far.

ACKNOWLEDGMENTS

The FAO Agrometeorology Group is grateful for having been associated with this very important national project. The experience which has been gained through the various activities has allowed the consolidation of cooperation with UCEA and the creation of new and very important synergies among FAO, Italian research scientists and those of developing countries in the Mediterranean region.

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