

# SCIENTIFIC REPORT

## of Short-Term Scientific Mission of COST Action 734

**Beneficiary's name and Institution:** MSc Višnjica Vučetić, Research and Development Division, Meteorological and Hydrological Service, Zagreb, Croatia

**Host's name and Institution:** Ao. Prof. Dr. Josef Eitzinger, Institute of Meteorology, University of Natural Resources and Applied Life Sciences (BOKU), Vienna, Austria

**Period:** from 20/04/2009 at 4:30 a.m. to 25/04/2009 at 0:30 a.m. (five working days)

**Place:** Vienna, Austria

**Reference code:** COST-STSM-734-04827

**STMS Topic:** Hands-on training on using the DSSAT crop model for research of climate change impact on the maize production in Croatia

### **Purpose of the visit:**

Analyzing agricultural systems and modelling the potential impact of climate change on crop production is a very important topic, particularly now as food supplies are becoming scarcer in many parts of the world and the need for all people to have sufficient food.

In Croatia maize and winter wheat are the most important agricultural crops. As the maize vegetation period is coincided with the warm season, from May to October, it was the decisive factor in the choice of the crop type for the investigation of the impact of climatic changes on biomass development and yield. In previous researches the old version of the DSSAT 2.1 (CERES Maize) model was used for simulation and projection of the maize production in the central part of Croatia into the future. The DSSAT model (Decision Support System for Agrotechnology Transfer) was developed within the IBSNAT project (International Benchmark Sites Network for Agrotechnology Transfer), which started in U.S.A. in 1982. The DSSAT model includes the main crop types intended for human consumption divided into three groups: cereals and maize, leguminous plants, and root and tuber crops. The most widely used are the simulation models for maize and wheat under the common name of CERES (Crop-Environment Resource Synthesis).

The purpose of this short-term scientific mission was therefore to learn the new version of crop DSSAT 4.0 model, using the crop, soil and weather data for the central part of Croatia, which is applied in the Institute of Meteorology, University of Natural Resources and Applied Life Sciences (BOKU) in Vienna. The visit was a results of the a discussions during the International workshop and course for decision makers on the effective use of water in agricultural crop production and meeting of WG2 COST 734 in Jois, Austria in October 2008 and meetings of MC and WG COST 734 in Bucharest in April 2009.

### ***Description of the work carried out during the visit:***

The programme of short-term scientific mission included the following:

- a preparation of the crop, soil and weather data for the particular location
- a introduction to the DSSAT model version 4.0
- a calibration the DSSAT model
- a running the DSSAT model for different initial conditions
- an analysis of the output data and results

The meteorological data used by the DSSAT 4.0 model are daily values of maximum and minimum air temperature, precipitation amount and global solar radiation. As the field experiment in 1999 was carried out at the farm of the Zagreb University Faculty of Agriculture, the meteorological data used in the analysis were taken from the nearest meteorological station, Zagreb Maksimir (1949-2004), located at about 650 m from the field experiment site. These data are representative for the continental climate in the central part of Croatia. Samples of the vertical pedological profile were taken for the chemical and physical analysis of the soil about two weeks before sowing. The crop, soil and weather data were prepared in the DSSAT format and imported to the model. After the introduction to the DSSAT model version 4.0 the model was calibrated and run by the Croatian data for different initial conditions.

In order to investigate the impact of weather conditions on maize growth and yield from year to year, the same pedological conditions, maize genetic conditions and soil management were presumed as in the 1999 field experiment. In the DSSAT model calculation the Zagreb meteorological data were changed year by year (taken from the 1949-2004 period). Thus, 56-year time series were estimated for the beginning of anthesis and maturity dates, grain yield, kernel mass, aboveground biomass, maximum leaf area index (LAI), grain N (%) and total N uptake. After that the output results were analyzed.

### ***Description of the main results obtained:***

The DSSAT model simulation underestimated the 1999 yield and biomass per hectare for 10% which is a good assessment. The reason for deviation between predicted and observed values is the model sensitivity to too warm condition during the vegetation period. Vegetation period in 1999 was extremely warm but the precipitation amount was at an average.

The effect of climate change on maize growth and productivity in the central part of Croatia has been analysed using the crop DSSAT 4.0 model for present climate in the period 1949-2004. The linear trends of particular maize parameters and the non-parametric Mann-Kendall test indicated a significantly earlier onset of anthesis by 1.4 days/10 years and earlier maturity by 4.4 days/10 years which started in mid-1990s. The linear trend analysis also showed a decrease in maize yield by 212 kg ha<sup>-1</sup>/10 years and in biomass by 120 kg ha<sup>-1</sup>/10 years.

In order to investigate the sensitivity of DSSAT model at the initial weather and CO<sub>2</sub> conditions, the global solar radiation was increased for 7%, minimum temperature for

2 °C, maximum temperature for 4 °C and CO<sub>2</sub> for 330 ppm but precipitation amount was decreased for 8%. It is shown that an increase in minimum and maximum temperature shortens the maize vegetation period and reduces maize yield, while a decrease in precipitation amount also reduces maize yield. An increase in CO<sub>2</sub> stimulates the leaf assimilation and maize yield growth, while a solar radiation growth also increases evapotranspiration. By applying all above mentioned modifications simultaneously it is shown that the maize yield is similar to a normal value estimated for the period 1949–2004. The prevailing influence comes from an increase in CO<sub>2</sub>.

***Future collaboration with host institution (if applicable):***

With the help of the COST Action 734 in the framework of the WG1 *Agroclimatic Indices and Simulation Models* the cooperation on the field of crop model simulation will be continued between Meteorological and Hydrological Service of Croatia and University of Natural Resources and Applied Life Sciences (BOKU).

***Projected publications/articles resulting or to results from the STSM:***

The results of the DSSAT crop model simulation will be presented at the WMO/COST Action 734/ADAGIO International symposium *Climate change and adaptation options in agriculture* which would be held in Vienna, Austria from 22 to 23 June 2009. The results will be also prepared for a scientific journal.

***Confirmation by the host institute of the successful execution of the mission:***

Institute of Meteorology, University of Natural Resources and Applied Life Sciences (BOKU), Vienna, Austria confirms that the short-term scientific mission *Hands-on training on using the DSSAT crop model for research of climate change impact on the maize production in Croatia* was successful.

***Other comments (if any):***

On behalf of USER institution



MSc Višnjica Vučetić

On behalf of HOST institution



Ao. Prof. Dr. Josef Eitzinger

Zagreb, 18 May 2009