RESEARCH INSTITUTE
FOR SOIL SCIENCE
AND AGROCHEMISTRY,
BUCHAREST
Computing Centre

JOINT RESEARCH CENTRE of the C.E.
ISPRA,
Institute for Remote Sensing Applications,

Agricultural Information Systems Unit

INTEGRATION OF AN EXPERT SYSTEM IN A G.I.S. FOR AGRICULTURE

by
Virgil VLAD

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INTRODUCTION

This report presents the research work carried out by the author in the Joint Recearch Centre of the European Communities (JRC-Ispra) – Institute for Remote Sensing Applications – Agricultural Information Systems Unit in the period 13 September – 12 December 1994.

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In the last years, the new requirements arisen for the decision-makers in the domain of agriculture and the progress obtained in the fields of the agricultural sciences and information technology have led, among others, to the development of the geographic information systems for the management and processing of the spatial-referenced agricultural data, the expert systems and new methods for land evaluation.

Research Institute for Soil Science and Agrochemistry-Bucharest has the responsibility and has elaborated for Romania methodologies (models) for agricultural land evaluation and soil protection/conservation and reclamation, as well as data bases concerning land/soil resources (scales – 1:10.000, 1:50.000, 1:200.000, 1:1.000.000). These are – in some respects – different from those of the European Communities. The computer implementation of these methodologies (models) and data bases was accomplished in classical manner.
The research programmes of the institute include the elaboration of land/soil expert systems and a geographic information system (GIS) for agricultural land/soil of Romania.

The general objectives of this work consisted of:

(1) Establishing the conception and requirements of an Expert System for agricultural land evaluation and technological recommendations concerning soil protection/conservation and reclamation, and of a Geographic Information System for Romanian agricultural land/soil, taking into consideration:

- present needs and realities;
- the specificity of the Romanian lands/soils and Romanian agricultural technological and economic systems;
- the existing Romanian agricultural data bases;
- the necessity of the compatibility with the systems of the European Communities (e.g. MARS and CORINE projects).

(2) Establishing the structure (data and functions/modules) of the two systems and the way to integrate them. Establishing the way to implement on computer their structures (methods and tools; hardware and software requirements).

CONCLUSIONS

In this work, the following main action werw accomplished:

1) Analysis of the concepts and methods concerning agricultural land evaluation, obtainning:
   - a coherent system of the Land Evaluation definition (objectives, principles, levels, main elements, classification),
   - classification of the methods used for Land Evaluation,
   - an analysis of these methods (advantages and disadvantages).

2) Analysis of the Romanian Land Evaluation Methodology used at present:
   - a synthetical presentation of the methodology and its implementation (ExET) using an expert system shell (ALES),
   - advantages and disadvantages of this implementation.

3) Analysis of the land/soil data – descriptive (data bases) and spatial (maps) – existing in Romania at present: This analysis pointed out:
   - the positive elements (large volumes of data, detailed-enough level of data),
   - the negative elements (great variety of data types/methodologies, lack of more detailed meteorological data, non-compatibility with the European and other methodologies, lack of digitized maps).

4) Analysis of the computerized land/soil data processing in Romania, which pointed out:
   - good pedo-transfer function (calibrated for Romanian conditions),
   - advances in soil water flow and crop growth simulation modelling,
   - good experience in advanced land/soil data processing.

5) Establishing the general requirements for a new Land Evaluation System in Romania – from the functional and operational point of view.

6) Analysis of the feasibility of the use a detrministic crop growth simulation model (WOFOST[1]) with the available Romanian land/soil data at large scale in the purpose of land evaluation:
   - establishing of general methods for obtaining of the input data for the WOFOST model from the available Romanian land/soil data,
   - establishing of general methods for comparison of the results obtained by the two ways of land evaluation: simulation based on a deterministic model (quantitative land evaluation) and semi-quantitative land evaluation based on a expert system (ExET) which implements the Romanian land evaluation methodology for the 1:10.000 scale: three land evaluation (suitability) indexes were defined for the two cases,
   - the experiments proved the feasibility of the proposed quantitative land evaluation method.

7) Establishing the general requirements for the Romanian Land/Soil Geographic Information System.

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[1] The WOFOST model was developed at the Winand Staring Centre for Integrated Land, Soil and Water Research Wageningen and is used by the Agricultural Information Systems Unit of IRSA/JRC in the Crop Growth Monitoring System (CGMS) for crop state assessment and yield forecast (MARS Project).

8) Establishing of the general structure of a new land evaluation system in Romania:
   - a new approach – the "integrated expert system" using a "models base",
   - the interface (integration) with the Land/Soil GIS,
   - the general principles, the way and the software tools for computer implementation;

9) Establishing the general structure of the Land/Soil Geographic Information System in Romania:
   - the data structures (layers and hierarchical attribute tables),
   - the interface (integration) with land evaluation system,
   - the general principles of the computer implementation,
   - the requirements for GIS software,
   - software and hardware configuration.

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For the requirements, analysis and system conception, the top-down approach was used.
Following this approach, further requirements analysis and systems conception must be carried out gradually on more detailed levels:

- more detailed analysis of the concrete utilization of the two systems (Land Evaluation Integrated Expert System and Land/Soil Geographic Information System) and of the available data; corresponding to the analysis results, the detailed function of the systems can be established (land utilization types, land suitability types, GIS layers, etc.);

- choosing the simulation models to be used for land evaluation; appropriate experiments are needed for this;

- establishing the pedotransfer functions, indirect data estimation algorithms, data coverters and data generators necessary for the chosen simulation models;

- establishing the methods and carrying out the experiments necessary for obtaining the unavailable pedotranfer functions and indirect data estimation algorithms;

- establishing the methods and carrying out the experiment necessary to calibrate and validate the chosen simulation models;

- establishing the expert rules necessary for land evaluation and technological recommendations;

- establishing the data presentation features;

- establishing the priorities for the implementation of different layers of the Land/Soil GIS;

- establishing the project requirements and planning (common project for the two systems);

- establishing the working standards and procedures for the project team.

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MEMO
27 Jan. 1995

To: Ms. Raendonck, DG XII-B

From: Anne Burrill

cc: The Director, ICPA, Bucharest
            P. Vossen, Head of Unit, AIS/IRSA/JRC
            V. Vlad

Re: Contract CIPA-CT-93-2350

We have received the final report on the above referenced contract from Mr. Virgil Vlad of the Research Institute for Soil Science and Agrochemistry in Bucharest, Romania. The report presents the work carried out by the author during his three month visit to our unit in Ispra.

During this period, Mr. Vlad managed to compile a wide range of information related to techniques and tools for land evaluation. From this basis, he undertook a thorough analysis of the Romanian requirements and an assessment of the suitability and reliability of different techniques to meet these needs, including trial runs of the WOFOST model using Romanian input data. The result is a proposal for an integrated system combining various models and database management tools within an expert system structure.

Mr. Vlad's work during his visit and his report are of a high professional standard. The results should be directly applicable in Romania and might serve as a model for activities in other countries with similar needs and requirements.

*O lucrare ce ar
trebui cunoscuta de
specialistii interesati in
domeniul tratat.*

09.02.1995