MULTI-DISCIPLINARY RESEARCH IN GREENHOUSE SOIL MANAGEMENT THROUGH GRID COMPUTING

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Grid Computing technologies have the potential of dramatically changing the use of computers in solving problems. Complex Grid Computing projects are under development worldwide. An academic Grid computing project that joins forces of four universities and one research institute of Iasi, Romania, is under development. The University of Agricultural Sciences and Veterinary Medicine of Iasi, Romania participates in this project with soil science research services. Such an multi-disciplinary application is described in the paper.

***Keywords**: Grid Computing, soil management*

Grid Computing is a modern concept that emerged in the last decade. It denominates an advanced infrastructural proposal for parallel/distributed computing that implies using component organized software that runs on a large number of computers [1]. The practical situations that led to this approach were linked to a series of issues that appeared more and more frequently in using computers in problem solving. Some of them are enumerated further on:

- the need for increasing computational power and storing capacities;
- the need to access databases being stored on different computers, maintained by different organizations and having different data structures;
- the need to access software applications that run on remote computers and to use their outputs on a synergic manner;
- the need for efficient and secure multi-disciplinary cooperation within research programs.

By its nature, agriculture is a field in which research and production require large scale coordination of efforts both at a geographical level as well as from a multi-disciplinary point of view. In this respect, the benefits that Grid computing can bring were accounted. Powerful Grid projects were developed worldwide to integrate different agricultural branches with other fields of activity. Some relevant achievements in this direction are described in [4, 5, 6, 7].

In 2006, four faculties and a research institute in Iasi, Romania started the research project named *Academic Grid for Complex Applications*. The acronym of the project is GRAI. The five participants in the project are:

- The Technical University of Iasi, Faculty of Automatic Control and Computer Engineering (code name UTI-CE), which also holds the leadership of the GRAI project;
- Institute for Computer Science, Romanian Academy, in the location of the Faculty of Electronics and Telecommunication (code name AR-IIT);
- The “Al. I. Cuza” University of Iasi, Faculty of Computer Science (code name UAIC-I);
- The University of Medicine and Pharmacy Iasi, Faculty of Biomedical Engineering(code name UMF-B);
- The University of Agricultural Sciences and Veterinary Medicine of Iasi, Faculty of Horticulture (code name USAMV-H).

The GRAI project aims to develop a grid computing structure for research and for other academic purposes. To achieve them, two main directions will be followed:

- Development of a grid computing system that would interconnect the scientific and computational resources of the five partners.
- Development of grid services and specific applications based on them.

The University of Agricultural Sciences and Veterinary Medicine of Iasi (partner USAMV-H) participates in the project not only with computational power, but also with research in developing multi-disciplinary applications based on the grid services that will intensively use the GRAI Grid resources. The pilot area that was chosen to develop multi-disciplinary research using GRAI resources is soil science. The reason for this choice is the multitude of external connections that soil scientists must have with people from other scientific fields: Mathematics, Computer Science, Physics, Chemistry etc.. Another reason was the previous multi-disciplinary expertise that was achieved in recent years between researchers from the above mentioned specialties working within research programs developed by the GRAI partner USAMV-H.

One of the goals of the project partner USAMV-H is to design and implement software services having as overall final purpose supporting decision for the durable exploitation of pedoclimatic resources in horticulture.

A special attention was played to the durable management of greenhouse soils. An example of software procedure that would be useful in this respect is computing the impact of water regime on the heat capacity of greenhouse soil. The thermal regime of horticultural soils or substrata in greenhouses is influenced both by air temprature and soil features. Maintaining during the cold season a small supply of water in soil contributes to diminishing calorie energy necessary to heat it as calorie capacity of the soil with little ammount of water is smaller compared to the moist soil.

CALCULATING THE IMPACT OF WATER REGIME

A method to determine the slightly changeable features on calorie capacity is presented further on. Soil calorie capacity is an extensive feature influenced by practically unchangeable features (granulometric composition), by slightly changeable ones (organic matter content), as well as by features that vary during vegetation (water and air content). The described procedure can be automated through software in order to participate in developing a sustainable technology of soil exploitation in protected areas.

1. Estimate the correction coefficient (*cf*) for the transformation of the value of the granulometric fraction content in values related to the solid part of soil

$$cf = \frac{100 - MO - CaCO_3}{100}$$

where MO – percentage content of organic matter (g/100g dry soil); $CaCO_3$ – percentage content of calcium carbonate (g/100g dry soil).

2. Compute the percentage of granulometric loam ($a_{ps}A$), dust ($b_{ps}P$), and sand ($c_{ps}N$)

$$a_{ps}A = a_0A*cf$$
$$b_{ps}P = b_0P*cf$$
$$c_{ps}N = c_0N*cf$$

where a_0A, b_0P, c_0N are the respective granulometric fractions related to the silica part of the soil.

3. Calculate the mass specific heat (c_m) of the solid part of soil.

$$c_m = \frac{0{,}233a_{ps}A + 0{,}213b_{ps}P + 0{,}194c_{ps}N + 0{,}447MO + 0{,}210CaCO_3}{100}$$

4. Computer the value of volume specific heat (c_v) of the solid part of soil.

$$c_v = c_m * DA$$

where DA is the apparent density (g/cm^3).

5. Compute the the value of the volume specific heat of the solid part of the moist soil at the level of water storing capacity (c_{vCC}) expressed in cal/cm^3 degree

$$c_{vCC} = c_v + \frac{CC}{100} * DA$$

where with CC was denoted the water soil capacity in protected areas.

6. Compute the volume specific heat of the solid part of the moist soil at the minimum moisture level (c_{vPM}) expressed in g/100g dry soil.

$$c_{vPM} = c_v + \frac{PM}{100} * DA$$

where PM is the minimum level of soil moisture in protected areas.

7. Compute the volume calorie capacity (C_v) of the soil layer in greenhouse, expressed in *megacal/degree*.

$$Cv = S * h * c_v$$

where S is the area of soil and h – the thickness of soil layer

8. Compute the volume calorie capacity of the soil layer in greenhouse at the level of water holding capacity and at the level of minimum moisture.

$$C_{vCC} = c_{v\,CC} * S * h \qquad C_{vPM} = c_{v\,PM} S * h$$

CONCLUSIONS

The Grid Computing is a long-term, complex, but cost effective approach. The usefulness of Grid computing for agricultural research and production was already proved worldwide.

The perspective of integration with the European Community demands the development of such entities that are already active in many European Countries.

The development of the GRAI project by several academic institutions of Iasi, Romania, follows this line of action.

A calculus method for soil calorie capacity was given as example of inter-disciplinary approach of a soil science problem. As one can see, the development of the GRAI academic grid will bring benefits on many directions. All partners will have their parts of contribution and benefit, but only the ones specific to the agricultural research were emphasized in the paper.

Acknowledgement. *The GRAI project runs under the CEEX grant no. 74 II03/31.07.2006 (the excellence research framework created by the Romanian Ministry of Education and Research, following the EU FD7 model).*

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