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EXPERIMENTAL SETUP TO STUDY THE LOCAL RENEWABLE ENERGY POTENTIAL AND THE ENVIRONMENT INFLUENCE ON FRUITS GROWING

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ABSTRACT

The paper is presenting an experimental setup designed for a double purpose. The researches will be focused on the evaluation of the local renewable energy potential in the region of Cluj-Napoca, Romania and on the study of the environment influences on the plants growing, considering different horticultural species. The experimental setup is based on two complex wireless meteorological stations and two wireless leaf and soil moisture stations. Environment and weather parameters are systematically measured with a baud rate of one minute and stored in a database, integrated into a web designed data acquisition system. Parameters characterising different fruits growing are measured daily. Solar radiation together with wind speed and direction will be used to evaluate the local solar energy potential. The other measured parameters, such as outside temperature, quantity of precipitation, leaf wetness, soil wetness, soil temperature, air humidity, solar radiation, ultra violet radiation, etc., will be used to highlight their combined influence to the growing process of different fruits, such as apples and pears.

Key words: *Solar, Wind, Monitoring, Environment, Data Acquisition, Database, Fruits*

INTRODUCTION

The paper approaches a very important subject for our day's complex situation, in both fields of renewable energies and agriculture. The world and financial and economical crisis is affecting both fields and both can offer viable solutions for the future development of the humanity.

In Cluj-Napoca, Romania, scientists from three important universities decided to cooperate and to develop a complex experimental setup, designed with a double purpose. The experimental equipment is used in a metropolitan area as a web based data acquisition system. Data are collected and stored into a database on a dedicated web server and will be used both to evaluate the local potential of the solar and wind energy on one hand and to study the influence of a large number of environment and weather parameters, on the growing process of different fruits, such as apples and pears.

The influence of different weather parameters are reported in the scientific literature, in paper such as [1]…[7].

Growth estimation, considering different weather parameters is presented in [8].

The humidity of the soil, resulting from irrigation and its influences is presented in [9]. The influence of the rain is approached in [10].

Different thermodynamic effects, such as evapotranspiration and evaporative cooling, are presented in [11] and [12].

From the renewable energies point of view, the paper is continuing previous researches of some authors of the paper, presented in [13…15].

METHODS

The experimental setup presented in the paper is characterised by a relative large coverage area. The measurement points (white circles) and database server (red circle), are situated at about 9…12 km distance between each other, as indicated in figure 1.

In each measurement point were placed a weather station and a distinct leaf & soil moisture / temperature station. The weather station is of Vantage Pro2 Plus wireless type provided by Davis Instruments from USA. The leaf & soil station is equally provided by the same manufacturer. Both measurement stations located on each measurement point are transmitting the collected data, based on a wireless radio communication system, to a receiver console. A data logger is connected both at the console and at a computer connected to the internet.

Using the indicated performing equipment it was designed an original experimental setup able to be driven in a particular manner, to reach both objectives of the research: evaluation of the renewable energy potential and study the influence of the environment parameters to the growing process of the fruits.

Each weather station is providing the following parameters:

- Barometric pressure;
- Outside temperature;

- Relative Humidity;
- Rainfall;
- Solar radiation;
- Ultra violet radiation dose;
- Ultra violet radiation index;
- Wind direction;
- Wind speed.

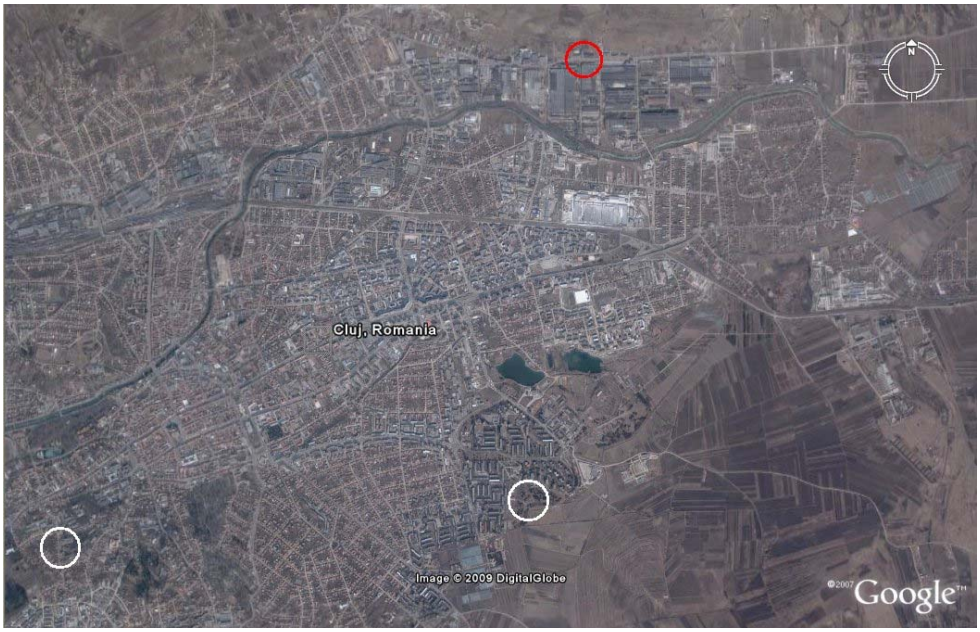

Fig. 1. Placement of the measurement points and database server in Cluj-Napoca, Romania

Each leaf & soil station is providing the following parameters:

- Leaf wetness (two measurement points);
- Soil moisture (four measurement points);
- Soil temperature (four measurement points).

The configuration scheme of the data acquisition system implemented on each measurement point is presented in figure 2.

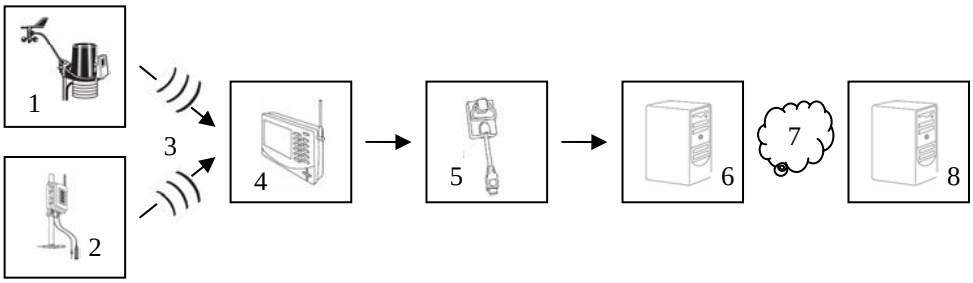

Fig. 2. Schematic configuration of each measurement point
1 - weather station; 2 - leaf & soil station; 3 - wireless radio communication; 4 - console; 5 - data logger; 6 - local PC; 7 - internet connection; 8 - server

Table 1. Main characteristics of the weather stations sensors

Parameter	**Characteristic**	**Value**	**Obs.**
Barometric pressure	Resolution	0.25 mm Hg	Other units are converted from Hg and rounded
	Range	406…850 mm Hg	
	Accuracy	±1.0 mm Hg	
	Elevation range	-460…4670 m	
Outside temperature	Resolution	1 °C	Converted from Fahrenheit and rounded
	Range	-40…+65°C	
	Accuracy	±0.5°C	
Relative Humidity	Resolution	1%	
	Range	0…100%	
	Accuracy	±3%	
Rainfall	Resolution	0.2 mm	With metric adaptor
	Range	0…19999 mm	
	Accuracy	±4%	
Solar radiation	Resolution	1 W/m^2	
	Range	0…1800 W/m^2	
	Accuracy	±5%	
Ultra violet radiation dose	Resolution	1 MED	
	Range	0…199 MED	
	Accuracy	±5%	
Ultra violet radiation index	Resolution	0.1 index	
	Range	0…16	
	Accuracy	±5%	
Wind direction	Resolution	1°	
	Range	0…360°	
	Accuracy	±4°	
Wind speed	Resolution	0.1 m/s	Converted from mph
	Range	0…67 m/s	
	Accuracy	±5%	

On each of the two local PC, located at each measurement point is continuously running dedicated software for data acquisition and specially realised software for the data transfer on the server, through the internet connection.

On the server, data is stored in a specially designed and dedicated database. A web based interface was created to interrogate the database and to display the user requested specific data. It can be selected specific values for specific data for specific periods such as one hour, one day, one month, one year, or user specified period.

The database from the server can be interrogated from distance from any computer, using internet connection and a browser.

The weather stations are equipped with sensors having the main characteristics indicated in table 1.

The weather stations are processing the data collected from the sensors and provide the parameters indicated in table 2, using the equally indicated methods.

Table 2. Parameters calculated by the weather stations

Parameter	**Calculation method**
Dew point	World Meteorological Organisation equation
Rain rate	Rainfall / Time
Evapotranspiration	Penman-Monteith Equation
Heat index	Steadman (1979) modified
Temperature humidity sun wind index	NWS / NOAA* / Steadman (1979) modified
Wind chill	NWS / NOAA* / Osczevski (1995)

* US National Weather Service / National Oceanic and Atmospheric Administration

The leaf & soil stations are equipped with sensors having the main characteristics indicated in table 3.

Table 3. Main characteristics of the leaf & soil stations sensors

Parameter	**Characteristic**	**Value**	**Obs.**
Leaf wetness	Resolution	1	
	Range	0…15	
	Accuracy	±0.5	
Soil moisture	Resolution	1 cb	
	Range	0…200 cb	
	Accuracy	-	
Soil temperature	Resolution	1 °C	Converted from Fahrenheit and rounded
	Range	-40…+65°C	
	Accuracy	±0.5°C	

DISCUSSION

The actual state of the presented experimental setup is the following. The two weather stations are acquired and tested. The wireless transmission was tested for all the equipment. The local data acquisition system (hardware + software) was tested and two notebooks were acquired and dedicated to this activity. The server dedicated for data storing is acquired and tested. The server database was designed and implemented. The software dedicated for data transmission through internet from the two local PC's to the server database is equally tested and working properly. To resume, all the positions 1…6 and 8 indicated on figure 2, are already tested and are working properly. The only element that must me realised, is the placement of the equipment on the measuring points.

CONCLUSIONS

Cooperation between researchers from three Universities from Cluj-Napoca, Romania was established, in order to realise a complex experimental setup, with two goals:

- Evaluation of the local renewable energy potential;
- Study the influence of some relevant environment parameters to the growing process of different fruits, such as apples and pears.

The data systematically provided by the two types of measurement stations, with a baud rate of one minute, will be correlated by specific statistical methods, with daily measurements of fruits growing.

The data will be collected for a long time period, in order to extract and provide relevant information.

The presented experimental setup, have a large potential to extend the researches to other elements such as weather and environment parameters influence in a lot of agricultural applications. The data acquisition system can be also completed with analysers of other environment parameters, such as polluting emissions in air, water or soil. The influences of these elements are also in the attention of the authors.

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