THE MANAGEMENT OF THE AGRICULTURAL INFORMATION SYSTEM "SHOCKS" THE CONVENTIONAL AGRICULTURE

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Abstract

The using of remote sensing became, in the last few years, something usual and it isn't considered a new technology anymore. We started from the desire to contribute, using modern methods, to the development of the oldest branch of the world's economy. We studied some ways of evaluating the crops at a certain point in time through remote sensing methods, putting an accent on descovering the origin and the justification of the occuring problems. We analized satellite imagery of some areas of the studied farm during a whole year and we generated a database containing correlations between the health of the crop fields for specific plants and the spectral response recorded in the satellite multi-band image. In the following year the crops would be evaluated only by studying the current satellite images. The result would be the creation of an Agricultural Geographic Information System. We used the same projection system throughout the study - Stereographical 1970, fact that allows the rapid localization in the crop fields of the areas in the analized satellite image.

Key words: remote sensing, precision agriculture, agricultural GIS, projection system

The present study was conceived in order to highlight the multiple using of remote sensing in the agriculture, as well as to search modern ways to assist the agricultural processes, using new technologies, which became more and more accesible in the last period of time from the financial and logistical point of view.

The conventional agriculture – heavily mechanised, using competitive products, but which relies especially on the concentration and specialisation of the production. The various components of the technological system are intensely used. Thus, in a constant way, the breaking up of the soil is only done through ploughing with rotation of the soil bed, followed by numerous secondary works of preparing of the germinating bed and maintenance in the vegetation period. The mineral fertilization is used in large and extra-large doses, an unique crop or at best, short rotations at two or three years, chemical treatments against weeds, diseases and pests.

This type of agriculture was widely spread in Romania until 1989. Today, it is unanimously accepted that this type of agriculture can affect the environment, especially if various components of the technological system are applied without any consideration of the local specifications: climate, soil, landscape, social and economical conditions, which determine the level of vulnerability regarding the various chemical, biological and physical degradation processes of the environment.

Speaking about remote sensing, we could say that the multispectral images became less and less expensive per surface unit; nowadays one could find multiple supplies from the satellite imagery management companies, supplies for images with little area coverage, thus the smaller acquisition price.

There is also the possibility to advance order of a satellite survey of a certain area over a certain period of time.

We tried to put ourselves in the position of the modern romanian farmer, that farmer who is open to new horizons, who understands how to use the new technologies in order for his farm to grow. This type of farmer, besides his expertise in the area of conventional and classical agriculture, acquired during decades of farming, has to accept the idea of some new and modern means which could influence the development of a particular crop, and finally of the entire farm itself.

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MATERIAL AND METHOD

During this study we used some specific software – Autodesk Map 5, the CAD software from Autodesk, the GIS platform ArcGIS 9.2 produced by ESRI, as well as the remote sensing processing application with graphical editor abilities for raster images, conceived by ERDAS for geospatial programs - ERDAS Imagine 9.1.

As source data we used georeferenced aerial imagery from the Romanian Agency of Cadastre (A.N.C.P.I.) created using a flight from 2008, with the spatial resolution of 1 m, as well as remote sensing imagery from the french program SPOT 5 with the spatial resolution of 2.5 m and satellite imagery from the american Landsat 5 program, downloaded for free from the U.S. Geological Survey servers. We also used, as helping material, cadastral maps of the studied farm and, for a more specific analysis we even consulted the Topographical Map, scale 1:25000, edited in the 1980s by the Romanian Military Topographical Department.

For the studied area we analized archived satellite imagery, from the previous years, corroborated with the data offered by the farm management about the crops present in the relative years.

For a retrospective analysis, the database will contain the values of the spectral responses for specific fields within the farm, corroborated with the data acquired by the farm management about the production and productivity of those relative fields. The database will also contain, as much as possible, data about the types and quantities of agrotechnical measures of improving the soil or crops applied in these fields, as well as data offered by other types of sensors (ex. humidity sensors).

The retrospective analysis is especially useful for the improvement of terrain and soil. By studying the satellite imagery we can determine areas with problems in plants' growths – either plants with low biological qualities (ex. wheat with inconformous growth), or areas with an exacerbated dispersion of the crop plants.

In the respective areas, we could schedule a variety of agrotechnical works for soil improvement, for those moments when the terrain is uncultivated.

If the work is thorough and organised, within a Geographic Information System, all these observations and analyses of areas with problems in the development of crops can be flagged with their exact geographic location. This implies the permanent work and management of the Geographic Information System using the same projection system.

We must mention that the study is made using the Stereographical Projection System 1970, so we have an accurate and easy connection between the GIS and the actual terrain, using the topographic and the GPS instruments, etc., with high precision, limited only by the spatial resolution of the studied images. This connection is very important for the application of measurements to improve the soil or crops (ex. watering or drainage, ploughing, chemization, fertilization, etc.).

The discovered problem must have a real solution, therefore we must permanently have a link between the area we determined to have problems and his exact location, meaning precise coordinates in our projection system.

The observations can be personalized and calibrated exactly on the studied crop of infield through the analysing of the archived images.

After the elaboration of the retrospective analysis and the general determination of the impaired areas regarding the soil and/ or the crops within the infields, one can proceed to analize these matters in real time, during a whole season or year.

One can choose specific crop fields which are going to be observed and the resulting conclusions will be extrapolated to the entire farm.

In order to have an image corresponding to each crop plant, we choose an infield for each plant.

For example, we chose field no. 152, which is cultivated with corn in the middle of april. During the vegetation season, we acquire remote sensing imagery of that infield. We visit the farm periodicaly, we take weekly rounds, and the acquired satellite imagery is analysed simultaneously with the analysation of the actual plants in the studied field. The studies are made hand in hand with the farm's agronomists, who have the required agricultural education and expertise; together we "decoded" the spectral responses captured in the satellite imagery of the corn field from field no. 152.

On the satellite image we mark the areas of the crop with different spectral responses and we go in the field to the precise locations of those areas. The correlation between the image and the terrain is eased by the unique projection system (Stereographical 1970). To arrive at the exact location of the problem in the field one can use a GPS RTK system for global positioning in real time, which uses the ROMPOS system, offered by the A.N.C.P.I. (the Romanian Agency of Cadastre).

Once arrived at the specified destination in the middle of the studied crop field, the agronomists take notes regarding the plants in that area, take samples, sort the sampled plants in order of their health and quality. Back at the desk, together with the Agricultural Information System administrator, we fill out the databases which will contain the correlation between the spectral response "read" on the satellite image and the properties of the actual plants sampled in the observed area.

This investigation method will extend throughout the vegetation period, for each analysed field or culture. At each moment there will be an acquisition of satellite imagery for the same studied areas, which will have specific spectral responses, in correlation with their quality at that specific moment in time.

The moments for the acquisiton of the remote sensing imagery and for the trips in the field will be appointed together with the farm's agronomists.

In the image processing we used vegetation indices and combinations between them. The vegetation indices are used in the remote sensing processing for a better interpretation of the satellite images, especially when analysing minerals and vegetation. Many natural surfaces appear almost as lightened in the visible spectral intervals as in the near infrared of the electromagnetic spectrum, except the green vegetation.

This means that the surfaces uncovered by vegetation or those who are only slightly covered by it will appear in a similar manner in the visible and near infrared, whilst the surfaces with a lot of green vegetation will be very lightened in the near infrared domain and very dark (almost black) in the visible domain. When the solar radiation interracts with the objects on the ground, some wavelengths of the eletromagnetic spectrum are heavily absorbed and others are just reflected.

The chlorophyl from the plants' leaves assimilates a large part of the electromagnetic energy from the visible spectrum (0.4 - 0.7 μm) in order to use it in the photosynthesis process. On the other hand, the cellular structure of the leaves reflects in a very large ratio the electromagnetic energy from the near infrared domain (0,7 - 1.1 μm). Through comparison of the acquired results in the two electromagnetic spectrum intervals one can deduct important information regarding the vegetation.

In the remote sensing technology, the following vegetation indices are mainly used: NVDI (Normalized Difference Vegetation Index), RATIO (Ratio Vegetation Index), SAVI (Soil-Adjusted Vegetation Index), TDI (Transformed Vegetation Index), CTVI (Corrected Transformed Vegetation Index), TTVI (Thiam's Transformed Vegetation Index), NRVI (Normalized Ratio Vegetation Index), EVI (Enhanced Vegetation Index), PVI (Perpendicular Vegetation Index), DVI (Difference Vegetation Index), AVI (Ashburn Vegetation Index), TSAVI (Transformed Soil-Adjusted Vegetation Index), MSAVI (Modified Soil-Adjusted Vegetation Index), WDVI (Weighted Difference Vegetation Index), etc.

We must mention that these indices were determined through repetitive analyses applied in multi-annual cycles.

RESULTS AND DISCUSSIONS

The first year will be one of data acquisition and creation of the databases for each crop which is cultivated within the farm.

After the harvesting, analyses will be made, as well as supplimentary statistics - there will be weights and calculations of the harvested crop from a specific field with a specific spectral response average and there will be comparisons with the harvested crop from another field with the same crop, assuming supplimentary elements of correlation between the spectral responses (averages, calculated within the boundaries of a whole field) and the quality of the crop from that specific infield.

The system and the methodology can be adaptated to specific requirements of the farm, as well as to the personal wishes of the farm's agronomists or farm manager.

With all of this acquired and classified data, throughout a whole season or year, in the next year one can proceed exclusively to acquire and analyze remote sensing imagery - but this time for the entire farm area - respectively to trace and mark the impaired areas regarding the development of the crop plants.

The system will be at any moment available to accomplish an analysis, only if there will be enough satellite imagery acquired, so that the manager will allways have an instrument at hand for a complete research of any crop within any infield of the farm.

Evaluating the data, together with the farm's agronomists, one can make previsions, on the one hand and can take action until the harvesting for improvement of the crops in the impaired fields, on the other.

Nowadays there is remote sensing imagery with superior resolution, at reasonable prices for present acquisitions, not only for the archived images.

With the increase in the images resolution, there will be an increase in the precision of tracking the impaired areas and the diagnosis will be more detailed.

CONCLUSIONS

The work is theoretical and it recquiers a lot of field work and the close collaboration with the farm's agronomists.

The proposed method offers the possibility of personalizing the study for a specific farm, a specific crop, a specific soil, etc.

This method will make the consulting of prerecorded databases - who may or may not be accurate or adapted to the specific of the soil and crops within the studied farm - obsolete.

The tools of this method help to accomplish the analysis internally, within the farm, even by an employee of the farm, an employee who would have the specific task to create the databases and to manage this Agricultural Geographic Information System.

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