Internetic GIS: An Open System for Organic Agriculture Administration, Verification and Planning

Ioannis M. IFADIS, Avraam P. MAVRIDIS and Paraskevas D. SAVVAIDIS, Greece

Keywords: GIS, Precise Organic Agriculture Network, Biological Farming Systems, Digital Certification

SUMMARY

Efforts to increase the availability of sustainable development in natural resources worldwide are consecutive and proliferated through the last decades. Sectors and divisions of many scientific networks are working simultaneously in separate schemas or in joined multitudinous projects and international co-operations. Organic Agriculture, as a later evolution of farming systems, was derived from trying to overcome the accumulative environmental and socioeconomic problems of industrialized communities and shows rapid development during the last decades. Its products day to day gain increased part of consumer preferences while product prices are rather higher than those of the traditional agriculture. Governments all over the world try to reduce the environmental effects of the industrialized agriculture, overproduction and environmental pollution, encouraging those who want to place their fields among others that follow the rules of organic agriculture. All the above make this new trend very attractive and promising.

But the rules in organic agriculture are very restrictive. The intensive pattern of cultivation worldwide and the abuse of chemical inputs, affected the environment, therefore any field expected to be cultivated under the rules of organic agriculture has to follow certain steps but also be 'protected' from the surrounding plots controlling at the same time different kind of unexpected influx (e.g., air contamination from nearby insecticides' use, water pollution of irrigation system from an adjacent plot that has used fertilizers, etc). It is obvious that the gap between wish and theory and the implementation of organic agriculture is enormous.

Obviously one can overcome this gap using a sophisticated complex system. Such a system can be based on a powerful GIS and the use of widely approved mobile instruments for precise positioning and wireless communication. In such a system data-flow could be an "easy" aspect, providing any information needed for the verification of organic product cycle at any time, any site.

In this paper we discuss the aspects of precise organic agriculture and a GIS based, dynamic system for continuous use from governmental agencies, farmers, dealers, and perhaps more important the final consumer.

Internetic GIS: An Open System for Organic Agriculture Administration, Verification, and Planning

Ioannis M. IFANIS, Avraam P. MAVRIDIS and Paraskevas D. SAVVAIDIS, Greece

1. INTRODUCTION

As the world's population has increased from 1.6 billion at the beginning of the 20th century to over 6.2 billion just before the year 2004, economic growth, industrialization and the demand for agricultural products caused a sequence of unfortunate results. This aggregation of disturbances moved along with the reduction in availability and deterioration of maximum yield results from finite ranges of plots on earth's surface. Overuse of agrochemical products (insecticides, pesticides, fertilizers, etc.), reduction and destruction of natural resources, decrease of biodiversity, reduction of water quality, threat over rare natural landscapes and wild species and an overall environmental degradation, appeared almost daily in news worldwide especially over the last two decades. The universal widespread of this situation has raised worldwide awareness of the need for an environmentally sustainable economic development. (WCED, 1987)

In the beginning of year 2004, EU Commission for Agriculture, Rural Development and Fisheries declared three major issues towards a European Action Plan on organic food and farming that may be crucial for the future of organic agriculture (figure 1):

- the market, (promotion and distribution)
- the role of public support and,
- the standards of organic farming.

It is obvious that in general the market has a positive reaction if there is a prospect of considerable gain. Thus we can say that the other two will define the future. The strict rules of organic agriculture have to be ensured and all the products have to be easily recognisable. Also a guarantee about the quality and the origin of any product has to be established.

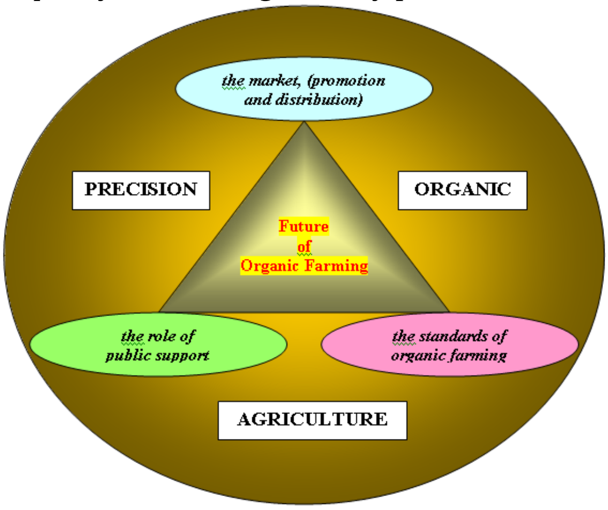

Figure 1: Elements of future development of Organic Farming

Organic Farming is derived as a sophisticated sector of the evolution of farming implementation techniques aiming through restrictions and cultivated strategies to achieve a balanced production process with maximum socioeconomic results (better product prices, availability of surrounding activities as ecotourism, family employment in low populated villages, acknowledge of natures' and rural environments' principles and needs, etc.).

Meanwhile, the combination of latest technological advances, skills, innovations and the decline of computer and associate software expenses were transforming the market place of geographic data. Now, more than ever before, common people, farmers, private enterprises, local authorities, students, researchers, experts from different scientific fields, and a lot more could become an important asset *supporting* the development of innovations of Informatics in Geospatial Analysis. With the use of Geographic Information Systems and Internet applications various data can be examined visually on maps and analyzed through geospatial tools and applications of the software packages. Much recent attention and efforts has been focused on developing GIS functionality in the Worldwide Web and governmental or private intranets. The new applicable framework, called WebGIS, is surrounded with a lot of challenges and is developed rapidly changing from day to day the view of contemporary GIS workstations.

Precision Organic Agriculture through GIS fulfils the demands of design strategies and managerial activities in a continuing process. By implementing this combination, certified methods for defining the best policies, monitoring the results and the sustainability of the framework, and generating a constructive dialogue for future improvement on environmental improvement and development could be developed.

2. BASICS OF ORGANIC AGRICULTURE

Organic Agriculture is derived from other organized smaller natural frameworks, publicly known as *ecosystems* which are complex, self-adaptive units that evolve through time and natural mechanisms and change in concern with external biogeochemical and natural forces. Managing ecosystems should have been focused on multiplication of the contemporary needs and future perspectives to ameliorate sustainable development. Instead, political, economic and social agendas and directives, as well as scientific objectives resulted in few decades such an enormous amount of global environmental problems like never before in the history of mankind. Valuable time was spent over the past 75 years by research, which was trying to search how ecosystems regulate themselves, for example how they adjust to atmospheric, geologic, human activities and abuse (Morain, 1999).

Organic Agriculture flourished over the last decade particularly after 1993 where the first act of Regulation 2092/91 of European Union was enforced. Until then, and unfortunately, afterwards, worldwide environmental disasters (e.g., the Chernobyl accident of the nuclear reactor in April 1986), accumulative environmental pollution and its results (acid rain, ozone's hole over the Poles, Greenhouse effect, etc.) and even lately the problems that occurred by the use of dioxins and the propagation of the disease of "mad cows", increase in public opinion the relation between natures' disturbances and the continuing abuse of intensive methods of several industrialized chains of productions. Among them, conventional agricultural intensive production with the need of heavy machinery, enormous needs of energy consumptions and even larger thirst for agrochemical influxes the last fifty years, created environmental disturbances for the future generations. Therefore, IFOAM (**I**nternational **F**ederation of **O**rganic **A**griculture **M**ovements) constituted a number of principles that are summarized in Table 1, enabling the implementation of Organic Farming's cultivation methods, techniques and restrictions worldwide.

Table 1: **Principles of Organic Agriculture**
(Source: **IFOAM**)

Organic Agriculture:
- aims on best soil fertility based in natural processes,
- uses biological methods against insects, diseases, weeds,
- practices crop rotation and co-cultivation of plants,
- uses "closed circle" methods of production where the residues from former cultivations or other recyclable influx from other sources are not thrown away, but they are incorporated, through recycling procedures, back in the cultivation (use of manure, leaves, compost mixtures, etc.),
- avoids heavy machinery because of soil's damages and destruction of useful soil's microorganisms,
- avoids using chemicals,
- avoids using supplemental and biochemical substances in animal nourishing,
- needs 3-5 years to transit a conventional cultivated field to a organic farming system following the restrictions of Council Regulation (EEC) No 2092/91,
- underlies in inspections from authorities approved by the national authorities of Agriculture.

An appropriate organic plot should be considered as the landscape where ecological perspectives and conservations activities should be necessary for effective sustainable nature resource management (Hobs, 1997). Considerable amounts of time and effort has been lost from oncoming organic farmers on finding the best locations for their plots. Spatial restrictions for placing an organic farm require further elaboration of variables that are affecting cultivation or even a unique plant, such as:

- Ground-climatic variables (e.g., ground texture, ph, slope, land fertility, history of former yields, existence of organic matter, rain frequency, water supply, air temperature levels, leachability, etc.),
- Adjacency with other vegetative species (plants, trees, forests) for propagation reasons or non-organic cultivations for better controlling movements through air streams or erosion streams (superficial or in the ground) of agrochemical wastes,
- Availability of organic fertilization source from neighbored agricultural exploitations,
- Quality of accessing road network for agricultural (better monitoring) and marketing (aggregated perspectives of product distribution to nearby or broadened market area) reasons.

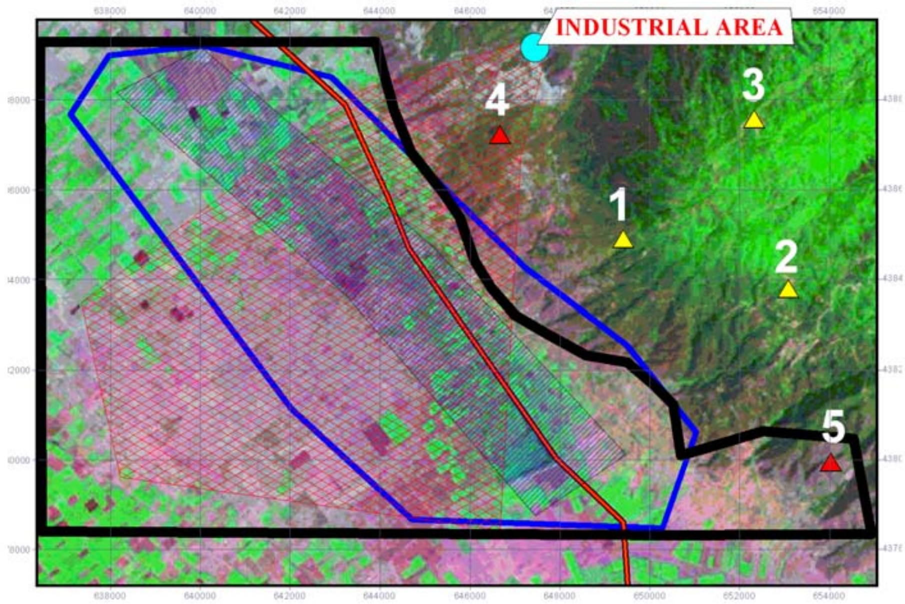

Figure 2a: Placement of the subject area in Greece

Figure 2. A part (red square in Figure 2a) of West Thessaly plain in Greece, which is one of the most productive areas in Agriculture. A scenario for establishing an organic farm could be related with the spatial variables and their elaboration through a GIS. Chemical emissions from the Industrial area are expanding through air streams and are shown with the red netting. The thick black line surrounds the area of conventional agricultural plots. The thin blue netting is a part of the area covered from the superficial irrigation system by using chemical fertilization; where as the thick blue line covers the underground percolation of the irrigated water. As a result, from 1 to 5 different possible locations for beginning our new organic plot the best places are number 1, 2 and 3. Even more, the locations 1 and 2 are even better because they are adjacent to small villages with available road network for distributing the products.

A GIS is consisted of computerized tools and applications that are used to organize and display geo-information. Additionally it enables spatial and non-spatial analysis and correlation of geo-objects for alternative management elaborations and decision making procedures. This gives the ability to GIS users or organic farm-managers to conceive and implement alternative strategies in agricultural production and cultivation methodology.

3. GIS CONCEPTS FOR PRECISION ORGANIC FARMING

The development of first concepts and ideas of a precision organic farming system in a microregion, demands a regional landscape qualitative and recovery master plan with thorough and comprehensive description of the territory (land-use, emission sources, land cover, microclimatic factors, market needs and other essential variables. Essential components on a successful and prospective organic GIS-based system should be:

- The time-schedule and task specification of the problems and needs assessments that the design-strategy is intended to solve and manage,
- Integrated monitoring of high risks for the cultivation (insects, diseases, water quality, water supply, weather disturbances (wind, temperature, rain, snow, etc.),

- Supply of organic fertilization because additional needs from plants in certain periods of cultivation could be not managed with fast implemented agrochemicals; instead they need natural fermentations and weather conditions to break down elements of additional fertilization,
- High level of communication capabilities with authorized organizations for better management of the cultivation and geodata manipulation, aiming on better promotional and economical results,
- Increased awareness of the sustainability of the surrounding environment (flora and fauna), enabling motivation for a healthy coexistence. For example, the conservation of nearby natural resources such as rare trees, small bushes and small streams, give nest places and water supply capabilities to birds and animals that help organic plants to deal with insect populations controls and monitoring of other plant enemies,
- Continual data capture about land variables, use of satellite images, georeference sampling proccedures and spatial modelling of existed or former geospatial historical plot's data could be used to establish a rational model which will enable experts and organic farmers to transform the data into supportive decision applications.

The combination and modeling of all necessary variables through any kind of methodological approach, could be achieved through GIS expressing the geographical sectors of land parcels either as a pattern of vector data, or as a pattern of raster data (Kalabokidis et al., 2000). Additionally, we could allocate the cultivation or the combination of cultivations[1] and their units (plants, trees, etc.) so as to be confronted in relation with their location inside the field, as well as with the neighbored landscape. For this purpose the most essential tool would be a GPS (Global Positioning System) device with high standards of accuracy. Several statistical approaches and extensions have been developed for the elaboration of spatial variables through geostatistical analysis. The usefulness of these thematic maps lies upon the tracing and localization of spatial variability in the plot during the cultivated period, enabling the farmer to implement the proper interferences for better management and future orientation of the farm and of the surrounding area.

Specific geodata receivers and sensors inside the plot, in the neighbored area, as well as images from satellites, could establish a "temporal umbrella" of data sources of our farm which would submit in tracing of temporal variability factors in our field. The agricultural management framework that takes into account the spatial or temporal variability of different parameters in the farm is called Precision Agriculture (Karydas, et al., 2002). The implementation of IFOAM's principles in such an agricultural model should be called Precision Organic Agriculture (POA).

4. ESTABLISHING A FUNCTIONAL POA MODEL

The development of appropriate analytical techniques and models in a variety of rapidly changing fields using as cutting edge GIS technology, is a high-demanding procedure. The linkages to different applications of spatial analysis and research and the ability to promote

[1] Two or more different cultivations could be implemented in a single organic farm as synergy mechanism between crops (e.g. beans with strawberries, potatoes with garlic, etc.) for microelements exchanges or protection from diseases, insects or weeds.

functional and integrated geodatabases is a time consuming, well prepared and carefully executed procedure which combines spatial analytic approaches from different scientific angles: geostatistics, spatial statistics, time-space modeling, mathematics, visualization techniques, remote sensing, mathematics, geocomputational algorithms and software, social, physical and environmental sciences.

An approach of a Precision Organic Farming model is presented in Figure 3, which uses as a structure basis the Precision Agriculture wheel (McBratney et al., 1999) and the introduction of organic practices for the sustainable development with the elaboration of any historical data about the plot. The basic components are:

- Spatial referencing: Gathering data on the pattern of variation in crop and soil parameters across a field. This requires an accurate knowledge of allocation of samples and the GPS network.
- Crop & soil monitoring: Influential factors effecting crop yield, must be monitored at a thoroughly. Measuring soil factors such as electric conductivity, pH etc., with sensors enabling real-time analysis in the field is under research worldwide with focusing on automation of results. Aerial or satellite photography in conjunction with crop scouting is becoming more available nowadays and helps greatly for maximizing data acquisition for the crop.
- Spatial prediction & mapping: The production of a map with thematic layers of variation in soil, crop or disease factors that represents an entire field it is necessary to estimate values for unsampled locations.
- Decision support: The degree of spatial variability found in a field with integrated data elaboration and quality of geodata inputs will determine, whether unique treatment is warranted in certain parts. Correlation analysis or other statistical approaches can be used to formulate agronomically suitable treatment strategies.
- Differential action: To deal with spatial variability, operations such as use of organic-“friendly”-fertilizers, water application, sowing rate, insect control with biological practices, etc. may be varied in real-time across a field. A treatment map can be constructed to guide rate control mechanisms in the field.

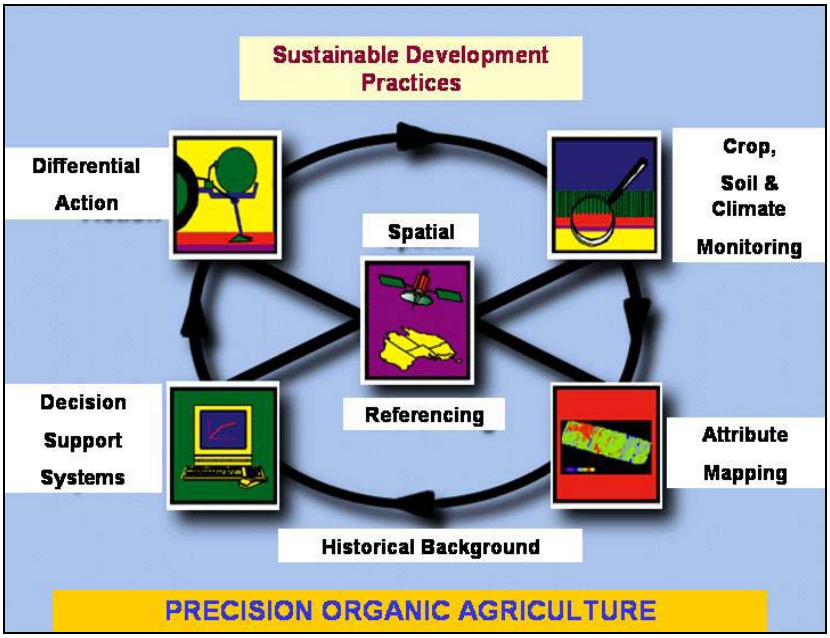

Figure 1: A diagram of structural components in Precision Organic Agriculture

Specification of organic farmers' needs and requirements should be the first criteria to be examined. It is important to identify and understand precisely what information the farmers will need for day-to-day operations, administration, or planning. Some years ago, typical questions might include:

- What geoinformation is needed regularly?
- What information (on all variables of cultivation system) is needed, but not currently available?
- How is information distributed?
- What kinds of maps are available for data mining?
- What kinds of detailed tabular data are available;
- Is the required information available in a timely manner?
- How often is data updated, and how are the updates made?
- Will other people outside the organic farm need to use or share this information?

Today, the above mentioned questions need to be enriched with the advances of GIS software accomplishments and their availability through Worldwide Web.

5. ISSUES OF TECHNOLOGICAL EVOLUTION IN GIS FRAMEWORKS

GIS systems from their beginning about than 30 years ago, step by step, started to progress from small applications of private companies' needs to high demanding governmental applications. At the beginning, the significance and capabilities of GIS were focusing on digitizing data; today, we've reached the last period of GIS's evolution of data sharing. Nowadays restrictions and difficulties are not upon the hardware constraints but they are on data dissemination. Several initiatives have been undertaken in order to provide basic standard protocols for overcoming these problem. The need of organisational and institutional cooperation and establishment of international agreement framework becomes even more important. Governments, scientific laboratories, local authorities, Non Governmental Organizations (NGOs), private companies, international organizations, scientific societies and other scientific communities need to find substantial effort to broaden their horizons through horizontal or vertical standards of cooperation.

Any GIS laboratory specialized in monitoring a specific field could give additional knowledge to a coherent laboratory which focus to an other field in the same area. As a result, especially in governmental level, each agency performs its own analysis on its own areas, and with minimal effort cross-agency interactions could increase the efficiency of projects that help the framework of the society.

Such a data-sharing framework was not capable in earlier years, where technological evolution was trying specific restrictions of earlier operational computerised disabilities. Hardly managed and high demanding knowledge in programming applications, unfriendly scheme of computer operating systems over large and expensive programs, and restricted knowledge on Internet applications now belong to the past. User friendly computer operation systems, high storage capacity, fast CPUs (Central Processing Units) sound overwhelming even in relation with PCs before ten years. Powerful notebooks, flexible and strong PDAs, super-computers of enormous capabilities in data storage, true-colour high resolution monitors and other supplementary portable or stable devices, created an outburst in the applications of Information Technology (IT). Additionally, the expansion of Internet in the '90s worldwide, contributed (and is still keeping on doing this) on redesigning specific applications for data mining procedures through WWW (World Wide Web), as well as for data exporting capabilities and maps distribution through Internet. The evolution in computer software derived new versions of even friendlier GIS packages.

6. COMBINING INTERNET AND GIS

The Internet as a system followed an explosive development during the past decade. The modern Internet functions are based on three principles (Castells, 2001):

- Decentralized network structure where there is no single basic core that controls the whole system.
- Distributed computing power throughout many nodes of the network.
- Redundancy of control keys, functions and applications of the network to minimize risk of disruption during the service.

Internet is a network that connects local or regional computer networks (LAN or RAN) by using a set of communication protocols called TCP/IP (Transmission Control Protocol/Internet Protocol). Internet technology enables its users to get fast and easy access to a variety of resources and services, software, data archives, library catalogs, bulletin boards, directory services, etc. Among the most popular functions of the Internet is the World Wide Web (WWW). World Wide Web is very easy to navigate by using software called browser, which searches through internet to retrieve files, images, documents or other available data. The important issue here is that the user does not need to know any software language but all it needs is a simple “click” with mouse over highlighted features called *Hyperlinks*, giving increased expansion on growth of WWW globally.

GIS data related files (Remote Sensing data, GPS data, etc) can benefit from globalization of World Wide Web:

- An enormous amount of these data are already in PC-format.
- GIS users are already familiar by using software menus.
- Large files could be easily transmitted through Internet and FTPs and software about compression.
- The Web offers user interaction, so that a distant user can access, manipulate, and display geographic databases from a GIS server computer.
- It enables tutorials modules and access on educational articles.
- It enables access on latest achievements in research of GIS through on-line proceedings of seminars, conferences, etc.
- Through Open Source GIS, it enables latest implementations of GIS programming and data sharing by minimum cost.
- Finally through online viewers, it gives the capability of someone with minimum knowledge on GIS to get geospatial information by imaging display. (Aber, 2003)

The importance of World Wide Web could become more crucial through wireless Internet access. For a GIS user who works on the street, or in our case, on the field of an organic farm and uses wireless access to the web, a GIS package through a portable device, data transmission is an important issue. This is more important especially if the data are temporal-affected (e.g., meteorological data). To overcome this problem, new data transmission methods need to be elaborated and used in web-based GIS systems to efficiently transmit spatial and temporal data and make them available over the web. Open Source GIS through Internet represents a cross-platform development environment for building spatially enabled functions through Internet applications. Combinations of freely available software through WWW (e.g., image creation, raster to vector, coordinates conversion, etc), with a combination of programming tools available for development of GIS-based applications could provide standardized geodata access and analytical geostatistical tools with great diplay efficiency. Under this framework, several geospatial applications can be developed using existing spatial data that are available through regional initiatives without costing anything to the end user of this Open GIS System (Chakrabarti et al., 1999). The basic framework of such a system is shown in Figure 4.

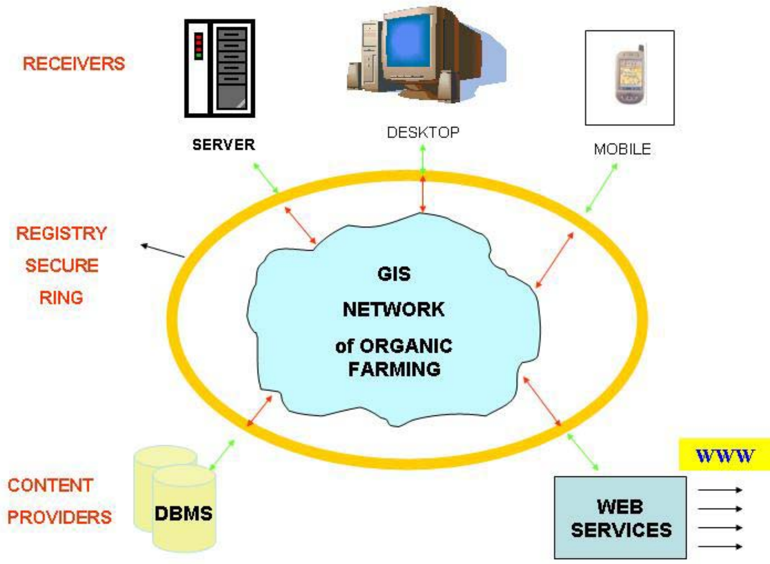

Figure 4: Components and Information Flow of a prototype Web based GIS system with a secure ring where needed.

7. CERTIFICATIONS AND STANDARDS OF ORGANIC PRODUCTS

As the World Wide Web grew rapidly, sophisticated and specialized methods for seeking and organizing data information have been developed. Powerful search engines can be searched by key words or text phrases. New searching strategies are under development where web links are analyzed in combination with key words or phrases. This improves the effectiveness at seeking out authoritative sources on particular subjects. (Chakrabarti et al., 1999)

Digital certification under international cooperatives and standards is fundamental for the development of organic agriculture in general and particularly in the market framework. Based on the theory of “dot per plot” different functional IDs could be created under password protected properties through algorithm modules. This way, a code bar (like those on products in supermarkets) could be related through GIS by farmers ID, locations ID, product ID, parcel ID and could follow this product from organic plot to market places giving all the details about it. Even more, authorization ID could be established this way for controlling even the farmer for cultivated methods undertaken in the field that are underlie EUs’ legislations and directives.[2] In many cases the only way to create or maintain a separate "organic market" is through certification which provides several benefits (Raghavan, et al., 2002):

- Production planning is facilitated through indispensable documentation, schedules, cultivation methods and their development, data acquisition (e.g., lab results on soil’s pH, electrical conductivity, organic conciseness, etc.) and general production planning of the farm.

[2] In Organic Agriculture, the plot needs 3-5 years to transit from a conventional cultivated field into a biologic farming system following the restrictions of Council Regulation (EEC) No 2092/91.

- Facilitation of marketing, extension and GIS analysis, while the data collected in the process of certification can be very useful as feedback, either for market planning, or for extension, research and further geospatial analysis.
- Certification can facilitate the introduction of special support schemes and management scenarios for organic agriculture, since it defines a group of producers to support.
- Certification tickets on products under international standards improve the image of organic agriculture in the society as a whole and increases the creditability of the organic movement.

Because a certification ticket is not recognised as a guarantee standard by itself, the level of control system in biological farming is quite low. In Greece, we are familiar with farmers having a bench by the road and using hand made tickets for their products, they call them "biologic" aiming in higher prices. Marketing opportunities for real organic farmers are eliminating while at the same time EU is trying to organize the directives for future expansion of organic agriculture.

Designing a functional infrastructure of a Geodatabase, fully related with Internet applications, requires accumulative levels of modular mainframes that could be imported, managed and distributed through WWW applications. The security and reliability of main GIS databases have to be established and confirmed through international standards (ISOs) and authorized GIS packages and users as well as in relation with governmental agencies (inner circle of figure 5) . On the next level, additional analysis of geodata files and agricultural related information data should be combined and further elaborated. For the base level (outer circle of figure 5), fundamental GIS functions and geodata digitization should be implemented through internetic report applications (HTML reports, site-enabled GIS, wireless GIS applications, etc.). By this framework we could create a data base where using any ID number (farmer, product, field, etc) will be easy to recognize the history of any specific item involved in the life cycle of the organic farming through a data-related link over thematic maps by GIS viewers in the Internet. Although this framework is supported by multifunctional operations, with reference to figure 5, we could distinguish sectors with homogeneity features:

In the first level of accessing an Open GIS Web system, (the outer green circle with green triangles in figure 5) the users should be first able to access the system through a Web browser. Free access should be available here for users who want to retrieve information, as well for users who want to login for further, more advanced queries. Fundamental GIS functions and geodata digitization should be implemented through internetic report applications (HTML reports, site-enabled GIS, wireless GIS applications, etc.). In this level public participation is enabled through importing additional geodata sets and any other kind of information resources (for example, latest weather information, market demands, research accomplishments, latest equipment facilities, personal extensions for GIS packages, etc.). The eligibility of these data should be applied after studying standards criteria in the next level by experts. Technological advances are also providing the tools needed to disseminate real-time data from their source to the web mapping services, available to the users through the Internet, portable devices, cellular telephones, etc. Basic field work for agricultural and Remote Sensing purposes, as well as data gathering for further statistical analysis should be implemented. By this level, the user could access the system through browsing commands or hyperlinks and through GIS queries. The significant point here is that the access is completely free for anyone who wants to retrieve information but classified to everyone who wants to submit any kind of information by the meaning that he has to give either a user's ID or personal details.

The second level of accessing the system (the orange circle with orange diamonds in figure 5), is the authorized expert's level. Here additional analysis of geodata files and agricultural related information data should be combined and further elaborated. Expert analysts from different scientific fields (GIS, economists, topographers, agriculturists, ecologists, biologists, research, etc.) are "bridging" the two levels of the system by using high sophisticated computer tools and GIS packages to facilitate data transportation through WWW channels between clients and servers. In the database file an identity code (IdC) or feature code (FC) is distributed, following the geodata file from main Geodatabase server to the final user. By this framework we could create a data base where using any ID number (farmer, product, field, etc) will be easy to recognize the history of any specific item involved in the life cycle of the organic farming through a data-related link over thematic maps by GIS viewers in the Internet. Additional demand on this level should be considered to be indispensable a background in Web functions with further support by Web experts for adequate Web System Administration.

In the third level of this Web based GIS system, (the inner red circle with additional red circles in the circumference in figure 5) the success is relying on cooperation between authorized users only. This partnership should be established between geographic information data providers and data management authorities at a governmental, local or private level by authorized personnel. International collaboration could provide even better results in data quality and quantity but requires additional data storage capabilities and special awareness on data interoperability and standards interchange eligibility confirmed through international standards (ISOs). The security of personal details must be followed enriching this level with further authorization controlling tools. The significance of designing successful strategies for case management, using authorized, legitimate GIS packages should also be supported through Web applications and algorithms available for GIS-Web users on global based patterns

8. CONCLUSIONS

The generally accepted purpose of organic agriculture is to meet the needs of the population and environment of the present while leaving equal or better opportunities for those of the future. Development of this sector is increasing through coordinated activities worldwide by international organizations (EU, UN, FAO, etc.) with long-lasting master plans. The dynamic factor of organic agriculture should not be kept without support. Political initiatives should stand side by side with organic farmers helping them to increase the quality of products and to multiply the number of producers and of the cultivated area.

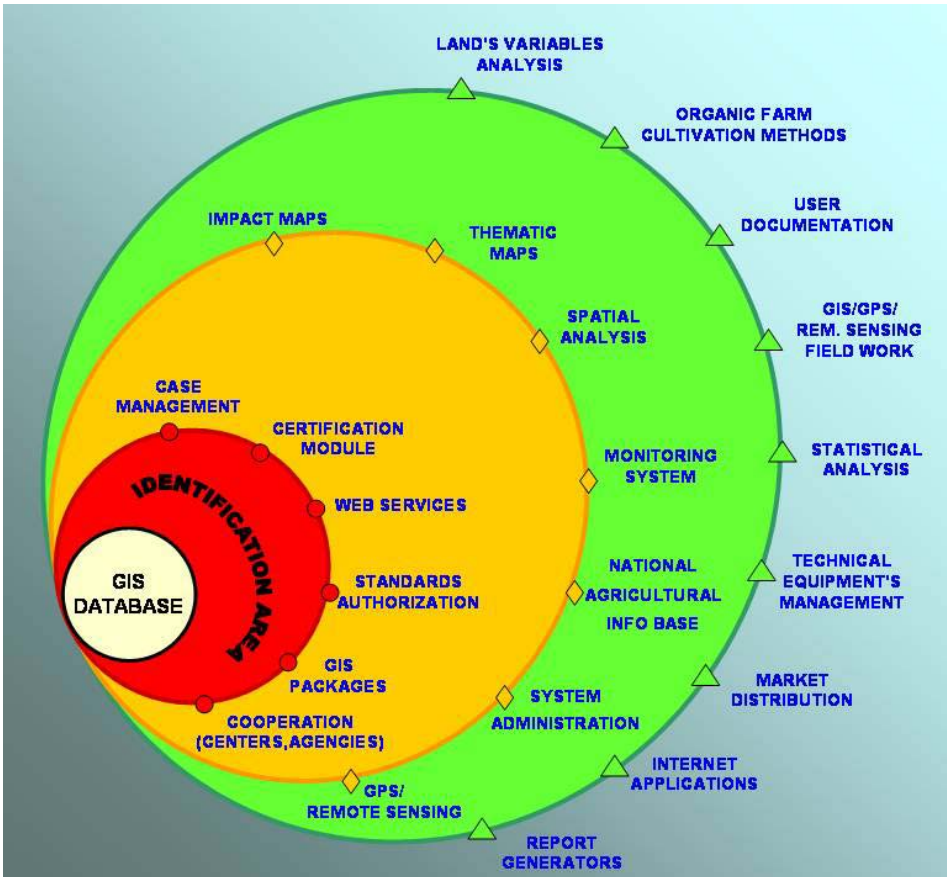

Figure 5: Modules framework and systems' interactions of a functional web-based GIS infrastructure in precision organic farming.

The accumulative development of Organic Agriculture in Europe needs to be followed by additional development of management activities and strategies in national, binational and international level. Combined actions should be undertaken in fields like telecommunications standards, computer software and hardware development, research projects on agricultural management through GIS, additional educative sectors in universities.

The restrictions that accompany organic farming should help in establishing international agreements that will help to increase the number of qualitative standards, allowing better perspectives for developing future GIS based management strategies.'

The implementation of an Internet Based Precision Organic Agricultural System requires committed research from the agricultural industry and improvements in geoanalysis, agricultural and information technology. GIS based systems will become more essential as a tool to monitor agricultural exchanges between inputs and outputs and in relation with adjacent regions at an increasingly detailed level. The results will enhance the role of Geographic Information as a functional and economic necessity for any productive community.

BIBLIOGRAPHY

Aber, S. J., "*Internet and the World Wide Web*", Emporia State University, Semester Courses, Fall 2003.

Hobs, R., J., "*Future landscapes and the future of landscape ecology*". Landscape and Urban Planning 37, (1997), 1-9.

Castells, M. 2001. "*The Internet galaxy: Reflections on the Internet, business, and society.*" Oxford University Press, p. 292.

Chakrabarti, S., Dom, B., Gibson, D., Kleinberg, J., Kumar, R., Raghavan, P., Rajagopalan, S., and Tomkins, A., 1999. "*Hypersearching the web*". Scientific American 280, no. 6, p. 54-60.

Kalabokidis K., Koutsias N., "*Geographic Multivariate Analysis of Spatial Fire Occurrence*", Geotechnical Scientific Issues, vol. 11, Issue 2, No 1, 2000, p 37-47.

Karydas G., Ch., Silleos G., N., "*Development of spectral models for estimation of wheat crop biomass and canopy cover percentage, using ground remote sensing*", Geotechnical Scientific Issues, vol. 13, Issue I, No 2, 2002, p 31-41.

Loomis, J.,B.,"*Integrated Public Lands Management: Principles and Applications to National Forests, Parks, BLM Lands*", 1993, New York, NY, USA: Columbia University Press: 474 pp.

McBratney, B., A., Taylor, A., J., "*PV or not PV?"* , Australian Centre for Precision Agriculture, 1999, Sydney.

Morain Ed., S., "GIS Solutions in Natural Resource Management, Balancing the Technical Political Equation", 1999.

Raghavan V., Santitamont P., Masumoto S., Honda K., "Implementing Web GIS Applications using Open Source Software", 2002, Proceedings of conference Map Asi, 2002

Rundgren G., "*Future perspectives for organic certification*", IFOAM Scientific Conference, Mar del Plata, November 1998.

WCED (World Commission on Environment and Development), 1987, "*Our Common Future"*, Oxford University Press, New York, GIS Solutions.

BIOGRAPHICAL NOTES

Ioannis M. Ifadis

Associate Professor in the Laboratory of Geodesy at the Department of Civil Engineering of the Aristotle University of Thessaloniki. Main interests: Influence of the atmosphere on geodetic measurements, Global Positioning System, Geographic Information Systems, deformation of buildings and technical works.

Avraam Mavridis

PhD Candidate in the Laboratory of Geodesy at the Department of Civil Engineering of the Aristotle University of Thessaloniki. Main interests: Organic Agriculture, GIS and Environmental applications, Remote Sensing.

Paraskevas Savvaidis

Professor and Director of the Laboratory of Geodesy at the Department of Civil Engineering of the Aristotle University of Thessaloniki. Main interests: Engineering surveying, GPS applications, Geographic Information Systems, deformation of buildings and technical works, software development for surveying applications.

CONTACTS

Asc. Professor Ioannis M. Ifadis
Aristotle University of Thessaloniki
Univ.Box 465, GR-54124 Thessaloniki
GREECE
Tel. + 30 2310 995745
Fax + 30 2310 996159
Email: ifadis@civil.auth.gr
Web site: http://gserver.civil.auth.gr

PhD Candidate Avraam Mavridis
Aristotle University of Thessaloniki
Univ.Box 465, GR-54124 Thessaloniki
GREECE
Tel. + 30 2310 995745
Fax + 30 2310 996159
Email: lmac7@civil.auth.gr
Web site: http://gserver.civil.auth.gr

Professor Paraskevas Savvaidis
Aristotle University of Thessaloniki
Univ.Box 465, 54124 Thessaloniki
GREECE
Tel. + 30 2310 995724
Fax + 30 2310 996159
Email: psav@civil.auth.gr
Web site: http://gserver.civil.auth.gr