DSS in Environmental Governance: the case of forest management in Greece

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Abstract. Lately, as sustainability has been globally a key goal at local and regional level, environmental governance and management issues, related to decisions that verify performance have also gained a continuously growing focus. DSSs designed for this purpose can use multi criteria analysis and indicators to implement sustainable forest management. This DSS application includes 6 variables for the forest and by using the specific programming code based on If – Then statements of Visual Basic, automatically selects and decides management measures to propose to the forest manager as an output for each variable. This happens by estimating the interaction of different variables in the forest, which concerns the allowance or conflict case of two different uses. The manager can accept, reject or complete the proposed measures. Such a DSS application can easily be connected to other software as GIS or CAD and can easily be expanded to many new technology applications.

Keywords: DSS, environmental governance, multi-objective forest management

1. Introduction

Governance constitutes a distinct policy regarding management issues and designates processes which focus on decision making and indicates the total sum of given and anticipated mechanisms. Decision support technologies have lately been widely used in many scientific fields and this diffusion affords many gains either to researchers or to the administrators. A Decision Support System (DSS) is a computer-based information system that supports business or organizational decision-making activities. DSSs serve the management, operations, and planning levels of an organization and help to make decisions, which may be rapidly changing and not easily specified in advance (Power, 2000). Information and Communication Technologies (ICT) is a discipline that can adequately be exploited for environmental management issues, such as wild flora and fauna management, aiming to help local authorities/administratives in decision-making process (Papastavrou et al., 1999). It is based on the specific administrative targets set and also aims to select the most suitable measures for their achievement. Environmental governance in Greece is

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entrusted on Public Forest Services, enterprises who are working with stakeholders and other non profit Organizations. Lately, as sustainability has been globally a key goal at local and regional level, environmental governance and management issues, related to decisions that verify performance have also gained a continuously growing focus DSSs in forest management are adaptable for small private holdings, large public properties or cooperative management across multiple ownerships (Twery et al., 2005). In recent research (Andreopoulou, 2000, 2009) regarding the introduction of informatics in Forest Service, it is estimated that the use of new information technology tools is the only process to meet the extended needs of the local forest units to protect forest ecosystems. Forest service in Greece is a non-profit government organisation. It is a sub-division of the Ministry of Environment, Energy and Climate Change and plays an important role in the sustainable exploration of forest areas and furthermore, the preservation of forest character. As forests and forest areas cover almost 20% of the area in Greece, the multiple roles of forests imposes the existence of several task divisions in a Forest district office, such as forest management, wood production, forest and wild life protection, forest technical constructions, treatments, reforestations, recreation, forest-related legal issues, administration and economics. All the above activities create a variety of administrative jobs towards the central service in the Ministry of Environment, Energy and Climate Change, to the Prefecture Forest Administration Department, to Regional Forest Service, other services or the local population. There are also many administrative and statistic books that need to be completed continuously. Therefore, the personnel are due to paperwork for administrative purposes that have to handle within timetables. For example, findings from the research in the Region of Epirus reveal that the forestry public sector has not reached high rates of adoption mainly concerning infrastructure, hardware, and LANs (local networks) and moreover, there is a certain lack in personnel's skills and education as to computer literature (Andreopoulou, 2011). Promotion of Information and Communication Technologies, including DSSs, will offer better administration results, helping sustainable forest management.

Forest ecosystems have several functions such as: a) Source of timber products and firewood, b) Wild fauna's biotope and habitat for fresh water fish, c) Water source and soil protection, d) Habitat for range-plant growing, e) Land with great biodiversity and f) Recreation sites. Nowadays, forests are often managed for multiple uses (Seely et. al. 2004). Forest planning is a very complex activity because there are many goals, which should be achieved simultaneously and a lot of components and elements, which must be considered (Tasoulas, 2011). Modern forestry mostly focuses on environmental sustainability of the ecosystems in relationship to the citizens as a result of the current change in both urban and rural areas (Helms, 2002).

A method for the measure choice in forest management is multi criteria analysis. In this case criteria and indicators are primarily used in implementing the principles of sustainable forest management at national, regional, and at forest management unit levels (Wolfslehner et al. 2005). The factors that must be reviewed, affect forest policy selection, including the nature of goods and services, social values, and economic values (Cubbage et al., 2007). In planning forest ecosystem management, evaluations of alternative plans with respect to ecological values are usually based on

a set of variables describing the forest and the relationships between the variables and ecological values is assessed on the grounds of expert judgments (Leskinen et al., 2003, Baskent et al., 2008). By using a DSS in forest management, administrators can achieve exploiting natural resources, focusing on sustainability and respect to biodiversity so great benefits can be offered to society (Tasoulas et al., 2010). The multiple benefits from forests and generally from natural environment can only be achieved by using tools of new technology and new daily workflow within Forest Service, aiming to increase the productivity of human resources, has to be redefined through the use of computers and network tools and techniques (Andreopoulou 2009).

This paper describes the planning and development of software for a DSS application, aiming to support the administrator/manager of Forest Service or stakeholder to properly manage forest ecosystems. In the DSS the manager will import data for all parameters as variables of the forest into the programme and after the elaboration of the system, specific management measures will be prompted for him to choose. This application includes a Data Base Management System (D.B.M.S.) for handling of stored data. It can be used by the National Forest Services, enterprises working on forest management and foresters that work in other Organization relative to this field. This work constitutes a part of a doctoral study, which is held on Laboratory of Forest Informatics, at Aristotle University of Thessaloniki, Greece.

2. Materials and Methods

The programming language that was selected to develop this DSS was Visual Basic and the platform of software that was used is Visual Studio.NET of Microsoft. Visual Basic constitutes a part of Visual Studio.NET as also other languages do. Visual Basic.NET (VB.NET) is an object-oriented computer programming language that can be viewed as an evolution of the classic Visual Basic (VB) which is implemented on the .NET Framework. Visual Basic was chosen because it does not require advanced training and can be quickly assimilated and used (Plant and Murrell, 2007). Microsoft Visual Studio is an integrated development environment (IDE) that can be used to develop console and graphical user interface applications along with Windows Forms applications, web sites, web applications, and web services in both native code together with managed code for all platforms supported by Microsoft Windows, Windows Mobile, Windows CE, .NET Framework, .NET Compact Framework and others.

In Visual Studio.NET, Project or Solutions are the fundamental screens of designing. The designer works new projects on Solution Explorer and Properties windows, using mainly Windows Form Designer and Toolbox. The programming steps for developing applications are a) Design the interface of the program b) set the properties for each element and c) write the source code.

During the source code writing, procedures as Private or Public Sub were developed, structures if-then-else and select case and loops do-while and do-until were used to express the queries for the variables.

The Data Base Management System was developed in Microsoft Access and connected to the application by the ADO.NET method.

The data that must be imported to the DSS Application pertains to the several functions of forest ecosystems and are categorized to six basic variables:

1. Timber management
2. Wildlife management
3. Mountainous water resources management
4. Biodiversity
5. Grassland management
6. Recreation areas

The raw data of these variables must be ad hoc collected in the forest and be available to specified users for insertion into the fields of the DSS application. The role that an expert will play in organizational decision-making by using a DSS is very important and cannot be substituted by non experts (Diasio et. al., 2009). That is why the insertion of the data in the program demands foresters with management experience.

Some basic calculations on forest variables refer to the estimation of the standing timber volume, the stand structure, the wildlife, the determination of the maximum hunting bag, the degree of roundness of the basin, the maximum quantity of the cascading water, biodiversity, the ordinary use of the grassland, suitable areas for human recreation and many other which are interlaced into the forest. For choosing the appropriate measures for the forest ecosystem, many uses concerning these six variables were recorded and the interaction between them was recorded too. The criteria for the proposed measures concern the allowance or the conflict case of two different uses that should take place simultaneously. Indicatively, uses that can take place at the same time is timber production and hunting or water production and uses that conflicts are protection of rare species of flora and deforestation or soil erosion and grazing.

3. Results

The DSS application that was planed and developed is composed of 20 different screens including over 300 components. The DSS application must be user-friendly aiming to be used from non-computer literate users as many foresters are, so the interface that was developed has served these assumptions. The first screen of the application is a typical window screen, with basic information such the name of the program and folding menus as File, Management and Suggested Management Measures (Fig. 1).

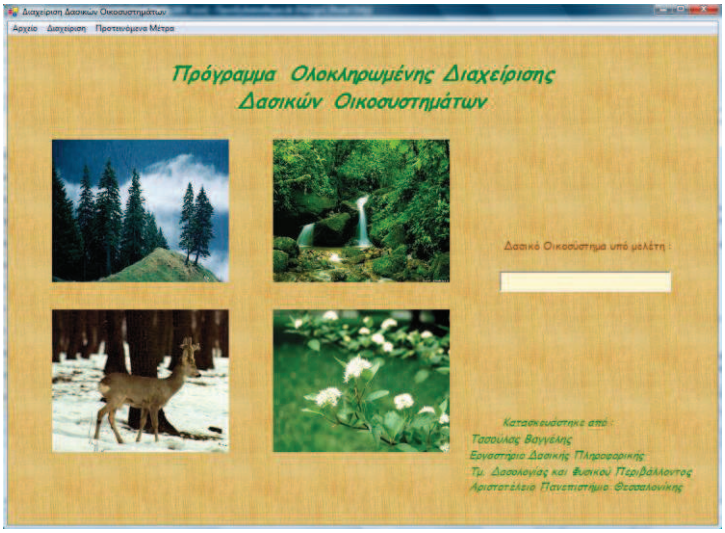

Figure 1. The introductory interface of the application

After the introductory screen, the forest administrator/manager can skip into six other screens, each for every parameter/variable and insert all the needed data (Fig.2). These data must already have been collected from the forest that is studied, under the directives of the administrator. In every phase of the insertion of the data, there is a button that appears a help screen which provides the necessary guidelines to the user how to fill the fields in each screen.

Figure 2. One of the six parameters/variables screens of the application

As the insertion of data is completed and by clicking the proper button in every screen for acceptance, the program automatically performs the respective calculations and transfers the records to the database. Every record is programmed to be inserted in the appropriate table which has been planed for this purpose. There, by using the specific programming code which is based on If – Then statements of Visual Basic, the application automatically selects and decides specific management measures to propose to the administrator as an output for each variable. These measures derive from the processing of inserted data, which are analyzed based on the interaction of the data that manager has introduced. This interaction concerns the allowance or conflict case of two different uses in the forest. The suggestions appear to the user either on message boxes during the filling of each field (Fig.3), or by opening the screen for the proposed measures. In this screen specific check boxes are already checked depending on user's inserted data (Fig.4).

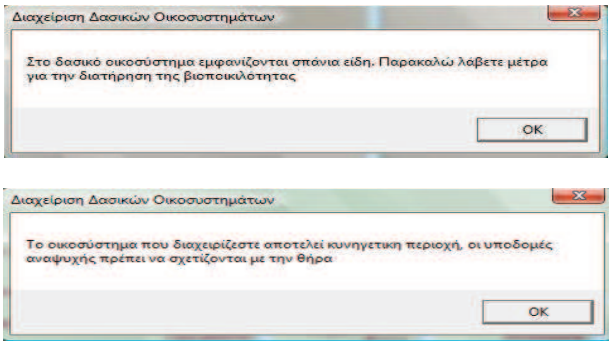

Figure 3. Message Boxes for allowance or conflict case of two different uses

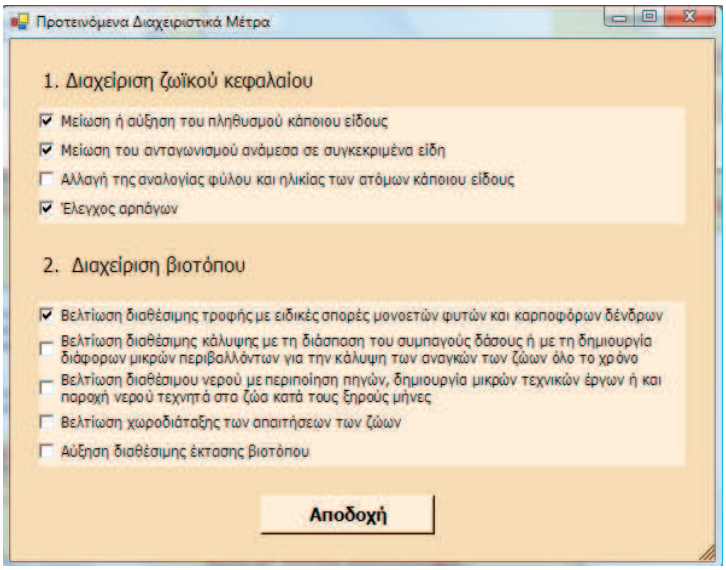

Figure 4. The screen of the suggested measures for a variable

During decision-support process, the forest manager can accept the suggested measures or reject some of them, based on other specific needs that the application can't read and introduces more measures. At last appears a final screen, with all the management measures gathered, ready for printing.

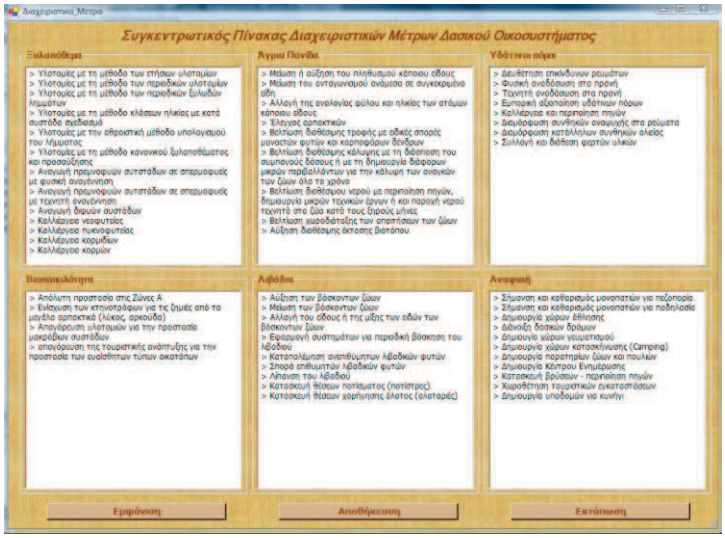

Figure 5. The screen of the recommended measures by the DSS

Verifying the actual use of the presented DSS application by people involved in forest management, data for the co-owned forest ecosystem of Tetrakomo in Prefecture of Arta, Greece, were inserted in the DSS, concerning the six variables that were mentioned. These data were taken from the approved management plan of this forest. The DSS application transferred the data properly into the data base, proceeded to the required calculations and finally recommended specific measures to the forester (Fig. 5). The measures, which are presented in the final screen, were totally accepted by the forester of the enterprise that is responsible for the management plan of this forest.

4. Discussion

The DSS application that was developed is an independent window application, which can be installed to every modern computer and it is not yet connected to any other software. It may have 20 different screens including over 300 components, but it is user-friendly, based on the usual interface of most common window programs and can be used as a tool for multi-purpose forest management. Such a Decision Support System must do, this one supports by using specific criteria and indicators the Forest Authorities/Administrators to select the appropriate measures for sustainable multi-objective management for forest ecosystems. This happens by analyzing the interaction which concerns the allowance or conflict case of two

different uses in the forest. The proposed measures can be accepted, rejected or completed by the forest manager-user of the application. That is because DSSs can not decide the measures instead of human mind, but their role is to support by processing a big store of data, make modeling calculations, revealing many aspects of the situation and at last propose specific measures. Human mind is indispensable and that's why it takes the final decision. Although the more comprehensive knowledge and analysis of the data, the better results for the administrator in adopting management measures for the forest ecosystem.

The programming code of Visual Basic.Net is the tool that has been used for processing the inserted data, making the connection with the database and permits or forbid specific actions, which conform or clash between two ore more different uses. This analysis in cooperation with the DBMS offered the application the feasibility to analyze a big store of data in short time (Elmasri and Navathe, 2004), reaching the proposal of specific measures after the exclusion of many others. Finally that is what why it is classified at the DSS systems.

The application interface is presented in the Geek language because it deals with the multi-purpose management of Greek forest ecosystems. Forest ecosystems in Greece are characterized by intense biodiversity and that imposes the 6 different topics to be dealt with. Therefore, foresters in Greek Forest Service will have to deal with management issues and they constitute the target audience of the application. A future extend of the application would be the creation of multiple versions of the interface, in other languages, such as an English version, a German version, etc aiming at being extensively used. However, changes have to be made also in the original code of the application aiming at fulfilling the managerial needs of other type of forest ecosystems, too, except of Greek forest areas.

5. Conclusions

The National Forest Services, enterprises working on forest management and foresters that work in other Organizations, can easily use that DSS application. As information and communication technologies (ICTs) are key elements supporting the growth of e-governance initiatives and projects, using this DSS in forest administration helped forest managers to achieve exploiting natural resources with focus on sustainability, with respect to biodiversity, by gaining great benefits for the forest owner and the whole society.

It includes open source code, which can be upgraded in the future when new management techniques will come to the front. It is compatible to various software platforms; it can be connected to Geographic Information Systems (GIS) by using dynamic link libraries (Sugumaran, 2002) and other software, so that in the future the data can acquire spatial information. At last it can be easily expanded to many new technology applications such as Internet, i-Pads and i-Phones to gather information and communicate at once with multiple users. Conclusively a DSS is an appropriate application for the Forest Administration, which can seriously contribute to a better

management of forest ecosystems and provide many scopes for improvement taping the future extends in information technologies to forest management' s account.

References

1. Andreopoulou, Z., 2000. The contribution of Forestry Informatics in Forest Service in Greece. Ph.D. Thesis. (In Greek with English abstract). Department of Forestry and Natural Environment, Aristotle University of Thessaloniki, Thesssaloniki. (2000).
2. Andreopoulou, Z., 2009. Adoption of Information and Communication Technologies in Public Forest Service in Greece. Journal of Environmental Protection and Ecology. Vol.10, No.4 1194-1204
3. Andreopoulou, Z., 2011. Introducing Computer and Network Services and Tools in Forest Service and the Human Resources Factor. *Journal of Environmental Protection and Ecology,* Vol. 12, iss 2.
4. Baskent, E.Z., Terzioglou, S., Baskaya, S., 2008. Developing and implementing multiple use forest management in Turkey. Enviromental Management 42, p37-48
5. Cubbage, F., Harou, P. and Sills, E., 2007. Policy instruments to enhance multi-functional forest management. Forest Policy and Economics, Volume 9, Issue 7, April 2007, pages 833-851.
6. Diasio, S., Agell, N., 2009. The evolution of expertise in decision support technologies: A challenge for organizations," cscwd, pp. 692–697, 13th International Conference on Computer Supported Cooperative Work in Design, 2009. http://www.computer.org/portal/web/csdl/doi/10.1109/CSCWD.2009.4968139
7. Elmasri, R. And Navathe, S.B., 2004. 'Fundamentals of Database Systems' 4th edition Addison-Wesley
8. Helms, J.A., 2002. Forest, forestry, forester: what do these terms mean? *Journal of Forestry* 100 (8), 15–19.
9. Leskinen, P., Kangas, J. and Pasanen, A.M., 2003. Assessing ecological values with depended explanatory variables in multi-criteria forest ecosystem management. Ecological Modeling, 170:1-12. DOI: 10.1016/S0304-3800(03)00283-7
10. Papastavrou, A.C., Lefakis, P.D., Andreopoulou, Z.S. and Iliadis, L.S., 1999. Forest Informatics, Volume II. Publishing Department of AUTH. Thessaloniki, p. 239.
11. Plant, R.T. and Murrell, S., 2007. An executive's guide to information technology. Cambridge University Press. p. 343.
12. Power, D.J., 2000. Decision Support Systems. Hyperbook. Cedar Falls, IA: DSSResources.COM, HTML version, Fall 2000, accessed at URL http://dssresources.com/dssbook/
13. Seely, B., Nelson, J., Wells, R., Peter, B., Meitner, M., Anderson, A., Harshaw, H., Sheppard, S., Bunnell, F. L., Kimmins, H. and Harrison, D., 2004. The application of a hierarchical, decision-support system to evaluate multi-objective

forest management strategies: a case study in northeastern British Columbia, Canada. Forest Ecology and Management Volume 199, Issues 2-3, 11 October 2004, Pages 283-305.
14. Sugumaran, R., 2002. Development of an integrated range management decision support system. Computers and Electronics in Agriculture Volume 37, Issues 1-3, December 2002, Pages 199-205
15. Tasoulas, E., Lefakis P., Andreopoulou Z.and Karamanolis D., 2010. Forest Informatics as axis for sustainable development and exploitation of the forest and nature resources. 16th Conf. of Regional Scientists Union, Book of Proceedings p. 48-55
16. Tasoulas, E., 2011. Development of an application's environment for multi-objective management in forest ecosystems. Ph.D. Thesis. Aristotle University of Thessaloniki, Thesssaloniki, 2011 (in Greek with English abstract).
17. Twery, M., Knopp, P., Thomasma, S., Rauscher, M., Nute, D., Potter, W., Maier F., Wang, J., Dass, M., Uchiyama, H., Glende, A. and Hoffman, R., 2005. NED-2: A decision support system for integrated forest ecosystem management. Computer and Electronics in Agriculture, Volume 49, Issue 1, p 24-43.
18. Wolfslehner, B., Vacik H. and Lexer J., 2005. Application of the analytic network process in multi-criteria analysis of sustainable forest management. Forestry Ecology Management, Volume 207 pages 157-170.