DSS applications in forest policy and management: Analysis of current trends

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Abstract. Today, not only scientists and researchers, but public services and governments as well use DSS (Decision Support System) methods to solve forest policy and management problems in order to meet the multiple needs of the public and to achieve the greatest possible effectiveness. This paper presents and analyses the current trends in emerging DSS applications for the sector of forest policy and management. The research relates to the scientific journal articles that propose a DSS since 2007 and until the present. The DSS are registered and classified as to their characteristics, such as their decision support topic, multiple-aim DSS, country of application, type of software, database use, GIS, mathematics, online presentation in the Internet etc. Finally the DSS applications are categorized as to the above characteristics and current trends are identified and discussed. GIS and Database technology seem to be the most popular software used by the decision makers, since Europe North America emphasize most in these kind of DSS applications.

Keywords: Decision Support Systems, forest policy, forest management, current trends,

1 Introduction

Information Systems researchers and technologists have built and investigated *Decision support systems (DSS)* for approximately 40 years. Computerized decision support systems became practical with the development of minicomputers, timeshare operating systems and distributed computing. Ferguson and Jones (1969) reported the first experimental study using a computer aided decision system. The authors have developed and conducted experiments with a time-sharing computer model. By modeling the dynamics of a job shop the authors were able both to make use of and to evaluate academic research in job shop scheduling. The response of over 300 managers and academicians who have participated in the experiments provides evidence of the practicality of such an approach to multi-dimensional, time-variant problem solving.

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There are many valid definitions regarding DSS. DSS have been initially defined as "…computer-based support system for the management decision makers who deal with semi -structured problems" (Keen and Morton 1978). Decisions are courses of action that are taken to avoid or reduce negative effects, or to take advantage of opportunities (Mc Leod 1998). It is a content-free expression; that is, it means different things to different people (Turban and Aronson, 1998) meaning that a D.S.S. interacts with the user in order to provide decisions. Recently, DSS are defined broadly as interactive computer-based systems that help people use computer communications, data, documents, knowledge, and models to solve problems and make decisions (Power, 2007). In this paper DSS are approached as a tool, available to managers, for solving complicated environmental problems by aiding in the decision making process.

The decision maker has to consult many factors and data in order to provide the best possible solution to a problem. According to Burstein and Holsapple (2008) the DSS relaxes cognitive, temporal, spatial and economic limits on the decision maker, since the support furnished by the system allows a decision episode to unfold:

- in more-productive ways (e. g., faster, less expensively, with less effort),
- with greater agility (e. g., alertness to the unexpected, higher ability to respond),
- innovatively (e. g., with greater insight, creativity, novelty, surprise),
- reputably (e. g., with higher accuracy, ethics, quality, trust), and/or
- with higher satisfaction by decisional stakeholders (e. g., decision participants, decision sponsors, decision consumers, decision implementers)

Today a number of academic disciplines provide the substantive foundations for DSS. Database systems provide tools on managing data; management science has developed mathematical models for use in building model-driven DSS, whilst some other important fields related to DSS are human-computer interaction, software engineering and telecommunications. Further, the Internet and Web have precipitated the development of the DSS through Information and Communication Technologies (ICTs) and its applications that act as providers of a great amount of information and services related to all sectors of science (Andreopoulou, 2006).

Based upon Alter's (1980) pioneering research we can identify the following three major characteristics: DSS are designed specifically to facilitate decision processes, DSS should support rather than automate decision making and DSS should be able to respond quickly to the changing needs of decision-makers.

In persuing the goal of improving decision-making, many different types of computerized DSS have been built to help decision teams and individual decision makers. Power and Sharda (2009) point that some systems provide structured information directly to managers. Other systems help managers and specialists analyze situations using various types of quantitative models, some DSS store

knowledge and make it available to managers and some systems support decision making by small or large groups.

1.1 DSS in forest management and policy

Today, Forestry has to resolve a number of issues and to find effective ways to deal with the ecological and social problems that act, in many ways, as a threat to the environment and the people. Such issues that forestry is confronting are: forests fires, land use, wildlife protection, reforestation, wind damages, illness and infection damages, infringement of the forest law and many others. In general, the major issue is the protection and conservation of the natural environment in a way that builds an intercourse between the people and the environment.

In our days, the definition of forest has been changing towards a wider range of qualitative characteristics and it is defined as an ecosystem that combines simultaneously various land uses (Helms, 2002). 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 (Andreopoulou, 2007). Forests and especially urban forests are considered to be the most popular outdoor recreation environments in Europe underlying the changing role of forestry through time (Konijnendijk et.al., 2000).

The multiple functions of forests imposes the existence of several tasks that have to be dealt in parallel and formulate the forest policy aspects such as forest management, wood production, forest and wild life protection, forest technical constructions, treatments, reforestations, forest recreation, land-use legal conflicts administration and economics (Tasoulas et.al., 2011).

Today, not only scientists and researchers, but public services and governments as well use DSS methods to solve forest policy and management problems in order to achieve the greatest possible effectiveness. Geographical Information Systems (GIS), Database technology, Mathematics, Economics, Chemistry, Internet and software engineering, are only some of the tools used and combined by the researchers with a view to create a DSS for an individual issue. Moreover, DSS provide an interesting framework to integrate database management systems with analytical and operational research models, graphic and tabular reporting capabilities to assist in natural resources management and policy analysis (Borges et al., 2003; Reynolds et al., 2005, 2008).

It is appreciated in recent research (Andreopoulou, 2009, 2011) that the use of IT tools is the only process to meet the extended needs of forests and in parallel, to protect forest ecosystems. This paper presents an analysis of the current trends in emerging DSS applications in forest policy and management sector through their registration and classification. The aim of the presented research project is to inform about the current trends in DSS regarding these issues, in order to service further scientific research.

2 Methods and material

Aiming to identify the current trends in DSS in the sector of forest management and policy, an analytical review of the articles of relative scientific journals has been performed, in order to register them. There has been a research among the web bases of the most known journals (High Impact factor) that deal with forest policy and management and DSS applications, detecting related journal articles for the period 2007-2011. As we can see in Figure 1, the findings were registered and classified using "EndNote X4", which is reference manager software.

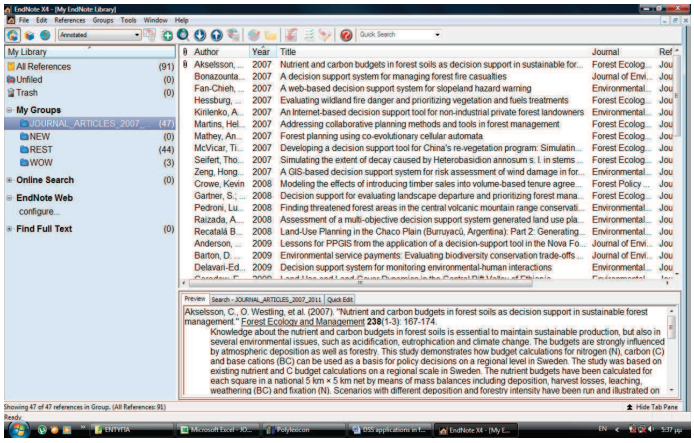


Fig. 1. Endnote Library

The DSS applications were registered and various characteristics have been studied aiming to be further classified. The characteristics studied are:

-the specific topic that the DSS deals with such as forest fires, land use, ecosystem protection, forest planning, etc ,

-if they constitute a multiple-purpose DSS or not,

-the country or the area of DSS application,

-the type of software used to develop the DSS,

-the employ of database,

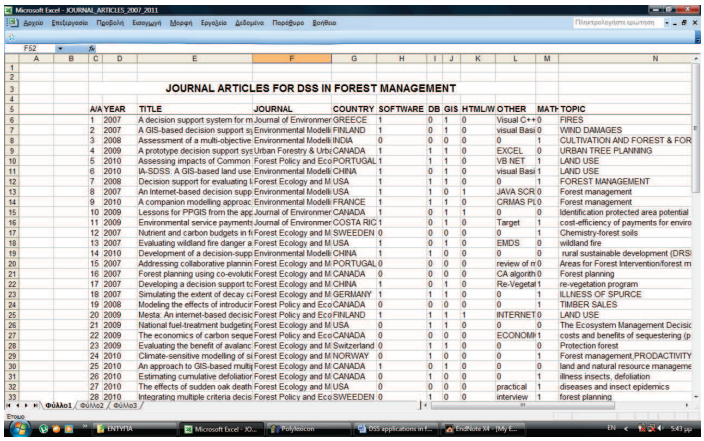
-the use of GIS technology,

-the existence of mathematic analysis, such as linear programming,

-online presentation and exploitation of the DSS in the Internet etc.

The classification as to their characteristics was accomplished with an Ms-excel sheet (Fig. 2).

Finally the DSS applications are categorized as to the above characteristics and current trends are identified and discussed.



JOURNAL ARTICLES FOR DSS IN FOREST MANAGEMENT

A/A	YEAR	TITLE	JOURNAL	COUNTRY	SOFTWARE	DB	GIS	HTML/W	OTHER	MATH	TOPIC
1	2007	A decision support system for m	Journal of Environmer	GREECE	1	0	1	0	Visual C++	0	FIRES
2	2007	A GIS-based decision support sy	Environmental Modelli	FINLAND	1	0	1	0	visual Basi	0	WIND DAMAGES
3	2008	Assessment of a multi-objective	Environmental Modelli	INDIA	0	0	0	0	0	1	CULTIVATION AND FOREST & FOR
4	2009	A prototype decision support sys	Urban Forestry & Urb	CANADA	1	1	1	0	EXCEL	0	URBAN TREE PLANNING
5	2010	Assessing impacts of Common	Forest Policy and Eco	PORTUGAL	1	1	1	0	VB NET	1	LAND USE
6	2010	IA-SDSS: A GIS-based land use	Environmental Modelli	CHINA	1	0	1	0	visual Basi	1	LAND USE
7	2008	Decision support for evaluating l	Forest Ecology and M	USA	1	1	1	0	0	1	FOREST MANAGEMENT
8	2007	An Internet-based decision supp	Environmental Modelli	USA	1	1	0	1	JAVA SCR	0	Forest management
9	2010	A companion modelling approac	Environmental Modelli	FRANCE	1	1	1	0	CRMAS PL	0	Forest management
10	2009	Lessons for PPGIS from the app	Journal of Environmer	CANADA	1	0	1	1	0	0	Identification protected area potential
11	2009	Environmental service payments	Journal of Environmer	COSTA RIC	1	0	1	0	Target	1	cost-efficiency of payments for enviro
12	2007	Nutrient and carbon budgets in fi	Forest Ecology and M	SWEEDEN	0	0	0	0	0	1	Chemistry-forest soils
13	2007	Evaluating wildland fire danger a	Forest Ecology and M	USA	1	0	1	0	EMDS	0	wildland fire
14	2010	Development of a decision-supp	Environmental Modelli	CHINA	1	1	0	0	0	0	rural sustainable development (DRS
15	2007	Addressing collaborative plannin	Forest Ecology and M	PORTUGAL	0	0	0	0	review of n	0	Areas for Forest Intervention/forest m
16	2007	Forest planning using co-evolutic	Forest Ecology and M	CANADA	0	0	0	0	CA algorith	0	Forest planning
17	2007	Developing a decision support tc	Forest Ecology and M	CHINA	1	0	1	0	Re-Vegetat	1	re-vegetation program
18	2007	Simulating the extent of decay c	Forest Ecology and M	GERMANY	1	1	1	0	0	1	ILLNESS OF SPURCE
19	2008	Modeling the effects of introducir	Forest Policy and Eco	CANADA	0	0	0	0	0	1	TIMBER SALES
20	2009	Mesta: An internet-based decisic	Forest Policy and Eco	FINLAND	1	1	1	1	INTERNET	0	LAND USE
21	2009	National fuel-treatment budgetin	Forest Ecology and M	USA	0	1	1	0	0	0	The Ecosystem Management Decisic
22	2009	The economics of carbon seque	Forest Policy and Eco	CANADA	0	0	0	0	ECONOMI	1	costs and benefits of sequestering (p
23	2009	Evaluating the benefit of avoianc	Forest Ecology and M	Switzerland	0	1	1	0	0	0	Protection forest
24	2010	Climate-sensitive modelling of si	Forest Ecology and M	NORWAY	0	1	0	0	0	1	Forest management,PRODACTIVITY
25	2010	An approach to GIS-based multi	Forest Ecology and M	CANADA	1	0	1	0	0	0	land and natural resource manageme
26	2010	Estimating cumulative defoliatior	Forest Ecology and M	CANADA	0	1	0	0	0	1	illness insects, defoliation
27	2010	The effects of sudden oak death	Forest Ecology and M	USA	0	0	0	0	practical	1	diseases and insect epidemics
28	2010	Integrating multiple criteria decis	Forest Policy and Eco	SWEEDEN	0	1	0	0	interview	1	forest planning

Fig. 2. Registration and classification of the findings in Microsoft Excel

3 Results

This survey concerns published journal articles derived from 9 individual scientific journals. There were identified and registered 46 emerging DSS applications for the sector of forest management and policy since 2007.

In a percentage of 43, 5% they constitute a multiple-purpose DSS as they apply to more than one specific topic of forest management and policy and can be adopted and support decision making widely.

As it concerns the specific topics that DSS applications deal with, there were identified 14 different topics. 15% of the findings relate to forest fires, 15% to forest management in general and 11% to ecosystem protection as it is presented in figure 3.

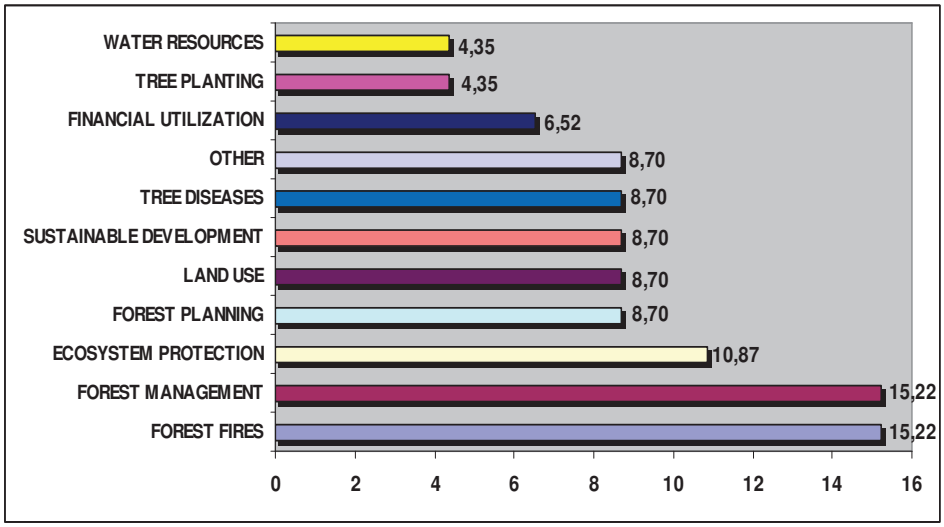


Fig. 3. Topics of the DSS applications in the sector of forest management & policy (%)

Regarding the country-area of the DSS application, a geographical allocation arises in figure 4. As it is obvious the DSS applications identified are mainly targeted to Europe and America. It is important to underline that 17 out of the 21 journal articles found in America, came from the USA and Canada and also apply to these countries. Further, the European DSS applications refer to EU nations except for one, which applies to Switzerland.

As far as the type of software used to develop the DSS, 18 out of 46 DSS used Database technology, 25 were based on GIS (Geographical Information System) applications and only four introduce a web DSS application available in the internet. Moreover, 37% of the total findings regard to DSS based on a combination of existing software applications and with the aim of programming languages and other software engineering, they present a prototype software as a decision making tool. Researchers are mostly using Visual basic (C++, NET), SPSS and Java script.

Last but not the least, 50% of the DSS applications seems to have processed mathematical data in order to achieve the desirable result and to present a reliable outcome.

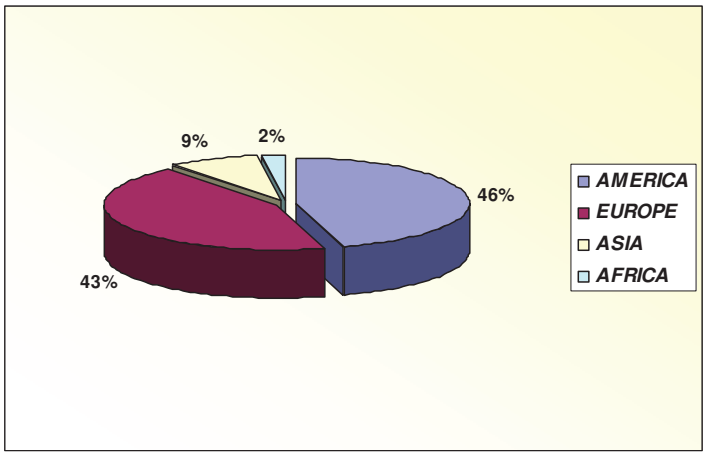


Fig.4. Geographical allocation of the DSS applications

4 Discussion

According to the results of this study, the current trends in the DSS in the sector of forest management and policy refer to implementation of geographically based data, through GIS software, which collaborates effectively with database technology. This kind of combination is considered to be so successive that 43 out of 46 DSS applications, registered in this survey, are using either GIS or Databases, whilst 12 of them are using a combination of both. It is also remarkable that this trend applies almost to the total of topics of DSS that were mentioned above. Particularly databases were applied in 10 out of the 14 topics recorded in this research, since GIS was the basic software for 11 DSS topics of the forest management sector.

The DSS applications identified are mainly targeted to Europe -especially to EU member nations- and the USA and Canada. This fact proclaims the interest that these countries show to the protection of the environment and their intention to study and establish new methods of managing forestlands. Northern states of the USA and mostly Canada maintain enormous forest areas and not only local institutes and scientists precisely work on these issues, but the governmental policy seems to encourage this trend.

As far as the European Union, European commission's effort to establish a common framework of managing the natural environment, is offering opportunities and possibilities to Universities and independent scientists to study upon these sectors of environmental sciences and to recommend computerized systems to aid critical decision making.

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