Spatial OLAP and Multicriteria Integrated Approach for Decision Support System: Application in Agroforestry Management

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ABSTRACT
This article describes how Spatial On-Line Analytical Processing, such a decisional technology, offers the possibilities of spatial and multidimensional analysis of data stored in multidimensional structure namely spatial data warehouse. However, this technology is limited in the quality aspect of the decision related to the multicriteria consideration. In the current article, the objective is to propose a Spatial Decision Support System namely “Silvicultura” for facilitating decision making in complex situations. This approach is based on integrating multicriteria analysis with SOLAP in order to enrich the spatial and multidimensional analysis with the contribution of MCA tools for mitigating conflict situations. The authors have based their proposal modeling on Unified Modeling language, since it is a well-known standard modeling language and can be easily extended for multidimensional modeling. Finally, in order to validate their proposal, the authors present a case study to show how to use it in the agroforestry management.

KEYWORDS
Agroforestry, Multicriteria Analysis, Multidimensional Analysis, SOLAP, Spatial Analysis, Spatial Data Warehouse, Spatial Decision Support System, UML Modeling

1. INTRODUCTION
Organizations in all governmental, private, economic or social sectors, etc. need data analysis tools allowing them to have indicators of the evolution of their activities.

These tools must be capable for storing and analyzing large volume of data from multiple sources taking advantage of the service offered by modern applications and technologies. They must also be able to provide a clear vision of the activity of an organization and its environment in order to develop its strategy of production, preservation of the existing patrimony and the regularization of its overall functioning.

Computerized information systems are typically used providing data storage and analysis mechanisms and are adapted to decision analysis queries (Kimball & Ross, 2003). They are called Decision Support Systems (DSS) with the aim of assisting decision-makers in their job.

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In this context, on one hand, Data Warehouse (DW) systems provide storage, integration and logging space for all the data needed for decision analysis. On another hand, On-Line Analytical Processing (OLAP) defines intuitive tools for a simple and interactive exploration of this data.

Furthermore, a Spatial Decision Support System (SDSS) is a specific tool for problem solving in management process. Basing on a spatial data infrastructure, this system is used to facilitate the evolution of actions which have spatial nature.

Nowadays, in Algeria, we note the increasing need to these systems in various domains namely the agroforestry area management. It includes forests, forest vocation areas, wetlands ... etc. These spaces are defined in the forests general regime.

In the management and preservation of forestry resources, efforts must allow to:

- Preserve, regenerate and develop the existing properties through silvicultural activities and management plans;
- Maintain and strengthen protected areas through the development and implementation of a management plan;
- Maintain and develop wetlands by their identifications, classification and protection of priority areas of economic and ecological interest;
- Rehabilitate the natural space by restoring recreational forests and green spaces.

In addition, in the fight against erosion and mountain agriculture, forestry policy aims to:

- Preserve the coastline by the stabilization based on a natural plant;
- Maintain the natural balance of ecosystems by the stabilization of the dune covered;
- Protect watersheds threatened by erosion, by the integrated development planning.

As such, the services responsible for managing the forest area have a large volume of complex and multi-source data. Hence the need for effective systems to access and analyze data for using them in planning purposes. This need is summarized by their role in the calculation and diffusion of statistical results that impact on the curve of economic and social development.

In this context, the development of an interactive tool for the decision-making to manage agroforestry areas at several observation axes, such as: cadastral properties, management of wildlife, silvicultural activities, etc., involves intensive use of databases, taking advantage of the spatial applications. This situation involves manipulating multisource data, where spatial data management is the task of the Geographic Information System (GIS) which allows the spatial analysis.

A GIS can be defined as a “...data management system designed to input, store, retrieve, manipulate, analyze, and display spatial data for the purposes of research and decision-making...” (DeMers, 1997). Indeed, GIS is used to manipulate spatially referenced data of objects and phenomena in geographic space. GIS is widely used in land-use planning and natural resources management.

However, GIS is based on transactional processes and is unable to perform multidimensional analysis offered by On-Line Analytical Processing (OLAP) technologies. That’s why a new technology has emerged known as the Spatial-OLAP (SOLAP). In fact, this last, allows studying the geographical distribution of phenomenon and effectuating comparison across geographic granularity by the visualization of the analysis results on tables, diagrams and maps.

Nevertheless, SOLAP technology alone still suffers from several drawbacks largely due to a lack of capacity for supporting spatial problems.

To evolve into a true decision support tool, the solution, in our proposal, is to combine it with Multicriteria Analysis (MCA) which offers several advantages when we must take into account conflicting interests.
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