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Integrating Multicriteria Analysis and Geographic Information Systems: a survey and classification of the literature

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Over the last few years, there has been a revolution in the availability of information and in the development and application of tools for its management. As a consequence, decision-making nowadays underpins on an ever increasing availability of data and there is thus a need to allocate the Decision Makers attention efficiently.
This need is real, above all, in the context of sustainability assessments which are based on a multidimensional concept, including socio- economic, ecologic, technical and ethical perspectives.
Within this context, a very important role is played by the so called Multicriteria- Spatial Decision Support Systems (MC-SDSS; Malczewski, 1999), which, being based on Geographic Information Systems (GIS) and Multicriteria Decision Analysis (MCDA) coupling, represent a very efficient tool to implement a multi- inter disciplinary, participative and transparent approach.
Conventional MCDA techniques have largely been non-spatial, using average or total impacts that are deemed appropriate for the entire area under consideration but the assumption that the area under analysis is spatially homogenous is rather unrealistic because in many cases evaluation criteria vary across space.
As a matter of fact, many decision-making problems are based on spatial (geographical) information, thus giving rise to the so called location decisions which represent now a major part of operations research and management science.
The most significant difference between spatial multi-criteria decision analysis and the conventional multicriteria decision analysis is the explicit presence of a spatial component. Spatial multicriteria decision analysis therefore requires data on the geographical locations of alternatives and/or geographical data on criterion values. The integration of the two distinctive areas of research, GIS and MCDA, allows to close their respective gaps and to enhance the efficacy and the reliability of the decision-making process.
There is now a well established body of literature on GIS-MCDA integration and the techniques and the applications concerning GIS-based multicriteria decision analysis have been recently discussed in a very interesting study developed by J. Malczewski (2006). From 2000 the number of studies has been increasing worldwide and several applications can be found in different fields. Starting from the study developed by Malczewski, the present paper expands the survey and classification of the literature concerning MCDA and GIS integration by considering the period 2007-2010. The paper thus provides a review on recent efforts and developments in MC-SDSS, highlighting which methodological approaches are more commonly used with reference to the MCDA components (Multi-objective Decision Analysis *versus* Multi-attribute Decision Analysis), the GIS components (raster *versus* vector data models), the aggregation rule used, the decision process approach (value focused thinking *versus* alternative focused thinking), the extent of the GIS and MCDA integration and the type of application domain and decision problem.
The main objective of the present contribution is thus to survey and classify the most recently published GIS-MCDA articles. The search for relevant publications has been performed using the SCOPUS web based scientific database, it was limited to articles published in refereed journals and it was done using a Boolean search based on a combination of keywords.
The electronic search indicated that over 300 articles appeared in refereed journals showing a growing trend in GIS based MCDA applications in recent years. The paper thus provides taxonomy of those articles by identifying trends and developments in GIS-MCDA.

Keywords: Multiple Criteria Decision Analysis, Geographic Information Systems, Multicriteria-Spatial Decision Support Systems.