

A Model to Assess Sustainability Using Multi-Criteria Analysis and Geographic Information Systems: A Case Study

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Abstract : The aim of this paper is to present a methodology and a computer model for sustainability assessment based on the integration of Multi-criteria Decision Analysis (MCDA) with a Geographic Information System (GIS). It presents the result of a study for the implementation of a model for measuring sustainability to address the policy actions for the improvement of sustainability at territory level. The aim is to rank areas in order to understand the specific technical and/or financial support that is required to develop sustainable growth. Assessing sustainable development is a multidimensional problem: economic, social and environmental aspects have to be taken into account at the same time. The tool for a multidimensional representation is a proper set of indicators. The set of indicators must be integrated into a model, that is an assessment methodology, to be used for measuring sustainability. The model, developed by the Environmental Laboratory of the University of Perugia, is called GeoUmbriaSUIT. It is a calculation procedure developed as a plugin working in the open-source GIS software QuantumGIS. The multi-criteria method used within GeoUmbriaSUIT is the algorithm TOPSIS (Technique for Order Preference by Similarity to Ideal Design), which defines a ranking based on the distance from the worst point and the closeness to an ideal point, for each of the criteria used. For the sustainability assessment procedure, GeoUmbriaSUIT uses a geographic vector file where the graphic data represent the study area and the single evaluation units within it (the alternatives, e.g. the regions of a country, or the municipalities of a region), while the alphanumeric data (attribute table), describe the environmental, economic and social aspects related to the evaluation units by means of a set of indicators (criteria). The use of the algorithm available in the plugin allows to treat individually the indicators representing the three dimensions of sustainability, and to compute three different indices: environmental index, economic index and social index. The graphic output of the model allows for an integrated assessment of the three dimensions, avoiding aggregation. The presence of separate indices and graphic output make GeoUmbriaSUIT a readable and transparent tool, since it doesn't produce an aggregate index of sustainability as final result of the calculations, which is often cryptic and difficult to interpret. In addition, it is possible to develop a "back analysis", able to explain the positions obtained by the alternatives in the ranking, based on the criteria used. The case study presented is an assessment of the level of sustainability in the six regions of Malta, an island state in the middle of the Mediterranean Sea and the southernmost member of the European Union. The results show that the integration of MCDA-GIS is an adequate approach for sustainability assessment. In particular, the implemented model is able to provide easy to understand results. This is a very important condition for a sound decision support tool, since most of the time decision makers are not experts and need understandable output. In addition, the evaluation path is traceable and transparent.

Keywords : GIS, multi-criteria analysis, sustainability assessment, sustainable development

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