

# A Multiobjective Spatial-based Zone Design Model (MoSZoD)

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**Abstract** - This paper presents a multiobjective approach for a spatial-based zone design model to the division of a land surface into two or more pieces. The model employs multiobjective optimization technique and Geographic Information System (GIS) as its components. This paper defines the problem based on multiobjective because it considers relationship among objectives and it is much more realistic to solve a real-world spatial zoning problem. The multiobjective decision analysis has been used to approximate and handle the pareto-optimal solution to get optimal solution set after this paper applies a heuristic method to generate non-dominated alternatives. This paper also aggregates the decision-makers' preferences by allowing interactivity with decision-makers. The flow of the model and its implementation in the GIS environment is presented. The computation has resulted in improvements in spatial zoning.

## I. INTRODUCTION

This paper reports a multiobjective modeling for a decision-support in the Spatial Zoning Procedure (SZP). The process of SZP involves the division of a land surface into two or more pieces [3]. According to [2], the aim of redistricting is to partition geographical zones or districts into territories, subject to some side constraints. 'Seeing relationships based on geography' is the selling point today for many practical oriented fields and 80 percent of decisions by state and local government involve a spatial component either directly or indirectly [4]. Geographers are used to thinking spatially, and geography has same common intellectual root related with spaces. Therefore, the study of SZP decision support system looks at a discipline that provides formalisms and theories fundamental to the management of space and automation of the land division process.

Therefore, this work is devoted to design a new methodology of multiobjective SZP model, called Multiobjective Spatial Zone Design Model (MoSZoD), which can handle for multiobjective SZP. The requirement specifications are as following:

- Problem definition should be based on multiobjective because it considers relationship among objectives and realistic to solve a real-world problem
  - Multiobjective decision rules should be able to approximate the pareto-optimal solution and able to handle the pareto-optimal solution set.
  - In aggregating the decision-makers' preferences, interactivity with decision-maker should be considered
- Thus, the main challenge of the study is to obtain a good evaluation method on intermediate spatial zoning solution for the purpose of approximation of the whole non-dominated solution set and to obtain the optimal solution set with a quality measurement from the non-dominated set. Besides,

the model needs to get the preferences of decision-makers in an interactive mode.

The rest of this paper is organized as follow. In Section 2, the background and some technical requirements of the Multiobjective GIS-Based Spatial Zoning Model is presented. The proposed model is described in Section 3. This is followed by implementation and application in Section 4 and by conclusion in Section 5.

## II. BACKGROUND AND TECHNICAL REQUIREMENTS OF MULTIOBJECTIVE GIS-BASED SPATIAL ZONING MODEL

Although SZP has some similarities with classical combinatorial optimization problems like location problem, making use of standard multiobjective scheme is unfeasible due to its spatial nature. In SZP, it is unavoidable to handle adjacency analysis, shapes of geographical features and the descriptions of each feature as well as to conduct spatial analysis such as topological overlay and contiguity analysis. Even the simplest aggregation scheme for SZP presents a massive number of possible alternative configuration without considering the fact that these criteria are conflicting with one another and do not share a common properties [6]. On the other hand, the pareto-optimal solution is a set of non-dominated solutions where each solution is not worse than the other solutions in the set on all objectives and better on at least one objective [12]. An optimal set of non-dominated solutions to SZP problem is found when all other solutions are dominated by a solution in the set. As a result, in multiple objective cases, there is no reason to expect approximately pareto-optimal solutions to have some common properties, which is actually reflecting the real-life SZP problem.

Any decision-making process begins with the recognition of decision problem. During the searching or scanning of the decision environment for conditions calling for decisions, raw data are obtained, processes and examined for clues that may identify problems and opportunities. In this phase of the process, adequate support is provided by current GIS systems, with special capabilities of processing spatially referenced data. The systems offer a unique opportunity to tackle problems traditionally associated with data collection and analysis more efficiently and effectively but only at the initial stage of decision-making process [13]. GIS can help in coordinating situation analysis through its ability to integrate data and information from a wide range of sources. It also effectively presents information in a comprehensive form to decision-makers, who otherwise may not be able to analyze all the data and information from pages of tabular report. However, for the time being, GIS only contributes to the optimization in terms of data gathering and visualization of the results because there are operational limitations on the use of optimization model for spatial decision analysis in GIS environment [14]. The functionality of GIS is essentially limited to overlaying deterministic digital map layers to define area simultaneously satisfying a set of locational criteria.