# A Soil Conservation Planning in Arid Environments by GIS and SMCE (Case Study: Jamz-Tabas-Iran)

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## Abstract

*One of the most important things involved in determination of soil conservation sites is to facilitate prioritizing sites. Objective is spatial multi criteria evaluation (SMCE) that shows the best site selection solution fast for arid regions. By considering the available, district condition and objectives a criteria tree model including spatial factors (soil erosion, vegetation cover, proximity to water, to village, to road, and to airport), and constraints (geomorphologic facies and plant density) were designed to determine suitable sites for soil conservation by SMCE. All factors were rasterised and standardized in value range between 0 and 1. Factors were weighted by ranking methods. Compositing of these layers were done by SMCE with ILWIS (GIS) software. Output was composite index map (CIM). CIM was classified, and proposed in each class which measure should be done. According to stakeholder preferences, district capability, government facilities and pixel values in CIM, soil conservation sites were recommended. In results about 18% of study area divided to 3 priorities. First priority for soil conservation included 370 ha. Consequently, a tree model was introduced for solving semi structure problems in arid region of Iran resembling Jamz district that it can help for soil conservation planning quickly and accurately.*

**Keywords**: *soil conservation; spatial multi criteria evaluation (SMCE); GIS; Arid Environment; Iran*

## 1. Introduction

For solving semi structure problems, we can use spatial data and computer in Geographical Information System (GIS) environment with expert's opinion. For soil conservation programming need a lot of spatial data and they should be combine with decision rules. Thus in this research Spatial Multi Criteria Evaluation (SMCE) in GIS environment was used. In the last decade or so, the combination of GIS and multicriteria evaluation (MCE) has been routinely adopted as an approach to assess the suitability of an area to land suitability, and consequently to select optimal locations for some facilities (Buenrostro Delgado et al., 2008). MCE or SMCE in a GIS environment is a procedure to identify and compare solutions to a spatial problem, based on the combination of multiple factors that can be, at least partially, represented by maps (Malczewski, 2006). This approach takes advantage of both the capability of GIS to manage and process spatial information, and the flexibility of MCE to combine factual information (e.g., soil type, slope, infrastructures) with value-based

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information (e.g., expert's opinion, quality standards, participatory surveys). Taking into account both technical elements and people's values and perceptions is essential to build consensus around a decision, to reduce conflicts, and consequently to pave the way to successful land priority siting interventions (Higgs, 2006).

SMCE is commonly applied to land suitability analysis (see reviews in Malczewski (2004) and Collins et al. (2001)), and specifically to site selection studies (Sener et al., 2006; Mourmouris, 2006). However, relatively few studies incorporate stakeholders and public's opinion (Higgs, 2006): in most applications, the value-based input (e.g., weights of the different criteria; critical thresholds of the adopted indicators) is provided by the same authors (Calijuri et al., 2004; Sener et al., 2006) or by a panel of technical experts, through techniques such as interviews or Delphi surveys (Buenrostro Delgado et al., 2008; Hatzichristos and Giaoutzi, 2006).

This research shows a rapid way to determine suitable sites for soil conservation by spatial factors and GIS tools. Objective is presentation of a soil conservation planning in arid environments by GIS and SMCE in Jamz-Tabas in Iran.

## 2. Materials and methods

### 2.1 Study area

The studied area is a part of Tabas district, that are located between Abbasabad village in the north, Jamz and Dolat abad villages in the south, Havas village in the west, and Tabas airport in the east. This district is located between the longitude 56˚ 49′15′′ and latitude 33˚ 36′15′′ to 33˚ 41′52′′ and the area is about 5001 hectares (Figure 1). The average of annual temperature is 21.6 ˚C and rainfall annual average is 84mm.

### 2.2 Research Methodology

#### 2.2.3 SMCE programming

Criteria may be of two types: factors and constraints. Factors are generally continuous in nature (such as the slope gradient or roads proximity factors). Proximity maps were made by buffering around line, point or polygon features. They indicate the relative suitability of certain areas. Constraints, on the other hand, are always Boolean in character. They serve to exclude certain areas from consideration. Factors and constraints can be combined in the SMCE programming in ILWIS as GIS software. SMCE is characterized by some level of assumed risk that will strongly influence the final suitability map. Factor maps (soil erosion, vegetation cover, proximity to water, to village, to road, and to airport), and constraints (geomorphologic facies and plant density). These spatial data were used to mapping soil conservation priority by entering to sub program "SMCE" from ILWIS 3.31 (GIS) software.

Factor and constraint maps changed to raster with unique georeference and pixel size.

Criteria tree designed and in every bench of tree, a map inserted.

#### 2.2.4 Standardization

Standardization converts a quantitative image to a new image expressed as standardization scores. Standardization of factors (benefits+ and costs-): output values range between 0 and 1; Standardization of constraints; output values are either 0 or 1. Unlike factor standardization, standardized constraints cannot be compensated by good performance of other criteria. For

Boolean geomorphologic facies map, standardization, "TRUE passes, FALSE will be blocked" was used. This means that all input pixels with value True will be included in the output map; all pixels with value False will be excluded from the output.

### 2.2.5 Weights

Weigh multiple factors (benefits and costs) and optional groups under the main goal, and/or weigh multiple factors and optional groups under a sub goal. Assigning weights is needed in order to indicate the relative importance of these factors with respect to the main goal or to optional sub goals. There are some methods for weighing: Direct Method, Pairwise Comparison, Rank Ordering. Weights are always numbers between 0 and 1. Weighing method in this study was Rank Ordering.

## 3. Result

From combination of factor and constraint raster maps, composite index map (CIM) in range 0 until 1 was generated by SMCE procedure. Near 0 values in this map had the last priority sites and near 1 vice versa. Area of priority 1, 2, and 3 was 240, 286 and 370 ha respectively (Figure 2).

## 4. Discussion and Conclusion

GIS and computer aided to decision makers and stakeholders to composite and analysis multicriteria. There are many factors in this projects that could not be consider all of them without GIS and SMCE. Then decision makers by considering some issues can decide to do project. As figure 2 obviously shows, priority 1 is near to water resource, to village, to road, and to airport more than two other priorities. In this paper, soil conservation priority mapping were developed to show the stakeholders where sites should be consider sooner than other sites and subsequently preparedness against soil erosion disasters. Modeling results for central Iran and desert regions suggest some spatial available factors and method for combination them. According to stakeholder preferences, district capability, government facilities and pixel values in CIM, soil conservation sites were recommended. In results about 18% of study area divided to 3 priorities. First priority for soil conservation included 370 ha. Consequently, a tree model was introduced for solving semi structure problems in arid region of Iran resembling Jamz district that it can help for soil conservation planning quickly and accurately.

## 5. References

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**Figure 1. Jamz district in Yazd Province and in Iran**

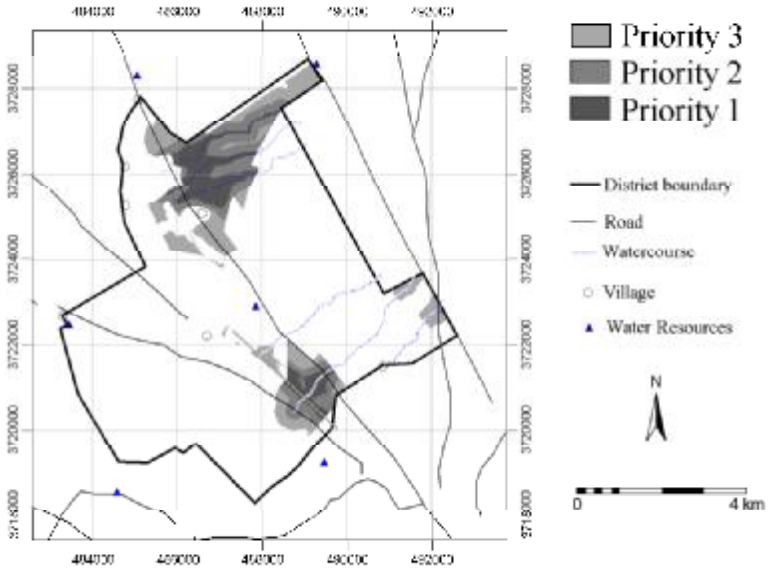


**Figure 2. Classified CIM and spatial priorities of soil conservation**