Agroforestal Suitability Evaluation of a Subregional Area in Portugal Using Multicriteria Spatial Analysis

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International Congress on Landscape Ecology
Understanding Mediterranean Landscapes: Human vs. Nature
23-25 October 2014, Antalya, Turkey

INTRODUCTION

It is generally agreed that the choice of the most suitable uses based in soil and climatic factors, complemented with socio-economic criteria, promotes sustainable use of rural land. Agroforestal management aims to choose the land uses according to soil suitability, contributing to an integrated and economically sustainable use of the land. The unprecedented expansion of human need for resources requires an approach to decisions regarding land use that would ensure the maintenance of biodiversity and sustainable natural resource utilization for the continued delivery of ecosystem services.

Land suitability analysis is an evaluation/decision problem involving several factors. The Analytic Hierarchy Process - AHP is a multi-criteria tool considered to be relevant to nearly any ecosystem management application that requires the evaluation of multiple participants or complex decision-making processes are involved.

This work was intended to search for the suitable areas which can be exploited for agroforestal land uses in the subregion of Beira Interior Sul. In this research, site suitability analysis was carried out using GIS and the AHP as multicriteria decision analysis (MCDA) technique.

METHODOLOGY

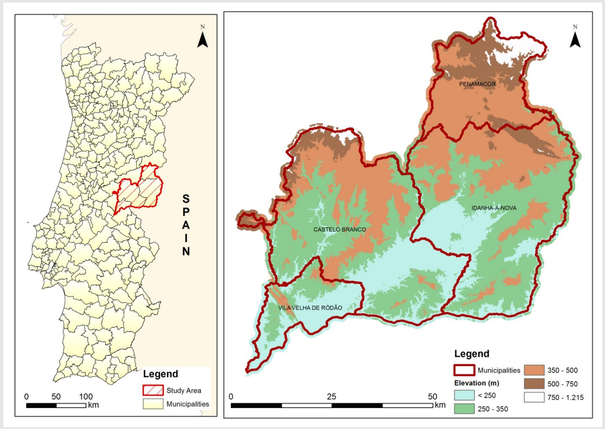

Figure 1: Study area location

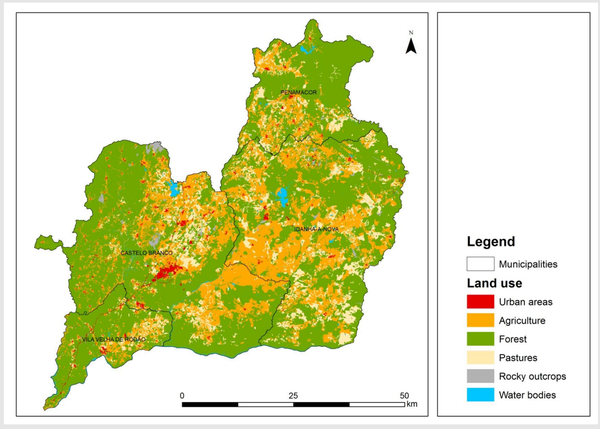

Figure 2: Land use map

The classification of agroforestal suitability resulted from the integration of a set of biophysical criteria using ArcGIS 10.2 software, based on the climate and soil requirements of crops and forest stands and the optimal operating conditions associated with different uses. Geoprocessing and spatial analysis was performed to geographic data, namely soils, elevation in order to produce the following layers: soil potentiality, slope and aspect.

The different layers were classified in three suitability levels: low or no suitability (1), medium suitability (2) and high suitability (3). After creating layers resulting from the reclassification in suitability levels, the general suitability for each land use was performed using the Analytic Hierarchy Process (AHP).

Table 1: Pairwise Rating Scale

Intensity of Importance	1	3	5	~~7~~	9	2, 4, 6, 8
Description	Equal importance of both elements	Weak importance of one element over another	Essential or strong importance of one element over another	Demonstrated importance of one element over another	Absolute importance of one elements over another	Intermediate values between two adjacent judgements

Pairwise comparison is performed based on the rating scale shown in **Table 1**. Two factors are compared using the rating scale which ranges from 1 to 9 with respect to their relative importance. This parameter is computed against each pair based on the opinion of experts.

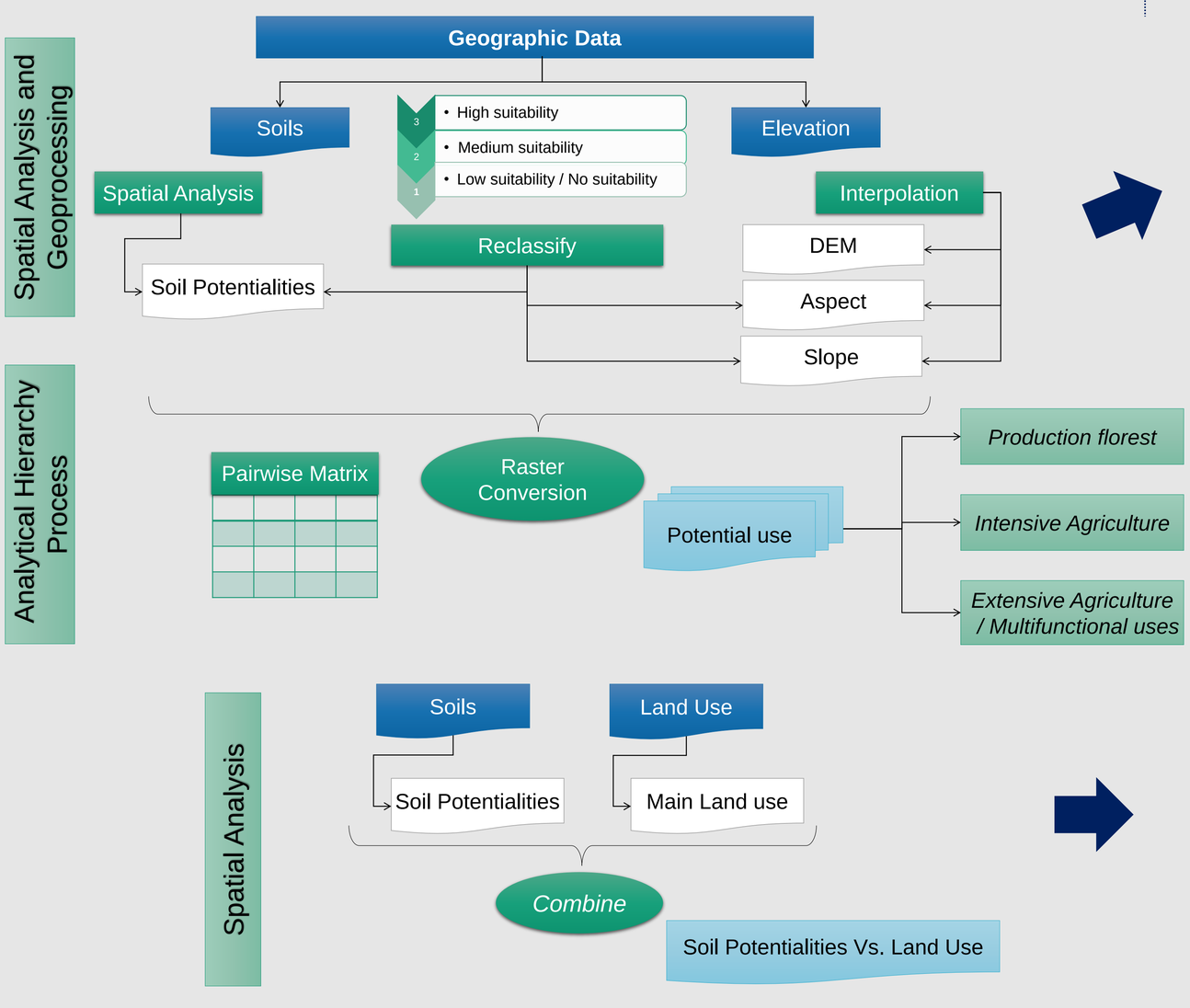

Figure 3: Methodology work flow

RESULTS

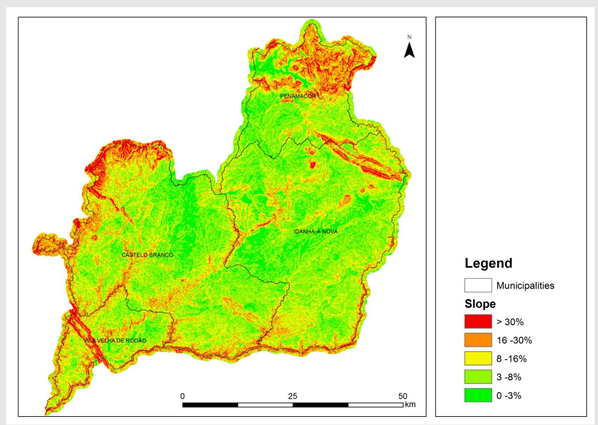

Figure 4: Slope map

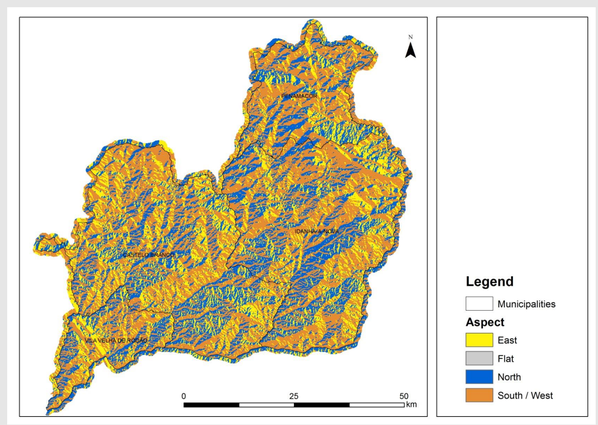

Figure 5: Aspect map

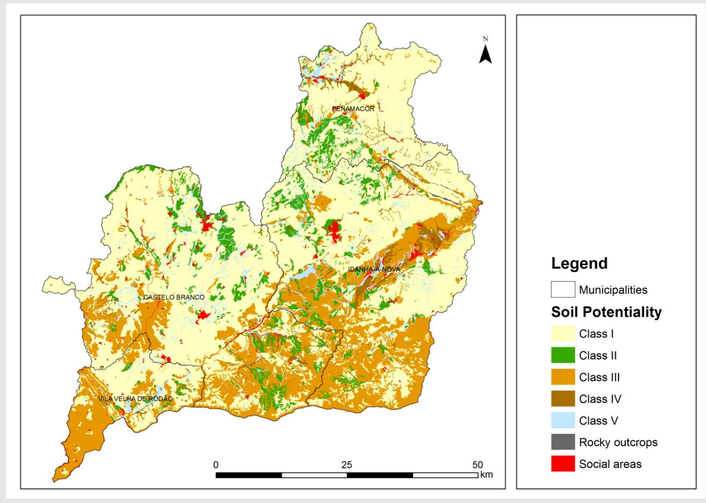

Figure 6: Soil potentiality

Table 2: Soil potentialities

Potentiality class	Soil characteristics	Potential use
I	Different soil types that present high to very high constraints to production uses due to soil thickness, vulnerability to erosion or stoniness. With very low fertility.	Woodland and scrub with soil protection and recovery functions. In some cases, more favorable, pasture under a "montado" system.
II	Soils with coarse texture, without severe erosion problems, generally with low to very low fertility.	Forestry (pineyards and "montado" system), pastures, vineyards. In some cases cereal crops and horticulture if water and organic matter is available.
III	Soils without severe erosion problems. With medium to low fertility.	Cereal crops, horticulture, orchards and improved pastures. Forestry.
IV	Soils without erosion problems. With medium o high fertility.	Cereal crops in intensive mode, orchards, improved pastures and forestry. Soils suitable for olive groves.
V	Soil with high fertility.	Good for different uses depending from drainage, soil texture and availability of irrigation water: irrigations systems. Intensive forestry.
Rocky outcrops	_	Not suitable
Social areas	Urban areas and water bodies	Not suitable

Table 3: Pairwise Comparison Matrix

Criteria	Soil potentiality	Slope	Aspect
Soil potentiality	1	9	7
Slope	1/9	1	5
Aspect	1/7	1/5	1

Table 4: Criteria weights

Criteria	Eigenvalues	Eigenvector of largest Eigenvalue	Weights
Soil potentiality	3,397	0,977	77,91%
Slope	-0,199	0,202	16,10%
Aspect	-0,199	0,075	5,99%

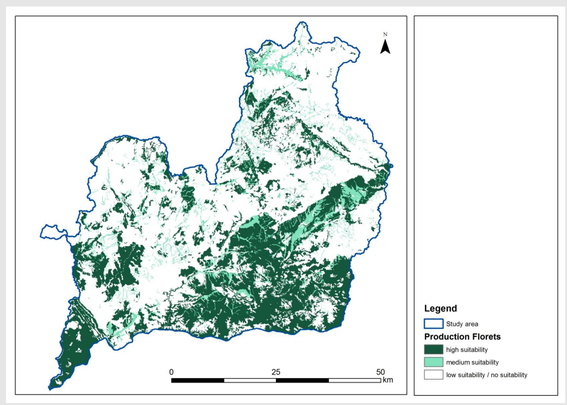

Figure 7: Suitability for production forest

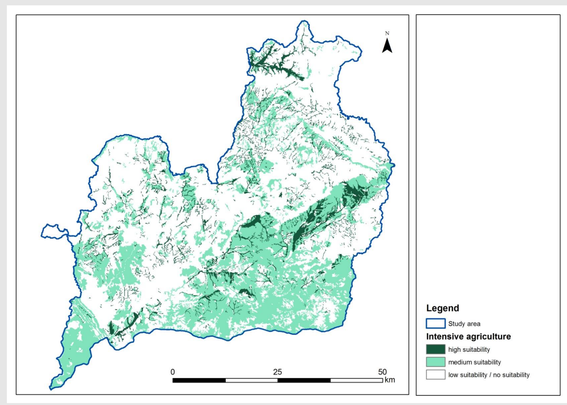

Figure 8: Suitability for intensive agriculture

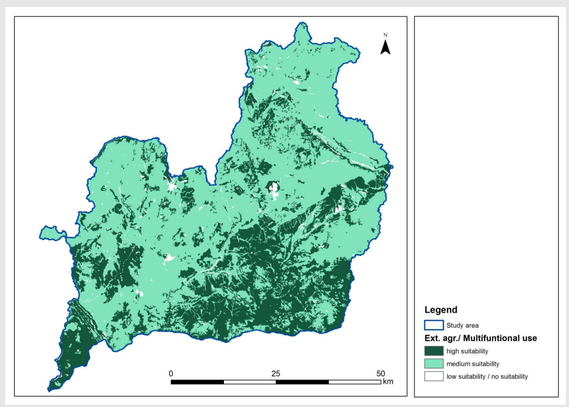

Figure 9: Suitability for extensive agriculture/ Multifunctional use

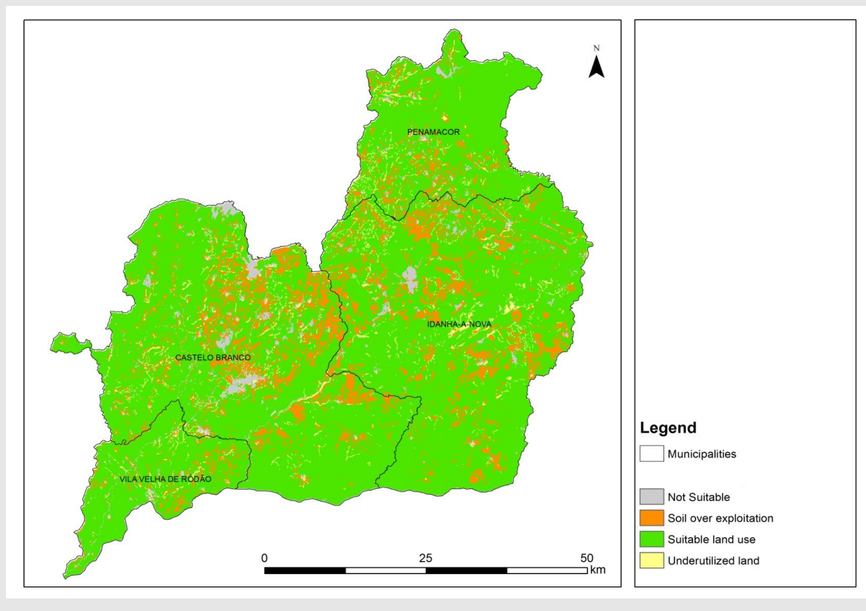

Figure 10: Soil potentiality vs. Land use