

## Case Study | Natural Resource Management

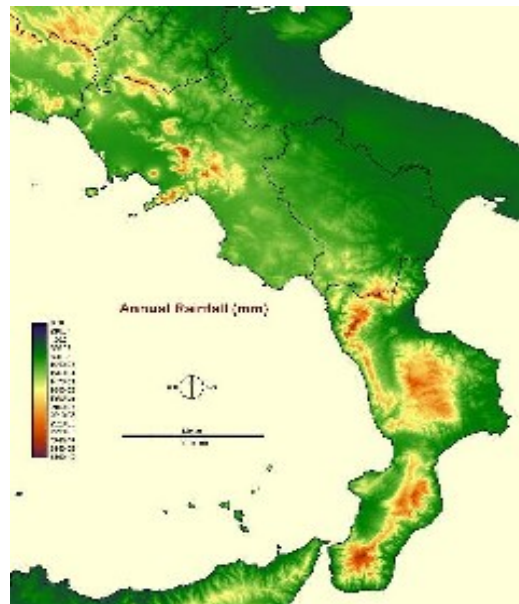
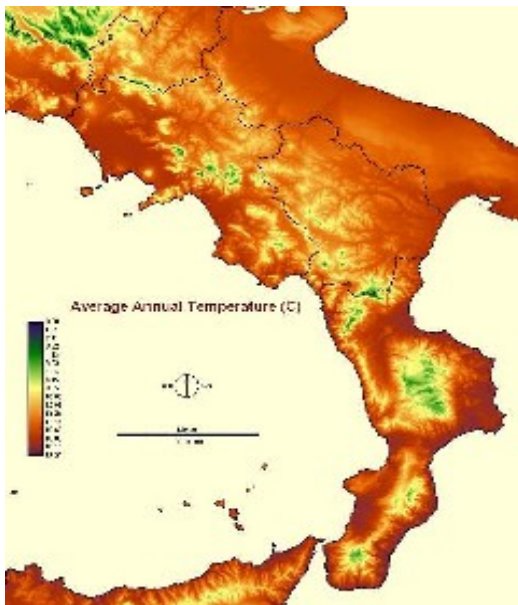
### Multi-Criteria Evaluation Tools in Sustainable Forest Management

The objective of sustainable forest management (SFM) is to ensure the productivity of forest resources over time, taking into consideration the environmental, economic and social values of the forest. Precise information on the extent, condition and productivity of forestry resources is critical for SFM, and remote sensing and GIS-based modeling technologies provide important analytical tools.

Laboratorio di Geomatica at Università di Firenze (Italy) utilized IDRISI Kilimanjaro to develop suitability maps, with a sustainable forest management (SFM) methodology, for the silviculture of *Juglans Regia* (Common Walnut) and *Pseudotsuga Mensiessi* (Douglas Fir) in southern Italy. The project is part of a Multiregional Operative Project and is concerned with the research, monitoring and modeling of forest plantations in Italy.

In a Multi-Criteria Evaluation, an attempt is made to combine a set of criteria to achieve a single composite basis for a decision based on a specific objective. One of the main tasks of this project was to test whether the MCE approach could produce accurate and reliable maps of potential areas for forest plantations. There was also concern about whether available spatial environmental data was adequate for this type of application.

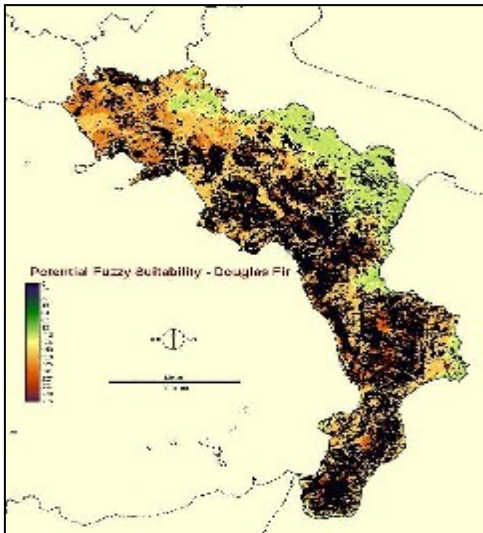
In this case, the criteria were a number of critical environmental requirements identified for each species based on the existing literature. Data on slopes, precipitation, temperature, soil type, distance from coast line and landuse were incorporated. Criteria for MCE may be of two types: factors and constraints. Factors are generally continuous in nature (such as the slope gradient or the soil type factors mentioned above); they indicate the relative suitability of certain areas. Constraints, on the other hand, are always Boolean in character (such as the landuse). They serve to exclude certain areas from consideration.





## Multi-Criteria Evaluation Tools in Sustainable Forest Management (continued)

In order to model the continuous nature of each factor in the land suitability analysis, the FUZZY module was used. This module determines the possibility that each pixel belongs to a fuzzy set. The module requires that a fuzzy membership function be developed for each factor under consideration. The advantage of this approach is that it avoids the traditional Boolean approach of classification, where a pixel either belongs to a class or does not (hard classification). Instead, a series of the factors is created, showing a gradual and continuous transition between suitable and non-suitable areas ranging from 0 to 255 (soft classification). The application of the fuzzy functions for each of the factors allowed the creation of a series of raster maps that reflected their particular importance for the cultivation of each species.



These factors were then aggregated, using the weighted linear combination approach within the MCE module and a suitability value was assigned to each pixel. For the sake of interpretation, the suitability images were hardened by converting the results into Boolean images where 0 = non suitable and 1 = suitable. In order to create these images, the mean ( $m$ ) and the standard deviation ( $s$ ) of the fuzzy distributions were calculated. Areas where the fuzzy values were greater than the  $m + s$  were classified as suitable. Further, regions with areas greater than 5 ha were classified as suitable.

The final results of this project were very encouraging and the Laboratorio di Geomatica is now working with the Italian Academy of Forestry Sciences ([www.aisf.it](http://www.aisf.it)) to implement this approach nationally to map forest areas for wood supply for a project recently funded by the Italian Ministry of Environment.