REMOTE SENSING AND GIS APPLICATION IN SUSTAINABLE DEVELOPMENT: A CASE STUDY OF ISLAND ZAKYNTHOS IN GREECE

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Abstract

The tourism in Greece has for many years been focused on coastal areas although the 70% of the area of Greece is of mountainous or semi-mountainous nature. The development of sustainable mountainous tourism or eco tourism could have positive effects in many socioeconomic factors of these areas. A diversion of tourist pressure from coastal regions to mountain regions could be achieved by the promotion of mountainous natural and cultural heritage. In this work a methodology for the production of detailed cartographical material concerning the mountainous paths and routes is described. The methodology is based in GIS, Remote Sensing and GPS technologies and is focused on the recording, mapping and labelling of mountainous paths and routes. For each path a description of the type of the path, the terrain involved, experience needed, estimated time required and a classification of the paths according to the difficulty is attempted. An easy to use 3-page leaflet is also created and distributed to the tourists A CD-ROM with the relevant information is created and distributed to local authorities and Public Tourist Offices and over the Internet

***Keywords**: sustainable tourism, ecotourism,, Remote Sensing.*

1. Introduction

There is a growing concern for issues related to tourism’s direct and indirect impacts on the environment related to the development, construction and operation of tourism infrastructure as a whole. Since the tourism in Greece is primarily associated with beaches and the sea, there have been - and continue to be - impacts from tourism on the coastal environment. A redirection of tourist pressure from coastal areas to mountainous and semi mountainous areas is therefore necessary and will benefit both coastal and mountainous areas. It is anticipated that it will open up previously disadvantaged areas for further development The key attraction to draw tourists into mountainous areas is primarily being associated with activities that allow visitors to explore and enjoy the breathtaking scenery of these areas.. One of the most popular activities associated with mountains is the walking in long or short distance footpaths and routes. Proper cartographical material that accurate displays the mountainous paths and routes is of great importance for these activities.

The use of sophisticated Information technologies such as Geographic Information Systems (GIS), Remote Sensing (RS) and Global Positioning Systems (GPS) offers many advantages.[1],[2]. Rapid advances are being made in these technologies, and they are becoming available at ever more reasonable costs.

In this paper a procedure for the integration Geographic Information Systems (GIS) Remote Sensing (RS) and Global Positioning System (GPS) technologies is described for capturing analyzing and displaying accurate information about footpaths and mountainous routes. A series of computerized maps is produced based on satellite images, field data and geographic locations.

2. Study area

Zakynthos is the southernmost and third largest in both size and population of the Ionian Islands. It is situated approximately 300 kilometres west of the capital of Greece, Athens. The Zakynthos environment has become an object of international interest because the loggerhead turtle *Caretta-caretta*, an endangered species protected by international conventions and by Greek legislation lays its eggs on the island's southern shores. Also, on the steep western shores of the island the Mediterranean monk seal Monachus-monachus lives and breeds, a species also protected by Greek low. A big part of the coastal region of the Zakyntos has been characterised as Marine Park (birth location of the caretta-caretta turtles which are highly protected marine species). The tourism sector is of major economic importance for local community but an effort is needed that one does not visit Zakynthos only for its beautiful beaches and crystal blue waters. The island also offers a rich endemic flaura [1] and a variety of landscapes including mountains. In the interior of the island, there are many traditional settlements and towns, whose inhabitants are engaged in cultivating traditional crops (olives, vines and vegetables).

3. Data and Methods

Geographical Information Systems are very well suited for cartographical production.[3] A number of topographic features were digitized from Topographic Maps of the Geographic Service of the Army (scale 1:50.000). Topographical data include the coastline, the main and secondary road network, caves, meteorological stations and village polygons (outline of village limits) (Figure 1). A similar procedure was followed in the digitization of the geological maps of the Institute of Geological & Mineral Exploration IGME (scale 1: 50.000) and soil maps(land use and land capability for forestry) Ministry of Agriculture (scale 1: 20.000). Geologic layers (vector) containing the hydrological network, lithological unit boundaries, tectonics (faulting and bedding system) were created. Following the digitization of the maps, georeferencing of them was performed with TNT mips software, by choosing specific GCPs in the corresponding maps and the digitized coastline. A 3D representation of the Zakynthos Island derived by processing of the corresponding Digital Elevation Model (Figure 2).

Every data set has a metadata code, which identifies the source of the data, when the data was collected or measured or monitored or surveyed by the source organization.

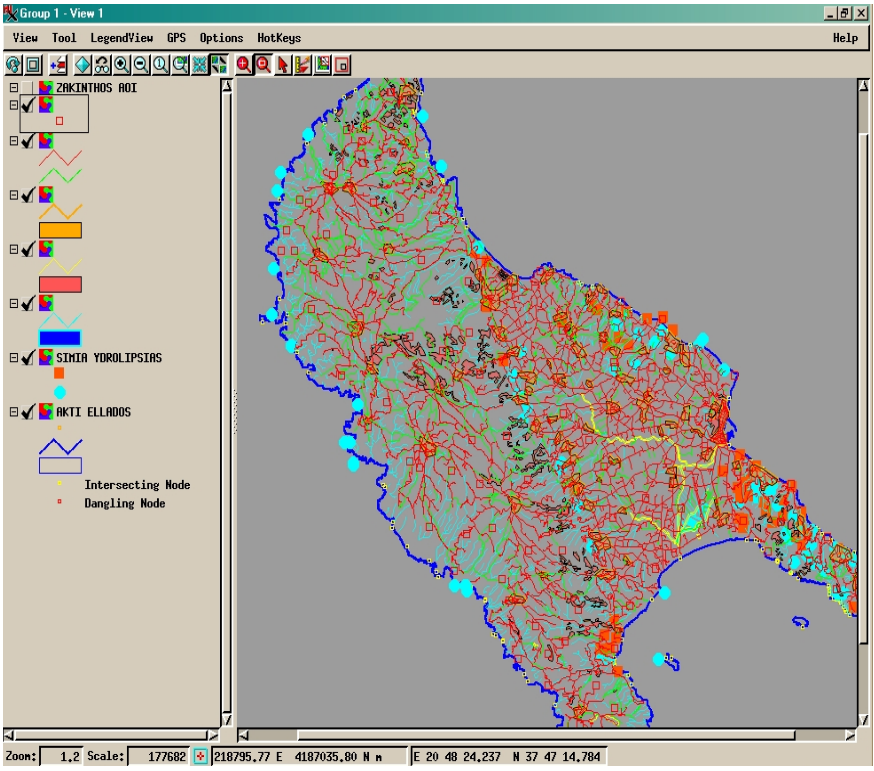

Figure 1:Vector data layers of Zakynthos island include: coastal line, main road network, hydrographic network, position of meteorological stations

Figure 2: The 3D representation of the Zakynthos Island derived by processing of the corresponding Digital Elevation Model

Two Landsat 7 Enhanced Thematic Mapper Plus (ETM+) scenes have been used, with acquisition dates 28/07/1999 and 15/08/2000 respectively .

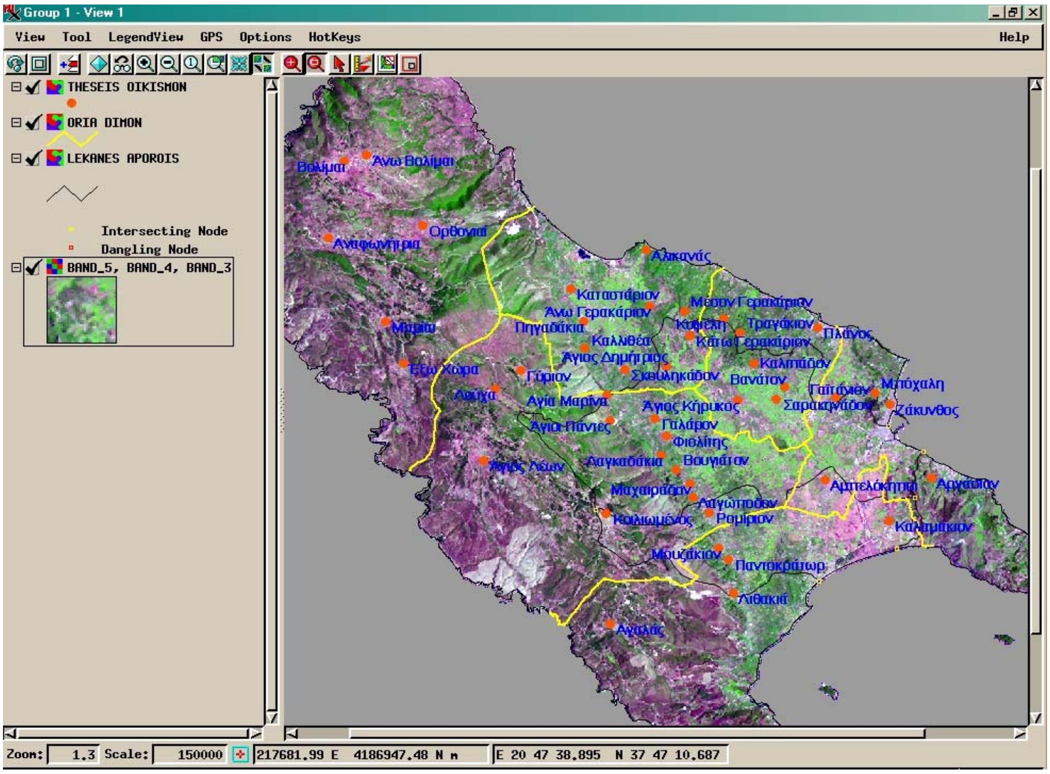

Figure 3: A combination of raster (pseudocolor composite RGB -543 of a Landsat-7 ETM) and vector data (administrative boundaries and water basin boundary in the GIS environment

Various image processing and vector GIS techniques have been used for the analysis of the satellite imagery (Table 1) and results of the application of those techniques are presented in Figure 3.

Processing technique	Result
Georeferencing	Image map output in Hellenic Projection System of 1987
Color Composites	Best combinations for Landsat data are achieved using bands TM 1,3 (or 4) and 5 (or 7) as well as real color composites.
Intensity Hue Saturation HIS Images	Images are enhanced while shadow is suppressed.
Unsupervised classification techniques (Neural networks))	Interpretation of spectral characteristics of images. Easy discrimination of land cover classes. The CORINE landcover nomenclature was adopted.
Automatic conversion of raster to vector data.	Map output. Inform the GIS database with the output vector data
Collection / input / coding, Storage/ Management, Retrieval, Processing / analysis, Presentation / Display, & Map making	Creation of a relational database of the collected data, map making. Evaluation of temporal changes, map updating.

Finally a Global positioning system, or GPS [4] was used to accurate plot footpaths. A complete survey of the Zakynthos footpaths was carried out. A Thales Navigation Mobile Mapper [5] GPS unit with post processing capabilities was used to delineate footpaths and points of interest. Mapping was performed when ideal satellite and PDOP numbers were available. The goal of successful mapping was to have the highest number of satellites combined with the lowest number for the PDOP. The minimum number of satellites that could enable accurate mapping was five. The highest number PDOP allowable for mapping was eight. At the end of each survey, footpath data was uploaded into the computer and exported into the TNT mips GIS and image processing software.

4. Application of the methodology

The above described methodology was applied to 6 case studys in Zakyntos island. For every footpath several maps (Fig. 4, 5, 6) and various diagrams related to the description of the land cover, the landscape, the degree of difficulty (slopes) and distances (Fig 7) were created. All data are organized in a form of an informational Atlas.

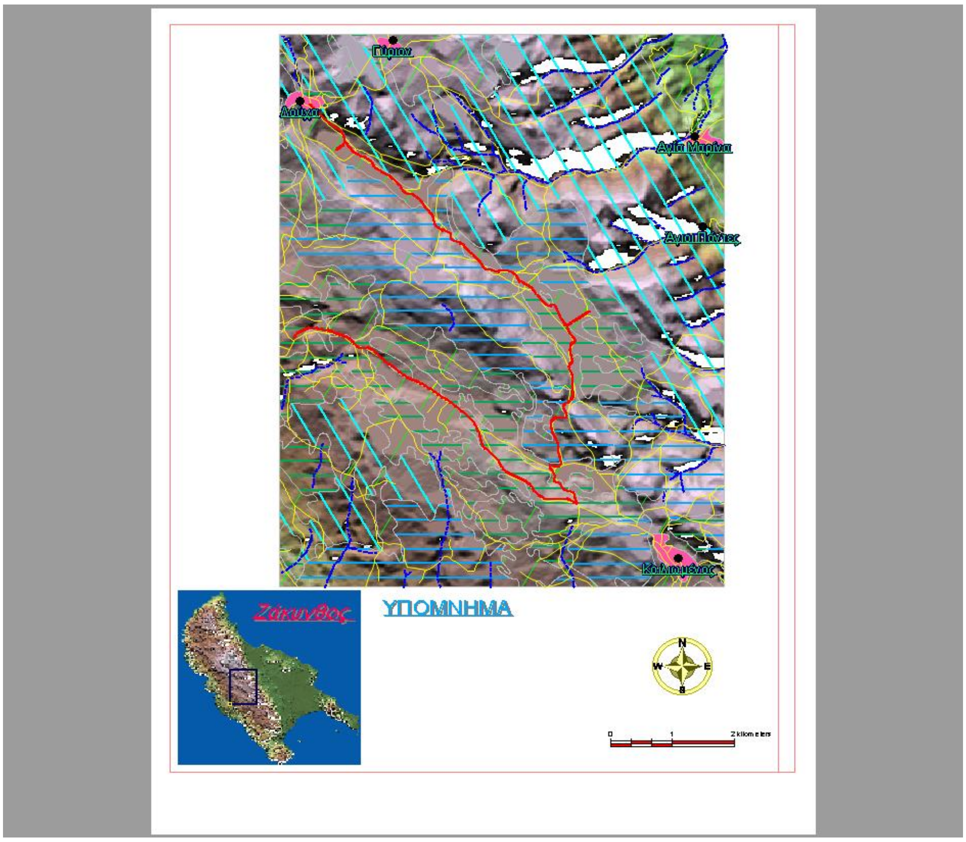

Figure 4: The Koiliomenos-Loucha footpath superimposed on the DEM and the vegetation map.

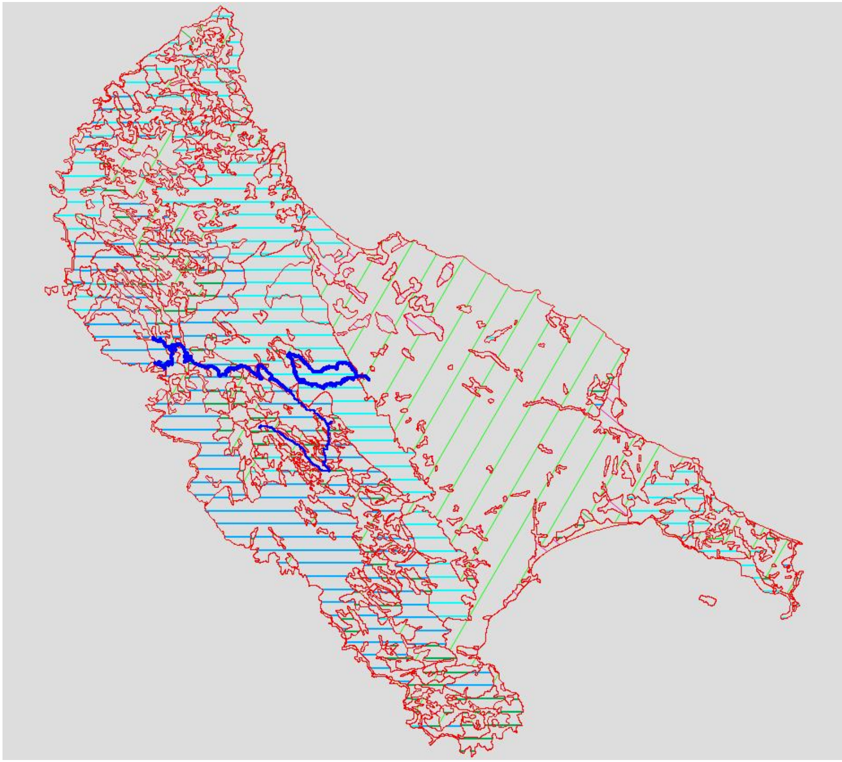

Figure 5: Two footpaths in the mountainous area. Vegetation and villages are also shown

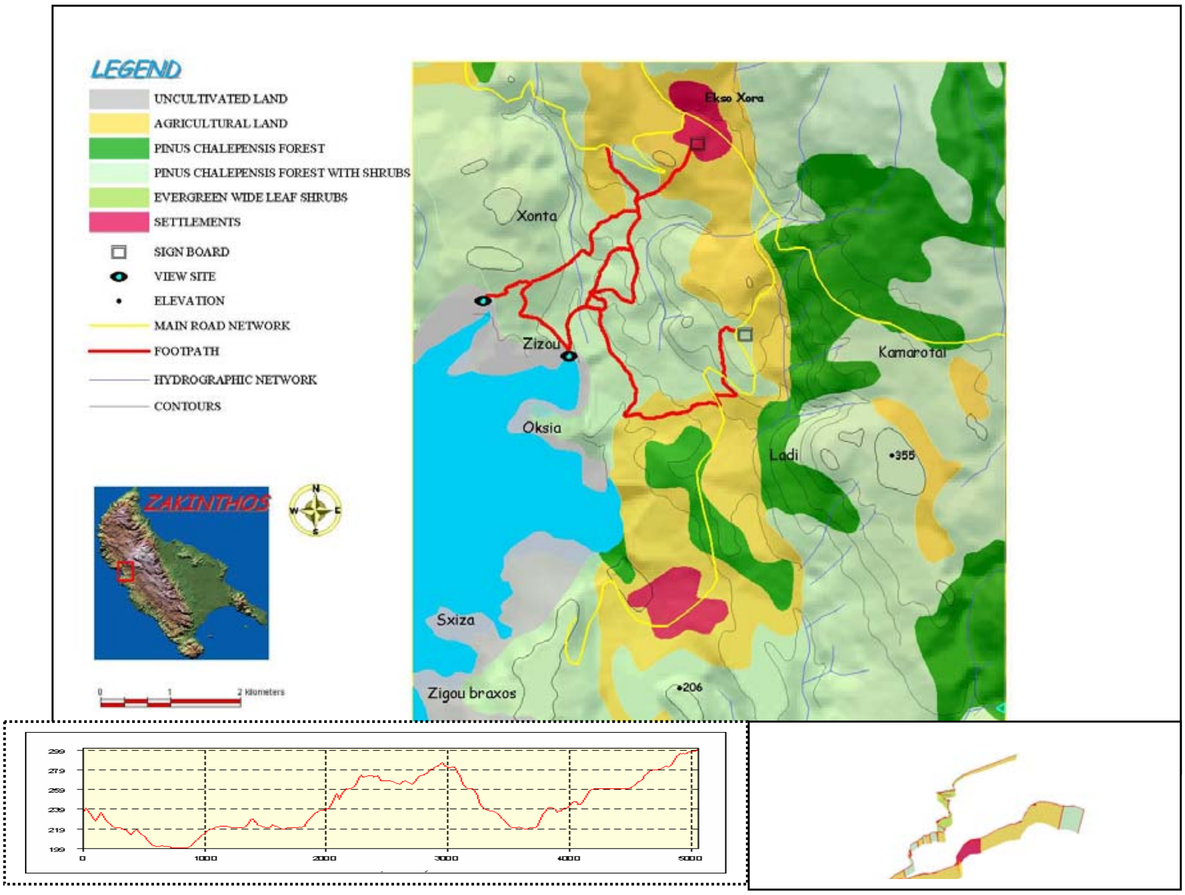

Figure 7: Distance/slope/land cover diagrams

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