Object-oriented image analysis of land cover for multi-temporal monitoring
Case Study: Zakynthos Island, Greece

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ABSTRACT:

The earth surface and human activities are interrelated in a complicated manner, and therefore it is somehow difficult to be monitored and managed. On this context it is required to develop effective directives of policies for environmental protection and management. These policies are rationally instituted by decision-makers, which take into serious consideration the output of appropriately designed geoinformation systems. Such environmental geoinformation systems contain adequate environmental information, such as land cover maps, images, elevation data, topographic data, geologic data, vegetation and forestry data, urban maps, demographic data, man-made activities, etc., in order to assist governmental and local administration services to form environmental strategies. This work is a part of the design of an integrated geoinformation system. The case study is Zakynthos Island, which is of very high ecological interest, once it is stated as an environmentally protected area according to the corresponding European Community Directives (birth location of the caretta-caretta turtles (highly protected marine species)). For the design of such an integrated geoinformation system, appropriate thematic maps shall be derived, which monitor potential changes of the environmental condition of the island. In this context, a knowledge-based scheme is proposed for the identification and classification of the inherent land cover classes. The main purpose of this scheme is to be repeatedly used for multi-temporal land cover change detection. The results derived from this scheme are compared to the results derived from other land cover classification schemes using neural networks and other classification methods, so as to estimate the appropriateness of each applied methodology and to assess its usefulness for change detection monitoring. The proposed scheme generally consists of the following stages: **(1)** Remote Sensing methods and analysis, **(2)** Data introduction and segmentation, and **(3)** Object-oriented knowledge base design and classification of the intrinsic land cover classes. Remote Sensing employs data pre-processing and main processing techniques, which are applied on LANDSAT images of Zakynthos Island, Greece, acquired on 1999 and 2000

respectively. The satellite images are orthorectified, geometrically co-registered and radiometrically corrected in order to eliminate the path radiance. Pseudo-colour composites (e.g. RGB-431 and 753) are used on the Aster and the Landsat images, in order to emphasize the features of interest, such as discriminated vegetation from barren soil, vegetation vigor areas, and burnt areas. Normalized Difference Vegetation Index (NDVI), Selected Principal Component images (PCIs) and ISODATA unsupervised classification are applied for the discrimination of vegetation vigor, of different lithological sub-types and for the accentuation of tectonic characteristics. An unsupervised classification method using Neural Networks (the ANN method) is used on the satellite images in order to discriminate and spectrally cluster all inherent land cover classes. Textural analysis using Haralick texture metrics is performed for extracting certain features of interest, which result in high values in certain texture metrics (e.g. roads, or urban areas). The input data layers to the land-cover identification system are:

(a) Topographic data (scale 1:50,000)

(b) Elevation data (in a form of a DEM or contours)

(c) LANDSAT satellite images of the Zakynthos Island.

(d) Scanned forestry maps (scales 1:20,000 and 1:50,000)

(e) Geologic layers (vector) containing the hydrological network, lithological unit boundaries, tectonics (faulting and bedding system), (f) The road network (g) Man-made activities, (h) Administrative boundaries and annotation. (i) Thematic maps derived from remote sensing methods and analysis, such as vegetation maps, texture maps, etc. Data segmentation is based on the multi-scale hierarchical segmentation algorithm proposed by Baatz and Schäpe (1999) for the extraction of primitive objects to be classified into the inherent land cover classes during the classification process. Finally, the design of the knowledge base is based on the creation of classes / sub-classes of the scene. Intrinsic spectral and geometric attributes, texture, spatial context and association are determined for the designed object classes / subclasses on each segmentation level, and fuzzy membership functions and Nearest Neighbor Classification were utilized for the assignment of primitive objects into the desired classes combining all participating levels of hierarchy. The output result of the system is a classified land cover map containing the inherent land cover classes of the study area, including classes of diverse vegetation density, burnt forest areas, urban classes, barren soil, forestry with present tree species, sea, road network, geologic and topographic features, etc. Finally, the output land cover map from the knowledge-based land cover identification system is compared to the classification outputs, stemmed from the application of Neural Networks and other classification methods in order to estimate the best fitted method for multi-temporal change detection.

REFERENCES:

1. Baatz, M. and A. Schäpe (1999): "Multiresolution segmentation – an optimization approach for high quality multi-scale image segmentation", in Strobl, Blaschke and Greisebener (Editors): *Angewandte Geographische Informationsverarbeitung*, *XI. Beiträge zum AGIT-Symposium*, Salzburg, Karlsruhe,Herbert Wichmann Verlag, pp. 12-23.