LAND COVER CLASSIFICATION IN ALBANIA

Pal Nikolli

Tirana University, Faculty of History and Philology, Department of Geography, Tirana, Albania - palnikolli@yahoo.com

KEY WORDS: land cover, classification, classification system, standardization, harmonization, Albania

ABSTRACT:

Land is one of our most precious assets, and its use is multi-faceted. Land cover and land use are, however, dynamic, and are affected both by natural phenomena, such as climatic events and natural disasters, and by human activities, although the impact of the latter has mainly been felt in the more recent centuries.

The Land Cover Classification System (LCCS) is a comprehensive, standardized a priori classification system, designed to meet specific user requirements, and created for mapping exercises, independent of the scale or means used to map. Any land cover identified anywhere in the world can be readily accommodated.

This article examines the land cover classification in Albania using the FAO/UNEP Land Cover Classification System for codification of classes. For this classification is used satellite remote sensing data. The aim of the land cover classification is to investigate the land cover transformations in the whole territory of Albania.

1. INTRODUCTION

Land cover is a geographical feature which may form a reference base for applications ranging from forest and rangeland monitoring, production of statistics, planning, investment, biodiversity, climate change, to desertification control. Better assessment of the changes of land cover by using digital analysis of remote sensing satellite data can help decision makers to develop effective plans for the management of land (Gordon, 1980; Milington et al., 1986; Franchek and Biggam, 1992).

Land cover classes are defined by a combination of a set of independent diagnostic criteria - the so-called classifiers - that are hierarchically arranged to assure a high degree of geographical accuracy. Because of the heterogeneity of land cover, the same set of classifiers cannot be used to define all land cover types. The hierarchical structure of the classifiers may differ from one land cover type to another.

One of the prime prerequisites for better use of land is information on existing land use patterns and changes in land use through time.

In Albania land cover classification, comprise three levels:

- the first level (five items) indicates the major categories (abstract to a greater or lesser degree) of land cover on the planet;
- the second level (15 items) is for use on scales of 1:500 000 and 1: 1 000 000;
- the third level (44 items) will be used for the project on a scale of 1: 100 000.

Knowledge of the present distribution and area of such agricultural, recreational, and urban lands, as well as information on their changing proportions, is needed by legislators, planners, and State and local governmental officials to determine better land use policy, to project transportation and utility demand, to identify future development pressure points and areas, and to implement effective plans for regional development. As Clawson and Stewart (1965) have stated: In this dynamic situation, accurate, meaningful, current data on land use are essential.

The framework of a national land cover classification system is presented for use with remote sensor data. The classification system has been developed to meet the needs of State agencies for an up-to-date overview of land use and land cover throughout the country on a basis that is uniform in categorization at the more generalized first and second levels and that will be receptive to data from satellite and aircraft remote sensors.

2. GEOGRAPHIC POSITION OF ALBANIA

Republic of Albania is situated on the west of Balkan Peninsula on the eastern littoral coasts of Adriatic and Jonnian seas (fig. 1.1).

It is situated in the north geographical latitude 42^0 39' (Vermosh), south geographical latitude 39^0 38' (Konispol) and eastern geographical longitude 21^0 40' (Vernik), west geographical longitude 19^0 16' (Sazan). Republic of Albania borders the Montenegro and Kosovo to the north and northeast, the Former Yugoslav Republic of Macedonia to the east, and Greece to the south. Its western coast faces the Adriatic and Ionian Seas. Albania has a total area of 28,748 square kilometres. Its coastline is 362 kilometres long and extends along the Adriatic and Ionian Seas. The lowlands of the west face the Adriatic Sea. The 70% of the country that is mountainous is rugged and often inaccessible from the outside. The length of the border is 1094 km where 657 km are land, 48 km river, 73 km lake and 316 km littoral border The north - south extension is 340 km, east - west 148 km and over the sea level 2751 m (mountain of Korab).

The relief mainly hilly - mountainous is significant for the various forms, big contrasts. Until 200 m over the sea level lays 23.4 % of the country. The altitudes 200 - 1000 m include 48.1 % and over 1000 m include 28.5 % of the Albanian territory.

Plain field areas suitable for the intensive agricultural development and without erosion problems are few and situated on the west. The rest hilly part which lifts up gradually toward east offers possibility for the

In: Wagner W., Székely, B. (eds.): ISPRS TC VII Symposium – 100 Years ISPRS, Vienna, Austria, July 5–7, 2010, IAPRS, Vol. XXXVIII, Part 7B

Contents   Author Index   Keyword Index

development of the fruit bearing, stock breeding, tourism etc.

Fig. 1.1. Albania on the west of Balkan Peninsula

The climate is Mediterranean on the west. Inside the country are appeared the influences of the continental phenomenons in the climate while in height the alpine ones. Summer, in general, is hot and dry, while the winter is wet. The period with equal or higher temperature than 10^0 C changes from 260 to 300 days in a year. In general there precipitate average 1480 mm in a year. But the average annual quantity of the precipitation changes from 600 mm to 2100 mm. There are met 2000 - 2700 hours with sun radiation. The extraordinary meteorological situations which are accompanied with economical damages happen rather often.

Albania is rich with water richness. It is traversed by a hydrographical network with general length over 49 000 km and mean density 1.7 km/km². The annual volume of the water quantity of the rivers arrives 41.2 km³. Main rivers are Buna and Drin with average discharge 680 m/sec, Vjosa 195 m³/sec, Mati 103 m³/sec, Seman 95 m³/ sec. It has parts of the big tectonic lakes (Shkodra, Ohri and Prespa), glacial lakes (about 30), charstic ones (80), littoral (10) and artificial (700). It is rich with underground water and big karstic springs, mineral springs and thermo mineral ones. Some of the rivers, parts of the littoral and some lakes are polluted by the industrial, agricultural and urban wastes.

Vegetation world is various. There are 3250 kinds of natural plants, which constitute 29 % of the total number grown in Europe and 47 % of the Balkan plants. In Albania are met plants of different regions such as: Mediterranean, north Balkanic, alpine - Carpathian, central of Europe, euroaziatics. etc. 1 % of the Albanian vegetation is endemic

and 5 % is sub endemic. There are four vegetation belts (Mediterranean shrubs, oaks, beeches and conifers, alpine in pastures).

About 35 % of the territory is occupied by the forests, from which to every person belongs 0.3 ha. The high forests occupy about 47 % of the forest area, low forest 29 % and shrubs 24 %. About 10 000 ha forest are proclaimed national parks. The wild world is rich with many kinds of animals, even rare ones (grey dark bear, wild cat and goat, pelican, etc). As we see the country is significant for the biodiversity but is damaged a lot by the man's activity.

3.   LAND COVER CLASSIFICATION SYSTEMS

Classification is an abstract representation of the situation in the field using well-defined diagnostic criteria: the classifiers. Sokal (1974) defined it as: "the ordering or arrangement of objects into groups or sets on the basis of their relationships." Classification is one of the most important steps in handling remote sensing imagery and represents important input data for geographic information systems (GIS) (Oštir 2006)

A classification describes the systematic framework with the names of the classes and the criteria used to distinguish them, and the relation between classes. Classification thus necessarily involves definition of class boundaries that should be clear, precise, possibly quantitative, and based upon objective criteria. Land cover classes are defined by a string of classifiers, but due to the heterogeneity of land cover, and with the aim of achieving a logical and functional hierarchical arrangement of the classifiers, certain design criteria have been applied.

A classification should therefore be:

- *Scale independent,* meaning that the classes at all levels of the system should be applicable at any scale or level of detail; and
- *Source independent,* implying that it is independent of the means used to collect information, whether satellite imagery, aerial photography, field survey or some combination of them is used.

Classification systems come in two basic formats, *hierarchical* and *non-hierarchical*. Most systems are hierarchically structured because such a classification offers more consistency owing to its ability to accommodate different levels of information, starting with structured broad-level classes, which allow further systematic subdivision into more detailed sub-classes. The Land Cover Classification System (LCCS) that is used for land cover in Albania is in the format hierarchical.

4.   LAND COVER CLASSIFICATION SYSTEM IN ALBANIA

4.1. USING LAND COVER

The words about land/terra/ground that are used until now in Albanian literature, are: "geography", "land/ground", "topographic elements of land/ground ", "geographic environment" "geographic landscape",

In: Wagner W., Székely, B. (eds.): ISPRS TC VII Symposium – 100 Years ISPRS, Vienna, Austria, July 5–7, 2010, IAPRS, Vol. XXXVIII, Part 7B

Contents | Author Index | Keyword Index

"geographic surface" etc. The above words are from deferent source and diverse and frequently contradictory.

The Land cover/land use concepts are used in Albania after 1990 year. After this year, land cover/use concepts are analysed and actual land cover/classification in Albania is revised by international standards. Land Cover Classification System (LCCS) is in response to the international need for:

- harmonized/standardized collection of land cover data;
- availability of land cover data for a wide range of applications and users;
- comparison and correlation of land cover classes.

LCCS is a comprehensive methodology for the description, characterization, classification and comparison of most of land cover features identified anywhere in the world, at any scale or level of detail. LCCS is a new language to describe, in a standardized way, the different land cover features. Albania involved with LCCS.

The LCCS is an existing, internationally accepted and widely implemented de facto UN standard, and while it accepts considerable re-organization of its structure as an ISO standard -its existing specifications and LCCS classifiers must be retained within the ISO technical enhancements.

4.2. CLASIFICATION OF LAND COVER.

Today, after international standardisation, land cover classification in Albania, as set out below, comprises three levels:

- the first level (five items) indicates the major categories (abstract to a greater or lesser degree) of land cover on the planet;
- the second level (15 items) is for use on scales of 1:500 000 and 1: 1 000 000;
- the third level (44 items) will be used for the project on a scale of 1: 100 000.

A fourth level could be added for some or all of the items, subject to the following requirements:

- additional items must include all the land covered by the corresponding level-3 item (four-figure codes are used for these items only);
- newly created items not relate to more than one three-figure item;
- the land cover mapping (three-figure nomenclature) must be completed prior to initiation of level-4 mapping.

At each level the defined classes are mutually exclusive. At the higher levels of the classification system few diagnostic criteria are used, whereas at the lower levels the number of diagnostic criteria increases. Criteria used at one level of the classification should not be repeated at another, i.e., lower, level (tab 3.2.2).

Finally, care must always be taken to see that newly created items are compatible with the scale, the size of the smallest area to be mapped and the basic information, i.e. satellite data.

Tab 3.2.2

Level 1	Level 2	Level 3
1.Artificial	1.1. Urban fabric	1.1.1. Continuous urban fabric surfaces
		1.1.2. Discontinuous urban fabric
	1.2. Industrial,	1.2.1. Industrial or commercial units and
	commercial	transport units
		1.2.2. Road and rail networks and associated land
		1.2.3. Port areas
		1.2.4. Airports
	1.3. Mine, dump	1.3.1. Mineral extraction sites and construction sites
		1.3.2. Dump sites
		1.3.3. Construction sites
	1.4. Artificial non-agricultural	1.4.1. Green urban areas vegetated areas
		1.4.2. Sport and leisure facilities
2. Agricultural	2.1.Arable land	2.1.1. Non-irrigated arable land areas
		2.1.2. Permanently irrigated land
		2.1.3. Rice fields
	2.2. Permanent crops	2.2.1. Vineyards
		2.2.2. Fruit trees and berry plantations
		2.2.3. Olive groves
	2.3. Pastures	2.3.1. Pastures
	2.4. Heterogeneous	2.4.1. Annual crops associated with permanent crops agricultural areas
		2.4.2. Complex cultivation
		2.4.3. Land principally occupied by agriculture, with significant areas of natural vegetation
		2.4.4. Agro-forestry areas
3. Forests and semi-natural areas	3.1. Forests	3.1.1. Broad-leaved forest
		3.1.2. Coniferous forest
		3.1.3. Mixed forest
	3.2. Shrub and/or herbaceous	3.2.1. Natural grassland vegetation association
		3.2.2. Moors and heathland
		3.2.3. Sclerophyllous vegetation
		3.2.4. Transitional woodland shrub
	3.3. Open spaces with little	3.3.1. Beaches, dunes, and sand plains or no vegetation
		3.3.2. Bare rock
		3.3.3. Sparsely vegetated areas
		3.3.4. Burnt areas
		3.3.5. Glaciers and perpetual snow
4. Wetlands	4.1. inland wetlands	4.1.1. Inland marshes
		4.1.2.Peatbogs
	4.2. Coastal wetlands	4.2.1. Salt marshes
		4.2.2. Salines
		4.2.3. Intertidal flats
5. Water bodies	5.1. Inland waters	5.1. 1. Water courses
		5.1.2. Water bodies
	5.2. Marine waters	5.2.1. Coastal lagoons

In: Wagner W., Székely, B. (eds.): ISPRS TC VII Symposium – 100 Years ISPRS, Vienna, Austria, July 5–7, 2010, IAPRS, Vol. XXXVIII, Part 7B

Contents   Author Index   Keyword Index

| | | 5.2.2. Estuaries |
| | | 5.2.3. Sea and ocean |

4.3. LAND COVER CLASSIFICATION USING REMOTE SENSING TECHNIQUES

Everything on earth is changing with time. Land cover map can be a powerful tool to compare the changes of an area over time. It is impossible to cover a large area in short time through manual survey but with remote sensing (land cover map) it is an easier task.

With land cover map it can be revealed how mach area of cities of Albania is using for what purpose, what are the pattern of land use change over time etc. which will help the policy makers to take necessary measure to ensure sound physical environment of the city etc.

Land cover maps constitute necessary tools for development planning and management of the territory. Furthermore, land cover maps depicting the current reality are essential in countries where, due to political changes, rapid dynamic phenomena have taken place, resulting in a complete restructuring of the agricultural and other sectors, as in the case of Albania.

For optimal use, land cover maps should be in digital format, which allows easy updating, and associated with a GIS including other information such as soil units, erosion features and provincial/municipal boundaries. The resulting database is an essential tool for decision-making in land management.

But, before the creation of land cover map, it is necessary to have land cover classification (LCCS) (fig. 3.3.1).
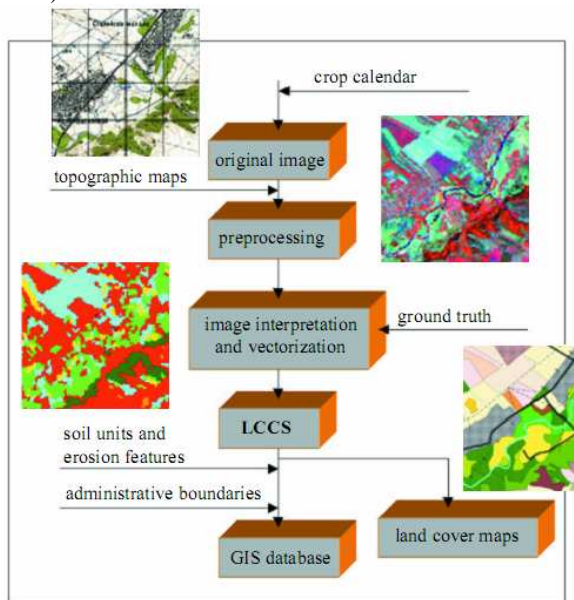

Fig. 3.3.1. The place of LCCS in methodological approach of land cover maps creation

Today, land cover classification based in use of satellite image data. The operational availability of high-resolution satellite imagery, namely Landsat TM, SPOT, Soyouz, ERS-SAR, RADARSAT and others, opens up new possibilities for investigating and monitoring natural resources.

Satellite imagery is recorded in various wavelengths, visible and non-visible, which provide accurate information on ground conditions. Each object has unique and different characteristics of reflection or emission in different environment. An object and it's environmental condition can be identified using reflected or emitted electromagnetic radiation from that object.

The use of satellite image is popular world wide but its application is limited in Albania. However a land cover classification in our study is done. The classes were: 1. Vegetation; 2. Built-up Area; 3. River/Deep Water; 4. Shallow Water; 5. Open Ground

LANDSAT TM image was used for this study (table 3.3.1).

Table 3.3.1: Wavelength and application of LANDSAT TM bands

Band	Wavelength (μm)	Application
1	0.45-0.52	Coastal water mapping, soil vegetation differentiation, deciduous, coniferous differentiation
2	0.52- 0.60	Green reflectance by healthy vegetation, excellent for pollution studies.
3	0.63-0.69	Chlorophyll absorption for plant species differentiation identifies contrast between the vegetation classes.
4	0.76-0.90	High reflectance for the vegetation, urban areas less reflective than the vegetation. Soil-crop and land-water contrasts are emphasized.
5	1.55-1.75	Important for the crop identification, crop water content and soil moisture content.
6	10.4-12.5	Hydro thermal mapping
7	2.08-2.35	Plant heat stress

The properties of the image were:
• Image Sensor: LANDSAT TM
• Image Format: BIL
• Number of Lines: 2185
• Number of Pixels per Line: 1441
• Spatial Resolution: Band 1-5, 7 30m x 30m and band 6 120mX120m
• Spectral Resolution: 7 BANDS (1, 2, 3, 4, 5, 6, 7)

Geocoding Wizard of ER Mapper was used for image registration and for registration, rectification and image classification the source image was converted from ERDAS LAN format to ER Mapper ERS format. The parameters of geocoding were:

Geocoding type: Polynomial
Polynomial order: Linear
GCP picking method: A pre registered image of the area.

The procedure of image enhancement makes it easy to identify and select ROIs (Region of Interest). In this study linear stretching and filter operations was performed for image enhancement.

In: Wagner W., Székely, B. (eds.): ISPRS TC VII Symposium – 100 Years ISPRS, Vienna, Austria, July 5–7, 2010, IAPRS, Vol. XXXVIII, Part 7B

Contents   Author Index   Keyword Index

Source image (LANDSAT TM) of this study contained 7 spectral bands. For display purpose 3 bands were selected which helped selection of training areas. For this study R: 7 G: 4 B: 3 were found suitable.

In training stage location, size, shape and orientation of each pixel type for each class was analysed to categories the satellite image accordingly. Some regions have been selected from Mirdita (district of Albania) area for five land cover class through training process.

In classification stage each pixel was categorised into land cover class to which it closely resembles. If the pixel was not similar to the training data, then it was labelled as unknown. Supervised classification of ER Mapper was used for image classification. 'Minimum Distance Classification' was used as it gave best result among all supervised classification available in ER Mapper. The land cover was classified according to the FAO Land Cover Classification System (LCCS) (Di Gregorio, A., & Jansen, L.J.M. 1996, 1997), a comprehensive, standardized *a priori* classification system, created for mapping exercises and independent of the scale or mapping method. The classification uses a set of independent diagnostic criteria that allow correlation with existing classifications and legends. The system could therefore serve as an internationally agreed reference base for land cover. The methodology is applicable at any scale and is comprehensive in the sense that any land cover identified anywhere in the world can be readily accommodated.

Soil types and erosion features, obtained from traditional sources, will linked to each land cover mapped unit as attributes into a GIS system. This results in a comprehensive database, which provides useful information for agriculture, forestry and urban development planning, for environment protection, and for many other applications. The data collected in the database allow for different kinds of spatial analyses, which are necessary in land management. As the database developed using ArcView, a common GIS software package, it will be easy to combine the database with other data sets, existing or in preparation, for a variety of different applications.

5. CONCLUSSIONS

In context of Albania, Remote Sensing technology is an non well unexplored field. By using this rarely used tool a land cover classification of Albania was done. LANDSAT TM image was used for this study. The land cover was classified according to the FAO Land Cover Classification System (LCCS).

REFERENCES

1. Di Gregorio, A., & Jansen, L.J.M. 1996. FAO Land Cover Classification System: A Dichotomous, Modular-Hierarchical Approach. Paper presented at the Federal Geographic Data Committee Meeting - Vegetation Subcommittee and Earth Cover Working Group, Washington, 15-17 October 1996.

2. Di Gregorio, A., & Jansen, L.J.M. 1997. A new concept for a land cover classification system. Proceedings of the Earth Observation and Environmental Information 1997 Conference. Alexandria, Egypt, 13-16 October 1997.

3. FAO. 1995. Planning for sustainable use of land resources. Towards a new approach. *FAO Land and Water Bulletin* No. 2.

4. http://www.fao.org/docrep/003/x0596e/x0596e00.htm

5. Meyer, W.B., & Turner II, B.L. 1992. Human Population Growth and Global Land Use/Land Cover Change. pp. 39-61, in: *Ann. Rev. Ecol. Syst.*, No. 23.

6. Mueller-Dombois, D., & Ellenberg, J.H. 1974. *Aims and Methods of Vegetation Ecology*. New York and London: John Wiley.

7. Nasreen, I.K., 1999: Present status of geoinformatics technology in Bangladesh: special Nègre, T. 1995. Report of the Preparatory Mission: Outlines for the Africover Classification System. Draft document. FAO, Rome.

8. Nghia C.X., 1999, Results of afforesting protective forest in the sand areas, *Journal of agriculture and development of rural area,* Vol 9, Ha Noi, 13-14. oi.

9. Olaf B. and Uta S., 2002. Development and perspectives of landscape ecology, Kluwer Academic Punlishers, Netherlands. *Operationalization of Remote Sensing, ITC*.

10. Oštir, K., 2006: *Daljinsko zaznavanje.*- Založba ZRC, p. 250, Ljubljana.

11. Reichert, P., & Di Gregorio, A. 1995. Preparation of a forest cover map and reconnaissance forest inventory of Albania. Technical Report of FAO Project GCP/ALB/002/IDA. *Remote Sensing Journal* 2(2), 33-41.

12. Sokal R. 1974. Classification: purposes, principles, progress, prospects. *Science* 185 (4157): 1115-1123.

13. Clawson, Marion, and Stewart, Charles L., 1965, Land use information. A critical survey of U.S. statistics including possibilities for greater uniformity: Baltimore, Md., The Johns Hopkins Press for Resources for the Future, Inc., 402 p.

14. Gordon, S., 1980. Utilizing Landsat imagery to monitor land use change: A case study in Ohio. Remote Sensing of Environment, 9, pp. 189-196