ENVIRONMENTAL LEGISLATION COMPLIANCE MAPS AT NATIONAL LEVEL: THE GREEK FOREST LAW CASE

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KEY WORDS: Buildings, Change detection, Edge extraction, Image processing, Interpretation, Land use / Land cover, Monitoring, Remote Sensing.

ABSTRACT

This paper investigates the possibility of producing reliable Environmental Legislation Compliance Maps at National level, by means of Earth Observation data and their appropriate processing and analysis using remote sensing methods and techniques. Research has been implemented and evaluated on the Greek Forest Law application.
An analysis of the Greek Forest Law indicated eight different law categories in which Environmental Legislation Compliance Maps could reliably be used: forests and forest areas; land-use planning and extension of city plans; fencing of private forests and forest areas; illegal building in forests and forest areas; fragmentation of forests and forest areas; quarries; reforestation of burnt forests and forest areas; Building Associations.
For each category, legal, administrative and technical requirements in order to produce the appropriate Environmental Legislation Compliance Maps have been defined. In the technical requirements, special emphasis has been placed on the remote sensing interface, the objects to be detected by remote sensing methods and techniques, and the remote sensing data, method and technique requirements, for each specific category.
Product requirements lead to the specification of the Environmental Legislation Compliance Maps appropriate for each law category, e.g. the definition of the information levels, the choice of the appropriate scale of the map, the graphic depiction of objects/layers, the color of lines or shaded areas, the nomenclature, etc.
The Environmental Legislation Compliance Map showing potential illegal buildings in forests and forest areas in the municipalities of Old and New Penteli, Attika, Greece has been produced, as an example.

1 INTRODUCTION

Earth Observation and Monitoring methods and techniques and Space and Airborne Remotely Sensed analogue and digital image processing can detect, discriminate, recognize, understand, measure, compare, correlate, evaluate, analyze, process, and interpret significant information vector and raster data, objects, patterns, conditions, similarities and change trends of the Natural and Socioeconomic Reality as well as of their multidimensional relations, interdependencies and interactions (Rokos, 1988). Thus, all the procedures, plans, studies and works of Integrated and Worthliving Development (simultaneously economic, social, cultural, political and technical/technological, and for that reason sustainable) and Protection of the natural and socioeconomic environment could (under specific presuppositions) be reliably and efficiently assisted by the appropriate imagery and remote sensing methods and techniques, taking into consideration that all persons involved in these procedures (scientists, engineers, citizens, administrators, politicians, judges, judiciaries) could clearly communicate, understand, evaluate and document relevant activities, impacts, judgements and decisions (Rokos, 1994a).

This paper investigates the possibility of producing reliable Environmental Legislation Compliance Maps at National level, by means of Earth Observation data and their appropriate processing and analysis using remote sensing methods and techniques. These maps essentially focus on containing evidence material for judicial and administrative procedures. Two information levels, one which identifies areas where a legal rule is applied and another which identifies areas where there is an infringement of that rule, are represented in each Environmental Legislation Compliance Map (APERTURE 1997, 1998a).

From the legal point of view, a methodology which defines National Environmental Legislation in a form that could be

used to delineate spatial legislation information on maps has been developed. For this purpose, three steps have been considered:

- the categorization of National Environmental Legislation in different sets and subsets of laws/decrees/rules;
- the definition of separate stages in the implementation of each legal decision making process and the indication in which of them and how Earth Observation data could be integrated; and
- the definition of the appropriate legislation map nomenclature.

From the technical point of view, an accurate, reliable and efficient Environmental Legislation Compliance Map, in order to cover the requirements of the judiciary procedures for conforming to environmental laws and regulations, should comply with the following:

- its scale should be the optimum one for the specific case,
- it should contain the maximum possible and appropriate for the specific case metrical and qualitative information,
- it should be the most recent one,
- it should facilitate, in the future, its comparison and/or correlation with similar maps of the same area produced on previous dates,
- it should contain a very clear legend understandable by Judges and citizens,
- it should contain the points, lines, surfaces, space segments, as well as the necessary specific "thematic" and "time" information which is critical in judging the specific case,
- it should clearly show similarities and differences in shapes, measures, patterns, textures, both in their horizontal and vertical geodetic position (x,y,z), in order to assist judges in documenting their judgements and decisions, and the administration in carrying out the necessary monitoring of Environmental Law Enforcement.
- it should be accurately and appropriately comparable with the existing topographic and land use/cover maps of the same areas, at the same scale.

Implementation of environmental legislation using EO data is not operationally satisfactory, due to the lack of standardization of methodologies and tools for controlling and monitoring compliance with laws, directives, and guidelines governing human beings' interactions with Environment. Although Remote Sensing methodologies and techniques have been proved a very useful tool for assessing and monitoring the natural and socioeconomic environment, the use of Earth Observation data as evidence material in judicial and administrative procedures is relatively sparse. If Earth Observation data are to be used in any legal process associated with the implementation of environmental legislation, the question arises as to what standards of data (or standards of evidence) will be necessary to demonstrate and verify the implementation or non implementation of environmental law (APERTURE 1998a, 1998b).

Towards this direction, European Commission funded the research project APERTURE (ENV4-CT97-437) which mainly aims to develop a methodology, based on Earth Observation data analysis, to map and characterize environmentally sensitive areas in Europe according to International, European and National Environmental Legislation by:

- proposing an interdisciplinary legislation and remote sensing nomenclature,
- compiling a detailed database of land-use in such areas, using merged very high spatial resolution and high spatial resolution Earth Observation (EO) data,
- developing quantitative measures of changes occurred in forest and water management over a period of time,
- developing a common approach between environmental lawyers and scientists in the drawing up of environmental law related to land-use,
- applying visualization techniques to these environmentally sensitive areas.

National, Regional and Local Authorities, as well as Governments, will directly use this methodology to assess environmental impacts at national, regional and local level.

The final product of this methodology is the Environmental Legislation Compliance Map (ELCM). ELCM is defined as a map derived from specific and appropriate integration and processing of Earth Observation and geographic data, identifying the areas conditioned by the application of environmental legislation, as well as the location of potential infringements. It serves as a management tool for the end user and as an evidence tool for judicial and administrative procedures. Within the APERTURE framework, four indicative ELCMs, corresponding to four national case studies located in Italy, Spain, Portugal and Greece respectively, were to be produced and submitted to moot (i.e. simulated) court proceedings.

This paper focuses on the Greek case study, which concerns the analysis of the Greek Forest Law and the procedure for the implementation of the respective ELCM. In the second chapter, the appropriate methodology and definitions required for the production of an ELCM, are outlined, while chapters 3-5 refer to the Greek Forest Law case.

Specifically, the third chapter refers to the analysis of the Greek Forest Law. In the fourth chapter, the Remote Sensing interface is defined and suitable image processing methods and techniques are summarized. In chapter 5, the specifications of the ELCM under implementation are given. An exemplar of ELCM showing the detected housing in the forests and forest areas of the municipalities of Old and New Penteli, Attica, Greece, at scale 1:5000, is also presented and conclusions are drawn.

2 METHODOLOGY AND DEFINITIONS

The analysis of any Environmental Law according to a formal and standard procedure leads to the specification of the technical requirements regarding the integration of appropriately processed EO data in the procedure of ELCM production. Once the technical specifications are defined, the formalization of a standardized procedure for the production of the ELCM is developed. Analytically, three steps could summarize the methodology developed:

- First, the specific Environmental Law has to be classified in different thematic categories of laws/decrees/rules, according to the criterion of the cause of infringement. This classification leads to the definition of ELCM layers necessary for the specific Law. ELCM layers are therefore legislation specific i.e. a legislation map layer should be developed for every category of laws/decrees/rules.
- Second, law provisions involved in the implementation of the legal and/or administrative decision making processes have to be identified for each law category and the stage and method of EO data integration into the procedure have to be indicated. EO data spatial, spectral and temporal characteristics, as well the pertinent photo-interpretation and image processing methods and techniques are consequently defined.
- Third, specifications regarding the presentation of the ELCM layers defined in the first step have to be set. These must conform to ELCM definitions.

According to these definitions, each ELCM layer should mainly contain information on:

1. the conditioned areas that are subject to restrictions imposed by the environmental legislation under analysis,
2. the areas where a potential infringement of these restrictions occurs, i.e. the breach areas.

Ancillary data will also be used to facilitate map interpretation (e.g. road network, drainage patterns, administrative boundaries, and contour lines).

3 THE LEGAL FRAMEWORK

3.1 Analysis of the Greek Forest Law requirements

The Greek Forest Law has been analyzed in order to extract all the legal requirements applicable to forests' and forest areas' control. The analysis of the Greek Forest Law revealed:

1) the legal requirements for the characterization of an area as a forest or forest area,
2) seven different causes of deforestation, which are subject to detailed regulation. The thematic classification of the different causes of deforestation is outlined as follows:
   - 2.1) land-use planning and extension of city plans.
   - 2.2) fencing of private forests and forest areas.
   - 2.3) illegal building in forests and forest areas. Building restrictions and exemptions.
   - 2.4) fragmentation of forests and forest areas.
   - 2.5) quarries.
   - 2.6) reforestation of burnt forests and forest areas.
   - 2.7) Building Associations.

For each cause of deforestation, an ELCM layer can be produced which shows implementation or enforcement aspects of specific law provisions..

3.2 Law Provisions

The seven categories listed in paragraph 3.1 are analyzed in legislation terms in table 1, i.e. for each category / ELCM layer the related main law provisions are presented. It is clear that all categories specifically depend on the presence or not of a forest or forest area, and therefore one more category of law provisions is added, which concerns the legal characterization of an area as forest (Alevizatos and Pavlopoulos, 1998, Gianakouros, 1988).

Category 1: Forest and forest areas characterization	
Law provisions	**Description**
Art. 2 Law 998/1979	'The country's administration is obliged to protect forests and forest areas in general'. (The Greek legal framework aiming at the protection of the forests of the country applies on

	'forests' and 'forest areas'. Therefore, the implementation of the Greek forest legislation depends on the detection and consequently the characterization of an area as such.
Art. 3 Law 998/1979	As **'forest'** will be deemed all area of the surface of the ground, covered in all or in part by wild woody plants of any growth or age, comprising, by their distance and interaction an organic unit. As **'forest area'** is considered all area of the surface of the ground, covered by sparse or meager, high or bushy, wooden vegetation of any formation and capable of servicing one or more of the functions mentioned in the previous paragraph.
Art. 11-13 Law 998/1979 Presidential Decree 141/1980	Procedure of characterization of an area as forest by using the available earliest air photos of the country. Technical specifications for the above procedure.
Category 2: Land-use planning and extension of city plans	
Law provisions	**Description**
Art.1-2 Legislative Decree of 17.11.1927 Council of State Decision 3414/1978	Settlements have to be developed according to an existing city plan. The Council of State has interpreted the above mentioned Articles 1 and 2 in the light of the provisions of Article 24 and 117 par. 3 of the Greek Constitution. The Council stated that (burnt) forest areas could not be included in existing city plans. Such an action would result in the total destruction of forest areas, which runs against the constitutional protection of forests in Greece.
Category 3: Fencing of private forests and forest areas	
Law provisions	**Description**
Art. 45 par.1 Law 998/1979 Council of State Decision 1516/1993	Any intervention in forests and forest areas is prohibited. No fencing of private forests and forest areas is allowed. The Council of State decided that this restriction of the property rights of the owner of a private forest or forest area is legal.
Category 4: Illegal building	
Law provisions	**Description**
Art. 71 Law 998/1979 Art. 45 par.1 Law 998/1979	The construction of buildings in forest areas is prohibited. Any intervention in forests and forest areas is prohibited.
Category 5: Fragmentation	
Law provisions	**Description**
Art. 60 Legislative Decree 86/1969	The fragmentation of private forests and private forest areas is not allowed without permission by the Ministry of Agriculture. According to Council of State Decision 285/93, this permission by the Ministry of Agriculture can only be granted for reasons of a more efficient forest economy.
Category 6: Quarries	
Law provisions	**Description**
Art. 57 Law 998/1979 Art. 45 par 3 Law 998/1979	Every damage caused to forests or forest areas must be restored after the end of the extracting activity. Holders of an operation permit that violate this duty are subject to criminal sanction, pursuant to Art.57 and 71 Law 998/1979. It is no secret that in most cases this provision is not enforced. Article 45 par. 3 states that any kind of operation in forests and forest areas can only be tolerated if an alternative location for this operation outside the forests and forest areas in question is not possible.
Category 7: Reforestation of burnt forest areas	
Law provisions	**Description**
Art. 117 Greek Constitution Article 41 Law 998/1979	Forests and forest areas, public or private, which have been destroyed by fire or by other means are still to be regarded as forests and forest areas and are subject to reforestation. This provision refers to the procedure of reforestation. The locally competent Prefect issues a decision, which clearly defines the (burnt) area that is subject to reforestation. Attached to

	this decision is a topographic diagram.
Category 8: Building Associations	
Law provisions	**Description**
Art. 21 Law 431/1968 as amended by Law 666/1979	Allows the cession of public forestland to Building Associations formed by members of the Military or public servants for the construction of buildings for accommodation or recreation.
Council of State Decisions 1009/87 and 4884/1987	The Council decided that Art. 21 Law 431/1968 as amended by Law 666/1979 runs against the constitutional duty of the State to protect the forests of the Country and can no longer be applied. Land that had already been surrendered but had not been built before the 1974 Constitution came into force, is not excluded from this decision.

Table 1. Analysis of the Forest Law

4 REMOTE SENSING INTERFACE

4.1 Issues to be demonstrated by Photo-interpretation and Remote Sensing methods and techniques

Following the legislation analysis given in chapter 3, table 2 shows what has to be demonstrated for each thematic legal category by the use of Photointerpretation and/or Remote Sensing methods and techniques (Karathanassi et al., 1998, 2000).

Category		**As demonstrated by EO data**
1	Forest and forest area characterization	The forest character of an area in the year that the earliest air-photos exist, that is 1937 for Attica and 1945 for the rest of the country.
2	Extension of city plans	The non forest character of an area subject to be incorporated in a city plan.
3	Fencing of private forests and forest areas	Fences on forests and forest areas.
4	Illegal building	The location and the period of construction of any building on forests and forest areas.
5	Fragmentation	Building plots and/or fences on forests and forest areas.
6	Quarries	The location of quarries and if possible, whether the quarries are active or disused.
7	Reforestation of burnt forest areas	The burnt forest areas.
8	Building Associations	The use of forests and forest areas before and after 1974.

Table 2. Remote Sensing Interface

4.2 Objects/patterns to be detected. Spatial, spectral, temporal requirements for EO data

In table 3, the primary objects/patterns to be detected, concerning the characterization of an area as a forest or forest area, is listed in the first category. The other categories depend specifically on the presence of a forest or forest area. Objects/patterns substantiating potential law encroachment are listed in them (Rokos, 1988, Konecny, 1995).

Category		**Objects / patterns to be detected**	**Spatial requirements**	**Image requirements**
1	Forests and forest areas characterization	Surface / spatial patterns showing the mixed class of "natural vegetation – soil – shadows" have to be identified. The participation of each member in the mixed class is not constant, as it depends on natural vegetation density. Consequently, a range of spatial patterns with different spectral characteristics have to be defined first.	Spatial units of 50,000 to 1,000 sqm size have to meet the spectral requirements of the defined patterns.	The earlier air-photos available for the Greek territory, dated in 1937 for Attica and in 1945 for the rest of Greece. Monitoring of the area character by the use of recent high resolution remote sensing images (SPOT XS, LANDSAT TM, IRS) helps confirm its forest character.

2	Extension of city plans	Linear (private roads, fences, etc.) and surface / spatial patterns (buildings, building plots, etc.) have to be identified.	Spatial units of 2,000 to 200 sqm size have to meet the spectral requirements of the spatial patterns.	Very high resolution remote sensing images e.g. SPOT panchromatic images, KVR, IRS, IKONOS, and/or air-photos.
3	Fencing of private forests and forest areas	Linear patterns have to be identified.	None.	KVR, IKONOS images, air-photos.
4	Illegal building	Point or surface/spatial patterns (depending on the size of the building and image resolution) have to be identified on a time series of images to detect buildings' location and reveal the time of their construction.	Spatial units of 200 sqm size have to meet the spectral requirements of the spatial patterns.	Very high resolution remote sensing images (KVR, IKONOS) and/or air-photos taken in various years.
5	Fragmentation	Linear (fences) patterns and/or spatial/surface patterns with spectral characteristics different from those of the surrounding area have to be identified.	Spatial units of 500sqm size at least.	KVR, IKONOS images, air-photos for linear patterns. SPOT XS, IRS for spatial patterns.
6	Quarries	Spatial/surface patterns have to be recognized on a time series of remote sensing images to detect quarry location and activities.	Various as required, depending on quarry size.	LANDSAT TM, SPOT XS, IRS images, air-photos taken in various years.
7	Reforestation of burnt forest areas	Surface/spatial patterns with specific spectral signature have to be recognized.	Spatial units of 1,000sqm size at least.	SPOT XS, LANDSAT TM, IRS, IKONOS multispectral images and air-photos taken in various years.
8	Building Associations	Surface / spatial patterns have to be identified.	Spatial units of 200sqm size at least have to meet the spectral requirements of the spatial patterns.	Air-photos taken before 1974 and very high resolution remote sensing images (KVR1000, IKONOS) and/or air-photos taken after this year.

Table 3. Objects/patterns to be detected. Spatial, spectral, temporal requirements for EO data.

4.3 Remote Sensing Methods and Techniques

4.3.1 Pre-processing methods and techniques. Among pre-processing methods, the geometric correction is considered mandatory. Radiometric correction, topographic normalization and atmospheric correction could be considered optional, depending on the image quality and on topographic and atmospheric conditions.

4.3.2 Image processing methods and techniques. These are listed in the table 4 (Rokos, 1988, 1994b).

Category		Image processing methods and techniques
1	Forests and forest areas characterization	• Application of photo-interpretation methods and techniques on the air-photos taken in 1945. • Application of photo-interpretation methods and techniques on the most recent air-photos. • Application of vegetation indices on multispectral satellite imagery to identify natural vegetation. • Application of classification algorithms on multispectral satellite imagery to identify natural vegetation. • Application of change detection algorithms on two sets of remote sensing data to indicate temporal changes in forests and forest areas.

2	Extension of city plans	• Application of photo-interpretation methods and techniques for the recognition of linear (private roads, fences, etc.) and/or surface (buildings, building plots, etc.) patterns on air-photos. • Application of edge detection methods on satellite imagery for the recognition of linear (private roads, fences, etc.) patterns.
		• Application of classification methods on satellite imagery for the recognition of surface (buildings, building plots, etc.) patterns. • Application of texture analysis on satellite imagery for the recognition of surface (buildings, building plots, etc.) patterns.
3	Fencing of private forests and forest areas	• Application of photo-interpretation methods and techniques on air-photos for the recognition of linear patterns (fences). • Application of edge detection methods on very high resolution satellite imagery for the recognition of linear patterns (fences).
4	Illegal building	• Application of photo-interpretation methods and techniques on a time series of air-photos. • Application of classification methods on IKONOS multispectral data. • Application of texture analysis algorithms on a time series of very high resolution panchromatic satellite imagery (KVR1000, IKONOS images).
5	Fragmentation	• Application of photo-interpretation methods and techniques for the recognition of linear objects (fences) on air-photos. • Application of edge detection methods on very high resolution remote sensing images (e.g. KVR1000 images, IKONOS) for the recognition of linear objects (fences). • Application of color composites and/or classification methods on high resolution remote sensing images (e.g. SPOT XS, TM images) to recognize surface/spatial patterns with different spectral signature from the surrounding area.
6	Quarries	• Application of photo-interpretation methods and techniques on a time series of air-photos. • Application of color composites on a time series of remote sensing data in order to identify quarries and if possible, to determine whether they are active or not. • Application of the Maximum Likelihood classification on remote sensing data. • Application of change detection algorithms to monitor changes in quarries.
7	Reforestation of burnt forest areas	• Application of Color Compositions on satellite imagery in order to identify burnt forest areas. • Application of classification algorithms on remote sensing data in order to identify burnt forest areas. • Application of change detection algorithms to indicate temporal changes in forests and forest areas.
8	Building Associations	• Application of photo-interpretation methods and techniques on the air-photos taken before the year 1974. • Application of texture analysis algorithms on very high resolution remote sensing images and/or air-photos taken after the year 1974 to recognize surface objects (buildings) and their changes during the last years. • Application of change detection algorithms on two data sets (air-photos, KVR1000 images, etc.) to indicate temporal changes in Building Associations.

Table 4. Image Processing requirements

5 GREEK FOREST LAW: ELCM SPECIFICATIONS

5.1 ELCM specifications

All the above information on legal and remote sensing requirements, as well as image processing methods and techniques, are combined to produce the optimized specifications for the ELCM concerning the Greek Forest Law (table 5). Seven layers corresponding to the seven thematic categories of Forest Law infringement have been defined for this ELCM. For each layer, conditioned areas arise from the category that concerns the forests and forest area characterization (category 1) and potential breach areas arise from the analysis of a thematic category concerning law infringement (categories 2-7).

Conditioned areas						
Category		**Law provisions**	**Scale**	**Graphic depiction of objects**	**Color of line or shaded area**	**Legend /nomenclature**
1	Forest and forest area characterization	Art. 2,3 Law 998/1979 Art. 11-13 Law 998/1979 Presidential Decree 141/1980	Defined by the scale of the breach areas	Shaded: areas legally characterized as forests or forest areas since 1937 or 1945	Yellow	Forests and forest areas
Potential breach areas						
	Category	**Layer**	**Scale**	**Graphic depiction of objects / layers**	**Color of line or shaded area**	**Legend / nomenclature**
2	Extension of city plans	Art.1,2 of Legislative Decree of 17.11.1927 Council of State Decision 3414/1978	1:5000 or 1:10000	Vector: boundary of areas included in the city plan Shaded: areas legally characterized as forests or forest areas in which a potential illegal extension of the existing city plan has occurred.	Black Red	Areas included in the existing city plan Potential illegal extension of the Approved City Plan
3	Fencing of private forests and forest areas	Art. 45 par.1 Law 998/1979 Council of State Decision 1516/1993	1:5000	Vector: fence in forests and forest areas	Red	Fencing of the forest
4	Illegal building	Art. 71 Law 998/1979 Art. 45 par.1 Law 998/1979	1:5000	Shaded: illegal building	Red	Building in the forest or forest area
5	Fragmentation	Art. 60 Leg. Decree 86/1969	1:5000	Vector: fence in forests and forest areas Shaded: fragmented forest areas	Red Red	Potential illegally fragmented forest areas
6	Quarries	Art. 57 Law 998/1979 Art. 45 par. 3 Law 998/1979	1:10000	Shaded: non-authorized quarry Vector: disrespect of operation conditions	Red Blue	Non-authorized quarry Potential infringement of Law 998/1979
7	Reforestation of burnt forest areas	Art. 117 Greek Constitution Article 41 Law 998/1979	1:5000 or 1:10000	Shaded: burnt areas Shaded: burnt forest areas whose forest character has changed	Blue Red	Burnt forest areas Burnt forest areas whose forest character has changed
8	Building Associations	Art. 21 Law 431/1968 as amended by Law 666/1979 Council of State Decision 1009/87 and 4884/1987	1:5000	Vector: creation of settlement areas in forest before 1974 Vector: creation of settlement areas in forest after 1974	Blue Red	Legal settlement areas according to Law 431/1968 Potential illegal creation of settlement areas

Table 5: Greek Forest Law: ELCM specifications

5.2 Exemplar of an ELCM layer produced. Conclusions.

A layer of the ELCM under implementation, showing buildings detected in a forest environment (category 4 of potential law infringement) of the municipalities of Old and New Penteli, Attica, Greece, at scale 1:5000, is presented in figure 6 and a map detail in figure 7. On this map layer (layer: Art. 71 Law 998/1979, Art. 45 par.1 Law 998/1979), the following information, appropriate and useful for judicial and information procedures, is shown:

- conditioned areas, i.e. the forests and forest areas, resulting from the relevant maps produced by the Hellenic Ministry of Agriculture. On these maps, land-use changes in forests and forest areas in the 1937 – 1978 period, in the municipalities of Old and New Penteli, are shown at scale 1:5000. After being compiled with the information included in the Maps of the Approved City Plan of Attica valid since 1985, this information was used to produce the conditioned areas of the proposed ELCM.
- potential breach areas, i.e. buildings, detected using image processing methods and techniques and specifically, classification based on texture analysis applied on the KVR1000 image captured in 1992 (Rokos and Karathanassi, 2000). This image was the most recent available satellite image of the area, which meets the image processing spatial requirements. Consequently, the produced ELCM layer refers to 1992 data.
- other background information, i.e. road network, forest road network, drainage network, contour lines, municipality boundaries, and annotations, which was selected from the respective topographical map (scale 1:5000) and overlaid on the ELCM layer.

The spatial accuracy of the ELCM layer is 3m. Detected buildings in forests and forest areas present an omission error of 8.39% and a commission error of 4.90%. The overall accuracy of the Image Processing products is 91.61%.

The methodology developed for the production of the ELCM was proved to be successful, despite the fact that the only available very high resolution remotely sensed image (KVR) for the area was not of optimum quality. Consequently, the certain prospect of continuous improvement of the spatial, spectral and temporal resolution of remotely sensed images will result, with equal certainty, in the improvement of ELCM quality and the dramatic reduction in the probability of confusion of land-use classes and/or objects, e.g. forests roads and/or rock outcrops confused for buildings.

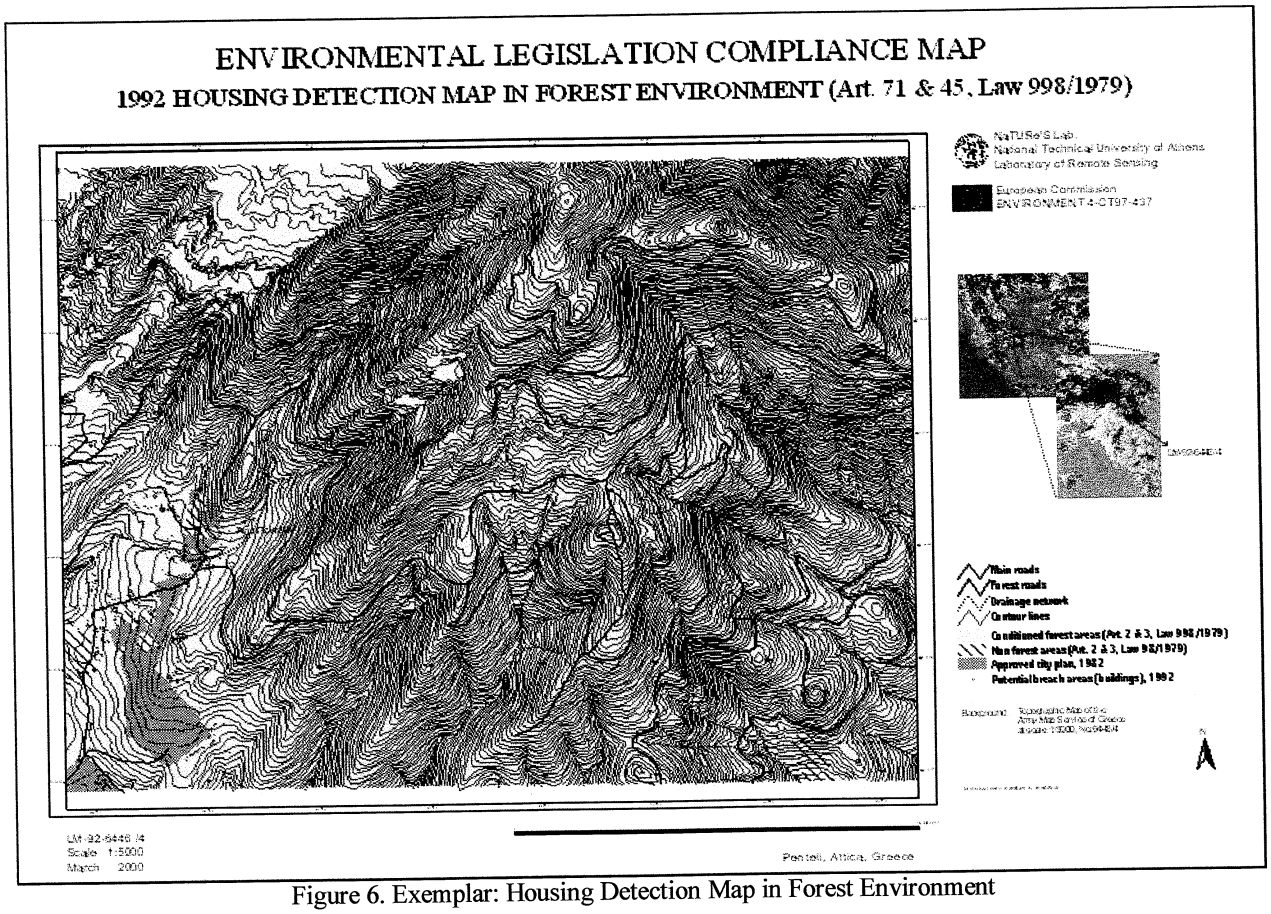

Figure 6. Exemplar: Housing Detection Map in Forest Environment

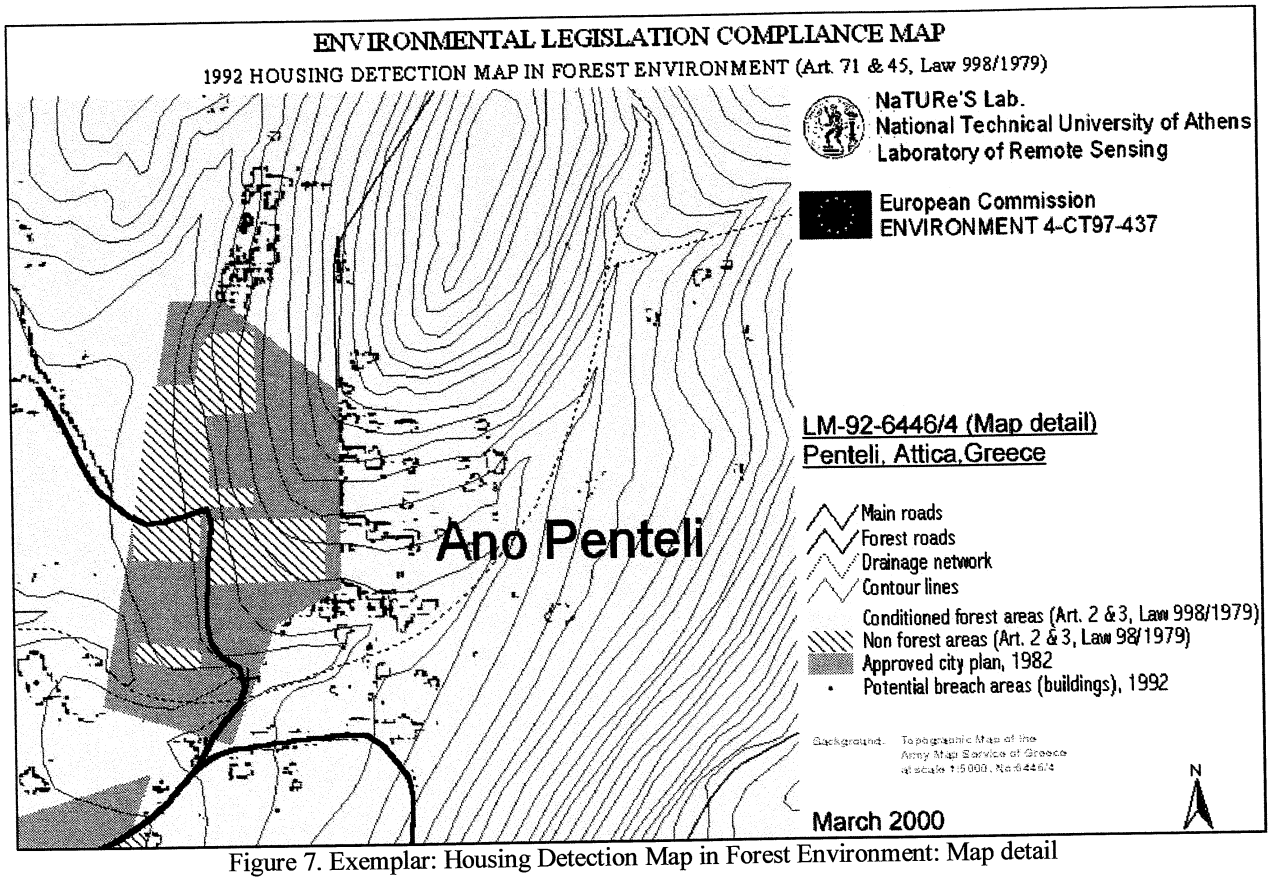

Figure 7. Exemplar: Housing Detection Map in Forest Environment: Map detail

ACKNOWLEDGMENTS

This work was performed under European Community contract No. ENV4-CT97-0437 (DG 12 - EHKN) in the framework of Environment Program APERTURE (Environmental Typological Space Facilitating the Implementation of European Legislation).

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