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CORINE LAND COVER 2000-2006

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Résumé: Cet étude présente les résultats du projèt Corine Land Cover á la fin de sa dernière phase déroulé au long de l'année 2007. Ci-dessous sont soulignés les principaux traits des changement intervenus dans l'utilisation du terrain sur la période 1990-2006. La phase 2000 du projet permet une analyse comparative de la structure des changements. En bref, les changements les plus significatives pour l'interval 2000-2006 sont liés aux processus de periurbanisation, tandis que la période 1990-2000 a été caracterisée par des fortes modifications dans la catégorie des terrains agricoles-spécialement l'extension des terrain arables.

Key-words: land use, remote sensing, changes.

Background and Objectives

The CORINE Land Cover (Co-ordination of Information on the Environment) project has been implemented in most of the EU countries, as well as in the 13 Phare partner countries in Central and Eastern Europe.

Following the setting up of the European Environment Agency (EEA) and the establishment of the European Environment Information and Observation Network (EIONET), the responsibilities of the CORINE databases - including the updates - rely on the EEA. CLC is the largest of CORINE databases, providing information on the physical characteristics of the earth surface. Images acquired by earth observation satellites are used as the main source data to derive land cover information.

There are three CLC inventories: CLC 1990, CLC 2000 and in progress CLC 2006.

As the first CLC inventory (named CLC1990) was completed and came to use, several users at national and European level expressed their need for an updated CLC database. Updating was implemented within the I&CLC2000 project. This project was based upon a number of key elements: lessons learnt from earlier CLC project, a current list of user needs, the options available for

satellite images and the processing and management requirements for the vast amount of data. The overall aim of updating was to produce an updated, so called CLC2000 database and the database of land cover changes (LCC) between the first CLC inventory and 2000 (named CLC-Change).

The I&CLC2000 project consisted of two main components, which were interconnected:

- IMAGE2000: covering all activities related to satellite image acquisition, ortho-rectification and production of European and national mosaic, and
- CLC2000: covering all activities related to updating of the first CLC inventory (CLC1990) based on IMAGE2000 (updated version is named CLC2000) and detection and interpretation of land cover changes (CLC-Change) by using CLC1990, IMAGE1990 and IMAGE2000.

Additionally, in order to prevent propagating errors into the new update, the geometric and thematic mistakes in CLC1990 have been corrected. The I&CLC2000 project was finished at the end of 2004 (Büttner et al., 2004, Hazeau, 2003).

CLC2006 is a direct continuation of previous CORINE Land Cover mapping campaigns. There are, however important differences compared to previous projects:

- In CLC2000 there was a strong requirement to improve CLC1990 (geometry and thematic content). Due to its higher quality standard, there was no need for such a significant improvement of CLC2000 data in CLC2006 project. However, if a mistake in CLC2000 was found, it has been corrected. Revised CLC2000 was not to be released by EEA as a new product. It was used only for production of CLC-Change and CLC2006.
- In CLC2006 the focus was on generating LCC data (between 2000 and 2006). Such a focus has not been declared in CLC2000. Half of the countries of the CLC2000 project have produced the CLC-Change database by intersecting the CLC1990 and the updated CLC2000, consequently, many false and non-real changes have been produced. Some countries flagged these non-real changes as "technical change". Production of these false changes was avoided during recent update.
- A novelty of CLC2006 project was that all changes > 5 ha have to be mapped, not only those that are associated to existing polygons.
- The CLC2006 database will be generated in a mostly automatic way with some human interaction by combining CLC2000 and the photointerpreted CLC-Change. In CLC2000 project half of the countries have interpreted

CLC2000 directly, while the other half produced it by GIS operation, using revised CLC1990 and CLC-Change.

Materials and Methods

As Landsat 7 satellite, used in CLC2000 had ended acquisition, new sources of suitable satellite imagery had to be found for purposes of CLC2006 project. As a result of agreements born between satellite owners and ESA, two satellites will provide imagery for CLC2006 project (EEA, 2006):

– French SPOT-4, and
– Indian IRS P6.

CLC2006 project aims to provide a double satellite data coverage for the area to be mapped in order to help high quality photointerpretation. The main characteristics of the expected imagery are shown in Table 4. Equivalent data for Landsat-7 are provided for comparative purposes. As the priority lies in the full (and double) coverage of the participating countries, and because of financial reasons, panchromatic bands will not be available.

Table 1. *Characteristics of SPOT-4 and IRS P6 imagery as compared to Landsat-7*

Satellite	**Landsat-7**	**SPOT-4**	**IRS P6**
Sensor	ETM	HRVIR	LISS III
Swath width (km)	180	60-80 (depending on looking angle)	141
Pixel size (m)	30 (multispectral) 15 (panchromatic)	20 (multispectral) 10 (panchromatic)	23
Image dynamics (bits)	8	8	7
Number of bands	7 + 1	4 + 1	4
Blue band	0.45 - 0.52 μm (TM1)	--	--
Green band	0.53 - 0.61 μm (TM2)	0.50 – 0.59 μm (XI1)	0.52 – 0.59 μm (MS1)
Red band	0.63 - 0.69 μm (TM3)	0.61 – 0.68 μm (XI2)	0.62 – 0.68 μm (MS2)
Near-infrared band	0.75 - 0.90 μm (TM4)	0.78 – 0.89 μm (XI3)	0.77 – 0.86 μm (MS3)
Middle-infrared band	1.55 - 1.75 μm (TM5)	1.58 – 1.75 μm (XI4)	1.55 – 1.70 μm (MS4)
Thermal infrared band	10.4 - 12.5 μm (TM6)	--	--
Middle-infrared band	2.09 - 2.35 μm (TM7)	--	--
Panchromatic band	0.52 - 0.90 μm (PAN)	0.61 – 0.68 μm (M)	
Observation mode	Vertical only	Tiltable sensor (up to +-31 degree)	Vertical only

Although the spectral coverage of the two sensors are very similar (2 visible bands, one NIR band and one SWIR band) slight differences in the technical parameters might provide small colour differences in the images, which the photointerpreters have to learn to tolerate. In order to gain similar

colours on screen as interpreters had got used to with the Landsat TM sensor, the following band combinations shown in Table 5 are advised to apply.

Table 2. *Recommended colour rendition for photointerpretation*

Sensor / **Colour**	**Landsat TM/ETM**	**SPOT-4**	**IRS P6 LISS III**	**Spectral range**
Red (R)	band 4	band 3	band 3	Near-infrared (NIR)
Green (G)	band 5	band 4	band 4	Middle-infrared (SWIR)
Blue (B)	band 3	band 2	band 2	Red (VIS)

Two images for each area will be acquired in the 2006 +/- 1-year period, in order to provide an opportunity for improved photointerpretation. Multitemporal imagery is considered especially useful in separating some land cover classes, e.g. irrigated / non-irrigated arable land and pasture land.

As parteners to the Corine Landcover 2000-2006 Romania, we have interpreted in collaboration with I.N.C.D.D. Tulcea the entire coverage of our country.

Therefore, we have adopted al the 44 classes of the Corine Landcover project and the methodology addendum for identification, delimitation, separation and agglutination of land cover polygons.

The minimum size of the polygon is considered 25 ha and for the changes between 1990 and 2000 is 5 ha. the results of the analysis is validated for this level of detail.

Results

The transformation that have occurred in the Romanian society, beginning with the change in the political regime from 1989 and continuing with the transition period that lasted till Romania's integration in the EU structures, have been reflected in all the aspects of the socio-economical life, motivating us to study the changes occurred in the land cover and their impact on the environmental conditions.

During our research we have identified some types of changes between land use category, the most representative ones being those from pastures to arable land, deforestation and the expansion of inhabited areas.

The transformation of the pastures into arable land was characteristic for the 1990-2000 period, but in 2000-2006 period there is a slight decrease of phenomena intensity, due to massive migration of the rural population, outside Romania.

The deforestation was not a major problem during the 1990-2000 period, from what we observed from the satellite images. Now, the deforestation appears as the dominant change in the mountain area. We can explain this , not by the ever increasing clearcuts, but throught the aggregation of deforested areas until they reached the 5 ha .

The expansion of inhabited areas is now one of the most characteristic landuse change that occurred in the late 5 years. This can be understood in correlation with the recent economic growth of the country.

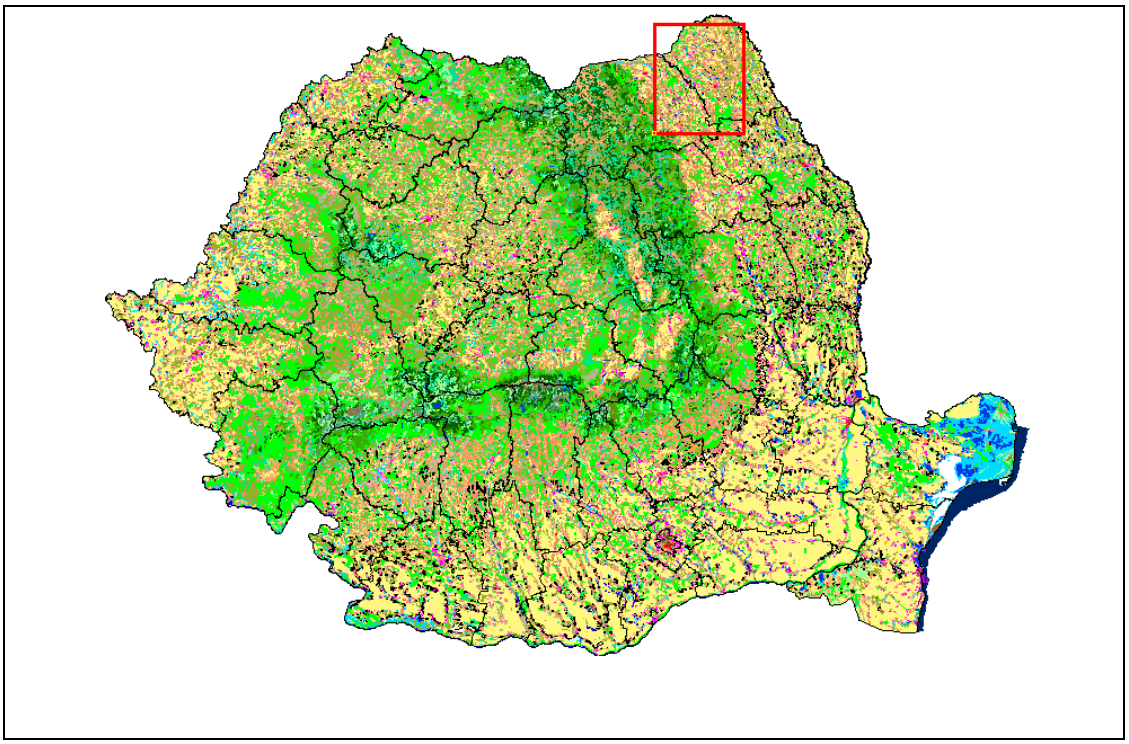

Figure 1. *Case study area localisation*

After the identification of some of the qualitative changes, we decided to become more quantitative. Therefore we choose a study area located in the north-east of Romania.

For these area we compared the landuse changes occurred in 1990-2000 period with those occurred in the last 5 years.

The total surface involved in these changes is bigger in 1990-2000 period than that involved in 2000-2006 , and seems normal if we take into consideration the number of years passed and the fact that the post communist transition period ended recently.

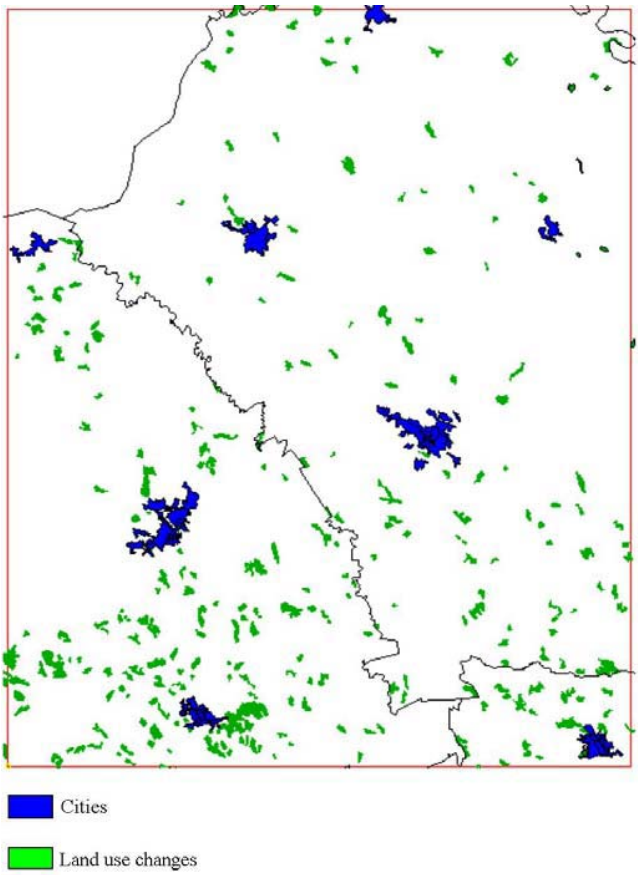

Figure 2. *Spatial distribution of land uses changes during 1990-2000*

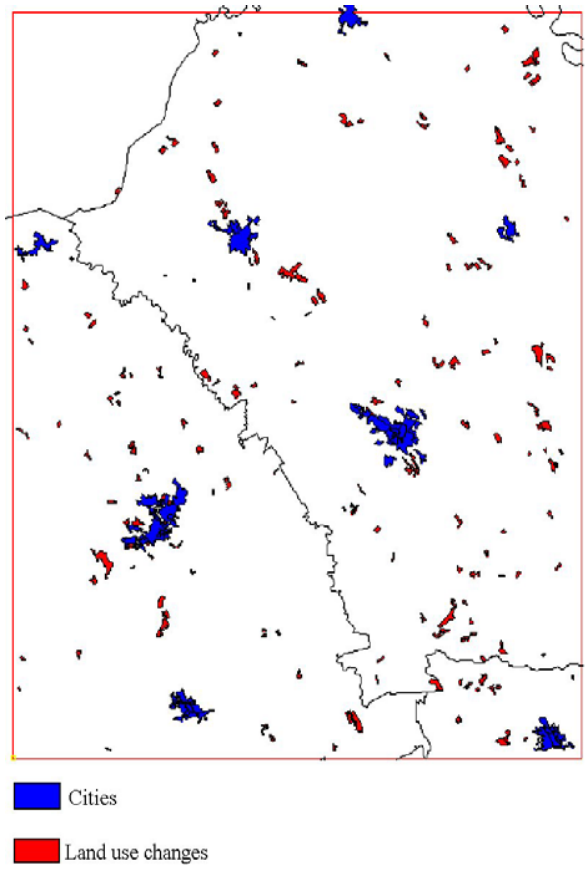

Figure 4. *Spatial distribution of land uses changes during 2000-2006*

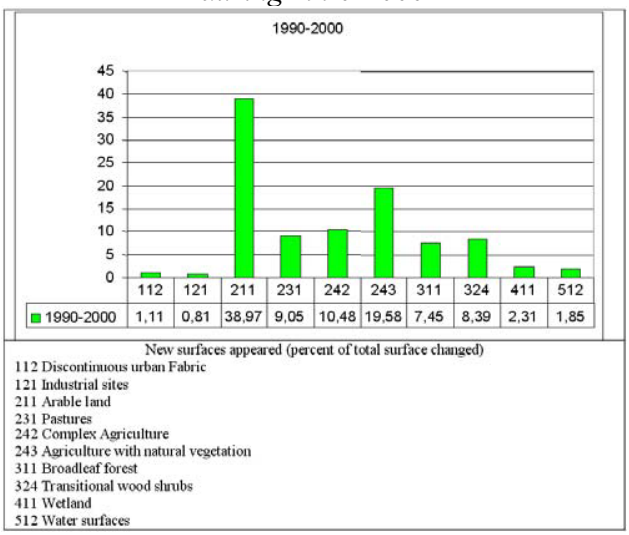

Figure 3. *Change's structure between 2000-2006*

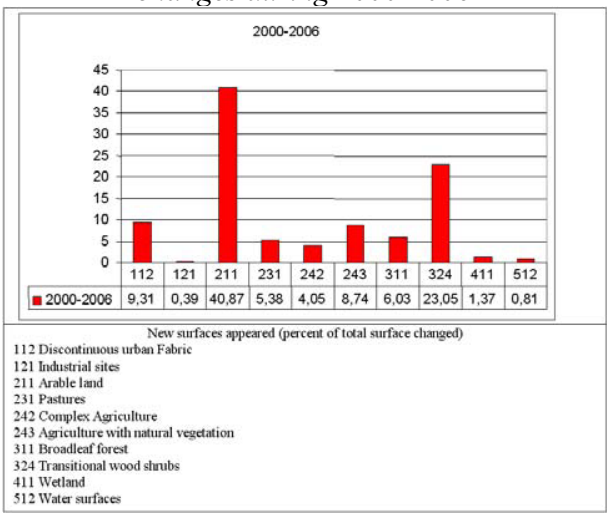

Figure5. *Change's structure between 2000-2006*

From the total surface changed, 38,875% represents the arable land gained from other land use category. This is the result of the rural return, migration of the urban population to the villages, caused by industry failing. A

great number of unemployed persons moved to the countryside as a form of surviving to the economic crises.

These new agricultural surfaces are not reflected in production, because the crop yields are very small in surface, and the exploitation proved inefficient.

These phenomena is not characteristic for the entire country, as the matter of facts, in south of Transylvania we've observed the opposite phenomena, abandoned arable land in favour of pastures, due to the massive migration of German population.

Also, from the above graphic we observe that the deforestation affected on 8, 39% and the reforestation on 7, 45% of total surface. As we can see the difference in small.

Almost 10% is transformed in complex agriculture areas, this reveals the fact that in some of the villages surrounding area a changes in tipes of agrliculture has produced, from cereals to a combination of trees vineyards , vegetables and cereals.

The inhabited areas have increased in these period with only 1%, but a slight building densification has been identified.

During 2000-2006 period the most frequent changes are the increase of arable land surfaces, the deforestation, settlements extension.

Total deforestated area is now 4 times bigger than the reforested one. This seems to be a dramatic change, if we take into consideration the fact that in the previous period the reforestation was the dominant phenomenon.

Anyway this results can not be understood only throught the clearcuts advance but also throught the fact that many polygons reached the minimum limit size of 5 ha . Many of the clearcuts had around 2,5-4 ha before the year 2000 and a small extension of these with 2 ha makes them reach the size limit.

In this way a change of 2 ha appears as one of 5 ha. These are the limitation of the methodology we used on this scale of detail, and in consequence we should be carefull in interpretation.

The total surface gained by the settlements , durig the last five years, is four times bigger that the surface changed into this category in the previous 10 years.

The new constructed areas are located near by the biggest cities situated in the study area Suceava, Botosani, Dorohoi.

As we can observe in the following image , two large surfaces of pastures from the proximity of Suceava , were transformed suddenly , in just 5 years , into discontinuous urban fabric.

We've created few buffer zones on diferent distances from the cities and then we tried to see what kind of changes are located in these peripheral areas.

As you can see in the following graphic, most of the new discontinuous urban fabric are situated within 1 km distance from the cities, and as we go further away from these the agricultural changes become dominant.

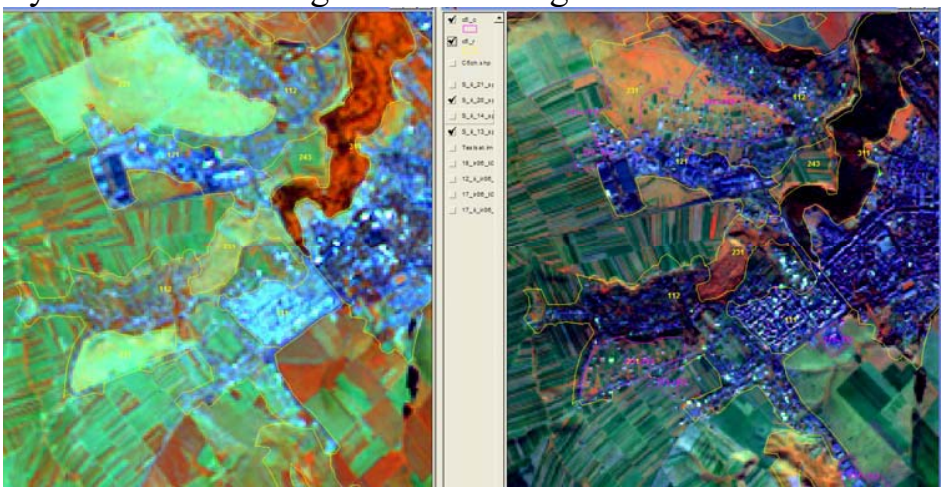

Figure 6. *Periurbanization between 2000-2006 (proximity of Suceava)*

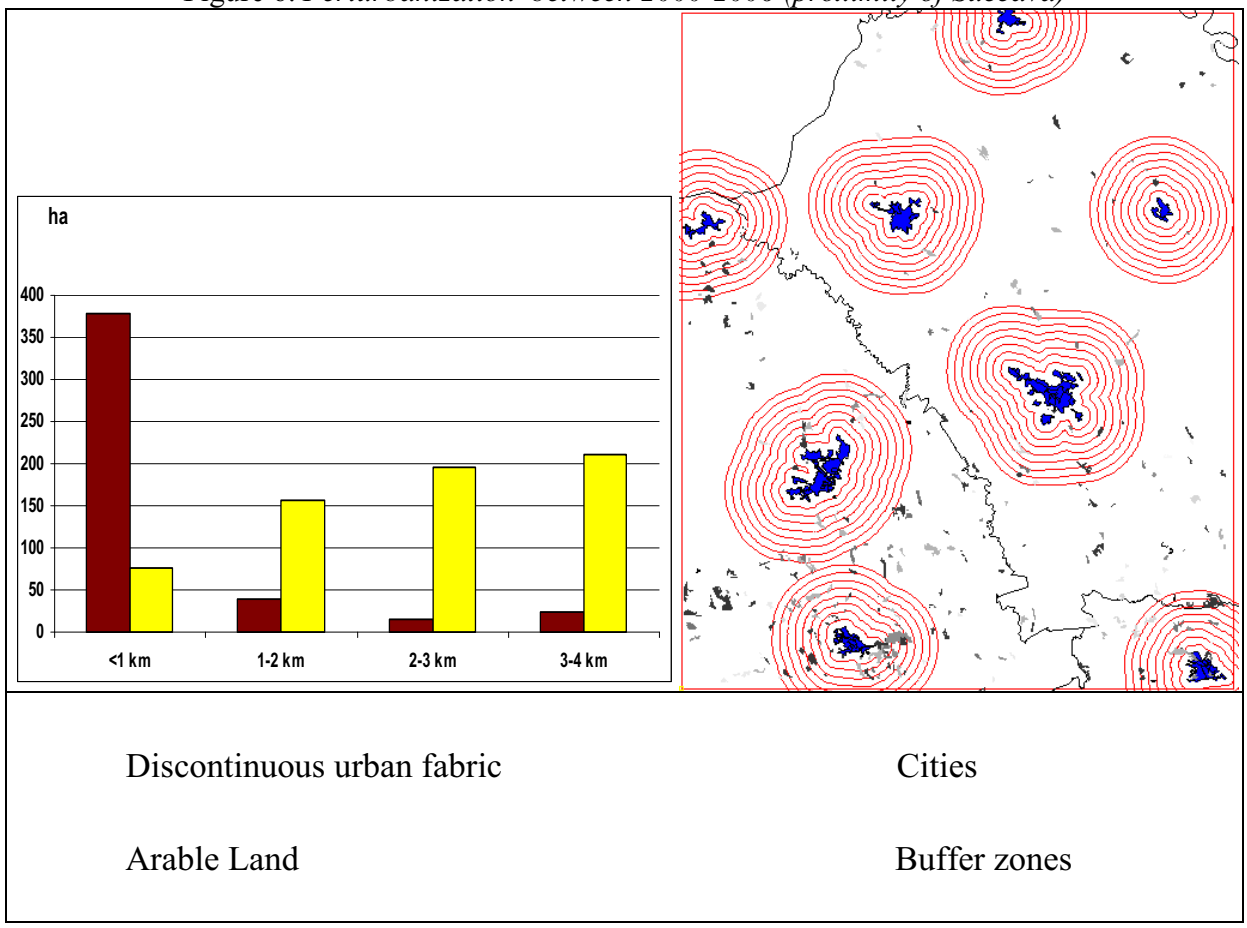

Figure 7. *The structure of land change around the cities*

Conclusions

Corine Land Cover 2006 project uses enhanced satellite images, with a better resolution, leaving aside the Landsat images and favoring IRS and Spot images. The methodology was improved, the minimum size of the mappable polygons indicating land use changes was reduced from 25 ha to 5 ha in the case of island polygons. As far as we noticed, the land use changes, which occurred during the last 5 years, are different from the previous changes. Settlements and forested areas display the most spectacular evolution. These are just some preliminary and partial conclusions, which will be refined by the end of the project.

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