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Land and ecosystem accounts, session II
Invited paper

Development of Land and Ecosystems Accounts in Europe

Implementation of land cover accounts
Discussion of accounts of land use functions

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Introduction

Land is a key natural asset which value results from its surface as well as from the presence the other natural elements (soil, water, climate, fauna and flora) and their combination with man made assets (activities, infrastructures and settlements). They determine the functions of land, its capacity to support the reproduction of natural ecosystems as well as to sustain the many uses by man. Functions of land resulting from geographical conditions and present and past use, they are unevenly distributed over the territory, as well as the environmental problems that they may generate. Therefore, the assessment of the potentials of land assets or of conflicts in the use of land requires combining statistical and geographical approaches.

In 2002, the European Environment Agency and Eurostat have started two case studies for preparing the implementation of land accounts as described in SEEA2003 Chapter 8 under the name of "Land & Ecosystems Accounts" [1], with the intention to use for this purpose the CORINE Land Cover inventory currently covering 30 countries in Europe.

CORINE Land Cover (CLC) is a cartographic survey from satellite images at an average date of 1990. An update for year 2000 is ongoing, with completion by end 2004, half of the deliveries being finalized by end 2003. Some years ago, tests where carried out on two zones for assessing the capacity of CLC for measuring changes in land cover, producing maps for 1975. These zones were the coastal strip of Europe (9 countries[2]) and four Central and Eastern Europe Countries (Czech Republic, Hungary, Romania & Slovakia).

[1] **SEEA2003, Integrated Environmental and Economic Accounting, Chapter 8, Section F Land and Ecosystems Accounts, §8.336 to §8.399** Publication forthcoming in the first half of 2004. Electronic version available at http://unstats.un.org/unsd/environment/seea2003.htm

[2] LaCoast project by the EC Joint Research Centre, Ispra. http://data-dist.jrc.it/en/data-dist/

The two case studies on the 4 CEE Countries[3] and the European coast[4] have been assigned to a subsidiary body of the EEA, the European Topic Centre on Terrestrial Environment, which regroups expertise in that domain.

The LEAC pilot study is based on these two surveys as for the land cover basic accounts, which have been fully implemented. In addition to these, land use accounts have been sketched for Forestry in the Czech Republic and Tourism on the European coast. While some empirical results have been compiled for forests, accounting for tourism in the coastal zones is currently facing difficulties with local statistics for the coastal strip at the European level.

The present paper addresses the following points:

1. Methodological principles of LEAC
2. Implementation of land cover changes accounts (basic LEAC accounts) in Europe based on Corine land cover
3. Targeted accounts and land use functions

1 Methodological principles of Land & Ecosystems ACcounts

The methodology of Land and Ecosystems Accounts in the SEEA is deep-rooted in the pilot studies carried out in the mid-90s by UNECE[5] and presented in 1996 at the IARIW Conference on environmental accounting in Tokyo[6]. In the continuation of this work, national developments in France (regional case study based on CLC), Great-Britain (Accounting from the Countryside Survey) and Germany (Ecological area sampling survey 1998) took place, with the support of Eurostat.

In order to accommodate standardisation, necessary for comparisons, as well as the diversity of national/regional conditions, which is the essence of spatial analysis, the UNECE task force set the distinction between core (or basic) accounts to be computed in a systematic way and supplementary (or targeted) accounts to be implemented according to priorities. It was summarised by the following scheme (cf. note 5).

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[3] Soukup, Tomáš (GISAT/ Prague), Kupková, Lucie (Charles University of Prague), Weber, Jean-Louis (EEA), Paramo, Ferràn (ETCTE/ Autonomous University of Barcelona), **Integration of geographical and statistical data in the environmental accounting framework; methodological development based on two case studies: Action 1: Accounts of the impacts on Forest and Biodiversity of Land Cover/Land Use changes; case from the land cover changes 1975-90 in the 4 Central and Eastern European countries**. Report of the European Topic Centre on Terrestrial Environment for Eurostat and the EEA - Prague, June 2003 - available on the website of the EEA at http://eea.eionet.eu.int:8980/Public/irc/eionet-circle/leac/library

[4] Weber, Jean-Louis (EEA), Paramo, Ferràn (ETCTE/ Autonomous University of Barcelona), Breton Françoise (ETCTE/ Autonomous University of Barcelona), Roy Haines-Young (University of Nottingham), **Integration of geographical and statistical data in the environmental accounting framework; methodological development based on two case studies: Action 2: Integration of environmental accounts in coastal zones; case study of tourism**, Report of the European Topic Centre on Terrestrial Environment for Eurostat and the EEA, Barcelona-Bellaterra, March 2003 - - available on the website of the EEA at http://eea.eionet.eu.int:8980/Public/irc/eionet-circle/leac/library

[5] UNECE/Conference of European Statisticians Task Force: **Physical environmental accounting: land use/land cover; nutrients and the environment**. Etudes et travaux, IFEN, Orléans, France, 1995.

[6] Parker Jonathan, Steurer Anton , Uhel Ronan, Weber Jean-Louis - **A general model for land cover and land use accounting** - Invited Paper drafted by from the report of the UN-ECE Task Force on Physical Environmental Accounting - Special Conference on "Environmental Accounting in Theory and Practice", Tokyo, March 5-8, 1996.

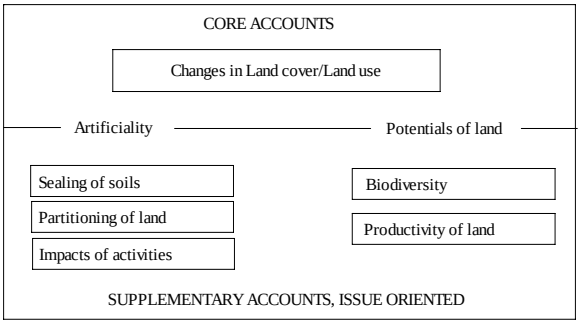

Figure 1: Overall framework of Land Accounts proposed by the UNECE task force

The core accounts are intended to provide a foundation to the overall framework according to the chain: land cover change matrix ➔ land cover flows ➔ land use ➔ industries/activities that generate the pressure. The following scheme, presented in the SEEA, summarises the **basic** LEAC accounts:

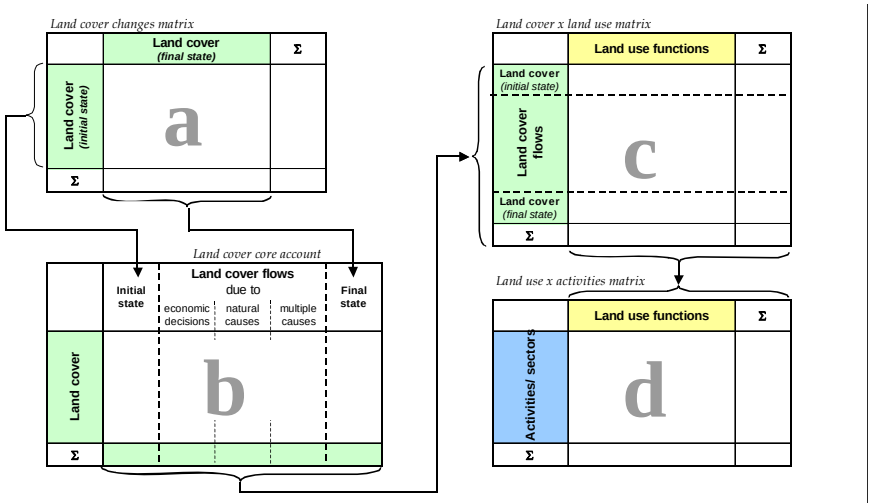

Figure 2: Structure of the basic set of land cover/land use accounts

A key distinction is introduced at this stage between **land use** and **land cover.** Although ambiguities may result from the fact that land cover (which can be observed from the sky) is sometimes considered as a proxy of land use when the latter cannot be surveyed with the appropriate field techniques, the distinction is essential, as it is clearly stated in the SEEA *(see the box below).*

A matrix (Figure 2 a) can, for example, be used to show how the stock of land in each cover category changes over time. Such a device is particularly useful because it records the transfers between categories as well as the overall change a given stock category exhibits over the 'accounting period'. Traditionally, such a change matrix has been used to present data on cover change from the analysis of satellite imagery or field survey data. Key features to note

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Land cover and land use *in SEEA 2003*

8.321 A basic distinction in land and ecosystem accounting is that between land cover and land use. Land cover reflects the (bio)physical dimension of the earth 's surface and corresponds in some regard to the notion of ecosystems. Typical examples for land cover categories are built-up areas, grassland, forests or rivers and lakes. Land use, on the other hand, is based on the functional dimension of land for different human purposes or economic activities. Typical categories for land use are dwellings, industrial use, transport, recreational use or nature protection areas.

8.322 Land use is a more complex issue than land cover because of the different functions a single land cover unit can fulfil. Often there are parallel or multiple land uses, in particular with regard to recreation /tourism and to use restrictions due to the protection status of land. A forest, for example, serves to provide timber, regulate climate and water regimes, sequester carbon dioxide, retain soil, provide habitat for wildlife and provide recreational functions. Land use in terms of human activities may result in changes in biophysical land cover (for example deforestation, transportation corridors, urbanisation) or in changes of the conditions of the natural or modified biotopes (due for example to use of fertilisers or pesticides or to leaving land fallow, to intensity of traffic on a road, or to the density of population in a town). These trade-offs among functions of natural assets are one of the focuses of the ecological-economic interrelationships that are studied in environmental accounting.

8.323 Land cover results from both the use of land by activities and natural processes, whether modified by human activities or not (see Conference of European Statisticians 1995). Land cover is normally observed by satellite observation, aerial photographs and ground surveys. Information on land use is gathered by cadastral surveys, surveys of economic units, aerial photography or ground surveys.

8.324 The distinction between land use and land cover is basic from an analytical point of view. Statistical work is, however, often characterised by more or less mixed classifications of land use and land cover. In principle land use can be better linked to economic activities. Sometimes land cover at a large scale is considered as a proxy for the use. Often built-up areas are more land use-oriented parts of the classification whereas the disaggregation of more natural categories (such as forest and woodland, wetland or semi-arid and arid land) reflects more land cover aspects. Sometimes the whole mixed classification is more use- or more cover-oriented. When a primary or dominant use is hard to determine, multiple allocation or a separate recording of multi use can be considered.

about the matrix are that the diagonal shows the proportion of each stock category that is stable over the monitoring period, while the row and column totals show the total initial and final stocks for each category.

These transformations expressed in the change matrix can be presented more clearly by constructing the table shown in Figure 2 b, which shows for each cover type the opening and closing balance, and the magnitude of the gains and losses due to various natural and economic factors. Such a Table is known as a **flow account**[7]. In the Table the (+) and the (-) values are explicit for each land cover, so that the final stock will equal the initial stock plus the algebraic sum of the flows into and out of that category. The ability to classify and represent these different types of transformation is a particular advantage of this kind of table over the simple matrix approach shown in Figure 2 a. More, the flows can be expressed as processes and defined on the basis of the analysis of elementary pairs of consumption of a given land cover type and formation of another one. In a second step, they can be grouped accordingly, which provides a very useful interpretation of the change.

In order to trace some of the implications of the changes in stock in a table such as that shown in Figure 2 b, a further matrix can be constructed, showing the multiple relations between land

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[7] Also known as a 'screen account' in traditional accounting practice

cover and land use (Figure 2 c). Such a matrix is particularly useful, because it represents the first step in relating land cover and use change to the various economic activity areas that are often a key aspect of any long-term policy strategy.

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Last (Figure 2 d), land use functions can be linked to economic accounts, directly or via satellite accounts.

The basic accounts as such contain extremely useful information on the processes that are taking place, as well as on their location via an adequate classification of the land reporting units in regions or landscape types. Therefore, policies can focus on those places or conditions where problems concentrate without loosing the overall picture.

A step further is however necessary to make the accounts fully operational by identifying and assessing the main interactions between use of land and the resulting impacts on landscapes, natural resources and the biodiversity. This necessity has been recognized and a solution proposed with the development of "supplementary" accounts targeted accounts. These accounts capture the essential specific aspects of a given environmental issue. They give the necessary detail of the links between this issue and economic and the social drivers on the one hand, as well as the environmental impacts, on the other hand.

This is summarised by the scheme below:

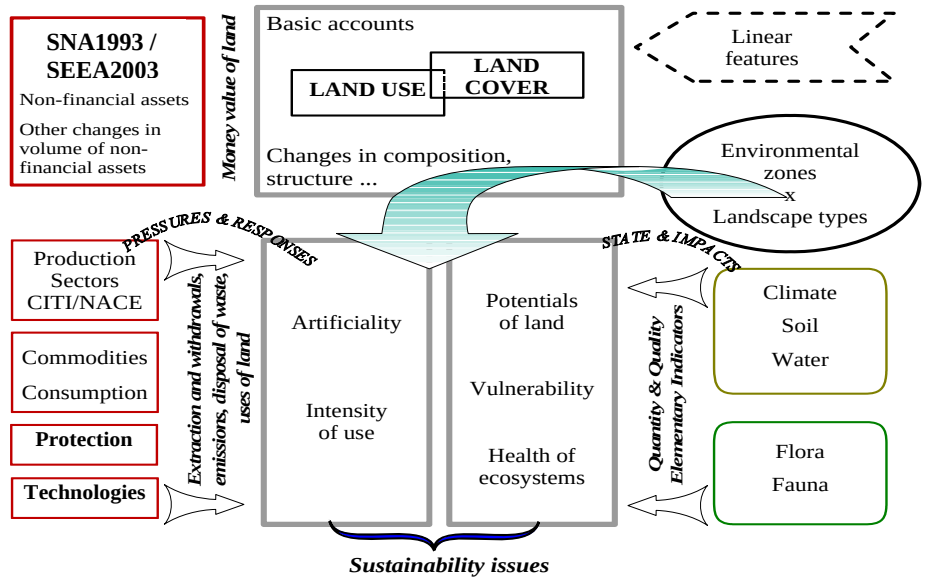

Figure 3: Overall framework of LEAC and of their connection to economic and environmental indicators

This framework is relevant at the national level where macro relations can be assessed. When it is possible and useful, geographical breakdowns are introduced to reflect strong interactions for given regions (e.g. coastal zones, river basins) or by landscape types (e.g. "dispersed urban areas", "upland composite rural landscape"). These breakdowns are useful for analysing environmental trends in particular in a sustainable development perspective, where thresholds have to be considered as reference values. They are as well important for policy-making as long as the information is reported in adequate formats.

In terms of information system, the "supplementary" targeted land accounts are part, on the one hand, of the satellite accounts of the national accounts, of which they are a subset or an extension. Symmetrically, they present a framework for environmental indicators, which can be interpreted alongside the DPSIR model. Driving forces, Pressures and Responses are presented on the left part of the figure when environmental State and Impacts are on the right side[8].

2 Implementation of land cover changes accounts (basic LEAC accounts) in Europe based on Corine Land Cover

2.1 Historical background

In the mid-90s, the European Commission and the EEA have carried out an experimental inventory of Europe's land cover based on the photo-interpretation of satellite images (Landsat and Spot), as part of the development of an environmental GIS for Europe called CORINE. A common methodology has been developed, including a standard classification, which is presented in annex 2. The project was first implemented for (and with) the Member States then in the countries acceding to EU. CORINE land cover (CLC) covers to-day more than 30 countries. After some years, it proved to be extremely useful for a wide range of uses in the environmental realm sensu stricto as well as for other policies such as agriculture, transport, land planning and in research. Therefore, the demand increased of an updating of the first inventory (which median year is 1990), with a particular emphasis on assessing land cover change. The European Commission proposed that this update is realised jointly with the Member States and Acceding Countries on the basis of a 50-50 sharing of the coast. This lead to the CORINE Land Cover 2000 project steered by the EEA with the support of the Joint Research Centre, the Directorates of Environment, Regional Policy and Agriculture of the Commission and the Member Countries of the EEA. CLC2000 is in progress, with half of the European territory available by the end of 2003 and hopefully completed for the second half by end 2004 (Greece and Turkey in 2005 due to a later start).

During this period, two tests had been carried out for the evaluation of CLC for assessing land cover change. One, known as LaCoast, was developed by the Joint Research Centre on the European coast in the context of the implementation of the new policy of integrated coastal zones management. EEA with 4 Central and Eastern Europe Countries, Czech Republic, Hungary, Romania and Slovakia carried out the second. In both cases, the reference year for the past was 1975, for which Landsat MSS images were available.

The preparation of the analysis of CLC2000 at the EEA met the development of environmental accounts at Eurostat and a decision was taken to experiment the production of land accounts on the basis of CLC.

[8] An additional loop should be presented on figure 3 for describing the impacts of environmental state on the economy (costs and benefits) and the society (health, quality of life).

2.2 Application of the LEAC methodology with CLC

As long as the purpose was to describe territories and the differentiation processes that are taking place all over Europe, the accounting exercise encompassed two actions:

- Definition of land analytical units, land reporting units and dominant landscape types on which can be based the interpretation of the changes.

- Analysis of the 44x44 cells of the CLC matrix of changes in order to identify the elementary processes that they reveal and classification in land cover flows.

2.2.1 CORINE Land Cover (CLC)

CLC is a European wide consistent land cover mapping based on the photo-interpretation of satellite images. The mapping scale is 1:100 000. The smaller mapping unit is of 25 ha and the smaller changes mapped are of 5 ha. More than 30 countries are now covered with CLC.

CLC nomenclature is made of 44 standard classes structured in a hierarchical way *(see annex).* An aggregated version is commonly used for reporting:

CLC 1	*Artificial surfaces*
CLC 2.1+2.2	*Arable Land & Permanent Crops*
CLC 2.3+2.4	*Pastures & Heterogeneous agricultural areas*
CLC 3.1	*Forests*
CLC 3.2+3.3	*Shrub and other semi-natural land*
CLC 4	*Wetlands*
CLC 5	*Water bodies*

Detailed handbooks are available at the EEA or via the following address: http://reports.eea.eu.int/COR0-part1/en and http://reports.eea.eu.int/COR0-part2/en

CLC update is foreseen every 10-year at the European scale and CLC2000 is presently produced as an update of CLC1990 and an assessment of land cover change.

2.2.2 Landscape analysis

The landscape analysis underlying LEAC aims at focussing on the strong interactions between environmental and socio-economic factors, which are often correlated to the physical geography and/or the historical heritage of territories. This means addressing the appropriate scales prior to producing aggregated indicators at the national or European levels. The purpose is to take stock of the uneven distribution of the phenomenon and of the differentiation processes of the territory as well as to produce new aggregates, which capture these changes and interactions more accurately.

Geographical or **zonal** accounts are particularly useful in the context of land cover and land use policy, because they allow us to see what geographical contrasts and differences occur between different regions and environments. More importantly they can show how a global indicator is expressed spatially.

Ideally, the zonal breakdowns used should be specific to the phenomenon under study. However, when we examine cross cutting issues and/or interactions, it is useful to find some commonalities, including some common geographical pattern.

Pre-existing units such as administrative units, river basins or other types of geographical breakdowns can be used. A classification of accounting units in Land Analytical and Reporting Units (LARU's) is shown below.

Nomenclature for Land Analytical and Reporting Units

A - Analytical Units

- Administrative Units
- Geographic Regions
- Geo-physical regions (River basins (small), Mountains areas (small…)
- Ecological regions (e.g. DMEER, Potential vegetation…)
- Other
- Land Analytical Units
- Geometric Units
- Grids
- Buffers

B - Reporting Units

- Administrative Regions, Countries
- Geographic Regions (e.g. River basins (large), Sea catchments, Mountain areas…)
- Bio-Geographic zones
- Geographic Sectors (grouping of LAU or Geometric Units according to proximity or to Landscape Types)

Other approaches that are available include analysing the territory with a regular grid to which are associated attributes related to physical geography, vegetation and ecosystems and by human activities. Multi-criteria analysis can be used, to define a set of zones according to the combination of a specific set of characteristics *(Figure 4)*.

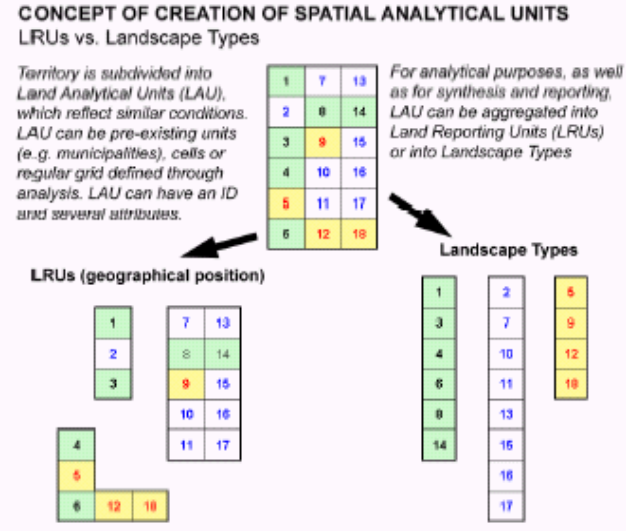

Figure 4: Methodology for the creation of spatial analytical units

A particular attention has been paid to the characterisation of accounting units according to Dominant Landscape Types. The methodology combines:

- an analysis of dominant land cover carried out with a smoothing algorithm so-called CORILIS (derived from Lacaze, Grasland et al.) and
- classes of relief based on general definitions (e.g. mountains means and the constraints of the available DTM at GISCO. The distinction is between : low coast (<50m), high coast and low inland, which compose altogether lowlands (<200m), uplands and mountains (> 1000m or + 500m when the average slope is > 2%).

The analysis of landscape types follows the broad principles defined in the Countryside Survey of Great-Britain (Departments in charge of Environment, 1980, 1990 & 2000) and tested in the Ecological Area Survey of Germany (StBA, 1998). The main difference is that the multi-criteria analysis has been based on smoothed values calculated from CLC instead of CLC values. The advantage of the methodology is that it gives in each point or cell of a grid the measurement of the intensity of a given topic, corresponding to the surface covered augmented by the surface in the surroundings (divided by the square of the distance to the centre of the cell). It allows therefore combining continuous values, with little or no holes at the working scale.

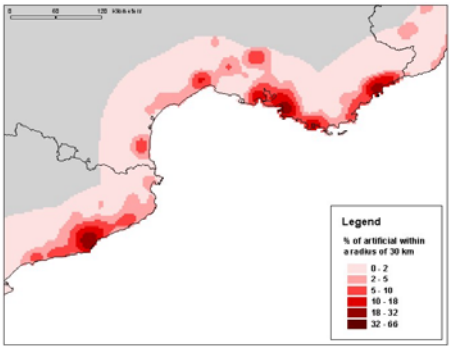

Figure 5: Example of result of CORILIS: Intensity of "artificial/urban" theme on a sector of the Mediterranean.

The rule for deciding of the dominant character of a cell was fixed in a following step, after testing several variants. The objective was to emphasise the urban pressure, which is less consuming in terms of hectares than agriculture but which is much more intense. The formula takes into consideration the values > mean + standard deviation of each (aggregated) land cover class, the calculation being done by broad geographical regions (so-called sea catchments). The grid below shows the rules for combining aggregated CLC classes into Dominant Land Cover Types.

	A1	A2	B1	B2	C1	C2	C3
Artificial							
Intensive agriculture							
Heterogeneous agriculture & Pasture							
Forests							
Non forested semi natural land							

Dominant LC character of the type
Possible co-dominance, considered as secondary
No co-dominance is possible

Figure 6: Correspondence between CLC (left) and DLT

At level 1, before incorporating relief criteria, the nomenclature of Dominant Landscape Types reads *(detailed nomenclature in Annex 2)*:

A1 Urban dense areas
A2 Dispersed urban areas
B1 Broad pattern intensive agriculture
B2 Composite rural landscape
C1 Forested landscape
C2 Open semi-natural or natural landscape
C3 Landscape with no dominant land cover character

The various steps of the process can be summarized as such:

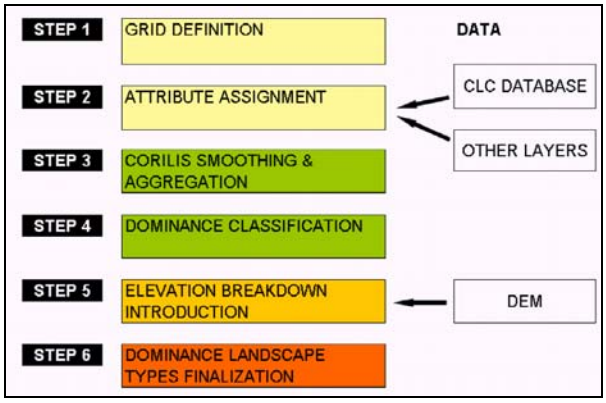

Figure 7: Steps of creation of Dominant Landscape Types based on CORILIS methodology

The map of DLT has been produced for all Europe, on the basis of a grid of 3x3 km, based on CLC1990[9]. Results will be computed again when the standard km² grid of Europe is adopted in the process of establishment of a geographic infrastructure for Europe.

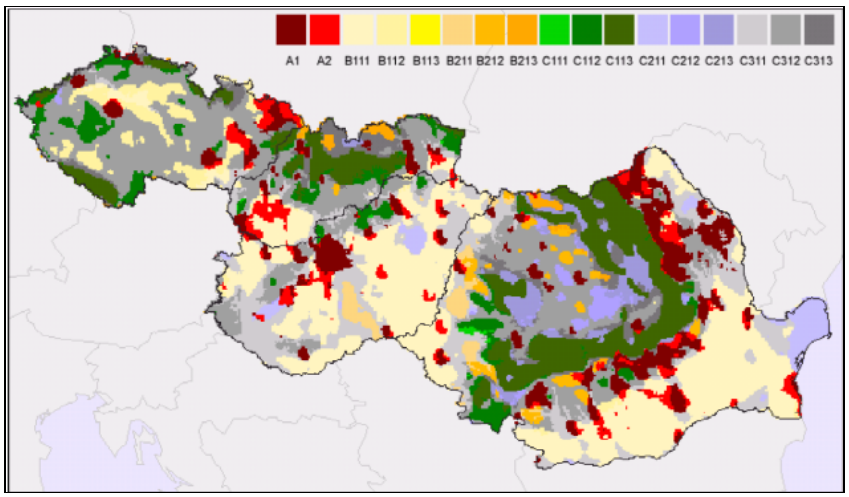

Figure 8: Dominant Landscape Types of 4 CEEC

[9] The database v.1 is available at the EEA.

2.2.3 Accounting framework for Land Cover accounts

2.2.3.1 Land cover flows

Land cover basic accounts have been established on the basis of the CLC matrixes of change 1975-1990. Individual changes (44x43, ~1900 cells) have been analysed, taking into accounts the initial land cover type and the final one. The purpose was to identify flows expressing processes. For example, the conversion of "Annual crops associated with permanent crops" into "forest" has been assigned to the flow "conversion of agriculture land to forests" but the conversion to "forests" of "Land principally occupied by agriculture with significant areas of natural vegetation" has been considered as "farmland abandonment with woodland creation". Typical flows are "continuous urban sprawl", "diffuse urban sprawl", "intensification of agriculture" (in the agriculture realm), "intensive conversion to agriculture", "diffuse conversion to agriculture"…

The level 1 of the flows classification reads *(detailed classification in annex)*:

LCF1 Urban land management
LCF2 Urban sprawl
LCF3 Extension of economic sites and infrastructures
LCF4 Agricultural rotation and intensification
LCF5 Conversion of land to agriculture
LCF6 Forests creation and management
LCF7 Water body creation and management
LCF8 Changes of land cover due to natural and multiple causes

Land cover flows have been established first for the case study on the coast. For the 4 CEE countries, CLC data on level 3 of CLC classification was available for 1990 year, while CLC data used for 1975 exist on level 2 only. Therefore the LCF definition had to be adapted to be applicable on level 2 and at the same time to be as much as possible consistent for use on both level 2 and level 3 of CLC data. In addition, a complete check up of the matrix of definition of land cover flows was done and several changes introduced.

LCF were originally classified for level 3/level 3 land cover changes, but analysis showed that most of the flows allowed aggregation of CLC classes to level 2 on consumption side ("from" class) of land cover change. Oppositely, aggregation of CLC classes to level 2 on formation side ("to" class) of the land cover change was not feasible without considerable modification in the LCF definition. Therefore, it has been decided that for the 4 CEEC study, the LCF definition based on level 2 / level 3 land cover change matrix would be used. It proved to be, with few exceptions, consistent with definition on level 3 /level 3 [10].

[10] Few exceptions in consistency between level 2 and level 3 matrices include:
• 243>22_ move from LCF52 "Intensive conversion of marginal land to agriculture" on level 3 to LCF42 "Planting of vineyards, fruit and olive trees over arable &pastures" on level 2.
• 243>21_ move from LCF52 "Intensive conversion of marginal land to agriculture" on level 3 to LCF45 "Intensification of agriculture" on level 2
• 213>41_, 42_ & 521 (abandonment of rice fields) move from LCF82 "Farmland abandonment without significant woodland creation" on level 3 to LCF89 "Other changes and unknown" on level 2.
• 523>423 move from LCF89 "Other changes and unknown" on level 3 to LCF86 "Coastal erosion" on level 2

Beside the exceptions described above, the extended diagonal has to be considered as well when using level 2/ level 3 change matrix. Obviously, this effect is concentrated on flows of internal rotations, but it can represent a limitation, when these flows are matter of specific interest.

This is the first version of the conversion table from the matrix of change to land cover flows. Improvements can be obtained in two different ways. The first one is a multi-scalar approach in which the assignments are validated according to the overall context defined by the dominant landscape types. The second approach is combining, region by region, information from cartography and statistics. Both ways will be explored in the next phases. Presently, priority will be to use the accounts and profit of their capacity to describe the European situation in a consistent way and at different scales.

2.2.3.2 Main tables

Four main tables are proposed for presenting the accounts:

- Matrix of Land Cover Change
- Account of Land Cover Change
- Account of Consumption and Formation of Land Cover
- Mixed Table of Use of Land Cover Resource

2.2.3.2.1 Matrix of land cover change

This is the traditional matrix presenting the change between stocks at two dates. The diagonal accounts for areas that have not changed. The rows record the output from a given class to another one (and the columns the inputs…). This presentation is directly derived from geographical databases. Its advantage is to present in a simple way the basic results. Its inconvenience is with its dependency on the level of aggregation retained. Therefore, the solution adopted is to measure the changes at the more detailed level and to accounts for internal rotations in an additional column. An example of land cover change matrix is:

FINAL YEAR ⇊ / OPENING YEAR ⇉		1 Artificial areas	2.1+2.2 Arable Land + Permanent crops	2.3+2.4 Pasture + Heterogeneous agricultural areas	3.1 Forests	3.2+3.3 Shrub and other natural & semi-natural areas	4 Wetlands	5 Water	TOTAL OPENING YEAR	*Increase*	*Decrease*	*Internal rotation*	*Net Changes 1975-1990*	TOTAL FINAL YEAR
1	Artificial areas	1264031	4813	8952	1454	4432	660	885	**1285227**	***186079***	***21196***	***21933***	*164883*	**1450110**
2.1+2.2	Arable Land+Permanent crops	63830	6450313	219568	6578	45874	15191	2421	**6803775**	***401183***	***353462***	***109632***	*47721*	**6851496**
2.3+2.4	Pasture + Heterogeneous agricultural areas	76048	316752	6160890	36559	51498	3040	1383	**6646170**	***291910***	***485280***	***378832***	*-193370*	**6452800**
3.1	Forests	11391	18971	13962	2557291	111889	931	945	**2715380**	***225868***	***158089***	***48854***	*67779*	**2783159**
3.2+3.3	Shrub and other natural & semi-natural areas	26945	57328	45677	171041	4148336	16343	8378	**4474048**	***227330***	***325712***	***298837***	*-98382*	**4375666**
4	Wetlands	4052	2664	3429	10016	10942	1351530	122918	**1505551**	***79790***	***154021***	***9668***	*-74231*	**1431320**
5	Water	3813	655	322	220	2695	43625	821027	**872357**	***136930***	***51330***	***7465***	*85600*	**957957**
TOTAL FINAL YEAR		**1450110**	**6851496**	**6452800**	**2783159**	**4375666**	**1431320**	**957957**	**24302508**	***1549090***	***1549090***	***875221***	*0*	**24302508**

Table 1: Consolidated Matrix of Land Cover Change on the European coast 1975-1990
Aggregated CLC classification; ha

2.2.3.2.2 Account of Land Cover Change

The second table is the **account of land cover change** directly derived from CLC matrix. The table present the total decrease and increase of each class, as well as the initial and final stocks. Increase and decrease are computed from the most detailed matrix of change, including internal rotations within aggregated classes, if any. The table records gross results.

Summary table			1	2.1+2.2	2.3+2.4	3.1	3.2+3.3	4	5	TOTAL COAST
			Artificial surfaces	Arable Land+Permanent Crops	Pastures+Heterogeneous agricultural areas	Forests	Shrub and/or other natural land	Wetlands	Water bodies	
A1	URBAN DENSE AREAS	1975	443027	357559	463575	236710	293099	100112	82866	1976950
		(-)	12312	26292	63728	16433	33166	20410	2878	175219
		(+)	54324	26810	33926	7985	31476	2935	17763	175219
		1990	485039	358077	433773	228262	291409	82637	97753	2007923
A2	DISPERSED URBAN AREAS	1975	356018	1116486	681108	256757	246902	79387	71898	2808556
		(-)	12798	67754	89278	11313	27495	8826	1908	219372
		(+)	67693	60826	52189	4965	23354	1130	9215	219372
		1990	410913	1109558	644019	250409	242761	71691	79205	2808556
B1	BROAD PATTERN INTENSIVE AGRICULTURE	1975	82468	1868999	369732	174192	93510	71455	101342	2761698
		(-)	1805	84251	45308	7494	24419	8176	2201	173654
		(+)	10430	84041	42387	4643	10614	14019	7520	173654
		1990	91093	1868789	366811	171341	79705	77298	106661	2761698
B2	COMPOSITE RURAL LANDSCAPE	1975	142553	1360293	2649937	220760	524374	175730	48386	5122033
		(-)	5289	97169	401739	14030	49724	11771	1201	580923
		(+)	28267	148987	325568	19904	45187	4572	8438	580923
		1990	165531	1412111	2573766	226634	519837	168531	55623	5122033
C1	FORESTED LANDSCAPE	1975	32153	131463	318407	931545	285362	13284	29975	1742189
		(-)	1842	10210	33957	71100	61841	658	770	180378
		(+)	6095	15433	16924	80722	59187	356	1661	180378
		1990	36406	136686	301374	941167	282708	12982	30866	1742189
C2	OPEN SEMI-NATURAL OR NATURAL LANDSCAPE	1975	64612	532812	775080	282041	2082340	870943	391503	4999331
		(-)	1940	58958	71517	38980	258576	87390	43512	560873
		(+)	11977	46128	67139	82932	223588	53653	75456	560873
		1990	74649	519982	770702	325993	2047352	837206	423447	4999331
C3	LANDSCAPE WITH NO DOMINANT LAND COVER CHARACTER	1975	164396	1436163	1388331	613375	948461	194640	146385	4891751
		(-)	7143	118460	158585	47593	169328	26458	6325	533892
		(+)	29226	128590	132609	73571	132761	12793	24342	533892
		1990	186479	1446293	1362355	639353	911894	180975	164402	4891751
TOTAL COAST		1975	1285227	6803775	6646170	2715380	4474048	1505551	872357	24302508
		(-)	43129	463094	864112	206943	624549	163689	58795	2424311
		(+)	208012	510815	670742	274722	526167	89458	144395	2424311
		Net Changes	164883	47721	-193370	67779	-98382	-74231	85600	0
		1990	1120344	6756054	6839540	2647601	4572430	1579782	786757	24302508

Table 2: Land Cover Change account (by land cover class)

2.2.3.2.3 Account of Consumption and Formation of Land Cover

Typically, the flows of consumption and formation can be analysed by land cover class and/or by region or dominant landscape type. The total amount of flows is independent of the level of aggregation.

Account of Consumption & Formation of Land Cover - European coast, 1975-1990, ha																		
Consumption of land cover										Formation of land cover								
1	2.1+2.2	2.3+2.4	3.1	3.2+3.3	4	5				1	2.1+2.2	2.3+2.4	3.1	3.2+3.3	4	5	
Artificial surfaces	Arable Land & Permanent Crops	Pastures & Mixed agricultural areas	Forests	Shrub and other semi-natural land	Wetlands	Water bodies	Total		Land cover flows	Artificial surfaces	Arable Land & Permanent Crops	Pastures & Mixed agricultural areas	Forests	Shrub and other semi-natural land	Wetlands	Water bodies	Total
15403	259	302	48	99		41	16152	LCF1	Urban land management	16152							16152
	40584	51657	7502	16314	178	131	116366	LCF2	Urban sprawl	116366							116366
6530	22987	24089	3841	10532	3874	3641	75494	LCF3	Extension of economic sites and infrastructures	75494							75494
	288686	605684					894370	LCF4	Agricultural rotation and intensification		388641	505729					894370
13765		57770	32933	103005	6093	977	214543	LCF5	Conversion of land to agriculture		122174	92369					214543
1454	7108	586	155744	171041	10016	220	346169	LCF6	Forests creation and management			633	238646	106890			346169
600	1695	1115	532	990			4932	LCF7	Water body creation and management							4932	4932
4702	101417	122710	6299	322040	141747	48005	746920	LCF8	Changes of Land Cover due to natural and multiple causes			72011	36076	418982	87312	132539	746920
	85433	*118419*					*203862*		*of which Farmland abandonment*			*72011*	*36076*	*95328*	*437*		
675	*358*	*199*	*44*	*528*	*1781*	*5780*	*9365*		*Adjustment*					*295*	*2146*	*6924*	*9365*
43129	**463094**	**864112**	**206943**	**624549**	**163689**	**58795**	**2424311**		**Sub/Total Flows**	**208012**	**510815**	**670742**	**274722**	**526167**	**89458**	**144395**	**2424311**
164883	***47721***	***-193370***	***67779***	***-98382***	***-74231***	***85600***			***Net Formation of Land Cover***								
208012	**510815**	**670742**	**274722**	**526167**	**89458**	**144395**	**2424311**		**TOTAL**	**208012**	**510815**	**670742**	**274722**	**526167**	**89458**	**144395**	**2424311**
									Land cover stock 1975	**1285227**	**6803775**	**6646170**	**2715380**	**4474048**	**1505551**	**872357**	**24302508**
									Net Formation of Land Cover	***164883***	***47721***	***-193370***	***67779***	***-98382***	***-74231***	***85600***	
									Land cover stock 1990	**1450110**	**6851496**	**6452800**	**2783159**	**4375666**	**1431320**	**957957**	**24302508**

Table 3: Account of Consumption and Formation of Land Cover

(This extremely summarised table illuminates that 26 types of land cover (green) are used for the formation of 10 types of new land cover (orange) only. At this level of aggregation, the only reverse flow is farmland abandonment).

2.2.3.2.4 Mixed Table of Use of Land Cover Resource

This a table that synthesises the consumption in terms of losses of land cover and the formation in terms of flows. It is a possible solution for presenting results by Regions or Dominant Landscape Types. Two examples are given in annex.

3 Targeted accounts and land use functions

Targeted (or Supplementary) accounts are a set of accounting tables connected to the LEAC basic accounts via the Land Use Functions account (*Figure 9*). Such accounts can incorporate detailed information on land such themes as biotopes and small linear features that occur in the landscape (hedgerows, lanes, walls…), rivers, buildings or transport networks, as well as data such for human population, vegetation, wildlife, crops. Targeted accounts can express stock and change in physical units, such as area or numbers, or there can be some attempt to monetize the account if this is appropriate.

The formal relationship of targeted accounts and basic accounts can be made at the level of land analytical units, where detailed and continuous statistics exist, as for population. More often, however, only more general information is available and more aggregated reporting units have to be created. Such accounts could, for example, be developed for large reporting units like Administrative Regions or River Basins when statistics are collected at this level.

The aggregation and linking process required to produce targeted accounts can be made either statistically or, as in the case of the present project, by landscape types, or be specific landscape characteristics derived from CORILIS, or from multi-variate statistical analysis of grids or of pre-established land units.

The value of targeted accounts is that they allow the calculation of a wider rage of indicators that can describe the potential or value or quality of particular resources, such as nature, or of the of intensity of pressure upon them. As a result, they allow the wider use of environmental accounts in decision-making processes.

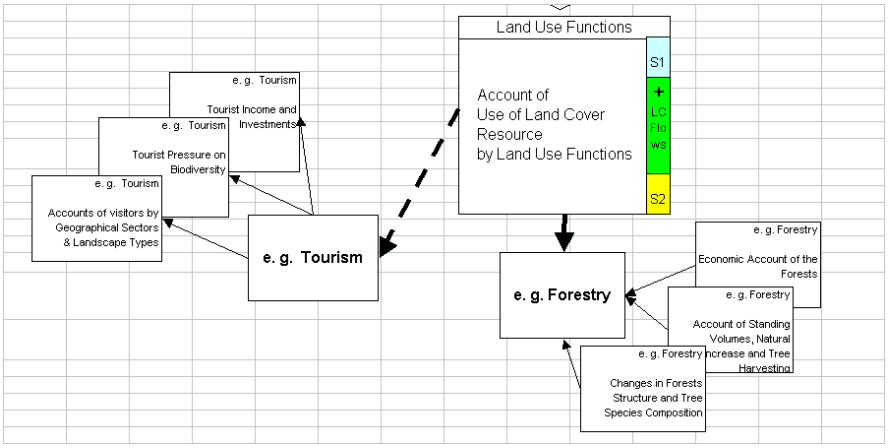

Figure 9: Relationship between basic and targeted accounts, linked by land use functions

3.1 The Use Functions of Land

The multiple use of the same land cover type is a well-known problem for statisticians and geographers. Generally, a given use is considered as the main or unique use, in a more or less arbitrary way. The advantage is that land cover surveys can be utilised as proxies of land use surveys. The inconvenience, ahead of some confusion, is a poor description of land use and of the resulting conflicts between men and Nature as well as between political, social or economic interests, which are the essence of the issue. The targeted accounts therefore have the ambition to set some simple rules that facilitate the organisation (and reading) of statistics and maps in this domain. Its is proposed that targeted accounts are:

- based on the concept of Land Use Functions;
- formally connected to land cover accounts in terms of total stock use as well as land cover consumption;
- flexible when addressing individual function in order to match the policy requirements in terms of environmental, economic and social data.

Targeted accounts are based on the concept of land use functions. **Land Use Functions** are described by the following nomenclature:

UF1 Residence, incl. services
UF2 Commerce
UF3 Transport
UF4 Industrial production
UF5 Energy production
UF6 Mining & quarrying
UF7 Waste dumping
UF8 Water management
UF9 Farming, food production
UF10 Forestry
UF11 Tourism & Recreation
UF12 Nature conservation
UF13 Other uses

Each function of this list can be subdivided according to specific analysis. Examples are given below for Tourism and Forestry where statistical assessments have been carried out. At a semi-aggregated level, these LUF nomenclatures read:

UF11 Tourism & recreation:
Housing & accommodation of tourists
Transport of tourists
Organised recreation
Countryside recreation
Site seeing

UF10 Forestry:
Wood production
Socio-economic functions (employment)

Of course, Forestry is not the unique function of Forests. Therefore, the targeted account of forests will cover a broader range of functions, reflecting the many uses of forested land. It can be summarised in the following figure:

Forest functions	Land use functions
Wood production	
Timber	UF10 Forestry
Pulp	UF10 Forestry
Firewood	UF10 Forestry UF5 Energy production
Other wood products	UF10 Forestry
Non-wood production	
Food	UF9 Farming, food production
Animal breeding	UF9 Farming, food production
Medicinal plants	UF9 Farming, food production
Industrial extracts	UF4 Industrial production
Protective functions	
Biodiversity protection	UF12 Nature conservation
Soil protection	UF12 Nature conservation
Landscape maintenance	UF12 Nature conservation
Water protection	UF8 Water management
Socio-economic functions	
Recreation & tourism	UF11 Recreation & Tourism
Provision of employment	UF10 Forestry UF13 Other uses
Research & education	UF13 Other uses

Figure 10: Functions of Forests and Land Use Functions

Therefore, in a given domain, Targeted Accounts will be made of a logical set of tables combing details of land cover accounts and relevant tables, of which some will be part of other SEEA accounts and others, if any, part of SNA satellite accounts.

3.2 Linkage of Basic Accounts and Targeted Accounts by Land Use Functions

Figure 11 shows the Use of Land Cover Resource by Land Use Functions, the stock used as well as the way it expands or shrinks over the accounting period.

Changes in land use may result in change in land cover, e.g. extension of residence areas and urban sprawl. But it is not always the case and the change in the surface used by a function may take place without any consumption and formation of land cover. For example, the expansion of cattle husbandry may as well simply use “CLC321 Natural pasture” without any land cover change (at least, during the accounting period).

More generally, the possible multiple uses of a given land cover require a separate accounting. Extensive Tourism (e.g. camping in forests) or the new protection of a forest (an extension of the Use Function “Nature protection”) does not generate loss of forests, although they may have consequences on the “Forestry” function. Consequently, the total allocation of

land to these functions is important in environmental and economic assessment and in policy-making, in particular when multiple use results in possible conflicts of use.

The basic equation of the Supply & Use of Land Cover Resource by Land Use Functions is:

Initial surface
+ Net Formation of Land Cover by Use
+ Net Extension of Use without Formation of Cover
= Final surface

This equation is valid for each individual function. When addressing several functions, overlaps generally happen due to possible multiple uses. Therefore, an additional column is necessary to adjust the total by deducing the multiple uses and maintain a formal identity between the sum total of land use and of land cover.

This last point is disputable when considering the Change in Use without Formation of Cover. As long as the total surface depends on the number of functions identified, it seams reasonable not to present results for this total. However, the land used by each individual function is presented and can always be added to others for specific analysis.

Use of Land Cover Resource by Land Use Functions	UF1 Residential, incl. services	UF2 Commercial	UF3 Transport	UF4 Industrial production	UF5 Energy production	UF6 Mining & quarrying	UF7 Waste dumping	UF8 Water management	UF9 Farming, food production	UF10 **Forestry**	UF11 **Tourism & Recreation**	UF12 Nature conservation	UF13 Other uses	*ADJUSTMENT FOR MULTIPLE USES*	TOTAL
Initial surface															
1 Artificial surfaces															
2.1+2.2 Arable Land & Permanent Crops															
2.3+2.4 Pastures & Mixed agricultural areas															
3.1 Forests															
3.2+3.3 Shrub and other semi-natural land															
4 Wetlands															
5 Water bodies															
A - TOTAL INITIAL SURFACE ~1975															
Net Formation of Land Cover by Use															
LCF1 Urban land management															
LCF2 Urban sprawl															
LCF3 Extension of economic sites and infrastructures															
LCF4 Agricultural rotation and intensification															
LCF5 Conversion of land to agriculture															
LCF6 Forests creation and management															
LCF7 Water body creation and management															
LCF8 Changes of Land Cover due to natural and multiple causes															
B - TOTAL Net Formation of Land Cover															**0**
Net Extension of Use without Formation of Cover															
1 Artificial surfaces															
2.1+2.2 Arable Land & Permanent Crops															
2.3+2.4 Pastures & Mixed agricultural areas															
3.1 Forests															
3.2+3.3 Shrub and other semi-natural land															
4 Wetlands															
5 Water bodies															
C - TOTAL Net Extension of Use without Formation of Cover															
Final Surface															
1 Artificial surfaces															
2.1+2.2 Arable Land & Permanent Crops															
2.3+2.4 Pastures & Mixed agricultural areas															
3.1 Forests															
3.2+3.3 Shrub and other semi-natural land															
4 Wetlands															
5 Water bodies															
D - TOTAL FINAL SURFACE ~1990 (D = A+B+C)															

Figure 11: Use of Land Cover Resource by Land Use Functions

3.3 Examples of frameworks of a targeted accounts for Tourism and Forests

In the pilot studies on the feasibility of LEAC with Corine Land Cover, 2 issues have been identified for tests: Tourism on the coastal zone and Forestry for the Czech Republic. They are both made of a list of Land Use Functions and a set of tables.

3.3.1 Tourism

In the case of Tourism, the test has been twofold: methodology and statistical implementation. Due to difficulties in collecting statistics, the methodological framework has not been tested and has to be considered as a very preliminary proposal. However, it shows clearly how the various sub accounts match and what is the interest in bridging them together.

The land use functions of Tourism are:

- Housing & accommodation of tourists
  - Hotels and similar
  - Tourist campsites
  - Holiday dwellings and other collective accommodation
  - Second homes
  - Accommodation by family and friends
- Transport of Tourists
  - Shopping and restauration areas
  - Airports in Tourism areas
  - Other airports
  - Specific transport infrastructure of Tourism areas
  - General transport infrastructure
- Organised recreation
  - Recreation parks and resorts
  - Marinas
  - Golf courses and other sport grounds
  - Countryside recreation

The accounting framework is composed of 5 accounts:

- Use of Land Cover Resource for Tourism & Recreation
- Population Account of Tourism areas (no. of persons)
- Supply & Use of Water in tourist areas (to be detailed), Quarterly accounts
- Tourism and Nature: Tranquillity Accounts (to be detailed)
- Tourism economic accounts (satellite account)
  - Account of specific tourism parameters (physical units)
  - Expenditures of the tourists (in €)
  - Investments in tourist areas (in €)
  - Tourism Balance of Payments (in €)
  -

Deleted: First, a classification of sub-functions has been established for Tourism. This classification takes into account the categories commonly used in Tourism statistics and Indicators (Table 6.1)¶
¶

Deleted: (nb

Deleted: Tourist Balance of Payments

The framework has been established in relation to existing regional statistics on tourism at Eurostat (which were not sufficient for getting details for the 10 km coastal strip covered by the basic accounts), a report under preparation at the EEA on tourism and environment reporting and on the framework of the Satellite Account of Tourism published every year in France.

3.3.2 Forests

Forest accounts are key element in designing the so-called "targeted accounts for forests" which aim at bridging them with the overall Land and Ecosystems Accounts. The references taken in LEAC are SEEA2003 – "System of Integrated Environmental and Economic Accounting" [11] and IEEAF (2002) – "The European Framework for Integrated Environmental and Economic Accounting for Forests" [12].

Functions of Forests and Land Use Functions have been presented above in Figure 9. The LEAC targeted accounts of forests are the following:

- Use of Land Cover Resource for Forestry and other functions of forests
- Forests by Dominant Landscape Types - broadleaves/coniferous (ha)
- Forests by districts and/or forest regions - broadleaves/coniferous (ha)
- Forest composition / age /structure / ownership / monetary value, by districts and/or forest regions (ha)
- Forest stocks and use (m3) by districts and/or forest regions
- Supply and use of wood m3 (annual)
- Carbon balance of the forest (annual, cf UNFCCC) by districts and/or forest regions to be defined
- Forest non-wood products by districts and/or forest regions, in tons and in €
- Forests and protection, by (a) landscape types, or by (b) districts and or forest regions, ha, %
- Forests under nature protection designation
- Forest composition and biodiversity, health of forest ecosystems by (a) landscape types, or by (b) districts and or forest regions (ha)
- Social account of forests, by districts and/or forest regions

A comprehensive data collection has been carried out for the forests of the Czech Republic[13]. Some results are presented par forests regions and/or by administrative districts (NUTS 4).

In comparison with the forest accounts of SEEA or IEEAF, the targeted forest accounts have usually to be simplified as long as not all statistics can be available for the geographical breakdown of land cover accounts. However, as long as most statistical difficulties come from the structural changes that have taken place in the country between 1975 and now (and of their consequences in terms of administrative an statistical organisation), improvement can reasonably be expected.

The accounting exercise scrutinises past, existing and emerging statistical sources for all the issues covered by the theoretical framework of LEAC targeted to forests. It includes a detailed

[11] .Integrated Environmental and Economic Accounting 2003 (SEEA 2003), ST/ESA/STAT/SER.F/61/Rev.1 (Final Draft)

[12] The European Framework for Integrated Environmental and Economic Accounting for Forests- IEEAF. Luxembourg: Office for Official Publications of the European Communities, 2002, Cat. No. KS-BE-02-003-EN-N

[13] cf. Lucie Kupková in **Integration of geographical and statistical data in the environmental accounting framework; methodological development based on two case studies: Action 1: Accounts of the impacts on Forest and Biodiversity of Land Cover/Land Use changes; case from the land cover changes 1975-90 in the 4 Central and Eastern European countries**, op. cit. - available on the website of the EEA at http://eea.eionet.eu.int:8980/Public/irc/eionet-circle/leac/library

set of practical proposals and options for a practical implementation and confirms the interest of such accounts as a bridge between forests and land accounting.

Conclusion

The implementation of land cover accounts from land cover inventories carried out from satellite images is feasible. The EEA is preparing now the systematic production of these accounts on the basis of Corine land cover 1990 and 2000.

The advantages of such accounts are in the geographical breakdowns that they introduce and in the comparability of the results throughout Europe given by the use of a standard methodology. This is an important element of the development of environmental integrated spatial assessments, which are now foreseen as a combination of GIS analysis, environmental accounting and modelling (alongside the DPSIR chain). First applications are foreseen in the domains of land planning (better integration of the environmental dimension in the European Spatial Development Perspective and the regional policy of EU), Integrated Coastal Zones Management at the European scale (streamlining of macro indicators in reference to coastal units and land cover flows) and agri-environmental indicators (the so-called IRENA project run by EC's DGs Agriculture & Environment, EEA and Eurostat.

Of course, several developments need to be carried out. First in terms of ecosystem accounting, expectations are in the possibility to correlate land use (and its drivers) with the extension and condition of the ecosystems and habitats following an approach similar to that of the Countryside Survey of Great Britain, which last report is called "Accounting for Nature"[14]. It could supply new indicators for assessing the state of biodiversity in Europe, one of the major challenges being its stabilisation by 2010. Methodological framework of ecosystems accounts has to be elaborated further, in particular in the perspective of filling the gap presently existing between the exhaustive assessment of the "surface" of the ecosystems (land cover) and the in-depth assessment of selected (designated) natural areas.

Second, cartographic and statistical approaches of land should converge in order to permit the delivery of accounts at a shorter frequency than the 10 years of Corine land cover. This could be achieved with simplified accounts, as long as they don't loose the geographical dimension of LEAC, which is essential when addressing land issues in the perspective of integrated assessments. Therefore, the expectation is that land use sampling surveys will incorporate systematically a spatial stratification by landscape types.

Third, social and economic statistics need to be more broadly accessible at the local level. When it is not possible, estimation methods have to be implemented in order to respond to the increasing needs of the users. This is another aspect of the integration of the information system required by sustainable development policies. The first, horizontal, aspect is that of the integration of environmental, economic and social dimensions. The second, vertical, aspect relates to the governance issue and the need for the actors at the various levels to integrate sustainability considerations in their own decision processes. Altogether with other tools offered by the technology or the statistics, LEAC can be a link between the central vision of policies and their local implementation.

[14] Haines-Young, R.H. *et al* (2000) **Accounting for nature: assessing habitats in the UK countryside**, DETR, London ISBN 1 85112 460 8, available at http://www.cs2000.org.uk/Report_HTML/index.htm

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Annex 1: ***CORINE Land Cover standard classification***

Level 1	Level 2	Level 3
1. Artificial surfaces	1.1 Urban fabric	1.1.1 Continuous Urban Fabric
		1.1.2 Discontinuous Urban Fabric
	1.2 Industrial, commercial and transport units	1.2.1 Industrial Or Commercial Units
		1.2.2 Road and Rail Networks and Associated Land
		1.2.3 Port Areas
		1.2.4 Airport
	1.3 Mines, dump and construction sites	1.3.1 Mineral Extraction Sites
		1.3.2 Dump Sites
		1.3.3 Construction Sites
	1.4 Artificial non-agricultural vegetated areas	1.4.1 Green Urban Areas
		1.4.2 Sport And Leisure Facilities
2. Agricultural areas	2.1 Arable Land	2.1.1 Non-Irrigated Arable Land
		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 agricultural areas	2.4.1 Annual Crops Associated With Permanent Crops
		2.4.2 Complex Cultivation Patterns
		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 vegetation associations	3.2.1 Natural Grassland
		3.2.2 Moors And Heathland
		3.2.3 Sclerophyllous Vegetation
		3.2.4 Transitional Woodland-Shrub
	3.3 Open spaces with little or no vegetation	3.3.1 Beaches, Dunes, And Sand Plains
		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 Peat bogs
	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 Coastal waters	5.2.1 Coastal lagoons
		5.2.2 Estuaries
		5.2.3 Sea and ocean

Annex 2: ***Nomenclature of Dominant Landscape Types of Europe, v.1***

A1 Urban dense areas
A2 Dispersed urban areas
B1 Broad pattern intensive agriculture
B11 Lowland broad pattern intensive agriculture
B111 Low coastal broad pattern intensive agriculture
B112 High coastal broad pattern intensive agriculture
B113 Low inland broad pattern intensive agriculture
B12 Upland broad pattern intensive agriculture
B13 Mountain broad pattern intensive agriculture
B2 Composite rural landscape
B21 Lowland composite rural landscape
B211 Low coastal composite rural landscape
B212 High coastal composite rural landscape
B213 Low inland composite rural landscape
B22 Upland composite rural landscape
B23 Mountain composite rural landscape
C1 Forested landscape
C11 Lowland forested landscape
C111 Low coastal forested landscape
C112 High coastal forested landscape
C113 Low inland coastal forested landscape
C12 Upland forested landscape
C13 Mountain forested landscape
C2 Open semi-natural or natural landscape
C21 Lowland open semi-natural or natural landscape
C211 Low open semi-natural or natural landscape
C212 High open semi-natural or natural landscape
C213 Low inland open semi-natural or natural landscape
C22 Upland open semi-natural or natural landscape
C23 Mountain open semi-natural or natural landscape
C3 Landscape with no dominant land cover character
C31 Lowland with no dominant land cover character
C311 Low landscape with no dominant land cover character
C312 High landscape with no dominant land cover character
C313 Low inland landscape with no dominant land cover character
C32 Upland with no dominant land cover character
C33 Mountain with no dominant land cover character

Annex 3: ***Nomenclature of Land Cover Flows***

LCF1 Urban land management
- *LCF11 Urban development/ infilling*
- *LCF12 Developed land recycling*
- *LCF13 Development of green urban areas*

LCF2 Urban sprawl
- *LCF21 Urban continuous sprawl*
- *LCF22 Urban diffuse sprawl*

LCF3 Extension of economic sites and infrastructures
- *LCF31 Extension of industrial & commercial sites*
- *LCF32 Extension of transport networks*
- *LCF33 Extension of harbours*
- *LCF34 Extension of airports*
- *LCF35 Extension of mines and quarrying areas*
- *LCF36 Extension of dumpsites*
- *LCF37 Construction*
- *LCF38 Extension of sport and leisure facilities*

LCF4 Agricultural rotation and intensification
- *LCF41 Recent extension of pasture, fallow land, set aside*
- *LCF42 Planting of vineyards, fruit and olive trees over arable & pasture*
- *LCF43 Rotation of annual crops*
- *LCF44 Rotation of permanent crops*
- *LCF45 Intensification of agriculture*

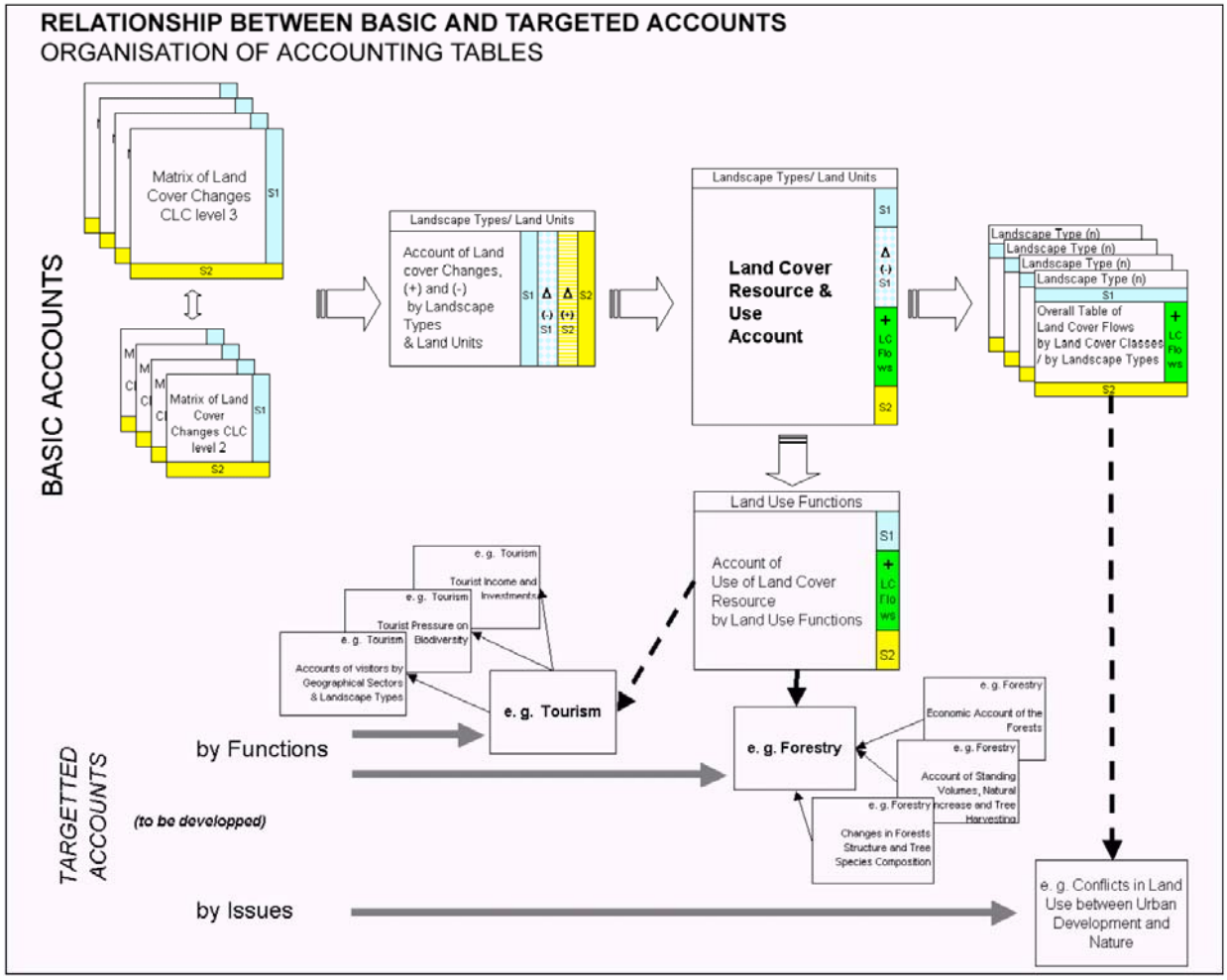
LCF5 Conversion of land to agriculture
- *LCF51 Intensive conversion of forest to agriculture*
- *LCF52 Intensive conversion of marginal land to agriculture*
- *LCF53 Diffuse conversion of forest to agriculture*
- *LCF54 Diffuse conversion of marginal land to agriculture*
- *LCF55 Conversion of wetlands to agriculture*
- *LCF56 Conversion of developed areas to agriculture*

LCF6 Forests creation and management
- *LCF61 Forests creation*
- *LCF62 Forests rotation*
- *LCF63 Recent felling and transition*

LCF7 Water body creation and management
- *LCF71 Water body creation*
- *LCF72 Water body management*

LCF8 Changes of land cover due to natural and multiple causes
- *LCF81 Semi-natural creation*
- *LCF82 Semi-natural rotation*
- *LCF83 Farmland abandonment without significant woodland creation*
- *LCF84 Farmland abandonment with woodland creation*
- *LCF85 Other land abandonment (other than farmland)*
- *LCF86 Forests and shrubs fires*
- *LCF87 Coastal erosion*
- *LCF88 Impacts of storms, floods…*
- *LCF89 Other changes and unknown*

Annexe 4: ***Relations between basic and targeted accounts***



Annex 5: ***Use of Land Cover Resource, European Coast, 1975-1990***

Summary Account	Dominant Landscape Types										TOTAL
	A1	**A2**	**B1**	***B211***	***B212***	***C111***	***C112***	***C211***	***C212***	***C311***	
	Urban Dense Areas	Dispersed Urban Areas	Broad Pattern Intensive Agriculture	Low Coastal Composite Rural Landscape	High Coastal Composite Rural Landscape	Low Coastal Forested Landscape	High Coastal Forested Landscape	Low Coastal Open Semi-Natural Or Natural Landscape	High Coastal Open Semi-Natural Or Natural Landscape	Low Coastal With No Dominant Land Cover Character	
A - OPENING SURFACE ~ 1975	**1976950**	**2808556**	**2761698**	***2341844***	***2780189***	***547153***	***1195036***	***2122568***	***2876763***	***2391115***	**24302508**
Consumption (loss) of Land Cover Resource											
CLC1 Artificial surfaces	12312	12798	1805	*2995*	*2294*	*1290*	*552*	*1046*	*894*	*3899*	43129
CLC2 Agricultural areas	90020	157032	129559	*226712*	*272196*	*10432*	*33735*	*42884*	*87591*	*133928*	1327206
2.1+2.2 Arable Land & Permanent Crops	26292	67754	84251	*43159*	*54010*	*4500*	*5710*	*21465*	*37493*	*62874*	463094
2.3+2.4 Pastures & Mixed agricultural areas	63728	89278	45308	*183553*	*218186*	*5932*	*28025*	*21419*	*50098*	*71054*	864112
CLC3 Forests and semi-natural areas	49599	38808	31913	*13177*	*50577*	*27531*	*105410*	*57154*	*240402*	*44827*	831492
3.1 Forests	16433	11313	7494	*2568*	*11462*	*16030*	*55070*	*2234*	*36746*	*9772*	206943
3.2+3.3 Shrub and other semi-natural land	33166	27495	24419	*10609*	*39115*	*11501*	*50340*	*54920*	*203656*	*35055*	624549
CLC4 Wetlands	20410	8826	8176	*9436*	*2335*	*658*	*0*	*76538*	*10852*	*24824*	163689
CLC5 Water bodies	2878	1908	2201	*1201*	*0*	*740*	*30*	*42693*	*819*	*6233*	58795
B - TOTAL CONSUMPTION OF LAND COVER	**175219**	**219372**	**173654**	***253521***	***327402***	***40651***	***139727***	***220315***	***340558***	***213711***	**2424311**
Formation of Land Cover											
LCF1 Urban land management	3993	6454	706	1032	1248	497	260	308	138	997	16152
LCF2 Urban sprawl	30962	36367	6408	10893	6529	1929	1097	4477	2095	9855	116366
LCF3 Extension of economic sites and infrastructures	19369	24872	3316	4878	3687	1736	576	3459	1500	8006	75494
LCF4 Agricultural rotation and intensification	44641	90815	100941	202098	214228	3892	6105	22723	31184	99162	894370
LCF5 Conversion of land to agriculture	14406	19681	22157	9646	40088	6165	12117	8769	24444	19945	214543
LCF6 Forests creation and management	15929	7524	6083	3219	18607	15593	81316	14275	91977	11398	346169
LCF7 Water body creation and management	452	967	579	97	401	688	238	172	118	563	4932
LCF8 Changes of Land Cover due to natural and multiple causes	45241	32588	32627	20577	42614	10139	38018	161929	189034	60964	746920
LCF81 Semi-natural creation	*1008*	*559*	*1107*	*297*	*616*	*25*	*660*	*1110*	*3007*	*993*	*10608*
LCF82 Semi-natural rotation	*10523*	*11186*	*11059*	*4673*	*10688*	*6140*	*13915*	*32279*	*133497*	*21217*	*317119*
LCF83+LCF84 Farmland abandonment without significant woodland creation+Farmland abandonment with woodland creation	*7691*	*8672*	*7573*	*6270*	*29707*	*3531*	*23283*	*11348*	*46969*	*13821*	*203852*
LCF85 Other land abandonment (other than farmland)	*1693*	*819*	*273*	*441*	*12*	*68*	*75*	*101*	*452*	*676*	*5002*
LCF86 Forests and shrubs fires	*5282*	*3052*	*50*	*45*	*1390*	*0*	*44*	*914*	*4038*	*981*	*20213*
LCF87 Coastal erosion	*16502*	*7110*	*4254*	*7845*	*63*	*33*	*22*	*69786*	*0*	*15844*	*121485*
LCF88 Impacts of storms, floods…	*76*	*78*	*136*	*185*	*22*	*172*	*6*	*172*	*0*	*386*	*1242*
LCF89 Other changes and unknown	*2692*	*1216*	*9012*	*1902*	*116*	*182*	*13*	*50422*	*1139*	*9867*	*76764*
C - TOTAL FORMATION OF LAND COVER	**175219**	**219372**	**173654**	***253521***	***327402***	***40651***	***139727***	***220315***	***340558***	***213711***	**2424311**
D - FINAL SURFACE ~ 1990 (D = A-B+C)	**1976950**	**2808556**	**2761698**	***2341844***	***2780189***	***547153***	***1195036***	***2122568***	***2876763***	***2391115***	**24302508**

Annex 6: ***Use of Land Cover Resource, 4 CEE Countries, 1975-1990***

Summary Account		Landscape Types							
		A1 Urban dense areas	A2 Dispersed urban areas	B1 Broad pattern intensive agriculture	B2 Composite rural landscape	C1 Forested landscape	C2 Open semi-natural or natural landscape	C3 Landscape with no dominant land cover character	TOTAL
A - TOTAL INITIAL SURFACE ~ 1975		**3826767**	**1919825**	**11620390**	**1693580**	**7375943**	**2639629**	**16766525**	**45842658**
Consumption of Land Cover Resource (Supply by Land Cover)									
1	*Artificial surfaces*	10075	3514	6711	147	3210	1346	9959	34962
2.1+2.2	*Arable Land + Permanent Crops*	49217	28491	204041	131058	18448	27433	206058	664746
2.3+2.4	*Pastures + Heterogeneous agricultural areas*	25616	6006	36043	28603	73014	12180	131700	313162
3.1	*Forests*	34629	12948	61967	15361	231287	37874	230420	624485
3.2+3.3	*Shrub and other semi-natural land*	54770	14385	89311	12778	90075	28000	119180	408499
4	*Wetlands*	1096	2366	23542	225	441	52912	17819	98401
5	*Water bodies*	3847	2727	16124	340	964	15904	14997	54903
B - TOTAL CONSUMPTION OF LAND COVER RESOURCE		**179250**	**70436**	**437740**	**188512**	**417438**	**175650**	**730132**	**2199158**
Land Cover Flows resulting from Changes in the Uses of Land									
LCF1	Urban land management	4636	890	1128	28	315	256	1994	9247
LCF2	Urban sprawl	5623	1863	6330	397	3284	1190	8409	27095
LCF3	Extension of economic sites and infrastructures	16936	8378	8477	382	4822	1341	12937	53273
LCF4	Agricultural rotation and intensification	36990	16681	154071	127077	38605	11460	218748	603631
LCF41	*Recent extension of pasture, fallow land, set aside*	*15484*	*8243*	*74729*	*115283*	*21629*	*2979*	*115583*	*353929*
LCF42	*Planting of vineyards, fruit and olive trees over arable & pasture*	*9949*	*3281*	*35834*	*2052*	*865*	*6443*	*31807*	*90231*
LCF45	*Intensification of agriculture*	*11557*	*5157*	*43509*	*9743*	*16111*	*2038*	*71358*	*159472*
LCF5	Conversion of land to agriculture	42505	14358	97918	11269	28244	49725	116077	360096
LCF51	*Intensive conversion of forest to agriculture*	*4734*	*2811*	*14752*	*1572*	*1396*	*1147*	*22171*	*48584*
LCF52+LCF54	*Conversion of marginal land to agriculture*	*27640*	*7165*	*55269*	*5951*	*10534*	*8670*	*46706*	*161935*
LCF53	*Diffuse conversion of forest to agriculture*	*6369*	*1659*	*6688*	*3342*	*14833*	*2512*	*26775*	*62178*
LCF55	*Conversion of wetlands to agriculture*	*1246*	*1537*	*16496*	*331*	*214*	*36797*	*16284*	*72905*
LCF6	Forests creation and management	40806	11573	73808	17699	289351	54226	249392	736856
LCF61	*Forests creation*	*21756*	*5751*	*37897*	*7472*	*78441*	*21612*	*74403*	*247333*
LCF63	*Recent felling and transition*	*19050*	*5822*	*35911*	*10227*	*210910*	*32614*	*174989*	*489522*
LCF7	Water body creation and management	5934	4864	9931	641	2364	2461	12405	38600
LCF8	Changes of land cover due to natural and multiple causes	25820	11828	86078	31019	50453	54992	110171	370361
LCF82	*Farmland abandonment without significant woodland creation*	*15367*	*6731*	*53738*	*27888*	*43576*	*23274*	*76857*	*247431*
LCF83	*Farmland abandonment with woodland creation*	*3442*	*624*	*2098*	*2458*	*4691*	*2815*	*9182*	*25309*
LCF84	*Other land abandonment (other than farmland)*	*1941*	*603*	*284*	*30*	*563*	*129*	*2400*	*5949*
LCF89	*Other changes and unknown*	*1220*	*746*	*7237*	*300*	*408*	*3213*	*3801*	*16926*
C - TOTAL LAND COVER FLOWS 1975-1990		**179250**	**70436**	**437740**	**188512**	**417438**	**175650**	**730132**	**2199158**
D - Final Surface ~ 1990 (D = A-B+C)		**3826767**	**1919825**	**11620390**	**1693580**	**7375943**	**2639629**	**16766525**	**45842658**