UP-DATING A LAND-USE INVENTORY

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ABSTRACT

In 1977 begun a land-use inventory of the French littoral. It consisted in a series of 147 large-format sheets at 1:25000 with about 50 categories for land and sea uses. The work has been completed by Institut Géographique National using computer-aided methods for producing maps and statistical data. By-products have been made at the same time. In 1982 a new air-photographic coverage has been made and photo-interpreted. The results were hand-drawn documents specially designed accordind to the up-dating digital process. Several difficulties appeared such as misfits between boundaries due to dimensional variations in base materials. Different kinds of products are proposed : modification maps, up-dated land-use maps, evolution maps, regional synthesis maps, statistical data, etc. This land-use up-dating stresses difficulties resulting from taxonomic changes : modifications appear as necessities in order to make the maps fit present decision-makers requirements which evolve between inventories. Will geographic information systems be able to take into account such a flexibility ?

INTRODUCTION

The "Inventaire Permanent du Littoral" (IPLI) is an interministerial organisation in charge of creating and maintaining analysis tools for the coastal area use in order to help in leading a protection policy in this area. The basic tool is a land use map at 1:25000 made from aerial-photographs interpretation and from subsidiary data compiled by local administrations.

The map states the situation at a precise time. Its inclusion into a management procedure forced to plan its up-dating and digital techniques were developed at the Institut Géographique National - France (IGN-F) in that respect. Despite precautions the up-dating process induces many difficulties.

INITIAL INVENTORY

The first inventory had been made from an air-photographic coverage dated on summer 1977. The communes sharing the coastline had been described through about thirty land-use categories and a maritime area with about the same 5-kilometre width had been described through ten categories. The polygons defining land and sea uses have been digitized in raster mode, as well as the administrative boundaries dealing with 1000 among the 36500 French communes.

Standard products have been (Grelot 1982) :
(a) a series of 147 A0-size sheets printed in four colours ;
(b) a statistical data file with the distribution of land uses within each commune.

Several by-products have been added such as small-scale maps (1:100000) directly drawn from archive files. Each one covers five to ten 1:25000 sheets and synthesizes land use in about ten categories.

UP-DATING DESIGN

As soon as the first inventory has been completed, a new photographic coverage was made during summer 1982. At the very same time the up-dating cartographic procedure was studied and showed a complex situation.

The 147 sheets consisted in 400000 polygons : for economical reasons it would not have been possible to interactively allocate a new attribute to each polygon according to its new characteristics. Moreover modifications often concerned polygon boundaries.

The sheets were not homogeneous. Although two years had been spent for defining the initial legend, new needs had been expressed when publishing the first maps and the specifications have been modified.

There were misfits between files and printed maps, due either to specification changes, or to hand-made editing on the films which were supposed to be recorded in the files, or to editing completed in the files after map publishing.

Through time the initial legend was regarded as not enough detailed. But instead of subdividing its categories, it has been decided to define a new legend only partially compatible with the first one : a change between digital situations can be either an actual change or only a legend change.

A last understandable change occurred : the studied area increased a little bit in order to contain communes close to the coastline or belonging to natural and ecological areas.

For making life difficult we decided that any thematic data (i.e. areal data, and as well linear and point data) and the city names and ancilliary data (i.e. coordinates, titles, map index, etc.) would be digitally drawn. It would reduce manual addings, photo-engraving operations and delivery times particularly when publishing by-products.

From printed maps and air-photos at both 1977 and 1982 summers, photo-interpretors drew an overlay using a copy of the first inventory black separate. This copy had topographic background and polygon boundaries. Only those polygons whose land-use categories had changed had to be drawn. Digitizing these overlays was not a difficult task. But the digital overlay of new and archive data created unpleasant surprises.

MAIN DIFFICULTIES

The first difficulties were due to misregistrations between boundaries. Distances were larger than a quarter millimetre which was the tolerance for graphic uncertaincy, and they reached one and sometimes two millimetres. They were not only due to bad-quality drawings but to dimensional changes in the films used as backgrounds. The backgrounds were supposed to be duplicated on polyester basis in contact frames but a few of them had been made again without respect to geometric considerations and had not been checked. Then we had to design a software package for areal fitting with two main steps : geometric transformation and new boundaries capture by old boundaries within a given tolerance (cf infra).

Decreases in minimum dimensions of polygons created a second set of difficulties, specially with quite-linear features (roads, channels, etc.) and quite-point features (houses, etc.) considered as areal features. Their minimum dimension has the order of magnitude of graphic uncertaincy. This aspect can be regarded as a fault in cartographic design when mixing location categories of features ; but it is mainly an incapability for distinguishing between thematic land-use mapping and topographic mapping, between photo-interpretation and photo-identification.

The new taxonomy created evolutions which were not real changes. They had no systematic characteristics and it was not possible to edit them by automated processing. They were eliminated at several stages in the production line by modifying the initial inventory. But methods which consist in writing again past history, which is philosophically suspicious, are lacking in consistency and in fiability. In our case, changes in the initial inventory are to be made all along the production line of derived maps : it looks more like arts and craft than like an industrial production line and it makes much heavier the project management. Four editing steps can be achieved after : (a) the checking plot, (b) the modification map, (c) the up-dated land-use map, (d) the evolution map. The maps will be described below.

Finally the graphic design of legends for the maps creates conflicts between the cartographers-producers and people responsible for the project who also are the map purchasers. They have not enough been trained in cartographic design and they do not clearly express their requirements in terms of colours, symbols, reading levels and main thematic appearance. They also suffer pressure from end-users who give financial support and who sometimes reject the layout of maps.

PROCESSING LINE

The processing line is subdivided into three components (cf figure in appendix) :

(a) areal data from photo-interpretation : only the features having been changed since 1977 are digitized ;
(b) linear data such as cliffs, docks, dikes, coastal pathes and other features drawn in linear symbols ;

(c) point data such as touristic harbours, houses ; city names are processed in the same way.

Areal data processing
A document with polygon boundaries is digitized by a drum scanner. Some editing eliminates small mistakes on an interactive workstation. 20 to 30 control points are selected when overlaying the initial file in order to calculate a geometric transformation which avoids main misregistrations. Polygons are identified and allocated a referring number.

A biquadratic distortion polynom calculated from control points is applied onto the derived vector file. The result is checked on an electrostatic colour plot, with different colours for initial boundaries and for final boundaries before and after distorsion. The final tolerance is a quarter millimetre.

Each polygon is allocated two attributes coming from two interpretation overlays : actual use with 67 categories and tide area with 6 categories. The attribute allocation is interactively performed on a digitizing table : many polygons are too small for automating this process.

Here the file describes the present situation for any polygon having been changed or created since 1977. It has to be superimposed to the initial file which is modified to take into account a few taxonomic changes.

Despite the distorsion polynom the registration is not perfect. A software package has been written for enhancing local fitting. It merges close boundaries avoiding small areas without any thematic significance. Priority is given to old boundaries during the capture process. The result is checked on an electrostatic colour plot. Attributes from initial and present files are automatically allocated.

Linear data processing
A line-work overlay is digitized on the drum scanner. After editing the file is attributed interactively on a digitizing table with eight categories.

Point data processing
The precise locations of point features and city names are recorded on a digitizing table with twelve categories and a five-digit identifier for each commune.

Graphic outputs
After these processings all thematic components have been digitized. A monochrome film is made on a laser plotter for checking. It contains patterns, screens, linear symbols, point symbols, place names, coordinates and legends. It has been specially designed for supporting ultimate editing.

Non-stop editing
Editing can deal with areal, linear and point features and is related to allocation mistakes or to geometric delineation mistakes.

Geometric mistakes are dramatic because the geometric consistency has to be maintained all along the inventories : that is the reason why editing is performed on interactive graphic workstations on which operators can display both old and new situations. We specially care about the preparation of editing materials because of their diversity and their number (up to 100 per sheet). They have to be checked, and we use an electrostatic colour plot drawing polygon boundaries and feature codes. We sometimes have to iterate these operations for avoiding omissions.

Further outputs show new mistakes which have not been seen on the check plot and which are corrected by the same process. It happens when producing the proof of the modification map : a new output has to be produced for each map.

Archiving

Only one file per sheet with areal data is archived. It gathers all data for both 1977 and 1982 situations. This principle will be expanded for further inventories.

Flexibility

The processing line has been built up for producing the first sheet but has been modified according to new events. It seems that flexibility is a critical element and has to be considered when designing any such complex production line.

PRODUCTS

As it has been made for the initial situation, the land use distribution is calculated for each commune with respect to the distance from the coastline : 0 to 2 km, 2 to 5 km, beyond 5 km. The results give an idea of evolutions and the system has a capability for producing more precise analytical data, such as the present situation of one or another initial category : we obtain some kind of evolution matrix (Grelot 1984) ; this capability has not been used up to now although it is an efficient criterion when designing evolution maps for both relevant taxonomic definition and main aspects to be graphically standed out.

The first graphic output is a check proof. For economical reasons it is a black-and-white film. But the great amount of legend categories and the small dimensions of polygons make the checking difficult and mistakes are forgotten which are seen on further outputs.

A modification map is systematically produced in two colours : screened black for the topographic background and violet fot thematic data. This map shows the 1982 land use in areas which have been changed, but does not give any detail on their former use.

According to changes and the interested expressed by local authorities (i.e. municipalities, departments, regions) through financial support, derived maps can be produced.

The 1982 land use map is printed in four colours. Its graphic design is close to the former map series but it looks more precise because of smaller patterns and smaller polygons : any graphic representation includes and may reflect subjectivity. The legend has been standardized for the whole series.

Evolution maps gather initial and present taxonomies for pointing out meaningful changes. They are printed in four colours and their legends may vary according to regions and changes. Evolving areas are drawn in alternate strips with light colours for initial situations and dark colours for present ones, and areas with no change only receive light colours.

Synthesis maps at 1:100000 are printed in four colours again with legends according to regions. They give some kind of mosaics like satellite imagery classifications but fortunately cluster reliability is much greater.

CONCLUSION

The products of the littoral inventory have been planned as soon as the first compilation had been mad in 1977-1981. But the difficulties only appeared during the up-dating procedure.

Taxonomic changes cannot be avoided. In order to really be a management tool, such an inventory has to be adapted to decision-makers worries. Industrial, touristic, agricultural, ecological pressures on the coastal zone vary through time according to circumstances which cannot be forcasted on long-range periods.

Faced with this phenomenon, cartographers will always try and build compability, then adapt products to compability restraints. Users on the other hand want everything immediately, arguing that nothing is impossible for computer processing. It is partially true but requires unexpected financial and time supports.

Technological choices modify the way problems can be solved. We choose raster mode, and automated processing prevailing the use of interactive workstations. What would have been interactive up-dating of 400000 polygons in vector mode, how long with how many workstations, including all checking and editing operations ?

Is automated cartography entitled to mistakes ? In other words, is it legitimate to keep mistakes in normal cartography because of editing costs, and to refuse them not only in data bases but also in automated printed maps ? Refusal results in iterating outputs up to a perfect map which causes overcosts and mainly disrupts and delays the production line. Imperfection acceptance requires users' training and obtaining an agreement before starting the work.

This kind of opportunities teaches a lot for designing geographic information systems. It points out functions to integrate to digitizing, processing and plotting stages. It also shows that these functions are quite fixed ; but on the other hand the data they process may change : in fact map readers are able to integrate a context to what they read and interpret, and then to adapt their conclusions according to interactions between these to sources, i.e. map and context. Will geographic information systems be able to provide such a flexibility ?

REFERENCES

Grelot J.Ph. 1982, An Inventory of French Littoral, Auto-Carto 5 Proceedings pp 367-373

Grelot J.Ph. 1984, Réalisation et exploitation de cartes d'inventaire en cartographie automatique, 12° Conférence Internationale de l'Association Cartographique Internationale, vol 1 pp 235-245

APPENDIX : PRODUCTION LINE OVERVIEW