A RATIONAL APPROACH TO DIGITAL ANCILLARY DATA ACCESS AND VISUALIZATION IN LAND COVER, LAND USE PROJECTS

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ABSTRACT:

During the last decade many national and regional Land Cover/Land Use projects are implemented based on computer aided satellite image interpretation. An essential procedure for the European CORINE Land Cover 2000 and EROSION projects is forward and backward change detection. The use of three generations of Landsat images (MSS, TM and ETM+) with different spatial and spectral resolution raises some specific geometric and thematic problems. Topographic maps and aerial photographs are indispensable sources of support information. Usually old archives are not in digital form. The use of hardcopy topographic maps and aerial photographs is a cumbersome and time-consuming operation. A rational approach to the conversion of these data and advanced methods for visualization are vital for the interpretation process optimization. In this paper the alternatives of using either geo-referenced or ortho-rectified aerial photographs are studied so that project specification requirements concerning planimetric and thematic accuracy could be achieved. In this case optimisation means minimal hardware, software and human resources used. A GIS data base management system is extended with a new structure in order to facilitate the fast and accurate choice of appropriate ancillary data. This approach for data organization is very useful in the verification phase, when data for large territories is processed. A fast and accurate choice of spatially overlapping data sets is achieved. The developed methodology is applied throughout the implementation of the projects mentioned above. Examples of making decisions in some cases of uncertainty during the interpretation are given.

1. INTRODUCTION

Throughout the last decade many national and regional Land Cover/Land Use projects are implemented based on computer aided satellite image interpretation. The European CORINE Land Cover 2000 (CLC2000) and EROSION projects are executed in Bulgaria during 2003 and 2004 based on harmonized technology (Bossard *et al*, 2000). The purpose of CLC2000 is a revision of CLC90 data (based on hard copy technology) mapping of 1990-2000 changes and CLC2000 database creation by an overlay procedure. The same technology is applied in the EROSION project for retrospective 1975-1990 change detection for Bulgarian Black Sea coastal zone. Three generations of orthorectified Landsat imagery are used – 1975 MSS, 1990 TM and 2000 ETM+ resampled to 50 and 25 m pixels respectively. The mapping scale is 1:100 000 with a minimum mapping unit of 25 ha and 5 ha for changes. A lot of ancillary data of different types should be used in order to reach the thematic and geometric accuracy specifications. The main purpose of this paper is to describe the acquisition and rational access to all ancillary data used during the implementation of the projects.

2. ANCILLARY DATA

To assist the computer aided satellite imagery interpretation process the following sources of ancillary data are used:

- topographic maps 1:100 000 and 1:25 000 scale;
- satellite images – SPOT, KVR-1000, Landsat;
- orthophotographs and aerial photographs 1:5 000 to 1:25 000 scale;
- thematic maps – city, forest, vegetation, geological and soil maps 1:5 000 to 1:600 000 scale;
- land and forest restitution vector data bases, obtained from 1:5 000 and 1:10 000 scale maps.

Most of the historical data are available in an analogue form. The use of hardcopy maps and aerial photographs is a cumbersome and time-consuming operation. To facilitate the computer aided interpretation a conversion to digital form and georeferencing is an indispensable procedure. The enormous amount of this heterogeneous data has to be arranged and stored in a proper database with an user's friendly interface. The database creation and management raises two main problems – the appropriate date preprocessing and flexible access/visualization.

3. METHODOLOGY

According to the CORINE methodology satellite images are the main source of information for land cover/land use mapping. Most of the interpretation problems could be solved using the interpreter's knowledge and proper combinations of Landsat channels. For the classes of non-homogeneous colour and texture like complex cultivated pattern, orchards, vineyards etc. in many cases it's difficult to make the write decision. Similar problems arise when relief or cloud shading masks the vegetation cover. Ancillary data is obligatory in such cases.

To prepare different data sources in GIS compatible format the several transformations are required.

3.1 Pre-processing

Colour topographic maps are scanned with a 300 dpi resolution by means of CalComp ScanPlus III 500 (A0). Metadata (ID, geographic location, year of last update and production etc.) is stored in a table. Paper print/film aerial photographs and orthophotographs are handled in a similar manner.
Georeferencing is performed in PCI Geomatics Orthoengine 8.2. environment. Four or five coordinate grid points are used for the conversion of each raster topographic map in the National coordinate system 1970. The same technology using well defined ground control points identified on the aerial photographs and proper scale topographic maps is applied for the orthophotographs.
To save time and reduce cost the aerial photographs are selected with minimal overlap. Their main use is to solve the thematic uncertainty and references are made in 1:100 000 scale. Orthorectification is not necessary in areas of flat and undulated relief. A polynomial transformation by means of 5 GCP-s selected from the 1:25 000 topographic maps meets the required accuracy.
Other ancillary data used are in digital form – georeferenced or orthorectified (Marinov *et al*, 2002) and doesn't need pre-processing.

3.2 Database structure and management

To facilitate interpreter's decision making the structure of the data base should meet the following requirements:

- fast access to all ancillary data available for the area of interest;
- the possibility to use a separate type of data or various combinations of data types;
- flexible links between the graphical and attribute part of the data base to retrieve user specified data;

Four graphical vector files are created which include the boundary lines of all raster and vector maps, aerial photographs and orthophoto mosaics. Each of them corresponds to one of the zones of the National coordinate system 1970 – K-3, K-5, K-7 and K-9 (Figure 1).
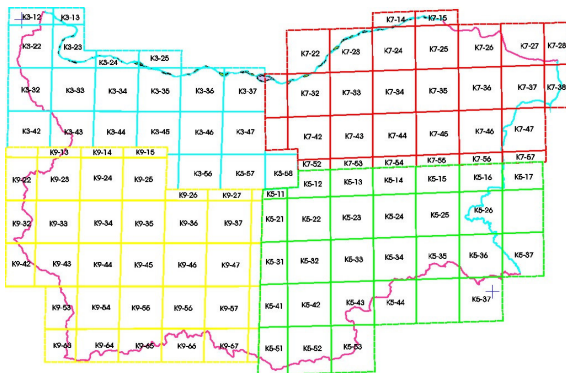

Figure 1. Zone division in the National coordinate system
The data base is created in ArcView 3.2. environment. The graphical vector file data are distributed in layers corresponding to the different types of data. In the automatically generated attribute table new columns with new names are added

containing data description information. For each ancillary data entry a specific ID is created with coded descriptive information. The content of an aerial photograph ID is shown on Figure 2:
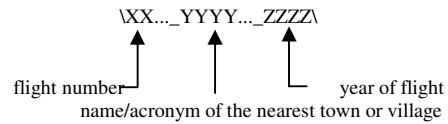

Figure 2. Aerial photograph ID coding example

The graphical polygons are linked to the respective attribute table to ensure the access to the data needed.

4. WORKING ENVIRONMENT

The interpretation process is performed in InterChange 2 software – extension of ArcView 3.2 GIS (Tarashak, 2002). Usually two synchronized windows are used for the Revision and Change detection procedures. The Basic Working Unit (BWU) includes the area of one or more standard 1:100 000 topographic map sheets. Two multi-temporal Landsat images and the CLC90 vector data for the working unit are visualized as standard themes (Tepeliev *et al*, 2003). The "ancillary" (graphical) file for the respective zone is added as a theme as well. In this way all available ancillary data could be properly accessed and visualized for the BWU area. When ancillary theme is activated after a click with the information tool on the boundary polygon closed information window appears.
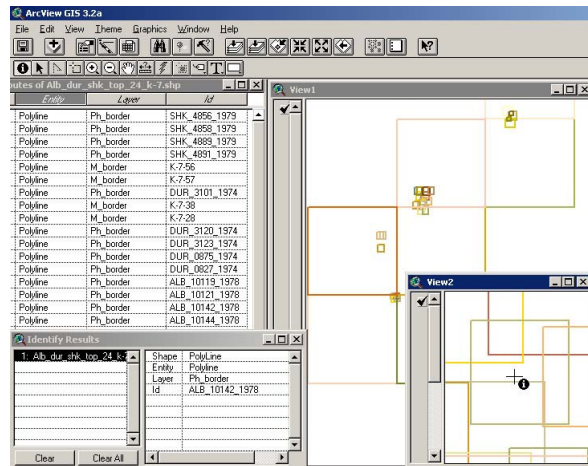

Figure 3. Example of window with Ancillary file information

The graphical interface is illustrated On Figure. 3. On the right part the boundaries can be seen of topographic maps and aerial photographs. At the bottom (View 2) enlarged presentation of an aerial photograph boundary clicked with the information tool is shown. On the left part the attribute table and the information about the type of the border line (aerial photograph) and the ID are displayed.
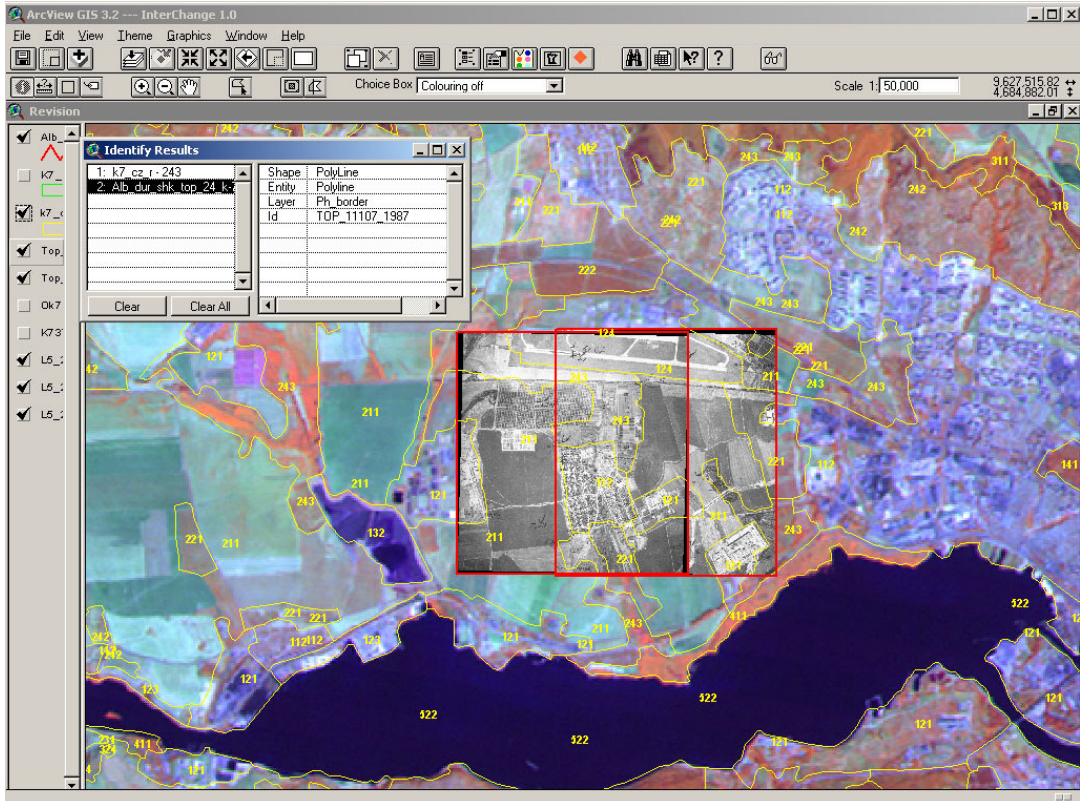
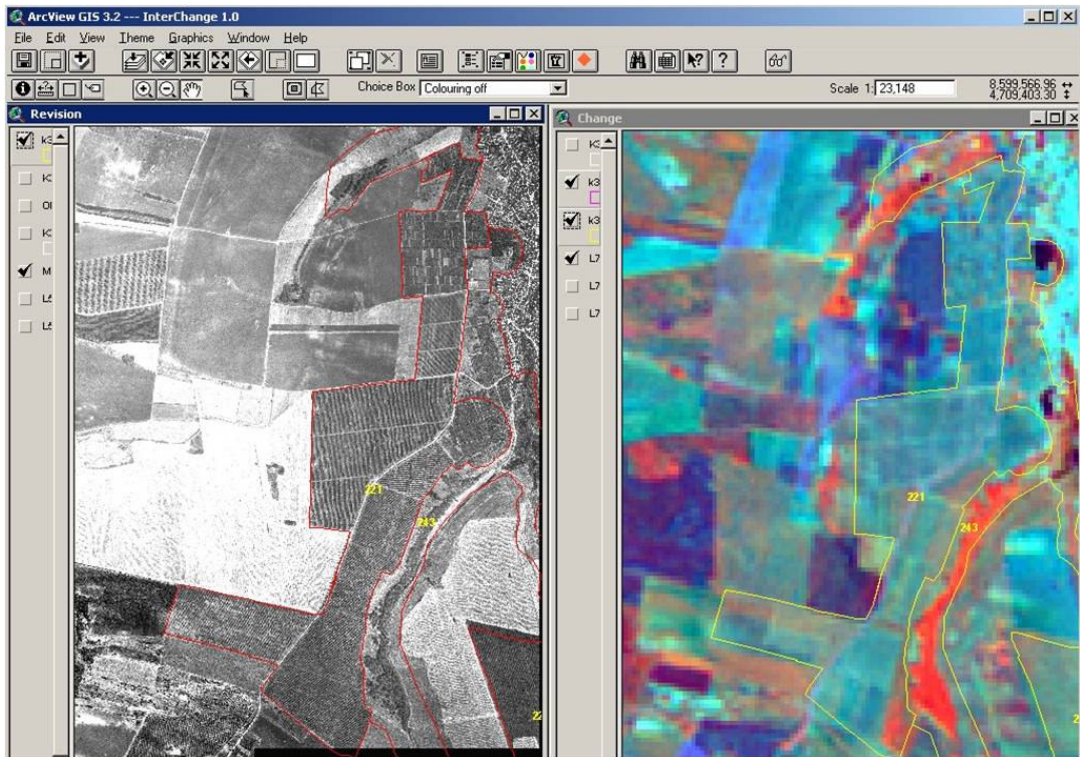Figure 4. Vector data base revision near Varna Lake

Figure 5. Use of ortophoto mosaic for vineyard fields in Pleven region

An example of two georeferenced aerial photographs chosen from the ancillary data base in the area of Varna Lake is presented on Figure 4.

The borders of the new build industrial zone, vineyards and discontinuous urban fabric are easily identified and delineated. The recognition of vineyard fields created by means of different planting and cultivation techniques is one of the most difficult tasks. A mosaic of aerial orhophotographs (Figure 5) is an excellent solution for this problem.

5. CONCLUSIONS AND RECOMMENDATIONS

The data base and graphical interface described above are successfully applied during the interpretation and verification phases of CORINE Land Cover 2000 project in Bulgaria. The methodology for optimal ancillary data acquisition, structuring and access leads to an effective time and costs reduction of the overall project implementation. The ancillary file could be used in other GIS and for other applications.

The practical work of interpreter's team with the ancillary data outlined several directions for improvements and enlargement of the data base for future developments.

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