# THE NATURAL PATRIMONY INFORMATION SYSTEM
# A DELTAIC CASE STUDY

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## ABSTRACT

The Natural Patrimony Information System (NPIS) is designed, firstly, considering the global structure of the basic GIS function. To develop a Natural Patrimony of Data Base (NPDB), we should take into account: (1) application of the Model Investigating Information Stock (MIIS); (2) presentation of the "study area" (DD-GC) features (3) (space/descriptive) information collection; (4) Remote Sensing data integration (such as SPOT images). Integrated NPDB data is further interpreted using a proper procedure removing dynamic elements/phenomena (such as "floating islands"). Finally, some preliminary conclusions are drawn.

## RÉSUMÉ

Le travail s'occupe du projet pour l'organisation du Système Informationnel du Patrimoine Naturel (SIPN), en comencemant par l'architecture globale et les fonctions fondamentales du S.I.G. Pour réaliser la Base de données du patrimoine naturel (BDPN), on a en vue: (1) l'application du Modèle d'investigation du fond d'informations (MIFI); (2) la présentation des particularités de la "zone d'étude" (DD-GC); (3) - la collection d'informations (spatiales/descriptives); (4) l'intégration des données de télédetection (le cas des images SPOT). Après ça, on fait une intérprétation des données intégrées, contenue dans la BDPN en utilisant une procédure adéquate à l'élimination des éléments/phénomènes dynamiques (le cas des "îles flotantes"), arrivant à la fin, à quelques conclusions préliminaires.

## 1. INTRODUCTION

### 1.1 The "Natural Patrimony" Protection Concept

When a new institution related to "the common marking patrimony" has appeared, and the peaceful usage of the various spaces including both territories and celestial bodies under no ownership and with its own rules has been advanced, "the world patrimony" protection (in accordance with 1972 Paris Convention, applied three years later) was approved implying a joint approach of the "cultural and natural" patrimony, so that the present-day and future generations should derive material and spiritual advantages.

While the "cultural patrimony" protections refers to the Art monuments, architectural ensembles and archaeological sites (generally, man-made works), having an important world-wide historical and scientific value and fame, according to the criteria established by the specialized non-governmental organizations, the "natural patrimony" protection contains invaluable natural monuments, formations, geological formations, mountaineous and deltaic reservations well-known in the whole world ecologically and aesthetically (Sion et al.,1993).

When we speak about Romania, we may say that in our country there are to be found "national parks, e.g. Rodnei Mountains", "natural reservations", e.g. Pietrosul Mare, as well as. Biosphere reservations, e.g. the Danube Delta.

In this way the criteria used to include "goods" within the second category are properly fulfilled. Undoubtedly, the Danube Delta needs a very special protection aiming at representative and unique ecosystem maintenances. That is why, to be a master of the natural equilibrium mechanisms and their dynamic constituent monitoring, our investigation is focused on the main environmental factors: water, soil and vegetation (floating reed islet formations and destructions, lake surface variations, impact of the fish breeding agricultural and touristic arrangements a.s.o.) using upgraded techniques and methods.

1.2 Information Sources, Used Products

According to the "natural patrimony" concept, there are two main information sources: (1) graphical information, i.e. data to be represented on maps and photomaps; (2) descriptive information, i.e. statistical and other (monographic, morphographical a.s.o.) data describing some object and phenomenon qualities, which are located on the investigated territory.

To study all these cartographic and descriptive data in close correlation, they have to be input in the same data base pointing out connections among them.

While space information is derived from the existing cartographic and photogrammetric products, the descriptive one is based on the statistical data on population, climate, people's jobs, (in our case, fishing, reed harvesting, a.s.o) the historical and legal background, etc. As Grindul Caraorman has been chosen as our test area for this stage, descriptive information also includes the Danube Delta ecosystem features (Sion et al.,1992).

So, data has been collected from: (1) geographical studies on the Danube Delta and its reservations:(a) "Morpholohydrographic Features of the Danube Delta" (authors: Petre Gâştescu et al.); (b) "The Complex Caraorman Forest Reservation" (prepared by the Institute for Geography); (2) The Romanian Statistic Year Book; (3) Other documents on Tulcea Country: (a) The Touristic Guide of Tulcea Country; (b) The Complex Danube Delta Arrangement (under the care of the Romanian Academy, 1953); (c) Contributions to the Vegetation of the Danube Delta (authors: V. Sand and A. Popescu, in Hydrobiology 1983, pp. 61-69); (d) Forests of the Danube Delta (Pence, 1971).

## 2. THE STRUCTURE OF THE NATURAL PATRIMONY INFORMATION SYSTEM (NPIS)

### 2.1 GIS Concept and Technique Application

A Geographical Information System (GIS) is an ensemble of equipment, software geographic and personal data able to efficiently collect, store, update, handle, analyse and visualise any geographic information. On the other hand, a GIS should be considered as a real life model developing, testing, and choosing some future evolution scenario. There are main graphical and descriptive already mentioned data within a GIS.

A GIS strength is derived from its possibility to also locate descriptive data in the space by relationally correlating them with the geographic ones established by their own coordinates directly. Thanks to this locating concept, a GIS technique properly answers our needs in the desire to know the natural patrimony condition and change; at the same time, it carries some bivalent (graphical and descriptive) information we are interested in, which could be visualized as suggestively as possible.

### 2.2 The GIS General Structure and Main Functions

Question types for which GIS users could get answers by properly handling the five main subsystems are briefly shown in Figure 1. Those subsystems correspond to some elementary functions (collecting, editing, analysing, managing and plotting) being the only one way to the data base, in fact, the GIS information core.

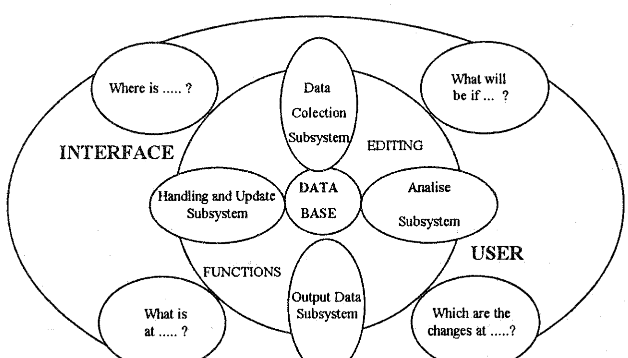


Figure 1. Concept organisation of a GIS

Besides the five elementary functions defining GIS all together, we can point out another four basic (general and complex) functions related to the general user's requirements. So, considering the GIS user standpoint, the basic functions are the following: (1) supply of the general geographic information related to the established territory; (2) extraction of all objects and phenomena belonging to a desired topic; (3) available information usage to find some special correlations among various topics and objects, based on pre-established algorithms; (4) supply of various outputs (maps, tables, diagrams and graphics, images).

### 2.3 Advantages in Using GIS Technique

When a NPIS is structured, the advantages in using GIS techniques are the following (Balotă,1992): (1) they allow to transform descriptive information into a suggestive graphical representa-tion overlapped on the classical cartographic representation (this facility enables an objective analysis thus the rural patrimony re-establishment could reach the desired levee; (2) they point out an efficient combination of many information derived not only from various sources, but also having different structures; (3) at the same time as the rural patrimony re-establishing operations are carried on, they structure a data base to be anytime used as a support in accomplishing impact studies on the environment to expand or establish new industrial works over the territory and, generally, as a support in decision-marking activities of those bodies charged with rural patrimony management; (4) they give the possibility to link information derived from a national complex data base (obviously, ensuring present-day and future collected information compatibility).

## 3. THE NATURAL PATRIMONY DATA BASE (NPDB) DEVELOPMENT

### 3.1 Model Investigating Information Stock (MIIS)

During this stage, based on a theoretical model, the inventory findings are: (1) 1:50,000 scale map squares (according to Gauss-Krüger division of map sheets) covering the whole area (see 1:350,000 scale county map compiled in 1987) are rendered also; (2) 1:5,000 scale cadastral maps compiled in 1979 are acquired; (3) 1:100,000 scale county maps compiled in 1988 are acquired; (4) 1:5,000 and 1:50,000 DTM (Military Topographic Department) maps carried on various dates during 1960 and 1980 are acquired; (5) inventory of the space images covering the deltaic area; (6) delineation of areas existing on Landsat 1 and 2 images; (7) inventory of map squares with 1:5,000 and 1:10,000 scale photomaps; (8) inventory of aerial photographs which IGFCOT has taken over during 1969 and 1991; (9) inventory of those square maps containing 1:2,000, 1:5,000 and 1:10,000 scale basic topographic maps; (10) inventory of those square maps containing 1:10,000 and 1:5,000 scale cadastral maps.

The above mentioned 10 item are the first inventorying action of the cartographic material which are found in IGFCOT. That information could be completed by other specialised institutes for various thematic applications. All existing information collection entails a multidisciplinary data (information) stock setting out required by the NPIS development. Because that is a complex study and the territory is large we have agreed upon to choose a test area within the 1: 50,000 scale L-35-107-D square map, i.e. Delta Dunării - Grindul Caraorman (DD-GC) (The Danube Delta -Caraorman Bank Ridge Top).

The findings could be then generalized over whole deltaic area.

### 3.2 Area Presentation

The test area, which we have chosen for the first stage, is representative as regards the various biomorphological shapes found within the Danube Delta (relief shapes, sand dunes, various-lakes, arable land, built-in area, quitted industrial areas, natural reservations, canals and dikes various vegetation-marshes, reed forests, a.s.o.). Caraorman village (also giving the name of the map sheet) is located in the middle of a large sand plateau (the second large and important plateau as against Letea one). Satellite image taken over that bank ridge top properly points out how it has been developed after the successive sea water retirement. That is why, there are large sand dunes oriented along the old sea-shore over Caraorman Bank Ridge Top.

### 3.3 Space/Graphic Information Collection

As regards the present-day methodology other counties (e.g. Dolj County) consider it is better to re-arrange thematic information after about a decade. So, a proper comparison to re-build, that is, to preserve various rural patrimony elements is assured. When the Danube Delta showing special dynamic changes is to taken into account, that period of time should be obviously, shortened, i.e. between 3-5 year, as it is the case.

Photogrammetric and Remote Sensing products are used in the Danube Delta photointerpretation. There are Remote Sensing images taken by the American Landsat satellite and the European SPOT over our test area. More than that, there are space maps already for maps L-35-107-D and L-35-107-C squares compiled to be employed in other projects using 1990 and 1992 space images. That important information has been supplemented by digital data derived from the maps existing in the IGFCOT Geodetic and Cartographic Fund, which were updated in 1981. Besides, 1:200,000 scale soil map and the General 1:100,000 scale Danube Delta map have been digitised, as well. The main problem which we should have solved was to make uniform all data collected from various sources.

The geographic grid was the only one common element used to assume a proper information overlapping; while digitising, TIC's (the coincident points of SIG-ARC/INFO terminology) were the intersections of parallels and longitudes delineating the test area. This maps have been brought into coincidence using special ARC/INFO functions. We used ARC/INFO ADS module to digitise, because it has more facilities to be put at the user's disposal: node and vertex digitising; a dynamic numerical element display, the working area setting out, the wrong element deletion, a.s.o. The digitising operation took the longest time; it had be be done properly (to consider few points without disturbing the graphical detail reproduction quality).

After all arches have been digitized, the corrections operation follows (in fact, continuous lines polygons should be closed). Topology should be also made.

As a matter of fact, during this stage, we can really point out digitising errors using tolerances tested already (Niþu C. & Niþu C.D,1992).

Another procedure element, which we should take into account, during digitising operations, is the separation of the themes (contained on the map) to be digitised as much as possible. Digitising operations should be ordinarily accomplished on the map manuscript; in this case, some digitising transparencies should not be done. Digitising by scanning followed by vectoring is a more efficient procedure. Unfortunately, map manuscripts are not always at our disposal. So, every important theme should be copied on a transparency and digitised on various layers later on. In this way, a topology for each theme is to be made separately thus simplifying the subsequent information analysing and plotting procedures. As regards themes, such as, hydrographic or road networks, a polygon-like topology should not be established but a line-like topology is enough. Such a well established topologic concept will make attribute input in an easy way (elements featuring a certain geometric shape: point, line, polygon).

3.4 Descriptive/Statistic Information Collection

Two methods were used to register attributes according to the established nomenclature: (1) the geometric element interactive selection using ARCEDIT function by filling in attribute column; (2) INFO - type auxiliary files containing a common column of a ARC/INFO attribute file. So, the attributes could be separately on files and automatically added to the corespondent object. Both line-like attributes (on maps with a topological grid, i.e. hydrographic grid of channels and road and dike grid) and polygon - like attributes (on maps showing land cover and hydrographic grid of lakes) have been input, as well. The data bank will be subsequently supplemented/completed with the statistical attributes derived from some other sources.

3.5 Remote Sensing Data Integration: SPOT Image Case

During the first stage, we have tried to integrate data derived from a SPOT image taken over in August 1990. Owing to the huge informatic amount and the small storage - computer capacity, we have chosen a subarea, of the test field. Later on, this data base was completed with other information derived from a 1992 SPOT image. The images have been corrected and brought at 2B level by IGN Espace in France, within another project. So, they have undergone the corrections: (1) radiometric corrections to equalise/level detectors on each spectral band; (2) geometric corrections due to systematic distortions (the Earth rotation, panoramic effect); (3) bi-dimension geometric corrections using some ground control points.

During the first stage of Remote Sensing integration (see Figure 2) we have selected a image window covering the test area. During integration process, images could be employed for two purposes: (a) for analysing needs when image information should be correlated to the other data; (b) for presenting needs when images are used as image background nevertheless being a support in result interpretations.

It is compulsory to do a vector - like integration when analysing requirements are envisaged.

Employing only one multispectral image, we can get more information plans, according to the investigated topic. All these plans, i.e. raster - like classified images, are made homogeneous and vectorial, being changed in information plans suitable to GIS structure. During the first stage, the hydrographic constituent was dwelt upon also taking into account the great dynamic changes arising from that information plan of the ever changeable area (Denegre,1991).

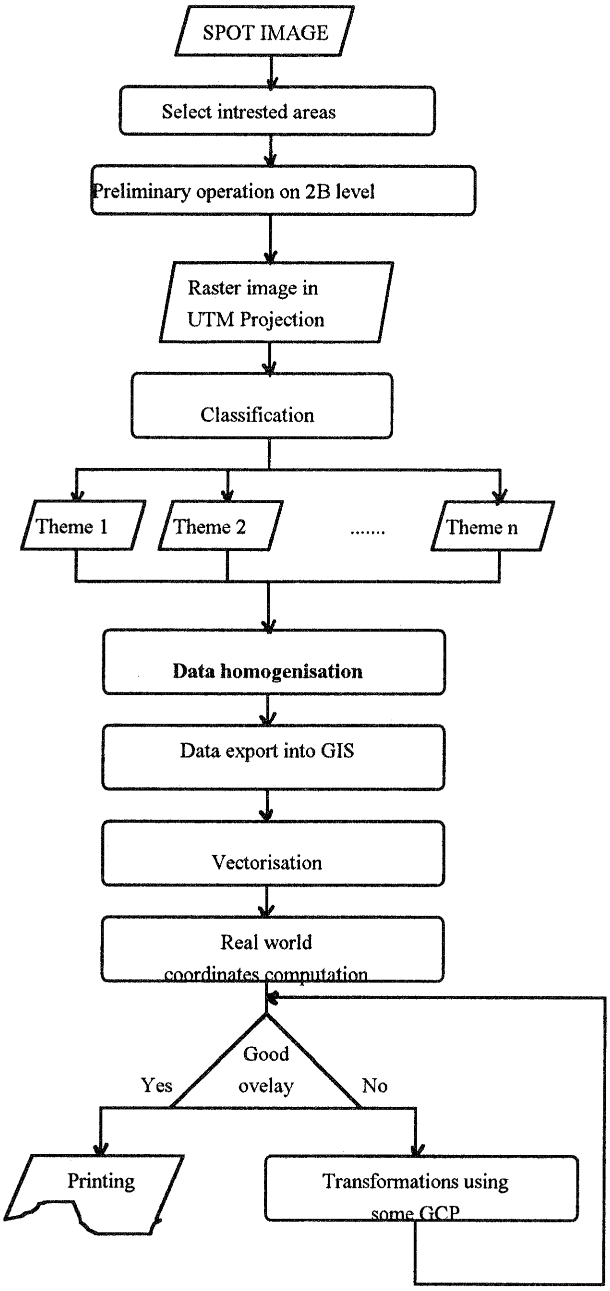


Figure 2.Integration of SPOT images

The second stage of the integration procedure is the image classification. As there are two main natural environmental types, each one having an important variety (vegetation and water), within the Danube Delta, firstly, vegetation information should have been masked not to influence water classification. Naturally, the Danube Delta aquatic vegetation is prevalent; therefore a proper precise separation between the water and vegetation plans was rather difficult. The same separator operations have been done when 1992 image was used.
The third stage of the integration procedure is to make classification image to be homogeneous (Ducamp,1991). During this procedure, the image legibility coefficient could be improved after reducing the number of the isolated pixels, i.e. polygon reductions after vectorial - like operation has taken place. It is quite difficult to get the best legible level because a too homogeneous information accomplishment entails removals, as well. Just an example: a hydrographic grid could lose the continuity due to its refinement. A small channel is represented on a classified image as a pixel array without being always well linked. Applying a "rude" homogeneity the channel pixels could be easily lost. Such an error could distort some analysing types. On the other hand a little homogeneity forth rather many isolated pixels. So, the image could not be analysed properly and clearly.

The fourth stage of Remote Sensing information integration procedure is to get vector - like classified images.
This operation includes raster - module image change (a large storage consumer) into - module one (more economic as regards storage). More than that, vector - module is more suitable for the complex graphical processings and topologic implementations.

The fifth stage (the last) of integration is overlapping the resulted plan over the other ones (information layers). The channel hydrographic grid was considered a basis and the channel intersection were used as control points in this operation.

## 4. PRELIMINARY INTERPRETATION OF INFORMATION OF THE DATA BASE

Analysis and Conclusions on the Floating Island Dynamics.

**(A)** To identify stable elements of the "natural patrimony", we have used a proper procedure removing dynamic elements/phenomena. Such a phenomenon is shown by "floating reed islets" (floating islands) made of vegetation and soil sometimes covering almost dozens of ha. In their removal, we have used an algebraic operation linking the floating reed islets derived from 1990 and 1992 images, called LAC90 and LAC92. To get the new attributes, we have used the following commutative rules:

Rule 1 : LAC90 + LAC92 = 900R92
water90 + water92 = water
vegetation90 + vegetation92 = vegetation
vegetation90 + water92 = water
water90 + vegetation92 = water

This new plan contains a stable condition of the soil cover as against the first classification level. On the other hand, if we want to investigate these floating reed islet evolutions, a new plan could be set up based on the linking operation but using a bit different commutative rules:

Rule 2 : LAC90 + LAC92 = 90AND92

water90 + water92 = water
vegetation90 + vegetation92 = vegetation
water90 + vegetation92 =vegetation
vegetation90 + water92 =vegetation

**Preliminary conclusions**. Such a plan contains the floating reed islet position during the two recording years. Measuring the distance between two positions on that plan, we could establish its average shifting speed (about 3 m per day). As its shifting direction is not a linear one owing to the predominant wind directions and lake bed configuration, this rough value could be seen as minimum.

**(B)** For the statistical study of the natural patrimony changes from the last 1981 updating, a new so-called NOUPLAN plan has been compiled using the linkage between the plan from which the dynamic phenomena were removed (L90SAU92) and the 1981 digitised plan (PLAN81). This time, no commutative rules were used to point out changes but only supplementary attributes.

Rule 3 : <u>L90OR92 + PLAN81 =NOUPLAN</u>
$LAC + LAC = LAC_n$
$VEGET + VEGET = VEGET_n$
$LAC + VEGET = LAC_m$
$VEGET + LAC = VEGET_m$

**Preliminary conclusions**. m index shows a change, but n index shows an unchangeable result. Adding surfaces with the same index, the change situations are quickly established. The analysis points out the water surface variation during the two reference years (1990 and 1992) - is about 100 ha against 2,200 has water we have investigated (i.e. a 5 per cent variation). The variation based on the oldest investigate plan PLAN81, is 450 has as against 2,200 has (i.e. a 20 per cent variation). These variations are caused by the permanent setting up and destruction of the floating reed islets owing to the wind and water action.

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