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TeleMap/DSS: Integration of GIS and Decision Support Systems for Agricultural Management.

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Geographic Information System (GIS) is an useful tool to acquire, integrate, analyze and present geographical data and has considerable potential in many different areas of the economic and social life of each country. However, it also has potential as a process-modeling tool, but in general, it still isn't playing such roll.

On the other hand, DSS for solving environmental problems require more than a GIS. A set of optimization procedures, knowledge-base components, environmental models and others techniques are necessary in an actual DSS.

This work describes the integration between GIS and decision-making techniques like multicriteria evaluation, multiobjective decision and fuzzy set modeling uncertainty. The advantages of such approach are demonstrated by means a case study in land classification applied to sugar cane crops.

Therefore, a specific windows-based software to decision support was built. It also was integrated into the software package TeleMap, developed by the Computer Agency of GEOCUBA Researching and Consulting and which integrates tools of photogrammetry, digital cartography, remote sensing and GIS.

The first version of this module includes standardization of criteria scores and the development of the weights, according to Saaty (1977) technique, in multicriteria evaluation. Optimization techniques for complementary and conflicting objectives were also included. The uncertainty modeled with fuzzy sets was designed, but it still hasn't been implemented in this version because we are looking for a suitable and easy-to-use user interface.

Finally, a new approach of Spatial Decision Support System linking GIS to Expert Systems and modeling is also proposed.

Introduction

Since 1990 a team of multidisciplinary specialists at GEOCUBA has been developing the software package called TeleMap: Software for Geosciences, which integrates tools for Photogrammetry, Digital Cartography, Remote Sensing and Geographical Information System. TeleMap/GIS module is its kernel and offers a considerable potential to carry out hybrid (vector/raster) analysis applied to different areas of the human activity. Nevertheless, there are situations, which need optimization techniques integrated in GIS. The following cases describe them:

1. It is necessary to combine the information from several criteria to evaluate the results, but the Decision Maker (DM) requires to rank his preferences, by developing weights to each factor.
2. Frequently, it happens that the DM needs to make decisions that satisfy several objectives. These objectives may be complementary or conflicting in nature (Eastman, 1994, 38).

In GIS context, to solve the above situation it is necessary to develop a set of tools addressed to multicriteria evaluation and multiobjective decision.

In general, current GIS are lacking in these kind of decision-making techniques. However, it is not the IDRISI case. IDRISI has been developed in Clark University since 1987. Its Version 4.1 includes a Decision Support Ring to land evaluation, which is, without question, the most significant addition to this version (Eastman, 1994, 35).

The authors of this paper took into account many theoretical and methodological aspects about Decision Theory related to GIS from the IDRISI approach, because we are thinking that is a professional and very understandable framework to generalize in others GIS. Thus, this work is aimed to demonstrate our own experiences integrating decision-making techniques with TeleMap/GIS in a new specific module TeleMap/DSS.

General characteristics of TeleMap/DSS Version 1.0

TeleMap/DSS is a Windows application developed in C++ for PC. It is built from the generic module TeleMap/GIS and the criteria are created previously in it. So the source of data for the DSS module is a TeleMap project.

The framework of TeleMap/DSS is shown in the following figure (Fig. 1):

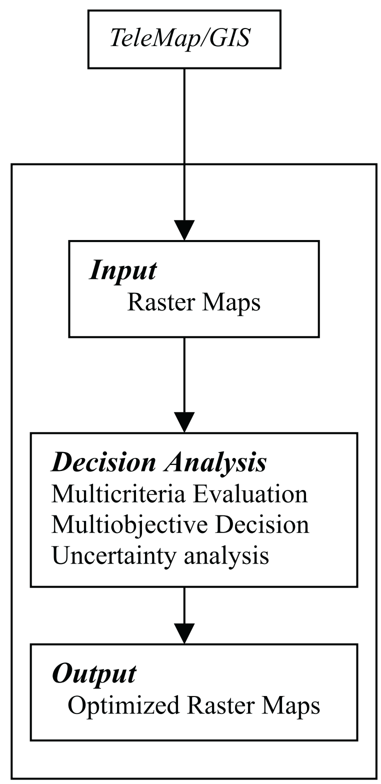


Fig 1. Framework of TeleMap/DSS Version 1.0.

Input-Output

Besides the simple computational management of the raster maps, the potentialities of this kind of data structure to combine several criteria and to represent the spatial variability of the land features, were the principal reasons to choose a raster approach in TeleMap/DSS. Thus, from TeleMap/GIS we can input, for example, relief, slope, drainage and others raster maps that will need to be evaluated and combined among them.

The result of the evaluation is also obtained through raster maps, in this case optimized raster maps.

Decision Analysis

One of the most common procedures for Multicriteria Evaluation is weighted linear combination, in which each factor is multiplied by a weight and then summed to arrive at a final suitability index. In TeleMap/DSS we implemented such procedure, that will see further. Before we must analyze some important aspects.

Before data may be evaluated by a weighted linear combination it is necessary to carry out an Exploratory Data Analysis in order to:

1. Select from available criteria those that describe the whole behavior of the phenomena to eliminate redundancy in the information. Frequently, statistical methods like principal-components analysis are used to reduce the amount of variables. In the first version of TeleMap/DSS an interactive way to choose these

factors is provided. Nowadays, we are studying not only statistical methods, but also descriptive ones in order to implement them in next versions.

2. Evaluate the mutual preferential independence among factors according to Decision Theory. During the decision analysis, the decision-maker is asked about if his preferences to meet a specific objective change when the factors are combined together. We can apply weighted linear combination if and only if DM preferences don't change for any combination of the factors.

After these two aspects are analyzed, it is possible to apply the Multicriteria Evaluation of TeleMap/DSS. The first step is the standardization of factors to transform them into a unique scale and thus each factor will have an equivalent measurement basis. TeleMap/DSS uses a very simple procedure for standardization by means of a linear scaling.

The second necessary step is the development of weights. There are many techniques to do it, but we implemented the Saaty method, which consists of pairwise comparisons known as the Analytical Hierarchy Process (AHP), (Saaty, 1977). In Saaty's technique, taking the principal eigenvector of a square reciprocal matrix of pairwise comparisons between the criteria we can derive weights which total is one. In TeleMap/DSS we developed a good approximation of this result by calculating the sum of elements of each column and then dividing the reciprocal of these sums by the sum of all the reciprocals. To compare two criteria, Saaty (1977) provides ratings on a 9-point continuous scale, where value 1/9 means that the first factor is extremely less important than the second one, and value 9 means that the first factor is extremely more important than the second one. Values between these extremes are logical levels of importance.

The process of assessing the relative importance between criteria is very subjective and it is necessary to carry out a sensitive analysis. Saaty (1977) also provides a way to determine the consistency degree that has been used in developing ratings based on statistical experimentation.

The last step in multicriteria evaluation is the evaluation itself, which consists of combining the criteria multiplying each raster map (cell by cell) by its weight and adding up the results. Finally, a suitability map is obtained.

Many decisions we make should satisfy several objectives. These objectives may be complementary or conflicting in nature. With *complementary objectives* optimal areas satisfy all our objectives to the maximum possible degree. These decisions can be solved through a hierarchical extension of the multicriteria evaluation process (Eastman, 1994).

On the other hand, it also happens that the result of the multicriteria evaluation is not enough. For example, if we want to limit the area of the best behavior in a suitability map, it is not sufficient to classify the land in regions according to the criteria. In such cases, we want to optimize our objectives. TeleMap/DSS has implemented a heuristic algorithm similar to the histogram creation in image processing in order to sort the areas that satisfy the objectives according with the user requirements.

With *conflicting objectives*, these compete for the available land because it can be used only for one or other, but not both at the same time. So, in this case it is necessary the development of a compromise solution depending on priorities assigned to each objective. Although, in TeleMap/DSS the solution to conflicting areas has not been implemented yet, we have thought to implement an iterative process to solve conflicts taking into account the priorities of the objectives.

Case Study to classify suitability of the land to sugar cane crops.

Guantanamo is located at the East region of Cuba and its agricultural resources are based mainly on sugar cane crops. Because this zone has been loosing the soil moisture available to crops, becoming in a very vulnerable area, we apply a deep study of land classification in order to establish a policy for a sustainable development. The area of interest is a Basic Unit of Sugar Cane Crops, scale 1:10000, at the Guantanamo valley.

The aim of the study was to apply a Decision Support System to increase the yields of sugar cane in the chosen zone. To achieve this objective it is necessary to make a Land Suitability Classification through four principal factors: salinity, drainage, slope and water depth. The criteria are shown in the following figures (Fig. 2, Fig. 3, Fig. 4 and Fig. 5):

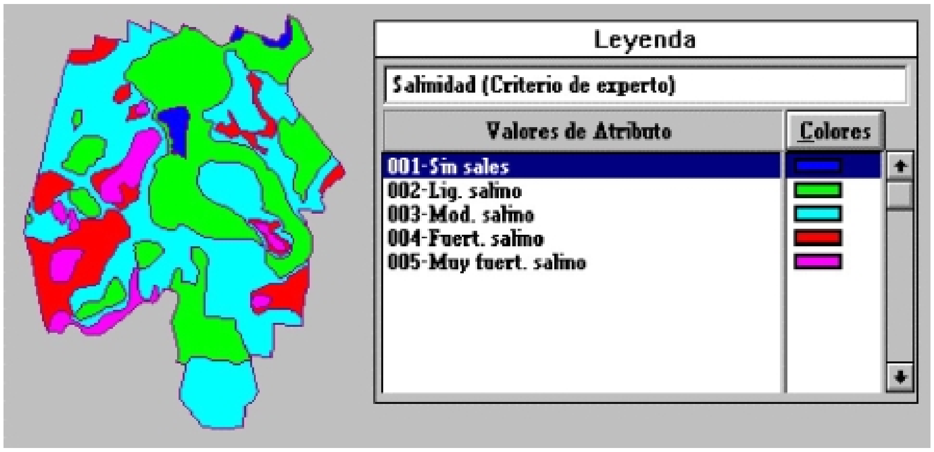


Fig 2. Salinity

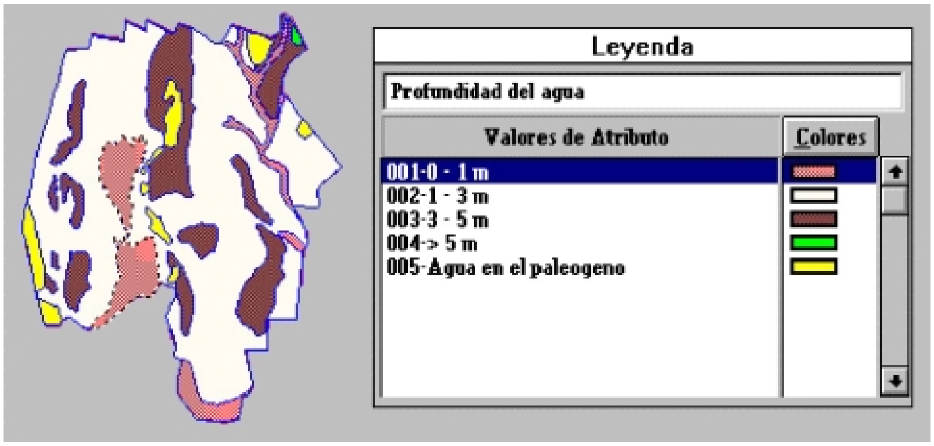


Fig. 3 Water depth

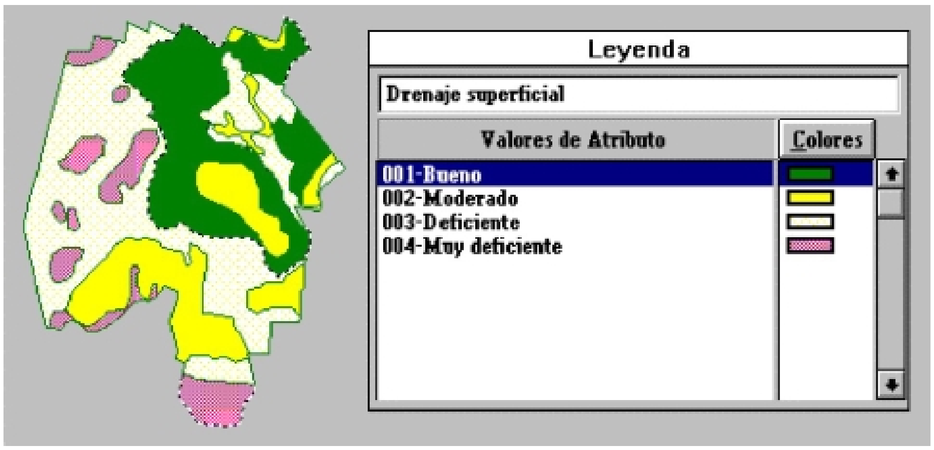
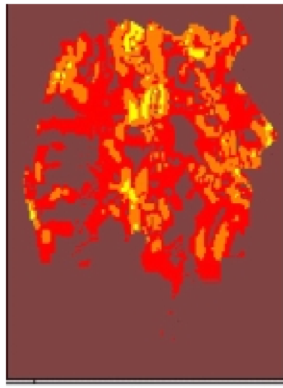


Fig. 4 Drainage.

Determining the Decision-Maker preferences.

The Saaty's technique to develop the weights in Multicriteria Evaluation was applied and as a result of this process, the Decision Maker compared every possible pair through a pairwise comparison matrix shown below with a consistency ratio of 0.06 (Saaty accepts that matrices with consistency ratio not greater than 0.10):



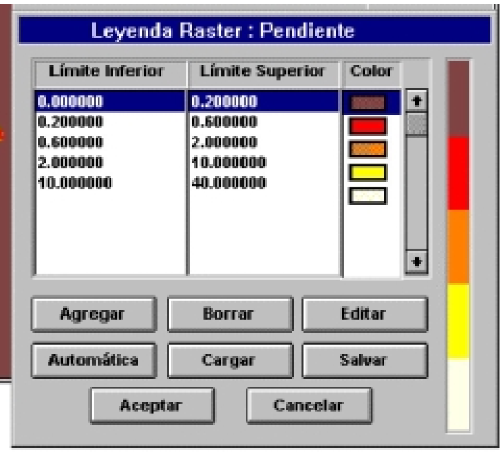


Fig.5 Slope.

	Salinity	Drainage	Depth of water	Slope
Salinity	1			
Drainage	1/3	1		
Depth of water	1/5	1/3	1	
Slope	1/7	1/5	1/3	1

Calculating the weights we obtained:

Variable	Weight
Slope	0.063
Salinity	0.605
Depth of water	0.109
Drainage	0.224

Evaluation

The final evaluation using weighted linear combination is shown in the figure 6. The studies carried out in the Guantanamo Valley have allowed establishing a suitable policy in order to preserve its agricultural resources and to stop the reduction of the moisture needed to sugar cane crops. However, it is not enough to satisfy the decisional requirements of agricultural management, and so we are working to offer an effective Spatial Decision Support System including spatial considerations in Multi-Criteria Decision Making techniques and integrating Dynamic Models, Expert Systems and others components in a flexible framework.

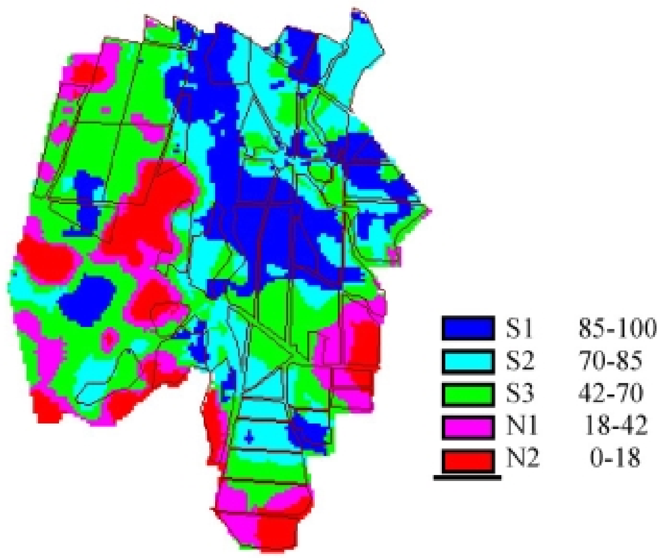


Fig. 6: Suitability Classes

Future work

The current trend in the software industry is now toward component-based programming to allow easier reuse and upgrading of components or replacement of parts without releasing an entire new application (Kopp, 1996). Such an approach for allowing interoperability among the commercial GIS software was proposed by Open GIS Consortium, Inc. (OCG). Component based software standards such as COM and CORBA has been used by OCG to distribute their specifications.

Since several months ago, the Computer Division of GEOCUBA has been implementing the new version of TeleMap based on Open GIS specifications (Active X) in order to take advantage of the interoperability standard.

Inside this project, our strategy is to develop new components aimed to Multicriteria Evaluation, Dynamic Modeling and Knowledge-based techniques besides the traditional services of a GIS. Figure 7 shows how all these pieces fit together in our model of Spatial Decision Support System.

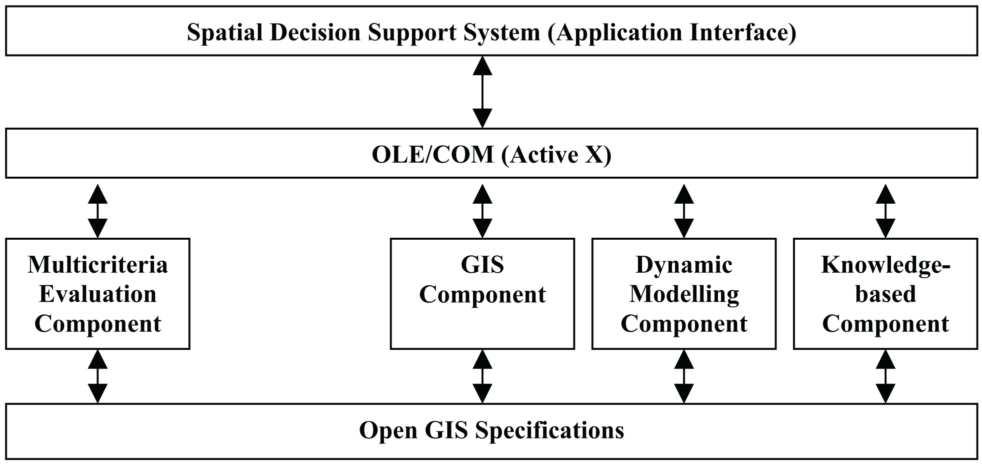


Fig 7. New model of Spatial Decision Support System to Environmental Management.

As a result of this approach, a methodology to tailor the Spatial Decision Support System in different environmental areas will also developed. The first scenario will be the agricultural management, specifically the monitoring of sugar cane crop like part of an International Project that is being conformed among SPOT Image (France), GEOCUBA and Sugar Ministry of Cuba.

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A Study of Spatial Layout of Environmental Punctual and Surface Elements in Agricultural Area Management

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Abstract

In the present paper, the author carries out a test investigation of spatial relations between punctual and surface elements with the use of cartographic and statistic methods. The aim of the paper is also to evaluate the methods used to make decisions about spatial organisation of a set of punctual elements or small area fractions.

Introduction

Maps are models used to present phenomena and information about their localisation in geographical space. Such a form of presentation allows to study the correlation of spatial objects, searching for order and laws governing the reality. It must be, however, noted that geographical phenomena are not always governed by deterministic rules.

Spatial analyses, which use statistical and mathematical methods, provide answers to many questions. A very important function in these analyses is performed by GIS, which facilitates the oriented processing and visualisation of data.

Information about a phenomenon's distribution in space may be used to solve problems concerning the functioning of the studied areas. It allows to understand the influence of spatial factors on the environment, helps to make decisions about the directions of human interference. The comparison of the data from various maps about the distribution of several phenomena allows to find their interdependence and establish the casual nexus.

Punctual phenomena, which are the subject of the present research may be analysed with the use of point diagram maps, point symbol maps and dot maps. One signature on a map represents one real phenomenon. Monovalued dots are used to represent one definite value, while several different values are represented by multivalued dots. Other information, except for localisation, is read from the point diagram map. Here the points represent phenomenon's individual values – continuous scale, or several values in the fixed intervals (classes) - step scale.

Methodology of testing the distribution of punctual elements

In the present paper, the analysis was carried out on the models of distribution of a 100-element group of points (of constant value) in square-shaped fields with a fixed area.
There are models of two types: ordered and random. The former were made purposely and they represent certain spatial configuration: streaked, insular, sinuous, circular. The latter were made by accidental arrangement of points in the field. 34 dot maps - models - created in this way were analysed.

In dot and signature maps, objects are usually placed in a topographic way. Information assigned to these objects is expressed in an absolute way. It may be, therefore, treated as a base for the presentation of data distribution.

Evaluation of points accumulation

The basic indexes for each model are average density, variance and standard deviation [Muehrecke, 1980].

For the tested models, average density, stated by the following formula: $\bar{x} = \sum_{N=1}^{N} x_i / N$, may be expressed in different ways, depending on the adopted denominator.

To calculate the density of the points, a number of reference units were adopted as the denominator. A grid of geometric fields (squares of 100 units) was put on each model. For each model the following were estimated: a number of dot fields, a number of dots in each field, number of fields in the fixed class of dot density, the area limiting the appearance of dots expressed in reference units.

If we adopt the integral area of a model *N* being 100 units, the average density for all models will be one dot per one area unit. While limiting the area to the number of units, in which the phenomenon occurs, we obtain the average density of dots in this fields. The smaller number of the engaged fields, the larger accumulation of points in them.

Average density is the measure of dispersion, which does not have spatial nature. The same average can be obtained from uniform and random layout. Position and mutual vicinity of units of different density is unimportant.

The second statistics, the relation of variance to the average was calculated according to the following formula:

$$V = d^2 / \bar{x} = [S(x^2) / (N–1) – (Sx)^2 / N (N–1)] / \bar{x},$$

where: *x* – the number of dots in reference units, *N* – the number of fields in the entire set, $\bar{x}$ – average density. The average density of one dot per one unit was adopted to calculate the index *V*. The scheme of forming the models determined that the second term of the formula $(Sx)^2 / N (N–1)$ is constant and amounts to 1,01. Therefore the first term $S(x^2) / (N–1)$ decides about the value of the index. The results are presented in table 1.

Ordering the models according to the value of the index *V*, beginning with the value 0 for the uniform, least random model, through the value ≈1 for the most random distribution, to the maximal value of 14.0, is, with few exceptions, in accord with the ordering according to the diminishing number of the dot fields. We can thus state that the index increases when the number of reference units, where dots occur, diminishes. The index reaches the value ≈1 when the distribution is random. In the tested models, the distribution with a big number of units, in which the dots have occurred, can be treated as random. These are occurrences with one or two dots and several units in the class of higher density.

The index ≈ 1 in models 16 and 17 is a kind of deviation. These models are regular (uniform), streaked (16 – horizontally, 17 – vertically) arrangements. This discordance is caused by the fact that for 50 engaged fields the first term is twice as big as for the second term. It means that the use of this index to estimate the randomness or uniformity of the layout is not always reliable. The *V* index does not also include spatial distribution, it only describes the distribution in density classes.

Inter-neighbour interval

The other measure of distribution may be obtained by calculating the average neighbour interval stated by the formula: $INI = \sqrt{A/x}$, where *A* is the area, and x is the number of objects (dots) [Court, 1966; Jagielski, 1977]. Inter-neighbour interval is expressed by a side of a square of an area equal to an average area falling on one dot.

When the number of dots in the tested models is constant, it is necessary for the interpretation of results to establish the surface A. As we use data referring to unit fields, we adopt the area following from this division. If *A* is the area of the whole model (100 units), then *INI* is constant and equals 1. Neighbour distance will be equal to the length of a side of a square of the model's reference unit. If *A* is a number of squares in which the dots have occurred, we will get neighbouring distance in spatially dense layout. It does not always refer to the real spatial distribution, and then such an evaluation is incorrect. The best area is the number of fields which includes the whole area of objects' occurrence. The fields of extreme occurrence constitute the border. This measure is more connected with the real spatial distribution. The index *INI = 1* indicates the layout approximate to uniform in the whole area. The index nearing 0 indicates more and more accumulation of the layout.

A disadvantage of inter neighbour interval is that it is constant for the models of equal area, independently of the internal layout of points. The comparison of inter-neighbour distance, calculated for a theoretically dense set and for the set within the bounds of the real area, is adopted as a measure of distribution within real bounds: $V_1 = INI_T / INI_P$ where INI_T refers to the inter-neighbour distance for a dense layout (a number of fields with occurrences), INI_P – inter-neighbour interval within real bounds. The index will reach value 1 if the arrangement is internally compact. A less value of the index indicates less accumulation of the set.

Table 1. The results of calculations of given indexes of layout for 19 models, expressed in unit areas and spaces

model no.	*Number of reference units with dots*	*Area of occurrence A ref. units*	*V index*	*INI index*	*max. number of neighbours* NG_T	*total number of neighbours* NG_P	*r' index*	*R index*	*relative entropy for ref. units*	*relative entropy for spaces*
1	100	100	0,00	1	360	360	1,00	2,00	0,00	0,00
2	90	90	0,20	0,95	322	302	0,88	1,87	0,58	0,86
8	76	100	0,50	1	262	203	0,43	0,86	0,76	0,91
13	76	100	0,65	1	246	157	0,78	1,86	0,83	0,83
19	68	72	0,65	0,85	238	216	0,60	1,64	1,00	0,89
2	67	90	0,83	0,95	234	158	0,78	1,66	0,80	0,97
16	50	100	1,01	1	170	90	0,59	1,18	0,63	0,91
17	50	100	1,01	1	170	90	0,56	1,12	0,63	0,91
9	54	54	1,23	0,73	186	168	0,69	1,86	0,82	0,80
18	60	72	1,54	0,85	208	181	0,69	1,64	0,69	0,92
3	40	40	1,62	0,63	134	88	0,54	1,20	0,68	0,91
7	34	34	2,44	0,58	112	84	0,30	1,03	0,54	0,95
14	30	30	2,63	0,55	98	90	0,42	1,86	0,58	0,83
15	30	30	2,83	0,55	98	90	0,36	1,33	0,54	0,94
4	26	26	4,08	0,51	82	81	0,38	1,52	0,51	0,88
10	35	100	4,40	1	116	84	0,29	0,58	0,46	0,94
12	20	20	4,42	0,44	62	55	0,38	1,12	0,34	0,91
5	25	25	4,95	0,50	80	58	0,40	1,60	0,43	0,80
11	10	33	9,09	0,57	26	0	0,23	0,62	0,14	0,86

Neighbourhood of reference units

The author proposes other measure of accumulation, which includes mutual vicinity of reference units. The content of the fields with punctual elements, regardless of the number of dots, is estimated in relation to the whole area. For each field with dots, vicinity is defined by the number of sides of the adjacent units with dots. The maximal number of neighbours is then 4 (full neighbourhood), and minimal is 0, when a unit is isolated. The total number of neighbourhood in a model is described by the distribution, as illustrated in Figure 1b.

The index of neighbourhood, which characterises the distribution for the entire set, is obtained by comparison with the vicinity of a theoretical, maximally dense layout. The distribution of maximally dense field of reference units has maximal number of neighbourhoods.

$V_{NG} = NG_P / NG_T$, where NG_P marks the practical total number of neighbourhoods, and NG_T the theoretical total number of neighbourhoods calculated according to the settled algorithm. The index $V_{NG} = 0$ indicates that the layout is isolated, with no neighbourhood among at least one row of fields. $V_{NG} \cong 1$ will be obtained for an accumulated layout. Accumulation here means concentration of all the fields with dots. This particular value of the index will be obtained for a uniform layout – one dot in one field, and layouts with different values, but for internally concentrated fields. The nearer the index is to 0, the less internal accumulation of the fields' layout (the distribution is rather random).

Relative entropy index

Spatial distribution of punctual objects may be tested by the analysis of the layout of dots, which represent objects in appropriate reference units, with the use of the method of entropy and relative entropy. In order to do that, class intervals, namely the number of dots in a reference unit, were fixed for all models. Calculation was made according to the formula:

$$H(\omega_1, \omega_2, \omega_3 \ldots \omega_n) = -\sum_{i=1}^{n} \omega_i \log_2 \omega_i ,$$

where ω_i marks probability of occurrence of i state out of all n possible and independent states occurring in given conditions and time [Sobczak and Malina, 1985].

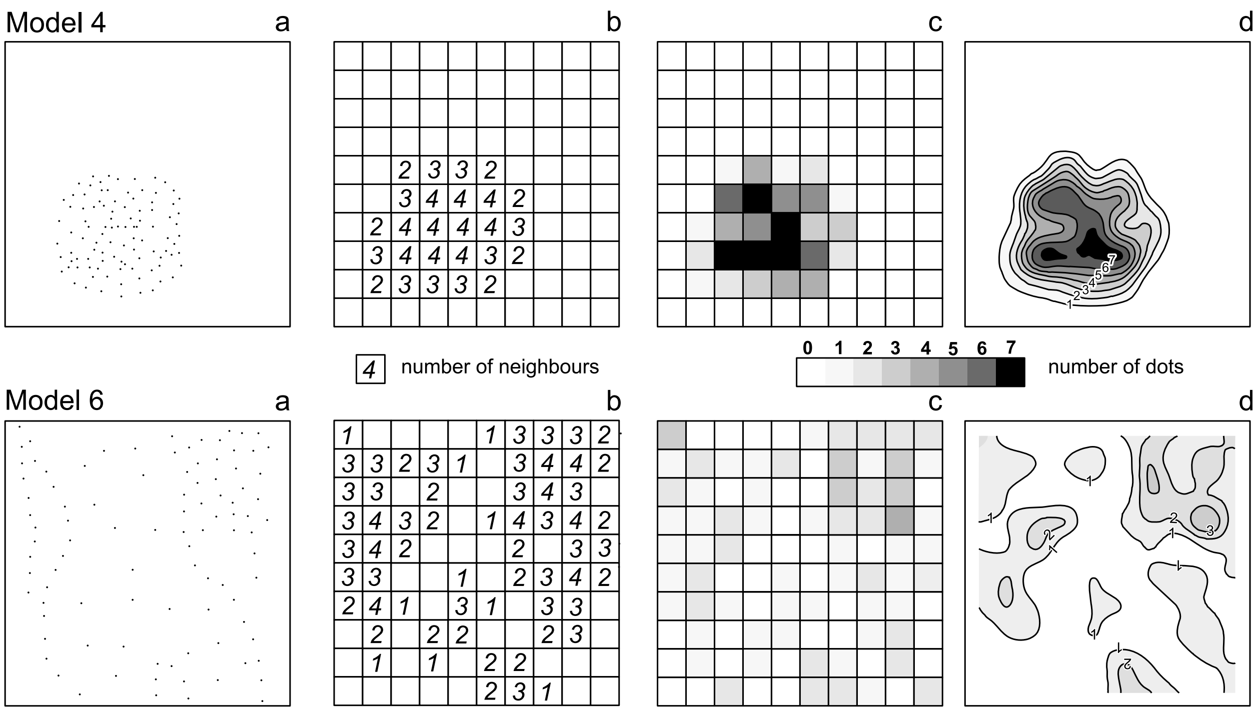

Figure 1. Distribution of points in given models presented with the use of method: a) dot; b) reference unit neighbourhood; c) dasymatric; d) isoline

The function reaches maximal value equal to $H_{max} = log_2 n$ for $\omega_1 = \omega_2 = \ldots \omega_n = 1/n$. Relative entropy amounts to $h = H / H_{max}$. The results of the calculations of entropy for the chosen models are presented in table 1.

The value of entropy allows to evaluate the distribution of fields in the fixed classes of dot density. It is not important whether the class has one or ten dots, what matters is the frequency of occurrence. This factor is not spatial. Entropy reaches higher values if the number of areas in the classes tends to be equal. Maximal entropy indicates that the layout is maximally differentiated, namely the same frequency occurs in every class. Entropy equal to 0 corresponds to a layout with uniform density distribution (all the fields are in the same class).

Relative entropy may have value from 0 to 1. We will get the value $h = 0$ when all the fields have the same number of dots (model 1). Whereas $h = 1$ indicates that the layout is maximally differentiated, namely each class has equal number of areas.

Analysing the results presented in the table, it can be claimed that model 19 (called three-circular – concentric) is maximally differentiated. The important information while evaluating the distribution is how many and which classes occur in the set.

Evaluation of the distribution based on "spacing"

In the earlier tests, evaluation of the distribution of punctual phenomena was carried out on the basis of analyses of dot density in unit areas of appropriately designed models. Another approach to evaluation of layout are analyses that use the length of segments, spaces connecting the nearest pairs of dots, as the measure of ordering. The distribution can be here defined as a local arrangement of dots with respect to all neighbouring dots [Muehrecke, 1980]. 19 basic models were chosen for the test.

Based on spaces, the following were estimated:

- the average distance of neighbours: $r' = \sum_{i=1}^{n} r_i / n$, where r_i marks the distance between a pair of points, and n a number of pairs;
- expected average distance: $r_d = 0{,}5\sqrt{A/x}$, where A marks area, x – a number of dots, $0{,}5$ is an empirically calculated factor;
- the index of deviation from randomness: $R = r'/r_d$. The results of calculations of the selected indexes are presented in table 1.

The average distance between the points in all models does not exceed one unit (the length of a side of a reference unit). Models 11, 7, 15, 12 and 4 have the shortest distance. A short distance between dots suggests that the set is dense. It is not always accumulation within the area of testing, which is proved by the layout of the mentioned models.

When we use the method of average distance, one numerical value represents the whole layout. To get more detailed information about a model, we must take deviation of distance from its average value into account, for it may happen that several different models have the same average value. It may characterise both the layout where the distance between pairs of points is the same ($\delta = 0$), and the one with extremely different distances.

The expected average space limits the field of research to the area of minimal occurrence of objects. For the models 4 and 5, it stays within the bounds of 0,50 to 0,25.

The index of deviation from randomness $R = 0$ indicates the maximum grouping (concentration), $R = 1$ denotes random distribution and $R = 2{,}14$ – a maximally scattered distribution. The index $R = 0$ did not occur in the tested models. Models 10 and 11, which are accumulated, have the smallest value. Model 10 can be described as bi-insular with different degree of accumulation in both islands. Model 11 consists of 10 fields of 10 dots that are internally dense, but their position in the tested area is isolated. This index exhibits some reference to spatial layout.

The same value of the index R, like for example in model 12, 17 or 16, cannot be interpreted as the same type of layout. Models 17 and 16 are similar, 17 being streaked and vertical, and 16 level, yet, model 17 is insular.

Method of entropy based on "spacing"

The calculated index of relative entropy h is presented in table 1. In this case, evaluation of layout refers to space which is the measure of connections between dots. We thus test the character of distance distribution in the fixed intervals of the measured spaces.

The value $h = 1$ indicates a maximally differentiated layout, namely one with the same number of spaces in the fixed classes. The remaining values indicate intermediate layouts, which are random, aiming at accumulation or maximal differentiation. Out of 19 tested models, model 6 has reached the highest value $h = 0{,}97$. Nevertheless, almost all models exhibit the layout of space $0{,}83 \leq h \leq 0{,}97$, which attests the level number of spaces in the classes.

On the basis of the presented indexes we can estimate the distribution in a numerical way and interpret it as random, uniform or accumulated. Each index provides evaluation of distribution of its various features. Therefore the terms random, uniform or accumulated should be interpreted in reference to the tested element of layout. The choice of a method of ordering the data in space is the basic determinant of everything characterised in the layout of objects presented on a map with the use of dots and signatures.

Evaluation of distribution based on maps

In the studies of spatial conditions of punctual objects occurrence as well as connected with them phenomena and processes, the methods presented above are often insufficient. The use of a map of a tested phenomenon may increase the credibility of evaluation. The basic fields should be then estimated on the basis of map analysis, their layout and size being adjusted to the real conditions of objects' density differentiation.

General information about the distribution that must be provided is the place where the objects occur on the earth's surface, or where they occur within the tested area. This evaluation may have different levels of accuracy. Another feature to be established is the degree of objects accumulation. On the basis of a map, objects can be divided into ones of big, medium or small density. It can also be estimated with the use of cartogram or isoline map [Klimczak, 1993]. Another advantage of map analysis is that looking at the layout of points we often try to shape simplified sets by comparing them to known shapes (shape isomorphism).

As a map may be treated as a graphic model of spatial aspects of reality, all the information can be obtained on the basis of further visualisation of the transformed data [Kraak, 1996]. In the models tested on the basis of dot maps, dasymetric cartograms and a map of isolines was made. The data was provided by the number of dots in reference units. Examples of such presentations for models 4 and 6 are illustrated in Figure 1c, 1d.

Data transformation and classification into density classes constitutes new information about a phenomenon, whose spatial structure can be revealed on a map. On the basis of maps, it is much easier to estimate mutual relations between objects or groups of objects, as well as compare their layout in particular districts.

The analysis of distribution of small fractions of afforested grounds in the area of Stronie Slaskie

In the analysis of afforested grounds in the area of Stronie Slaskie, attention was paid to the evaluation of usefulness of different methods of testing spatial arrangements of sets of objects.

Presented in Figure 2 fragment of a map includes part of the area of Stronie Slaskie. It has been pointed out that the area should have its forest grounds developed, mainly due to the fact that the land is not arable. The tested area in Eastern Sudety Mountains is of great natural value and includes many preserved parts of international importance.

Spatial distribution of two-dimensional phenomena is presented on the example of real arrangement of afforested area. In the Polish cadastral record, forest produce is divided into forest grounds, marked with the symbol *Ls*, and afforested and shrubbed grounds, marked with *Lz*. Classification of area into one of the groups is bound by the requirements connected with land cultivation and surface limit. To *Ls* group belong grounds of > 1000 m^2 covered with forest flora, while *Lz* grounds must have < 1000 m^2. To differentiate the two groups in the research, a class of objects with surface up to 1000 m^2 was distinguished. In the analysis of spatial layout, the areas *Ls* and *Lz* are treated both as afforested ones.

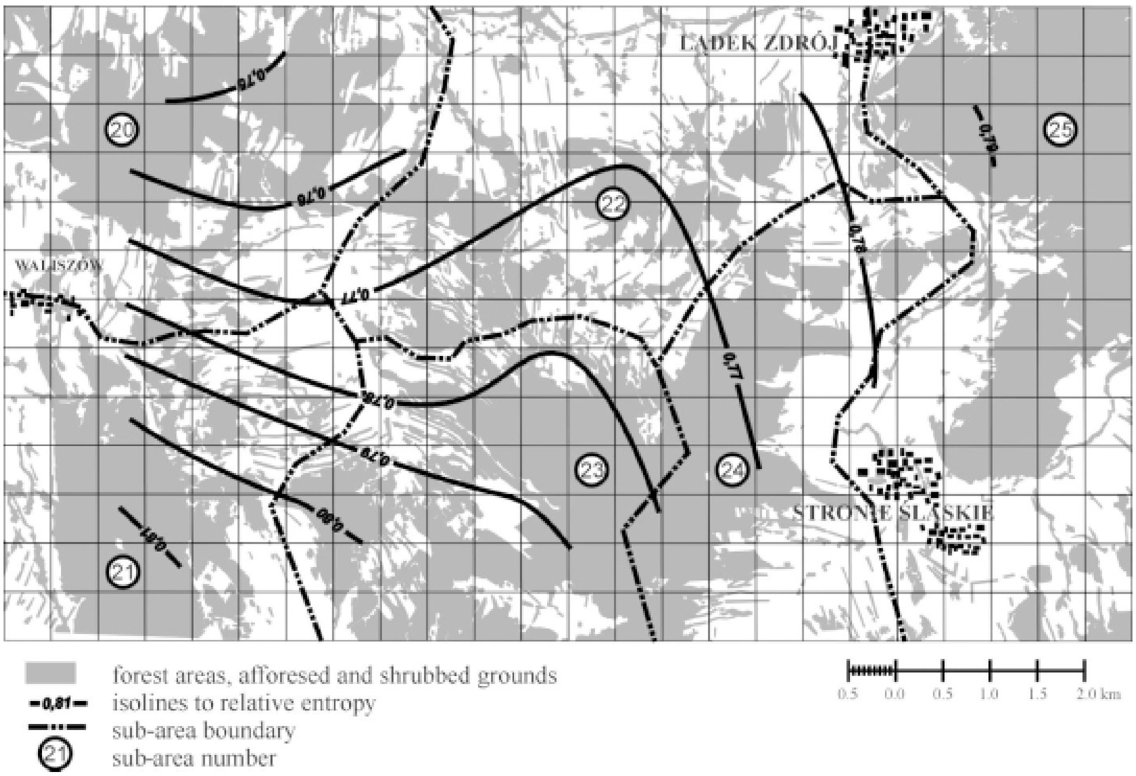

Figure 2. Forest and afforested grounds in the area of Stronie Slaskie

The cataloguing of forested areas was made on the basis of transformed aerial photographs on a scale of 1:30 000 but the numerical map was adjusted to the scale of 1:25 000 that is also the scale used for the forest maps. The adjustment did not refer to the degree of detail of the map and prepared map includes even objects with the surface of 300 m^2. The use of photographs helped to prepare such a detailed and actual list of data. It is especially important for the realisation of the National Program of Forest Extension, whose first stage is to be completed by the year 2000. The author of the present paper is the supervisor of a research grant financed by State Committee for Scientific Research. One of the aims of the research is to model spatial layouts of areas to be afforested. The existing multi-scaled maps do not mark all areas because most objects are created along with the natural development of forest, and are not measured at all.

A graphic and thematic database, created with the use of MapInfo 5.0, facilitated the process of carrying out the research. The analysed area is a compact unit due to the morphometric conditions, elements of infrastructure and distribution of large forest areas. It includes a surface of 8 000 ha, 50 % of which is afforested. These terrains are located on 1012 objects, which are of different size and shape due to varying shape of ground and afforestation along the rivers, brooks and roads.

Table 2 presents the results of the analysis of the distribution of objects made with the use of the method of entropy. It is the evaluation of layout in 10 classes of area sections. Out of 1011 selected objects in the whole set, 860 constitute afforested areas with surface up to 1 ha. 89% constitute areas below 0,5 ha.

The method of entropy allows to check if the surface objects grouped in 10 classes are accumulated, uniform or random. The value of the relative entropy index equals to 0,74 indicates random layout tending to be a differentiated one. Maximal differentiation, in this case, indicates equal number of objects in all classes. When testing entropy, objects up from 1 ha were included as representative for the tested area.

A more detailed picture of the distribution can be obtained by calculating the indexes of relative entropy for sub-areas and presenting results by the method of isoline. Taking into account the principles formulated for the whole area of research, six sub-areas were separated and given numbers 20, 21, 22, 23, 24, 25. Localisation with respect to big groups of forest and the way of land cultivation were additional factors that decided about separation of the sub-areas.

Entropy and relative entropy were calculated for each sub-set. The results are presented in table 2. The values of relative entropy served to draw isolines of entropy (Figure 2). They show increase of differentiation of accumulation to the South East, and bigger accumulation to North East.

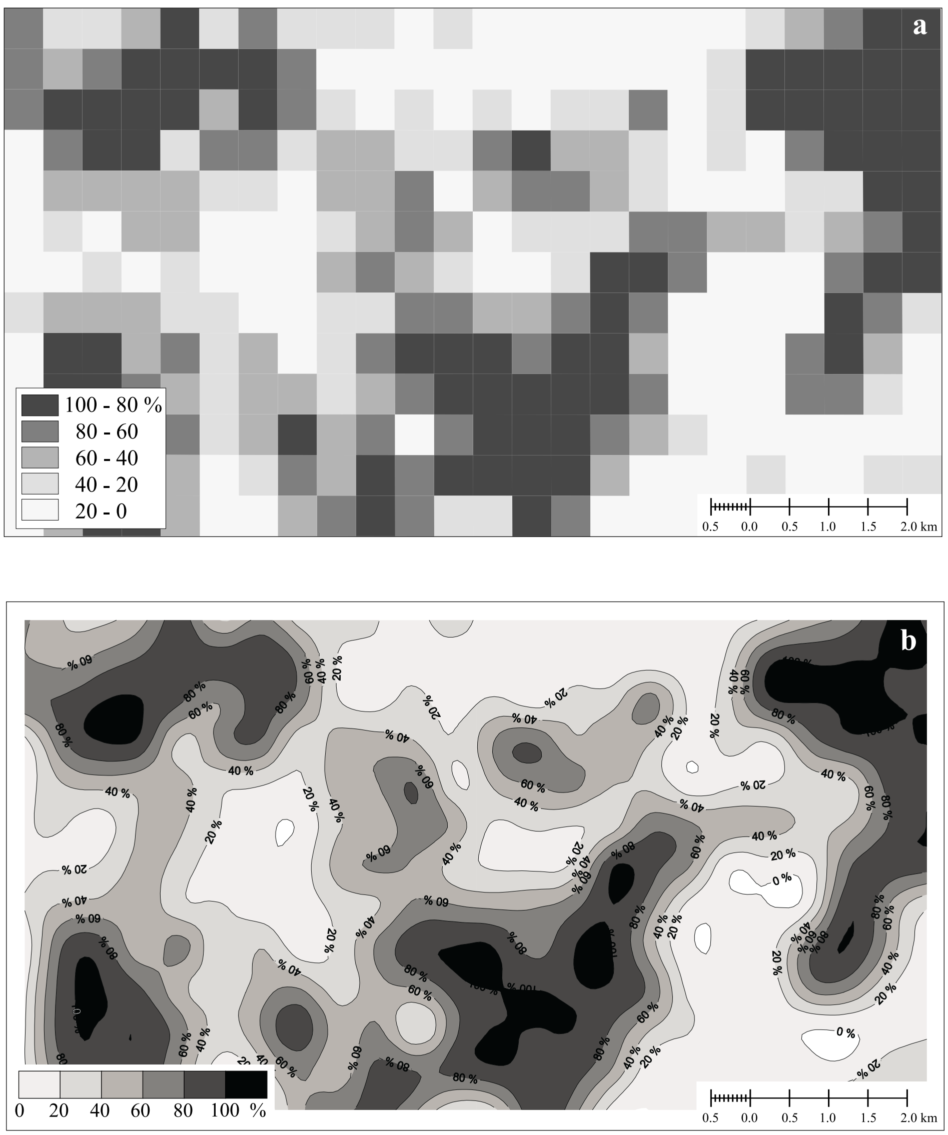

Figure 3. Percentage participation of forest and afforested grounds: a) dasymetric map; b) isoline map

Table 2. Results of calculation of entropy in sub-areas for objects of surface < 5 ha.

Sub-area no.	*Number of objects*	*number of objects $A < 1000\ m^2$*	*entropy*	*max. entropy*	*relative entropy*
20	172	71	2,847	3,807	0,748
21	131	34	2,697	3,322	0,812
22	283	115	2,750	3,585	0,767
23	113	44	2,744	3,459	0,793
24	121	43	2,569	3,322	0,773
25	145	36	2,817	3,585	0,786

Next, spatial distribution of afforested areas, without taking into account the size of the selected fractions, was presented using the method of dasymetric cartogram. In order to do that, a grid of unit fields, constructed on the base of geographical co-ordination, was put on the tested area. In the given example, the co-ordinates were recounted to Cartesian co-ordinates in the ‘1965’ arrangement, which is obligatory for topographic maps in Poland. In the example, the area of the field is about 2,5 ha. Using MapInfo’s procedure of dividing objects, a base was created in which the unit fields were assigned the afforested areas grouped in them. Defining these areas as the participation degree: $C = S\ [a_i / A] * 100\%$, and including C into one of five classes dasymetric cartogram, presented in Figure 3a, was made. The data transformed in this way may be treated as continuous and presented with isolines. SURFER program was used to make the isoline map presented in Figure 3b.

What kind of information can be read from these models? Both of them are generalised pictures of distribution of afforested areas. Thus precision of evaluation of their arrangement depends, first of all, on the adopted reference unit and simplification. Grouping individual values of afforested areas, which are set to these units, into classes is another simplification. Precision, in this case, depends on the number of classes and the adopted way of division. Taking these into account, a cartogram can provide information about localisation of afforested areas and fields with specified information about the degree of the phenomenon. A cartogram can show if the spatial layout is uniform or differentiated. If it is differentiated, then looking at the neighbourhood, it is possible to estimate whether the layout is regular (density in the neighbouring fields gradually increases), or whether it is a set of randomly placed fields of different density. Units’ position and density is here taken into account. Determining its shape, a map provides information about the degree of area’s density and the ways of its occurrence. Similar information can be obtained from the model of isolines. Here, the distance between isolines provides information necessary to estimate the density.

Summary

The paper presented the most often used methods of analysing the real layouts of punctual elements and small surface fractions. Model analysis pointed out some difficulties in explicit interpretation of the results. Therefore simple indexes including the neighbourhood of elements were proposed and special role of cartographic model in the analysis of layout and interpretation of phenomena arrangement was emphasised.

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Session / Séance 29-B1

Evaluation of Agricultural Influence on the Natural Environment by GIS

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Preface

The impact of agriculture on the environment is significant and diverse. A lot of methods of impact assessment and evaluation and its danger were recently developed, but there is no one universal among them. Complexity of the studied system, affected by a great number of natural and anthropogenic factors, that are themselves in complicated relationships between each other, stipulate a multitude of criteria and approaches for the evaluation of the ecological danger.

Everything in environment is related to everything else. Some relations between natural and human factors are direct, immediate and obvious. Others are indirect, develop on the long term and are difficult to detect. But whatever the nature of these relationships, together they form the set of the unique ecological situations that can be recognized, classified and ranged.

The present work is an attempt to solve the problem of the integral quality and quantity assessment of ecological danger of agriculture management systems.

Agricultural assessment influence factors

The total impact of agriculture on the environment is determined by numerous factors of farming and stock breeding impact. In Russia the importance and degree (extent) of impact of different factors vary greatly because of great diversity of types of agriculture, environment and historical factors affected state of the environment of different regions.

The most significant agricultural activity's influence factors taken in account are:

types of agricultural land use,

the coefficient of soil erosion for different crops,

the coefficient of erosion for different soils,

soil insolation,

fertilizer use,

pesticide use,

pressure on pasturelands.

Crop composition, cropping pattern and crop rotations mainly characterize the degree of agricultural impact on the environment. The methods of cropping (close-growing and tilled crops) determine the area of uncovered soil surface and its liability to water and wind erosion. That is why the coefficient of soil erosion for different crops is most important one. The second important factor is fertilizer use and type of applied fertilizers - nitric, phosphorous, potash and others - used for nutrient compensation carried out by erosion and crops. This factor causes the problem of pollution of the environment and agricultural production by nitrates and some other toxic substances. On the other hand fertilizer use leads to accumulation in soils of some harmful substances and elements. For example, application of phosphorous fertilizers is accompanied by fluorine, strontium and uranium accumulation in soils.

Systems of livestock breeding that are under practice in many regions of Russia lead to pasture digression and as a result to decrease of soil protective properties and accelerated erosion. Therefore, for total impact assessment of agriculture it is important to take into account the pressure on grazing lands calculated separately for different types livestock, for pastures under different stages of digression which vary in yields and quality of fodder resources.

The impact of different types of agricultural practices may be aggravated by some environmental factors, i.e. severe erosion and deflation. Pesticide and insecticide use is very important for some areas in Russia.

The total environmental impact assessment of agriculture should take into account the impact of each branch of crop raising and livestock breeding, natural processes capable to increase the negative impact and possibility of cumulative effect of secondary consequences that can cause nature degradation and deterioration of the environment.

Source date for analysis

The spatial database of the GIS-version of Ecological Atlas of Russia was used as the source data for performing analysis. Hand-made Ecological Atlas of Russia, created by Laboratory of Complex Mapping of Geographical faculty in 1996 year, which serve as the basis for GIS-version, which develops as solid spatial database under management of ArcView GIS power query and analysis tools. This spatial database accumulates wide range of actual information of ecological situation on the whole territory of Russia.

Database includes more then 60 themes of thematic spatial information that logically divided into four main partitions:

1. Conditions of forming of ecological situation
2. Anthropogenic assessment and changes in environment
3. Ecological situation and demography
4. Strategy of ecological balance

All this data are referenced to the digital vector map base of Russia, which initially automated from original digitization from 1:10,000,000-scale source map of Russia using ARC/INFO software. This digital map base was strongly checked and attributed using most modern statistical sources and now it is one of most comprehensive, 1:10 000 000-scale, vector base map of Russia, which consists of 11 geographic base layers (hydrography, sea shore, populated areas, latitude and longitude grid and other), attribute and textual data that may be accessed, queried, displayed and modified using ARC/INFO and ArcView software.

Thematic layers for this database was initially obtained by digitization from 1:10,000,000 and 1:20,000,000 scale hand-made ecological thematic maps of Ecological Atlas of Russia also using ARC/INFO software. Editing, coordinating and attributing of thematic layers was performed using ArcView GIS.

We use next main datasets in our research: Landscapes; Land Use; Crop Raising; Live Farming; Soil Erosion; Soil Degradation; Ability of Soils to Selfcleaning of Pollution; Ability of Soils to Accumulation of Pollutants, Ravines, Marshness.

Offered approach, Methods and Results

The offered approach of agricultural impact assessment, considered in spatial aspect, based on the two main statements:

1. Agricultural lands can be divided onto rather stable in time parcels with homogeneous set of main anthropogenic factors of influence and natural conditions which stay constant on the whole extent of the each parcel.
2. The verisimilar integral coefficient of the influence for the recently existed forms of the plant-growing and live farming can be estimated for each parcel on the base on the set of factors, normalized and weighted in final calculation according to expert's evaluation of their meaning.

The most significant factors taken in account are: land use, the coefficient of soil erosion for different agricultural plants, the coefficient of erosion for different soils, soils insolation, the extent of soil degradation, ability of soils to selfcleaning of pollution and ability to accumulation of pollutants, ravines, marshness and other.

Although, according to our opinion, this approach can be most applicable for the local and regional evaluation (under conditions of the presence of the sufficient set of the source data), the described analysis was fulfilled for the whole territory of Russia.

All work that are needed to provide our analysis: visualization, editing, geoprocessing, modeling and creating maps was done in ArcView GIS 3.1 with Geoprocessing Wizard and ArcView Spatial Analyst extension.

Four main steps was fulfilled:

1. Performing the spatial overlay upon the selected themes of source actual data to obtain new parcels on intersections and union database.
2. Estimation of the integral coefficient of the agricultural assessment for each obtained polygon for the recently existed forms of the plant-growing and live farming separately.
3. Building the surfaces of spatial distribution of coefficient.
4. Creating maps.

Two maps was produced on the base of the obtained results:

1. The extent of the influence of the plant growing.
2. The extent of the influence of the live farming.

These maps can be used for determination of the optimum variant of livestock farming and plant growing to reduce negative ecological consequences on regional extent.

Session / Séance 29-A

The Evolution of Eucaliptus and Sugarcane Cultures in the County of Torrinha (São Paulo, Brazil) Through the Use of Digital Cartography Techniques

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Abstract

The main goal of this research was to study the spatial changes in the cultures of eucalyptus and sugarcane in the county of Torrinha, state of São Paulo, from 1965 to 1992, using digital cartography techniques as an aid to rural planning and management of the county's agricultural space. Through the use of charts, maps, aerial photographs, computers and graphic editing programs, it was possible to prepare thematic maps of the previously mentioned cultures. The study method consisted in digitizing analog data as a dynamic instrument for analysis and synthesis. In order to do this, the data was scanned and treated in digital format through the graphic editing programs Adobe Photo Shop, Corel Photo Shop and Corel Draw. The digital cartography was shown to be efficient and precise in representation, easy to correct and quick to work with data, as opposed to conventional cartography. The development of works which evaluate the changes in time and space that have taken place in soil use and development, through the presentation of faster and more accurate diagnostics, enable us to obtain the direction and intensity of the changes these cultures are submitted to in a specific area through time. The results obtained were presented in four maps of distinct times (1965, 1972, 1981, 1992), showing the growth of the sugarcane culture to the expense of eucalyptus in the county of Torrinha. It was also shown that the changes which took place in the eucalyptus and sugarcane cultures in Torrinha during this period, place the city within a regional tendency making sugarcane the main agricultural product.

INTRODUCTION

This work was based on digital cartography. The application of computer techniques, programs and equipment has been transforming the cartographic activity allowing more dynamic spatial analysis and the development of more agile projects.

The methodological proposal of this work consisted in the analysis of the temporal evolution of the sugarcane culture, used on the production of alcohol and sugar by the mills in the region; as well as the evolution of the eucalyptus culture, used in the production of essential oils by the county's distilleries. Thematic maps were elaborated applying digital cartography techniques as an aid to study the spatial behavior of the aforementioned cultures in the county of Torrinha from 1965 to 1992.

Through the used of documents such as charts, maps and aerial photographs, it was possible to elaborate thematic maps of the cultures of eucalyptus and sugarcane at distinct periods which were digitally treated through specific graphic editing programs.

Digital cartography was shown to be effective to represent, easy to correct and agile in handling the data bank, when compared to conventional cartography; which is, by no means, invalid, since digital cartography applies basic concepts used by conventional cartography as scale, projection, point, line and area among others.

The study of the evolution of these cultures in Torrinha was necessary due to the great fall verified in the area planted with eucalyptus simultaneous to the increase in area of sugarcane which mirrors the process of change in the county's economy. According to Matias [1989], from the development of projects like this, the importance of mapping and soil use evaluation techniques is evidenced, the application of the digital technique in spatial-temporal studies enable critical evaluation on the use of technology as an instrument of analysis and synthesis of information besides offering a sophisticated resource to manipulate information for rural planning.

The study of peak activity and fall of eucalyptus culture and its possible substitution by sugarcane was pictured in four moments in the history of Torrinha: 1965 the beginning of eucalyptus plantations in the county; 1972 until 1981, when the extraction of eucalyptus oil was in full activity and Torrinha started to be considered "The Eucalyptus Capital of Latin America"; and finally 1992, when the eucalyptus became secondary to the city's economy. This work, then consisted in establishing in historical line through the elaboration of thematic maps, from the appearance of eucalyptus, its peak, fall and the implantation of sugarcane, and the changes in the county space since 1965 to 1992.

OBJECTIVES

The main goal of this work consisted in studying the spatial changes which have taken place with sugarcane and eucalyptus cultures in the county of Torrinha, from 1965 to 1992, making use of digital cartography techniques as an aid to rural planning and management of agricultural space.

As specific objectives, we intended to apply and evaluate the technical resources offered by digital cartography, that is, how and to what extent the use of digital techniques contributes to the success of temporal studies. We also intended to evaluate the spatial changes in the city during the study period and make up thematic maps focusing on the changes that have taken place.

On the spatial context, we intended to identify the way and the areas in which the sugarcane has grown, in which direction and intensity and how the county's agricultural landscape has changed from the introduction of eucalyptus to the present.

CHARACTERIZATION OF THE AREA

The city of Torrinha is located in the center of the state of São Paulo (Fig. 1), and 22º 22' latitude south and 48º 18' longitude west in the administrative region of Campinas, administrative sub-region of Rio Claro. The county's area is 323 km^2.

Regarding its topography, Torrinha is located on the Paulista Plateau, above the São Pedro Sierra, the city is at 820 meters above sea level, some points in the district being estimated around 1000 meters above sea level. Regarding the state capital, Torrinha is 201 km Northwest of São Paulo in a straight line, by road, the distance is increased to 289 km and by railroad the distance is 300 km. The most important cities near Torrinha are: Bauru (to the west), São Carlos (northwest), Rio Claro (east) and Piracicaba (south east), with an average distance of 100 km from the city. The bordering counties of Torrinha are: Brotas (north and east), São Pedro (southeast), Santa Maria da Serra (south) and Dois Córregos (west).

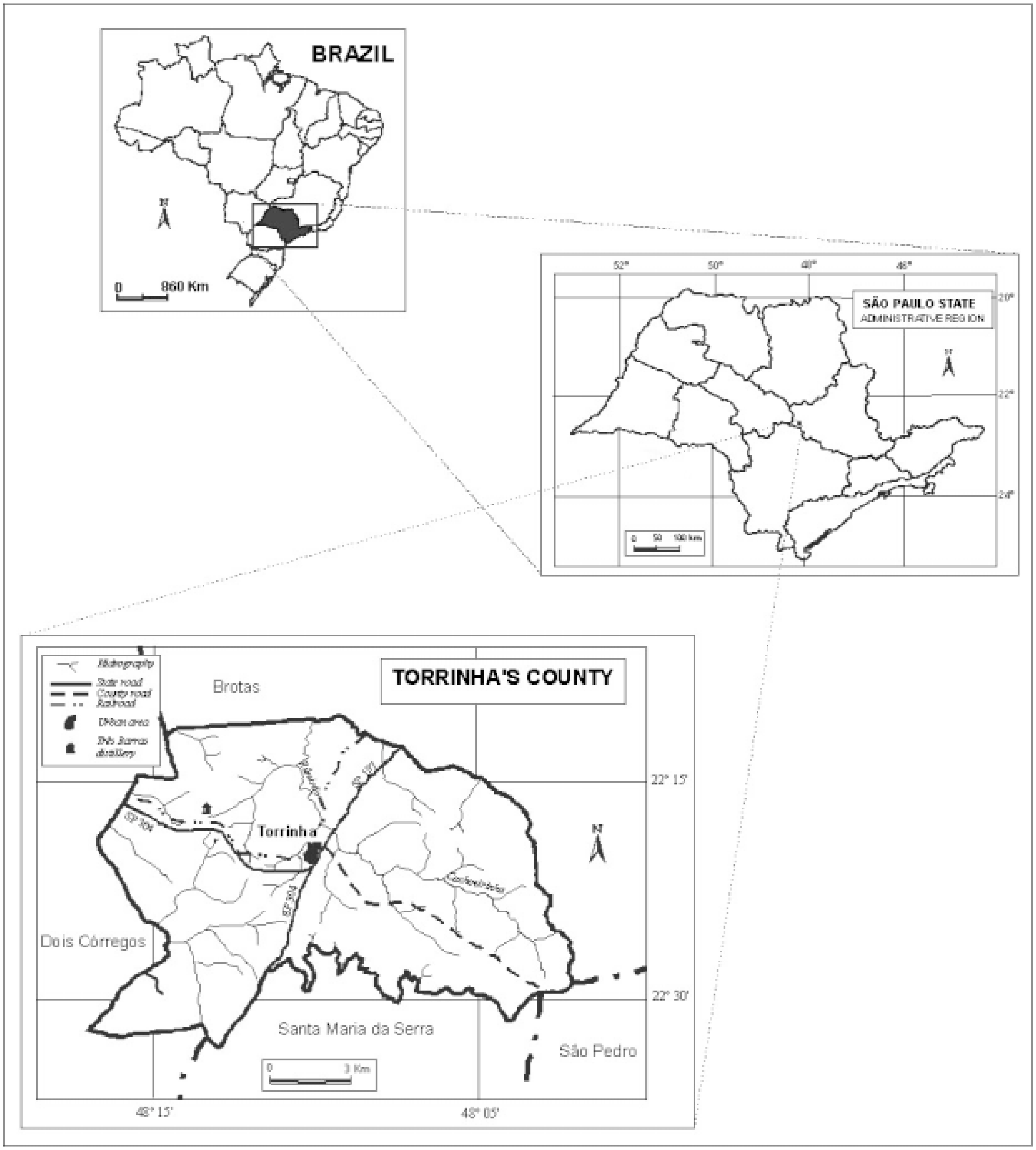

Figure 1. Location of the county of Torrinha relative to the state of São Paulo and Brazil

According to Köppen's classification the predominant climate in Torrinha is of the type *Cwa*, that is, tropical with two well-defined seasons. The average annual temperatures are 30^{o}C in Summer and 15^{o}C in Winter, with hot and rainy Summers and cold and dry Winters. The annual rainfall is 1130 mm early (average of the last ten years according to the Casa da Lavoura de Torrinha). The natural vegetation in the county is completely destroyed, but there are some spots of Atlantic Rainforest and Cerrado.

The hydrographic is made up of basically, small rivers streams and creeks with the large number of waterfalls due to the uneven relief. The main water course is the Ribeirão Cachoeirinha whose spring lies in the extreme southeast of the county and crosses it completely, running to northwest to the county of Brotas. The majority of the river that supply the county belong to the micro-water basin of this creek, tributary of the Jacaré-Pepira river, which in turn, belongs to the Tietê river water basin.

Regarding the population, according to the 1991 census, the county had 7,604 inhabitants, of which 1,672 in the rural zone and 5,932 in urban zone. Of the economically active population, 25% were on the primary sector, 25% on the secondary sector and 50% on the tertiary sector.

METHODOLOGY

The mapping of the temporal evolution of cultures enables the preparation of diagnostics and prognostics about the dynamics of a given region [Matias, 1989]. In this perspective, the methodology employed in this work observed the following steps: 1) Data collection; 2) Photointerpretation; 3) Scale correction; 4) Digital cartography and graphic representation; and 5) Temporal analysis.

The first step was the identification of sources of data about the area such as: aerial photographs, satellite images and maps of soil use in the region. The importance of this stage of work is in defining the years to be studied since the maps do not obey a regular order and a homogeneous scale. This way, the years 1965, 1972, 1981 and 1992 were chosen due to the availability of documents as: Topographical charts from the Brazilian Institute of Geography and Statistics (IBGE) sheet of Brotas SF-22-Z-B-III-4, scale 1:50,000 from 1974; Aerial photographs from the city of Torrinha, scale 1:25,000 from 1972; Chart of land use of the state of São Paulo from the Geographical Cartographical Institute (IGC/SP) sheet Bauru, scale 1:250,000 from 1981 and; Forest Inventory of the State of São Paulo, scale 1:250,000 from 1992.

The following step was the photointerpretation of the sugarcane and eucalyptus cultures for each year, aiming to map and identify the areas. The sugarcane and eucalyptus areas were mapped through the use of identification marks, that is, characteristics which could identify these cultures. According to Matias [1989], the sugarcane is one of the cultures or modality of soil usage easiest to identify.

Ceron *et alii* [1985] *apud* Matias [1989], assert that, in aerial photography, sugarcane presents a light gray color, velvet texture, great fragments, regular geometric shapes with well-defined forms taking up great extensions of land. Another identifying mark consists in the presence of roads where cargo trucks pass through. The eucalyptus presents black color, fine and uniform texture, regular and geometric shape. They form a uniform “roof” due to the uniform planting system. They occupy from small segments to great extensions. In this larger areas, it is rarely possible to find roads or reference points observable on the photographs, making it difficult to establish control points.

Since the data from the different years were in different scales, it was necessary to correct these to a common scale of 1:100,000 making use of an Aerosketchmaster. From the maps of distribution of sugarcane and eucalyptus cultures, we proceeded to enter data using a table color scanner of the Department of Cartography of Unesp – Rio Claro, which were filed with the extension .TIF.

During the scanning process there were some problems regarding the quality of the digitized source. The maps are scanned with a number of correctable defects. In first instance, the occurrence of sugarcane and eucalyptus were edited using the computer program Corel Photo Shop for the years of 1965, 1972, 1981 and 1992. The corrections were made on the in the computer program Adobe Photo Shop. Subsequently the maps were edited on the computer program Corel Draw, through the creation of a legend, scale, title, etc.

CHANGES IN EUCALYPTUS AND SUGARCANE CULTURES FROM 1965 TO 1992

The analysis of the map made for the year 1965 (Fig. 2) shows a concentration of eucalyptus in the surroundings of the Três Barras distillery on the northwest portion of the county; as for the sugarcane, it was dispersedly distributed in small areas, which can be explained by the expansion of the sugarcane boundaries from the county of Brotas.

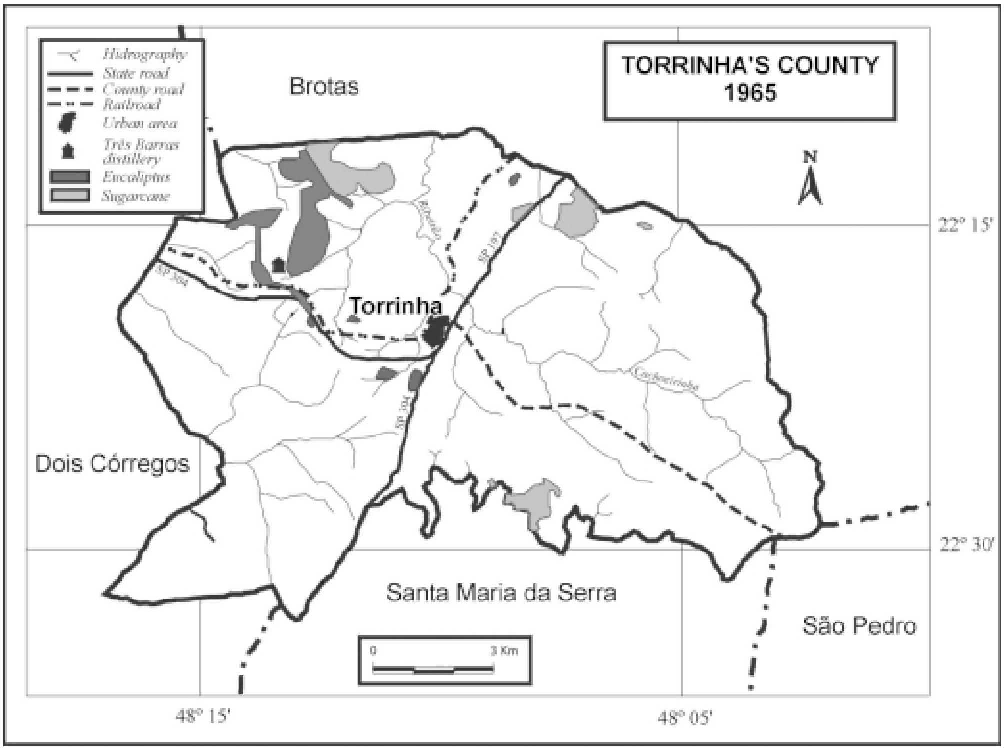

Figure 2. Distribution of the eucalyptus and sugarcane cultures in the county of Torrinha in 1965

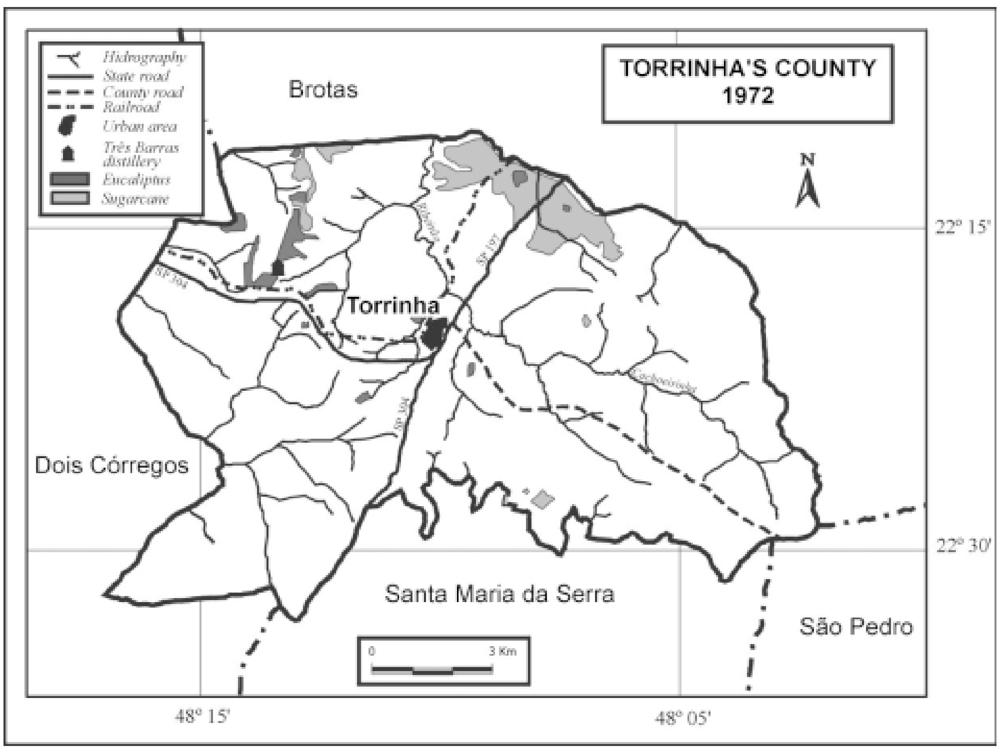

Figure 3. Distribution of the eucalyptus and sugarcane cultures in the county of Torrinha in 1972

The map in Figure 2 mirrors the socioeconomic situation of the county of Torrinha during the 1960's, that is, the migration of the workforce from the country to the city and from the city to the metropolis of São Paulo, as shown by the high rural exodus of the decade. The migration is clear when we analyze and compare the maps of 1965 and 1972 (Fig. 3), that is, seven years later, the eucalyptus area was drastically reduced, probably due to the lack of labor to work in the distillery, while the sugarcane expanded its borders.

It was thought that the eucalyptus would have a vertiginous climb after the 1960's, but what actually happened instead was a decrease in area of eucalyptus at that time. The explosion of eucalyptus can be observed on the 1981 map (Fig. 4), four years before the city be considered the eucalyptus capital of Latin America. It can be seen that the area planted with eucalyptus is, without a doubt, expressive in the county. The eucalyptus plantations were not restricted to the area surrounding the Três Barras distillery, but also around the other distilleries there were at the time. In 1985 there was an eucalyptus explosion in the county with a great increase in cultivated area which reached its peak between 1985 and 1988.

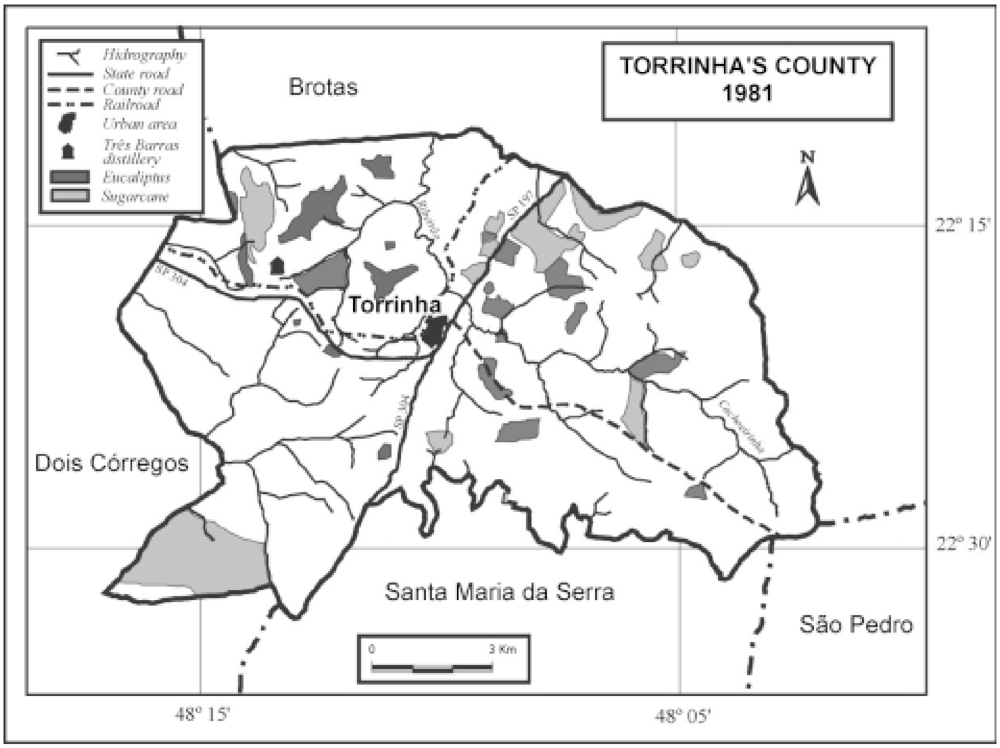

Figure 4. Distribution of the eucalyptus and sugarcane cultures in the county of Torrinha in 1981

The sugarcane also presented a considerable growth during the year of 1981, no longer being restricted to the border with the city of Brotas to spread on the sides of the highway SP-197 and on the borders of the counties of Dois Córregos and Santa Maria da Serra. This increase can be a consequence of the exhaustion of land in the counties of Jaú and other neighboring counties, which have been taken by sugarcane by many decades; and also to serve the demands of a market economy, through the expansion of the sugarcane monopoly and sugar agroindustries of the state of São Paulo.

Figure 5, of 1992, shows that the perspective for eucalyptus is not satisfactory, with sugarcane distributed in three large areas in the city. This growth can be explained by the natural development the sugarcane culture has obtained in the region thanks to government incentives of the PROALCOOL program.

The eucalyptus lost space in the county's economy and was restricted to only small areas dispersedly distributed as it is evidenced by the 1992 map. After that year the regional tendency for the culturing of sugarcane decisively arrived to Torrinha, with the areas close to the counties of Brotas, Dois Córregos and Santa Maria da Serra being taken by sugarcane with progressive growth perspectives in the following years.

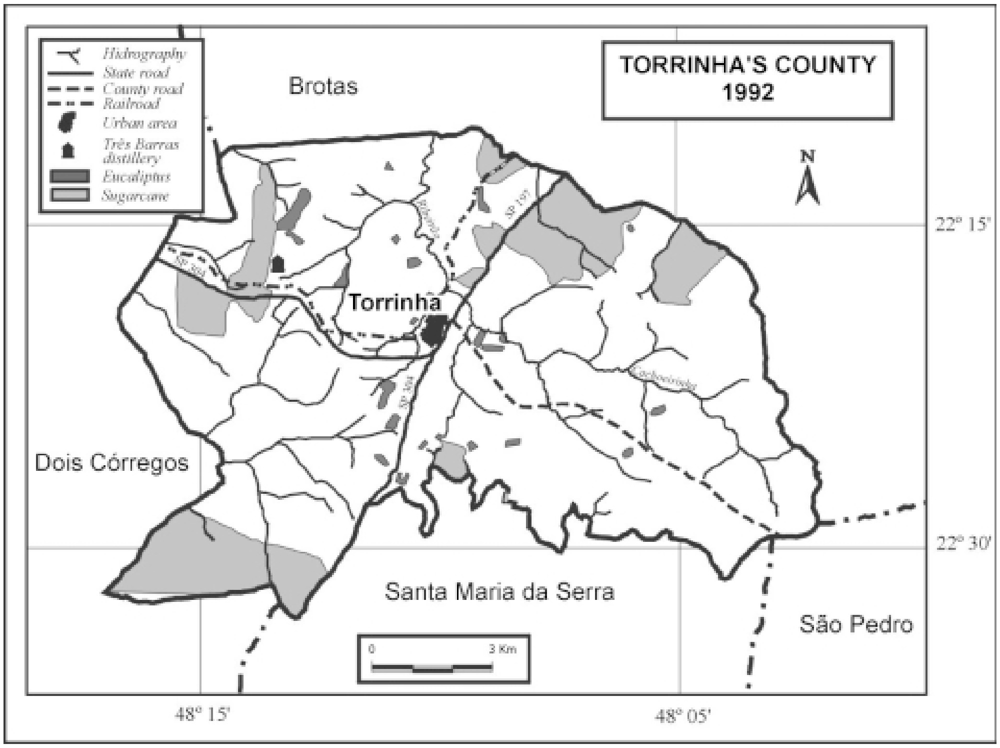

Figure 5. Distribution of the eucalyptus and sugarcane cultures in the county of Torrinha in 1992

CONCLUSIONS

The study of the changes which have taken place in the eucalyptus and sugarcane cultures in the county of Torrinha from 1965 to 1992, through the use of digital cartography, allowed the creation of a digital data bank, analysis and representation of information referring to the evolutionary process of these cultures. Such information was fundamental for a more refined evolutionary analysis for rural planning and for comprehension and management of the agricultural space of the county.

Even though there are some limitations, mainly due to the lack of a source of data necessary to the development of this type of work, the use of a computer was shown to be efficient, quick and precise in the process of obtaining and analyzing spatial information, such as: data collection by scanner and information treatment by graphic edition programs.

The future research perspectives have in spatial analysis the necessary theoretical and methodological basis to: create a digital database (layers) in Geographical Information System (GIS) environment; create a census database referring to production and planted area of the cultures studied for the respective years in study; generate choropleth cartograms; compare, in GIS environment, the area planted with sugarcane and eucalyptus obtained on the analog map with the area obtained from the census data; incorporate to the database the Cerrado and Atlantic Rainforest areas in the city; refine the database and the analysis of culture evolution through the incorporation of classified satellite images; and ultimately, to integrate the map of soil usage with the pedologic map and with the map of soil agricultural capacity, aiming a synthesis of the city's agricultural situation.

The development of research evaluating the changes occurring in the process of use and occupation of soil enable the acquisition of fast and precise diagnostics. With the use of computing resources, the direction and intensity of the changes occurring in a certain space through time can be easily obtainable.

In respect to changes that have occurred in Torrinha from 1965-1992 in the cultures of eucalyptus and sugarcane, we concluded that the county has joined in a regional tendency making sugarcane the main agricultural product.

The spatial change that has occurred substituting the eucalyptus for sugarcane demonstrates a tendency towards modernizing the agriculture, once the sugarcane culture needs cutting-edge technology when compared to eucalyptus, which still makes se of a rudimentary technology to extract the oil from the eucalyptus leaves.

Starting from this study, we intended to assist the public authorities in planning and managing the county of Torrinha, in need of development in this fields, and we hope this work is incorporated into the county's archives and that it contributes to the development of Torrinha.

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Session / Séance 29-E

Mapping of the urban areas evolution and evaluation of urbanization impact on agricultural lands

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Abstract

The economic development of Morocco is accompanied with a rural population displacement towards cities which generates a great increasing in surfaces used by housing, equipements and activities in urban areas. This increasing, badly controlled, causes an important urbanization phenomenon, especially illicit one, outside the areas allocated for urbanization. To put right this situation, measures which are aimed to more protect agricultural lands against urbanization will be taken particularly the development of a database which permits a spatial and temporal tracking of agricultural and urban areas. To start developing a similar database, the rural engineering administration (AGR : Administration du Génie Rural) made a deal with the Royal Centre for Remote Sensing in order to use remote sensing and GIS technologies for the establishment of urban evolution maps and estimation (under statistical form) of the urbanization effect on agricultural areas during the last three decades (1970, 1980 and 1990). Three cities, for which elaboration of urban planning director sheme is in progress, are concerned by this study : Béni-Mellal, Khémisset and Ksar El Kébir.

The methodology adopted in this study consists in using panchromatic Spot images in order to survey the urban areas during 1980 and 1990 decades. Regarding the 1970 decade, the available topographic maps dated in this decade were used. Once the photo-interpretation of images and the digitizing of topographic maps are completed, and with the help of GIS capabilities, maps of urban evolution for each region with the related statistics were established allowing the evaluation of the urbanization impact on agricultural areas.

1-Introduction

The economical development and the population increase, combined with the occasional drought in Morocco, induces a farming exodus which operates a strong urbanization of the most fertile lands. To put right this situation, measures which are aimed to more protect agricultural lands against urbanization will be taken particularly the development of a database which permits spatial and temporal tracking of agricultural and urban areas. To start developing a similar database in Morocco, the rural engineering administration (AGR: Administration du Génie Rural) made a deal with the Royal Centre for Remote Sensing in order to use remote sensing and GIS technologies for the establishment of urban evolution maps and the estimation of the urbanization effect on agricultural lands during the last three decades (1970, 1980 and 1990).

2- Study areas and data used

The study concerns three Moroccan regions each covering 30 km x 30 km and centred on a city for which the elaboration of urban planning director sheme is in progress. The three cities are: Béni Mellal, Khémisset and Ksar El Kébir.

Since Spot images are not available before 1986, we were constrained of using cartographic maps to have the state of the regions during the 1970 decade. However, any map for the Khémisset town which date back to 1970 was found. As well as the maps related to the 1970 decade, other maps at different scale on the study areas were used for geometric correction of images, field data collection mission and the toponymy information (Table 1).

Regarding the two decades 1980 and 1990, the information on the extent of built during these two periods was extracted from panchromatic Spot images (10 meters of spatial resolution). So, a catalog research was made in order to identify the images which were acquired for each zone during the years 1986/ 87 and 1996/ 97 of preference in summery season (Table 1).

Tableau I : Topographic maps and satellite images used in this study 3- Methodology

Regions	*Cartographic maps (scales and quantities)*	*Spot Images panchromatic images (Date of acquisition)*
Ksar El Kébir	4 maps 1/50.000	20-07-1987
	1 map 1/100.000	11-08-1996
Khémisset	3 mapes 1/50.000	19-01-1987
	1 map 1/100.000	10-07-1996
	1 plan 1/10.000	
Béni-Mellal	4 maps 1/50.000	18-09-1986
	1 map 1/100.000	10-07-1996
	1 plan 1/10.000	

The adopted methodology which is based on remote sensing, geographical information system and existing maps includes severals stages for each zone (Figure 1) :

- Production of a digital land use map for the 1970 decade from the available documents.
- Stratification (Anys and al. 1998a) of the panchromatic Spot images in order to produce the land use maps for the 1980 and 1990 decades. This stratification was made by an on-screen image-interpretation assisted by computer. The 8 considered classes are : Water, plantation, irrigated land, non irrigated land, range land and undergrowth, forest, discontinuous urban, dense urban.
- The control of the stratification results by means of field truth and available topographic and thematic maps.
- Analysis of cartographic and statistic results and production of built evolution and urbanization impact maps.

4- Results :

The study allowed to provide for each region the following products (Anys and al., 1998b) :

- Land use maps with 8 themes at 1/ 50.000 scale and the corresponding statistics at 1970, 1980 and 1990 decades.

- Themes evolution maps and matrix for 70-80, 80-90 and 70-90 periods. The evolution matrix gives, in quantitative form, extension and regression of each theme including the extension of built over agricultural areas.
- Maps which synthesis the built evolution during the three decades. Tables II and III gives the related statistics.
- Maps of urbanization impact on agricultural lands. Those maps indicates the first land use type before to be transformed to a discontinuous or dense urban area during a given period.
- Digital database was also constituted by the coverage of land use and of evolution and by the used Spot images. This database, easy to update, could be enriched by of other types of cartographic and/ or alphanumeric information in order to integrate the maximum of parameters which intervenes in urban planning and decision making.

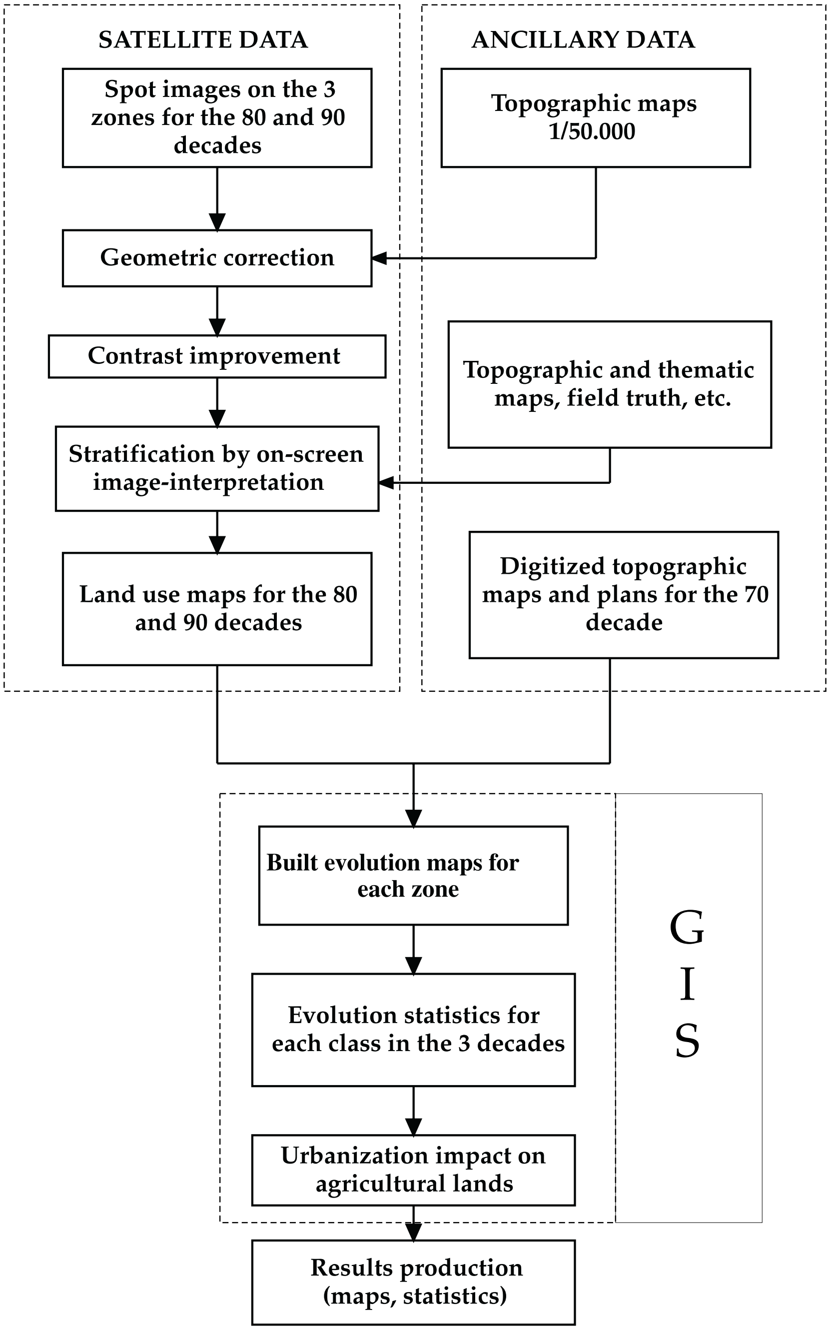

Figure 1. Methodological diagram

As an illustration of results obtained in this study, the figure 2 shows the results of stratification for the three decades as well as the map which synthesis built evolution for the Béni-Mellal zone. For the same zone, the table IV gives the evolution matrix for the 1980 to 1990 period. This matrix indicates in hectares extension, regression and evolution (difference between extension and regression) of each class considered.

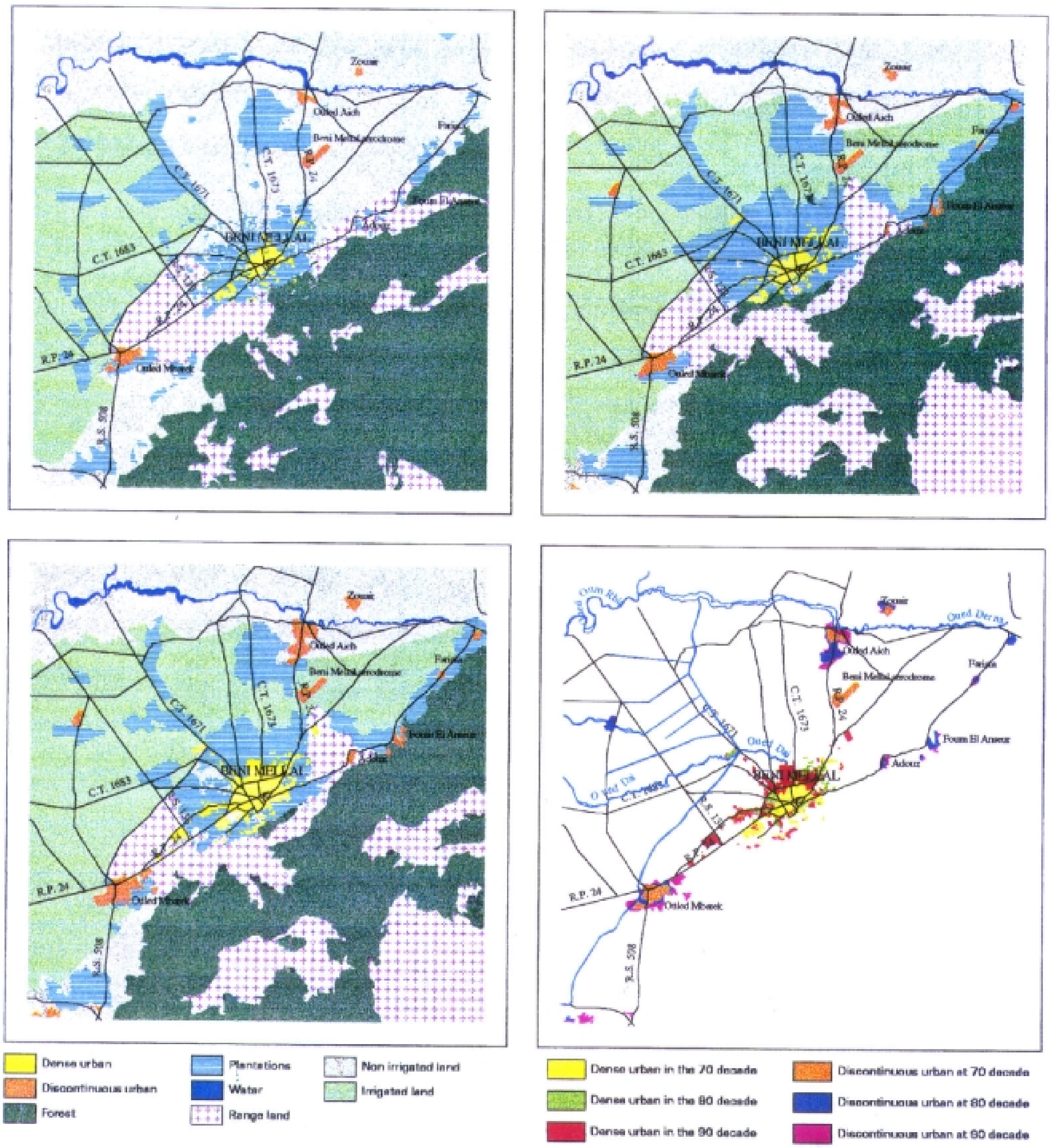

Figure 2 : Example of cartographic results obtained on the Béni-Mellal zone

Figures a, b, c, show the stratification maps respectively obtained for 70, 80 and 90 decades. Figure d corresponds to the evolution built map during the 3 decades

a	**b**
c	**d**

5- Results analysis

The tables II and III, respectively showing the built state and evolution in the three towns during the 1970, 1980 and 1990 decades, allowed to make the following observations :

- Khémisset and Béni Mellal cities have the equivalent extend of built and they are subject to nearly the same evolution,
- Ksar El Kébir built-up area has a surface nearly two time less than this of Khémisset or Béni Mellal. However, and since 1980 decade, we assist to a rapid evolution of Ksar El Kébir town.
- During the last considered decade (1980-1990), the Ksar El Kébir city has known an important development (170.5%) compared to khémisset (70.7%) and Béni Mellal (89.6%)
- Inversely, the discontinuous built area is three time more important in Ksar El Kébir than in the two other regions. This can be explained by a high density of rural population in the Ksar El Kébir zone.
- From the 1970 decade to 1990 decade, the built area evolution induced the following impact on agricultural areas :

* In the Ksar El Kébir zone, the dense urban area increased by 598.1 ha to the detriment of 61.7 ha of discontinuous urban, 18.8 ha of plantation, 501.4 ha of non irrigated lands and 16.2 ha of irrigated lands.
* In the Béni-Mellal zone, the dense urban area increased by 980.7 ha to the detriment of 24.7 ha of forest, 752.3 ha of plantation, 113.4 ha of rangeland, 69.7 ha of non irrigated lands and 20.6 ha of irrigated ones.
* In the Khémisset zone, and from 1980 to 1990 the dense urban area increased by 647.8 ha to the detriment of 7.7 ha of plantations and 640.1 ha of non irrigated lands.

Tableau IV : Evolution matrix for the 1980-90 period (Béni-Mellal zone)

Décennie 80 / Décennie 90	A (ha)	B (ha)	C (ha)	D (ha)	E (ha)	F (ha)	G (ha)	H (ha)	Extension (ha) (+)	Évolution (ha)
A	----	0	24.7	591.8	109.4	0	40.0	0	765.9	765.9
B	0	----	12.4	62.2	73.4	0	219.1	48.2	415.3	415.3
C	0	0	----	0	719.6	0	0	0	719.6	- 378.6
D	0	0	263.4	----	40.4	0	2.9	202.6	509. 3	- 1171.9
E	0	0	797.7	20.3	----	0	0	0	818.0	- 153.5
F	0	0	0	0	0	----	0	0	0	- 19
G	0	0	0	285.5	24.8	19.0	----	0	329.3	59.8
H	0	0	0	721.4	3.9	0	7.5	----	732.8	482.0
Régression (-)	0	0	1098.2	1681.2	971.5	19.0	269.5	250.8		

A = Dense urban *B = Discontinuous urban* *C = Forest* *D = Plantation* *E = Rangland an undergowth* *F = Water* *G = Non irrigated land* *H = Irrigated land*

Table II. Built-up area state in 1980, 1980 and 1990 decades.

Regions	Urban Type	Built-up area in (ha) and in (%)		
		Decade 70	Decade 80	Decade 90
Ksar El Kébir	dense	173.8 (0.2 %)	285.4 (0.3 %)	771.9 (0.9 %)
	discontinuous	1206.4 (1.3 %)	2717.6 (3.0 %)	3151.6 (3.5 %)
Khémisset	dense	---------------	916.3 (1.0 %)	1564.1 (1.7 %)
	discontinuous	---------------	584.6 (0.7 %)	948.1 (1.1 %)
Béni-Mellal	dense	542.6 (0.6 %)	757.4 (0.9 %)	1523.3 (1.7 %)
	discontinuous	374.5 (0.4 %)	715.1 (0.8 %)	1130.4 (1.3 %)

Table III. Built-up area evolution during the 70-80, 80-90 and 70-90 periods.

Regions	Urban type	Built-up evolution in (ha) and in (%)		
		70-80	80-90	70-90
Ksar El Kébir	dense	+ 111.6 (+ 64.2 %)	+ 486.5 (+ 170.5 %)	+ 598.1 (+ 344.0 %)
	discontinuous	+ 1511.2 (+ 125.3%)	+ 434.0 (+ 16.0 %)	+ 1945.2 (+ 161.2 %)
Khémisset	dense	---------------	+ 647.8 (+ 70.7 %)	---------------
	discontinuous	---------------	+ 363.5 (+ 62.2 %)	---------------
Béni-Mellal	dense	+ 214.8 (+ 39.6 %)	+ 765.9 (+101.1 %)	+ 980.7 (+ 180.7 %)
	discontinuous	+ 340.6 (+ 91.8 %)	+ 415.3 (+ 58.1 %)	+ 755.9 (+201.8 %)

6- Conclusion

This thematic study related to the cartography of urban areas and the evaluation of the urbanization impact on the agricultural lands is an example which shows that remote sensing, integrated with other types of data in a GIS, could procure some remarkable and unique information for a good management and planning of urban zones. On the other hand, the cost of this study (18 American dollars by km2) and the delays of its realisation (8 month) will more facilitate the use of these new technologies as a complement or a substitute to the conventional methods. Regarding to the use of high spatial resolution data (10 meters), this allows to have a more accurate determination of the limits between the urban and rural areas. In addition, the on-screen interpretation of this type of images, combined with the field truth, allows to distinguish between all considered classes in this study. However, this kind of data could be less appropriate if an automation of the stratification process is considered. In this last case, the combination of these data with other multispectral and/ or textural ones will be necessary (Anys and al. 1998c). Concerning the three studied areas, we could conclude that they knew an important growth of their built zones. Consequently, some urgent planning actions, which take into account the results of this study, must be made in order to control the urbanization in these regions and limit its bad impact on agricultural lands.

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Session / Séance 40-C

Mapping of landslide zones and relationship of the fractures and faults resulting from earthquake hazards in the Bozgoush-Dagh SE of Tabriz city in Azarbaidjan-IRAN

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Abstract

There has been a long standing need in landslide zones for quantitative information on fractures and microcracking and faulting resulting of the earthquake hazards in both stressed and unstressed rocks. The 10-15m size of the pixel allows precise mapping of fault and landslide traces and a good estimate of horizontal offsets. A horizontal displacement rate that is higher than 2-3 cm/yr. leads to significant off sets of land forms as rivers and drainage patterns, after only a few thousand years, and these offsets can be observed and measured on S.P.O.T. images. If the age can be estimated, reasonably, a displacement rate can be obtained. A landslide involves vertical and horizontal movement of rock, soil or same combination of the two under the influence of gravity. These slope movements are usually categorized as being either faults, topples, slide spreads or faults.

1 Introduction

Among natural hazards, landslides present a major danger for most Iran areas, specially in areas of the Azarbaidjan where the risk is increased by human settlement. Research is being conducted in order to improve the methods of mapping the areas that are vulnerable to landslides, and current approaches are based on geological and structural studies, geomorphology and modeling.

The geological application of aerial photographs in the Bozgoush-Dagh to Savalan and Ardabil region in NW of Azarbaidjan - Iran demonstrates the use of aerial photographs in mapping the zones that are susceptible to landslides. Landslides are most commonly triggered by precipitation, but earthquake and volcano triggered landslides have killed more people than all other type landslides combined.

NW of Iran specially Azarbaidjan area has been the scene for many earthquake in the past. The historical earthquake records are not sufficient future seismic activity because of the long recurrence intervals of destructive earthquakes in Bozgoush to Savalan volcanic and seismic area. As an example, the case of the 1997 Sarein-Ardabil earthquake of M=5.6-5.8. The Sarein is situated in the flank of Savalan volcanic area. This earthquake was the largest earthquake on the Sarein of Ardabil side, and its focal region covered an area 60-70 km long and 30-40 km wide, extending from south to north. Bozgoush-Dagh to Savalan volcano is also one of the most typical examples of landslide prone areas in the Azarbaidjan region. Azarbaidjan is divided into nine geological zones on the basis of landslide types and their hazard characteristics. These geological zones are:

1. The zone of granites (i.e. Kantal area in situated border of Aras river)
2. Late Paleozoic to Paleocene terrestrial volcanic (Sahand to Savalan area)

3. Ophiolite and associated basic rocks
4. Paleozoic to Meso-Cenozoic sedimentary rocks of crystalline schist faces (Khoy to Ourmiah region)
5. Miocene to Pliocene marine clastic sediments
6. Late Miocene to early Pleistocene terrestrial volcanic rocks
7. Quaternary volcanic rocks composing volcanic edifice
8. Mio-Pliocene-Quaternary pyroclastic and ashflows associated pyroclastic rocks
9. Late Plio-Pleistocene and Holocene sediments filling valleys. (Ghanbari, E. 1998)

2 Prediction and prevention of landslide hazards

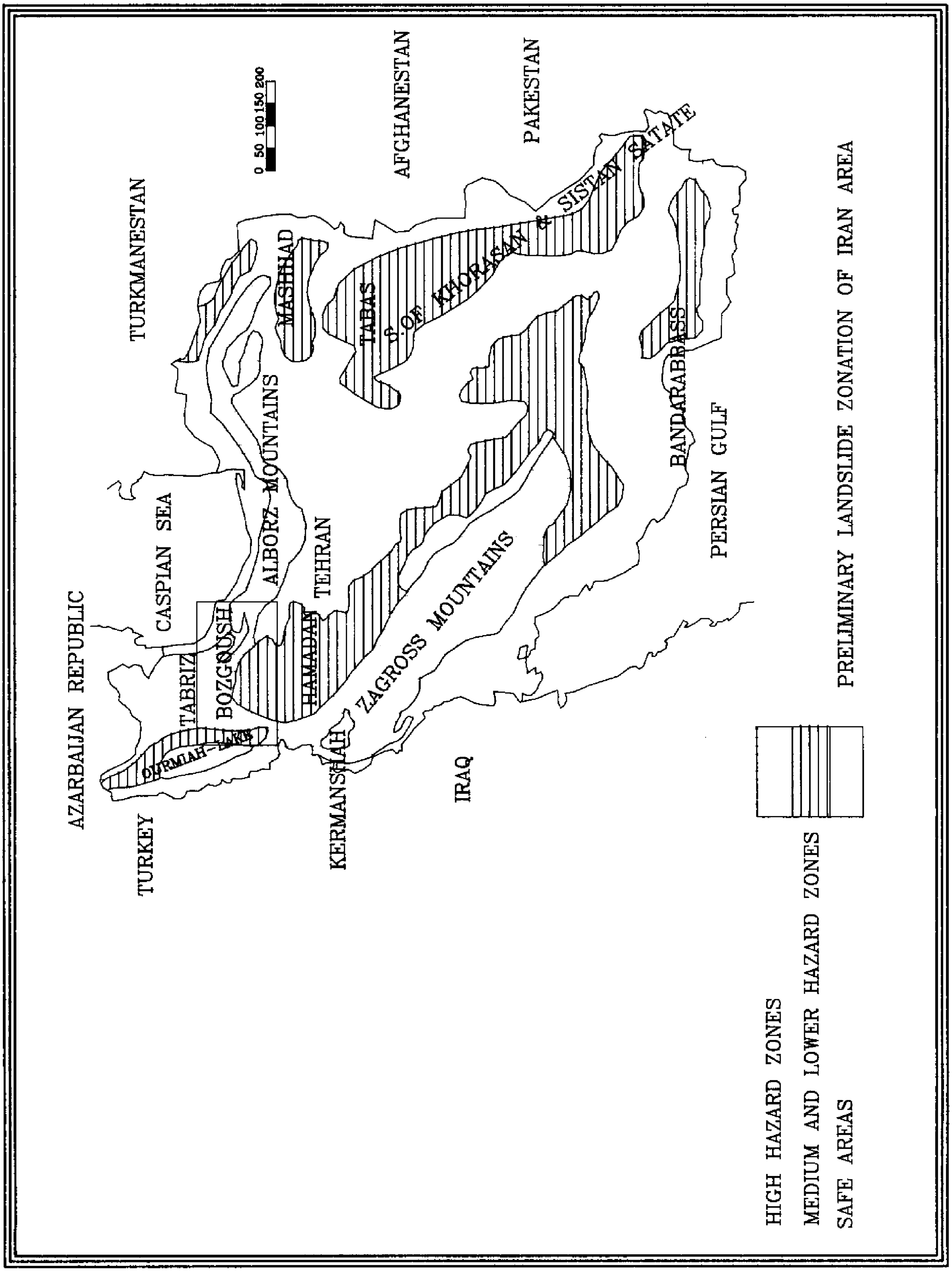
NW of Iran has experienced many major earthquake disasters an landslide hazards in the past. In 21 June 1990, 40 to 50 thousand people were killed by the Tarom-Roudbar great earthquake that occurred in the NW area. Iran is one of the most earthquake prone countries in the world. This has led to great interest in earthquake prediction, ever since seismological studies were begun in Iran a century ago. Earthquakes occur when stress within the earth's crust reaches a limit, and a sudden fracture (The sudden slip of a fault) occurs in part of the crust. In general, brittle materials fracture suddenly, and it is difficult to predict this fracture accurately. Fortunately, ruptures of the crust do not happen without warning, in most cases. As stress on the crust increases, crustal changes proceed by degree, and various phenomena occur immediately before the principal rupture.

NW of Iran particularly Guilan to Azarbaidjan area is also of the most typical examples of landslide prone areas in the world. As a result of this neotectonic activity, the NW of Iran consist of Plio-Quaternary volcanic rocks, thick but weakly consolidated Paleocene- Neogene deposits, older sedimentary rocks and metamorphic rocks. These rocks have been severely deformed and weathered or hydrothermally altered by the tectonic activity. Several mountains with height 2000-4000m were constructed by the neotectonic Alpine orogenic activity.

This contributes to the formation of thick weathering crusts and alluvial and colluvial deposits on slopes landslides is the main erosion style in specific zones, owing to the nature of the geological materials and the triggering agents of precipitation, strong earthquake motion. Landslides or mass movements can be classified into three types: Creep slide, rapide slide and debris flow, many landslides were designated for control works by the International Institute of Earthquake Engineering and Seismology (IIEES), Ministry of Construction and the ministry of agriculture. The landslides are distributed through out the country but most of them are concentrated in specific belts (Fig. 1).

3 Conclusions

Among natural hazards, landslides, earthquakes, present a major danger for most Iran areas, especially in areas of Azarbaidjan where the risk is increased by human settlement. The Geological application of aerial photographs in the Bozgoush-Dagh to Savalan and Ardabil areas in NW of Iran demonstrates the use of aerial photographs in mapping, the zones that are susceptible to landslides. Landslides are most commonly triggered by precipitation, but earthquake, landslides have killed more people than all other types landslides combined.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MASHHAD
TABAS
S. OF KHORASAN & SISTAN SATATE
ZAGROSS MOUNTAINS
KERMANSHAH
IRAQ
BANDARABBASS
PERSIAN GULF
PRELIMINARY LANDSLIDE ZONATION OF IRAN AREA
HIGH HAZARD ZONES
MEDIUM AND LOWER HAZARD ZONES
SAFE AREAS

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Session / Séance 26-A

Cartographie de L'environnement Communautaire Çomme Outils d' Education et Transference des Connaissances Tecniques

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Resumé

L'objectif de ce travail est de présenter une méthodologie de cartographie de l'environnement dans les favelas en tenant compte de l'aspect social, informatif et pedagogique de leurs habitants à travers l'usage de cartes de risque comme véhicule de communication dans le transfert de connaissances techniques.

La méthodologie a été testé avec des adolescents qui habitent la Communauté de Tuiuti - Rio de Janeiro et a démontré que le transfert de la connaissance technique(accidentes geologiques) aux adolescents, de manière simple et clair, avec travail sur le terrain et language cartographique, a été très efficiente dans le processus de l'apprentissage et dans la formation d'une conscience de l'environnement.

Le language cartographique comme ressource didactique rend plus agréable et plus rapide le processus d'acquisition de la connaissance. D' un autre côté la connaissance geotechnique commence à remplir la fonction pour laquelle elle a été élaboré, c'est à dire prendre en compte l' intérêt social.

L'application de cette méthodologie poursuit les objectifs suivants: réveiller une conscience des habitants des "favelas" à l'environnement sur les risques d'accidents existants sur les pentes instables, et à travers la connaissance de forme rationnelle, de la possibilité de se relationer avec son milieu; sensibiliser la population pour prendre soin d'elle et pour le développement de pratiques quotidiennes face aux problèmes d' environnement de sa communauté, cherchant la réduction des risques et par consequent l'amélioration de la qualité de vie.

I -Introduction

La ville de Rio de Janeiro avec ses caractéristiques morphologique, souffre de l'augmentation accélérée de sa population qui occupe aussi bien la périphérie de la métropole que les régions plus urbanisées, principalement les pentes des massifs montagneux, où la forme d'occupation est desordonnée et les conditions d'habitation sont précaires et sujette aux glissement de terrain.

Cette problèmatique social, d'environnement relationnée aux communautés qui habitent de façon desordonnée ses pentes sont l'oeuvre d' investissements en travaux de stabilisation des pentes principalement en mesure corrective.. La ville de Rio de Janeiro investit en moyenne, par an, plus de 20 million de dollars dans les travaux, et la tendance est d' augmenter les investissements, plus de 200 million de dollars usés dans des travaux de "lutte" de 1988 à 1997.

D’un autre côté, ces problèmes ont besoin d’être abbordé sous l’ optique d’une activité préventive. Actions qui vont de la réalisation d’ études de risques et de vulnerabilité et l’implantation d’oeuvres de prévention, jusqua à un programme d’éducation à l’environnement.

Beaucoup de chercheurs affirment qu’à Rio de Janeiro, la plupart des glissements de terrain sont associés à l’action antropique, malheureusement de caractère irresponsáble en grande parti au processus de croisance d’habitations sur les flancs des favelas [Pedrosa, 1994; Barros, 1992].

Les informations techniques sur la connaissance de l’environnement ont un rôle primordial pour l’appropriation de l’espace territorial urbain, principalement dans les zones de favelas. De cette forme la connaissance geotechnique, pour sa performance dans le processus d’organisation et d’ occupation de l’usage du sol, entre comme élément important dans cette transformation.

Ce sujet peut être abordé à travers les moyens de communication limités entre les techniciens et les autres sections sociales. Cette étude propose le développement de pratiques d’éducation de l’environnement comme une stratégie dans la réversion du processus de dégradation et pour la conservation et l’ usage rationnel du milieu ambient de ces communautés.

L’adolescent profite de la carte pour remarquer, savoir et analyser les problèmes de l’environnement qui sont présent dans son contexte et dans sa vie, acquerir assimiler une conscience et devenir un citoyen critique, avec la capacité d’intervenir.

II-Methodologie

Le développement de ce travail suit le processus d’investigation basé sur les présuppositions de l’Éducation De l’environnement et il formule une méthodologie d’un projet d’environnement interdisciplinaire conjugant les connaissances geotecniques et l’éducation à l’environnement avec l’appuie de la cartographie de l’environnement.Figure 1.

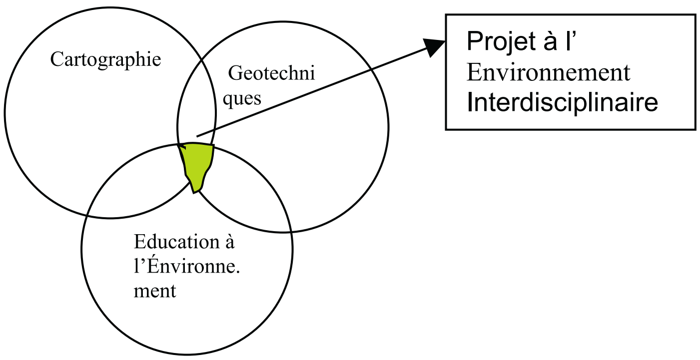


Figura 1 – Projet à l’Environnement Interdisciplinaire

Une vaste recherche bibliographique sur l’éducation à l’environnement et cartographie de l’environnement et les données disponibles sur les études geotechniques des favelas ont contribué à la création d’instruments pédagogiques pour rendre opérationnelle cette étude

Prenons en considération la complexité de l’environnement urbain, notammant les pentes des favelas dans une approche systémique que a été adopté pour identifier, analyser et intégrer les éléments de ces communautés, définit le Systéme de l’Environnement des Pentes des Favelas et est présenté figure 2.

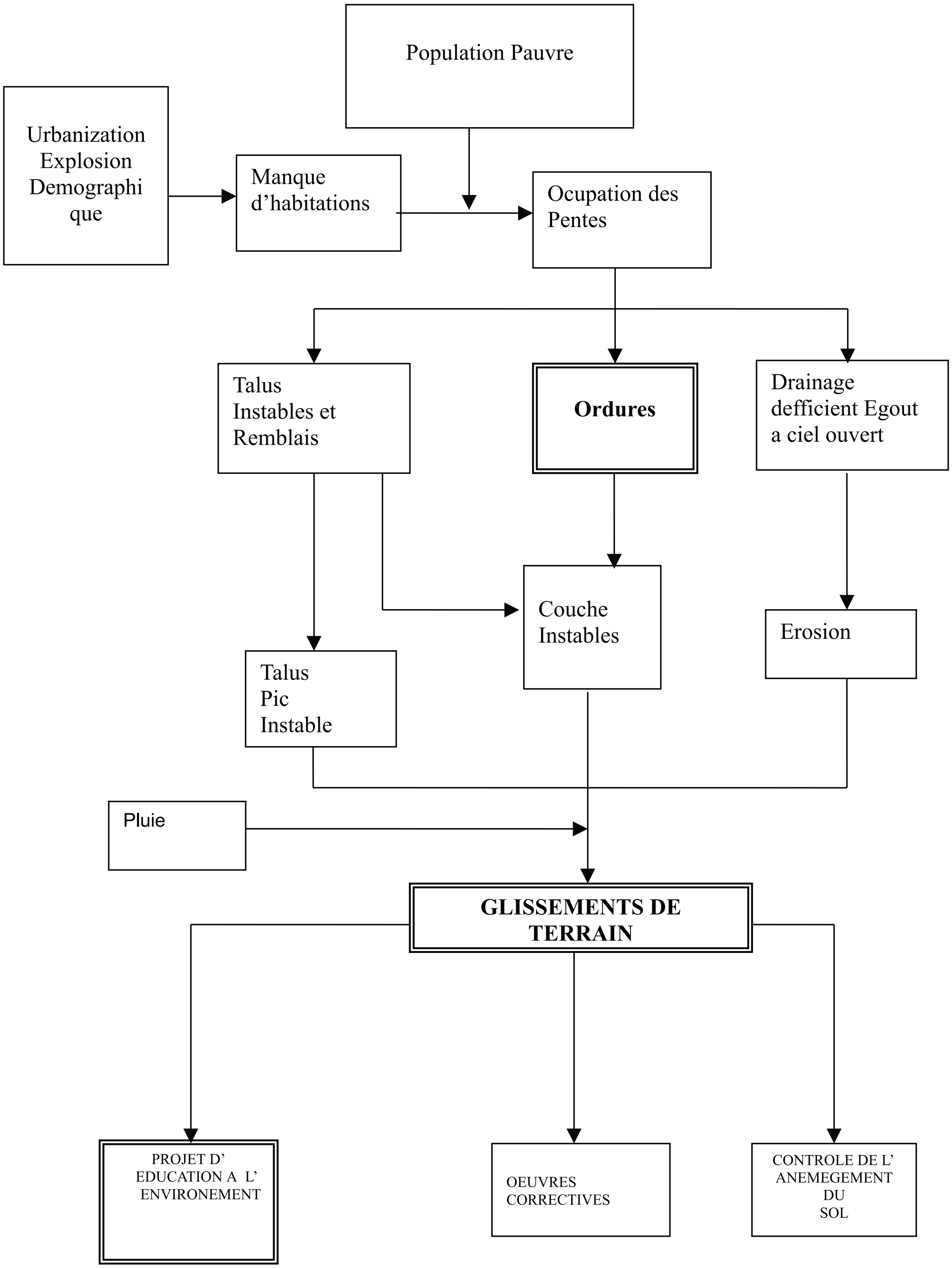


Figure 2– Système d'Environnement des Pentes de " Favelas"

La méthodologie s'appuie sur les principes basiques de base de l'environnement urbain de la cartographie comme instrument dans la prévention de risque. Elle a été testée avec des adolescents de 14 à 17 ans qui habitent la Communauté de Tuiuti dans la ville de Rio de Janeiro.

L’objet central du projet est la conscientisation de l’environnement et la recherche de l’amélioration de la qualité de vie de la communauté à travers sa capacité à atteindre les objectifs spécifiques suivants:

-Amélioration des conditions sanitaire de la favela;.

-Assimilation de nouvelles habitudes et entraînements par rapport à la prévention de risques de glissement de terrain et contrôle de maladies;

-Récupération, avec des solutions simples et des petits travaux dans les lieux critiques et résoudre ou minimiser les problèmes sérieux d’instabilité des pentes.

Le projet a été accompli en deux phases: La caractérisation de l’environnement de la Communauté et la carte “Sentimental” des Risques de glissement du terrain.

Phase I–Caracteristique de l’environnement

Cette phase se propose de comprendre l’environnement de sa Communauté et a comme objectif d’eduquer l’adolescent pour reconnaître les problèmes de sa communauté connaisant les facteurs qui favorisent les situations de risques de glissement de terrain.

Le Cours consiste en débat, et Travail sur le terrain, Élaboration de la carte infantil de Risque et Discussion des Problèmes et Recommandations:

*1er cours-**Exposer des expériences***

La première leçon est la présentation du Projet. C’est le premier contact de l’adolescent avec le travail et montre l’objectif du projet et son importance. La technique utilisée est la dynamique de groupe qui permet aux éleves de parler d’eux et de leurs habitations, les amenant a reflechir sur les dangers de vivre sur les pentes et des risque auquels ils sont exposées.

***2eme** cours Application du questionaire” Vous et Votre Habitation”*

Le questionnaire Vous et Votre Habitation est appliqué on soulevant des questions sur le milieu ambient dans lequel ils vivent.

***3eme** cours Application du Questionnaire Vous et l’environnement, votre Communauté et les Risques de Désastre*

Le questionnaire est appliqué pour exposer les aspects geologiques et geotechniques, et les causes principales qui favorisent les situations de risque de glissement de terrain avec des conséquences terribles pour les habitants, utilisant des dessins comme recours didactique. Les dessins facilitent la compréhension montrant des situations négative à l’environnement.

***4eme** cours Travaille avec le Texte: Etude Intégré du Milieu et le Questionnaire Vous et les Changements de Votre Communauté.*

Dans cette leçon est travaillé le texte Etude de l’environnement de Tuiuti qui montre les zones de risques et les facteurs qui ont produit les processus de deflagration de situations de risque.

Dans ce cours, le questionnaire est appliqué Vous et les Changements de votre Communauté, relatant une enquête au sujet de l’identification des problèmes, les aspirations de la communauté, les transformations passés et les avantages apportés par ces transformations.

***5eme** cours–Identification des Causes des Accidents*

Les étudiants relatant les causes qui peuvent provoquer des accidents et ils créent les légendes pour identifier les problèmes de l’environnement de la communauté. Il est défini un symbole pour chaque type de problème.

***6eme / 7eme** cours–Leçon sur le terrain*

Le travail sur le terrain est realisé en 2 jours et a comme objectif: l'identification des problèmes, et connaissances de la réalité de l'environnement de la communauté qui est présenté dans le rapport photographique.

***8eme** cours - Interprétation des Risques D'environnement Local- Élaboration de la carte Infantil de risque.*

Au retour du travail sur le terrain, la carte de risque est élaborée et signale les endroit à problèmes identifiés sur le terrain et les zones de problèmes d'environnement 'débattus dans la salle de classe et détectés sur le terrain, les symboles ont déjà été utilisés par des dessins sur des etiquettes.

Les problèmes encontrés ont été discutés pour élaborer la carte de risque . Chaque adolescent crée sa carte de risque et utilise l'information relevée sur le terrain faisant la somme des informations retirées de la carte et du rapport technique. Le materiel didactique utilisé sont: des étiquettes, stylo, hidrocor et crayon de couleur et etc (carte 1 et 2).

***9eme** cours–Discussion Sur les Risques encontrés et Quelques Recommandations.*

Une dynamique de groupe est realisée, les adolescents precisent les points qui nécessitent une intervention et à travers le dessins sont fournis quelques solutions simples qui peuvent être prises par eux et par leurs parents ou responsables.

Carte 1- Carte Tecniques de Risque

Phase II–Carte "Sentimental" de Risque dans le Communauté Tuiuti

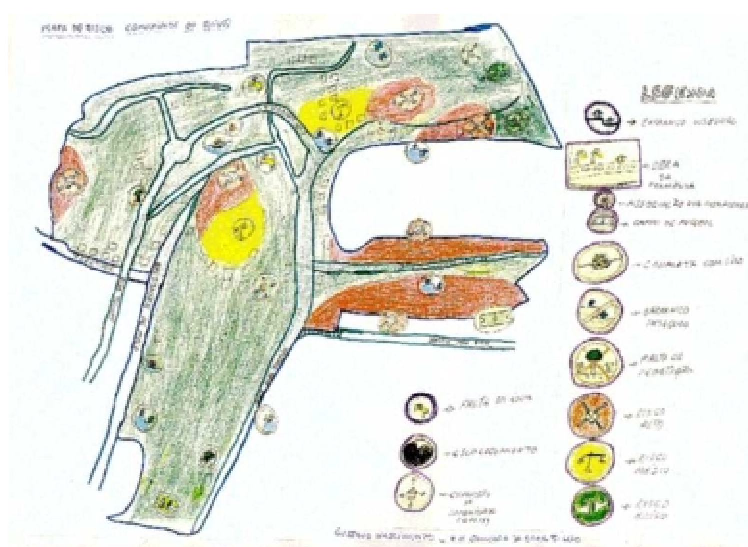
L'objectif dans cette phase du projet est de realiser une carte sentimental de risque de la communauté. Elle pretend déchiffrer la connaissance retirée des cartes de risques faites par les techniciens, pour la population qui reside dans les régions de risque, à travers la collecte d'informations de l'environnement et de l' exprimer dans un language cartographique. Elle est divisée en quatre étapes:

II-A Former le Collecteur avec un questionnaire graphique;

II B .Recherche sur les "avis"de risque et listes d'informations;

II-C. Création de la Carte de la Communauté a Risque;

II-D Comparaison des cartes de risque de la Communauté avec celui des Cartes Techniques de Risque.



Carte 2 - Carte Infantil de Risque

III-Conclusion

La méthodologie du projet de cartographie de l'environnement proposée pour le systeme de pentes de favelas est testée dans une étude de cas. La communauté de Tuiuti a permis de démontrer que l'éducation de l'environnement, appuyée par les instruments Cartographique favorise la transmission des connaissances geotechniques pour la population résidante sur les flancs des collines, sujettent aux glissements de terrain.

Ce type de carte, faite de façons attractive, invite la population a participer à la gestion du risque et à la prévention d'accidents. Elle aide les membres de la communauté a avoir conscience de l'existence de moyens pour les réduire. Elle représente un role important dans l'éducation de la communauté dans la préparation de la lutte contre les catastrophes, prenant en considération la forme rapide et efficiente de l'appréhension de la connaissance, en rapport avec les ressources de la communication visuelle encontrée dans les cartes et dessins.

L'expérience a aussi facilité l'exploration des espaces ou vivent les enfaants de la communauté, afin qu'ils puissent localiser pour eux et les autres, les differents points de références utilisés.

À travers la compréhension des problèmes de l'environnement de sa communauté l'habitant des favelas cherche a se reveiller trouver sa citoyenneté et avec elle reconnaitre ses droits et devoirs avec sa ville.

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Session / Séance 26-B

Swedish CORINE Land Cover – a new mapping completed by 2002

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Abstract

Sweden is to get completely new mapping of vegetation and land use covering the whole of the country. This project meets the requirements for a countywide, geographical database produced in a homogeneous manner, as well as the requirements of the CORINE Land Cover programme, covering the whole of Europe. Swedish CORINE Land Cover is a part of the overall mapping scheme, which guarantees integration with other national mapping activities. The main products consist of two databases covering the whole of Sweden - one (Swedish Land Cover Data - SLD) compliant with national requirements and one (CORINE Land Cover - CLC) compliant with EU requirements. The Swedish product contains information on vegetation and land use in 52 classes and has a minimum map element of between 1 and 5 hectares. The EU version contains information in 44 classes (i.e. 35 of the 44 possible classes occur in Sweden) with a minimum map element of 25 hectares.

The production of both the Swedish SLD and European CLC databases builds on data from three main sources:

- *Digital satellite data (complete coverage, up-to-date image data for classification and interpretation).*
- *Digital geographical data and map information (the best ancillary data).*
- *Test-area data, including co-ordinates from the National Forest Inventory (objective, detailed reference measurements for calibration of satellite data).*

The major part of the work comprises classifying and interpreting the satellite data in the light of other information. The subsequent stages of work involve consolidating the different elements into one database and then generalising. In addition to these stages there are quality assurance procedures involving visual checks, editing and assessment of the thematic accuracy.

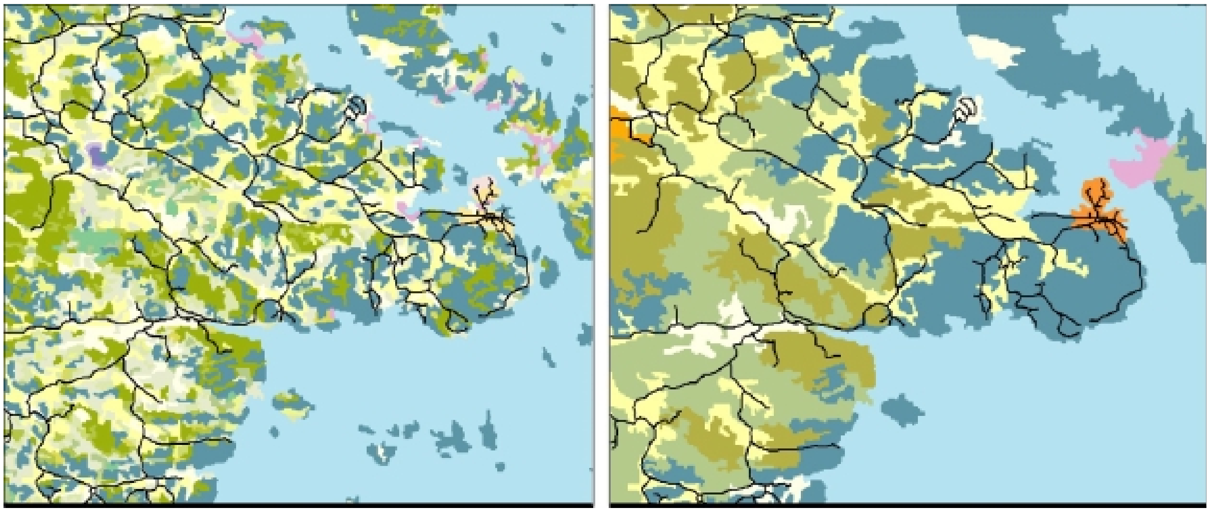

Figure 1. Swedish Land Cover Data (left) and CORINE Land Cover (right). The figure visualises an area east of the city of Norrköping, and covers 10 x 8,5 km. Road network from the topographical map is overlaid.

Introduction

The CORINE programme (Co-ordination of Information on the Environment) was started in 1985 to facilitate the planning and execution of EU environmental policies. CORINE, which in addition to land cover also comprises biotopes and air pollution, provides a broad and up-to-date picture of the state of, and of changes in the environment, that can be used for comparisons between countries. There are essentially three objectives for the programme:

- To create an information system on the state of the environment.
- To develop nomenclatures and methodologies.
- To harmonise activities involved in the production of environmental information.

The European Environment Agency (EEA) is in charge of the CORINE Land Cover programme. The EEA set up a European Topic Centre on Land Cover (ETC/LC) in 1995 to co-ordinate and direct the mapping and application of land cover data. MDC – The Environmental Satellite Data Centre at Kiruna manages the work at ETC/LC.

The end product of the CORINE Land Cover programme consists of a geographical database describing vegetation and land use in 44 classes. The smallest reporting unit is 25 hectares in size. The information, which is obtained from satellite data in combination with map information, is to be updated every 5-10 years. Most European countries have already completed their mapping and a decision has now been made to create a Swedish CORINE Land Cover.

Swedish CORINE Land Cover

The organisations mainly responsible for producing the Swedish CORINE Land Cover are the National Land Survey, the Environmental Satellite Data Centre, the Swedish Environmental Protection Agency, the Swedish Armed Forces and the Swedish Space Corporation. Development work was carried out by the Remote Sensing Services department at the Swedish Space Corporation, during 1993-1997, and has resulted in a method for achieving a national mapping system. Pilot production will be in progress up to 1999, after which the remainder of the production, taking an estimated three years, will be completed.

Swedish CORINE Land Cover is part of the overall mapping scheme for Sweden. The chief products will be two national databases – one that meets European requirements (CORINE Land Cover – CLC), the other a more detailed national database (Swedish Land Cover Data – SLD). The EU version contains information in 44 classes (i.e. 35 of the 44 possible classes occur in Sweden) with a minimum map element of 25 hectares. The more detailed base has national sub-classes, with a total of 52 classes, and uses a reporting unit that varies between one and five hectares in size. Since the final products are digital, they will allow great flexibility for further applications in digital analysis or as material for printed maps, for example.

The development work has defined methods to produce both databases within an integrated production system, at a marginal cost compared to that of the production of CORINE Land Cover only. It has also been an important objective to build the production system in such a way that it has full co-ordination with other national databases under the responsibility of the National Land Survey.

Production and products

The pilot production, led by the Remote Sensing Services department at Swedish Space Corporation, covers 21 topographical map sheets. Two areas are covered, one in the northern part and one in the southern part of

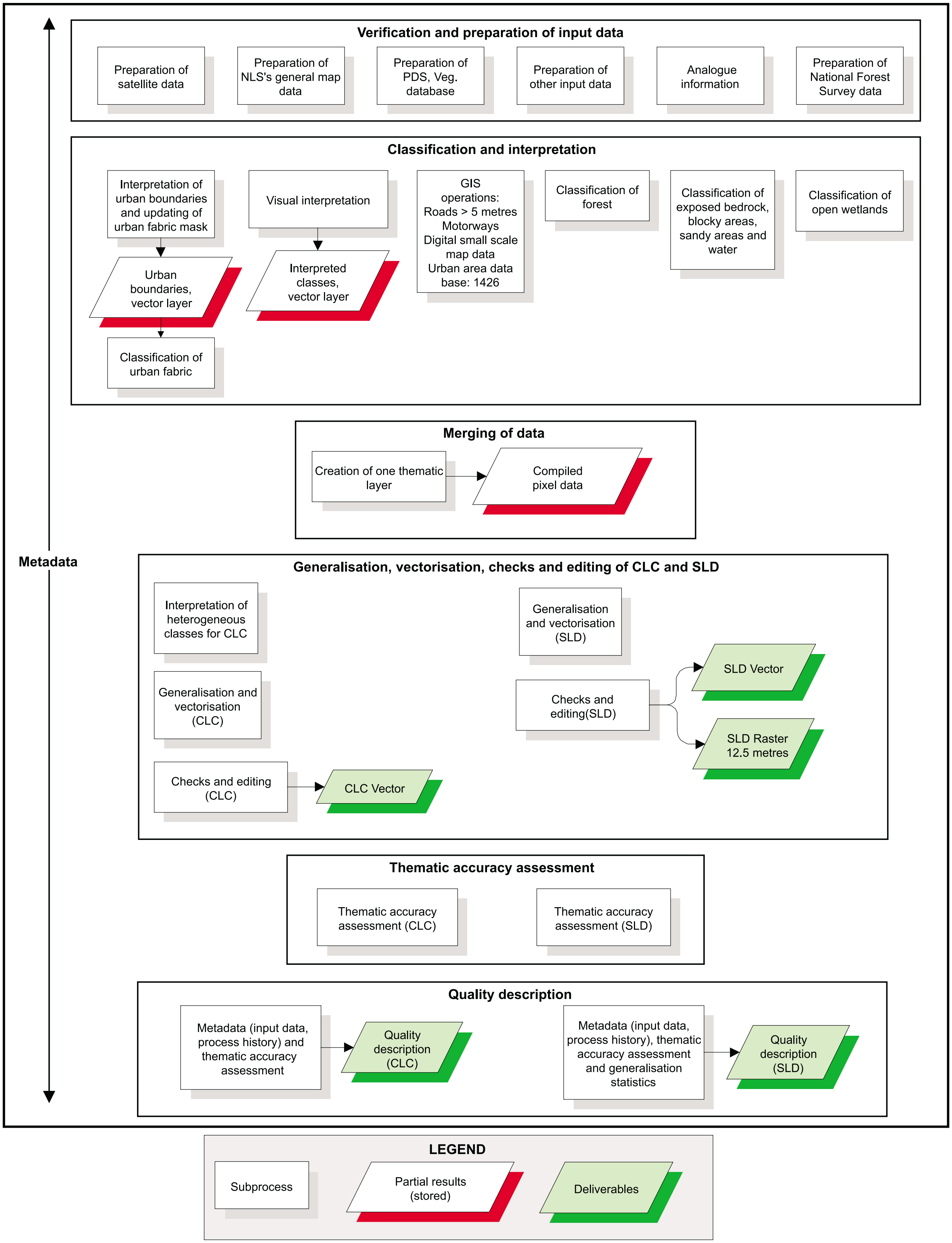

Figure 2. Outline of the production flow for the Swedish CORINE Land Cover project.

Sweden. This work has been an important step towards full-scale production and has provided both an implementation and a verification of the production process, together with a validation of the products.

The SLD and CLC databases are both based on data from three main sources:

- Digital satellite data (complete coverage, up-to-date image data for classification and interpretation).
- Digital geographical data and map information (the best ancillary data).
- Test-area data, including co-ordinates, from the National Forest Inventory (objective, detailed reference measurements for calibration of satellite data).

The major part of the work comprises classifying and interpreting the satellite data in the light of other information. The subsequent stages of work involve assembling of the different elements in one database and then generalising. The aim of the latter is to generate products with specified minimum map elements for both the Swedish and EU products. In addition to these stages there are quality assurance procedures involving visual checks, editing and assessment of the thematic accuracy.

Through the whole production, metadata is stored in a standardised way following international standards. This serves the purpose both of keeping track of the production flow and later of providing users with the necessary information about the data in the form of a quality description.

Among the advantages of the Swedish production system one can mention the use of a digital production line, the high degree of automation (including computer-based classification and a fully-automated generalisation process), cost-effective quality control and co-ordination with other national map production systems. The principles behind the Swedish CORINE Land Cover production systems and some of its components are readily applicable to other countries.

The following products will be delivered by the Swedish CORINE Land Cover project:

- Swedish Land Cover Data, vector format
- Swedish Land Cover Data, raster format
- CORINE Land Cover, vector format
- Statistics, describing the generalisation from pixel data to Swedish Land Cover
- Quality description (Swedish Land Cover Data and CORINE Land Cover)

There will also be other sub-results stored during the production, possible to use as input in future updating or as input to specific analyses.

Use of the Swedish CORINE Land Cover

The demand for high-quality environmental data is increasing. Methods for analysis of such data are also constantly being developed and refined. To have comparable data, produced in a homogeneous way, is essential in the work with environmental monitoring and planning.

For some time, there has been a need for mapping of vegetation and land use covering the whole of Sweden. This need will now be met with the Swedish CORINE Land Cover. The data will be used in environmental activities within specific areas such as the development of methodology and models for environmental applications. Examples of methods and indicators are:

- environmental monitoring,
- environmental influences on infrastructure,
- influences on watercourses and drainage basins and
- modelling of nitrogen leeching.

Upon the revision of the product every 5 to 10 years, information on changes in vegetation and land use will be stored, thus extending the possible uses. A product showing changes, for instance, can be used in the monitoring of special classes and special areas, or in climate and environmental models where information on changes in land-cover area and class is of significance.

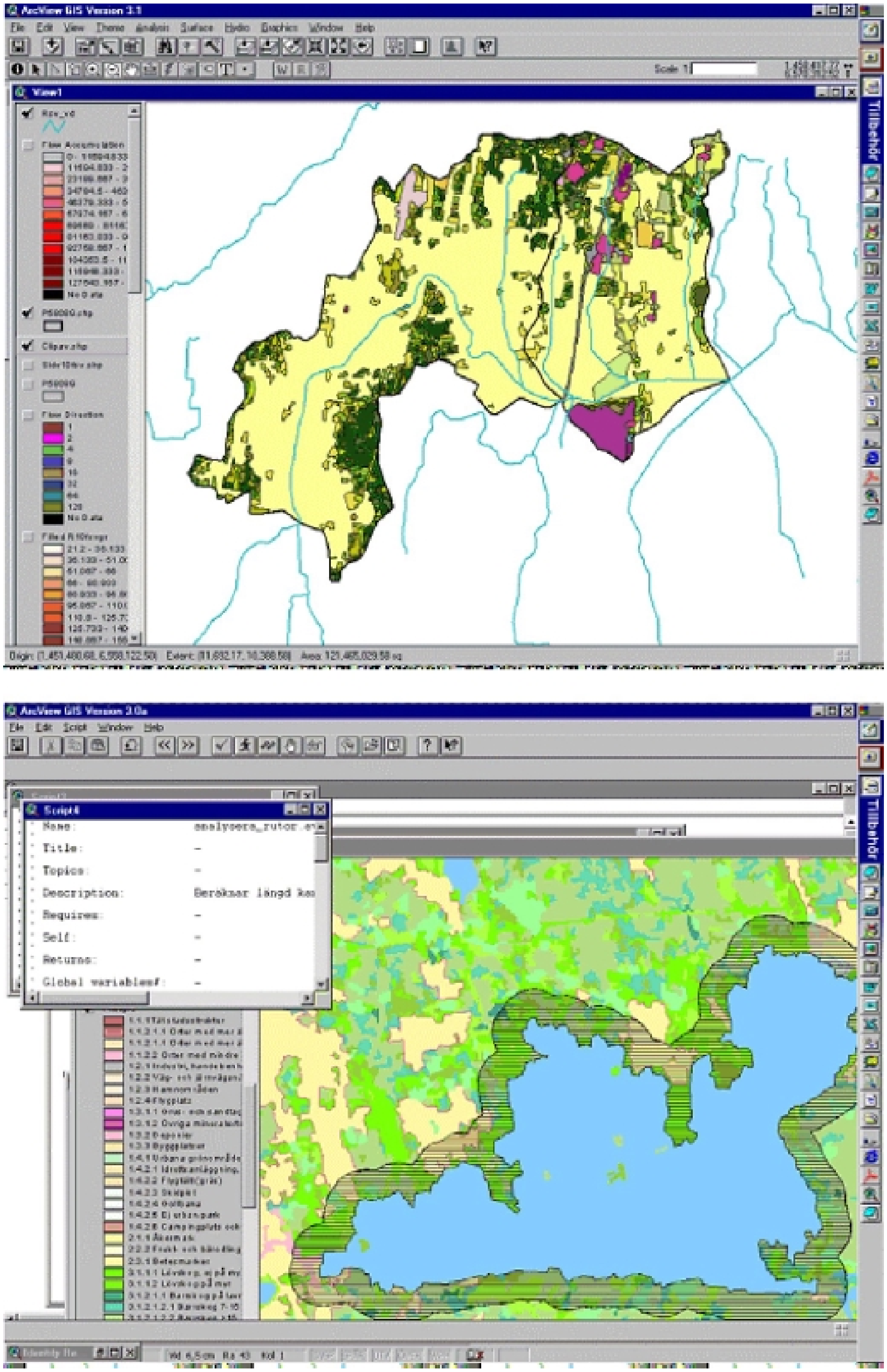

Figure 3. Analyses of land cover distribution in e.g. watersheds (top) and buffer zones (bottom).

Nomenclature for the Swedish CORINE Land Cover

The CORINE Land Cover database (3rd level) in Sweden is represented by 35 classes out of a total of 44 classes. The number of classes in the Swedish Land Cover database is 52 (down to 6th level).

1. ARTIFICIAL SURFACES

1.1 Urban fabric

1.1.1 Continuous urban fabric

1.1.2 Discontinuous urban fabric

1.1.2.1 Discontinuous urban fabric with more than 200 inhabitants

1.1.2.1.1 Discontinuous urban fabric with more than 200 inhabitant with minor areas of gardens and greenery

1.1.2.1.2 Discontinuous urban fabric with more than 200 inhabitants with major areas of gardens and greenery

1.1.2.2 Discontinuous urban fabric with less than 200 inhabitants

1.2 Industrial, commercial and transport units, public services and military installations

1.2.1 Industrial or commercial units, public services and military installations

1.2.2 Road and rail networks and associated land

1.2.3 Port areas

1.2.4 Airports

1.3 Mine, dump and construction sites

1.3.1 Mineral extraction sites

1.3.1.1 Sand and gravel pits

1.3.1.2 Other 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

1.4.2.1 Sport grounds, shooting ranges, motor, horse and dog racing tracks

1.4.2.2 Airfields (grass)

1.4.2.3 Ski slopes

1.4.2.4 Golf courses

1.4.2.5 Non-urban parks

1.4.2.6 Camping sites and holiday cottage sites

2. AGRICULTURAL AREAS

2.1 Arable land

- 2.1.1 Arable land

2.2 Permanent crops

- 2.2.2 Fruit trees and berry plantations

2.3 Pastures

- 2.3.1 Pastures

3. FORESTS AND SEMI-NATURAL AREAS

3.1 Forests

- 3.1.1 Broad-leaved forest
  - 3.1.1.1 Broad-leaved forest not on mires
  - 3.1.1.2 Broad-leaved forest on mires
- 3.1.2 Coniferous forest
  - 3.1.2.1 Coniferous forest not on mires
    - 3.1.2.1.1 Coniferous forest on lichen-dominated areas
    - 3.1.2.1.2 Coniferous forest not on lichen-dominated areas
      - 3.1.2.1.2.1 Coniferous forest 7-15 m
      - 3.1.2.1.2.2 Coniferous forest >15 m
  - 3.1.2.2 Coniferous forest on mires
- 3.1.3 Mixed forest
  - 3.1.3.1 Mixed forest not on mires
  - 3.1.3.2 Mixed forest on mires

3.2 Shrub and/or herbaceous vegetation association

- 3.2.1 Natural grassland
- 3.2.2 Moors and heathland
- 3.2.4 Transitional woodland/shrub
  - 3.2.4.1 Thickets
  - 3.2.4.2 Clear-felled areas
    - 3.2.4.2.1 Open clear-felled areas
    - 3.2.4.2.2 Regrowing clear-felled areas
  - 3.2.4.3 Younger forest
    - 3.2.4.3.1 Younger coniferous dominated forest
    - 3.2.4.3.2 Younger broad-leaved dominated forest

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 Mires

4.1.2.1 Wet mires

4.1.2.2 Other mires

4.1.2.3 Peat extraction sites

4.2 Coastal wetlands

4.2.1 Salt marshes

5. WATER BODIES

5.1 Inland waters

5.1.1 Water courses

5.1.2 Water bodies

5.2 Marine waters

5.2.1 Coastal lagoons

5.2.2 Estuaries

5.2.3 Sea and ocean

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Session / Séance 48-D

Spatial Analysis and Mapping of *Leptospirosis* Disease in the Urban Area of Sao Paulo, Brazil, Using GIS.

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Abstract

The objective of this research is to determine the spatial patterns of leptospirosis disease in the urban area of Sao Paulo, Brazil, using GIS tools and surface analysis methods. Point data from the number of contaminated people by 100000 inhabitants of districts, related to 1991-1996 period were interpolated to generate annual leptospiroses surfaces. The resulting grid data were analyzed and displayed as isoplethics maps and diagrams blocks. The spatial-temporal data base was manipulated by grid overlay tools in the Idrisi GIS to map the most probable areas of lepto occurrence through Poisson distribution. The results showed that the highest rates of lepto contamination follow an SW-NE axis determinated mainly by the Tiete, Pirajussara, Pinheiros and Aricanduva river floodplains, in districts located in the North, East and South zones. The probability map showed the disease tends to increase in most povertry areas of East Zone, wher the floods are extreme in the summer.

Introduction

Leptospirosis (lepto) is a zoonosis caused by *Leptospira spp* bacteria that affects humans and animals living in poor urban areas exposed to floods. The transmission happens when people make contacts with river water contaminated by urine of rats. In Brazil the lepto epidemic grows in the summer, when the rain reaches the maximum monthly rate, which results in large floods in the urban areas.

In poor districts of the Sao Paulo metropolitan area, cases of contamination reaches the maximum in the months of January and February, and the total number of people contaminated in the city reaches 650. The mortality rate from this disease is about 11%. In the 1985-1993 time period, over 20341 persons were affected in Brazil and 2232 died. Sao Paulo has suffered annually leptospirosis epidemic, mainly in the peripheral districts and in areas located near large flood plains. Houndred of people died in the last six years.

Lepto is an essentially geographical epidemic. Its spatial patterns of genesis, concentration and expansion are associated with urban watersheds characteristics and demographics indicators of districts. The mapping of lepto is urgently needed to contribute to the modeling and predicting of new epidemies in Sao Paulo, the most populous city of South America (over 12 million inhabitants).

GIS methodology and techniques may be used in this case, resulting in the analysis and modeling of the most probable areas of lepto occurrence in the city, using a spatial data base mixing point data of contamination rate, demographic data, drainage network and geographical objects defining urban districts. The objective of this research was to study the spatial pattern of lepto in Sao Paulo, in the 1991-1996 time period, using GIS tools, to map the most probable areas of contamination in the city.

Literature Review

Probability mapping is a fundamental procedure to know the relationship between epidemics and environmental indicators. The most common technique used to identify districts with high and low incidence of disease is the Poisson distribution [Gesler, 1986]. The surface method is used also to mapping the diseases through scalar surfaces based in the Z value of cases positioned on X,Y geographical plane [Kwofie, 1976]. This approach allows the evaluation of paths were the disease spreads and the barriers that prevent its expansion, using tendency surfaces.

Geographical information systems have been used in many countries to map and model spatial characteristics of disease. GIS methods and techniques were used to study the *Dracunculiasis* in Benin [Tempalski, 1994]; the risk of *malaria* occurrence in Mexico [Beck, 1995]; the *Cholera* epidemic of 1971 in Nigeria [Adesina, 1981]; child mortality in Iowa, USA [Tobias, 1996] and cancer in Sheffield, England [Haining et al., 1996].

Methods and Material

The epidemiological data consisting of the total number of people contaminated with leptospirosis annually (1995-1996) by districts were obtained in the Vigilance Office of Sao Paulo Health Secretary. The cartographic material consists of Sao Paulo District Map at 1:60.000 scale [Geomapas, 1995] and Sao Paulo Topographic Sheet, at 1:50.000 scale [IBGE, 1981]. The population data by districts were published in the Demographic Census of Sao Paulo [IBGE, 1991;1996].

The data and maps were processed using the spatial analysis tools of Idrisi for Windows 2.0 [Eastman, 1995] and surface generation tools of Surfer 5.0 [Golden Soft., 1994]. Cartographic data were digitized by table and exported to GIS. The polygonal districts maps and the drainage network data were rasterized as a image file. The lepto point data were geocodified in the cartographic base at 1:60.000 scale using as reference the centroid of the respective polygonal districts maps. The demographic data were assigned to the district maps and structured as an image file in the Idrisi GIS.

Annual surfaces of lepto were elaborated in the Surfer, using the minimum curvature algorithm with a 375 by 570 grid. Six contour maps and diagram blocks were carried out, one for each year analyzed. The grids were exported to Idrisi and converted to a raster image file format. Next, the lepto raster data were normalized by the total population of each district using overlay tools. The resulting maps were sent again to Surfer to produce the final contour maps and diagram blocks. The probability map was produced by the Statistical module of Idrisi (Count and Pclass functions), using the six annual maps of lepto incidence rate.

Results and Discussion

Figures 1 to 3 show the isoplethics maps and diagrams blocks of the city. Comparing these figures, we can note there are some areas in all the maps with spatial correspondence of number of cases by 100000 inhabitants. In all the maps, the, South Zone and the North Zone of Sao Paulo have the higher frequency of cases. Also in the extreme East Zone and in the West Zone, we may note a significant concentration of the epidemic, mainly in 1994 and 1995 years.

The 1991 and 1995 data show the typical epidemic area of Sao Paulo, located in the South and North Zones. Lepto is likely to increase in the Easte Zone in coming years, as show in the 1995 and 1996 maps. In 1996, although the total number of cases had decreased, it spread to large areas of the city, mainly in the South and East zones. Figure 4 shows the relative frequency of lepto occurrence in the city in the six years analyzed. Four important areas of lepto occurrence can be noted, in order of relative frequency (Figure 6):

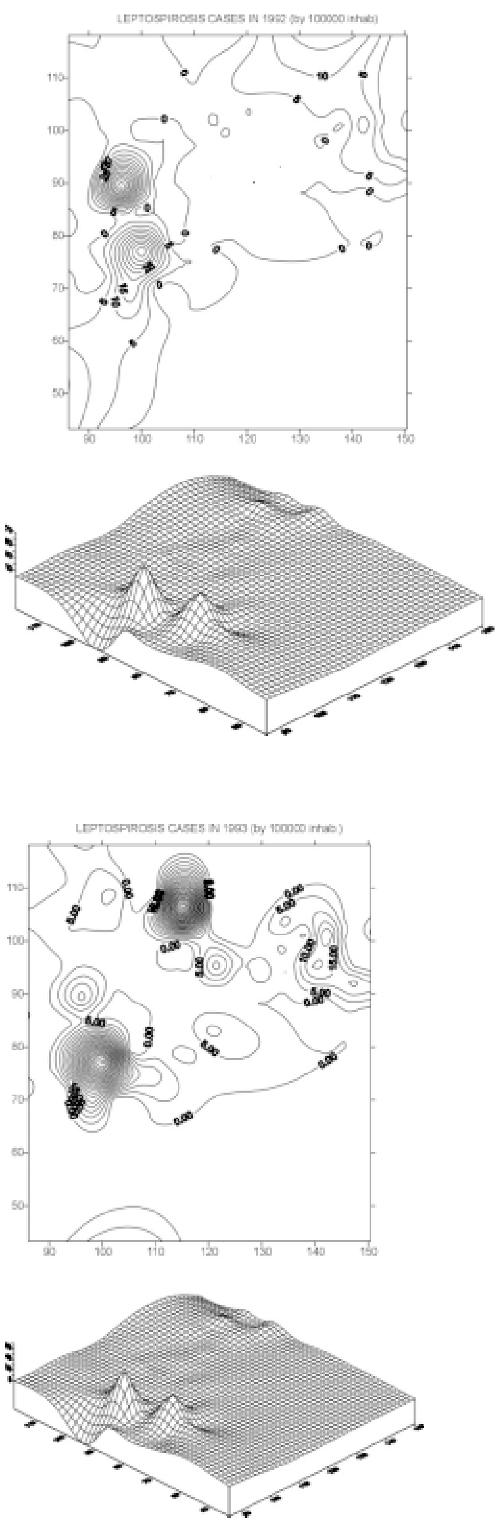

Figure 1 - Isoplethics maps and surfaces for 1991 (above) and 1992 (below) leptospirosis cases.

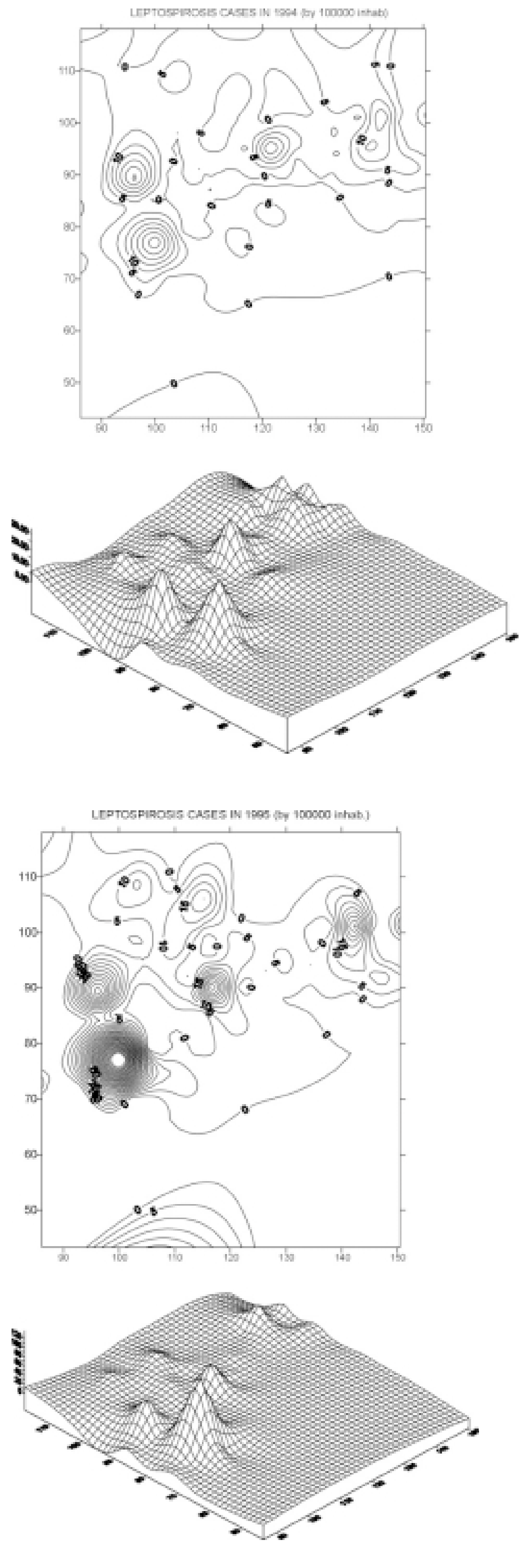

Figure 2 - Isoplethics and surfaces for 1993 (above) and 1994 (below) leptospirosis cases.

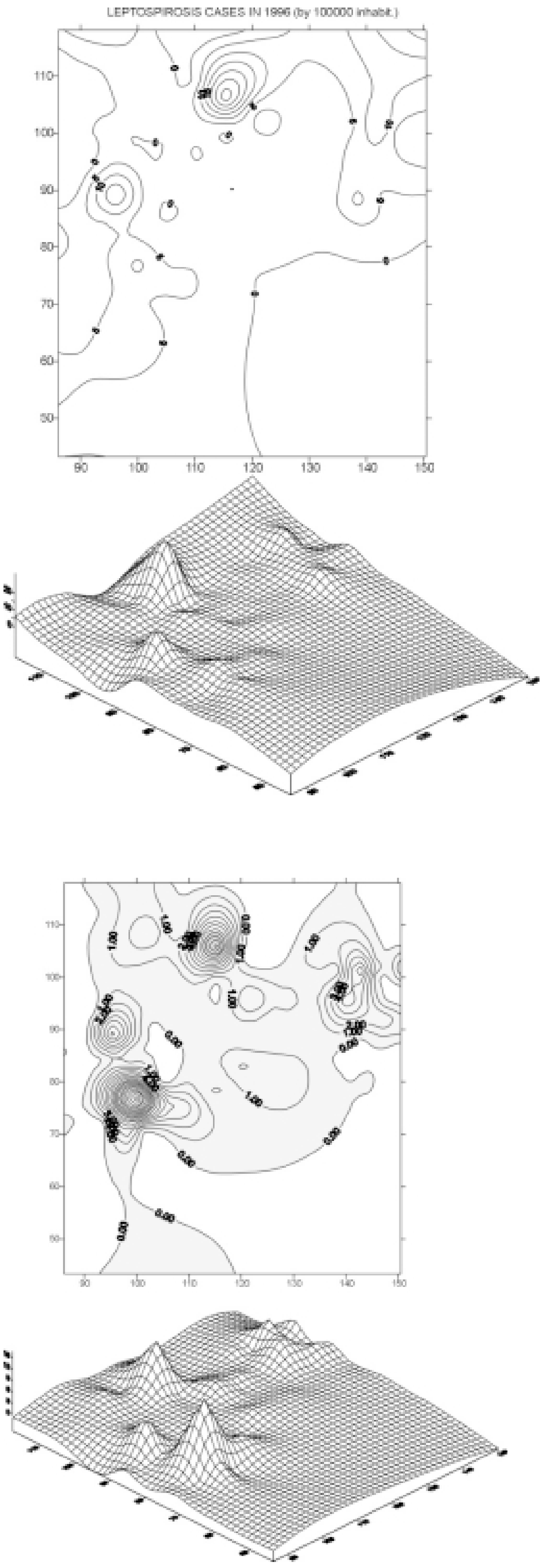

Figure 3 - Isopleths maps and surfaces for 1995 (above) and 1996 (below) leptospirosis cases.

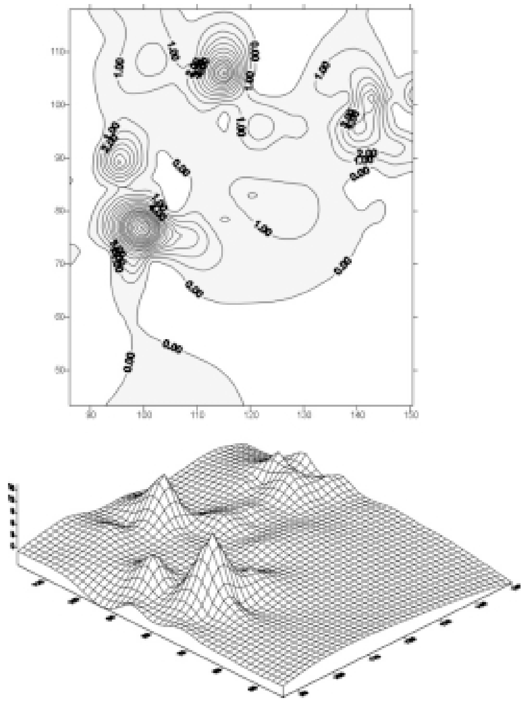

Figure 4 - Relative frequency (%) map of lepto occurrence in 1991-1996 time period

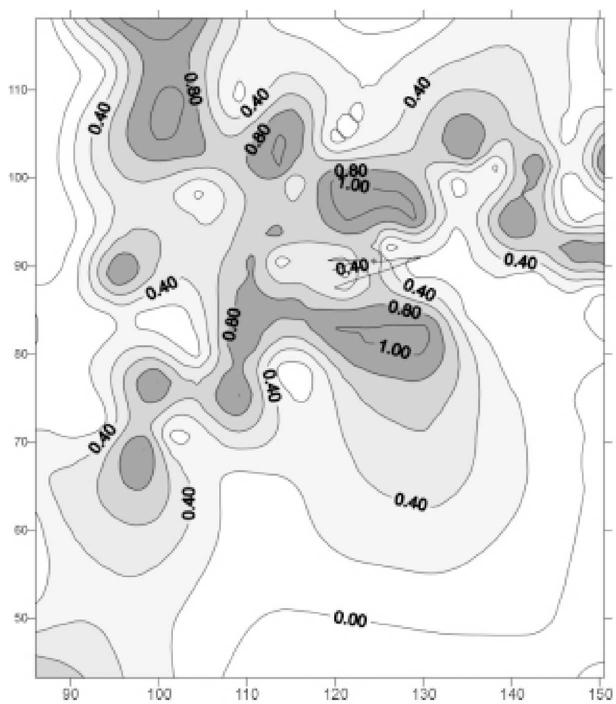

Figure 5 - At least case occurring per year probability map.

Region I - Concentrated in the South Zone, presents the highest frequency. It is composed of Santo Amaro, Socorro, Jabaquara, Saude and Ipiranga districts, located in the Pinheiros, Aguas Espraiadas and Ipiranga river floodplains.

Region II - Characterized by Tucuruvi, Casa Verde, Santana, Barra Funda and Vila Maria districts, in the North Zone, located mainly in the Mandaqui, Cabuçu and Tamanduatei river floodplains.

Region III - Composed of districts located in the East Zone, as follows: Ermelino Matarazzo, Itaim Paulista, Guaianazes, Itaquera, Sao Miguel and Cidade Tiradentes. Those areas are located in Aricanduva, Itaquera, Tietê and Jacu river floodplains.

Region IV - Located in the West Zone, is characterized by Butanta, Jaragua and Rio Pequeno districts. They are located in the Jaguare and Pirajussara river floodplains.

Figure 6 shows the probability map of at least one case occurring per year. The map reveals a large area of probable epidemic in the next years, mainly in the SW-NE axis of the city and passing by the downtown. If we consider the 0.40 probability label, almost the entire urban area of Sao Paulo is subject to that disease.

Figure 6 - Map of leptospirosis incidence regions.

Conclusions

The methodology allowed the mapping of different zones of lepto occurrence in the city, and definition of the most probable areas of future contamination. Although there is strong evidence that proximity to river floodplains is a determining factor of the higher frequency of cases, the districts located in these areas have low economic level with high poverty level, mainly in the Region II (East Zone) and Region I (South Zone). Thus, it is necessary to define the role of socioeconomic factors in the spatial concentration of this disease. It will be the next step of this research, when we will map the socioeconomic indicators of the population and to compare with the relative frequency and probability maps.

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Session / Séance 48-A

The Making Use of the Urban Soil and the Environmental Problems of Itajuba (MG)

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INTRODUCTION

The urban space represents the humanized nature making an artificial environment, where environmental problems can appear because of an inadequate occupation.

At the urban area study, approaches can be done on two different viewpoint according

to FOREST(1978). One of the viewpoint is related to the standart of the soil use, functional areas, and the relation which occurs in the cities. The other one is related to the way of interaction among cities and region.

The city watching and the survey of the soil use are indispensable for the racional planning on a municipal and regional aspect. They can overcome the development problems and the deterioration of the environmental quality.

Based on these considerations, a study about the city of Itajubá has been done.

Located on the South of Minas Gerais state 22º 26'S of latitude and 45º 27'W of longitude, Itajubá has about 80.000 inhabitants.

The objective of this research is to identify and take up the environmental problems decurrent of the urban soil occupation in Itajubá, with conventional, mapping and remote sensing data from 1981 to 1998.

CHARACTERISATION OF THE AREA

Geographicaly the borough is 22º 30'30" S of latitude and 45º 27'20" W of longitude. Itajubá is located on the South of Minas Gerais state, bordering the boroughs of Piranguçu, Brazópolis, Delfim Moreira, Wenceslau Braz, Marmelópolis, Maria da Fé, São José do Alegre e Piranguinho.

The climate of the region is tropical mesotermic – mild moist with na average annual temperature varying around 18º C to 19º C. According to GUIMARÃES (1987), the climate is the type Cwb, considering the classification of Koeppen. The average rainisses is around 1400mm yearly.

Itajubá borough is classified as a paleozoic ground (acid eruptivs) and archaeozoic from the brazilian crystalline complex (gnaisse, micaxitos, dolomites, granite, etc.) according to OLIVEIRA (1938).

Itajubá lands are on the Mantiqueira foothills, and the geomorphologic complex is made of the following principal chain of moutains: Juru, Ano Bom, Goiabal, Lourenço Velho, to the north; Água Limpa e Toledos, to the east; Pouso Frio, to the south; Morro da Piedade to the west.

The topography varies from undulated to mountainous. The region (territory) is plan (flat) (10%), undulated (12%) and mountainous (78%). The highest altitude (heigh) gets 1287m and the lowest is 895m, with an area of 281 Km2 (Itajubá 180 years, 1999).

The heighs quotas on the urban area of Itajubá varies from 840 to 920m and it is crossed by Sapucaí River, which divides the city in two equal parts. The river flows this space from east to west. This River has affluents wich cross the urban soil as: Ribeirão José Pereira (José Pereira Small River) right riverside affluent and Ribeirão Água Preta (Água Preta Small River), Ribeirão das Anhumas (Anhumas Small River) and Ribeirão Piranguçu (Piranguçu Small River), left riverside affluents.

METHODOLOGY

A planimetric plan had been taken to map the use of the soil in the urban area in 1981. It had been made by Itajubá city hall, on a scale of 1:10.000. Thirty air pictures (photos), on a scale of 1:8.000, had been selected. The air photos had been taken by Enbrafoto Ltda in 1981.

Figura 1: Map of Urban Area - Itajubá (MG) - 1998

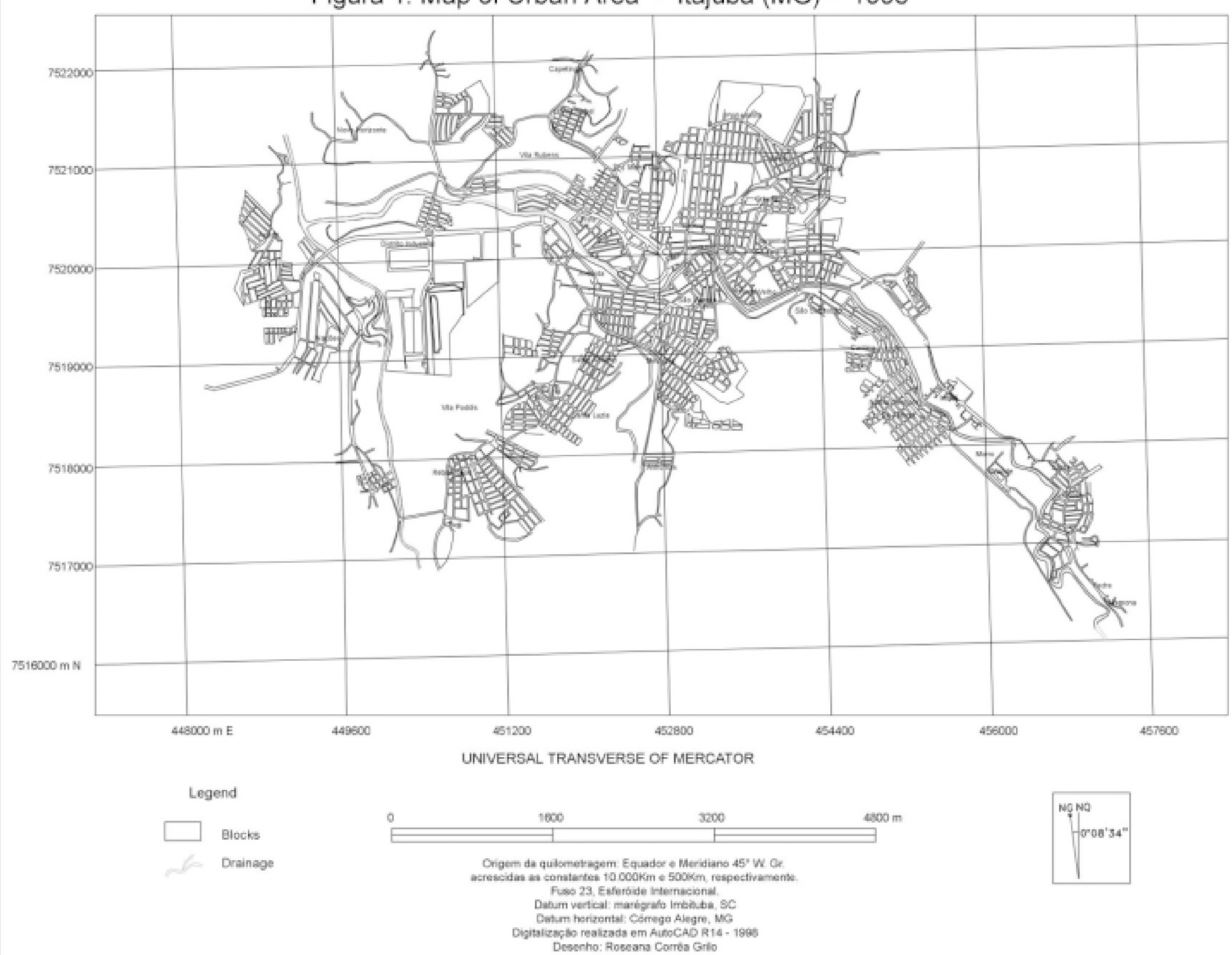
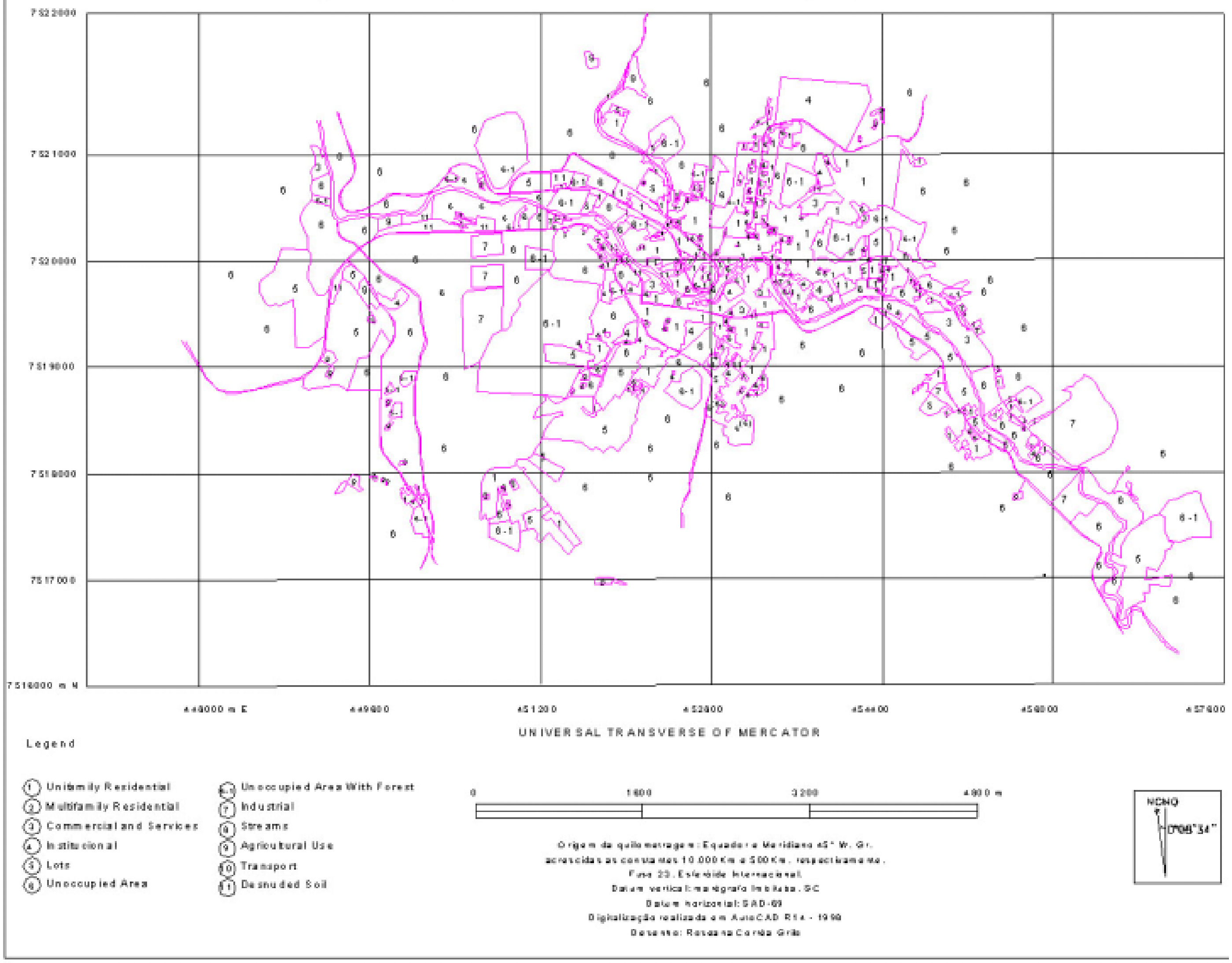


Figura 2: Map of Urban Soil Use - Itajubá (MG) - 1981



The photo interpretation together the work field were done and the process of getting the order of the use of the urban soil was based on the analysis of the homogeneous photo graphic texture patterns, grey level shades, spatial arrangement; shape, size and urban target shadows (KURKDJAN 1987; NIERO 1988), by this analysis, the interpretation key was set and adapted to the level 01 and 02 of the land use classification system proposed by ANDERSON ET ALII (1979).

The planimetric plans of the city on the same scale 1:10.000 from 1981 and 1998, made by Itajubá city hall, were utilized to compare the urban extension in this period.

The planimetric plan digitization, on the scale 1:10.000, of the urban area with its blocks and drainage (figure 01) and the use of the urban soil had been in AutoCAD R-14 (figure 02).

Based on the area altimetric plan, on the scale of 1:20.000, provided by Itajubá city hall, digitized in AutoCAD R-14 and printed in the software spring 3.1, the declivity plan had been gotten.

The urban pluvial system, on the scale of 1:10.000, was digitized in AutoCAD R-14 and checked with the other data.

PRELIMINARY RESULTS AND ARGUMENTATION

The integration of the cartographical data allow a pre-analysis of the city spreading, showing that it occured not only on the main riverside (Sapucaí River) which flows across the city on East-West way, but also on the uphill over flowing.

On the urban soil occupation 11 steps were identified:

1. Residential Unifamiliar:

   Gardens and yards, small structure.

2. Residential Multifamiliar:

   Few apartment buildings located downtow or near by.

3. Conventional And Works

   Tradeng buildings located downtow as hotels, hospitals, post office, public departament buildings, etc.

4. Institutional

   Native vegetation, gardens, presence of large dimention areas, big structure with presence of recreation areas as schools, cemeteries, churches, convents, clubs, public square, parks, penitentiary home for old people.

5. Lots

   Arrangement of streets system with the presence of a thin vegetation; it had considered areas which had been occupied as areas with a demarcated system of roads and without any human occupation.

6. Empty Areas

   Absence of human occupation and presence of thin vegetation.

6.1 Empty Areas With Native Forest.

   Absence of human occupation and presence of native forest.

7. Industrial

   Presence of huge roofs, big pavemented areas, parking places and gardens.

8. Water Flow or Water – Course

   The main drainage is Sapucaí River and its affluents on the left riverside (Ribeirão José Pereira and Água Preta stream) and its affluents on the rigth riverside (Ribeirão da Anhumas and Ribeirão do Piranguçu).

9. Cattle – Breeding Areas

   Presence of chicken farms, little farms, kitchen gardens as cultivated areas and native vegetation.

10. Transport

   Rail tracks of Rede Mineira de Viação (Mineira Railway) and the Poços de Caldas – Lorena road which follow the tilled plain of Sapucaí River.

Studying the map of the urban soil use, the declevity plan and matching the evidence on present day in the field (field work), there are dwelling, high middle class and lowclass (popular houses) with the district of Morro Chic and Estiva which area located on areas of environmental impacts.

FINAL CONSIDERATIONS.

The presents research has been under development, the introductory results gotten up to now, are important when the urban environmental analysis are studied. These results offer subsidy that together other variable contribute on the showing up of environmental urban problems.

The city structure occupyng the tilled palin of Sapucaí River (the main River) and its affluents together the lack of urban pluvial system cause flood, mainly in the summer, when there heavy rains in this region.

The soil occupation with house building, in sloping areas can use environmental impacts.

The expansion and occuapation of the uncontrolled use of the urban soil in Itajubá, asks a deep study to audid the sprouting and the aggravation of environmental problems.

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Session / Séance 44-A

The Compilation of 1:4,000,000 Map of the Chinese Nature Reserves

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Abstract

This paper describes the significance of compiling the 1:4,000,000 map of the Chinese Nature Reserves, the types and grades of the nature reserves, the manifestation of the characteristics of special subjects and further development.

Introduction

The nature reserves indicate those specific and protected nature regions that are approved by the government. It is an important policy of protecting environment to build nature reserves in China, to keep nature reserves as the strategy basis of protecting nature environmentnature resources and preserving variety of living beings. Since 1956, under 40 years of incessant efforts, Chinese construction of the nature reserves has been developed rapidly from small to large. Up until now, the whole country has built various nature reserves in about 800 places. The total area is over 60000000 hectare, covering about 7% territory area, achieving middle level at present world. A Nature reserve's network of each province in the whole country has been initially set up.

With a huge area, China has a complex geographical environment. Natural resources are rich and natural landscapes are beautiful. The types of protected targets are various and are found all over the country. All kinds of features and information contained in nature reserves are extremely rich, thus it has an important significance in representing essential factors of the distribution , type, area, rank of the whole country's nature reserves by means of the map's form, so as to provide a firm ground for policy-making, project management and scientific research. Also, maps are suited to international nature protection cooperation as well as making propaganda and education for people.

Nanjing Institute of Environmental Science and Nanjing Institute of geography and Limnology, Academia Sinica worked together and jointly compiled the first 14,000,000 nature reserves map of our country. The map is color-printed, published by Scientific Publishing House. The map's precision is high, and it is scientific and useful. The map's plates are clear and beautiful. It filled in the Chinese gaps in this field, and has been well accepted by the concerned department and many readers.

The Categories and Ranks of the Nature Reserves

1. Categories of the nature reserves

According to the present conditions and characteristics of the Chinese nature reserve's development and the concerned management rules of state, we drew up a two-level division system of the Chinese nature reserves by considering the standard of international division systems. First of all, we divided all nature reserves into three types with regard to major protected targets. Then, we divided each type again into the different types with regard to the landscape's character and nature quality of the protected targets.

Table 1. Categories Of The Chinese Nature Reserves

Nature Ecosystems	*Wild Life*	*Natural Relics*
Forest Ecosystem	Wild Animal	Geological Relic
Grassland Ecosystem	Wild Plant	Paleontological Relic
Desert Ecosystem		
Terrestrial Wetland and Waters Ecosystem		
Sea and Coast Ecosystem		

2. Grades of nature reserves

Though the quantities of the nature reserves are huge, they are not necessarily at the same important positions. Grading is to make clear the important degrees of the nature reserves, further adopt the policy and measures with aim for the nature reserves of the different grades in order to make management, and equitably apply the limited manpower and financial resource. The nature reserves' grades can fully reflect the scientific significance of its protected regions and the major protected targets, as well as the values in the economic, social and environmental fields. As to natural ecosystems, its values mainly reflect in the fields of the ecosystem's representative character, typical character, rare character, natural character, species' various characters, as well as ecosystem's complete character etc. As to wild life nature reserves, its importance mainly reflect in the fields of the protected species' scientific, cultural and economic values as well as species' rare character, peculiar character etc. As to natural relics nature reserves, its values mainly reflect in the fields of the protected natural relic's rare character, natural character, typical character, representative character and complete character etc, it also takes an important role in the fields of entertainment, medical treatment and health, tour, education as well as science research etc.

In accordance with these standards, the Chinese nature reserves are divided as four grades of the National, Provincial, Municipal and County Level. The standard for each grade's nature reserves has been made according to the three different types.

There are still a number of the nature reserves in China that are accepted as "World Biosphere Reserves Network" by the United Nations Education Science Culture Organization, for example WOLONGCHANG BAI MountainBOGDA Mountain Peak etc. The important international significance can be seen in the fields of preserving all earth lives' various characters and specific science research, and there are some differences from other reserves in management methods and task requirements. Not being a special management grade, they still belong to the four grades discussed above. In addition, the nature reserves of Taiwan province and Hong Kong regions are indicated only in their types and areasTheir grades are not included.

3. Size of nature reserves

As an important factor, to a certain extent, the nature reserve's area represents the importance degree of a reserve, especially in the Natural Ecosystem's Reserves. Generally speaking, the larger the areas are, the more steady the Ecosystems are, the safer the living beings are. Our country has a large region, but with an even larger population, it actually has relatively less land areas. Therefore, the nature reserves can only be limited to a certain range. Considering the actual distribution of our country's nature reserves and the difference among various nature reserve areas, we divided the nature reserve areas into six grades.

Table 2. The Nature Reserve's Area Grade

Grade	*Area(Thousand Hectare)*	*Quantity*	*Proportion to the total quantity(%)*
1	>1,000	11	1.44
2	100-1,000	36	4.72
3	50-100	46	6.03
4	10-50	162	21.23
5	1-10	325	42.60
6	<1	183	23.98
Total		763	100.00

Manifestation of Characteristic Information of Special Subjects

A comprehensive survey of the map of the nature reserves should represent the total distribution features of the Chinese nature reserves. After further observation, the contents of the map's main parts should show the name, position, type, level, area and mutual relation of each nature reserve. But these special subjects' information is often closely integrated together, we must make an overall consideration, design carefully, then we can obtain a satisfactory result.

1. The exact and brief symbols

The varied characteristic information of every nature reserves needs to have exact positions. Different types and levels should be separated clearly. The geometric figures and symbols should be simple in order for an easy comparison and its central point is just the nature reserve's actual position. We use symbol's shapes to represent the three big categories of the nature reserves: Cycles are natural ecosystems; squares are wild life types; Triangles are natural relics. The symbol's colors distinguish the categories: Blue green represents the forest ecosystem; Grass green represents the grassland ecosystem; Yellow represents desert ecosystem; Light blue represents the terrestrial wetland and waters ecosystem; Deep blue represents sea and coast ecosystem; Similarly red and brown separately represent wild animals and wild plants; Rose red and black separately represent geological relic and paleontological relic types. The selecting of colors requires to consider not only their symbolic significance, but also their differences and similarity.

The nature reserve's areas are divided into six grades in accordance with the size of the figure symbols, the least area symbol's diameter is 2mm and the greatest is 12mm, thus it can guarantee the attraction of the symbols and reduce the possibility of overlapping.

The nature reserve's grades are distinguished by the different styles of fonts. The national grade is marked by a red line under the name. The nature reserves entering into world biosphere reserves networks have yellow bottom to serve as a background under the name, in order to make it especially attract attention.

2. The background color of administrative regions

Usually in order to highlight the main objects, the background will use light yellow or light green. In order to explicitly show the administrative regions where each nature reserve belongs to on the nature reserve map, to be convenient for the nature reserve's management, to improve the practical usage of the map, we adopted the different background colors of the province, municipal administration regions, separately use light red, cream color, light green, light purple etc. to give the differences. The thing deserving a special notice is that the color of the background should be light in order not to make any confusion with the administrative maps.

3. The compactness of the map and its rich information

All the foreign part's contents are cut off. By not using map frames, we spared the space for listing the name catalogue of the Chinese nature reserves. Compiled and listed by the province names, its contents include the data of the nature reserve's name, place, area(hectare), main preserving targets etc. One list per province, with different background colors, it can be looked up easily and fully make use of the map area to add a lot of information.

Further Development

It's the first time to compile and publish the 1:4,000,000 colorful dual-sheet "The Chinese Nature Reserves Map". Therefore, we met with lots of difficulties in this demanding work. Especially the levels of building and managing every nature reserve are uneven and the data collection for compiling the map is quite difficult. For this reason, throughout various ways by collecting the national compilation materials, related books, year-books and document data as well as various region maps, we resolved the most parts of nature reserves. But still some are resolved by the mail investigation and the field investigation. The map compiling group has made great efforts in making the data collection, arrangement and supplement, guaranteed to fulfill the map compiling task in best quality on time.

For all the nature reserves which have already been built or are currently under construction, the national departments responsible for the work should make the statistical work as a standard process, and build the information database of the whole country nature reserves as fast as possible, to provide accurate information for the future nature reserve map's renewal, reprint as well as planning, scientific research, and education.

Session / Séance C6-A

Un outil d'aide à la gestion du territoire partie I : Les cadres écologiques de référence en atlas

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Gestion intégrée des bassins versants, du milieu agricole, des forêts sont des appellations récentes, très à la mode et comme tout ce qui est à la mode, vouées à l'oubli. Pourquoi de nouveaux mots pour des idées déjà anciennes de gestion harmonieuse de notre milieu de vie? Peut-être parce que l'application de ces idées exige une somme de connaissances multiformes, polythématiques et véritablement intégrées et que leur bon usage n'est pas simple. Cartographies et typologies traditionnelles ou système d'information géographique (SIG), entrepôts de données, ne sont que des montages théoriques si l'usager n'en comprend que le côté ludique. L'aménagiste à qui est soumis un ensemble d'outils d'aide à la décision doit pouvoir compter sur une forme de notice explicative qui, non seulement s'arrête sur la nature des données et des connaissances, mais aussi, et surtout, sur son potentiel. Les cadres écologiques de référence (CER) pour l'aménagement du territoire et la gestion des ressources développés au ministère de l'Environnement et de la Faune sont livrés aux utilisateurs sous deux formats bien distincts : un système d'information sur le territoire (SIT) (voir la communication « Un outil d'aide à la gestion du territoire : le système d'information sur le territoire du bassin versant de la rivière Saint-Charles, Québec par Jean Bissonnette et Vincent Gerardin ») et un atlas. Ce dernier constitue à la fois la vitrine, la notice explicative et le déclencheur d'idées du CER et du SIT. C'est une approche au transfert des connaissances qui poursuit des objectifs propres et suit donc des règles particulières : l'image est plus importante que les mots, le sens de la donnée est plus nécessaire que la donnée. Impact visuel et concision textuelle, telle est la devise de nos atlas. Divers aspects de la conception et de la réalisation des atlas de cadres écologiques de référence sont discutés sur la base de nos travaux récents sur les bassins versants des rivières Saint-Charles et L'Assomption et sur la biodiversité du littoral du Saint-Laurent, ils seront également présentés lors d'une conférence abondamment illustrée.

Le cadre écologique de référence : définition et principes

Le cadre écologique de référence est un outil de cartographie et de classification écologiques du territoire [Ducruc *et al*., 1995]. Il permet de connaître la composition et l'organisation spatiale des écosystèmes terrestres et des hydrosystèmes à plusieurs niveaux de perception. Il propose une approche globale et hiérarchique et reconnaît les écosystèmes terrestres et les hydrosystèmes comme des entités spatiales cartographiables. Le CER est un outil qui vise surtout l'utilisation de la connaissance écologique pour la gestion des ressources et du territoire [Beauchesne *et al*., 1998].

La production d'un CER s'appuie sur les principes majeurs suivants :

- Le territoire est toujours cartographié du général vers le particulier (du haut vers le bas) à l'aide de niveaux de perception successifs emboîtés les uns dans les autres.

- À chacun des niveaux de perception, le territoire à cartographier est abordé globalement puis découpé en sous-ensembles spatiaux selon les variables écologiques physiques permanentes prépondérantes à ce niveau de perception.
- Les limites des écosystèmes terrestres et des hydrosystèmes sont considérées permanentes, à l'échelle humaine. Les éléments dynamiques comme la faune, l'occupation du sol, la végétation peuvent être cartographiés et analysés à l'intérieur de ces limites.
- Les polygones cartographiques, c'est-à-dire les portions de territoire cartographiées, sont hétérogènes, peu importe le niveau de perception.

Constituants d'un cadre écologique de référence

On trouve généralement dans un CER des cartographies des écosystèmes terrestres et des hydrosystèmes à différents niveaux - de perception exprimés à différentes échelles, des typologies des écosystèmes terrestres et des hydrosystèmes, des grilles et des cartes interprétatives ainsi que des guides de terrains (dépôts de surface, formes de terrain, drainage, etc.). Peuvent s'intégrer au CER, des informations et des données complémentaires, des données et des cartes climatiques, des données de forage (profondeur des nappes aquifères, stratigraphie des dépôts meubles, etc.), des données socio-économiques (démographie, revenus, etc.), des données et des cartes forestières, des données relatives à la qualité de l'eau, l'utilisation du sol, etc.

Utilisations

Le CER est porteur d'informations objectives qui ne visent pas une utilisation particulière a priori. Selon le niveau de perception, il permet d'aborder des problématiques d'aménagement du territoire nationales (bilan de l'état de l'environnement, planification d'un réseau d'aires protégées, évaluation de la sensibilité des écosystèmes aux précipitations acides, etc.), régionales (révision des schémas d'aménagement des MRC, bilans agro-environnementaux, protection des eaux souterraines, gestion des bassins versants, etc.) ou locales (zones d'instabilité du milieu riverain, plan de gestion intégrée des ressources, recherche de sites d'enfouissement sanitaire, etc.).

Concept, principes et méthode de réalisation des atlas

Présentés depuis nombres d'années aux intervenants de l'aménagement du territoire par le biais de cartes, de rapports scientifiques, de notices explicatives et de présentations ponctuelles, les cadres écologiques de références devaient se donner une formule de communication nouvelle pour atteindre le niveau des décideurs (politiciens et technocrates). Les données techniques et scientifiques ont peu de chance de se retrouver spontanément dans le vocabulaire et l'environnement des ces personnes; il faut d'abord les accrocher par la qualité du contenu et les possibilités d'application apportées par ces outils d'aide à la décision. Concepts et méthodologies sont trop difficiles à saisir et à retenir dans une courte période de temps, des images reprenant les mêmes thèmes attirent d'avantage l'attention de l'interlocuteur et soutiennent son intérêt.

Grâce aux atlas écologiques, les cadres écologiques de références (CER) développés au ministère de l'Environnent et de la Faune n'auront jamais été représentés avec autant de visibilité. Loin des rapports scientifiques par la simplicité du texte et par l'exploitation de l'image, ils expriment les données récoltées, la connaissance acquise et les multiples utilisations possibles pour lesquelles ils sont, en même temps, les déclencheurs.

À ce jour deux projets on fait l'objet d'un atlas : « l'Atlas du cadre écologique de référence du bassin versant de la rivière Saint-Charles, Québec » [Gerardin et Lachance, 1997], « l'Atlas écologique du bassin versant de la rivière L'Assomption. La partie des Basses-terres du Saint-Laurent » [Beauchesne *et al.*, 1998]. Un troisième atlas est en préparation; il s'agit du « Portrait de la biodiversité du Saint-Laurent : Atlas de la diversité écologique potentielle et de la biodiversité du Saint-Laurent au Québec » [Desgranges, J.-L. et J.-P. Ducruc, 1998].

Tous se présentent en format de page 11" x 17" (27,94 cm x 43,18 cm) mais se différencient par la présentation de leur contenu. Prototype de cette série, le projet « l'atlas du cadre écologique de référence du bassin versant de la rivière Saint-Charles » est aussi le plus simple en ce qui a trait au texte, laissant beaucoup de place à l'image. Dès les premières pages, le lecteur se voit présenter le territoire de l'étude à travers des planches simples sans éléments graphiques complexes où aucune couleur n'est agressive sinon justifiée. La cartographie y est précise sans être lourde, des éléments représentés y ont été simplifiés afin de montrer l'occupation d'un thème à l'intérieur du découpage du bassin versant (ex. : le réseau routier). Élément déclencheur de l'étude, l'hydrographie du bassin versant y est représentée de façon complète avec justesse au niveau des éléments graphiques (grosseurs des traits et disposition des écritures), cette couche d'information se retrouvant sur presque tout les thèmes traités. Quelques planches illustrent les découpages des divers niveaux de perception du CER appliqués au bassin versant de la rivière Saint-Charles. Viennent ensuite des propositions d'interprétations des données qui s'adressent plus particulièrement aux spécialistes en aménagement du territoire (géographes, aménagistes, urbanistes, analystes) rejoignant ainsi l'idée première de ces documents en tant que déclencheurs d'idées (ex : le potentiel d'habitat du poisson, le potentiel forestier, horticole, l'aptitude à l'implantation des services urbains, etc.). Puisque cet atlas n'a pas de visées scientifiques autre que celles de montrer les utilisations possibles du CER, ses auteurs se substituent à l'aménagiste en proposant un modèle d'évaluation de l'état de l'environnement du bassin versant à partir duquel des objectifs et des moyens sont proposés pour appliquer une forme possible de gestion intégrée du bassin versant.

Le second projet, « l'atlas écologique du bassin versant de la rivière L'Assomption » propose une mise en page plus élaborée et un contenu plus pédagogique, démontrant l'application du CER particulièrement au niveau des districts écologiques à l'intérieur de la partie agricole du bassin versant. Le découpage de ce dernier étant très différent du premier projet, texte et cartographie se partagent les mêmes pages, souvent bonifiés par des graphiques, des tableaux, des diagrammes, des photos et des illustrations diverses. La première partie est dédiée au CER qui est défini de façon plus complète que dans le premier document, en élaborant notamment sur les niveaux de perception des écosystèmes terrestres et des hydrosystèmes d'eau courante. Des exemples de descriptions d'unités écologiques et d'interprétations complètent cette partie qui se démarque par rapport à l'atlas du CER de la Saint-Charles par des illustrations plus abondantes reliées par des liens dynamiques mais toujours dans un style simple afin de ne pas alourdir la présentation. Suit alors la présentation du territoire avec les thèmes suivant : localisation, climat et bioclimat, géologie, réseau hydrographique, occupation du sol (image Landsat) et limites administratives. Les sections suivantes présentent les districts écologiques, les ensembles topographiques et les segments de rivière, les entités topographiques et les faciès d'écoulement en mettant en évidence l'emboîtement des niveaux de perception.

Le troisième projet d'atlas est pour l'instant demeuré à une version préliminaire car deux conceptions différentes de l'information véhiculée par un atlas se sont confrontées. La première, qui nous est chère veut que l'image soit plus importante que les mots, le sens de la donnée est plus nécessaire que la donnée et qu'en fin de compte l'atlas n'est que la vitrine de l'outil d'aide à la décision, ce dernier se présentant sous la forme d'un système d'information sur le territoire (SIT). L'autre partenaire préconisant une démarche différente où l'atlas est l'outil d'aide à la décision, présentant les données scientifiques et techniques complètes. Donc un rapport scientifique ayant la facture d'un atlas où les interprétations sont définitives et non évolutives. Très tôt à la lecture du document il se dégage que les thèmes les mieux représentés sont ceux qui sont les plus épurés, le lecteur n'étant pas entravé par une surabondance de textes ou de graphiques. La conclusion est évidente, le lecteur n'ira pas jusqu'au bout du document. Il n'en demeure pas moins que ce projet est extrêmement intéressant du point de vue cartographie, le territoire couvert allant des Grands lacs au Golfe du Saint-Laurent sur tout le littoral du fleuve.

Comme tout travail cartographique est l'aboutissement de travaux étalés sur une longue période de temps, la conception et la réalisation des atlas ne peuvent débuter que vers la fin des projets de CER, donc avec un délai de production serré. Le choix du logiciel d'édition graphique Corel Draw™ fut pour nous un fait car il permet à la fois l'édition de planches cartographiques et de planches texte. Bien plus que les SIG existants (Mapinfo™, Arcview™ et Spans™ qui ont été utilisés dans ces projets), le logiciel d'édition graphique permet l'application des règles fondamentales de cartographie, sans contrainte, avec un plein potentiel de créativité. Un processus d'échange *SIG - logiciel d'édition* très simple permet un transfert des interprétations et des éléments cartographiques en respectant l'échelle.

Conclusion

La demande pour les atlas écologiques s'est avérée beaucoup plus importante que prévue. L'objectif de visibilité a donc été largement dépassé. Les demandes proviennent d'un public très diversifié allant du citoyen avec des préoccupations écologiques, au gestionnaire du territoire préoccupé par les attentes de ses projets en passant par le monde de l'éducation, le monde municipal, les groupes de pressions, etc. Pour répondre à ces demandes, les atlas complets sont disponibles sur cédérom (contenant aussi le SIT) auquel ils se rattachent via un logiciel de visualisation de documents (Acrobat Reader™). Malgré cela un constat s'impose : pour la majorité des gens, un document papier de la qualité des atlas demeure le médium avec lequel ils sont le plus à l'aise, beaucoup plus qu'avec un cédérom ou internet. Autre aspect important des atlas, ils sont évolutifs et non fixés dans le temps, des thèmes peuvent être ajoutés ainsi que des données provenant de nouvelles études qui permettent de compléter les systèmes d'information sur le territoire.

L'atlas du cadre écologique de référence du bassin versant de la rivière Saint-Charles, s'est vu décerné le prix J.M. Ellis 1997 « Carte innovatrice de l'année » par le comité technique de cartographie de l'Association canadienne des sciences géomatiques. Ce prix vise à promouvoir l'intérêt pour la cartographie et reconnaître l'excellence d'une présentation créative dans ce domaine.

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Session / Séance C7-C

Un outil d'aide à la gestion du territoire partie II : Le système d'information sur le territoire du bassin versant de la rivière Saint-Charles, Québec

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Le bassin versant de la rivière Saint-Charles supporte la plus forte densité humaine du Québec puisque pour 550 km², la population dépasse 350 000 personnes qui tirent leur eau potable d'une même source, la petite rivière Saint-Charles. En 1992, le ministère de 1'Environnement et de la Faune fut sollicité par la Communauté urbaine de Québec (CUQ) pour développer des outils d'aide à la décision en matière d'aménagement du territoire. Ces outils devaient permettre à la CUQ, aux villes membres et à la MRC de la Jacques-Cartier, qui couvre la moitié nord du bassin, de planifier leur déve1oppement en protégeant la ressource hydrique, qu'elle soit en rivière, en lac, en milieu humide ou souterraine. Nous avons donc produit un cadre écologique de référence (CER) comportant cartographies et typologies écologiques - le bassin versant est cartographié à quatre niveaux de perception correspondant aux échelles du 1 : 250 000, 1 : 100 000, 1 : 50 000 et 1 : 20 000 et le lit majeur de la rivière à un niveau de perception exprimé au 1 : 5 000 selon 1es concepts et méthodes que nous avons développés au cours des 30 dernières années.

Comme l'aménagement du territoire exige des connaissances polythématiques véritablement intégrées et des outils de traitement efficaces, nous avons structuré autour d'un CER, un ensemble de données et de connaissances essentielles à la prise de décision dans un système d'information sur le territoire (SIT). Ce SIT du bassin versant de la Saint-Charles, monté sur cédérom en format Mapinfo™ et ArcView™, comprend, outre, l'ensemble des documents écrits pour ce territoire ainsi qu'un dictionnaire de données, toutes les couches cartographiques nécessaires tant pour l'ensemble du bassin que pour le lit majeur de la rivière : topographie, hydrographie, sous-bassins, utilisation du sol, 1imites administratives, écologie des milieux terrestres et aquatiques. Deux gratuiciels sont inclus permettant des fonctions géomatiques simples et la consultation des textes.

Un cadre écologique de référence adaptés problématiques de gestion du territoire

La direction de la conservation et du patrimoine écologique du ministère de l'Environnement a le mandat de produire un cadre écologique de référence (CER) pour le Québec. Le CER comprend plusieurs niveaux adaptés aux différentes problématiques de gestion du territoire. Quelque soit l'échelle, la carte écologique comporte deux volets : le découpage des structures naturelles du milieu et la description détaillée de ses composantes, c'est à dire climat, géologie, relief, matériaux de surface et hydrosystème. Pour le milieu terrestre CER comporte huit niveaux de perception qui vont de la province naturelle dont les unités sont de l'ordre de 100 000 km² au faciès topographique qui n'ont que quelques hectares.

L'équipe de la cartographie écologique a à son actif plus de 30 ans de production cartographique. L'ensemble du Québec est couvert avec les deux niveaux supérieurs du CER, soit les provinces et les régions naturelles, tandis que plus du tiers de la province est couvert avec des cartes écologiques par les moyennes et grandes échelles. Chaque projet comporte des cartes et aussi une notice explicative permettant de décrire la méthodologie et d'expliquer la signification de l'information contenue dans les cartes.

Les systèmes d'information géographique améliore les projets de cartographie écologique

Il y a plus de dix ans le SCE s'est tourné vers la géomatique pour réaliser ses projets de cartographie écologique. Les avantages étaient nombreux : analyse spatiale, production de cartes thématiques et interprétations des potentiels et contraintes à l'aménagement. De plus, les produits numériques ont permis d'améliorer la validation et la corrélation des cartes écologiques.

Malgré le virage numérique, les données cartographiques et descriptives étaient principalement publiées et distribuées en format papier. Avec l'arrivé de documents complémentaires de vulgarisation comme les atlas couleurs (voir la communication « Un outil d'aide à la gestion du territoire partie I : Les cadres écologiques de référence en atlas, par Yves Lachance et Vincent Gerardin ») qui sont plus coûteux à produire et à diffuser. Il devenait impératif de trouver un moyen de distribuer plus adéquatement l'information.

La production d'un cédérom contenant les différents documents du cadre écologique de référence s'avérait une avenue intéressante étant donné que l'environnement technologique est plus performant et convivial et que les ordinateurs sont tous munis de lecteurs cédéroms.

Un système d'information géographique à un système d'information sur le territoire (SIT)

Malgré les larges possibilités de gestion de traitement et d'analyse de l'information qu'offre les systèmes d'information géographique (SIG), ceux-ci sont dépendants des données qu'on leur fournies. En effet, trop fréquemment, la plupart des SIG sont utilisés pour générer des données sectorielles déjà produites par un autre service ou une autre organisation (réseau routier, réseau hydrographique, etc...) [Prélaz-Droux *et al.*, 1993]. Ceci a pour conséquence de doubler une information déjà existante et d'exiger des efforts considérables et d'autant qu'inutiles.

Le territoire est le dénominateur commun des différents producteur de données à référence spatiale, d'où l'intérêt de stocker toutes les données territoriales dans un même environnement. Un système d'information sur le territoire (SIT) favorise l'intégration de l'information provenant de plusieurs sources en fournissant un cadre structuré et normatif pour les données à référence spatiale. Le projet GERMINAL (Gestion de l'Espace Rural au Moyen des systèmes d'Information appliqués aux équilibres Naturel et à leur ALtérations), développé par le département de Génie Rural de l'École Polytechnique de Lauzane, est un des premiers SIT fonctionnelle à être mis sur pied avec toute la phase de développement liée à la géomatique (inventaire de donnée, modélisation conceptuelle, modélisation fonctionnel de données et modélisation physique de données) [De Sède *et al.*, 1993].

Le SIT du bassin versant de la rivière Saint-Charles a été produit avec des moyen beaucoup plus modeste que le projet GERMINAL. Il faut savoir que les 30 années de production cartographique dédiée à des environnements très variés (forêt, agriculture, milieu urbain) et à des préoccupations d'aménagement tout autant diverses, nous ont permis de cerner précisément les besoins en données et les liens qui les unissent et les analyses attendues. Il n'y a donc pas eu de phase de modélisation des données proprement dite. Nous nous sommes limités à la production d'un dictionnaire de données originant de nos travaux et d'accompagner les données de sources externe de leur métadonnées.

Notre SIT comporte donc deux blocs de données numériques. Le premier est constitué des cartes écologiques et de leur fichiers descriptifs que nous avons produits :

• pour tout le bassin versant de la rivière Saint-Charles

- Carte et fichiers des districts écologiques (1 : 250 000)
- Carte et fichiers des ensembles topographiques (1 : 50 000)
- Carte et fichiers des entités et des éléments topographiques (1 : 20 000)
- Carte et fichiers des segments de rivière (1 : 20 000)
- Carte des aquifères (1 : 50 000)

¨ pour le lit majeur de la rivière Saint-Charles

- Carte et fichiers des faciès topographiques (1 : 5 000)
- Carte et fichiers des groupements végétaux (1 : 5 000)
- Carte et fichiers séquences de faciès aquatiques (1 : 5 000)

Le deuxième bloc est constitué de cartes, en format numérique ou papiers produites ailleurs que dans notre service. On y trouve :

• Cartes topographiques du Québec (1 : 20 000)

- Carte des sous bassins versants de la rivière Saint-Charles (1 : 20 000)
- Carte d’affectation du sol (1 : 20 000)
- Carte de localisation des prises d’eau (1 : 20 000)
- Carte de localisation des fosses septiques (1 : 20 000)
- Carte de localisation des barrages (1 : 20 000)
- Carte de localisation des sites d’enfouissement (1 : 20 000)
- Image Landsat TM classifier de l’utilisation du sol (résolution 25 m)
- Carte des zones inondables (1 : 2 000)

Dans la majorité des cas ces cartes ont été nettoyées, structurées et souvent numérisées avant d’être intégrées au SIT.

Finalement, un fichier d’aide contenant toutes les métadonnées des cartes est aussi disponible, facilitant l’accès aux informations techniques.

Les utilisateurs du SIT

Le SIT du bassin versant de la Rivière Saint-Charles permet donc, par l’information provenant de plusieurs sources, de concevoir des scénarios d’aménagement ou d’évaluer certains projets en tenant compte de critères écologiques, sociologiques ou réglementaires. C’est ainsi qu’un groupe de pression environnementale a étayé ses représentations vis-à-vis d’un projet d’implantation d’un golf le long de la rivière Saint-Charles sur la base des données du SIT. Ceci n’aurait pas été possible si les données n’avaient pas été diffusées de cette façon. En effet, ce type d’organisation a généralement peu de ressources pour colliger et traiter toutes ses informations. Par ailleurs, les institutions d’enseignement et de recherche se sont montrées très intéressées par ce produit car il offre un cadre éducationnel intéressant, notamment pour les laboratoires de géographie ou les projets de recherche pour les étudiants gradués. Les cédéroms ont été aussi distribués à d’autre autres ministères, villes et organismes qui ont fait la demande.

En plus de la réduction des coûts de distribution de la connaissance écologique, le cédérom est un support intéressant car il permet de diffuser à la fois les données mais aussi les logiciels qui permettent d'en consulter le contenu. Les données textuelles sont distribuées en format PDF, lisible sur n'importe quel ordinateur avec le logiciel Acrobat ReaderÔ. Pour ce qui est des données cartographiques, elles sont disponibles en format ArcViewÔ lisible avec le gratuiciel ArcExplorerÔ. Ces deux logiciels sont inclus dans le cédérom, ils n'ont donc pas à être téléchargés à partir d'Internet. Les données géographiques ont aussi été traduites en format MapInfoÔ.

Conclusion

Depuis sa sortie en mars 97, plus de 150 cédéroms ont été distribués. Des cours de formation sur l'utilisation du SIT ont été dispensés à une soixantaine de personnes intéressées à la gestion du bassin versant de la rivière Saint-Charles (villes, gouvernements, citoyens et milieu éducatif). Cette façon de faire a fait des petits, puisque, quelques mois plus tard, le SIT du bassin de la rivière L'Assomption voyait le jour, suivi de celui de l'Agence Forestière des Bois-Francs. Même si la formule du SIT est semblable, les données sont adaptées aux problèmes spécifiques du territoire. Ainsi, le SIT du bassin versant de la rivière L'Assomption porte surtout sur des problématiques agricoles tandis que le SIT de l'Agence Forestière des Bois-Francs est plus adapté aux problèmes forestiers et fauniques. Deux autres projets, présentement en cours, auront leur SIT bien à eux. Il sagit du Système Intégré d'Aide à la Décision (SIAD) de l'Outaouais (33 000 km^2) et le SIT de la forêt modèle de Waswanipi.

En conclusion, les SIT produits sur cédérom sont d'excellents moyens de diffusion de données à référence spatiale. En favorisant le partenariat et la mise en commun des données à référence spatiale, on passe d'une série de documents techniques isolés à un véritable SIT où la connaissance écologique occupe une place prépondérante et intégratrice en regard de l'aménagement du territoire. L'approche intégratrice du SIT en fait un véritable outil de planification et d'aide à la décision.

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Session / Séance 44-D

The forest “green belt” around Moscow (experience of mapping).

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Abstract

Till recent times Moscow has been surrounded by continuous belt of mixed forests - so-called “green belt”. During last decade this unique “green belt” has been undergoing the risk of complete destruction because of intensive cutting of these forests and building country cottages and villas on cutting areas.This house-building is uncontrolled and destroys unique forest stands thus this process leads to elimination of Moscow “green belt”. In order to determine modern ecological condition of the “green belt” it’s large fragment has been studied on the territory of Narofominsky district, Moscow oblast, situated to the South-West from Moscow. Counting of mammals and estimation of current state of environment have been done during three years, since 1995 till 1997, both in winter and summer seasons. As a result an ecological map (scale 1 : 200,000) was compiled.

It is the creation of the system of ecological corridors with large forests and narrow vital passages which may help to solve the problems. It is necessary to know areas where any building activity should be prohibited. If it is extremely necessary, new country-house settlements should be placed in areas with highly disturbed ecosystems and as far from ecological corridors as possible.

The subtitle of this paper may be: “We are loosing Moscow “green belt”.

Till recent times Moscow has been surrounded by continuous belt of mixed forests - so-called “green belt”. During last decade this unique “green belt” has been undergoing the risk of complete destruction because of intensive cutting of these forests and building country cottages and villas on cutting areas.

This house-building is uncontrolled and destroys unique forest stands thus this process leads to elimination of Moscow “green belt”.

In order to determine modern ecological condition of the “green belt” it’s large fragment was studied on the territory of Narofominsky district, Moscow oblast, situated to the South-West from Moscow. The counting of mammals and estimation of current state of environment have been done during three years, since 1995 till 1997, both in winter and summer seasons. As a result an ecological map (scale 1 : 200,000) has been compiled. The zoomed out variant of this map is shown on figure 1.

The results of thorough field research made by a method of the field route counting were used as a basic material for the map. The routes passed through the main landscapes of South-Western Moscow environs. The mammals density was estimated with the help of the winter field route counting method applied in Russia. Full geobotanic descriptions in different forest types were done on the plots with the area 20*20 m. The degree of biocenoses anthropogenic transformation was assessed. Topographic maps 1:100000 and maps of forest management were used as a cartographic basis during the field research .

The massed land withdrawal for country-houses has become one of the principal forms of the anthropogenic impact for the last decade. Since 1990 till 1994, in Vereisky forest-management complex for example, 826 hectares of forest stands were picked out for country houses. It makes up 2% of the entire area of federal forests here (44,400 hectares). For country house building lands are given both in unique forests of high value and low price damped forested areas which play never the less, a vital role for fauna. Many country-house cooperatives are trying to occupy lands close to rivers and springs. Only the operative activities of the district Committee for nature protection stopped cutting primary spruce-oak forests with settlements of badgers on the left bank of Neznaika river.

Not only disturbance of natural habitats but the sharp increase of bothering factor and wild dogs population affect fauna negatively as well. In the vicinity of country-house settlements the density of wild dogs was at least 4-5 individuals per sq. km. Dogs hunt on young deer, hare and other animals. Such high density of predators and hence their impact is not typical for natural ecosystems. The “dead” zones develop around such settlements. Their area is 3-6 times higher than the area of settlements themselves. Communal network, connected with country-house settlements also obstruct free migration of animals.

Isolation of forest areas uses to be one of the negative factors of building. New settlements appear close to the vital forest corridors, connecting huge forests. Due to this a list of negative factors for wildlife appear:

1. Decreasing of protective and feeding abilities of lands. Elks for example when disturbed on willow valley feeding-grounds try to escape in a neighboring forest with vegetated cuttings. They use well-known forested corridors which may be obstructed by a settlement. The animals will leave these feeding grounds, preferring poorer but more safe sites.
2. Disturbance of seasonal migrations patterns and regular passage corridors. The well defined seasonal migrations of elks and roe deer were marked in the district. They are described later. Here we mark that migrations of nomadic animals occurs only in connected forest areas.
3. Obstruction of territory inhabitation of mammals may result in decreasing of ecosystems sustainability. There is a wild boar reproductive area on the territory of Narofominsky district. Here its density is sustained at a level of 30 individuals per 10 sq.km. This area is connected with adjacent one by forest corridors. Now it is surrounded by country-house settlements. In case of isolation of reproductive area the wild boar density will decrease in the entire district, the population in the reproductive area will suffer from lack of food, diseases and soon. The natural reinhabitation of these lands seems to become problematic in this case. These problems are actual for the majority of animal species. The genetic consequences of isolation can hardly be prognosed.

The chaotic house-building in the vicinity of Moscow intensifies different kinds of anthropogenic influence on animals. They are habitats destruction, forested areas isolation, increase of poaching, aggression of dogs, bothering, making illegal damps in forests.

Where country-house settlements occupy a negligible area or absent at all, the maximal wildlife density and diversity is recorded (Vyshegorodsky forest and some others). The spruce and deciduous-spruce forests survived here. They have a well developed undergrowth and grass cover. They differ amazingly from other Moscow region forests.

In the places where building has just started, the doubling of dogs traces density is observed. The decrease of populations of hair, and marten are observed. Squirrels and foxes keep their density at first. In places with a few country-house settlements and they don’t obstruct passages between forested areas elks, wild boars and roe deer appear.

In places where country-houses have been already built, the net of roads and paths is well developed but forested areas still exist. Here elks and roe deer almost disappear and density of wild boars decrease in 2-2.5 times. The density of martens decreases 3-4 times.

In areas where country-house settlements occupy more than 15-20% and the majority of forest corridors is obstructed ungulates, wolfs and martens disappear. Vegetation is degraded greatly here. This makes conditions worse for small rodents, such as shrews, mice and voles. Their density decreases greatly. There are a few martens in such forests. The great number of dogs, which appear in such forests causes the extremely low density of hair. It is 6-20 times lower than in slightly disturbed forests.

Recently forest degrade very rapidly. May be really elks, roe deer, wild boar and martens will extinct in Moscow environs? We cannot say that it is wrong. It will become reality of the country-house building will be so rapid and poorly organized. In this case many forest corridors will disappear.

There is still a chance to keep biodiversity and productivity of Moscow environs forests on the basis of connected forests to have survived. We managed to estimate location of ecological corridors remained in the Narofominsky district. One of the criteria in this research were seasonal migrations of elk.

The network of the ecological corridors is easily traced throughout the district on the schematic map. In many cases huge forested areas are connected by the forested passages which are only 100 m wide! It is these corridors which are used by wild animals for migration. Here they are undergone the greatest risk. Recently many of them were obstructed. It was estimated that the corridor to the South from Narofominsk is cut down completely. Penetration of large animals from the eastern part of the district is difficult. All relations occur via Kaluga oblast. The value of the corridors remained is only increasing because of this. As our research showed, they still sustain all the system of ecological corridors.

What are the peculiarities of this system? It is known that in Moscow ecological corridors are represented only by valleys of streams. In the South-eastern environs of Moscow they are represented mainly by forests on watersheds. The valleys of the Oka river affluents (Nara and Protva) are still being transformed by humans. The majority of bank ecosystems is disturbed. There are many buildings which appear despite these areas are protected by law.

Valley forests are represented by separate fragments. It is these areas where the most important passages of wild animals between forests situated on different banks exist. Such passages were found on Protva to the North-west from the town of Vereya and on Nara river close to the village of Kamenskoe. They use to be the most vulnerable spots in the ecological corridors network. The Protva and Nara rivers valleys keep a role of ecological corridors for water mammals such as musk-rats, beavers, otters and others. The density of beaver is extremely low due to poaching and transformation of bank ecosystems. Otter is very rare. It was noticed only a few times.

The valleys of small streams are less disturbed by man. They form a good supplement to the system of ecological corridors. The areas hardly accessible for people acquire a great importance due to their high protective properties. Valleys use to be permanent habitats for some non-water mammals. The main part of badger settlements in Narofominsk district were found on river terrases.

When working out proposals for marking protected areas we assumed that it is impossible to keep wildlife diversity and density on isolated areas. It is impossible even if almost undisturbed ecosystems exist there. Isolation results in the loss of biodiversity, bioproductivity and sustainability of wildlife communities. Recovery of the most important communities will become almost impossible.

We propose not a number of separated protected areas but a network of them connected by ecological corridors. Its cells are huge forest massifs and knots - forested passages between them. When glancing to a map one can say that the area of protected lands is too big. But it is obvious, that due to the Western air mass drift they provide Moscow with oxygen. The forest of Western Moscow environs are of great recreation, esthetic and nature protective values.

Conclusions

It is the creation of the system of ecological corridors with large forests and narrow vital passages which may help to solve the problems. It is necessary to know areas where any building activity should be prohibited. If it is extremely necessary, new country-house settlements should be placed in areas with highly disturbed ecosystems and as far from ecological corridors as possible.

Territories with different degree of disturbances have been represented on the map: 1) “dead zone” with the lack of natural wild life due to strong anthropogenic impact; 2) moderately disturbed territories; 3) territories with slightly disturbed natural ecosystems; recently the territories of this type have become the most intensively developed ones and will have been transformed into “dead zone”) well-conserved natural ecosystems - mixed coniferous broad-leaved forests with specific flora and fauna; these territories have been conserved because of their situation away from main roads, but now even they are in danger of extinction.

Special attention was paid for presenting ecological corridors which are narrow forests passages connecting vast wood stands. They can be called “corridors of life”. Mammals use ecological corridors for seasonal migrations. Elimination of such corridors will lead to the loss of the entire complex of animal species.

Ecological map created has been given to the regional Committee for nature protection for using as a base for protection program for unique forest stands in higher parts of Moscow region. Compiling similar maps for the whole “green belt” of Moscow is necessary for its effective conservation.

Session / Séance 29-D

Changes's Analysis of Land Uses in An Area of Buenos Aires, Argentina

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ABSTRACT

The land use, seen in certain moment, seems something stable. However, a multitemporal analysis allows to know the changes in the land uses and its magnitude. In this article, the results of this analysis are presented in an area of approximately 17 km². Embracing a 33 year-old period, were mapping the land uses for different years. Then, there was carried out a map that synthesizes the changes in the land uses.

This work focusing their attention in the changes happened between 1965 and the present time. Using geoinformatics tools is sought to demonstrate the great variety of changes in a marginal area of Buenos Aires, Argentina. These changes reveal that exists a dynamic with economic and environmental effects little studied. Aereal photographs were used, topographical maps, satellite images, data obtained in the field work and in the cabinet work.

Key words: land uses, time, changes, value of the land, management, cartography and environmental control.

INTRODUCTION

The land use is one of the most important variables in the environmental studies. Each economic activity has diverse effects in the environment. It is very common that a parcel suffers significant changes along the years. After some decades of having been used for different purposes, can be rakes like for example: pollutants's spill, pesticide and fertilizer polutions, organic residuals, pathogenics or inorganic, soils compression and loss of nutrients. This implies to waste, the possible contamination and, in some marries, the existence of dangerous residuals or the elimination of the substratum. An example of it, is it a type of mining activity as the exploitation of "tosca" (carbonatic rock of sedimentary origin), which generates digs (depressions of 10 to 20 meters deep and 10 hectares of surface). The same ones become areas of sanitary lanfiller, illegal trash cans or not controlled drains. Who will remember the location of these places in 20 or 30 years?. Several authors (Moon, 1994; Colten, 1990; Girardi, 1992; Olivares, 1994, 1995) treated the topic of the historical risks and the environmental cartography of these places.

At the same time, the changes in the land uses can condition the value of the earth. Maybe not at the moment, but yes in the future. In turn, this can condition the distribution of new uses in function of the resulting aptitude of the current uses.

This work recognizes antecedents in Olivares (1994), an article in which was discussed the problem of the quarries and the possibility of recycling them. With regard to the cartographic report, Colten (1990) demonstrates the importance of a historical registration of the places that there are present environmental risks; Moon (1994) has discussed the importance of the handling of the solid residuals and of the planning of the territorial administration. Hernández et al (1991) and Girardi (1992) demonstrate the danger of the not controlled drains and the necessity of avoiding the overturn of residuals that could contaminate the underground waters.

From the methodological point of view, Díaz de Terán (1989) and Cendrero (1991) provide important guides for the elaboration of the environment cartography.

The study area is located in the basin of the Conchitas creek, near Florencio Varela City, province of Buenos Aires, Argentina (Fig. 1). This place is inside what is known as "Gran Buenos Aires" (the metropolitan area of Buenos Aires, of 7.200 km² and 12 million inhabitants, approximately). The surface of the study area is of 17 km², inside which combine rural and urban places. The population, in general, is of low resources and the quality of the services is low to null. It is considered to the town of Florencio Varela like a city bedroom, and the same one possesses one of the highest rates of vegetative growth in the Gran Buenos Aires.

OBJECTIVES

In this work is presented a study of the changes in the land use, with the purpose of determining the magnitude of the change. In turn, it is looked for to know which the land uses are, in those the biggest changes take place. The results won't be extrapolated to the rest of the Gran Buenos Aires because we treat a small area. But it should be kept in mind that cases exist where the population is bigger and the environmental problems are more serious.

METHODS

Aereal photographs have been used, to scale 1:20.000 of the years 1965, 1972, 1983 and 1996 with the purpose of mapping the land uses of the classified in the following way and keeping in mind a factor of risk:

Land use	Factor of risk
1. Agricultural intensive:	pesticide and fertilizer remains in the soils.
2. Agricultural extensive.	Superficial deterioration, erosion.
3. Mining.	3 to 20 substratum meters are removed. Possibly it can have residuals.
4. Industries.	Diverse pollutants remain in the soils.
5. Urban use.	Waste liquids and waste can filter in the soil.
6. Recreational use or park.	Erosion, flora impoverishment and fauna.
7. Forest.	None.

The category "forest" it is considered inside land uses because in most of the cases they are implanted by the man.

It is common that when comparing two pictures it exists until 20% of difference of covered area. This owes it to that the flights have not followed the same trajectory and that, also, the companies that carry out the flights have changed after some years.

Later on, the maps of every year were superimposed and the difference was analyzed among the same ones, being obtained a map synthesis of changes of land uses.

Topographical maps have been used to scale 1: 50.000 and cadastral planes 1: 20.000 for to use the coordinates system on the aereal photographs. The field work allowed to upgrade the information and to adjust the cartography.

It was considered that the land use changed when among a picture and other differences of tones, features and distribution were detected, which allowed to define another land use or the same one but with another distribution. Also, there is leaned on this result with cartography of the study area.

RESULTS

The maps 2, 3, 4 and 5 represent the land uses for four moments of the analyzed period. They correspond to the years 1965, 1972, 1983 and 1996. The map 6 is a document that synthesizes the information of the changes that there are took place in four uses selected by its high index of environmental impact (Silva and Olivares, 1998 unpublished). These uses are: mining, industry, urban use and intensive agricultural. It can be observed that not alone it changes the size of the busy surface but rather new parcels occupied by some uses also exist that before were not there. The urban use presents an important advance and the parcels occupied by mining they have grown, mainly, in size.

Purpose of the maps.

Essentially it is to know where they are these risky places, from the environmental point of view. How they are, what evolution they present and what risk they possess. Many of these data can figure in a database associated to the map.

The bring up to date is a vital factor for the success of these maps. Of there, the importance of applying the geoinformatic. Each new place, or changes taken place in other, it should be entered to the system. This way, the product will complete diverse functions. Although naturally for it is necessary the collaboration of the companies, the ONGs, the government, the scientists, the technicians and the population.

CONCLUSION

This cartography type, that could be framed in the environmental cartography, represents to possibility to have the information in quick, modernized and white form.

The real state speculation is one of the problems that can face and to be solved with this type of documents. But, also, the administration of the territory at municipal level requires cartographic inventories, because if we don’t know where these places are, how they are and what history they have, it exists a high probability that the same ones are a source of environmental risk, with consequences impredecibles for the population. Maybe, the key words are: control and administration. It is not then, to attack to certain activities like the mining exploitation or the sanitary fillers. For the time being only it interests to know where, how and when.

We cannot refuse that the residuals exist. We hide them but they increase. If they are not recycled, it is not another possibility that to bury them. Therefore, it is important to avoid the paranoiac attitudes regarding the sanitary fillers. On the contrary, it should have a bigger exchange of information among the companies, the technicians and scientific, who, through the means, they should inform the population. In this sense the environmental cartography can play an outstanding paper. For it is needed that the companies to contribute data with the purpose of carrying out this type of maps. The same ones can be useful for them, but mainly for the decisores and, so that the population knows that there is “lower their feet.” This way you can achieve a bigger transparency in the environmental administration. That said previously is valid for other uses like the industry, the hatcheries and other agriculture and breeding activities.

Lastly, if we think long term, in 3 or 4 decades these places can be forgotten, that which could generate diverse problems related to the use of non capable lands. For example: What value does it have a parcel with pollutants already left by old industries missing?. Does somebody know that this substances are present?. How will a company manufacturer know in 20 or 30 years, if the place where she will be carried out the work, a sanitary filler it is? What consequences would it have the unexpected and not planned opening of these fillers?

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Session / Séance 44-B

The Mapping of Actual Vegetation of the Caspian Sea Region

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Abstract

The greater part of Caspian plains (Caspian and Kura-Araks Lowlands, Mangyshlak, plateau and lowlands of West Turkmenistan) lies in the limits of the Sahara-Gobi Desert Region. Its vegetation represents various latitudinal (Northern, Middle, Southern) and ecological (pelithophytic, hemipsammophytic, psammophytic, hemipetrophytic, petrophytic, galophytic) types of deserts. In the last years the maps of reconstructed vegetation of Eastern Europe, Kazakhstan and Middle Asia, including the Caspian Sea Region, were published (s. 1:2 500 000). These maps reveal the ecological potential of the territory.

The main growth form on Caspian plains is dwarfsemishrub. Besides dwarfsemishrubs essential role belongs to xerophylic and hyperxerophylic micro- and mesothermic plants of other growth forms - shrubs, semishrubs, short and long vegetating perennial grasses, annuals. In the Northern temperate deserts vegetation is quite monotonous, there predominate dwarfsemishrub communities united in small number plant formations: Artemisia lerchiana, Artemisia arenaria, Artemisia pauciflora, Calligonum aphyllum, Tamarix ramosissima, and some others. In the Middle deserts noticeable role in vegetation cover belongs to communities of more than 30 formations: Anabasis salsa, Nanophyton erinaceum, Arthrophytum lehmannianum, Salsola orientalis, Artemisia terrae-albae, Artemisia gurganica, Artemisia lerchiana, Artemisia santolina, Atraphaxis replicata, Caragana grandiflora, Rhamnus sintenisii, Salsola arbuscula, Convolvulus fruticosus, Krasheninnikovia ceratoides, Salsola arbusculiformis, species of genera Calligonum, Haloxylon, etc. In the Southern deserts Salsola gemmascens communities and Artemisia kemrudica communities predominate; on sand massifs prevail shrub (of genera Ammodendron, Calligonum, Haloxylon) deserts.

At present the mapping of actual vegetation of the Caspian Sea Region is being carried out. It includes the small scale (1: 2 500 000) map of actual vegetation of the whole region and the middle-scale (1:300 000) maps of its separate parts. Their main task is to reflect the ecological status of the region, the degree of anthropogenic influence, to bring out the ratio between areas with disturbed and undisturbed vegetation, to reveal the regions of ecological disaster and the areas to be preserved.

The map legends are being constructed at the base of the hierarchic system of subtitles. The highest subdivisions reflect the diversity of latitudinal types of desert. After that the ecological types of desert are differentiated. The next rank of subdivisions shows the typological composition of deserts. The lowest rank is the mapping unit that is the type of plant community or the type of territorial combination of plant communities.

The anthropogenous vegetation is subordinated to natural one. It is represented by 3 variants: agricultural lands, overgrazed pastures and territories with technogenic influence. The intensity of anthropogenic factor is indicated also.

Introduction

Most part of Caspian plains (the Caspian and Kuro-Araks Lowlands, Mangyshlak, plateau and lowlands of West Turkmenistan) belongs to the Saharo-Gobi Desert Region [Lavrenko, 1962]. The general regularities of their vegetation cover have been reflected on the maps of reconstructed vegetation of the larger territories [Isachenko, Lavrenko (Eds.), 1979; Belov, Gribova, Karamysheva, Kotova (Eds.), 1990; Ladygina, Rachkovskaya, Safronova (Eds.), 1995; Gribova, Neuhäusl (Eds.), 1996].

The main growth form in temperate deserts on Caspian plains is dwarfsemishrub. Besides dwarfsemishrubs essential role belongs to xerophylic and hyperxerophylic micro- and mesothermic plants of other growth forms - shrubs, semishrubs, short and long vegetating perennial grasses, annuals. Dwarfsemishrubs form communities in various environments. Shrubs, semishrubs, grasses usually grow on stony-skeleton underdeveloped soils, soils of light texture (mechanical composition) and sands. Annual plants (shortly and long vegetating) are rather characteristic of temperate deserts. The abundance of ephemers (shortly vegetating annuals) depends on weather conditions of one or other place. In years of favourable moisture condition they are so abundant that dominate in plant communities and their projective cover exceeds that of perennials which are the edificators of these communities [Rachkovskaya, Safronova, Khramtsov, 1990].

In the North of the Caspian temperate deserts (from 48° N to 44° 30′ N along the Western shore of the Caspian Sea and from 48° N to 46° 30′ N along the Eastern one) vegetation is quite monotonous, there predominate dwarfsemishrub communities (of genera *Artemisia* subgenus *Seriphidium*) united in small number plant formations: *Artemisia lerchiana, Artemisia arenaria, Artemisia pauciflora, Calligonum aphyllum, Tamarix ramosissima*, and some others. On plains between 46 30′ N and 43° N. on the Eastern shore of the Caspian Sea noticeable role in vegetation cover of the Middle deserts belongs to communities of more than 30 formations. Dwarfsemishrubs are species of perennial saltworts (*Anabasis salsa*, *Nanophyton erinaceum, Arthrophytum lehmannianum, Salsola orientalis*) and wormwoods (*Artemisia terrae-albae, Artemisia gurganica, Artemisia santolina*). Along with them large areas are occupied by shrub (*Atraphaxis replicata, Caragana grandiflora, Rhamnus sintenisii, Salsola arbuscula*) and semishrub (*Convolvulus fruticosus, Krasheninnikovia ceratoides, Salsola arbusculiformis*) communities on stony-skeleton soils and shrub communities (species of genera *Calligonum, Haloxylon, Atraphaxis replicata, Salsola arbuscula).* Southern deserts spread from 43° N up to 38° N. On plains northwards of Kara-Bogaz-Gol Bay dwarfsemishrub communities of *Salsola gemmascens, Artemisia kemrudica* predominate; southerward of the Bay sand massifs prevail with shrub (of genera *Ammodendron, Calligonum, Haloxylon*) deserts. The foothill southern deserts are characteristic of the Kura-Araks Lowland, situated between ranges of the Large Caucasus and the Small Caucasus; their peculiar feature is the presence of well developed ephemeroid synusia (*Poa bulbosa*, *Catabrosella humilis*). The most common are the deserts of *Artemisia fragrans, Salsola ericoides, Salsola nodulosa.*

At present time the mapping of actual vegetation of the Caspian Region is being carried out in different scales: 1 : 2 500 000 - for the whole region and 1 : 300 000 - for its separate parts. The map legends are constructed at the base of hierarchy of subtitles. The highest subdivisions correspond to three latitudinal desert types: “Northern dwarfsemishrub deserts on brown soils”, “Middle dwarfsemishrub, semishrub and shrub deserts on grey-brown soils”, “Southern shrub and dwarfsemishrub deserts on grey-brown soils”. Then ecological desert types are differentiated in each latitudinal type: “pelitophytic”, restricted to the loamy soils, “hemipsammophytic” - to the loamy-sandy soils, “psammophytic” - to the sandy soils and sands, “ hemipetrophytic” - to the skeleton soils, “petrophytic” - to the stony soils, “ galophytic” - to the saline soils, solonets and solonchak. The next rank of subtitles reflects the typological composition of deserts. The lowest rank is the mapping unit that is the type of plant community or the type of territorial combination of plant communities - “complexes”, “series”, “combinations”. “Complex” - includes 2-3 plant community types, regularly repeated according to microrelief and soil varieties on uniform (as to its genesis) territory. “Serie” is the group of plant communities, successively connected with each other, representing consecutive stages of change in the process of vegetation development on definite area (on hilly and barkhan sands, rolling-hills, etc). “Combination” consists of regularly alternating plant communities, their series or complexes restricted to the territories of different genesis.

The anthropogenic vegetation is subordinated to natural one. It is subdivided into pastures (with slight, temperate and strong grazing and overgrazing), fields (cereal and melon cultures), fallows (of various restoration stages beginning from the tall weeds stage).

The Northern Caspian Region and mapping its vegetation

By way of illustration we can propose the legend to the map of actual desert vegetation of Northern part of the Caspian Lowland, Scale 1 : 300 000. The region extends for the space of 250 km from the North to the South, from railway station Bogdo (48°N) up to Astrakhan (46°20¢N) and of 200 km from the West to the East on both banks of the Volga River.

Physiography of the Northern Caspian Region

The Caspian Lowland is the driest part of Europe. In respect of geology it is a young formation, composed by marine sediments of Guarternary transgressions of the Caspian Sea. Most of the territory lies below Word Ocean level. The absolute height of surface is lowered gradually from 15-20 m in the North up to 27 m below 0 at the coast of the Caspian Sea. The relief is even as a whole however the plain surface carries various forms of meso- and microrelief (depressions, rolling-hills, barkhans, etc). Human activity also often promotes some relief-forming processes, such as the development of mobile sands.

The territory under consideration has no outflow. The Volga River has no tributaries here at all, but is divided into lot of channels, the largest of them is Akhtuba. Among the artificial hydrological objects, received wide distribution in the last decades, irrigation channels of various function can be named.

Climate of the Northern Caspian Region is characterized by low precipitation (150-250 mm), high evaporation (800-900 mm) and the large year and summer daily amplitude of air temperature. The summer is warm (the mean temperature of July is +24° - +26°C), the winter is temperately mild (the mean January temperature is -5° - -9,5°C).

In the region brown desert soils predominate. They are often salt enriched, very characteristic are solonets, solonchaks and sands [Zonn, Neronov (Eds.), 1995; Ushakov et al. (Eds.), 1996; Pjatin (Ed.), 1997].

Vegetation : general characteristics

The Northern Caspian Region lies in the limits of latitudinal belt of Northern temperate deserts. It is characterized by scanty vegetation. The wormwood deserts predominate, among them the deserts of *Artemisia lerchiana* prevail considerably. Large areas are occupied by the deserts of *Artemisia arenaria*; deserts of *Artemisi*a *pauciflora* are less common. The characteristic feature, especially to the East of Volga River, are the deserts dominated by xerophilous shrubs, however there occur only three species of shrub (*Calligonum aphyllum*, *Tamarix ramosissima*, *Tamarix laxa*) and one semishrub (*Krascheninnikovia ceratoides*). In the Volga-Akhtuba flood-plain grass-herb meedows, mesophytic shrub communities and forests are distributed.

In the region the set of ecological types of plant communities is not large, which is accounted for small diversity of nature environments. In connection with prevailing the sandy-loam and sandy soils and wide distribution of sand massifs two desert ecotypes predominate: hemipsammophytic and psammophytic. The first one is represented by the bluegrass-wormwood (*Artemisia lerchiana*, *Poa bulbosa*) coenoses on sandy-loam soils. The psammophytic desert consists of *Artemisia lerchiana* communities, *Artemisia arenaria* communities and shrub communities (*Calligonum aphyllum*, *Tamarix ramosissima*, *Tamarix laxa*). The coenoses of *Artemisia* *lerchiana* with grasses (*Stipa sareptana, Stipa lessingiana*), those of *Artemisia lerchiana*, *Agropyron fragile*, and the communities of *Artemisia lerchiana*, *Ephedra distachya*, locally with *Calligonum aphyllum*, are developed on sand plains and hilly nonmobile sands. The sand-wormwood (*Artemisia arenaria*) deserts, usually with shrubs (*Calligonum aphyllum, Tamarix ramosissima, Tamarix laxa*), rarely with semishrub *Krascheninnikovia ceratoides*, predominate on hilly weakly stabilized sands. Shrub coenoses are formed on the tops of weakly stabilized sand hills and barkhan.

Pelitophytic deserts on loamy soils occupy small areas. In this region they are only communities of *Artemisia lerchiana* which always form complexes with galophytic black-wormwood *Artemisia pauciflora* deserts restricted to saline soils and solonets.

Communities of perennial dwarfsemishrub saltworts (*Halocnemum strobilaceum, Obionne verrucifera, Camphorosma monspeliacum, Atriplex cana*) on solonchaks around saline lakes, which often occur between sand massifs, is refered to hypergalophytic deserts.

As to its structure, vegetation cover of Northern Caspian Region is very heterogeneous, which is connected with frequent alternation of relief elements. In order to show this heterogeneity various territorial units (complexes, series, etc), as it was mentioned earlier, are used in the legend [Prozorovsky,1940; Levina, 1959,1964; Ivanov, 1961; Lavrenko, 1965; Safronova, 1975, 1980].

Because of strong anthropogenic influence the actual vegetation is considerably changed, there often predominate dynamically unstable plant aggregations and communities.

Legend of the actual vegetation map of the Northern Caspian Region, Scale 1 : 300 000

Northern dwarfsemishrub deserts on brown soils

Pelitophytic on loamysoils

Complexes with dominant of wormwood communities of *Artemisia lerchiana*

1. Communities of *Artemisia lerchiana* in complex with those of *Artemisia pauciflora*

   Complexes with the dominant of wormwood communities of *Artemisia pauciflora* on saline soils

2. Communities of *Artemisia pauciflora* in complex with those of *Artemisia lerchiana*

   Hemipsammophytic on loamy-sandy soils

   Wormwood Communities *of Artemisia lerchiana*, complexes with their dominance on saline soils and agricultural lands instead of them

3. Communities of *Artemisia lerchiana, Poa bulbosa*

   3a. Pastures:

   - a_1 - slightly grazing (communities of *Artemisia lerchiana with Artemisia scoparia, Euphorbia seguierana, Ceratocarpus arenarius*)
   - a_3 - strongly grazing (*Euphorbia seguierana, Peganum harmala, Leymus racemosus, Artemisia arenaria, Achillea micrantha, Anisantha tectorum*)
   - a_4 - overgrazing (mobile sands without vegetation or with single plants - *Peganum harmala, Coryspermum arenarium, Leymus racemosus,*)

   3b - Fallow lands:

   - b_1 - tall weeds (*Artemisia lerchiana, Artemisia austriaca, Tanacetum achileifolium, Agropyron fragile, Ceratocarpus arenarius*)
   - b_2 - wormwood-ebelek (*Ceratocarpus arenarius, Artemisia lerchiana*)
   - b_3 - wormwood (*Artemisia lerchiana*) with single grasses (*Poa bulbosa, Stipa sareptana, Agropyron fragile*)
   - b_4 - grass-wormwood (*Artemisia lerchiana*, *Stipa sareptana*, *Agropyron fragile*), bluegrass-wormwood (*Artemisia lerchiana, Poa bulbosa*)

3c - Fields:

c_1 - cereals

c_2 - melon and vegetables plantations

4. Bluegrass-wormwood (*Artemisia lerchiana, Poa bulbosa*) in complex with communities of *Artemisia lerchiana*
5. Bluegrass-wormwood (*Artemisia lerchiana, Poa bulbosa*) in complex with bluegrass-blackwormwood (*Artemisia pauciflora, Poa bulbosa*); blackwormwood (*Artemisia pauciflora*); locally with communities of *Anabasis salsa*

5a. Pastures:

a_3 - strongly grazing (*Alhagi pseudoalhagi, Anabasis aphylla, Poa bulbosa, Ceratocarpus arenarius, Eremopyrum orientale, Descurainia sophia,*)

5b. Fallow lands:

b_2 - bluegrass-ebelek (*Ceratocarpus arenarius, Poa bulbosa*)

b_3 - wormwood (*Artemisia lerchiana*)

5c. Fields:

c_3 - fallow lands after melon plantations

Complexes with dominant of communities of *Artemisia pauciflora* on saline soils

6. Bluegrass-blackwormwood (*Artemisia pauciflora, Poa bulbosa*) in complex with bluegrass-wormwood (*Artemisia lerchiana, Poa bulbosa*)

Psammophytic on sandy soils and sands

Communities of *Artemisia lerchiana* on sandy soils, series of communities of *Artemisia lerchiana* on stabilized sands and agricultural lands instead of them

7. Communities of *Artemisia lerchiana* locally with participation of grasses (*Stipa sareptana, Stipa lessingiana, Agropyron fragile, Poa bulbosa, Leymus racemosus*) and psammophytic herbs (*Syrenia siliculosa, Helichrysum arenarium*)

7a. Pastures:

a_1 - slightly grazing (wormwood communities of *Artemisia lerchiana* with *Artemisia scoparia, Euphorbia seguirana, Ceratocarpus arenarius*)

a_3 - strongly grazing (*Artemisia lerchiana, Artemisia arenaria, Ceratocarpus arenarius*)

a_4 - overgrazing (destabilized sands without vegetation or with single plants - *Peganum harmala, Coryspermum arenarium*)

7b. Fallow lands:

b_1 - tall weeds (*Artemisia lerchiana, Artemisia austriaca, Agropyron fragile, Ceratocarpus arenarius*)

b_3 - communities of *Artemisia lerchiana* with single grasses (*Poa bulbosa, Stipa sareprana*)

b_4 - grass-wormwood (*Artemisia lerchiana, Stipa sareptana, Agropyron fragile*), bluegrass-wormwood (*Artemisia lerchiana, Poa bulbosa*)

7c. Fields:

c_1 - cereals

c_2 - melon and vegetables plantations

8. Serie of bluegrass-wormwood (*Artemisia lerchiana, Poa bulbosa*) with semishrubs and shrubs (*Krascheninnikovia ceratoides, Calligonum aphyllum*) on stabilized saline sands

8a. Pastures:

a_1 - slightly grazing (communities of *Artemisia lerchiana* with *Artemisia scoparia, Euphorbia seguirana, Ceratocarpus arenarius*)

a_2 - temperate grazing (*Artemisia lerchiana, Poa bulbosa, Ceratocarpus arenarius*)

a_3 - strongly grazing (*Artemisia lerchiana, Artemisia arenaria, Peganum harmala, Ceratocarpus arenarius*)

9. Serie of bluegrass-wormwood (*Artemisia lerchiana, Poa bulbosa*) with shrubs (*Calligonum aphyllum, Tamarix ramosissima, Tamarix laxa*) on slightly stabilized saline sands

9a. Pastures:

a_3 - strongly grazing (*Artemisia lerchiana, Artemisia arenaria, Peganum harmala, Ceratocarpus arenarius*)

Macroseries with prevailing of bidominant wormwood (*Artemisia lerchiana, Artemisia arenaria*) communities on slightly stabilized sands and agricultural lands instead of them

10. Macroserie of bidominant wormwood communities (*Artemisia lerchiana, Artemisia arenaria*) with *Calligonum aphyllum*, locally with *Salix caspica*

10a. Pastures:

a_1 - slightly grazing (communities of *Artemisia lerchiana* with *Artemisia scoparia, Artemisia arenaria*)

a_3 - strongly grazing (*Artemisia lerchiana, Artemisia arenaria, Euphorbia seguirana, Leymus racemosus, Peganum harmala, Alhagi pseudalhagi*)

10b. Fallow lands:

b_1 - tall weeds (*Artemisia lerchiana, Artemisia arenaria, Agropyron fragile, Helichrysum arenarium, Anisantha tectorum*)

Macroseries with prevailing of *Artemisia arenaria* communities on slightly stabilized sands and agricultural lands instead of them

11. Macroserie of *Artemisia arenaria* communities with *Calligonum aphyllum*

11a. Pastures:

a_3 - strongly grazing (*Artemisia lerchiana, Artemisia arenaria, Euphorbia seguirana, Leymus racemosus, Peganum harmala, Alhagi pseudalhagi*)

a_4 - overgrazing (destabilized sands without vegetation or with single plants - *Peganum harmala, Coryspermum arenarium*)

12. Macroserie of *Artemisia arenaria* communities with *Calligonum aphyllum, Tamarix ramosissima, Tamarix laxa*, locally with *Krascheninnikovia ceratoides,* on slightly stabilized saline sands

12a. Pastures:

a_1 - slightly grazing (*Artemisia arenaria, Artemisia lerchiana, Artemisia austriaca, Artemisia scoparia, Euphorbia seguirana, Ceratocarpus arenarius*)

a_3 - strongly grazing (*Artemisia lerchiana, Artemisia arenaria, Leymus racemosus, Euphorbia seguirana, Peganum harmala, Alhagi pseudalhagi*)

Conclusion

The maps of actual vegetation show the ecological status of region at present time, and the extent of vegetation change under anthropogenic press. They permit to reveal the relation of areas with strongly disturbed and nondisturbed vegetation, to determine the territories of ecological disaster and areas to be protected. Comparison analysis of maps of the reconstructed and actual vegetation will help to direct the efficient ways out of ecological crisis.

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Session / Séance 44-C

Maps of the 3 National Parks in Poland as an illustration of the specific approach to cartographic presentation of various landscape forms in protected areas.

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Abstract

Protected elements of the environment have their specific character. The area of occurrence of valuable landscape elements and plants communities, rare types of animals, birds, etc. should be presented alongside with the information describing the landscape and its dynamics.

There are problems in selecting the appropriate way of presentation the information of such a wide thematic range. Using of suitable techniques of cartographic presentation ranging from symbolised signs of standard topographic maps to photographic structure of remote sensing images, we obtain a number of solutions dependent on the particularity of the protected area.

To investigate the method of the cartographic presentation the following parks in Poland have been selected: Slowinski National Park, Kampinowski National Park, Karkonoski National Park. They represent different area as far as placement and the type of protected environmental elements are concerned so they create perfect material for investigation.

The project is financed by Research Committee (KBN).

National parks are areas of particular importance for the natural environment. Legal protection helps to maintain them in conditions unchanged by the process of urbanisation and policies of industrial expansion. However, indirect influences are noticeable: acid rains and air pollution which act on protected areas lead to deforestation and the extinction of certain plant species.

An array of tourist maps have been produced up to now, which are based on topographic maps, supplemented by a thematic “tourist” layer. These are becoming less attractive because they have not been updated after the changes in the topographic information of the region.

After an analysis of the usefulness of these materials, we noticed deviations in the presentation of surface features with the help of symbols, of rocks in their actual position and size (see Figure 1), too large a generalisation of content, as well as a shift in the structure and texture of surface objects and their change into a single, large, monochromatic area. We remember, however, that national parks are diverse terrain with a rich landscape: dunes, peat bogs, forests and individual trees under protection, and also diverse fauna depending on geographic location on the map of Poland.

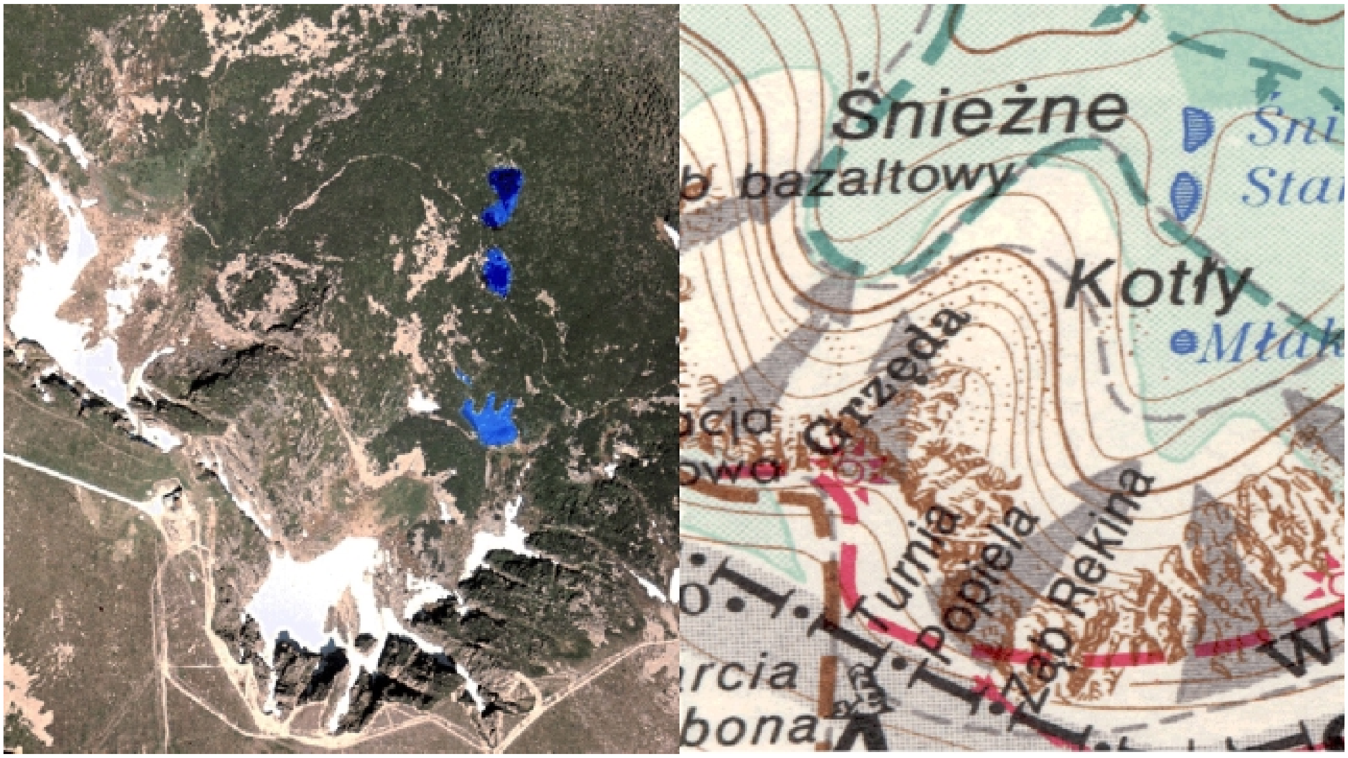

Figure 1. The area around Szyszak (Sniezne Kotly and rocks) aerial photograph image and tourist map of the same area.

During editorial work the idea arose of landscape maps based on the photographic structure of aerial or satellite images.

The comparison of the legibility of geomorphological forms on tourist maps (based on topographical maps) with the mosaic of aerial and satellite photographs made possible an assessment of their usefulness in the realisation of successive phases of the project (see Figure 2).

Since aerial and satellite photographs do not possess generalisation, there was a problem conveying tourist information of a descriptive character and it was also necessary to create new symbols and limits which harmonised with the tonal content of the photograph in the background.

Cartographic editing of such a map is very difficult because widening of roads or changes in position as a result of generalisation violate the uniformity of the photograph. The ranges and elements artificially introduced should be traced subtly in order not to conceal tonal information about objects, and at the same time to ensure their lack of ambiguity. In the case of maps based on topographic maps it is more difficult still, since some of the forms are not presented with the help of symbols, but only described.

The tonal media carried by photographs demonstrates the beauty of the landscape of the protected area, in many places inaccessible, which we can now admire thanks to aerial or satellite images. However, this requires precise tonal processing and correction with regard to geometry, and only after this can the background be prepared for the introduction of symbols and limits, providing complex information about the fauna, flora, and topography of the area of the national park.

This type of map can become an interesting new solution, departing from the manner of a working document (such as a topographical map) in the direction of a true representation of the surface of the Earth.

Examples of the landscape map project we conducted come from Slowinski National Park and Karkonoski National Park.

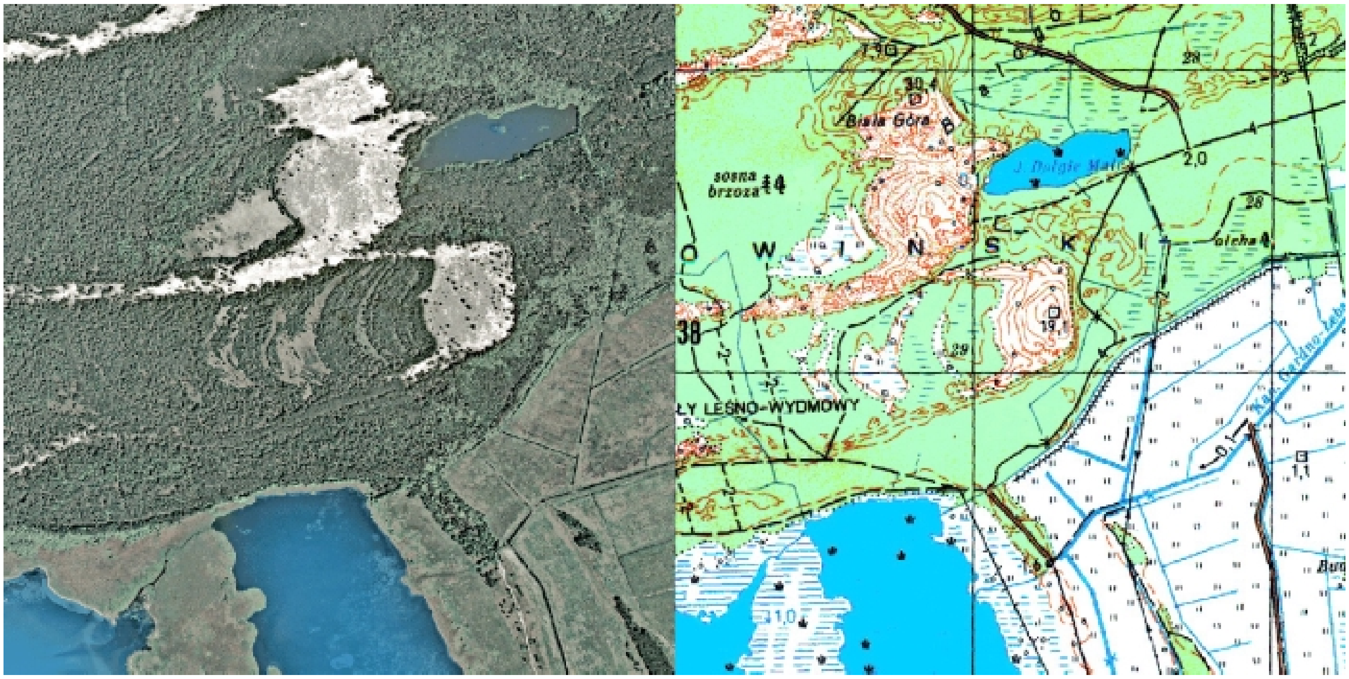

Figure 2. The area around Lake Gardno, drifting dune presented on photograph and topographical map.

Session / Séance 17-B2

Dynamics of low-lying Kalmykian coast under the Caspian Sea level rise conditions: 1990-s

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Abstract

The coastal zone response to sea-level rise was studied on the north-western coast of the Caspian Sea by comparative analyses of multitemporal space imagery taken in periods of sea regression (1975, 1977-1978), beginning of present-day sea transgression (1982-1986), its increasing (1990-1991) and at present time (1995-1998). In addition to early compiled schemes of 1978-1991 new schemes (1991-1998) of transgressive changes in the coastal zone (scale 1:200 000) were compiled on the basis of those space imagery. Results of the compiled schemes interpretation are discussed in the paper.

Introduction

The present-day Caspian Sea level rise (from -29.02 m in 1977 to -26.95 m in 1997) is modelling the situation that is waiting on the World Ocean coasts in the next century due to global warming. Therefore the Caspian Sea can serve as a unique natural laboratory for study of the coastal zone response to sea-level rise. Long-term investigations [Ignatov et al., 1991] show that this response of coastal zone is not equal on the coasts of different types. But a principal element of this response is shoreline retreat being particularly significant on the low-lying coasts where gentle slopes of the nearshore plain are favourable to free and deep intrusion of sea waters to landward direction.

The Caspian north-western coast belongs to such type of shallow-water coasts. Low-lying and flat marine terraces formed during the sea regression period under rapid fall of sea-level in 1929-1940 dispose along the Kalmykian coast. This coast stretches in submeridional direction from the Volga delta to the Kizlyar Bay at about 120 km. The coast exposes to the most strong south-eastern winds with which the powerful surges are related. They are the principal shoreforming factor here. Height of the wind-induced surges is average 1.5-2 m, maximum 2.5-3 m. As a result, Kalmykia characterises by predominantly shallow-water coasts with wide mud flats [Leontiev and Khalilov, 1965; Leontiev et al., 1977].

Present-day rise of the Caspian Sea level has to influence on this low-lying coast. And it is very important to study a character of possible changes along the coast for an appraisal of the ecological situation under replacement of the sea regressive regime by the transgressive one.

Methods

The study of the corresponding changes in the Kalmykian coastal zone that occurred during the recent transgression has been carried out by means of comparative interpretation of multitemporal space photographs.

Spectrozonal and multispectral space imagery at original scales 1:200 000 and 1:600 000 with resolution of 10-12 m were used for the comparative analyses. Those photos were obtained from the Russian “Resource-F” satellites during periods of sea regression (1975, 1977-1978), the beginning of present-day transgression (1978, 1982-1986) and its increasing (1990-1991). The survey photos obtained from the “Resurs-0” satellites by scanner systems of the middle resolution (MSU-SC, resolution 170 m) and the high resolution (MSU-E, resolution 45 m) in 1997-1998 were analysed to characterize the nowaday situation. For interpretation, colour prints have been done from spectrozonal negatives which show best the coastal features and vegetation in particular. Zonal prints in the red and near infrared bands were also used which appeared to be most reliable source of information about various water bodies and the coastline position.

A majority of the photos studied were taken at the same season (in June-July); it is essential for reliability of the imagery interpretation as the Caspian coast of Kalmykia (its northern part, in particular) is subjected to considerable seasonal fluctuations of sea level due to the Volga spring floods.

The multitemporal space imagery show very well the wind-induced surge mud flats densely overgrown with reed through which can be seen sometimes series of the low beach ridges. The latters testify that sea waves take also part (especially during wind-induced surges) in the relief development of this extremely shallow-water coast.

The dense reed vegetation makes essentially difficult the identification of the water edge which is here very unstable and varies over a wide range due to wind-induced surges. The photos, however, show

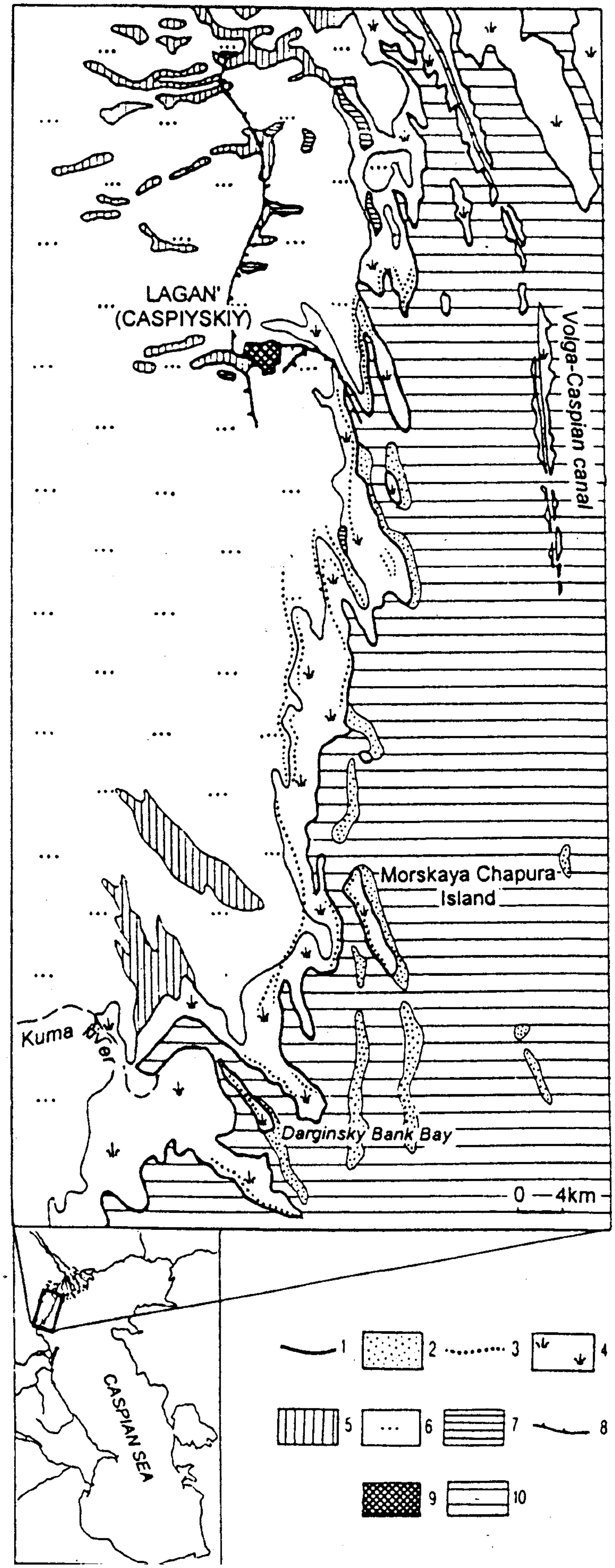

Fig.1. Kalmykian coast of the Caspian Sea. The state of the coastal zone in 1978:

1 - shoreline (outer limit of reed-covered mud flats);

2 - offshore depositional features; 3 - beach ridges; 4-reed-covered mud flat; 5 - meadow-solonchak depressions;

6 - semideserted plain; 7 - inner water bodies; 8 - canals;

9 - urban area; 10 - sea

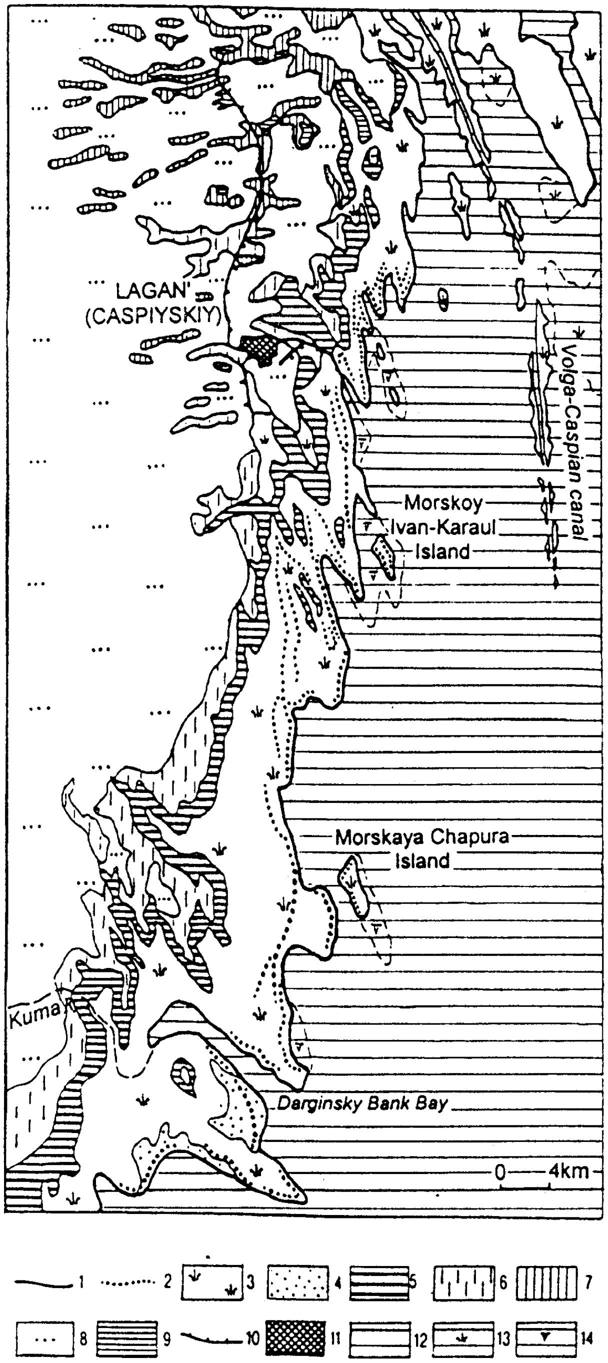

Fig.2. Kalmykian coast of the Caspian Sea. The state of the coastal zone in 1991:

1 - shoreline (outer limit of reed-covered mud flats);
2 - beach ridges; 3 - reed-covered mud flat; 4 - sand flat;
5 - lagoons behind of reed-covered mud flats; 6 - waterlogged area along the lagoons and canals; 7 - meadow-solonchak depressions; 8 - semideserted plain; 9 - inner water bodies (lakes, man-made reservoirs); 10 - canals;
11 - urban area; 12 - sea; 13 - sea zone with water vegetation; 14 - sea zone with submerged reed vegetation

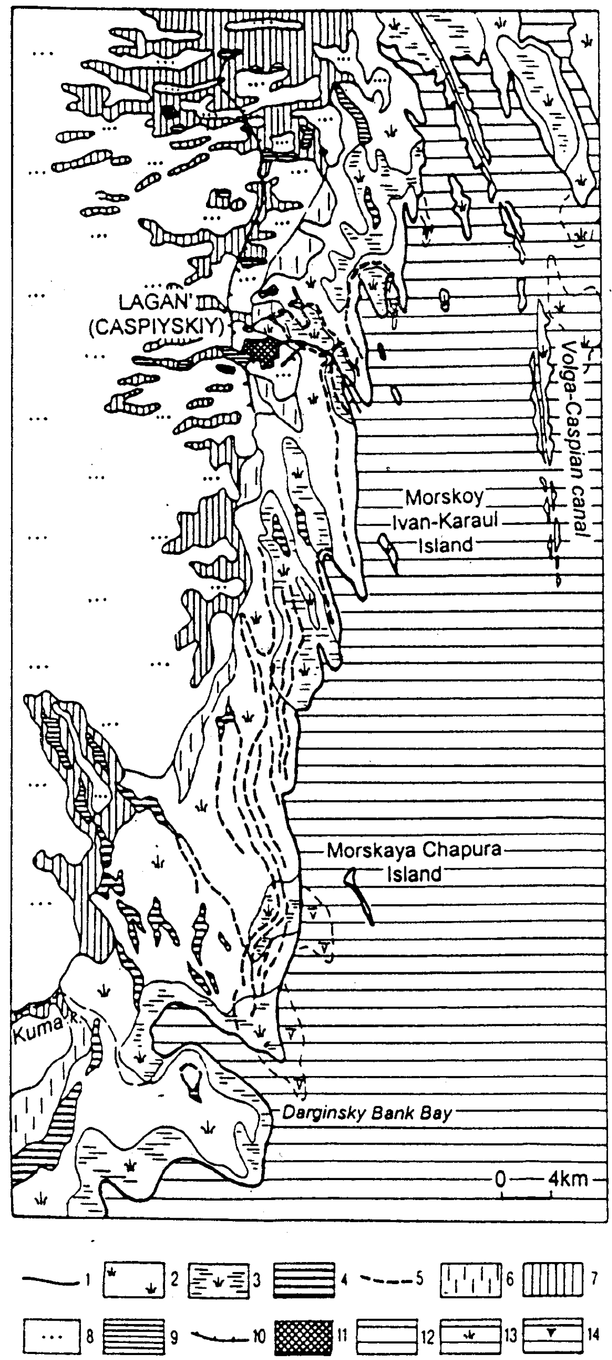

Fig.3. Kalmykian coast of the Caspian Sea. The state of the coastal zone in 1998:

1 - shoreline (outer limit of reed-covered mud flats);
2 - reed-covered mud flat; 3 - mud flat oversupplied with water; 4 - lagoon relicts behind the reed-covered flats;
5 - narrow strips of water along beach ridges within the reed-covered flat; 6 - waterlogged area behind mud flat;
7 - solonchak meadows in troughs between Baer's mo-unds; 8 - semideserted plain; 9 - inner water bodies (lakes, man-made reservoirs); 10 - canals; 11 - urban area; 12 - sea; 13 - sea zone with water vegetation; 14 - sea zone with submerged reed vegetation

quite distinctly the outer limit of the reed growth on the mud flat. Though individual plants may grow at a water depth as great as 2 m, the reed growth on the Kalmykian coast have never been reported beyond the depth of 0.5 to 0.7 m; this may be accounted for by some local factors (probably an effect of fringing currents due to the Volga water inflow) which increase their negative impact on plants with depth. The space image of 1975 shows that separate reed clumps witnessed the coast accretion under sea-level fall were only situated near water edge. That is, the reed did not “go” into the open sea and was concentrated near the shore and over surface of the sandy-mud flat even under the most favourable sea regression conditions. In that time,

1-meter isobath followed the outer limit of the reed growth at a distance of some 5 to 6 km. It is not inconceivable that any changes in the depth suitable for the plant growth as a result of passive sea-level rise, wave erosion or deposition on the sea floor would lead to shifting of the reed growth edge landwards (in case of depth increase) or seawards (in case of deposition and the coast accretion). Therefore, any shifting of the outer edge of the reed vegetation may be used as an indirect evidence of certain dynamic transformations within the coastal zone which are the basis of vegetation cover changes. This assumption was widely used in the interpretation of the space imagery.

The comparative interpretation of above mentioned photo materials results in a series of schemes which show the condition of the Kalmykian coastal zone in different time (1978 - Fig.1, 1990-1991 - Fig.2, 1997-1998 - Fig.3) and the dynamic changes of this zone in periods of 1978-1991 (Fig.4) and 1991-1998 (Fig.5). The changed and unchanged objects are specially di-

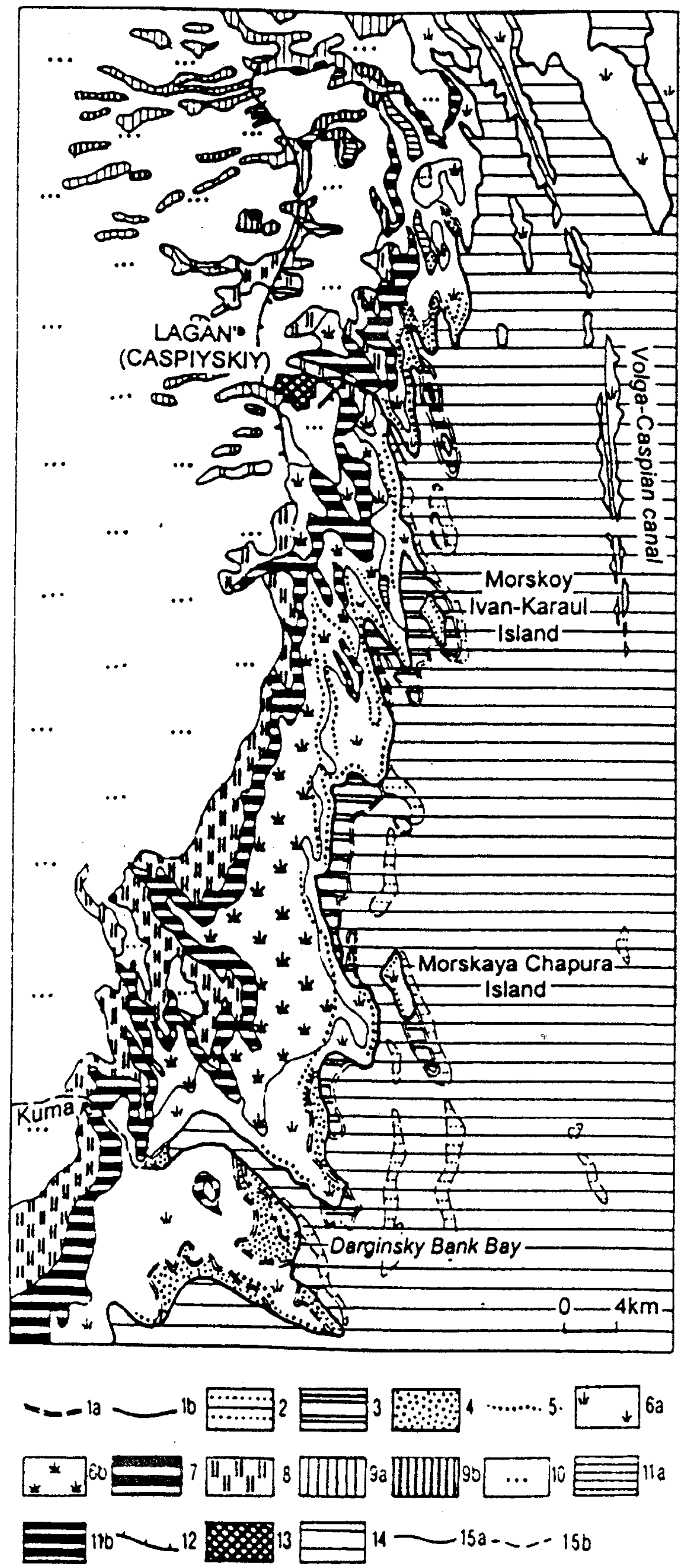

Fig.4. Kalmykian coast of the Caspian Sea. Dynamics of the coastal zone in 1978-1991:

1 - shoreline (outer limit of the reed-covered mud flats): 1a - in 1978, 1b - in 1991; 2 - offshore depositional features eroded; 3 - submerged reed-covered mud flat (zone of the coast retreat); 4 - sand flat appeared (zone of the coast accretion); 5 - beach ridges; 6 - reed-covered mud flat: 6a - retained, 6b - newly appeared; 7 - lagoons formed behind the reed-covered mud flat; 8 - waterlogged area along lagoons; 9 - solonchak meadows in troughs between Baer’s mounds and in erosional basins: 9a - retained, 9b - newly appeared; 10 - semideserted plain; 11 - inner water bodies (lakes, man-made reservoirs): 11a - retained, 11b - newly appeared; 12 - canals; 13 - urban area; 14-sea; 15 - boundaries of: 15a - retained and newly appeared objects, 15b - disappeared objects

vided in the dynamic schemes. The new and former situations are characterized for the changed elements of the coastal zone. The changed objects are shown by bold strokes.

Results

Comparative analyses of the compiled schemes shows (Fig. 1, 2, 4) that there are little changes in the position of the reed mud flat outer edge in the northern part of the Kalmykian coast (between the Vyshkinskaya Spit Peninsula and the Lagan' region). This may be attributed to the influence of the adjoining vast shoal of the Volga prodelta which acts as a buffer of a sort and attenuates the effect of the rising sea level. According to current views (Mikhailov et al., 1993), this effect would last until the sea level reaches -26.5 m; after that, it would be the sea level rise and not the river inflow that controls principal processes and phenomena on the low coasts adjoining the prodelta.

The mentioned above accounts for the fact that the depositional processes still continued in the northern part of the Kalmykian coast up to 1991 although they were very typical processes for the preceding long period of the sea regression. The deposition is the most

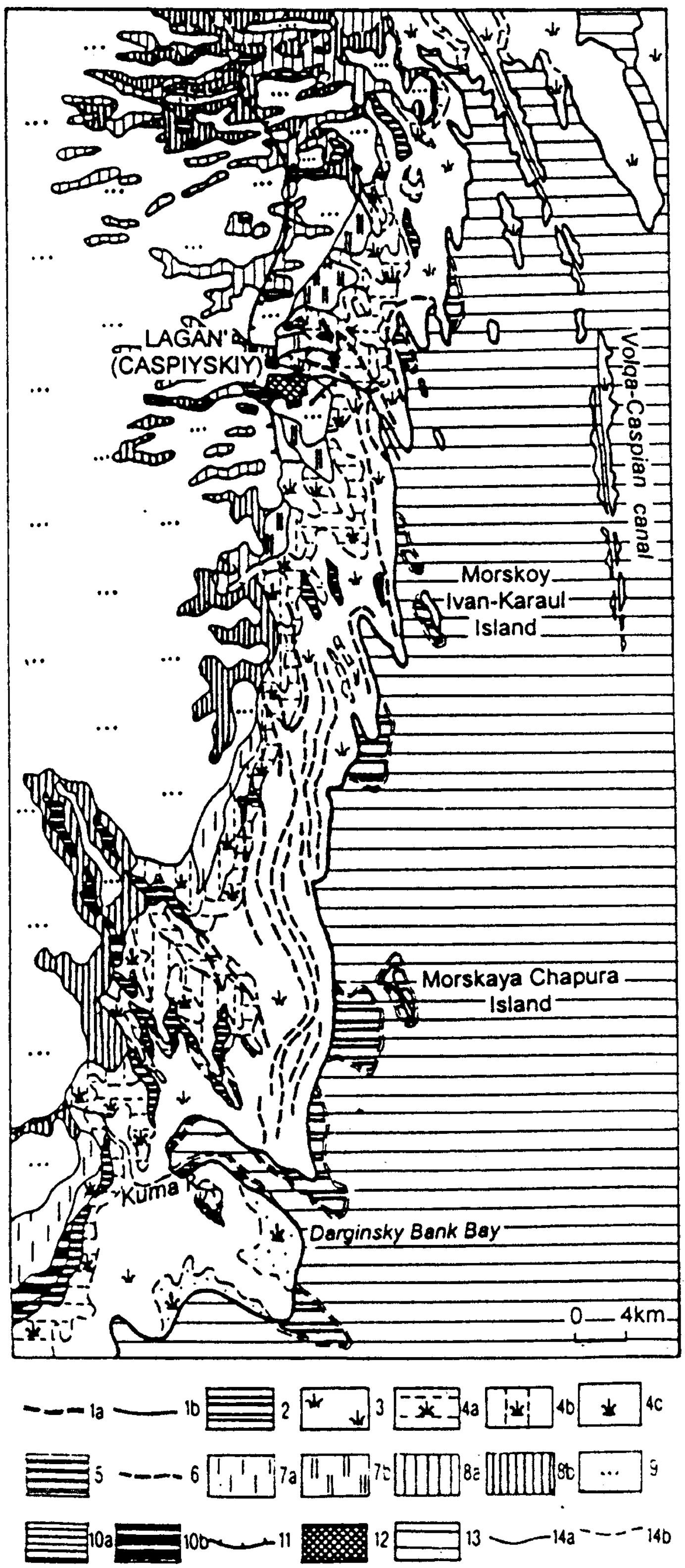

Fig.5. Kalmykian coast of the Caspian Sea. Dynamics of the coastal zone in 1991-1998:

1 - shoreline (outer limit of the reed-covered mud flats): 1a - in 1991, 1b - in 1998; 2 - submerged reed-covered mud flat (zone of the coast retreat); 3 - reed-covered mud flat retained; 4 - reed-covered mud flat newly appeared (zone of the landward shift of the reed-covered flat) in place of: 4a - lagoon behind the reed-covered mud flat,

4b - waterlogged area along the lagoon, 4c - semideserted plain; 5 - retained segments of the lagoon behind of the reed-covered mud flat; 6 - narrow strips of water appeared along beach ridges within the reed-covered mud flats; 7 - waterlogged zone along the reed-covered mud flat: 7a - retained, 7b - newly appeared in place of semideserted plain; 8 - solonchak meadows in troughs between Baer's mounds and in erosional basins: 8a - retained, 8b - newly appeared; 9 - semideserted plain; 10 - inner water bodies (lakes, man-made reservoirs): 10a - retained, 10b - newly appeared; 11 - canals; 12 - urban area; 13 - sea; 14 - boundaries of: 14a - retained and newly appeared objects, 14b - disappeared objects pronounced in the heads of small bays between the shore cusps characteristic for this coast (north of the Vshivy Peninsula, along the Ilmen-Tatarskaya Trough); individual locations of 2 to 3 km wide show the coast accretion by 0.5 to 1 km, in spite of sea-level rise.

In the south of this coastal sector the sea level rise effect is somewhat greater; the reed-covered flat doubled its width (from 1 to 2 km) advancing landwards. A lagoon of intricate shape and 1-2 m wide appeared at the back of the reed flat; it is fed by wind-induced surges and groundwater, the latter responding to the rise of the sea level. The landward edge of the lagoon is fringed with waterlogged strip. A certain increase in moisture is also recorded within the nearshore terrestrial area: some waterlogged patches appeared along the Caspiysk Canal, as well as several lakes and reed marshes in depressions.

The southern half of the Kalmykian coast (between the Morscoy Ivan-Karaul Island and the Kizlyar Bay) south of the Volga prodelta is marked by a certain increase in the coastal zone slopes and more pronounced effect of the sea-level rise (Fig. 2,4). The effect is seen, first of all, in a retreat of the seaward limit of the reed-covered mud flat over the whole stretch of the shoreline. The coast locally receded as much as 1-1.5 km by the beginning of 1990-s. Some of depositional landforms in the nearshore zone - offshore bars and ridges - were eroded. Sedimentation had been recorded only near the mouth of the Darginsky Bank Bay, where input of the Kuma River sediment load compensated for the sea level rise, at least in part. Local coast accretion was here 1 to 2 km.

At the same time, a new fringe of reed growth reappeared locally along the receding coast; it is distinguished in the photos by longitudinal stripes. The fact suggests that a series of young beach ridges is forming there; the material is supplied from eroding seaward edge of the mud flat and the upper offshore zone. The data obtained seem to disagree with formerly accepted ideas that the sea transgression onto the low Kalmykian coasts proceeds passively, without shore profile reformation and sediments redistribution by waves. The slopes in the coastal zone here (and at the water edge, in particular) appear to be steep enough for wave action manifestations.

The reed-covered flat of this region expanded noticeably landward: in 1978, it was 1-2 km wide, while by 1991 it came to be as large as 5-10 km. It seemed to encroach upon the land. At the back of the mud flat along the whole stretch under consideration a permanent lagoon appeared by 1991, its width varying in the course of the year. The lagoon was clearly seen even in small-scale scanner images of medium resolution taken from the “Resurs-01” satellites. The colour images show a waterlogged zone about 3 km wide at the back of the lagoon; it is well distinguished by a lush vegetation against the background of the surrounding semideserts.

Scanner images obtained in the beginning (1995) and the end (1997-1998) of the last decade witnessed, as a whole, a reservation of the general character of the coastal processes which were here revealed by the early 1990-s. Shoreline in the northern half of the Kalmykian coast, near the Volga prodelta, has little changes, as before. However, wetting of the nearshore plain is noticeably increased. Troughs between Baer’s mounds, being before weakly bogged up or occupied by solonchaks, now changed into the heavy wetted reed swamps with many small lakes.

In the southern half of the Kalmykian coast, submergence and retreat of the outer edge of the reed mud flat continued with sea-level rise up to -26.95 m in 1997. Sections of submergence by sea waters and dying off reed vegetation are well seen in the colour scanner photos. They have the greatest width in narrow bays near the Morscoy Ivan-Karaul Island, along coasts of the Darginsky Bank Bay and open coast near the Morscaya Chapura Island where general shoreline retreat attains 5 to 6 km. The length of the Darginsky Bank Bay is shortend significantly (at least by 1.5-2 km) due to submergence of mouth segments of its banks by sea waters. Apparently, the Kuma River sediment input which promoted before the depositional processes in this bay now is already not able to withstand the rapid sea-level rise.

The mud flat surface changed noticeably by 1997-1998. Its former dense vegetable cover thinned rather out (probably due to increase of the mud flat wetting), open water windows are very frequent, especially in the narrow and prolonged (some kilometers) troughs between beach ridges. These narrow “strips” of water emphasize clearly a disposition of beach ridges complicating the mud flat surface.

The backside of the mud flat changed essentially. The wide (1 to 2 km) lagoon formed here in the beginning of the sea transgression and retained steadily up to 1990-s began to disintegrate into separate segments by 1995. This process relates apparently to rapid landward shift of the mud flat that favours to filling of the lagoon by sediments and its overgrowth by reed vegetation. The lagoon disappeared fully by 1997 in the most part of the coast. Its separate fragments are only reserved in the Lagan’ region, in the south of the coast (near the Morscaya Chapura Island) and around the Kizlyar Bay.

Landward widening of the mud flat (with simultaneous retreat of its outer edge) was continued and by 1998 gave an increase of 2-4 km else. The reed vegetation has spread beyond the former lagoon and occupies now the zone showed in the 1991 scheme (Fig. 2) as a waterlogged area along the backside of the lagoon. The general width of the mud flat did not change practically after 1991 but the mud flat stripe was shifted landwards. A zone of the new waterlogged low-lying area is seen behind the mud flats. It is especially clear (about 2 km wide) near Lagan.

The character of nearshore plain is essentially changed. Troughs between Baer’s mounds were overgrown by reed everywhere. Erosional hollows cutting the coast in the north of the Darginsky Bank Bay were filled with water and a chain of small lakes stretches within them and in the lower reaches of the Kuma River.

Conclusions

The comparative analyses of the multitemporal space photographs (1975-1991 and 1995-1998) fixing the Caspian north-western coast at a time junction of regressive and transgressive periods of the sea shows that the imagery may supply useful information about changes within the coastal zone under conditions of sea-level rise; the information is of general character and may cover large sectors of the coast. On the whole, the interpretation results indicate that the effect of the Caspian Sea level rise becomes more pronounced from north to south along the Kalmykian coast with the distance from the Volga delta and increasing of coastal zone slopes. However, in the southern half of this coast, gradients of underwater and abovewater parts remain not great (about 0.0005) that favours the far landward intrusion of sea waters especially during wind-induced surges. The transgressive changes include here the zone of some kilometers wide. Submergence of the outer edge of sandy-mud flats by the transgressive sea with some wave reconstruction of the coastal zone profile (new beach ridges are appeared along the water-edge) and shift the whole mud flat complex landwards are predominated along this coast. Accordingly to some data [Reed, 1990], the grassy mud flats and marshes which are characterized by great role of vegetation in their sedimentation will not be able to withstand the sea-level rise rates over 1.6 cm/y. It appears that Kalmykian reed is rather more steady to sea-level rise but it does not also bear the great rates (12.5 cm/y) of the Caspian present-day transgression. This ensures the intensive submergence of the low-lying Kalmykian coast and predominance of landward retreat of the reed-covered stripe.

The tendency of these changes, apparently, will retain under the further sea-level rise conditions. However, shift of the mud flats to land direction will not be able to continue without end. Increasing of the nearshore plain gradients hinders this process already now. At the end, this will lead (with simultaneous erosion and submergence of the mud flat outer edge) to the reduction of its width. If sea level comes nearer to the old (Holocene) coastal lines at -26.5 m and especially at -25 m the mud flat width, apparently, will be minimum due to the general change of the coast. The latter will more and more obtain the features of the erosion-depositional type (Lukyanova et al., 1996).

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Session / Séance 26-C

Évaluation spatiale de l'impact et de l'insertion des projets d'aménagement dans le paysage

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Résumé

En matière d'aide à la décision, nous exposerons une approche d'évaluation spatiale et quantitative des impacts d'un futur aménagement en vue d'une meilleure insertion dans le paysage.

Introduction

De plus en plus le paysage se trouve au centre de différentes disciplines dont l'aménagement de l'espace.

Dans le cadre de la 19ème Conférence Cartographique Internationale, ce texte résume une méthode spatiale et quantitative d'approche de l'objet paysage pour l'aménagement.

Ainsi, dans un premier temps, nous exposerons les objectifs et la méthodologie de ce travail. Ensuite, nous proposerons une alternative et/ou un complément au regard du constat. Enfin, nous achèverons notre propos sur l'intérêt de l'image en général et de la cartographie numérique en particulier pour d'aménagement.

L'aménagement face au paysage

L'évaluation de l'impact et de l'insertion des projets d'aménagement sur le paysage est plus que jamais une procédure qui s'impose particulièrement pour les ouvrages de grande ampleur. La systématisation de cette pratique en aménagement a été principalement induite par la récente *loi paysage* de 9 janvier 1993. En effet, même si cette dernière ne s'est pas intéressée à l'approche de la définition de son objet même, elle est initiatrice de la création de Zone de Protection de Patrimoine Architectural Urbain et Paysager (ZPPAUP), de l'instauration d'un permis de construire paysager avec l'appréciation de l'impact visuel du projet (décret de 22 mai 1994), de l'évaluation des effets des grands projets d'aménagement sur le paysage pour tous les travaux de plus de 12 millions de francs français (décret de 26 février 1993)...

Parallèlement à ce cadre juridique favorable, on peut résumer en deux points la situation actuelle en matière d'évaluation quantitative :

- Les logiciels ; en particulier les Systèmes d'Information Géographique (SIG); montrent que de très nombreuses avancées ont été réalisées ces dernières années. Néanmoins, ces modèles souffrent soit de l'absence de certaines fonctions, soit d'une insuffisance dans leur mise en œuvre.
- Si le recours aux techniques de simulation et d'évaluation des impacts de futurs projets d'aménagement sur le paysage est de plus en plus fréquent, on peut en regretter deux caractères. D'une part, l'utilisation de ces techniques intervient, très souvent à une étape très avancée dans l'évolution du projet. D'autre part, ces mêmes moyens sont utilisés non seulement pour simuler et choisir la solution la plus satisfaisante, mais aussi, parfois pour justifier à posteriori une décision préconçue.

Ainsi, l'objectif de cette publication est d'apporter des propositions quant à l'étude d'un aménagement prévisible pour une meilleure prise en compte de son insertion dans le paysage.

Pour se faire, trois méthodes complémentaires ont été mises au point :

· La méthode de topographie : correspond à la création du modèle numérique de terrain en 3-dimensions plus la représentation multi-échelles d'un espace.

· La méthode de co-visibilité : permet la délimitation du paysage vu depuis une infrastructure donnée (impact visuel d'un ouvrage sur un paysage).

· Enfin, la méthode de drapage vectoriel : a pour objectif d'appréhender le paysage dans sa « globalité ».

Un modèle informatique d'aide à la décision (3D-IMA) spécifique au paysage pour l'aménagement de l'espace est en cours de développement au laboratoire du CESA en s'inspirant de l'architecture générale d'un SIG (Cf. Schéma 1. ci-dessous). En effet, 3D-IMA est le processeur ou le moteur qui réalise le pont entre les données (après traitements, calculs...) et le logiciel de visualisation des résultats obtenus : AutoCAD® (AutoCAD est une marque déposée d'Autodesk).

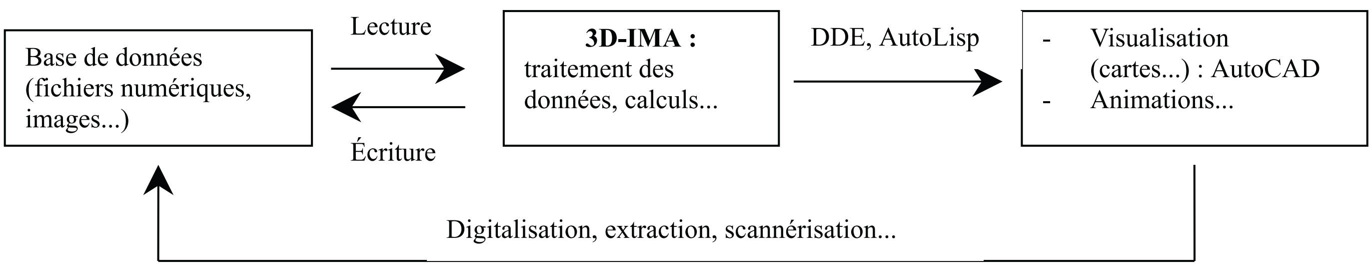


Schéma 1. Architecture du modèle 3D-IMA

Des images pour mieux aménager

Topographie et multi-échelle

Cette première étape, qui a été développée en raison des coûts excessif des données en France, correspond à la mise en place d'une technique de modélisation et de représentation en 3 dimensions de la topographie d'un espace quelconque à partir de données relativement accessibles (lignes de niveau d'une carte de l'Institut Géographique National - IGN au 1/25000 par exemple). Cette étape est un point de passage obligatoire pour toute modélisation qui tend vers l'intégration de la dimension spatiale de l'objet traité : le paysage (Cf. Figure1. ci-dessous).

Grâce à cette première étape nous avons pu modéliser différents espaces Français soit sous forme d'un maillage carré avec un pas régulier (le pas du MNT est une propriété interactive fixée par l'utilisateur), soit sous forme d'un graphe planaire saturé (maillage triangulaire).

L'intérêt de cette méthode est de pouvoir appréhender visuellement les différents obstacles et déformations de l'espace, les changements, l'évolution du paysage notamment avant et après la mise en place d'un ouvrage...

Conséquence : le multi-échelles

Le multi-échelles, considéré comme étant la conséquence de cette première étape, permet d'imbriquer et donc de prendre en compte différentes échelles spatiales dans une même situation. Ici, l'objectif est d'obtenir localement des définitions spatiales plus précises pour mieux représenter plus finement les informations géographiques traitées sans pour autant généraliser cette précision à l'ensemble de l'espace en question ce qui alourdirait énormément sa manipulation (Cf. Carte 1. ci-dessous).

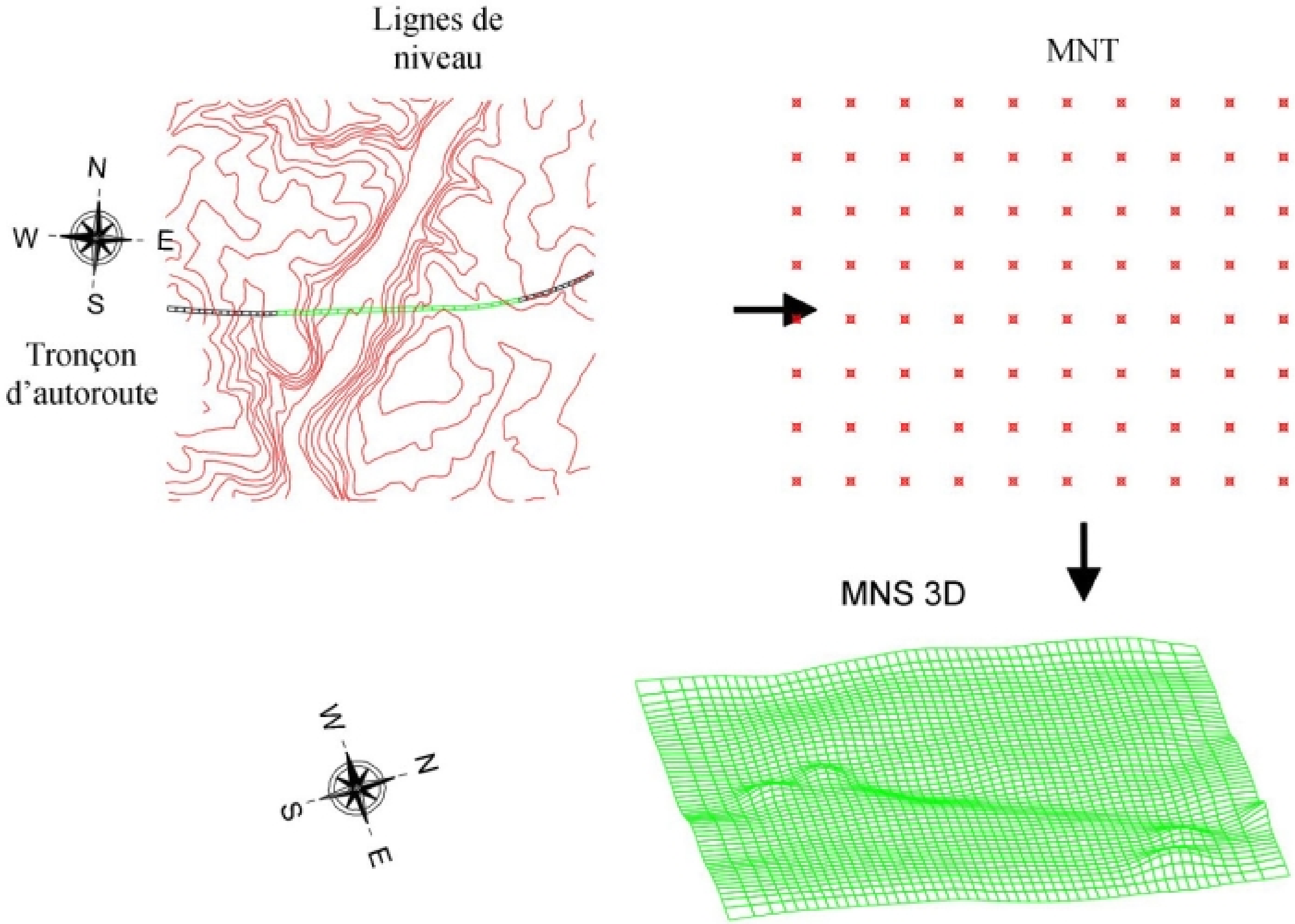


Figure 1. Étapes de modélisation d'un espace en 3 dimensions.

La co-visibilité

Elle constitue une possibilité d'approcher l'objectif fixé par le décret français de 22 mai 1994, relatif à l'application du volet paysager du permis de construire et qui porte sur la notice qui doit permettre d'apprécier l'impact visuel de l'ouvrage.

Cette seconde méthode correspond à la détermination des régions pour lesquelles l'ouvrage (ponctuel : on parle alors de visibilité localisée ou linéaire : visibilité généralisée) est visible et inversement à l'aire de visibilité de cet ouvrage d'où le terme de *co-visibilité*.

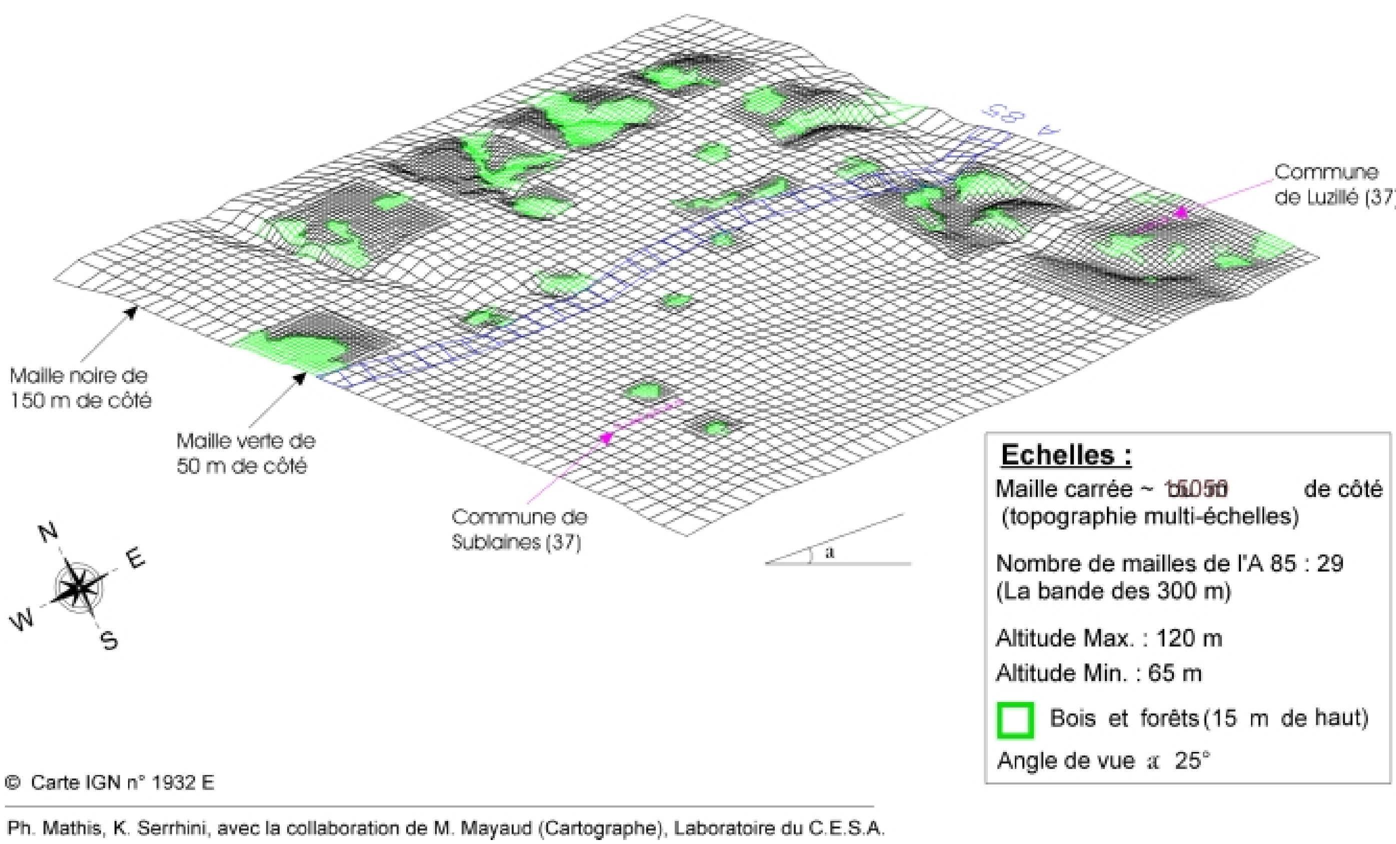
Quatre contraintes interviennent dans la détermination du champ de co-visibilité d'un objet :

1. La topographie de la zone d'étude (l'altitude des sommets des différentes facettes représentant le Modèle Numérique de Surface - MNS).
2. La hauteur de l'objet traité (autoroute, bâtiment...).
3. La localisation et la taille des obstacles présents à la surface du relief.
4. Enfin, la distance maximale de visibilité

Co-visibilité localisée

Cette technique a été appliquée sur de nombreux cas. La carte 2 ci-dessous est un exemple de co-visibilité localisée depuis un futur bâtiment (HLM) de la commune de Schoelcher en Martinique (Antilles françaises - 972).

Carte 1. Représentation multi-échelles des principaux bois et forêts
Imbrication de deux échelles de l'espace relatif au tronçon de l'autoroute 85 passant au nord des communes de Luzillé et Sublaines (Indre et Loire 37, France)



Le champ de co-visibilité de cet ouvrage ponctuel est représenté par l'ensemble des mailles carrées rouges. Ici le résultat obtenu obéit à la loi du tout ou rien (visible ou pas) d'où le terme de co-visibilité *localisée*. Cette aire rouge est assez limitée au regard de l'importance des forêts et du relief très vallonné de cet espace. Ensuite, on déduit statistiquement des renseignements dont le nombre, le pourcentage... des mailles visibles ou non et la surface totale correspondante.

Enfin, au regard des autres informations géographiques présentes sur le site, on proposera ; parallèlement à l'ouvrage ; des aménagements adéquats dans l'esprit de la politique française du *1% paysage et développement* qui impose au concessionnaire et/ou au maître d'œuvre d'investir à la hauteur de 1% du montant total du projet pour des actions en faveur du paysage.

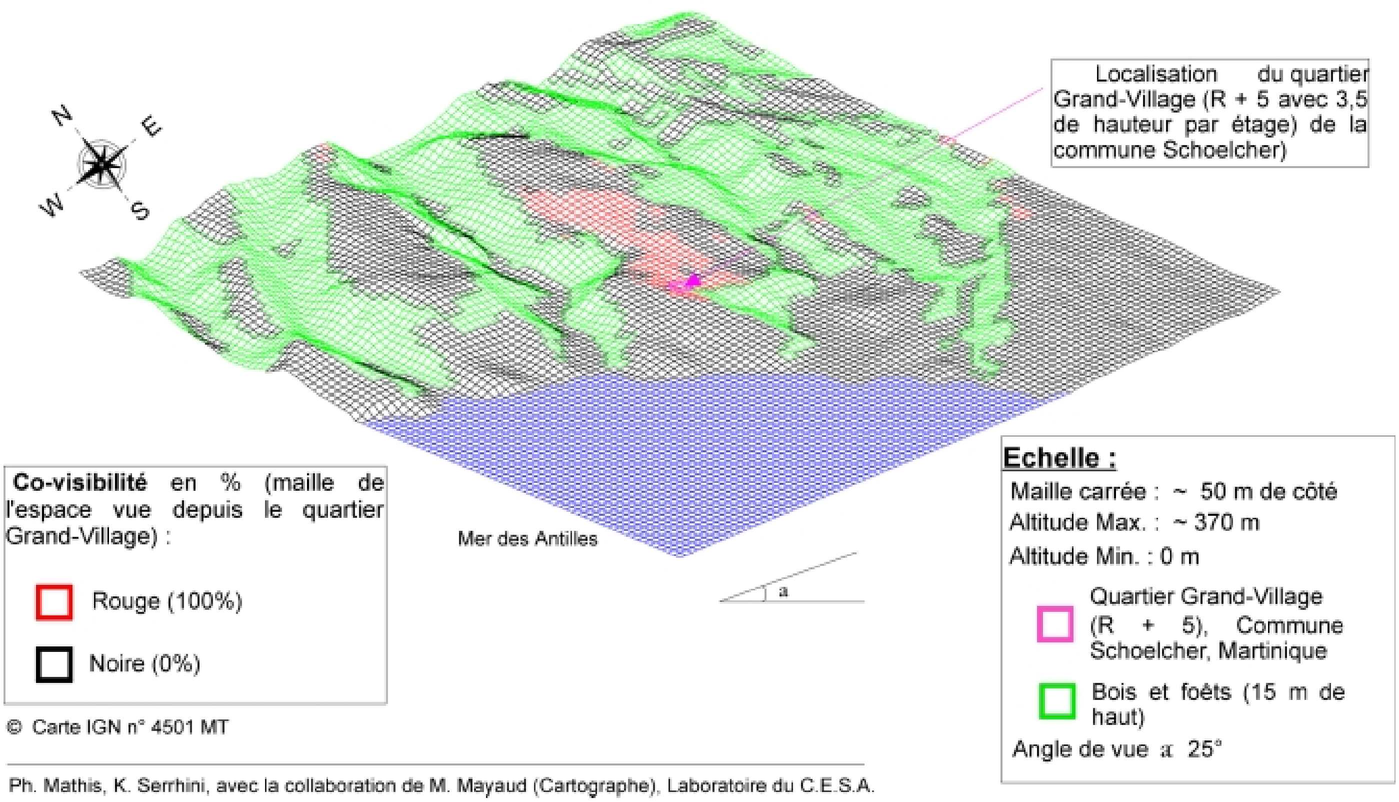
Co-visibilité généralisée

Contrairement à la co-visibilité localisée, quand il s'agit d'un ouvrage linéaire (autoroute, TGV...), il est possible de déterminer les champs visibles depuis le projet sous forme d'un gradient de couleurs : co-visibilité *généralisée*. Ainsi, une maille rouge sera par exemple visible sur plus de 70% du tronçon de l'ouvrage alors qu'une maille noire est visible sur moins de 10% du tronçon étudié. Entre ces deux extrêmes, différentes couleurs sont utilisées pour représenter différents pourcentages de co-visibilités (Cf. Carte 2. ci-dessous).

Pour le cas particulier du tronçon de l'A 87 (entre Angers et La Roche-sur-Yon) traversant la vallée du Layon (département du Maine Et Loire - 49) on remarque qu'il n'y a pas d'espaces rouge, c'est à dire pas de point qui puisse être vu sur plus de 70% de ce tronçon. Ceci peut s'expliquer d'une part par la dimension du tronçon qui atteint environ 10 km et d'autre part la présence de certains secteurs en déblais. Ce qui limite les zones visibles.

Carte 2. L'espace vu depuis le futur HLM du quartier Grand-Village

Co-visibilité localisée du quartier Grand-Village (maille centrale en magenta) de la commune Schoelcher reportée en pourcentage sur les mailles carrées (100 x 100) de l'espace (5 sur 5 km)



Quant au premier secteur en magenta (où la co-visibilité comprise entre 50 et 70%) situé au nord, il correspond a la ligne de crête, aux points les plus hauts du coteau. Le second secteur en magenta au sud correspond à une portion où l'autoroute suit la topographie qui est relativement plane.

Vient ensuite une importante zone verte (avec une co-visibilité comprise entre 30 et 50%) localisée à l'ouest de la vallée de l'Hyrôme et montre que le village de Saint-Lambert sera visible sur une bonne partie de ce tronçon.

En conclusion, les vallées (en cyan, bleu ou noir) sont très peu visibles voir invisibles alors que les coteaux et les points hauts (en vert ou en magenta) constituent les espaces les plus fréquemment visibles pour un automobiliste traversant ce tronçon.

Approche esthétique du paysage : la méthode de drapage vectoriel

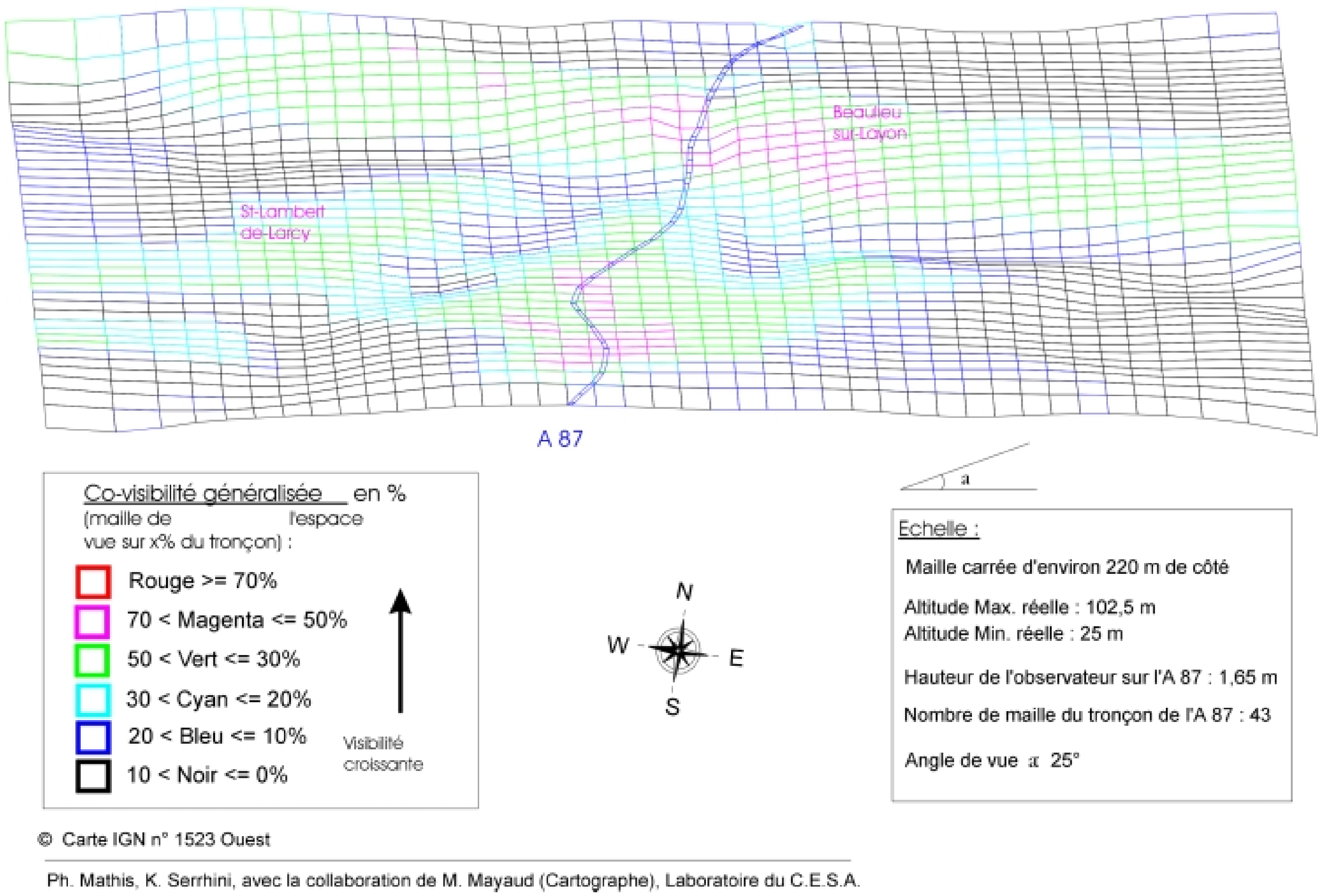
L'ensemble des résultats ci-dessus se présentent sous forme de cartes thématiques en “fil de fer” (maillage régulier). Ces dernières permettent d'approcher la question étudiée avec une grande précision et fiabilité.

Ces mêmes cartes thématiques peuvent être présentées dans le plan (vues en 2 dimensions) au dessus de la portion d'une image raster (carte topographique, photographie aérienne, image satellite...) correspondante. On obtient ainsi des cartes ou des documents de travail très pratiques en matière d'aménagement de l'espace (carroyages, hachures, croisements d'informations...).

Par ailleurs, ces mêmes résultats peuvent être aussi présentés, avec des vues en 3 dimensions, comme une couche supplémentaire venant se rajouter aux diverses informations existantes en particulier celles des images rasters : la méthode de *drapage*. Cette technique permet de réaliser de multiples croisements entre les différentes

Carte 3. L'espace vu le long de l'A 87 : passage du Layon

Co-visibilité généralisée depuis le tronçon de l'A 87 traversant la vallée du Layon reportée en pourcentage sur les mailles carrées lissées de l'espace (40 x 40)



informations géographiques et donc de cerner le paysage dans sa “globalité”.

La méthode de drapage *vectoriel* (contrairement au drapage classique existant d’un raster) correspond tout d’abord à la vectorisation d’une image raster à partir du MNT en 3 dimensions correspondant. Ainsi, grâce à ce MNT, les coordonnées absolues de chaque pixel sont calculées puis un maillage carré est alors généré en s’appuyant sur les caractéristiques (coordonnées et couleur) des pixels : obtention d’un MNS en 3 dimensions très fin. Ensuite, à la superposition (au drapage proprement dit) par exemple d’une carte thématique sur ce MNS.

Le drapage vectoriel s’inspire du mode de représentation de données numériques en “fil de fer” pour restituer une nouvelle approche en 3 dimensions d’une image raster sous forme vectorielle.

La carte ci-dessous correspond géographiquement à la portion “centrale” de la carte de co-visibilité localisée (Cf. Carte 2.) du HLM du quartier Grand-Village à Schoelcher (en Martinique). Celle-ci a été obtenue par la méthode de drapage vectoriel de la partie de la carte topographique correspondante après scannérisation.

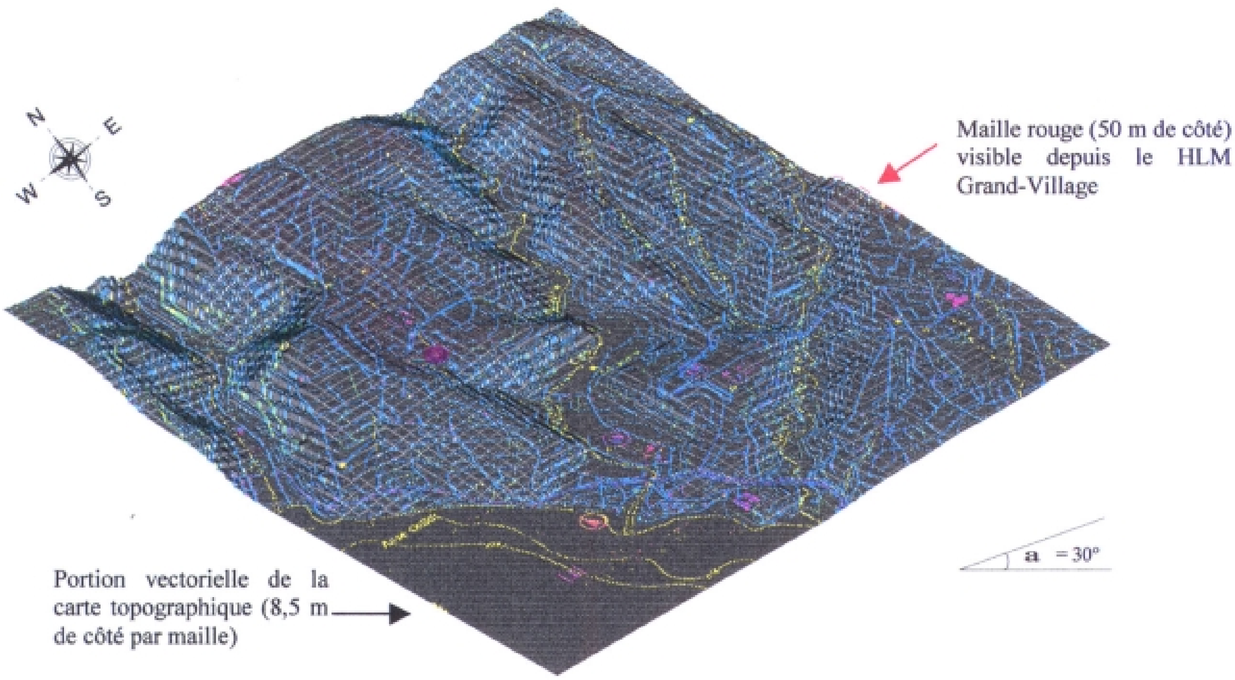
Carte 4. Drapage vectoriel de la co-visibilité localisée du HLM du quartier

Grand-Village (Martinique) sur la portion de la carte topographique correspondante

La méthode de drapage vectoriel, développée très récemment, présente de nombreux intérêts :

- Vectorisation sous forme d’un maillage carré régulier d’une image raster : obtention d’un MNS en 3 dimensions de haute définition spatiale avec les “couleurs” des pixels du raster de départ ;

Carte 4. Drapage vectoriel de la co-visibilité localisée du HLM du quartier Grand-Village (Martinique) sur la portion de la carte topographique correspondante



© Carte IGN n° 4501 MT

Ph. Mathis, K. Serrhini,, avec la collaboration de M. Mayaud (cartographe), Laboratoire du CESA

- Possibilité de superposition de différents résultats thématiques sur le drapage obtenu : réalisation de multiples croisement entre diverses informations.

Cependant, l'obtention d'un MNS en 3 dimensions et sous forme vectorielle à très fine échelle spatiale (de l'ordre de la dizaine de mètres par exemple) entraîne une quantité importante de données numériques à traiter.

Conclusions

Il n'est pas sans intérêt d'insister sur l'importance de l'informatique graphique et de l'imagerie numérique qui permettent d'obtenir une cartographie de l'insertion et de certains impacts d'un futur aménagement sur le paysage, cela constitue un outil d'aide à la décision.

En effet, la cartographie numérique reste un outil de premier choix pour apporter de multiples propositions claires et précises non seulement lors de la prise de décision par les collectivités territoriales, les services d'aménagement et d'urbanisme...mais aussi, tout au long d'un projet d'aménagement.

Enfin, dans le cadre d'un développement futur, nous comptons intégrer les trois méthodes exposées dans cet article dans un cadre plus général qui est celui d'une démarche multi-critères (prise en compte simultanément de nombreux critères paysagers et autres pour proposer la(les) meilleure(s) implantation(s) d'un futur projet d'aménagement).

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Series of Ecological Geographic Maps of Various Eco-Systems: Conceptual Models and Development Experience

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Abstract

The use of natural resources of different regions is inevitably accompanied by the growth of ecological problems in relevant states as well as worldwide. Internationally, the following tasks become quite urgent: detection of global emergency situations; elaboration of means enabling to regionally regulate the economy of involved states exploiting the same resources; development of effective measures to be taken by such states based upon the international cooperation that will be needed since the ecological risk comes from different countries. All those circumstances underline the importance of international cooperation in the field of mapping as well, since the cartography represents an effective tool for the management of spatial and temporal information.

The conceptual basis of ecological and geographical mapping seems to us to be in the representation of the territory to be mapped as the natural - anthropogenic complex forming a unique ecosystem allowing for the character and the tightness of relationships between the components involved.

When constructing a cartographic model of an ecosystem, an integrated processing of heterogeneous data is usually assumed, and namely, the processing of cartographic, statistical, aerospace and textual materials, as well as the development of databases and geographic information systems on such basis.

Several series of mutually supplementing and interrelated maps have been elaborated by us for two types of ecosystems, - for littoral regions and for the cities. The first type is mainly dominated by the natural component while in the second type anthropogenic and technogenic factors are prevailing. Each of those types has its proper particularity.

The problems of ecological mapping of the sea littorals were studied using the example of the northern part of Caspian Sea. That region is the representative one having typical features of littoral zones of most seas, and its own uniqueness. The latter consists in the complete set of dynamical processes causing diurnal, seasonal, multi-annual and non-periodic fluctuations of the coastline. The authors have substantiated the necessity of such maps and compiled a series of 10 maps representing the dynamics and the forecast of changes at the littoral zone enabling to solve a wide scope of scientific and practical problems.

The second type of ecosystems to be mapped is the urban territory having a huge transformational potential with respect to the natural environment. An analysis of cities' ecological mapping (in Russia and abroad) has been performed, a series of maps considered as the most urgent ones for the most of big cities, has been proposed. The recommended series of maps includes the following types: Natural Conditions, City and Suburban Landscapes, Anthropogenic Impact, Economic Losses, Medico-ecological maps, Complex Appraisal maps, Protection of Environment. Theoretical results have been tested in the series of maps compiled for the territory of the Russian city of Ulyanovsk. The maps of littorals and cities designed and compiled at the Department of Cartography of MIIGAiK are presented in the report.

Introduction

The exploitation of the natural landscape resources is accompanied by the growth of ecological problems in many countries, as well as all over the world. In this context the following problems become urgent in international scale: revealing the global emergency situations; the development of forms the regional economical regulation in connection with the usage of resources by separate states; efficient measures to be taken on the base of international cooperation related to the ecological hazard coming from different countries. These circumstances intensify the role of international cooperation in mapping as an efficient and optimum way for representing time and space data.

We think that the conceptual basis for the environmental geographical mapping consists in the representation of areas to be mapped as natural and anthropogenic complex (integrated ecosystem) with provision for the nature and tightness of relationships between the components forming such complex. When designing cartographic models of ecosystems it is important to perform the integral processing of heterogeneous information, i.e. cartographic, statistical, aerospace, textual type data, and to build the databases and geoinformation systems on this base.

A systems of mutually supplementing and interconnected maps was designed for two ecosystem types:

- Sea littorals where the natural component prevails;
- Cities, with the prevalence of anthropogenic and even technogenic component.

The choice of the first type is explained by the fact that the distinctive feature of economic development of many countries, is the extensive involvement of various resources of the world Ocean in national economy.

Mapping the littorals

The aftermath of different types of economic activity in aquatic areas has the most important impact for the especially vulnerable zone, the boundary between the mediums of the Ocean and lithosphere, i.e. in the coastal area of the world Ocean, where ecological problems have no bounds.

The multi-purpose exploitation of the unique nature and resources of littorals requires an integrated dataware to be developed. It seems expedient to elaborate a programme for the exploration of coastal areas of the world Ocean aimed at the development of related databases, as well as the set of parameters of natural environment and anthropogenic influence.

A distinctive particularity of areas of contact between the sea and the land, is the complexity and diversity of processes occurring there, ranging from morpholithological processes (at the boundary of interaction between the water masses and the lithogenic base of the coastline) to biochemical ones related to the diversity of flora and fauna living conditions.

A program of complex mapping of littorals could be very ample and multilateral corresponding to the present state of thematic cartography and to the wide spectrum of thematic maps. As essential parts of such program which have to form the arrays of mutually supplementing maps, the following ones could be pointed out:

- Climatic maps representing the nature of motion and changing of the air masses, temperature conditions, its seasonal character, the mode of moistening, evaporation, the direction and velocity of winds;
- Hydrological maps, representing the regime, properties and dynamic characteristics of water masses;
- Geomorphological maps showing the relief of land and contiguous ocean floor, its dynamics;
- Biosphere (biotic) maps that have to portray interconnected forms and types of flora communities and soils, participating in the joint process of development and in the ecological cycle.
- Social-economic maps enabling to reveal the particularities of national enterprises operating in aquatic areas, to analyze the land use, distribution of population, transport networks.

The difficulty of that task consists in the absence of a comprehensive system of regular monitoring which should serve as a main source for the maps compiled on the base of factual observations. Non-standard (specific) contents of maps is determined by ecological problems of littorals related to the instability of their state, by the complexity of the regime of the sea level fluctuations, anthropogenic impact coming out differently in particular regions. It is namely that aspect of ecological mapping that is the most difficult and comparatively new field of research, although the geo-ecological problems of the Ocean are widely discussed.

Our study of coastal areas and their mapping allowing for the dynamics in all its manifestations are carried out using the example of the northern part of Caspian Sea (our study was sponsored by the Russian Fund for Fundamental Research, project # 97-05-64495). In this region one could observe the full set of types and effects of changes, caused by the secular fluctuations of the sea level, by the phenomena of tides and ebbs, run-ups and set-downs of water, by various types of anthropogenic factors .

It was found out that in the Quaternary period the evolution of Caspian Sea was characterized by the 100-m amplitude of the sea level fluctuation [Leontiev et al, 1986]. Multi-annual observations reveal the periods of the stable sea level (1900-1929), periods of regression (1929-1977) and transgression (from 1978 up to the present time). A fluctuation amplitude for those periods reaches 3 meters: from -26.0 m to -29.0 m. An average intra-annual fluctuation caused by run-ups and set-downs, was reaching 2-3 meters. The maximum short-term raise of the sea level caused by the wind produced run-ups, could reach 2.5-4.5 m, while the set-downs may cause the fall of that level by 1.5-2.5 m. For extremely small land gradients and for the coastal relief of accumulative flat type, the position of the coastline could vary within the range of 30-50 km. The run-up and set-down streams are not only changing the coastline, but they are causing the littoral landscape alteration as well.

During the period of the Caspian sea level fall (1929-1977), at the derelict territories there was started the exploration of oil fields, there were built roads, oil-extracting facilities, dwelling and production complexes. The rise of the sea level has brought about the flooding and bogging of the dry land bands having width of 20-30 km. The waters brought by the run-ups have spread further, inundating the areas that were not flooded for many years. The danger of floods has incited the construction of downstream channels, dams, jetty roads, but that did not guarantee a protection against the flooding because of the imperfection of protecting earthworks. For instance, as a result of the disastrous 3-meter run-up (March 1995) there were destroyed winter crops, settlements were impounded, roads, communications, self-floating and fishery structures were damaged. The threat of oil pollution of aquatic areas caused by the oil washout to the sea is constantly present. Any development of a territorial-industrial complex under conditions of desert or semi-desert areas, leads to the degradation of the poor vegetation, to the deflation, soil erosion, deformation of the relief, to the appearance of the focuses of salt and dust carry-over, to the desertification of littoral zones. Technogenic factors of desertification replenish the natural ones.

Basing upon those premises, a series of ecological geographical maps of Northern Caspian was compiled in 1:500 000 scale (for some areas more detailed 1:100 000 maps were compiled).

Map of multi-annual dynamics of the coastline (1900 - 1999). It generalizes the data obtained from hypsometric and topographic maps of different scale and vintage, from the results of space imagery interpretation, aerovisual and in-site examination executed by the authors of the paper, accompanied by instrumental leveling, carried out in 1978, 1981, 1986 and 1988. Our analysis of temporal dynamics of the sea level since the year 1900 with the use of hydro-meteorological multi-annual data, enabled to reveal typical sea level for the periods of its stability, regression and transgression (in meters):

- 26.0, maximum annual for the century (1900-1929);
- 28.0, steady low (1942-1969);
- 29.0, minimum for the century (1977);
- 27.8, growing (intermediate) (1985-1987);
- 26.8, at the present time.

The map shows coastline position corresponding to the values specified above. For the delta areas of Volga and Ural the current position of the seaside reed thicket border, is portrayed. The map enables to evaluate the speed and the surface of the dry land extension (or flooding) during periods of the sea level fall (or rise), to determine the duration of the main relief-forming process in littorals, caused by the wave and wind accumulation, to estimate the evaporation from water surface, and to solve some other problems.

Maps representing episodically inundated and drained areas (derelict) and the risk of economic exploration of lands. On these maps several dynamic areas having different probability of being flooded under the action of winds of various directions, are emphasized. In the legends there are shown deflections of the sea level in relation to different values of the steady low sea level (in meters) and the repeatability of those deflections (in % to the number of observations per annum). Four levels of flooding risks are determined for the current sea level.

Map of evaluation of green crop fields loss (with elements of forecast). The borders of inundation, corresponding to the basic sea level (-28.0 m), current (-27.0 m) and maximum level (-25.0 m) observed when the height of run-ups amounted to two meters, are shown. In areas between those borders the following territorial types are shown: (1) completely immersed; (2) partly covered by water; (3) inundated by maximum run-ups. The areas of natural green crop fields are also shown. Taking account of the productivity of consumable dry green crops (in metric quintals per hectare) and the areas of flooding, the evaluation of losses of green crop resources, factual and predicted was carried out.

Prognostic map of littoral flooding caused by the gale surge (western seaside). According to the forecasts by the majority of researchers, the level of the Caspian sea could reach an absolute maximum mark -25.0 meters, which was observed more than once during the period of observations. That is why the contour line -*25.0 m* is taken for this map as an assumed position of the coastline. There is also shown the area of supposed derelict up to the absolute height of -20.0 m (super maximum level). Within this derelict area, there were calculated ground slopes with the use of fourteen transverse profiles, and taking into account the relief peculiarities there were marked the boundaries of outspread of run-ups of different height (0.5, 1.0 and 2.0 meters). That enabled to derive a number of forecast conclusions concerning probable geo-ecological changes in the area (morphological, hydrographic, etc).

Maps of anthropogenic disturbance. It is a series of maps that represents the nature and extent of anthropogenic load on littoral landscapes. These maps cover the temporal domain from the beginning of forties to the present time. During this period three stages of economic exploration of the territory could be pointed out, each of them having the duration of 20 years, what has predetermined the number of maps in the series. The maps characterize the extent of anthropogenic disturbance by the scale of 7 gradations and have detailed legends.

Each of those seven gradations of anthropogenic load, from practically insignificant to the critical one, is characterized by the indices of areas of anthropogenic objects (in %) shown in the legend; is accompanied by the description of types of anthropogenic impact and its consequences. The conclusion concerning the possibilities of natural reconstruction of landscapes is drawn.

An analysis of maps is logically completed by the forecast of the territory state (in 20 years), which would be effective under the following conditions:

- Stabilization of the coastline at the position close to current one;
- Same extent and nature of anthropogenic impact.

The important conclusions concerning the probable increase of the areas with irreversibly disturbed landscapes in more than 3 times and the shrinkage of natural landscapes in two times, are drawn.

Maps of landscape transformation (dynamics). The state and transformation of landscapes at different periods of economic exploration, as from the year 1940, were studied in more detail for separate areas at scale of 1:100 000. The dynamics is portrayed for two periods of twenty years each and for the whole period of observation as well. The map legends were designed in the matrix form: the signs for the objects of primary state are placed in columns, the signs for the secondary state objects, are placed in rows. Thereby, the close-up is given for the tracking of qualitative landscape changes, of transformation stages, changes, degradation of their components. Each of maps compiled could be taken as «a reference point» for further detection of changes.

Urban Eco-systems

The second type of ecosystems studied, i.e. urbanized city areas, is known to have an enormous transformational potential with respect to the natural environment causing deformation of its structure. As our analysis shows, this branch of mapping is one of the least developed ones [Vereshchaka and Mitkova, 1997].

The ecology of such complex formation as a city, is determined by social-economic, natural and natural and anthropogenic factors (objects, processes and phenomena) related to the geo-sphere on the whole and to its components: social sphere, techno-sphere, atmosphere, hydrosphere, pedosphere (soils), biosphere (see Fig. 1a). The natural component is the background; its elements determine the geo-system stability and natural conditions of the matter and energy migration flows, such as the concentration of pollutants or their dispersal, physical, chemical, hydro-biological, bacteriological and other environmental indices. The impact of those factors has its particularities in each city, but it is possible to portray a typical ecological urban image and to emphasize the mapping dominants (see Fig. 1b). Basing upon the model developed it is supposed to create an integral system of maps representing the ecological state of the city. That system consists of the following blocks:

· Natural features (geographical location, climate and climatic zoning, geology, relief, soils)

· urban and suburban landscapes

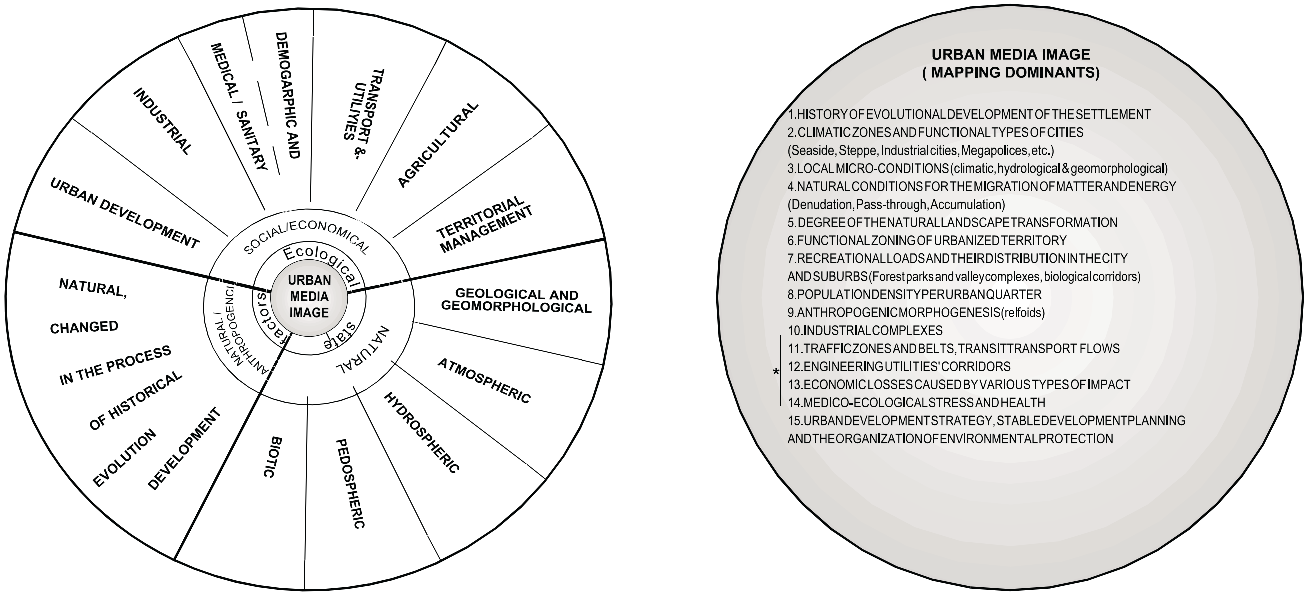
· Anthropogenic impact (historical evolution of territory, functional structure, (land use), population density per urban quarter, artificial coatings, pollution by media and type, anthropogenic morphogenesis, dangerous engineering geological and exogenic processes, economical losses

· Medicine and ecology state (sickness rate, mortality rate epidemiologic stress)

· Environmental protection (control & monitoring, network, areas of preferential protection and unique natural objects, environmental actions

A technological scheme includes the formation of cartographic database. Such scheme should describe the processes and steps to perform, from field observations to the reproduction of computer maps (see Fig. 2).

Methodically, for the design and compilation of ecological maps of cities a special attention is to be paid to the unified general geographic and mathematical base for all the maps of the system. In practice the city management is usually based on large-scale maps, 1: 50,000 and greater, comparable with scales of topographic maps. Remotely sensed aerospace data and topographic maps known for their high accuracy, richness and versatility of contents, are the best source for composing general geographic database. That is why it is reasonable to use the projection of topographic maps. The choice of maps' layout is to be made with the use of two criteria, and namely, coverage of neighboring territories and city development prospect plan. Obviously, when choosing elements of mathematical base the following factors are to be taken into account: map destination, city area and its shape. General geographic (topographic) map base should meet the requirements of open accessibility, comprehensiveness, regular update, it also has to ensure a special contents localization. Regardless of the prevalence of the unified general geographic elements, some variations are possible depending on thematic subject. A lot of objects shown on topographic maps, become features of special contents.



1a 1b

Social and Economic Factors
- Urban development (city infra-structure and its planning);
- Industrial (industry and its branches, power engineering, classes of hazardous production);
- Demographic and medico-sanitary (population and its density, migration, health)
- Transport and utilities (traffic loads, engineering communications)
- Agricultural (gardening and horticulture)
- Territorial management (planning, normalization, land use monitoring, cadastre, ecological control and protection measures)

* POTENTIALLY DANGEROUS OBJECTS CAPABLE TO LEAD TO THE APPEARANCE OF TECHNOGENIC ANOMALIES

Figure 1. Graphical model of urban ecological state

When compiling ecological maps a great attention should be paid to the methods of evaluating ecological state of geographic environmental components. Each of them is a subject of related geo-science, such as meteorology, hydrology, soils analysis and others. On the base of inter-component and inter-ingredient integrating methods, the problem of complex territorial ecological evaluation could be solved. The peculiarity and accuracy incidental to the mapping of urban agglomerations in greater scales correspond to the most developed and normalized parameters used in methods and criteria applied for the evaluation. Such approaches are designed for the evaluation of pollution by environments (air, water, soils, biota, etc.) and types (chemical, mechanical, acoustic, radiation). They are stipulated in National Standards and used in sector techniques.

The results of conceptual and methodical research are embodied in series of ecologo-geographical maps of the Russian city Ulyanovsk. This series includes the maps of the following contents:

1. The history of the city development for 100 years, represented by 4 maps corresponding to the years 1898, 1957, 1971, 1998. For the aims of comparison all these maps have the same layers, such as urbanized territories and their main ecological types.
2. Geographical Location and Climatic Features.
3. Geological and Mineralogy.
4. Soils.
5. Functional Zoning.
6. Engineering Geological Conditions and Anthropogenic Morphogenesis .

7. Pollution Types.

8. Control and Protection of Environment.

The maps compiled were analyzed along with old cartographic materials what enabled to reveal some trends in the city development and to evaluate its ecological state.

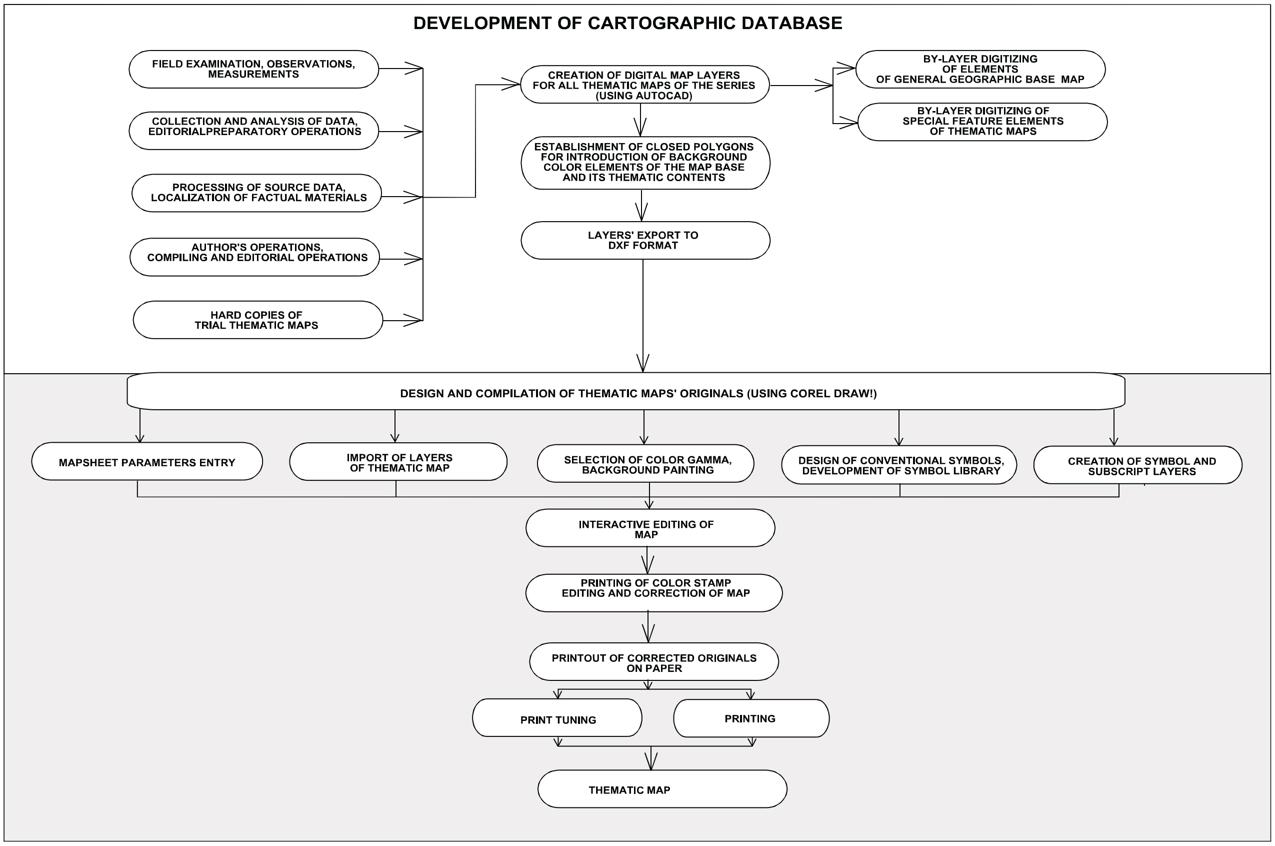


Figure 2. Technological scheme for the creation of digital cartographic database and computer thematic maps.

Conclusions

Thereby, for the urban agglomerations, as well as for the littorals, we applied the integrated system of cartographic method of studies while compiling the maps and using them.

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Current Works on Environmental Cartography for Sustainable Development in Poland

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Abstract:

The paper presents the chosen examples of Polish cartographic works from the last few years, concerning the status, changes and threats of natural environment, with regard to the country as a whole, its provinces and communes. The paper offers a review of sources of environmental information, used in cartographic elaborates, as well as a thematic range of selected maps and atlases and their usefulness for spatial economy.

Introduction

The Spatial Management Act, adopted by the Polish Parliament in 1994, stresses the importance os sustainable development (ecodevelopment) in spatial order and spatial economy. The assumptions of ecodevelopment are being introduced to the policy of spatial land development, referred to as program „Poland 2000 plus".

Finding solutions for ecological (sozological) problems bases, on the one hand, on the system approach connected with regulations and principles of ecodevelopment and, on the other hand, on the continuous collecting and updating of information concerning the state and changes in natural environment.

Topographic maps and various kinds of thematic maps and atlases provide basic information about environment in which (mainly negative) changes occur, caused by anthropopression. Environmental (ecological) cartography has been dynamically developing in Poland for several years. It is a separate branch of cartography constituting the background for routine work in the field of spatial management [Kozlowski, 1995].

The main aim of this paper is to present the chosen current works on environmental cartography with regard to the country as a whole, its provinces and communes, to offer a review of sources of ecological information, used in cartography (cf poster) and the usefulness of selected cartographic elaborates for sustainable land development

Sources of environmental data

The physiographic information, also for the needs of cartography, consists of data which may be obtained:

- by way of direct field measurements (meteorological, ecological, and concerning natural resources, etc.);
- by the use of methods of photogrammetry and remote sensing from satellites and image processing systems;
- through the use of existing cartographic elaborates, docummentation, statistical setting up, state environmental monitoring, data bases [Koreleski, 1995; Koreleski 1998].

These data may occur in the two essential forms: digital and analogue.

The direct field measurements provide digital data for the preparation of the vector model or for environmental monitoring.

Black and white or colour photographs are an important source of environmental data, especially aerial photogrammetric images and raster recorded remote sensing data constituting properly registered reality models, surving the identification of objects and taking measurements. Within photogrammetric and remote sensing sources one may distinguish, among others, aerial photographs, numerical terrain models and satellite pictures.

Also the cartographic elaborates in traditional graphic form, constitute a basis of data concerning environment.

Other sources of physiographic data are: various elaborates of statistical institutions, data coming from departments of environmental protection in province offices, elaborates carried out by the state, scientific and social institutions.

In the creation of spatial information systems concerning natural data, a very important role is played by environmental monitoring carried out by the province inspectorates of environmental protection. The state of environment is periodically assessed at the level of communes. Moreover, at the beginning of the 90s, started the common natural inventory of communes. At the state level, the Polish station of the GRID system, working under the UNEP supervision, is of special significance.

Another source of spatial information is a specialistic GIS, concerning such elements of environment as: forests, swamps, lake areas, or the so called problem areas of important ecological value, or under strong anthropopression [Ney, 1997]

Cartographic works at the all-country level

Among cartographic works concerning national level, the following examples of publications will be characterized:

a) Atlas of Resources, Values and Threats of the Geographical Environment in Poland (1994, Polish and English version). The Atlas is the first publication of this kind which presents the basic problems of environmental protection in a complex and synthetic approach. It contains ample information about the environment, its value and resources, as well as the state, range and directions of its sustainable development and transformation. The Atlas was worked out in the Institute of Georgaphy and Spatial Management of the Polish Academy of Sciences (PAN) in Warsaw. The Atlas contains 97 multi-colour tables with 444 maps (in three basic scales – 1:2 000 000, 1:4 000 000, 1:6 000 000, in some divisions also in scales from 1: 200 000 to 1:2 500 000) and diagrams. There are 11 thematic divisions: I. Consequences of geographic location, II. Climatic phenomena, III. Water resources, IV. Mineral resources, V. Landscapes and their transformations, VI. Bonitation and soil management, VII. Plant world, VIII. Animal World, IX. Leisure and tourist utilization of the geographical environment, X. Natural and cultural values of geographical environment, XI. The Baltic Sea – Polish zone. It is to be hoped that the Atlas will become an important tool in a correct understanding and management of the environment. Together with the work „Strategy of Poland‘s Ecodevelopment“, published 1993 – both these publications create a firm basis for the accomplishment of the ecological policy of the State

b) Atlas of the Republic of Poland (published since 1996 by the PAN), among others, part II consists of maps informing of the geological structure, relief, waters, climate, vegetation and fauna, as well as on transformations and protection of the natural environment. The basic maps are those in scale 1:1 500 000. The Atlas has been included by the Surveyor General of Poland in the elementary program of the National Geodetic and Cartographic Service as its official publication

c) Atlas of Threats and Protection of the Environment in Poland (Warsaw 1996) comprises such divisions as: contamination and protection of air, water resources – their use and protection, threats and protection of land surface, state and threat to flora and fauna, areas of ecological threat, proecological undertakings, possibilities and directions of economic development

d) Contamination of Environment of Poland – wall map 1:700 000 (State Cartographic Publishers, Warsaw 1996). The map presents the contamination of surface waters and their pollutants, main places of waste disposal, places and areas of ecological threat, the ecological state of forests, etc.

e) Hydrological Atlas of Poland (State Institute of Geology - PIG, Warsaw 1995) contains maps (1:500 000) concerning : underground waters, their resources, management, evaluation and protection, quality and threats

f) Geochemical Atlas of Poland, in scale 1:2 500 000 (PIG, Warsaw 1995) includes 72 multi-colour geometric cartograms informing about chemical compounds in: soils, water deposits, surface waters; soils radioactivity, kinds of built up areas, land utilization, etc.

g) Map of Caesium Pollution in Poland in scale 1:1 000 000 (PIG, Warsaw 1996) is based on surveys done in 1992 and 1994. The map is supplemented by cartographic presentation of the Warsaw and Opole anomalies

h) Atlas of the Redox Properties of Arable Soils in Poland (Institute of Agrophysics, PAN, Lublin, and Institute of Grasslands, Falenty). Redox (reduction – oxidation) properties connected with water – air conditions of arable soils are presented with regard to the time of oxygen exhaustion, redox potential, conditions of soil protection against mineral components losses, etc.

Environmental cartography at the regional level

The hitherto experience indicates that regional studies and analyses, adjusted mainly to the administrative division of the country into voivodships (provinces) or economic regions, play the major role in the understanding of problems related to the natural environment. With reference to environmental cartography at the regional level, the following further examples of elaborates will be mentioned:

i) Atlas of the Conditions and Threats to the Environment of the Plock Province (State Inspectorate of Environmental Protection, Plock 1997). The Atlas consists of 72 maps and cartograms, mainly in small scales (1:500 000), which present: forms of nature protection, protection of water, air and land; noise and other threats

j) Radioecological Atlas of Warsaw and Environs (PIG, Warsaw 1995) comprises 6 maps in scale 1: 200 000, informing about: distribution of measurement points, intensity of gamma radiation, concentration of some radioisotopes (Cs, U, Th, K) in the surface land layer. The data were collected in dBase by the use of the GIS Arc/Info system

k) Map of Groundwater Pollution Sources in the Upper Silesian Coal basin and its Margin in scale 1:100 000 (PIG, Warsaw 1995). The map comprises data concerning: spot, linear and spatial sources of water contamination

l) Geological - Sozological Atlas of the Tarnobrzeg Sulphur Basin, in scale 1:50 000 (PIG, Warsaw 1996) comprises the southern part of the Tarnobrzeg province. The subject matter of maps concerns: geology and structure of deposits, water conditons and contamination, soil – forest relations, threats and environmental protection

m) Atlas (in English): Geology for Environmental Protection and Territorial Planning in the Polish – Lithuanian Cross-Border Area (PIG and Lithuanian Institute of Geology, Warsaw 1997), in scale 1:500 000. The Atlas contains 60 maps concerning such problems as: geological and geochemical structure, radiogeology, chosen geoecological problems

n) Geochemical Atlas of Walbrzych and Environs, in scale 1:50 000 (PIG, Warsaw 1996). The Atlas presents problems of anthropogenic concentration of chemical elements (10 metals) in soils and in contemporary water deposits – and therefore plays an intrinsic role in spatial planning and ecodevelopment.

Provincial ecological maps fulfil a double purpose. Firstly, educational: for inhabitants and particularly for state and local government administration [Kozlowski 1995]. These maps are a basis for developing voivodship studies in accordance with the Spatial Management Act. Secondly, the environmental maps are the final stage of actions performed by the provincial inspectorates of environmental protection. The materials published by them contain also cartographic elaborates.

Environmental cartography at the local level

The elaborates concerning local level are carried out mainly within the range of the so called "Study of determinants and directions of spatial management of communes" in spatial planning. The study takes into consideration and defines specially the following problems;

- areas included in the protection of natural and cultural environment
- local resource values of natural environment and environmental threats
- areas of agricultural production land, including areas on which building development is forbidden
- built up areas, with the indication, if necessary, of lands which require transformation and reclamation
- areas which can be most used for building development, with the indication, if necessary, of lands designed for investment activity
- directions of the development of technical infrastructures, including areas on which individual or group systems of waste treatment will be used
- areas on which preparation of local plans of spatial management, on the basis of detailed regulations or due to the existing conditions, is obligatory.

The Study must also take into consideration determinants, aims and directions of the spatial policy at the stage of voivodships. This means that there must be a compatibility of a commune study with the study of spatial management at the level of voivodship.

Moreover, both studies ought to be compatible with the superior document concerning the ecological policy of the State.

For the purposes of the Study and a spatial local plan, as its consequence, it is necessary to elaborate special environmental large scale maps. This kind of mapping may be exampled by sozological and hydrographic maps, both in analogue and digital form. These two maps in scale 1:50 000 are being produced in the MapInfo for Windows system in the coordinate system "92". The numerical version comprises about 70 layers creating information system concerning natural environment of the area within map sheet.

o) Sozological Map of Poland [Surveyor General...1997a] is directed at the institutions connected with spatial planning and environmental protection at regional and local level. Sozological map is especially useful for the localization of new investments. Its information system includes: forms of natural environment protection, degradation of environmental components (land surface, soils, forests, waters, air, investments harmful for the natural environment), environmental degradation control, land reclamation, wastelands, etc.

p) Hydrographic Map of Poland [Surveyor General...1997] is aimed at institutions related to water management, spatial planning, and environmental development. Its information system comprises: watersheds, surface and ground waters, underground water outflows, rock permeability, phenomena and objects of water managements, hydrometric points, etc.

There are also similar numerical maps, in scale 1:50 000, concerning geology, geology and economy, and hydrogeology.

Usefulness of cartographic elaborates for sustainable development

The above presented examples of environmental maps currently produced in Poland demonstrate their multiplicity and thematic variety. They serve the purposes of spatial planning based on the principles of sustainable development.

The usability of the maps and atlases quoted has been determined in Table 1.

The following aspects have been considered: mining and processing of minerals, agriculture, forestry, environmental protection, water management, development of settlements, recreation and medical care.

Table 1: Usability of selected cartographic elaborates

Usability for:	*Country level (a-h)*	*Regional level (i-n)*	*Local level (o-p)*
mining & processing	a	l	
agriculture	a,b,f,g,h	i,j,m.,n	o,p
forestry	a,d	l	o
environ. protection	a,b,c,d,f,g	i,j,l,m.,n	o
water management	a,b,c,d,e,f	k,l,n	o,p
settlement develop.	a,d	i	o,p
recreation & medical	a,d,g	i	o

The data listed in the table justify the statement that the thematic contents of the above analysed maps and atlases may prove most useful for works in the range of environmental protection, agriculture, and water management.

The atlases and maps present various aspects of the differentiation of geographic environment which increasingly determines the standard of human life. These publications are becoming an important tool for understanding the role and significance of natural environment in formulating spatial, socio-economic plans for land development

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Real-time Flood Analyzing System with Integration of Raster and Vector Date

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Abstract

This paper introduces a real-time flood analysis system. The system integrates raster and vector data effectively to display and analysis. According to the user input or real-time hydrological data the system can make flood simulation analyzing and calculate flooding areas, loses and evaluation. The system had supplied service for some province leadership in China.

1. Introduction

The struggle of human against flood had lasted thousand of years. Though the technology of flood prevention has developed, the fact that flood has been the first calamity of human being don't changed. When the flooding happen, how to use variety of existing information effectively to superintend and making decision to reduce the loss of calamity is the top issue which government leadership very care of. Based on this situation, we develop a real-time flood analysis system. It offered a speedy, effective assistance decision-making facility for government. In the system, the basic data include DEM, basic geographic information and other thematic information in different scales. The idea is through the front-back double layer management, integration of raster with vector data effectively, display and analysis based on DEM (raster data). The goal of the system is to make flood simulation analysis under fixed condition using geography and other correlative information, to calculate flooding areas, loses and evaluation.

2. Data source analysis and integration of raster and vector data

According to the requirements, the data of the system are divided into several classes:

1). Raster data: DEM included high precision, high resolution in part of study area and low precision, low resolution covered the whole area .

2) Vector data: included basic geography information, such as boundary, hydrography, transportation, residence, etc. Besides, according to the specific requirements of the system, coordinate, name and elevation of the dam are also included.

3) Other data: included some perspective image, hydrology information and descriptive data.

The system is a multi-scale system and it can query and overlay data from the same or different scale. Because of multi-scale and multi sources, we need to manage data effectively. For the organization and management of vector and raster, we use integrating raster and vector technology. The technology combines the two kinds of data with logic connection. The connecting processes include two layer what we called it front and back layer. The back layer is used to store data. The front layer is used to display, inquiry and analyze. In the back layer, raster and vector data store separately while they are combined to display, inquiry and analyze together in the front layer. That is, the integration is the overlay of two data upon logically. The steps of process which integrate raster and vector is as follows:

1). Data registration: because the data are from different sources, their coordinates must be converted into the same system, then we can operate them integrally. Data registration include projection conversion, scale matching and coordinate matching.

2). Data organization: because of the different data structure between vector and raster, the system must determine the major and auxiliary data and the operations of system are based on major data. Here DEM data is chose to be the major data, all the operations of the system work through the DEM as the integrated connector.

3. Real-time simulation and determination of flooding area

Real-time simulation and determination of flooding area are the major functions of the system based on DEM. When flood has coming or will come, integration of the different existing data (such as DEM and hydrology data etc.) in the system can simulate the flooding, determine the flooding area and calculate the loses at different assuming water level. Thus we can get possible disaster degree before flood occurs. In addition, a special function in the system is added to real-time simulating flooding area in the conditions of dam burst or heightening the dam. The functions can used for decision-making in prevention of flood and arrangement for rescue work. There are two ways used in the system:

1). Fitting of flat area: for the inner-waterlogged area, flood detention area and small area, the water surface treat as horizontal plane and the flooding area is determined by the elevation of water level. The procedures are as follows: Firstly, a image with the same cell size as the DEM is created for marking the flooding units. The cell in the image is corresponding to the DEM and set the value of "0" at the beginning, and then give the value of "1" to all cell below the water level, making that area may be flooding. Secondly, eliminate isolated area which mean the area don't connect with real flooding area, depending upon user input according to operator's knowledge from reference material. Finally get the real flooding area and set the corresponding cell of the image to "2". So the real flooding area is determined.

2). Fitting of curve surface. For the large area, the surface of a river is not a horizontal plane but a complicated curve surface. In that case, the flooding area can not be simply determined by the contour line. It is also difficult to simulate using a certain curve surface. In our system, water levels observed by the hydrological observation station at each terminal of a river is used to calculate the flooding area. The surface is treated as a tilted plane. The question will be answered by the intersection of the tilted plane and the DEM. The procedure is almost the same as the previous one except that the selection of the cell which its elevation is less then level of the tilted plane is set to "1" in the marking image and get the possible flooding region.

In the latter process, The user is permitted to add virtual hydrological observation station, in order to simulate flooding state of certain region assuming the water level raise. This method is quite simple and efficiently. The more hydrological observation data is used, the more efficient.

Dams are important installations for preventing the flood. In our system, their information are also important for flood simulation and analysis. This information directly affect the result and reliability. So the information about dams is added to the data source. The position of the dams store as vector data. Other information, like dam elevation and dam name, is stored in the relational data base. Generally, small scale DEM does not contain dam information because of the large cell size and the dam information must be added. The procedure is as follows: Firstly, join the vector data and data base, get dam elevation of each segment through interior ID, rasterize the vector data of dam, set elevation of each point equal to elevation of the top of dam. Overlay rasterized dam data with DEM, then we can use dam data instead of original DEM data. Sometimes the width of dam is smaller than the cell size (for example, cell size is 500m, but width of dam is only 20m), to ensure the precision of simulating result, we need exaggerate width of dam.

In the direction of flood prevention, a commander often need to know when is need to heighten the dam or mitigate the flood, and when flood must be diverted or dam must be burst, what about the loses in different situations. According to these requirements, we add a function, namely change of establishment of water prevention. The system can simulate the situation of flood diverting or dam burst. Flooding area and different kinds of statistics about loses can be obtained. It can also simulate the situation of construction of the dam. This process is finished by user input of position and elevation of dam and system modify the elevation of corresponding DEM data real time.

4. Statistics and analysis of flooding area

The statistics and analysis of loses are done under the support of Geographic Information System. The data in the system include terrain data and social and economic data in the data bases. The statistic results include flooding area, capacity of flood, inhabitants, roads, railways inside flooding region. The result can also be social and economic data in the system.

According the DEM, we calculate the area of flooding and capacity of the flood. Setting a calculator, the system sum up the pixel number that the value equal to “2” (it mean the pixel lies in flooding region) in the marking image. Complying with the result of statistics and a grid area of DEM, we can get the area value of flooding region. For each pixel unit, we can get the flood water capacity according to its elevation, water level and unit area. Accumulating all of them, volume of flooding region is obtained.

For the statistics about vector data such as residents, roads, rail etc., it means to get partial or entirely information about the element in the flooding region. It works on integrating raster and vector technology. After registration of raster and vector data, each point of every layer in vector data can be correspondence to the grid location(row and column) in the raster data. Overlay the vector data and marking image, we can get the vector information in flooding region, and also can get their attribute data in database by joining the vector and database through their inter- ID. For the statistics of social and economic data, the result can be obtained in the same procedure.

According to simulation and analysis, we can get several kind of statistic result under the different water level or hydrological data.

5. Characteristics of the system

1). The system uses the technology of integrating raster and vector data. by a series of technique, combining raster and vector data, vector and image can zoom in , zoom out, move at the same time. These characteristics make the system work fast and efficiently.

2). The system is a real-time simulation and analysis system. User can simulate and analyze real-time by two ways. The first way is horizontal plan simulation. User can change flood water level and get the result of simulation and analysis real-time. The second way is simulate and analyze by the input of the hydrologic data. The users can set virtual hydrological data to simulate the fact when water level raise. In that case, we can know the situation beforehand.

3). The variety information is used. The background data of the system display is DEM, overlay it by variety of vector and other information. By use of technology about integrating of raster and vector, data with different property can zoom in, zoom out and ramble. The content display on screen can be adjusted according to the scale of display. It also suit the vision behavior of human. As background data , DEM can display by black-white shading and color shading. The system can also use multimedia information.

6. Application of the system

The system is a part of "governmental flood prevention and weather service system of Hubei province of China". The vector data at 1:1,000,000 cover the whole Hubei province. For DEM, the cell size is 500 X 500 meter and its precision of elevation is 1 meter. The vector data include 7 classes of basic geographic information. As a single class, dam information store with vector data, which is used to modify DEM. As a thematic information, hydrology station data store as a single class. Besides, for the specific area, 1:10,000 scale vector data and DEM with the resolution of 12.5 meters and elevation precision of 0.1 meters is used. In that case, the precision of DEM is accurate enough to represent dam, so it is not needed to modify DEM. 16 sheets 1:10,000 scale perspective view image and ortho-images was also employed.

7. Conclusion

1). To improve the productivity, the system need more detailed geographic information, detailed social-economic information (such as population, income, gross output value of industry and agriculture, distribution of importance facilities) and other real time thematic data (such as hydrology and irrigation work). All of these will improve the accuracy of the analysis results.

2). Water surface in the flooding is a very complicated. More precious analysis, assessment and real time simulation will be finished by the combination of GIS and flooding hydrological models.

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Geocartographie et feux de végétation au Chili tempéré.

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Abstract

Mapping the spatial distribution of forest fire.

During the last fours years we have studied the changes experimented by the sclerophyllous and tempéré forest in the mountains of central Chile, due to effects of summer fires, wich have been common ocurrence since 1940. A great part of the hills sides exposed to the north have lost many comunities of Schinus latifolius, Porlieria chilensis, Quillaja saponaria, Lithrea caustica, Myrceugenia spp., Nothofagus obliqua. *Only the last one shows a fire resistance. The rest of them have by replaced by demixeromorphic shrubland(with thorns) and* Acacia caven *all hills sides wich show evident erosion processes.*

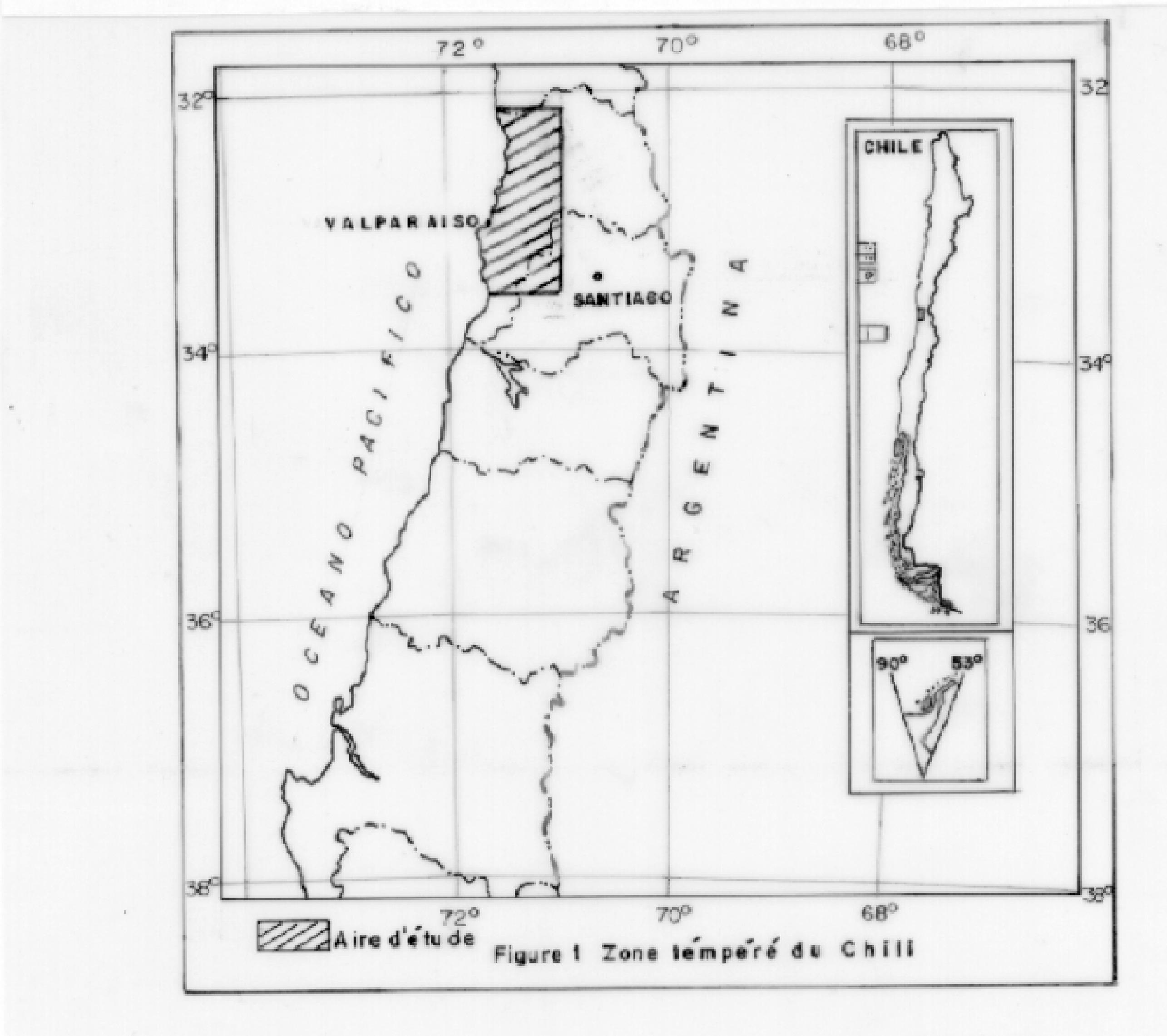
In the shadowed hill sides Cryptocaria alba, Peumus boldus, Azara celastrina,*etc. Have not been fire damaged, shaw a reduction in distribution areas and frecuently covered by* Chusquea cumingii *and* Rubus ulmifolius *dwarf shrub. The sclerophyllous forest, after exploitation and degradation, originates the "matorral" wich is very inflamable. The results are sumarized graphically by means of diachronique cartography on a midle and highs scalles (inflamability and combustion riske for example). The methodology and data reduction with working remote sensing. Some of the test area charts will be performed in GIS. This work represent 4 years forgoing research work and has the main objective of studing the changes experimented due to effects on the natural vegetation of central Chile, with the mapping using. (Project DICYT-USACH).*

Caracteristiques générales de la végétation mediterranéenne du Chili et son environnement.

La région consideré pour nous á l'interieur du Chili Central, s'étend d'une manière aproximative entre les 32 et 38 degrés de latitude sud. Au point de vue climatique cete zone participe en géneral des caractères d'un climat avec tendance méditerraneenne que présente une longue période de sécheresse. Celle ci diminue à mesure qu'on avance en latitude vers le sud, comme consequence de l'augmentation de l'humidité et de la modération des temperatures qu'on observe particulièrement sur les versants des cordilleres. (Figure 1). D'autre part le relief présent une physonomie longitudinale tripartite. Entre la Cordillére des Andes et la Cordillère de la Côte, se développe une grande vallée centrale d'une largeur moyenne de 90 au 100 kms. Dans la latitude 33º sud, les sommets superieur des Andes arrivent aux 6000 mts. Pour descendre ensuite peu á oeu vers le sud et avoir autour des 3.500 mts. vers les 37º. On a aussi un phénomene similaire, même avec des hauteurs inferieurs aux 2500 mts. dans la cordillére côtière, oú la chaine se coupe dans quelques secteurs mettant en contact les plaines litorales avec la Vallée Longitudinale.(Borde et Santana,1980).

Du même le climat mediterranéen est au Chili, trés chaud et sec pendant l´éte et avec très peu de précipitations dans l'automme et l´hiver surtout dans la vellée centrale. Par exemple 356 mm annuelles au Santiago, et 712 mm au Talca vers les 35º Sud. Depuis cette latitude la tendence mediterranéenne est moins accentué avec un

Figure 1. Chili témpéré et localization aire d'étude.



accroissement important des precipitations et plus au sud, on observe aussi une diminution moderée de la période de sécheresse.(Quintanilla, 1974).

D'autre part, la période pluvieuse et le total des précipitations sont plus élevés dans la versant pacifique de la cordillére et aussi dans la cordillére andine. Toutes ces conditions ont un'influence sur le développement de la végétation, laquelle au sud du 33º peut présenter des formations arborescentes mésophytes et encore de caractère higrophyte dans les secteurs les plus humides des montagnes. Les sols dans la plupart du territoire sont encore des sols jeunes avec une grande influence volcanique au centre du pays. Prédominant laterites bruns rougéatres, de sols bruns typiques et plus au sud nous trouvons des sols brun podzoliques. Dans les Andes, les lithosols humiques occupent une place importante. (Weischet,1973).

Dans la Vallée Longitudinale, la forêt sclerophylle a disparu toute à cause de l'intervention humaine, en donnant lieu á une formation stepppique avec un arbuste semixérophyte qui colonise aujourd'hui une grande partie d'endroits du Chili central avec des conditions écologiques mediocres. (Quintanilla,1983 et Gajardo 1994). Il s'agit de l'*Acacia caven* dont ses groupements constituent la formationn de l' *Espinal* laquelle vers le sud du 36º prend la physonomie d'une seudosavane, trouvant actuellement sa limite meridionale d'expansion autour des 39º sud.

Etant donné qui le Chili est un pays très élongé et étroite, les reliefs montagneuses et les pentes marquent une grande influence sur la distribution actuelle de la végétation. L'étage collinéen des deux cordilléres est maintenant très alteré. Les collines de la cordillère de la Côte dont les versants sont beaucoup plus exposés á l'influence océanique constituent l'habitat de la plupart des forêts sclerophylles "qui restent" caracterisant de la même maniére les endroits de l'étage montagnard mais en donnant lieu ou groupements arborés de quelque importance. L'aire de contact entre les étages collinéen et montagnard est principalement occupée par *Acacia caven* et des autres espéces épineuses. Quand la forêt se développe degradée ,l 'espinal et son cortége pénétrent á l'interieur en se mêlant en partie avec les arbres en donnant lieu á une fourrée connue avec le non du "*Matorral*".

Les sommets les plus hautes de la Cordillére de la Côte (1930 et 2.220 mts.) grâce aux avantages que lui donnent l'exposition océanique de ses versantes , on des communautés de *Nothofagis obliqua* avec des espéces higrophytes comme *Myrceugenia obtusa, Drimys winteri, Crinodendron patagua, Aextoxicon punctatu* . Le *Persea lingue* et *Aristotelia chilensis* parmi d'autres, forment un "monte" arboré et plus ou moins fermé, qui se ressemble beaucoup en physonomie et composition aux forêts de type mediterranéen humide qui nous trouvons vers la latitude 36º et 37º S. dans les deux cordilléres. Ici surtout dans la montagne cotière nous rencontrons des autres hêtres.

L'étage montagnard se montre quand quelques espéces xerophytes disparaissent et se déplace á peu prés entre les 800 et 1.800 mts. Petit a petit on trouve des arbres plus specialisés aux effets des hauteurs. Il s'agit de *Azara petiolaris, Quillaja saponaria, Schinus montanus* qui remplacent au *Schinus latifolius* et *Kageneckia angustifolia* que d'autre part remplace a *Kageneckia oblonga.* Les *Kageneckias* représentent ici, le maximum ascensionnel en hauteur des arbres sclerophyles. A partir des 35º l'étage montagnard change avec la présence de *Peumus boldus*, *Maytenus boaria* et les Lauracees *Cryptocaria alba* et *Persea lingue*. *Des Protacees* aussi comme *Gewuina avellana, Lomatia hirsuta* et *Embotrium coccineum.* Autour des 1.900 mts. apparaît l'horizon montagnard superieur des Andes, dénotant une dominance de Nothofagus notament *Nothofagus obliqua* . Plus au sud cette fôret caduque est remplacé vers les 37º, par la forèt pluvieuse sempervirente.

L'apparition des premières coniféres correspondantes a la famille des *Podocarpaceaes* vient a signaler la présence de l'étage subandin : *Austrocedrus chilensis* et *Podocarpus spp.* Vers le sud de notre région, la cordillére montre aussi d'autres feuillus: *Nothofagus dombeyi, N.alpina, N. pumilio, N. antarctica.* Surtout les deus derniéres á partir plus ou moins des 2000 mts., predominent exclusivement dans l'étage andin. Dans le sud des cordilléres mediterranéennes on rencontre aussi jusq'au les 2.200 mts., l'existance de *Araucaria araucana* conifére éndemi que de l'Amérique du Sud. Depuis les 2.500 mts et á partir des 36º,dans cet étage,

Les Notgofagus comme *Ntothofagus pumilio* et *N.antarctica* ont presque disparu et on trouve maintenant une steppe altitudinale basse plutôt épineuse et appouvri avec de taches de pelouses andines(*Stipa sp.,Festuca sp.)*

La vulnerabilité au feu de la végétation des montagnes du Chili Central: objectifs de recherche.

Au Chili la plupart des incendies de végétation son de type superficiel et derivés d'activités humaines. Cartwrigth(in Donoso 1981) estime que dans les années anterieurs au 1968 s'ont brulê au Chili environs de

1.200.000 hectares de forêts, en equivalent au 4 mil millions de pouces de bois. La plupart des incendies est sur la végetation naturelle et concentré entre les 32º et 37º sud, c'est a dire au Chili mediterranéen. Il est extrement difficile de distinguer la cause des changements produits dans les communautés des plantes. Quelque fois, ces alterations sont provoquées par l'action des facteurs anthropogéniques et biotiques, et finalement, nous trouvons avec celles qui ont l'origine dans les changements cumulatifs qui se produisent dans les mosaiques de microclimats et orographie sur de grandes étendues de terrain, par une regression du tapis végétal à cause de l'action humaine vers un type de communautés plus arides.

Les alterations climatiques du Chili on été aussi de caractère cyclique. Dans le dernier siècle ont eu une tendance á se présenter chaque 10 ou 40 ans.(di Castri et Hajek, 1976). Cette sécheresse dans la zone central du pays a eu des repercusions importantes car se présentent ici nettement differenciés les périodes de pluies et l'absence de celles, là pour être la zone qui a la plus grande extension géographique et avec la plus grande partie de population du pays en incorporant aussi, la plupart des aires d' utilisation agricole. (Quintanilla 1974 et 1983). Dans ces dernières 30 années on doit ajouter un nouvel facteur trés active, qui en plus contribue a l'altération des ecosystemes et a la regression de la végétation native: ce sont les incendies.

Mème les feux ont arrivée quelques étés a la zone de la forêt témpére pluvieuse en touchant des formations trés riches comme celles des coniféres a *Fitzroya cupressoides*. (Quintanilla 1995).

La vulnerabilité au feu des différentes communautés végétales de la forêt sclerophylle est trés evidente, surtout dans les ravins ou l'exposition au soleil est trés forte et la composition des plantes a un grand risque d'inflammabilité. Développés princepalement dans l'étage meso-mediterranéen (200 au 450 mts. d'altitude) sur des ravins avec des processus d'érosion, les groupements á *Lithrea caustica* constituent aujourd'hui de fréquents points de départ d'incendies qui se propaguent rapidement. Dans ces anciennes zones d'exploitation, les formations végétales complexes qui predominent sont de type ligneux comme ligneux hauts, ligneux bas (Lab) ou ligneux hautes (LH) ou ligneux bas herbacées (LHBL). Le risque d'incendies est alors directement fonction de la présence ou non de la strate herbacée et de l' importance de biomasse combustible inflamable.

On doit rémarquer quand même que *Lithrea caustica* est l'espèce qui se régénera plus rapidement aprés le passage du feu. A la saison suivante plusieurs bourgeons qu'il n'ont pas était touché par le feu, reprenent vite la vie. D'autre part, et localisés sur l'ubac des crêtes recouvrant les versantes humides de la forêt sclérophylle, les communautés á *Cryptocaria alba, Peumus boldus* et *Schinus latifolius* son peu sensibles au feu.

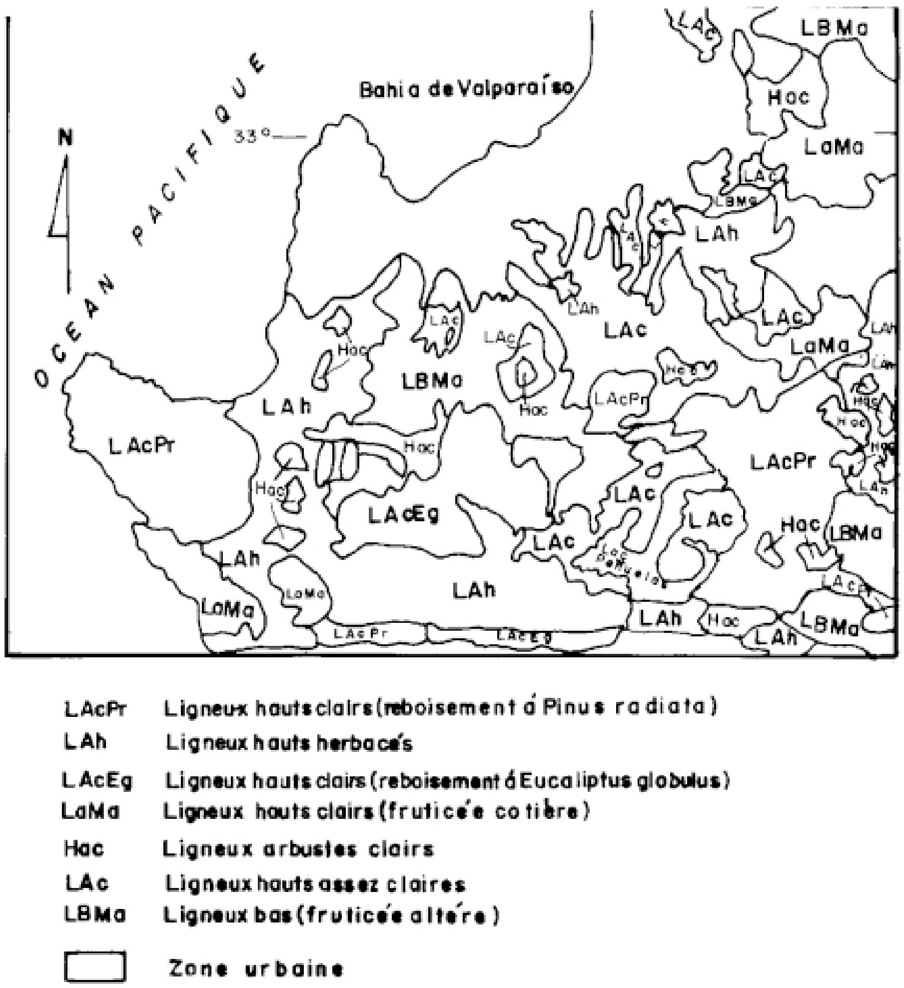
De la cartographie des formations végétales combustibles.

Notre premiére aire d'étude se centre dans les collines des chaines cotières situés a 115 kms vers l'ouest de la ville de Santiago et avec une surface approximative de 1.500 hectares oú on compte 8 periodes des incendies dans ces dernieres 10 années. La végétation est composé de matorral et d'arbres de *Jubaea chilensis*, la palmier plus australe du monde. Aprés d'avoir fini de déterminer la vulnerabilité au feu des différents groupements végétales de nos parcelles cadastrales dans notre zone d'étude, nous avons commencé la travail cartographique.

Les méthodes traditionnelles de cartographie du couvert végétal n'apportant qu'une contribution partielle à l'appréciation du potentiel combustible forestier, la carte des formations végétales combustibles doit intégrer des paramètres aussi diversifiés que représentatifs qui facilitent, d'une part, la connnaissance des combustibles végétaux et, d'autre part, la connaissance des facteurs qui déterminent la nature même de ces formations. Intégrant des données propres aux combustibles, ce type de cartographie traduit de façon objective la complexité naturelle de la végétation.

La réalisation de la carte passe par deux étapes: a) . Définition d'un ensemble de parcelles isophènes. Ce travail préliminaire, consistant en une interprétation des différentes sources d'informations(photographies aériennes,carte d'occupation des sols) a permis, par l'intermédiare d'une zonation à 1:25.000, de mettre en évidence des zones dans lesquelles la végétation présente,tant du point de vue de la structure que de la composition floristique, une certaine homogénité. b). Identification des communautés végétales: Celles sont identifiées en fonction de diverses variables. Par exemple: - Nature du type de formations, c'est-à.dire distribution horizontale et verticale des individus végétaux et de leurs organes végétatifs (agencement dans l'espace des strates herbacée H, Ligneuse basse LB (0,5/2 mètres) et ligneuse haute LH (superieure à 4 mètres). Nous avons individualisé sept unités de stratification fondamentales. (Figure 2). – Types de combustible et des espèces végétales dominantes qui influent sur l'état d'inflamabilité et de combustibilité de la formation. Sur le terrain, il s'est vite avéré difficile de ne retenir que deux ou trois espèces dominantes, surtout dans le “matorral”. Sur la carte des combustibles végétaux, seules deux ou trois plantes on été référencées; néanmoins, lorsque des espèces paraissent avoir un rôle non négibleable dans la vulnerabilité au feu de la végétation. c). Taux de recouvrement des différentes strates constitutives, égal à la somme du quotient de la projection verticale d’une strate donnée par rapport à l’aire total d’échantillonnage correspondant au biovolumen que représente le volume total occupé par le matériel végétal de la formation susceptible de brûler lors d’un incendie. d) Commodités poiur la lutte contre le feu: c’est une autre variable par rapport à la propagation de l’incendie. La symbolisation finale de la description détaillée d’une formation végétale est de la forme par exemple: LHd.311= type de formation, nombre de strates, indice de biovolumen. — CV- Ea- br : espèces dominantes par ordre d’importance décroissant (en capitales, les ligneux hauts; en minuscules, les herbacées; en mixte, les ligneux bas).

Figure 2. Extrait de la Carte des Formations végétales Combustibles des collines côtières de Valparaíso.



D’autre part l’évaluation des risques potentiels d’incendies inhérents aux formations végétales; passe pour l’aplication des autres trois principes et techniques:1.- La notion et méthode d’évaluation du “risque d’incendies”. Cette notion est inhérent à une formation végétale et se réfère tant à la probabilité qu’un incendie puisse s’y déclencher qu’à la facilité avec laquelle il risque de s’y propager. Dans son ensemble, l’évaluation de cette intensité fait appel à une notion fondamentale, celle de “l’état du combustible végétal” lui-même.

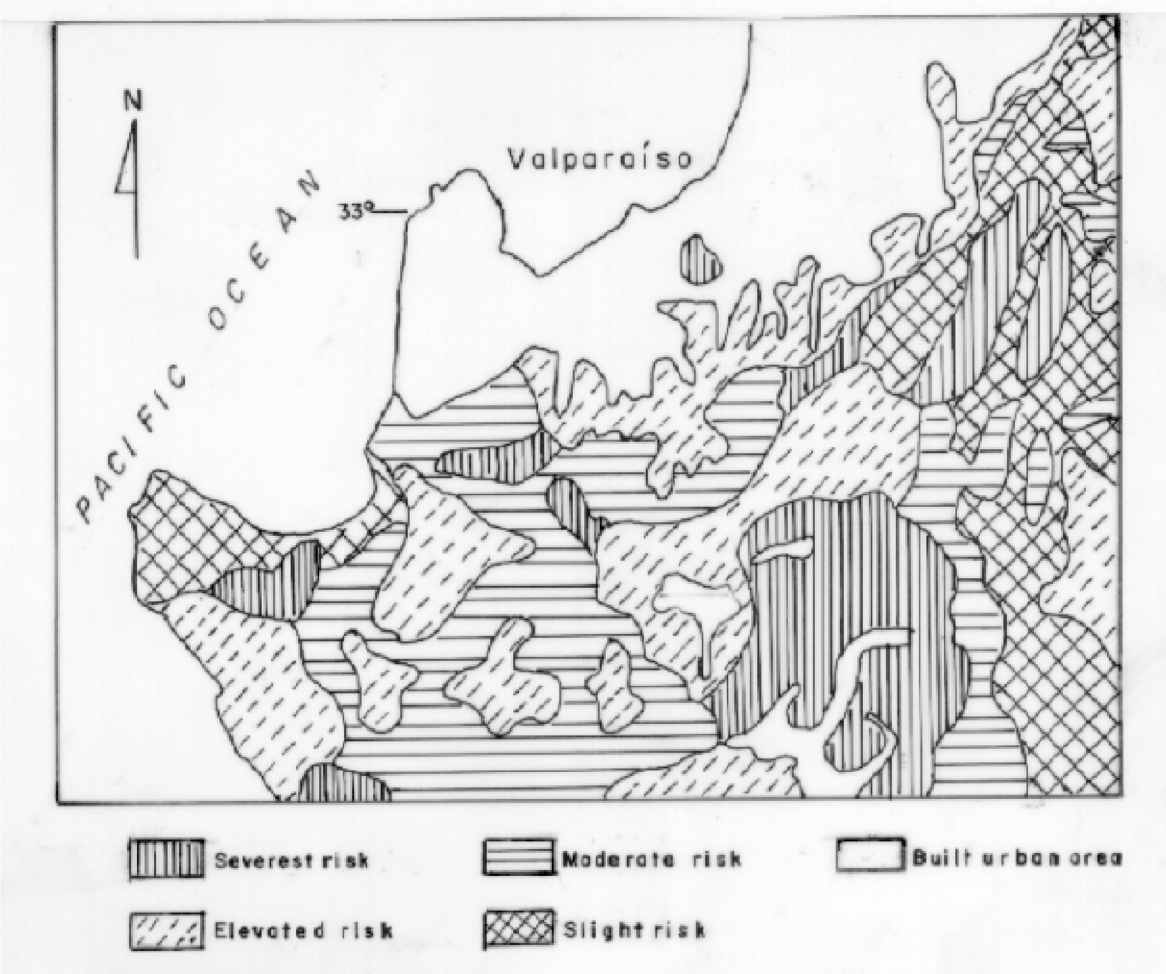
2. Carte de la sensibilitá au feu, laquelle a pour objeticf de renseigner sur l’état d’inflamabilité d’une formation

végétale combustible donnée. Résulte de la combinaison de l'inflammabilité des espèces dominantes et de la structure de la formation qui tient compte à la fois de l'ensoillement du sous-bois, de la multiplicitá des strates et de la proportion des formes biologiques. 3. Carte du comportement au feu: Fondée sur les notions de biovolume, cette carte traduit l'état de combustibilité des formations végétales dans leur diversité spatiale.

Alors en suivant à Trabaud(1970,1973,1993) et à Ozenda (1988), la cartographie se continue après para la carte de sensibilité au feu ou Carte de Risques, à partir des cartes anterieures de synthèse. Ces informations permettent d'avoir une meilleure connaissance du risque et du comportement du feu dans cette région cotière du Chili central. A l'échelle de la région, il s'agit à la fois de localiser les zones à risque et d'en évaluer l'étendue dans l'espace en fonction des quatre indices de risque retenus. Schématiquement, l'évolution de la sensibilité au feu des formations végétales se traduit par une diminution progressive de cette sensibilité du West vers Ouest de la zone cotière. (Figure 3).

Pour le moment nous sommes en train de finir la première phase de cette cartographie diacronique: celle des cartes de formations végétales combustibles et celle des cartes de risques à grande et moyenne échelles,1:25.000 et 1:50.000. Nous avons travaillé sur un total de 45 parcelles isophènes pour aboutir en une description détaillé de la végétation. La typologie d'identificaction des communautés végétales, ce fait en suivant la classification proposée par Godron et al. 1968 et modifié par Trabaud(19971 et 1973).

Figure 3. Map the risk of fire the Valparaiso zone.



Conclusion.

Faire un diagnostic prévisionnel sur les changements de la végétation native au Chili méditerranéen á cause des incendies avec l'appui de la cartographie, pour l'instant devient très difficile lorsqu'il y a l'apparition des conditions écologiques inédites. On a encore une manque d'information et des études sur le comportement du feu et de la réaction des écosystemes. Outil de travail et de réflexion, la carte des formations végétales combustibles de Valparaíso et les cartes de synthèse du risque d'incendie qu'on en tire, peuvent trouver une application tant dans le domaine des óperations de lutte contre le feu que dans celui de la prévention.

Pour le moment on constate une régression espacial de la forêt sclerophylle et de bois humide des ravins, une régeneration assez importante de quelques espéces (exemple *Lithrea caustica)* ; mais aussi l'installation de plusieurs arbustes et herbes introduites. Avec l'appui de la cartographie et des GIS, nous esperons suivre la modification dans le temp et l'espace de quelques aires du Chili Central qui'ont été brûlés depuis 35 années.

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Modern Challenges of Geological Cartography

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Abstract

In the paper major emphasis is placed on the methodological and applied aspects of geological cartography. The correlation between factographic and interpretational information in the maps is the key issue in this problem. An important means for improving geological maps is to emphasize their orientation at solving the practical tasks.

Generalization was and remains one of the key issues of mapping. The basic approach to the solution of the problem is the development of the system of qualitative and/or quantitative criteria for selecting the displayed bodies, rules and techniques of constructing a correct generalised presentation. Quality control forms a separate part of the generalization problem.

A very important condition for compiling modern geological maps is account for the regional context, which allows a deliberate generalization and compilation of map bases and interpretation maps.

One of the most important methodological issues is the study of geological maps. Its tasks range from the cartometric study and structural analysis of the image to the study of its semantics.

In the field of atlas cartography, the issues concerning the composition of atlases intended for different purposes are not adequately developed, as well as of the scales of maps in them, the necessary minimum of the general elements of geological structure in different maps, unanimity of the cartographic design, etc.

Application problems of cartography primarily result from the necessity of increasing the social significance of geological maps and the closely associated problem of increasing the accessibility of the maps for a great number of consumers. The above problem cannot be solved without geological maps marketing, study of the range of consumers and their demands and the degree of their satisfaction by the modern maps

Problems of cartographic design include the improvement of the system of symbols, modifications of the forms of legends and other elements for the geological maps presentation

The considered problems are also important for transferring cartographic works to computer technologies.

Introduction

Since the mid-90's, realization of several major cartographic programs started in Russia, primarily the 2nd edition of the State Geological Maps on 1:200 000 scale (SGM-200) and the 3rd edition of the State Geological Map on 1:1000000 scale (SGM-1000). In this connection, it would be reasonable to consider the key issues of geological cartography with regard for the new geological notions and technological possibilities with a view to increasing the quality of maps with geological contents (MGC) and effectiveness of their public use.

The theory of geological cartography is not adequately refined. The instructive developments prevailing in the Russian publications mostly generalize the experience of the MGC compilation and do not touch upon the theoretical issues; and the publications available [Berlyant, 1986; Burde, 1990; Zablotsky, Strelnikov, 1997;

Zabrodin et al., 1986] cover only a part of theoretical problems. Insufficiently explicit theoretical issues result in a certain indefiniteness, and sometimes errors in the development of the MGC contents, selection of the methods and means for presenting geological information. The same reason also interferes with the implementation of computer technologies into the process of the MGC compilation.

The present paper emphasizes the methodological and application problems. Technological aspects (GIS and other computer technologies of the MGC compilation and publication, etc.) constitute an independent set of problems that require special consideration. Therefore, this paper touches upon them only in connection with the topics under discussion.

Methodological problems

Improvement of methodological approaches is the main mechanism for increasing the MGC quality and efficiency of their use. The central point in this problem is the relationship between factual and interpretation evidence in the MGC.

Factual and interpretation evidence

Historically, for the geological maps proper, this relationship varied from the predominant presentation of factual evidence on rocks in the petrographic maps of the XVIII - the beginning of the XIX century up to a rather significant share of the interpretation data in lithostratigraphic and stratigraphic maps of the XX century. Essentially, only maps of observations and measurements in points and along routes are purely factual. When all the other MGC are compiled, the factual information is interpreted in terms of various geological concepts . As a result, it assumes the form that does not allow restoration of the actually observed characteristics of objects in each point and each field of the map.

The presence of the factual and interpretation components in the MGC is invariably making urgent the question of their optimal combination. The new geological concepts that appeared during the last 20-30 years (lithosphere plate tectonics, notions on the evolutionary pattern of magmatism, metamorphism, concept of ore-forming systems, etc.) call for increasing the role of the interpretation component. The tasks of mineral prediction, evaluation of the presence and significance of geological hazards, etc., have a similar effect.

Genetic evidence

The general tendency of this alteration is a more conspicuous representation of the genetic evidence that allows a deeper understanding of the evolutionary history of the region or body and more grounded prognostic inferences. The most logical means for showing the genesis is the inclusion of these data into the characteristic of units in the legend and their demonstration by additional cartographic materials.

For the geological maps, the tendency of displaying more extensive genetic evidence shows up in the inclusion of information on the tectonic or paleogeographic environment under which the geological bodies form. This trend is advancing A.P.Karpinsky's concept [Karpinsky, 1949] of the presentation of the environment under which the deposits emplaced. Under such an approach, the map units are distinguished with regard for both their composition and age, and the tectonic (and for sedimentary formations - paleogeographic) environment. Presentation of these data allows a more grounded evaluation of the mineral potential of the mapped area. The most informative procedure is to construct (in addition to the usual legend) a zonal correlation scheme of geological formations with indication of the tectonic and/or paleogeographic environments under which certain units form. These schemes can also demonstrate the age affinities of mineral deposits, specific character of the dislocation, magmatic, etc., processes.

Practical significance

Mineral prediction

An important means for improving the geological maps is to enhance their orientation at mineral prediction. This, particularly, means the indispensable presentation in the geological maps of independent map units for bodies that are of prognostic significance (ore-controlling faults, metallogenically specialized sequences and intrusive masses, areals of metasomatic formations, etc.). For determining the prerequisites to the development of the region it is also necessary to supplement the characteristic of the legend units at least by a qualitative evaluation of geotechnical properties of rocks (stability of slopes, ability to swelling, landsliding, etc.).

Mapping of the productive systems

Enhancement of the genetic trend is also necessary for the maps of mineral deposits; this is attained by their compilation on the geological base containing geological bodies that are of prognostic significance. This enables to connect the generation of minerals with the formation stages of volcanic structures and intrusive masses, epochs of folding, paleotectonic and paleogeographic environments, etc.

One of the potential trends is the distinguishing the productive (ore-forming) systems of different type, rank and age, i.e. systems of ore-controlling factors that reflect a successive concentration of the commodities and have different prognostic significance, as an independent mapping object. The deposits forming a common genetic series and assigned to a single productive system (for instance, tin deposits from greisen to low-temperature hydrothermal ones) will be presented as parts of such a system. For the maps on different scale, the productive systems will correspond to ore regions, clusters or deposits.

Mapping of the productive systems envisages the development of their classification and mapping procedures. Certain, though inadequate steps in this direction have already been made in the Instruction on the Compilation and Preparation for Publication of the State Geological Maps on 1:200 000 issued in Russia in 1995.

One of the aspects of improving the maps of mineral deposits is to ensure the possibility of their studies, primarily cartographic research. The available recommendations imply the selection of the displayed bodies without distinct selection rules that restricts the possibility of cartometric research (for instance, density of mineralization shows).

Schemes displaying the economic geological conditions of deposits development should be an essential element of the map.

Presentation of subsurface geological structure

Presentation of subsurface geological structure refers to the interpretation constituent of the MGC. The key issue is to show the three-dimensional space and three-dimensional geological bodies using the two-dimensional cartographic material. Several techniques are applied to solve this problem - maps of isohypses and isopachs of units, sections, systems of sections located in axonometric projections, block-diagrams, etc. However, generally, no satisfactory graphical solution has been found. As yet, it seems it would be best to present subsurface structure in the geological-geophysical sections and special schemes.

Generalization

Generalization was and remains one of the key issues of mapping since it represents the basic contents of the map compilation process [Burde, 1990; Strelnikov, 1995; Zablotsky, Strelnikov, 1995]. At present, it has a particular significance in Russia, since the new editions of the State Geological Maps-200 and 1000 (SGM-200, SGM-1000), to a major extent, display the result of larger-scale MGC generalization.

The main approach to the solution of the problem is the development of a system of qualifications (criteria) for selecting the bodies displayed rules and means for constructing a correct generalized image. One should distinguish between the qualifications of the contents generalization (selection and generalization of bodies in terms of the scientific and practical significance) and qualifications of spatial generalization (selection of objects in terms of size, including the use of cartometric characteristics). The rules for constructing a correct image should also be applicable for automatic generalization. The development of such automated procedures is an important task for ensuring the computer map compilation.

An independent element of the generalization problem is its quality control. The following techniques should be regarded as the most perspective ones [Burde et al., 1997; Zablotsky, Strelnikov, 1995]: analysis of triple junction points (indicators of the space-time relations character), extreme points and segments of boundaries, perturbation method (borrowed from the theory of catastrophes) and preservation of the fractal dimensionality of the initial and final images.

Account for the regional context

Account for the regional context (data on the geological structure of the entire area within which the mapped region is located) is becoming an ever more important condition for compiling modern MGC. Only account for these data enables to deliberately conduct the generalization and compilation of base maps (geological, Quaternary formations, minerals, etc.) and interpretation maps (tectonic, subsurface structure, etc.). Presentation of the regional context also includes reconstructions (palynspastic, paleotectonic, etc.).

One of the mechanisms for displaying the regional context is the compilation of legends for the series of the State Geological Maps. It is critical to determine the minimum rank of units in the legend. The instructive materials in force envisage the use of units of local occurrence (subformations, members). This overloads the legend of the series with details, impedes its compilation and results in the necessity of constant additions to it when specific areas are mapped. The legend of the series should be considered only as a framework for the legend of a specific sheet and its details for the scale 1:200000 should be restricted by a formation and equivalent units; and for the scale 1:1 000 000, by a formation or a group; and for a number of settings, by a horizon.

Maps research

Solution of the MGC research problem involves the elaboration of research procedures for different geological settings and different practical tasks [Berlyant, 1986; Burde,1990; Merke,1983;Morrison,1983]. The range of the tasks of map studies problems is rather extensive: from cartometric studies of the image (hence, also the geological structure) and structural analysis of maps (particularly, distinguishing of the regular constituents of geological structure and deviations from uniformity) to the studies of the image semantics and compilation of the derivative maps. Here, the theoretical and methodological elaborations are necessary with regard for the potentialities of GIS technologies.

Atlas cartography

Atlas cartography is the most powerful means of comprehensive geological studies of the territory and evaluation of its development conditions. It also provides extensive possibilities for using computer technologies in map studies. However, at the moment not sufficiently perfected are such theoretical and practical aspects as the compilation of atlases for different purposes, scales of their maps (they can be different), the necessary minimum of the general elements of geological structure in different maps, unity of cartographic design, etc.

New types of maps

In connection with the map compilation it is often necessary to compile the new types of maps. At present, new types of the MGC are, as a rule, connected with presentation of the new geological theories and new practical tasks. The analysis of the national experience shows that in certain cases new types of the MGC are compiled without adequate theoretical basis that reduces the efficiency of their use. In this connection, it is necessary to develop the system of the MGC that would enable to predict new types of maps and carry out their well-grounded design.

Application problems

Social significance

Application problems primarily result from the necessity of increasing the social significance of the MGC. This challenge in the last 10-15 years was the concern of the geological surveys in practically all the developed countries [Strelnikov et al., 1996]. Its importance increases due to the fact that only public recognition of the usefulness and necessity of the MGC for solving an extensive range of practical tasks will ensure stable financing of geological mapping. For increasing the social significance of the MGC a special program on public enlightenment is necessary through the mass media, publication of popular books and brochures, lectures and exhibitions, initiating special school curricula, etc.

Users

Increase of the social significance of the MGC is closely related to the issue of increasing the accessibility of the MGC to a broad range of users. This is due to the fact that the MGC are a highly scientific product overfilled with diverse information and based on a number of theoretical concepts and the use of specific cartographic language with a great number of provisions. Due to this, the MGC are difficult for understanding for many, as a rule, not sufficiently skilled consumers. One of the possible solutions can be the compilation of specialized maps, using the base MGC, that are aimed at solving definite practical tasks (for instance, the map of slope stability, map showing the possible occurrence fields of road ballast, etc.). GIS technology allows a rather quick compilation of such maps.

Marketing

The above problem cannot be solved without MGC marketing, studies of the range and requests of the consumers and their satisfaction degree with modern MGC. Such research has not been conducted in Russia. The above tasks can be solved by surveying the potential consumers using special questionnaires (as this is done by the state geological surveys of Canada, France, USA, etc.).

Cartographic design

The issue of cartographic design should be considered both in terms of increasing the information capacity of the MGC, and their accessibility for the consumer. This is particularly urgent at present due to the implementation of computer technologies of MGC compilation and publication. The problem of cartographic design includes the improvement of the systems of symbols, modification of the structure of legends and other elements of the MGC presentation. The improvement of the systems of symbols should be conducted continually in terms of increasing the illustrative character of maps and presentation of the new practical and scientific information. Modern systems are inadequate in terms of their perception. For instance, in the series of symbols designating the deposits of different size the neighbouring gradations differ 1.3-1.6 times, whereas for their separate perception the difference of at least 1.7 times is necessary (Feher's rule). A similar situation is also recorded in the systems of specks, line thickness, etc. Presentation of the new data (for instance, on mineral deposits and composition of enclosing rocks and vein minerals) also calls for the improvement of the systems of symbols.

The modern indexing system is also rather cumbersome when the index is transformed into an abbreviation of the inscription to the symbol. However, the role of the index is to correlate the given map field with the legend. Therefore, the length of the index should be actually restricted by 3 or 4 symbols that would facilitate the compilation of maps, including the case when computer technologies are applied.

Legend

The necessity of improving the structure of the legends is determined by the fact that the traditional legend as a vertical column of rectangles in many cases does not allow a visual presentation of the specific geological structure of different parts of the region. It should be noted that in the foreign practice the diversity of legends is approved even in sheet-by-sheet editions of geological maps [Strelnikov et al., 1996]; there are such legends as matrix, tectonized (compiled from individual structures), zonal of different versions, legends - stratigraphic columns, legend with grouping of sedimentary, volcanogenic, intrusive and metamorphic formations, etc. Sometimes the legend of one map represents a combination of different legends for different complexes of formations. For the domestic MGC the use of different types of legends in conformity with the specific geological structure of the region should also be recommended.

Increase of the information capacity of the MGC and of the possibility of their practical use can be attained by introducing additional schemes and maps into the marginal representation (see above).

Conclusion

The present paper is an attempt at considering certain issues of geological cartography that are most critical in the authors' opinion. The authors are hoping that this will enable to more clearly present the processes that occur in geological cartography and are commonly not formulated explicitly. The formulation of these problems and the possible ways of their solution can be an impetus for initiating the research on the theory and practice of geological cartography and will enable, at least to a certain extent, to avoid the predominantly "normative" trend of its elaboration which was characteristic of Russia during the last 150 years. At the same time, the considered problems are also important for transferring the cartographic works to computer technologies. In the process of technological renovation the problems of taking into account the requirements of technology to the contents and design of maps and their compilation procedure will, inevitably, arise. In this case, it would be necessary to reconsider the meaning of several provisions of cartography. Possibly, the problems of contents and design of a number of maps (particularly, maps of mineral deposits), atlas cartography, etc., would be solved differently. Essentially, the case in point are other forms of presenting the information.

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