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CONNECTION BETWEEN REMOTE SENSING AND DATA-BANK FOR THE LAND THEMATIC MAPPING

Abstract

The photointerpretation of satellite imagery or aerial photographs, represent a necessary integration of the territorial data, collected in a data-bank.
This methodology permits the systematic revision of the above mentioned bank and, in the same time, the detailed investigation at larger scala of territory relevant problems.
For example, is mentioned here the methodology for the carring out of slope stability and erodibility maps.

Introduction

The special geolithologic characteristics of several regions, a marked exodus of the population from the hilly areas, changing climatic conditions, make Italy one of the European countries, today most subject to imbalance. Given this difficult situation, public bodies and research organizations must strive to pick out the most suitable and speedy means to face in a concrete manner, the problems which nature creates for the expansion of mankind. Several technical and research units of the Emilia-Romagna region and Bologna University inspired by these ideas, have for some years now been setting up a series of methodologies which are meant to become concrete and useful instruments of intervention, able to answer the various political/administrative needs and therefore offering the possibility of reference to the various territorial autorities (national, regîonal, provincial, council

and so on).
Many research studies also form part of several projects drawn up by the National Research Council.
And in fact, it was as a result of one of these Regional University/N.R.C. collaborations, made possible to define the working methodology and its subsequent application, which constitutes the theme of this report.
A map showing tendencies to hydrogeological imbalance and risk of natural disasters should not be missing among the instrumentsneeded to better the knowledge of the Italian territory and for plans to reshape it; in the case of mountainous and hilly territories, it is possible to prepare these documents, having defined, above all, as a starting point, the degree of stability and tendency to erosion of the slopes.
Cartographical representation of territorial zones having varying degrees of stability on the one hand and of erodibility on the other, allow us to pinpoint the areas "at risk" and at the same time clearly to define areas needing intervention, foreseeing among other things, if only notionally, the measure of finance needed for saving and renewal and offering to those administering the territory, the possibility of choosing priority interventions wisely. These research studies can now be carried out quite speedily, and above all with a great deal of credibility, thanks to the instruments available: high altitude pictures from satellites and areoplanes (remote sensing), large scale cartography based on good quality high altitude vertical aerial photography, photomaps and orthophotomaps for bringing rapidly up to date existing cartography, automatic recording and processing systems of simple and complex data.

<u>Common and specific factors for compiling slope stability and erodibility maps</u>.

The salien points which serve to define the degree of imbalance tendency to which a given territory is subject, are fundamentally morphologic (altimetry and inclination of the slopes) geolitologic, pedologic, geomorphologic, climatic and concerning vegetation. In the diagram at table I the logical sequences between the various subjects are shown, both vertically and horizontally.
From a vertical view, manual and automatic superimposition of several factors under various subject headings, leads to the splitting up of territory in areas with different degrees of imbalance tendency, or of erod bility or stability of slopes; subject matter common to the different sequences and other specifications will thus be available, depending on the final aims to be achieved.
Looking vertically, we see on the one hand, a progressive study in depth of each subject and the greater meaning of the final results, and on the other hand, we observe updating and archiving of new data, which may either be brand new or having undergone variations with the passing of time or originally not very credible.
Three phases are shown in this process and they correspond directly to the type of cartographic scale necessary for representation, and which theerfore take into account at

the same time, aerial pictures used for photointerpretation and the territorial dimension chosen for automatic processing.
The following sequences will therefore be at our disposition:

Cartography scale 1:100.000/1:200.000	Satellite or aerial pictures with a scale of 1:60.000/1:30.000	Data processing for 25 hectare	Ist phase
Cartography scale 1:50.000/1:25.000	Pictures from aerial photos with scale of: 1:13.000/1:15.000	Data processing for 1 hectare	2nd phase
Cartography scale 1:10.000/1:5.000	Pictures from aerial photos with scale of: 1:15.000/1:8.000	Data processing for continuous drawing	3rd phase

It seems obvious therefore, that progressive increase in scale, gradually increases the significance of the subject matter at the starting point, which should, among other things, be represented separately from any possible subsidiary subjects, at least in the majority of cases.

Integrated system of photointerpretation - data bank - processing, for the creation and bringing up to date of thematic cartography.

The type scale which should be emploied for a cartographic document, depends on the use to be made of it;

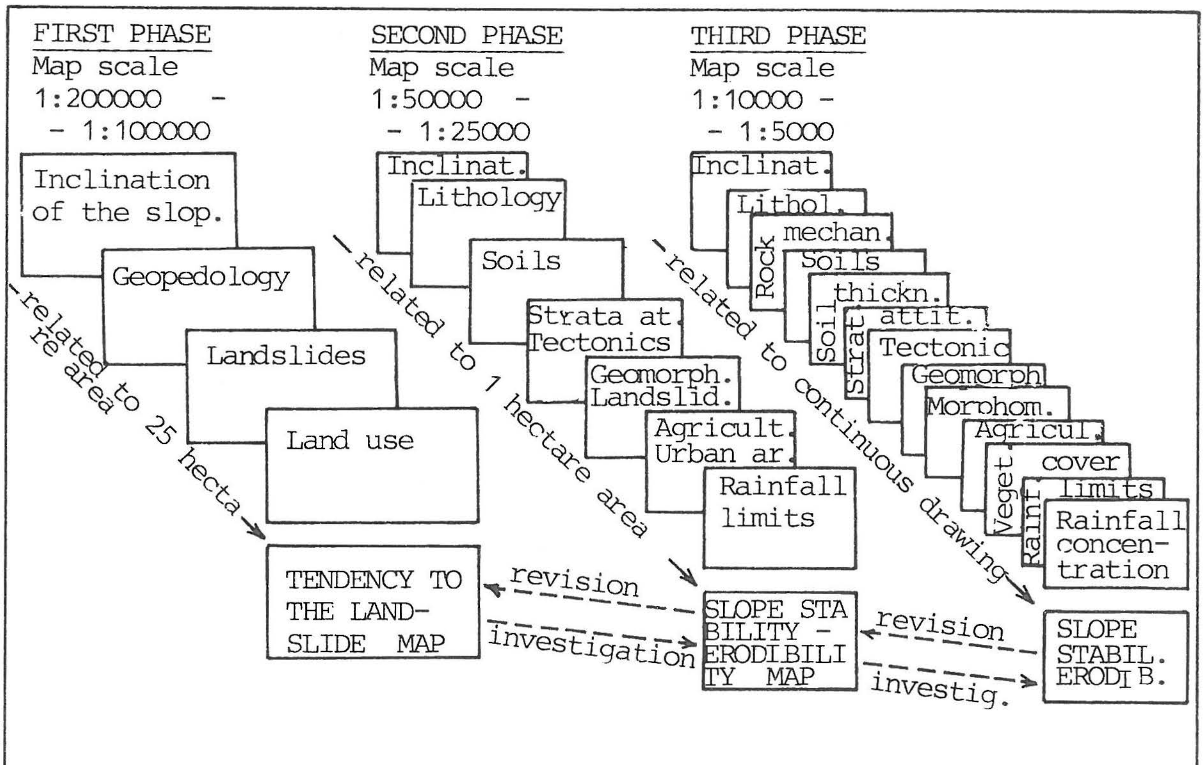

TABLE 1 - OVERLAPPING PARAMETERS FOR THE AUTOMATIC CARTOGRAPHY

It seems certainly more just, in the context of planning geared to save territory, to begin with a general review (geographic scale) and then move on to deeper research of those areas which seem to be in a greater state of disorder or affected by urban or infrastructural development; on conclusion of this last phase succesive and definitive planning choices are then possible.
During this stage of the process, the most suitable tools should be chosen and in our case, these can be summed up as follows:

- the type of photographic image for reading and interpreting the environment (pictures from satellites aerial photographs of various scales and using various emulsions);
- collection and selection of existing data in relation to their meaning and quality;
- choosing supporting cartographic evidence and its scale;
- the degree of importance to be given to the information collected in the data bank;
- definition of plants for processing the parameters of the various basic subjects, and the type of automatic cartography which it is intended to create.

The diagram below (table 2) summarizes what has been said up to date.

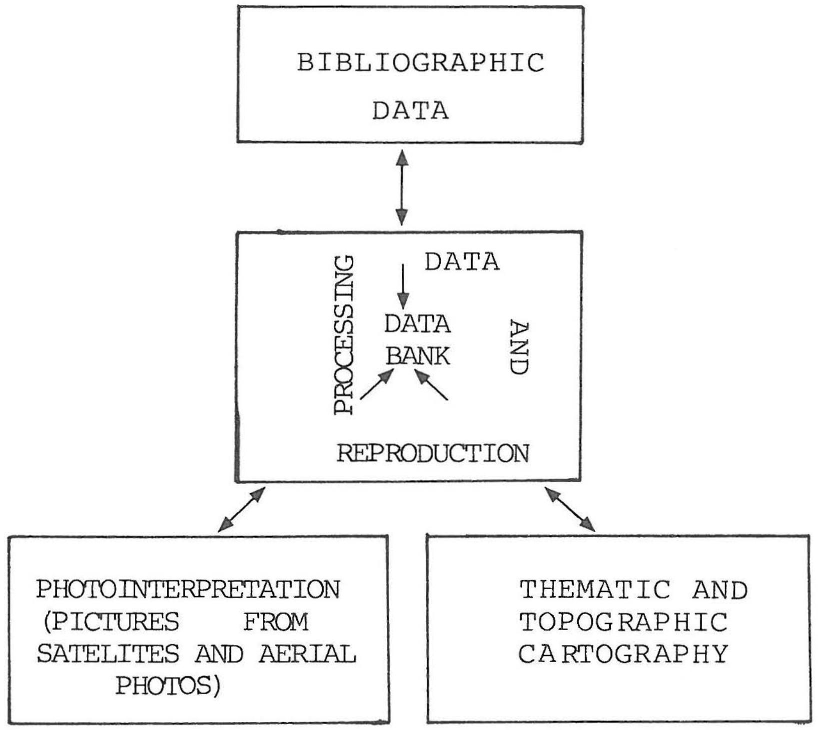

Table 2

Instruments which may be used to work the system

The instruments which are essential for an operation involving the field of territorial planning using thematic cartography brought continually up to date, are images from satellites and aerial photographs, due to the fact that they take little time and their cost is reasonable. The satellite has the undoubted advantege of providing photographs of an identical zone within a few days of each other (18 days in the case of Landsat 2); this allows us above all, to follow phenomena which periodically or repetitively affect a given zone. We use these images, in particular, to define all the areas subject to over flowing by watercourses during the longest possible period of time and also to aid in the study of both coastal erosion and establishing the relationship between erosion and development of beaches. In consequence, it is on the one hand necessary, to have a complete picture of all the defence projects which have already been carried out in order to confirm their efficiency, and on the other hand, to be able to control the various activities (extraction work, creating artificial basins, removal of woodland, etc, etc.) which go on along the banks of the main water courses and their basins.

Fires in woods during the dry season, is form the agronomic-forestry point of vieew, one of the biggest problems which is about to be faced through the use of satellite pictures. It is in fact vital, for the purpouses of any intervention aimed at improving the situation, to know the exact limits of the areas most frequently hit by such disasters, the prevailing direction of development of these fires, the relationship between the fires and the access to the areas by tourists, especially at the weekend, as well as, of corse, the type of woods, the existence or lack of undergrowth, the distance from urban areas.

Therefore the study of satellite pictures gives us the opportunity of drawing up geographic scale thematic maps, on which, through the use of various colours and simbols, we can represent the evolution or repetition of a phenomenon in a given zone during the course of a season and/or a year, in order to make comparisons with analogous data of preceeding years stored in the data bank. Aerial photographs should be used for medium-large thematic maps because of the need for greater detail and because often it is necessary to bring up to date the topographic basis of the thematic map.

Besides, the possibility of having straightaway photograms on different types of film and at various scales, at reasonable cost and within quite brief periods of time (providing the atmospheric conditions necessary are sufficient for photography) makes aerial photography extremely versatile and so of great help in dealing with any problem. In particular, for maps of a scale 1:10000

1:5000 and over, the information required has to be so detailed that only a large scale aerial photograph, possibly carried out with a lense with a focal length of 300mm, 600 mm, is capable, on the one hand, of satisfying this demand, and on the other, make for a valid integration of the data gathered on the ground, to continuously complete and bring up to date the material in the data bank. Further, the importance of medium large an medium small scale aerial photographs should not be underestimated, because of the wide overall view which they provide and because they make the identification of physical factors and environmental characteristics, much surer and quicker.

Let's quote a few examples. A lithological border can more easily be indentified and followed in its phases of development on photographs which are usually monochrome, panchromatic and of a scale of 1:25000 - 1:33000; but if we wish to map the exact points through which the border passes, therefore taking into account any possible local variations due to fractures or faults or simply to a slight folding of the strata, we need to use large scale photograms. Geohydrologic study of a basin can be done by using medium-large scale black and white photograms, but the systematic study of all manifestations at the water surface to identify springs or water beds at surface level or at slight depth, calls for the use of infra-red , preferably in black and white and at large scale.

The identification of a landslide movement and the accurate demarkation of a landslide body, on the other hand, call for large scale photographs with very little image distortion, and for these reasons it is necessary to employ lenses with long focal lengths (300 mm) and narrow fields of view; as far as the type of film is concerned, colour and false colour are preferable, the latter being especially useful for identifying the plants uprooted by the landslide and therefore dead, and those unaffected and still living. Last of all, gathering statistics of special cultivations and the verification of the spread of plant diseases, make necessary the use of very large scale false colour type photographs.

All the informations provided by the satellite pictures and the aerial photographs may be used according to two different schemes, both as far as the creation of thematic maps is concerned and for bringing up to date the data bank. The first scheme includes the following stages: notating the photos; drawing up the thematic map with possible up dating of the topographic basis; bringing up to date the data bank. The second scheme, on the other hand, includes the following stages: reading the photographs; completing and bringing up to date of the data bank; automatic drawing up of the thematic maps.

We use the first scheme when the principal aim of the work consists of the creation of a thematic map for which there is urgent need. In this case the photographs are read and notated using transparent and non-deformable templates, the information is subsequently transfered, by the use of apropriate instruments such as the Zoom Transfer Scope by Bausch and Lomb of Rochester (New York), or the Stereo Facet Plotter of OMI (Rome), onto a topographic map of the desired scale, at the same time, bringing it up to date, if necessary.

Later the data bank is brought up to date by transfering onto the thematic map, the grid relating to the scale of the map, that is; in the case of a hundredthousand map we show grids of 25 hectares; in the case of a twentyfivethousand scale map we show grids of one hectare; and lastly for scales of over tenthousand we digitize the data on the map by points (continuous drawing). We use the second of the two schemes when the purpose of the operation is to complete and enrich the data bank. Photographs are read by instruments such as the Stereocord G. 2 by C. Zeiss (Oberkochen) and data for grids of 25 hectares, 1 hectare and for continous drawing, is memorized according to the scale which it has been decided to use. Later, when a thematic map is needed, it is possible to obtain one immediately and automatically by use of the plotter.

The creation of a territorial information system calls for the reproduction of thematic maps of the required form and scale by means of the plotter. This is particularly useful as it allows:

a) to have the results of processing immediately at one's disposal, in visible form;
b) to check the correctness of the memorized maps in relation to the basic data;
c) to have map making instruments which are completely complementary to others.

But the system shows just how useful it is,when we want to compare data from different thematic sources and process it in order that it may be cartographically reproduced, thus avoiding a long and sometimes imprecise manual task.

Nevertheless, various methods exist for preserving a thematic map in the memory of the calculator, depending on one's aims and especially on the scale one intends to use, and these methods can be placed into two fundamental categories: the first is based on the precationary subdivision of the territory under examination into elementary areas, usually of regular shape and equal one to another (subdivisions for geometric units); the second consists of reproducing the various zones making up the map in the form of regular and closed sequences of points.

In the first case it was considered simpler to subdivide the mapped territory with a right-angle map grid based on the kilometric U.T.M. (Universal Transversal Mercator) system in order to obtain square shaped cells with surfaces of 25 hectares (500 m x 500 m at the side) for geographic zones having a scale of 1:200000 and 1:100000, or with surfaces of 1 hectare (100 m x 100 m) for district zones at a scale of 1:50000 and 1:25000.

The values shown by the various attributes and parameters on the corresponding map are asigned to each cell; when several values of one attribute are present in the same cell, the "medium" or "prevalent" value is used.

There is good, quick reproduction of the contours in the second case, which nevertheless calls for an utilization of memory depending on the degree of fragmentation of the map and on the precision required (territorial zones expressed to the scale of 1:5000 and 1:10000); it is clear that this system shows disadvantages as far as bringing up to date information and processing are concerned, when these mean uniting and comparing various thematic maps.

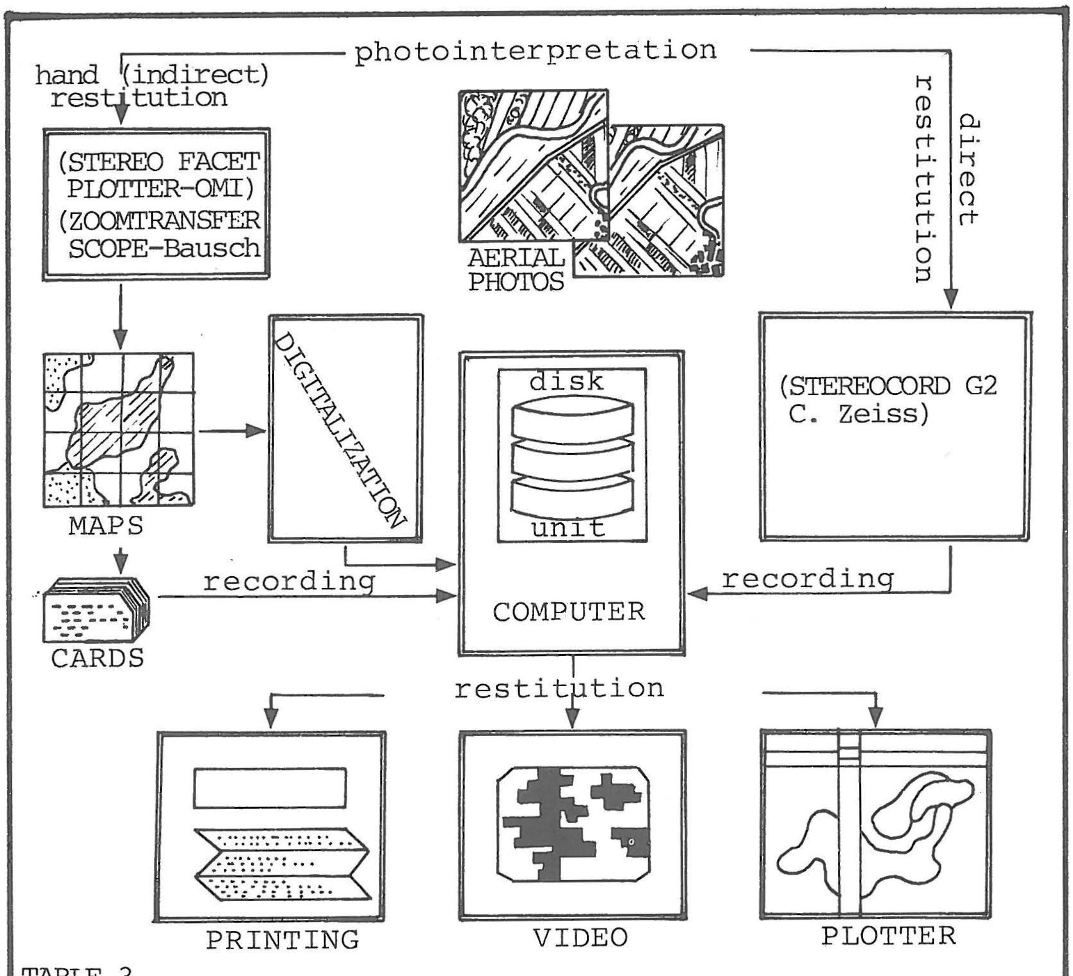

TABLE 3

An applied example: the Mount Sole park project

The above mentioned schemes have been applied to a sample area of about 6000 hectares, located at the confluence of the Reno and the Setta rivers in the province of Bologna (Italy).

The zone is made up of altimetric belts of 100 m to 700 m above sea level with a very varied lithology showing sedimentary features consisting mainly of sandstone, marl and clay of Oligocene and MioPliocene age with the exception of several not very widespread outcrops of heterogeneous rocks (argille scagliose unit and red-beds), which can be attributed to the Jurassic-Eocene age.

The material at our disposal was made up of a topographic base of I.G.M., 1:25000 scale, and a series of thematic maps of the same scale, being the slopes inclination map, the lithologic map, the land-use map, the geomorphologic and geostructural maps.

As the need for further detailed study had shown itself to be necessary in view of the probable setting up of the Mount Sole experimental park for zootechny and forestry, we started out by using the existing data, following the scheme shown on table 1, later adding data relating to the type of soil and the pluviometric. threshold, thus obtaining a map having a scale of 1:25000 as ever, showing the stability and erodibility of the zone.

Later we moved on to further detailed study of the physical and mechanical characteristics of the more interesting areas or still better those areas which had been found to be critical from the point of view of their stability and erodibility vis-à-vis present and future anthropic activity.
The topographic bases for these studies were new orthophotomaps with a scale of 1:10000.

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