A SYSTEM , BASED ON VISUAL COMMUNICATION, ORIENTATED TO NON DEDICATED USERS , PROCESSED BY A PERSONAL COMPUTER , FOR MERGING LANDSAT REMOTE SENSED DATA AND PLANNING INFORMATION IN LARGE METROPOLITAN AREAS. PRELIMINARY IDEAS.

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In Italy Landsat data are not,unfortunately,widely used in the study and management of metropolitan areas. One reason is that in using remote sensed data ,it is extremely difficult to classify different activities,physical structures, textures and patterns in Italian settlements ;another lies in the fact that at federal level there is a lack of nation-wide land-use and land cover general classification.

The lack of a general land classification has been and still is a serious obstacle at all levels especially in the communication between various territorial boards and links between the various planning stages.

In countries such as Italy planning is now playing a larger role and involving wider sectors of the population (though the latter may be represented only) but nowadays,more than before,planning requires technical and advanced technological support,which can only be supplied by land information.

Land cover information,as we know, consists of two essential parts: physical and non-physical(social,economic,behavioural etc.),and the planning programme should comprise both these parts. Planning agecies or boards should then communicate partial and final results of planning,and this is quite indispensable when dealing with higly urbanized territories.

Since urban areas involve complex mechanisms it is impossible to deprive the inhabitants of that advanced technology which enables them,through the knowledge acquired,to improve their conditions of life.In this paper I would like to demonstrate how through the use of "simple instruments" which are however ideologically sophisticated,advanced technology for knowledge and the monitoring of the territory may be supplied to zones in large metropolitan areas.

There is no final product to this paper,it gives simply and conclusively information on communication through the vision of images of a system which is being constructed and because of a shortage of funds requires long-term implementation.

The first part of the paper shows some of the results of the research,sponsored by the Italian Commission for Cultural Exchanges between Italy and the United States,which was carried out at the ORSER (Office for Remote Sensing of Earth Resources) see note Ø1.

The second part of the paper shows the first results and the generated ideas of merging the information obtained by satellite data with geographic information, processed by a small personal computer in some test settlement areas in Rome (Italy). Note Ø2.

The results given in the second part are not to be taken as the first output of our method and system which when completed will enable us,through the use of the equipment shown (see figure A),to take subscene data of remote sensed images as our starting point and monitor them directly,rather than utilising results already obtained by monitoring images another way.

It must to be remembered here that the products of remote sensing are rapidly improving their quality and this will obviously facilitate land data monitoring (e.g. the use of thematic mapper on the next Landsat).

A few data and some detailed indications can provide a better understanding of the area that has been studied .

Area in Square Kilometres :1499
Population :2769 thousand people(1971Census)
Estimated average density of inhabitants: 8945 inh./sq.Km.
Lowest density level : 131 inh./sq.Km.
Highest density level :19105 inh./sq.Km.
Parks and open spaces : 21 sq.Km.
Approximate diameter of area covered by the municipality : 50 Km.
Approximate diameter of high density area : 15 Km.

From the geological point of view the river Tiber ,which flows through the town ,gives particular features to the valley : alluvial soil,clay and extrusive igneous rocks.

There is a great lack of parks in Rome but quite a number of open spaces. The texture of the settlement is such that open spaces are easily found between blocks and buildings; sometimes there are trees along the sidewalks.

The historical centre has no green spaces but its small dimensions and the archeological sites allow the inhabitants a satisfactory quality of life.

Several centuries ago the Rome countryside was very well-known and had a wealth of typical unique features;now the urban sprawl has changed these features and the surrounding environment is an example of a low-urbanized area.
In spite of this there are still some gricultural fields which produce vegetables for small family units.

On the edge of the municipal territory ,which is the largest in Italy, having a diameter of about 50 Km.,there are grape fields on the hills and large agricultural areas.

Public transportation in Rome runs almost exclusively on the surface,there are two subway lines in use and another under construction.Private transport has an important part in urban traffic and is used especially for commuting.

In accordance with the compact style of European cars the roads are eight meters wide, the medium-sized ones ten meters and the widest roads twenty one meters. In the old parts of Rome and the historical centre streets are often no wider than two or three meters.

There are three important constraints to overcome in the study of a metropolitan area such as Rome :
- the definition of the borders;
- the definition of sample areas;
- the definition of parameters for land -use classification.

These definitions must be drawn up each time an urban area is approached for study. The Rome area was chosen as representative of a typical urbanistic situation in order to have an example of a settlement in a geographical position which is easily locateable in Italy.

The purpose was to provide an itemized approach in order to use remote sensing in European urban areas charact terized by high density population and large settled areas.

Three sample areas were analyzed and selected to have indications of the three most important constraints mentioned above.

It must be pointed out that increasing the number of sample areas also increase the classes of land-use.It means that the detail increases, but on the other hand the aggregation of land use data decreases and the data can not be used to recognise the patterns and parameters of urban environment .The problem lies in the optimization of the detail in classification. In order to do this the aims of land-use classification must drafted beforehand.

In this research there was no specific aim so the analysis of the sample areas was comprehensively oriented to give the broadest scope and information in preparation for future studies and also define how urban areas of this type should be approached.

Land-use classification must provide classes to distinguish different types of urban environment . The classes must be realted to the urban environment parameters and the fëatures of the existing situation.

The analysis made on the sample areas in this research gives classes realted only to the features of the existing physical situation above the ground in the urban areas studied.

The sample areas were analyzed through categories identified by signatures obtained from the study of training areas. These categories and their signatures were obtained by studying the urban area through:
- computer programs able to recognize the uniformity of pixels (picture element);
- computer programs able to give statistical information about the area;
- computers programs able to cluster the signatures into categories;
- computer programs able to interpret the study area and modify the categories according to statistical information of all urban area;
- computer programs able to correct the data on the desired scale and produce display files.

See the ORSER system,see bibliographic references.

The signatures dropped from the training areas were used to find categories to classify the urban areas. The results were displayed on the video color display and/or on gray tone maps and aerial photographs of the urban area to define signatures of particular componentsof the urban environment.

One of the most important constraints to overcome in studying the sample areas and the study areas as a whole was to choose the most convenient scale for study of the sample areas.

The scale for the gray tone and colored maps was chosen in order to be overlayed on the regular maps provided by federal agencies in Italy and generally used to draft master plans and design particulars.
Thus the scale 1:25,000 ; 1:15,000 and 1:12,500 were chosen.

Merging Landsat and planning information -- (part two).

The city of Rome is divided into twenty administrative zones which correspond to the same number of territorial characteristics as well as unequal number of inhabitants et.

The system being studied, some of whose results we give here,aims at merging remote sensed data with those existing on the territory related to the citizens' quality of life.

The first objection to be made against remote sensed data on this territorial scale is the scale - must this data be used for planning such small segments of settlements? Even though the answer today may be negative ,preparations must be made against the future and the continual information arriving from outer space; we need to know the scale required which gives an optimum representation of the total situation on the land .

One of the most important problems large metropolitan areas and their subdivision must face is up-dating land data and the efficacy of planning decisions.
On some occasions it may ha-pen that while a decision is being taken the land set has in fact completely changed and bears no resemblance to the forecast.

One of the features in Rome which has caused the authorities great difficulties is unauthorised building and uncontrolled inurbation. Several years ago central authorities decided to make a low-altitude aerial photographic survey which cost several billion lire in order to obtain a truly up-to-date image of the situation. For lack of funds and planning the photographs obtained did not go to form part of an information system which could be continously up-dated,and thus remained mere photographs.

The system whose results we give was set up in the following way :

- An administrative area of Rome was chosen: area number one in this case ,which had been one of the sample areas of the ORSER survey.

- The results of the Landsat image (4 August 1975) were used processed through the Orser system. (See classification given in the sub-titles to figure Ø2).

- The data for classification taken from a six class thematic gray tone map produced by a computer and geometrically corrected to a 1:25,000 scale (see note Ø3) were put into the micro system through a digitizer.

- The data of the main characteristics of the first administrative area including building blocks,roads and the course of the river Tiber ,taken from a cadastral register map scale 1:10,000 were input.

- A program was written which showed Landsat data by selecting the part of the image required (see figure) and selecting as many classes desired to be shown by the micro computer.

- A program was written to enable us to overlap the Landsat data indications with planimetric ones given by digitizing.

Figure 01 showes the central part of the metropolitan area of Rome,it is a map surveied in 1969 and is drawn at the original scale 1:25,000.

Dark areas are the built areas;some typical features of the settlement are monitorable:the Tiber river,the State of Vatican,some open green areas and part of the belt way (Grande Raccordo Anulare) that is closing the most urbanized area of the municipality.

Figures Ø1,Ø2

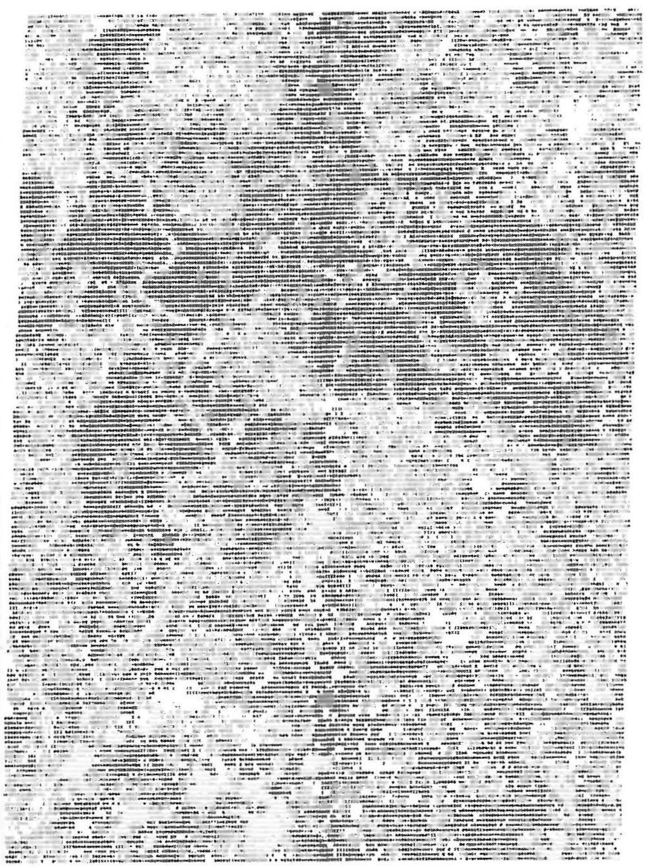

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Figure 02 is a gray tone map of urban area of Rome monitored by the Landsat 2 at date 4 August,1975.
The image is showing the area on the East side of Tiber,it was produced at the original scale 1:25,000.

Scale correction factor used on the raw data: 25,000.
Percentage covered by categories: 92%

Not classified area; 8%
Number of categories: 39
Number of land-use classes surveied: 7

The classes of land-use surveied were grouped in six tones of gray in order to guarantee the best understanding of gray tones and in order to give the most important information at this scale (1:25,000) about the studied settlement.

The six gray tones represent :

1-water bodies
2-green areas(high type)
3-green areas(low type)
4-open spaces,green in built environment
5-settlement type 01
6-settlement type 02
0-not classified areas (white).

Figure 02 showes some particular patterns of the settlement under study. It is easy to monitor the path of Tiber and the settled areas (dark areas).
Two types of settlements were checked at this scale:type 01 is a settlement characterized by compact texture and gable roof buildings;type 02 has less compact texture and is characterized by open spaces in the built area and plane roof buildings.
The old part of Rome is specified by the settlement type 01,on the other hand the new ones built after 1870 show typical features of the type 02.

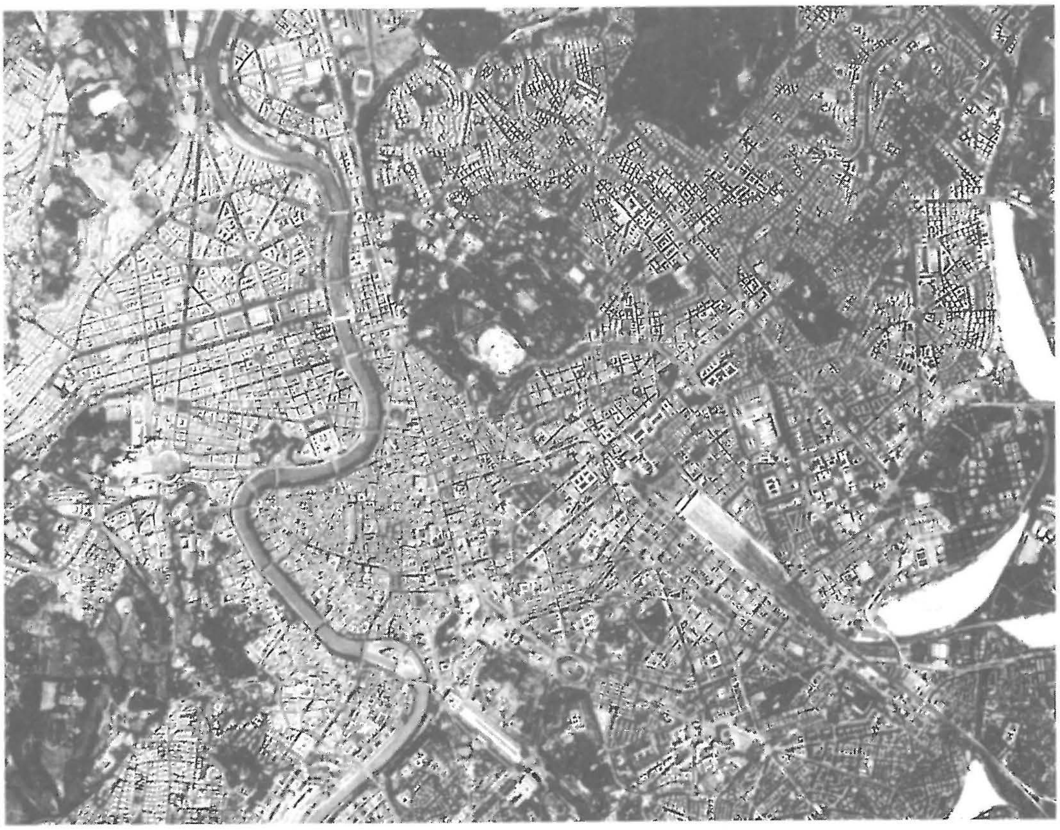
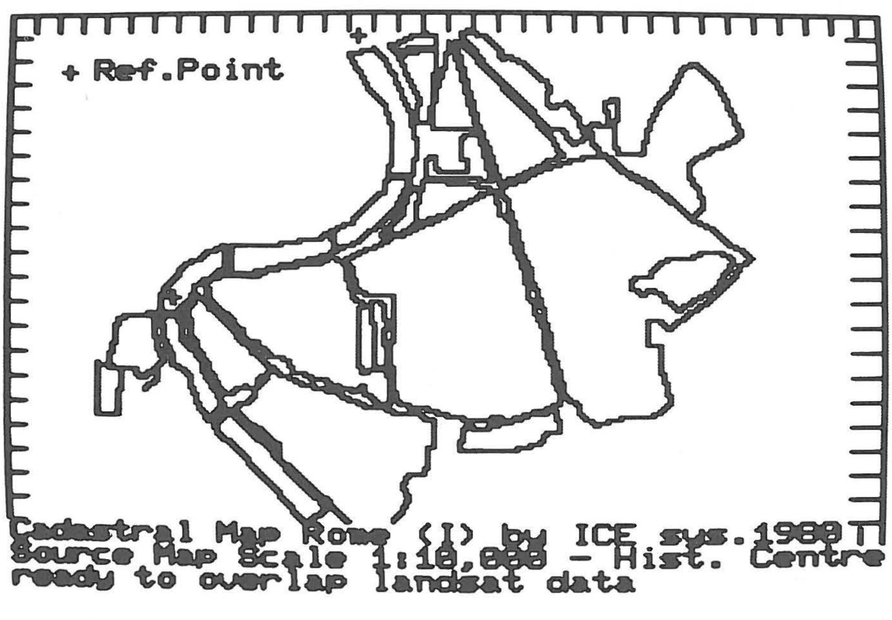


FIGURE Ø3
Is an aerial photograph taken about 1,000 meters altitude in 1976. It shows the old part of the Rome settlement containing the historical centre.
It is easy to recognize the little island in the river (Isola Tiberina) which divides the Tiber in two narrow branches.

FIGURE Ø4
Shows cadastral map of historical centre of Rome ditized from a source map (scale 1:10,000).
Three reference points were established for the alignment.
The major blocks of the urban texture were ditized in order to optimize the overlap of the Landsat data (digitized at 1:25,000 scale) and the resolution of the B/W monitor.

Figures Ø3,Ø4



The system is under study to achieve :

- inputting Landsat data directly from CCT into the micro computer;
- classifying the Landsat data directly through the micro;
- improving geometric correction;
- enabling user greater freedom in the questions he puts to the system through the use of images;in other words by distinguishing parts of the territory on the map (through the digitizer table) and receiving the response in terms of Landsat information;
- putting the information into a historical context thus enabling the user to know the previous conditions of the territory,or part of it,starting from the earliest Landsat image;
- arranging the possibility of direct interaction on Landsat information in terms of varying the values of the pixels in order effect simulations.

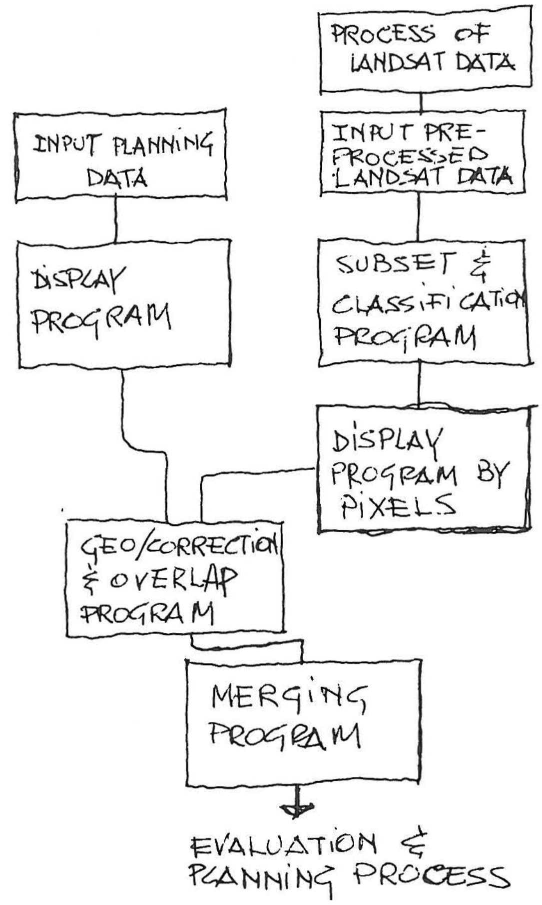
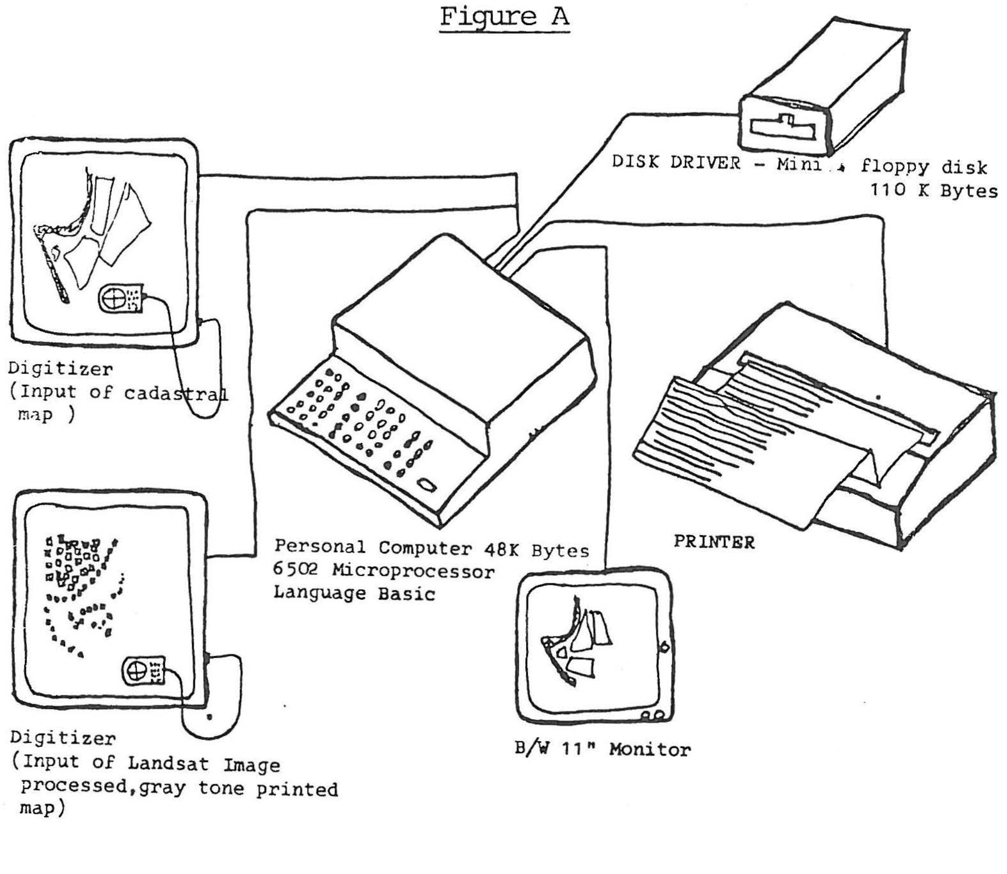
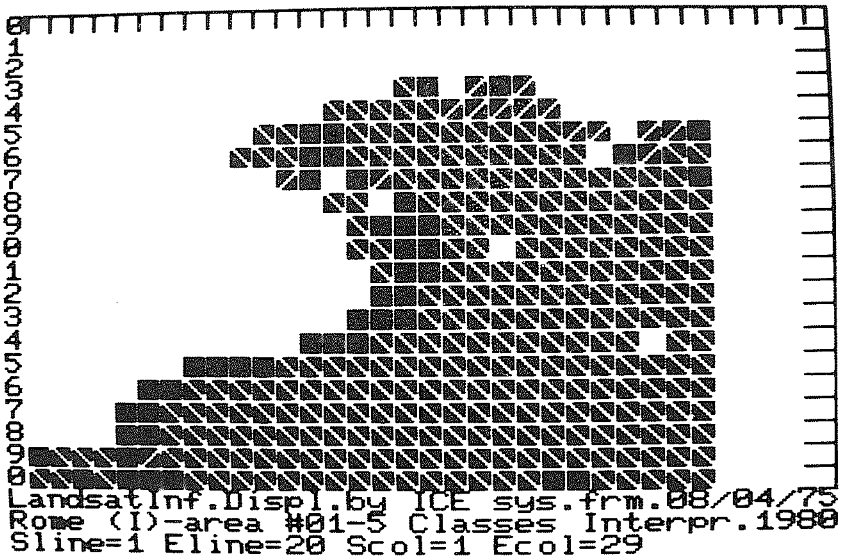
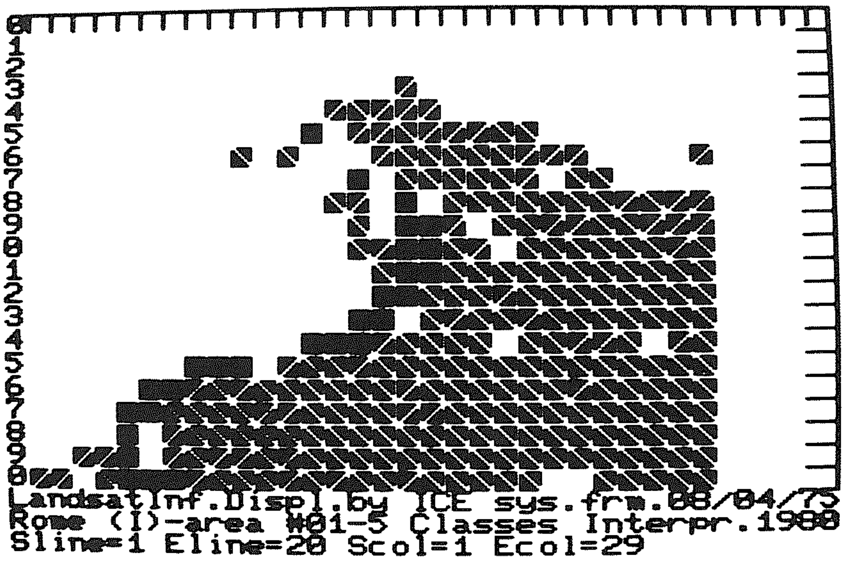
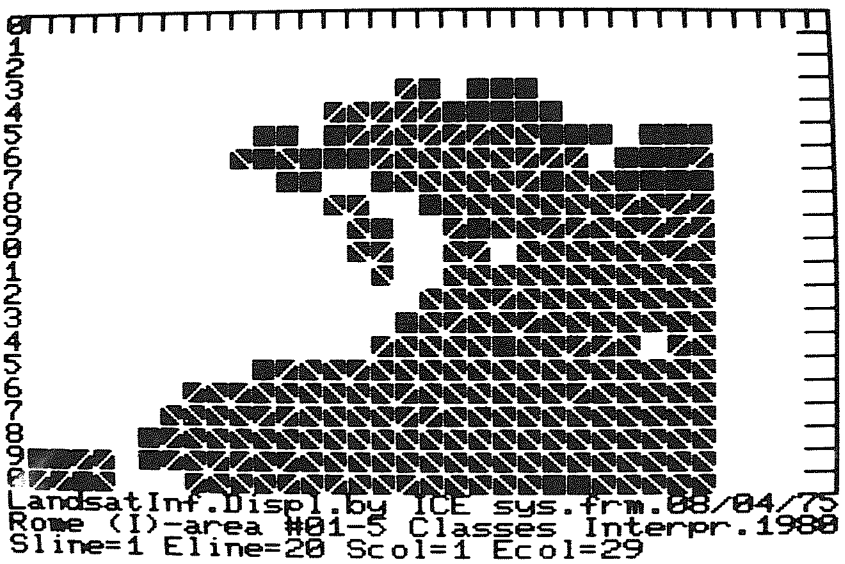


Figure A

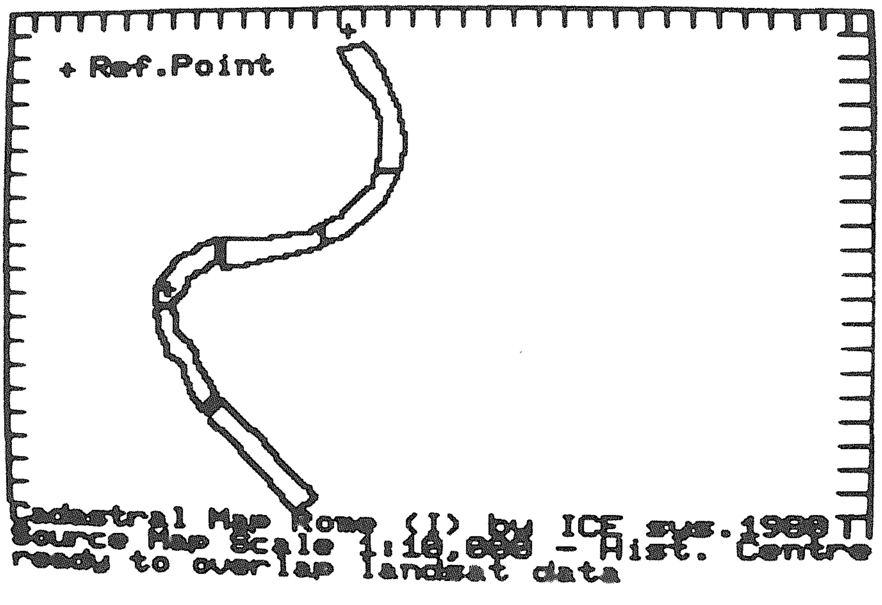








Figures Ø5,Ø6,Ø7



Figure

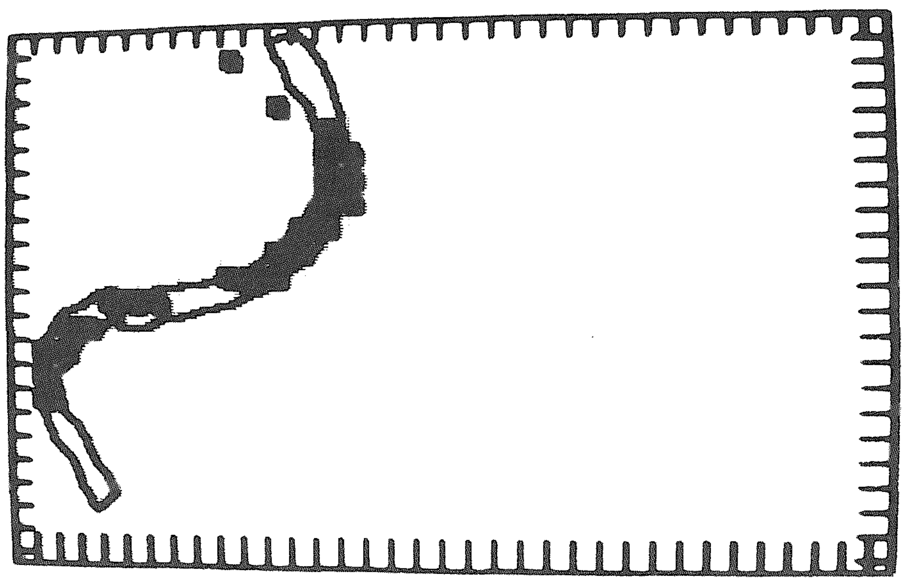


FIGURE 05 - FIGURE 06 - FIGURE 07
Show the output of the procedure on the 48 K Bytes personal computer for processing the Landsat data input by digitizing a grey tone map (see figure 02).
Five classes can be displayed on B/W monitor through five different patterns 5(black pixel, blank pixel, pointed pixel, left crossed pixel, right crossed pixel)
The user can play with categories in order to achieve the better understanding of the area.
It has to be defined by the user :
- the step of the grid;
- the start column in Landsat data;
- the ending column ;
- the starting line;
- the ending line;

FIGURE 08 - FIGURE 09
The shape of Tiber river was chosen to match the Landsat data and the cadastral information.

Conclusions.

The project is based on several guide lines discussed below :

How may a non-dedicated user utilize remote sensed data in an information system of a metropolitan area? Remote

Remote sensed data can be utilized only if the non-dedicated user can :

- understand remote sensed data easily by finding land-marks he recognises such as squares and roads etc.;
- mix remote sensed data with other land data;
- easily attempt a classification of data mentioned above .

What characteristics must data have ?

- they must be easily traceable through quick looks,for example,at the user's disposal and cartesian references placed on them;
- they must be easily dis-aggregateable, or in the other words partial classifications of the same data must be easy to obtain.

How to set up communication between the system and non-dedicated use?

- the image is the best means of communication;
- non-specialists often have difficulty reading maps;
- Landsat images are even more difficult to read and interpret especially if printed in gray tones and with partial land cassifications.

What procedure should be set up to facilitate non orientated user's work?

- colloquial ,possibly menu programs;
- questions should not be put to the user simultaneously ,only a few at a time, and possible mistakes caused by erroneous use of the programs should be envisaged.

What are the realtions between remote sensed data and the landplanning program?

- it is not easy to think of them all but as they have not all been widely used in the planning program it is impossible to envisage the developments they might have.

The salient point is that it is possible to plan on a live support,such as remote sensed images instead of on a static one such as map.

Bibliographic references:

-GeorgeJ.McMurtry,F.Y.Borden,H.A.Weeden,and G.W.Petersen,The Penn State ORSER System for processing and analyzing ERTS and other MSS data-- NTIS: E 74-10573.

-F.Y.Borden,D.N.Applegate,B.J.Turner,B.F. Merembeck,E.G.Crenshaw,H.W.Lachovski,and D.N.Thompson, Satellite and aircraft multispectral scanner digital data users manual-- published by ORSER,The Pennsylvania State University,1977.

Mauro Salvemini,Mapping and land-use classification of urban areas of Rome and Milan by Landsat MSS data--published by ORSER, The Pennsylvania State University,(1979)

NOTE 01

In 1978 the author carried out a research project at ORSER.

It was probably the first research made by an Italian research planner on large urban areas in which Landsat data were also used.

The research ,sponsored by the Italian Commission for Cultural Exchanges between Italy and United States was made with minimal resources: a single researcher over a period of approximately four months ; The Pennsylvania State University gave access to the necessary facilities of their computer center.

NOTE 02

The author elaborated the data ,previously monitored, using his own means;the system described is the property of the author and its purchase was unsponsored.

The author would be interested to be put into touch with colleagues and sponsors in order to implement the project.

NOTE 03

The procedure used to perform geometric correction of Landsat data was ORSER procedure based upon Anuta's algorithm (1973).