

A GIS FOR THE PLANNING OF OPERATIONS OVER SMALL SURFACE AREAS OF A HIGH SCENIC VALUE: EVALUATION OF THE OPERATIVE POTENTIAL OF NON-PHOTOGRAMMETRIC DIGITISED PHOTOGRAPHY

Ilaria Ambrosini*, Giovanni Checcucci[€], Lodovico Gherardi*

All the authors contributed equally to the work in this research paper.

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This work fits into a project of collaboration between the Institute for Forest Management and Technology of the University of Florence and the SELESMAR-SISCAM company. The aim of the research was to appraise the possibilities of using photographs in various formats (not all of them taken for photogrammetric purposes) in the framework of a GIS which was designed for the cataloguing and management of photographic and cartographic material of use in the planning of operations on limited areas which, nonetheless, held a particular scenic value.

The informatics system used was TNT-MIPS, the MicroImages Inc. program distributed in Italy by SELESMAR-SISCAM. This is a GIS which functions in a Windows environment and which has been purposely elaborated to sort out and handle photographic images of different types and formats and to relate them one to another and formulate links with cartographic bases of all kinds. Because of its characteristics, this program was deemed to be particularly suitable for operating with large-scale photographic images (not necessarily photogrammetric ones) on smaller surface areas.

The subject of the experimentation was a hilly territory of roughly fifty hectares, situated at about fifteen kilometres south west of Bologna, along the River Reno. Comprised in it were the historical park of Villa Aria and bordering zones within the municipality of Marzabotto, part of the province of Bologna. This place was chosen because held to be valid for assessing the operative possibilities of an integrated monitoring system.

The experimentation here described fits into a wider project which calls for the assessment of various monitoring methodologies as alternatives to the traditional ones. These should enable small areas to

* Institute for Forest Management and Technology, University of Florence.

€ SELESMAR-SISCAM, Florence

* Institute for Forest Management and Technology, University of Florence.

be studied and would be viable for small public or private enterprises from both the technical and economical points of view.

In this first stage, we assessed the potential of using 70mm-format photographs in the framework of informatics programs specifically dedicated to the manipulation of photographic material.

Preliminary note

Italy is a country rich in natural and artistic protrusions which greatly influence the landscape on account of their beauty and also for historical and cultural reasons, especially when they are included in an area of marked anthropic activity.

Very often, however, these protrusions are in an extremely precarious state because of:

a) the owners' abandon and negligence, as often the expenses of refurbishment or even sometimes of ordinary maintenance cannot be afforded;

b) the lack of interest or available funds on the part of public corporations in charge of the conservation of the historical and cultural heritage since the number of such cases may be too elevated. Because of this, very frequent are the instances where only urgent and thorough salvage action can guarantee the conservation of this heritage.

The aim of this study was to assess the operative prospects and the economic viability of informatics correction systems of vertical, aerial, non-photogrammetric, small-format photographs (70mm) for the study of vegetation over limited areas.

This experimentation, which permitted the assessment of various monitoring methodologies as alternatives to traditional ones, intended to give operative instruments to smaller users (private technical offices and small corporations not generally enjoying the benefits of huge economic resources) which allow the accurate study of small portions of territory and permit the carrying out of salvage actions which are both technically and economically viable.

Introduction

The area under study was the historic park of Villa Aria (in the municipality of Marzabotto, Bologna) and the Etruscan necropolis immediately bordering on it, a hilly territory of roughly fifty hectares in all, situated in the vicinity of the township of Marzabotto at about fifteen kilometres south west of Bologna.

Until the first years of last century, the area belonged to the Barbazza, a Bolognese senatorial family, and in 1831, Count Giuseppe Aria became the new owner. During work in the fields and the

landscaping of an English-style park according to the fashion at the time, important archaeological finds of Etruscan origin came to light and Count Giovanni Gozzadini, an eminent archaeologist, was induced to set off an excavation campaign in the area near the villa.

In the years from 1839 to 1860, during the excavations within the park for the instalment of a pond and the arrangement of the main driveway and the wide open spaces of grassy glades or woodland, the remains of the necropolis of the nearby Etruscan city of Misano were uncovered. In the highest part of the park, where a second pond had been sunk near some thermal springs, the acropolis was discovered. The park unexpectedly found itself enriched by those ruins which became such strong features of the romantic park.

The great amount of uncovered archaeological material and the huge interest in the digs in that area shown by the international scientific world induced Count Aria to array the finds (already classified and displayed inside the villa) in a more stringent and organic way. So it was that the collection was organised in a museum which was even the object of a visit by participants at the Fifth International Congress of Anthropology and Prehistoric Archaeology, held in Bologna in 1871.

The archaeological excavations proceeded over the years, spreading onto the Misa plain in particular where today the ancient ruins of the Etruscan city may be visited.

The park extends a considerable way, offering various viewpoints with charming glimpses of the surrounding Apennine landscape and the valley of the Reno River. Leaving from the wide parterre facing towards the mountains, an ideal itinerary leads to the pond with rocaille ornament surrounded by large conifers towering over the ancient tombs in the necropolis (today no longer belonging to the Aria family but to the state), continuing on to reach the huge grassy glades contained within small paths serving to link the open spaces up to the woodland areas.

The park of this villa is what remains of a greater "Romantic Garden" which was planned and laid out at the beginning of the nineteenth century, the original plan of which has been lost. Historical events, especially those taking place over the last fifty years, such as the transit of the war front during the Second World War and the urban expansion since the late sixties of the municipality of Marzabotto, have, in part, wiped out the original structures.

Among the topics of analysis of the area, it was considered appropriate to conduct:

- a study from the historical point of view to discover the park's "date of birth" and its evolution through time:

- a study from a structural point of view by means of the use of mapping and photographic material which, through the employment of various methodologies, among which photo interpretation and different informatics systems, could lead to the drawing up of a document concerning the present situation of the park (a *de facto* map).

This place was chosen because considered to be extremely interesting for the assessment of the operative possibilities of an integrated monitoring system as:

- the historical development of the park of Villa Aria is very important and well-known, in local circles at least;
- though not in a condition of abandon, the present-day park is in need of urgent and adequate restructuring;
- the owners (private, Count Aria's descendants) still reside in the villa and, though well intentioned to carry out salvage operations, are not in a position to face on their own works which are too onerous;
- the original projects for the park lay-out (the project could date from the end of the eighteenth century) have been lost and the name of the designer is unknown;
- the orography of the area under study is hilly (though not exceptionally uneven) and the distribution of the soil usage types is extremely widespread with their number being relatively high with respect to the dimensions of the area they lie in;

With regard to informatics, the study dealt with the following main points:

- the search for a suitable digitisation format of the photographs (and consequently a format for filing) so as to obtain digital information which could be manipulated by PC programs, without excessively reducing the informatics content;
- the construction of a digital model of the land, based on existing cartography and, through this, be able to correct and georeference all archived photographic material;
- the substantiating of connections both between the archived images themselves and also with data of a different kind, so as to create complex interrogation procedures;
- the production of map-based manuscripts for planning purposes. In particular, the creation of an orthophoto map derived from the mosaicking of three 70mm CIR non-photogrammetric photographs to which depression contours derived from the regional map scale 1:10,000 have been added.

The identification of the park area, subdivided into homogeneous areas of forestry typology, was carried out on an orthophoto map at a scale of 1:1,000, converted into hard copy.

The next stages will concern:

- a historical comparison between the large-format (23cm) conventional photographic coverage of 1954 (B/W scale 1:40,000), those of 1986 (B/W scale 1:33,000) and the small-format photographs expressly taken in 1993 (CIR scale 1:5,000);
- the input of data, deriving from both remote-sensed images and alpha-numeric files, into a GIS where these kinds of information are related one to another and may be used for planning purposes and salvage operations;
- the introduction into the GIS of ground exposures which have been made expressly so as to examine the different points of view inside the park and which are also useful in working out simulations of intervention.

Materials and methods

The technical material used in the research and available at the appropriate public corporations (*Istituto Geografico Militare* and the Emilia-Romagna Regional Government) was the following:

- enlargements of B/W aerial photogrammetric exposures at a scale of 1:10,000 and 1:5,000 respectively, included in the I.G.M. coverages of 1954 and 1986;
- the regional technical cartography at scales of 1:10,000 and 1:5,000.

Carried out specifically for this research were:

- in June 1993 - two small-format (70mm) aerial photographs at a large scale (approx. 1:10,000 relating to the negatives and the un-enlarged transparencies) which concerned the entire park area and the Etruscan necropolis. The first batch was taken with Kodak Aerochrome 2443 Infrared slide film, the second with Kodak Vericolor III 160 ASA film;
- during the summer and autumn of 1993 - several ground photographs in 35mm format with normal Kodak Ektachrome 100 ASA film for slides.
- in November 1994 - exposures of the hilly part of the park with Kodak Aerochrome colour film in 70mm format.

The vertical aerial non-photogrammetric photographs in a 70mm CIR format were taken from a PIPER PA18 plane, using a motor-driven Hasselblad camera, equipped with 80mm planar lens.

The entire informatics section was executed with the aid of a Compaq 486 50 MHZ Personal Computer. The choice to operate in a PC environment became necessary so as to keep management costs down and maintain operative difficulties at similarly low levels. Indeed, it is expected that the exclusive user of this type of equipment may not be personnel particularly skilled in informatics but rather technically-qualified personnel, though they may possess a basic knowledge of informatics.

A mosaic of three photograms covering the central part of the park, the villa and the Etruscan necropolis included, was effected.

In order to carry out the rectification of the photographs, a map at scale 1:10.000 was acquired by a format A0 scanner. The numerically-formatted map was then converted and georeferenced (the map in the Raster format, using GEOSOFT's program GCARTO). Once a few recognised points had been determined, the program used allowed the automatic conversion of the raster vector format and consequently permitted the three-dimensional vision of the map and the co-ordinates of any other points. This program was used to determine the co-ordinates of the points to use in the rectification of the photographs.

The photographs were acquired by a scanner (with a resolution of 300 points per inch) and transformed into a numeric format (in colour - we worked in parallel both at 8 bits and at 24 bits).

The images were imported into the ARCHIS program which was used for their rectification. In this specific case, a picture plane and not a differential orthophotograph was projected, as the exact knowledge of all exposure parameters was missing, thus preventing us from using particularly sophisticated and accurate corrective algorithms. This was also due to the fact that a knowledge of the exact features of the camera was lacking. However, the images turned out to be geometrically good.

The same program was used to make a mosaic of the three images.

The depression contours were converted in vector format by GCARTO, transformed and laid over the image (photographic mosaic) as the mosaic photograph and the topographic map had been georeferenced in the same frame of reference (Gauss Boaga co-ordinates).

A few considerations of a technical order emerged from the applications produced:

working on a PC in 24 bits means lengthening work time and weighing it down a great deal, but there are considerable advantages - for example, in the printing stage, all details of the photograph are retained.

If solely study and computer consultation is of interest, working in 24 bits can be avoided. Indeed, many PCs have screens which improve resolution (DITHERING). If printing is required, the only possibility is, however, 24 bits (24 bits over 16 million colours - the visual display card of a particularly sophisticated type: 8 bits 256 colours - classic-type visual display card).

Results

In this first phase of the research, the following elements were obtained:

- the mosaicking (rectified and corrected) of three CIR photographs:
- the picture plane at a scale of 1:1,000 deriving from the depression curves (obtained from the regional map scale of 1:5,000) overlapping the photographic mosaic expressly reproduced in such a scale and the successive enlargement:
- the numeric mould of the area under study (at the scale of 1:5,000 and 1:1,000), the result of the HI-FI program processing data deriving from the regional map scale of 1:5,000 and the realisation of the main orography perspective views and the aspect and declivity maps.

The processed files (in bit map format at the scale of 1:5,000 and 1:10,000) were measured in the framework of the ArcCAD GIS and here associated to a database of historic type.

The picture plane at the scale of 1:1,000 was, on the contrary, overlaid on historic cadastral maps reduced to that scale so as to verify the variations which had been made to the arrangement of the garden.

The following operations can now be effected over the whole data series:

- thematisations (digitisation of areas to which determined functions are attributed):
- construction of an informatics structure in which sub-levels are associated with each area and these, in turn, are associated with certain elements (further images, vectors, text and other things). This process may be developed *ad infinitum*.

The images were processed by using the RP.S program (a module produced by SELESMAR-SISCAM) which allows the generation of printing files of the RASTER type at the desired scale.

Conclusions

The construction of a base from which to start was achieved on order to initiate the following:

- the planning of an operative system:

- the creation of a structure to link to the project.

The work carried out has produced a series of results which are extremely partial and indeed very small considering the informatics means employed. However, these results have their importance in determining:

a) an operative methodology outline for application when work is carried out at the same time on mapping and photographic material (of a different nature and not necessarily photogrammetric):

b) the assessment as to which among the various informatics PC-operated methods better sums up characteristics of operative versatility and economic viability, making it desirable and economically exploitable even by small corporations.

This is only one of the first phases in the research which will be examined more thoroughly later on and which will be amplified particularly towards the study of an informatics vehicle suitable for use as a GIS in territorial planning.