GEOGRAPHIC INFORMATION SYSTEM FOR MONITORING AND CONSERVATION OF THE CULTURAL LANDSCAPE

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ABSTRACT

The contribution offers a critical synthesis of an experimental research in progress, concerning the creation of a Geographic Information System applied to a mountain area of architectural and landscape interest: Frassinetto, in the Orco Valley and Soana (Turin). The work gathers multidisciplinary competences from the restoration and geomatic branches, strongly integrated with each other in order to develop an analytical protocol for a cultural-historical territory. Frassinetto's architectural and connective tissue – of ancient and complex origin – shapes the landscape univocally, becoming its cultural issue. The considerable critical and vulnerable conditions distinguishing this heritage – right at a time in which we are witnessing a growing social demand of "cultural landscape" – make of its systematical knowledge an urgent issue, in order to preserve its authenticities as well as to give it a full value. The interpretations of aggregation processes, permanent elements and of the condition of material documents (viewed as "documents/monuments") have been formulated on the basis of surveys and cataloguings at different scales (landscape sites and elements, aggregated settlements, architectural manufactures, building systems and characteristics). The contextualization of acquired knowledge is conducted through the creation of databases integrated by digital cartographic mediums. Computer cartography – within a conventional coordinates system – is made on the basis of aerophotogrammetric surveys with direct integration on the spot. The case study has also been analyzed in relation to the geographic context where it is set, that is the whole area of the valley. Above all, this is an occasion to examine a possible, profitable application of computer technologies to the systems of cultural landscape and traditional building heritage, both for their integrated conservation and to give them full value. The potentialities – as we believe – are to be found both in an exhaustive scientific knowledge used for an applied case through the creation of a GIS, as well as in the possible diachronic implementation of data. This implementation - carried out in relation to planned time scannings and specific necessities identified by the "caretaker" of material and cultural resources (local administrations, protection institutions, research organs) - would allow a real monitoring of consistence and criticality conditions of the heritage. In this way the patterns of knowledge and interpretation of fragile cultural realities would not stop their knowledge function preliminary to interventions, but would record any progressive change of the structures, providing an updated support to protection policies, also in relation to an application of the new law.
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1. THE SITE AND CULTURAL VALUES

In the start-up phase of the research, the territory of the Orco Valley and Soana (Turin) has been subjected to a general survey on the consistence of the widespread traditional heritage (considering historical nuclei, aggregated hamlets, testimonies of religious housing, collective goods and the main historical routes) on municipal territories. The subsequent decision to choose Frassinetto as survey site has been determined by the identification of an extraordinary persistence of authentic historical building testimonies, still well readable both as cultural system and as main elements. Here, over the centuries, historical routes have woven a thick infrastructural network, cultivations, the exploitation of pastures and woods have marked the grounds with different uses; subdivisions of properties and canalisation of water streams, multifunctional buildings and those of collective use have formed architectural aggregated and stratified nuclei. The critical and vulnerable conditions which distinguish today this cultural landscape, real piece of the "paesaggio rudere" (tr. landscape ruin, Lanzani 2003) are the result of demographic retraction processes from upper-level settlements in favour of industrial cities, abandonment of houses marked today by decades of lack of maintenance, of some inadequate interventions conducted in time for functional reasons. Therefore, its systematic knowledge is an urgent necessity, in order to preserve its authenticities as well as to give it a full value.

Figure 1 Frassinetto's landscape context in the Orco Valley and Soana

2. THE PRESERVATION AND KNOWLEDGE PROJECT

The interpretations of aggregation processes, of permanent elements and of the conservation conditions of material documents have been formulated on the basis of surveys at different scales (landscape sites and elements, aggregated settlements, architectural manufactures, building systems and characteristics). An analysis of Frassinetto's environmental-architectural systems has been carried out by recording, and

transforming into thematic maps, the consistence and spreading of the main architectural goods and elements, which are the material documents of the local cultural matrixes. On the whole territory a formulation of the historical knowledge of the landscape, the resources and uses of the ground is in progress. The research has then considered the forms of settlement, through the processes of settlement and aggregation, with the identification of "monumental" poles, of buildings and manufactures of collective use, the evolution of architectural processes, up to the present condition, with functions and typologies. The analysis has been subsequently extended to the building characteristics of historical housing, focusing on the supply of materials, set-up techniques, recurrent elements, finishings and patterns.
In the aggregated nucleus of Borgiallo, a sequence of building cells of ancient plant (14th-15th centuries and subsequent stratifications) develops with compact fronts flanked along a road directrix. These building cells, pointed out through photostraightenings which read their relation systems and fix their total consistence in relation to the road spine, are subjected today to architectural surveys (instrumental and with photogrammetric support) and those concerning the employed materials. A particular importance is reserved to the analysis of elevation structures (attics and vaults, vertical structures, coverings) which are the essence of the buildings. The analysis of architectural manufactures, which is still in progress, will form the basis to learn about their preservation conditions, with mappings of deterioration, a study of typical cracking systems, schedules on preservation conditions of some single significant interiors and elements, recognition of recurrent causes of deterioration or disruption and of correlated problems.

Figure 2. Foreshortening of Borgiallo nucleus' roadspine

The contextualization of acquired knowledge is reached through the creation of databases integrated by digital cartographical supports, that is through the creation of a real Geographic Information System. The established aim is that of realizing a synthesis on historical and present consistence of the studied site, which can be implemented in time by introducing new information or updating the researches in progress. This implementation – carried out in relation to planned time scannings and specific necessities identified by the "caretakers" of material and cultural resources – will allow a "monitoring" of consistence and criticality conditions of the heritage, according to a pattern which is not different from the Risk chart of cultural heritage (Dezzi Bardeschi, 2001; Monti, Brumana, 2004). In this case the studied system is not the single manufacture but rather the architectural tissue of the site chosen for the study in its complexity, in order to investigate beside the buildings also their relations to one another .

3. THE GEOGRAPHIC INFORMATION SYSTEM

The separation between technical disciplines that years ago had reached very high levels seems to recompose itself slowly through a thicker network of scientific relations among the scholars engaged in different disciplinary areas, and dealing with occasionally common topics. Most of the times, the contrast has been determined by an improper use (or one estimated as such) that scholars would have made of parts of disciplines quite different from their own. Today it has become clear how the integration of the single competencies can be the only means of obtaining results from any sort of survey and of acquiring all the necessary knowledge to make compatible choices. In the case at issue here, our objective is the creation of a Geographic Information System, a system which cannot rule out interdisciplinarity. Therefore we intend to support restoration with the competencies of a discipline, geomatic, more specifically, by trying in particular to use and mediate the methodological and technical knowledge of each sector for the creation of a complete and easy-to-use instrument within a protection project. Therefore, the fusion of different competencies, refined by punctual contributions capable of tackling always new problems, becomes the necessary condition for a correct preservation intervention. Here we want to verify this track on the organicity of an architectural tissue which shows a continuity of signs of ancient matrix, which go on existing in a critical context both for the natural cultural evolution and for the inexorable passage of time.

3.1. Spatial data

Cartography is the necessary instrument for a proper knowledge of the territory. Therefore it becomes necessary, rather than fundamental, to base oneself upon an updated and articulated series of cartographical bases for the creation and implementation of the information system. Since the basis of our research is the control of the criticality conditions of the buildings as well as the monitoring of possible changes of the preservation conditions of the architectural tissue and of the territory, it is necessary to identify a complex series of cartographic bases appropriate both for the representation scales and for typology and elaboration process. These bases represent the pattern of territory whatever the realization process might have been (by pointing out the necessary conformity to the cartographic process, since some specified tolerances correspond to each representation scale). In the case at issue we have particularly used the Technical Regional Numeric Cartography to the scale 1: 10000 (Fig. 3), which, in the GIS application, thanks to its vectorial format, allows the making of the spatial analyses of the information contained; the orthophotomap in raster format and the cadastral map (Fig. 4).

This basic cartography has been then integrated with a series of instrumental surveys (carried out using GPS and Total Station) useful for punctual analyses on the buildings which have been analysed and classified during the study.

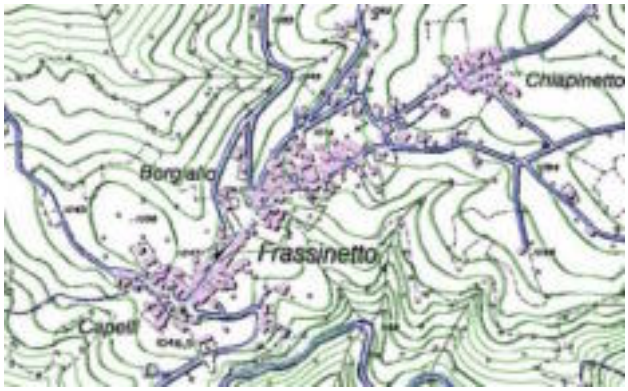

Figure 3. CTR Regione Piemonte original scale 1:10000

To overcome one of the most complex problems of cartography (L.Surace,1997), that of reference systems, it has been decided to adopt one system only (UTM WGS 84) to implement spatial data into the GIS (Chiabrando F., De Bernardi M.L., 2004).

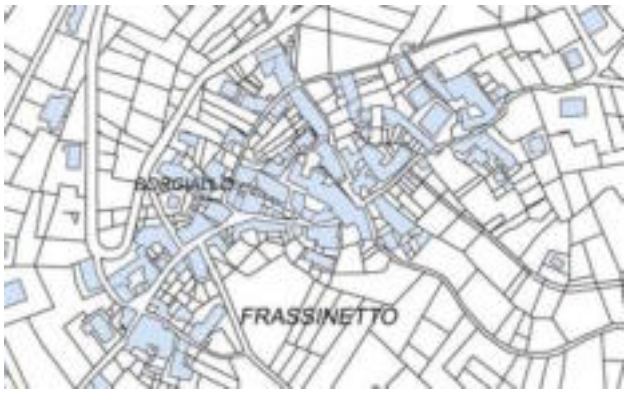

Figure 4. Cadastral map of Frassinetto municipality original scale 1:2000

Since regional cartography is today provided in the above quoted system, while otherwise specific programs of rototranslation (in the case at issue the Vertogis software has been used) can be adopted, spatial information can be visualized in the representation of interest. Cadastral cartography, which is georeferenced in the Cassini-Soldner system, and the surveys carried out for the realisation of cartography on a very big scale of a portion of the village of Borgiallo, have been correctly referenced thanks to a framework created on purpose on the site. In particular, two Leica System 500 double frequency GPS receivers have been used, connected to the Politecnico of Turin permanent station. Later on, all the above quoted cartography has been implemented into the Geographic Information System. Thanks to the potentialities offered by the softwares on the market for the creation of GIS (in our case it has been decided to use ESRI ArcMap 8.3), it is possible to obtain some tridimensional views from the numeric cartography used. These representations, which are doubtlessly of great impact, facilitate the analysis of the territorial orography.

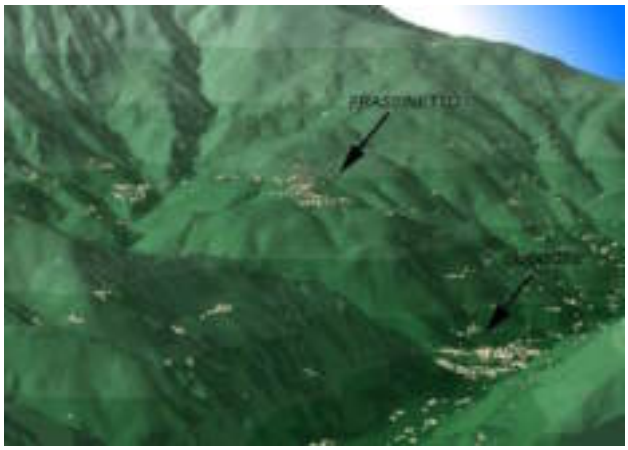

Figure 5. 3D view of Frassinetto area.

3.2. Non-spatial data

The condition of Piedmont's cultural goods documentation is so articulated as that which can be found in the Italian context (A.Spanò 2002). The activities and projects under way – aimed at documenting and creating information concerning those cultural goods present on the regional territory – observe the intervention directives established by the central headquarters, specifically the lIstituto Centrale per il Catalogo e la Documentazione of the Ministry for Cultural Goods and Activities. In particular, the data collected on the territory have been filed using the Guarini program. (Fig. 6).

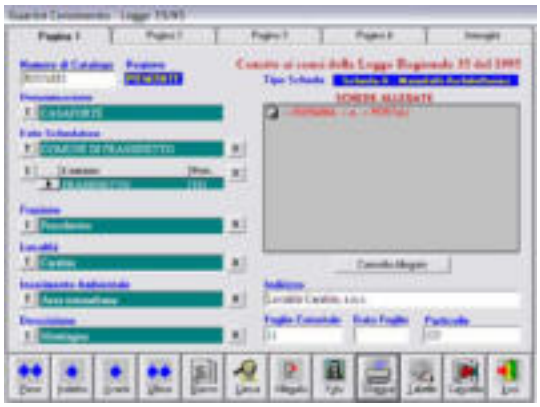

Figure 6. Graphic interface of the "Progetto Guarini" program

Guarini (Regional law n°35, 1995) is a project born to promote the knowledge of Piedmont's cultural heritage. It is primarily an instrument of work capable of rationalizing knowledge and cataloging specifically in the field of cultural goods and, consequently, it is addressed both to the public subjects who carry out institutional tasks concerning the management of cultural heritage and to qualified associations supporting a public institution in the safeguard of this heritage The first version of the program, used in the "Dalle Alpi alle Piramidi" project for cataloging goods at risk in Piedmont, has been created during the two-year period 1991-92 in cooperation with the Piedmont Superintendencies (former Soprintendenza per i Beni Artistici e Storici, Soprintendenza Archeologica, Soprintendenza per i Beni Architettonici e il Paesaggio, Soprintendenza al Museo delle Antichità Egizie), which have provided a remarkable contribution to the definition of data characteristics .
Through this system every information regarding the

architectural cells analysed on the territory subjected to study, particularly the Frassinetto territory, has been implemented into the database. The survey has specifically considered:

- Localization
- Dating
- Morphology of the building
- Conservation conditions
- Destination of usage
- Photographic documentation

Some fields can be opportunely deeper investigated with descriptions and precise definitions on the typological characteristics. During the first stage of the study, guidelines have been developed, dictated by regional and Italian cataloguing rules (ICCD). Subsequently, in order to shape this system according to more specific needs of preservation and restoration, a series of additional information (georeferencing, morphology of the building, characteristics of materials, structural typologies, deterioration, cracking surveys) have been inserted into the database. This is necessary for the creation of an instrument capable of providing – both to the insiders (preservators) as well as to public institutions and professionals involved in the planning and protection of the territory – the useful knowledge to carry out their activity in a conscious manner. One of the most significant and experimental aspects of the research at issue concerns the monitoring of the preservation conditions of the architectural tissue. The most fitting solution for doing this has seemed to be the use of photoplans (Fig. 7). The criticality conditions, which can develop on the buildings in time, are monitored through a series of digital camera shots (Nikon D1). Later on, for each single photogram, support points have been gathered (by using a no-prism Leica TCR 703 Total Station), necessary to the straightening operations (for which the Archis-Siscam program has been used). The mapping of the present criticality conditions and the comparison with the monitorings, periodically surveyed according to the situations which can be found, allow the understanding of the evolution of phenomena in time.

Figure 7. Photoplan portion of an analysed building

We are now proceeding to the connection between spatial data and non-spatial data of all surveyed and classified buildings. Then we'll carry out investigations within the information system (Astori B., Bonfanti C., Chiabrando F., Spanò A.,2004). A next development of the GIS is the possibility of implementing it onto the web in order to make the system more utilizable by those people who are interested in these subjects.

4. MORPHOLOGY OF THE ARCHITECTURAL TISSUE. BUILDING PATTERNS.

Our purpose is therefore that of creating an instrument which allows preservation proceedings "à outrance", "assicurando il prolungamento della curva di decadimento nel tempo" ("by ensuring an extension of the decay curve in time", Dezzi Bardeschi, 1992) for these material documents representing a cultural necessity of the territory. Consequently, the architectural tissue is analysed in order to deduce, through a complete knowledge process, some indications for a protection policy addressed not only to an intervention on the existent criticalities (which is often an intervention of "necessity") but also to the prevention of those phenomena connected to the vulnerability of the site and of the manufactures themselves. In this sense, the knowledge process, qualified in its complexity by multidisciplinary contributions can be optimized provided that the direct source, the building, is investigated in its whole materiality, that is also in its building techniques, structural organisms, mechanisms leading to alterations and structural decay and provided that, starting from these parameters we get to the evaluation of the different factors which represent a risk for surviving. This allows to formulate a building pattern – by focusing on the technical-structural connections – which is in any case the most direct and safest instrument for a compatible preservation intervention. Hence derives the consciousness of the authenticity, of the value of the solutions representing a typological element, even though it is a modified one in some cases, of the studied territory. The built heritage at issue is characterized by buildings of simple geometries, similar to one another for their building age, and with a strong building homogeneity. These values cannot be drawn out of written documentary testimonies, anyway scanty in this case, but rather by verifying them on the direct sources. The analyses have considered the permanent elements of a once poor territory , of strong emigration for most part of the year because of rigorous winter-seasons. These permanent elements are fully dignified and are still showing walls which weren't made by rough hands but rather by people owning the ancient knowledge regarding the needs of agro-pastoral living and a proper building craft. They are strong and massive buildings, not for reacting to war attacks but rather to face predators' attacks on foods which were precious goods at that time for the inhabitants of the place. In the village of Borgiallo, carefully investigated, the architectural tissue develops essentially along the road axis following the natural course of the ground. Therefore, some cells have a strong slope and their foundations emerge from the rock buttress in many different points of their development. In these cases, even though geomorphological characteristics are excellent being those of compact rocks, the alterations of the ground determined by the extension of the banks, their position and the possible interposed layers of less consistent materials, determine a very slow but inexorable sliding of the building structures downwards. This is caused by cracking situations found in the vertical structures which nevertheless – also considering the morphology of the building structures – don't preoccupy but determine a necessity of checking. The structural plant is made of load bearing stone walls, carefully set and typologically belonging to subhorizontal courses (Marchetti, 2000-2002). The ashlars are quite irregular, of different size, well bound by thin maltha junctions mixed with tiny stones in order to create a sort of compactness in the cross sections and to exalt resistance qualities. Maltha, made of aerial lime as a binder and sand of fine granulometry as aggregate, has a rather low consistency. It's lacking in some areas towards the external parament where the effects of the washing away and eolian erosion are more present, while it is still quite present inside the

junctions. The lithotypes are mainly granitoid gneiss (Fig.8). Generally, the building structure is fairly good in most part of the architectural tissue, even though a detailed survey of each cell shows different conditions of mechanic and resistance behaviour, as regards the making of the junctions, their organisation and localised criticality conditions. The good execution of the building structures can also be found in the realization of the external arrises of the buildings, where the particular structural function of anchoring is often solved by using rectangular blocks of stone, well worked, of bigger dimensions than in the general context of the building structure, cross-superimposed and with regular junctions (Fig. 9).

Figure 8. Particular of a building structure's tissue

Horizontal structures distinguish themselves both for the materials employed and building techniques according to the level of the plant. On the low floors horizontal structures are often realized with pushing barrel structures. Of these, some are coeval with the original plant, while others are not. In any case they are made of cleft stone vertically set. The working technique and maltha, which is always present in the junctions, allows a resistant morphology of high intensity and excellent conservation. The vaults often develop with the generatrix perpendicular to the road axis. Instead, the last floor is made up of wooden attic with beams laying parallel to the façade. The roofs – with struts leaned against the façade wall perpendicularly to it – are made up of two pitches and covered with surface slabs of stone.

Doors and windows, two building elements decorating the openings are, among all those employed on the spot, signs of the architectural tissue. Even if referred to another building, the following description seems to be appropriate:

Figure 9. External arrise with employment of rectangular stone blocks

"La sua parte più interessante è costituita dalle inquadrature delle porte e delle finestre fatte con lastre di pietra secondo una caratteristica della nostra regione anteriore al '400…L'elemento essenziale è dato dalle lastre greggie di pietra che inquadrano le porte e le finestre molto strette a fessura o feritoia, una lastra per lato del vano, allungata, sorregge un architrave massiccio di forma triangolare o semicircolare appiattito…due lastre simmetricamente disposte, ma orizzontali rompono …la linea 'ascendente'…con ricerca di armonia nell'aspetto decorativo" (tr. Its most interesting part is the framing of the doors and windows made up of slabs of stone according to a characteristic of our region prior to the 15th Century. The main element are rough slabs of stone framing doors and windows. They are very narrow with a slit or loophole.. one slab for each side of the opening, stretched, supports flat massive lintel of triangular or semicircular shape. Two slabs symmetrically set, but horizontal, break the rising line with a research of harmony in the decorative aspect. Bertotti, 1979; Viglino Davico, 1993). Lingering now upon these realizations, their morphology for instance, and on the technique employed for the arch portrayed in Figure 7, we can make some considerations.

The shapes of this sort are made up, according to the cross section, of a line of parallel arches, sometimes two or even three of them.

One first external arch, responding almost exclusively to an aesthetic function, is made of stone ashlars in which the stream of the compressions goes directly through the faces of the ashlars themselves, well worked and without interposed maltha.

Figure 10. Openings with window jambs and monolithic architraves

A second inner arch, with a hight of the section which is sometimes smaller than the external one but with a bigger width, well leaned but not anchored to it, is realized with a technique similar to that used for barrel-vaults, that is cleft stones vertically set. The good execution and constant presence of the maltha between the ashlars is a realization with an excellent resistant stream. This arch has a load bearing function.. Following the logic of the static regime of the arches concerning the effect of great deformations., this coupled structure seems to respond to an economy of the materials according to static laws. Therefore, this technique can be regarded as safer than in case of the employment of a single arch with ashlars of big dimensions. A much higher number of the present "hinges" allows, as already known, a definitely higher degree of structure deformability thanks to a higher number of possible rotations. A logical stratigraphic hypothesis makes us believe that originally the arch was the frame of an opening and that both the present passage and the curtain wall are not coeval with the arch. Analysing this structure in its initial form, we can still distinguish the artisan's care in ensuring the cooperation of a good portion of lateral building structure with the pier in order to guarantee an absorption of the eccentric efforts deriving from the arch. Following this logic, the dimensions of the two long stones interposed between the sections of the arches' impost and the piers are justifiable. Therefore we believe that the geometry of this element was not dictated by precise aesthetical purposes but rather by the need of specific static bonds.

It is therefore important – as a necessary preliminary statement to a proper preservation operation, immediate intervention or monitoring in time – to interpret the intentions of those who realized the building, in its original yard and subsequent transformations, through the archives and the manufactures. The last ones clearly show their needs. Sometimes we should commit ourselves more to understand their requests.

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