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A building characterization-based method for the advancement of knowledge on external architectural features of traditional rural buildings

Método de construcción en base a la caracterización orientado a fomentar el conocimiento de las características arquitecturales externas de edificaciones rurales tradicionales

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SUMMARY

The significant role that traditional rural buildings have with regard to environmental conservation and rural development is widely acknowledged by the scientific community. These buildings must be protected from inappropriate building interventions that may stem from their rather superficial knowledge. Therefore, this study was directed towards overcoming such a limitation by developing a method based on traditional rural buildings' characterization. In particular, the study aimed at the characterization of building materials and techniques used for the construction of a number of building components that make up the external envelope of traditional rural buildings. The application of the method to a homogeneous area of the Etna Regional Park (Italy) highlighted the need to improve the technical norms of the park's Territorial Coordination Plan to respect the building characteristics of the traditional rural buildings located in the protected area.

235-2

Keywords: Rural heritage; agricultural landscapes; building rehabilitation; building materials and techniques; protected areas.

RESUMEN

La comunidad científica le atribuye a las construcciones rurales tradicionales un papel fundamental en términos de conservación del medioambiente y de evolución rural. Dichos edificios deben ser protegidos contra obras inapropiadas debidas a un conocimiento más bien superficial. Por lo tanto, el objetivo de este estudio fue el de eliminar dichas limitaciones desarrollando un método basado en la caracterización de las construcciones rurales tradicionales, que puede ser aplicado para mejorar el conocimiento de estas últimas. En particular, el susodicho estudio tiene la finalidad de caracterizar los materiales y las técnicas constructivas a emplear para la construcción de algunos componentes del envoltorio externo de las construcciones rurales tradicionales. La aplicación del método propuesto a una zona homogénea del Parque Regional del Etna (Italia) puso de relieve la necesidad de mejorar las normas técnicas del Plan de Coordinación Territorial del parque para respetar las características de las construcciones rurales tradicionales situadas en la zona protegida.

Palabras clave: *Patrimonio rural; paisajes rurales; rehabilitación de edificios; materiales y técnicas constructivas; zonas protegidas.*

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1. INTRODUCTION

Rural landscapes require special protection because they document the relationship between natural resources and human activity. Among the possible interpretations of rural landscape genesis, forms and dynamics, those considering them as the materialization of a farming system are widely shared among the scientific community (1). In this context, traditional rural buildings (TRBs) (*i.e.*, traditional farm buildings and rural houses) endow rural landscapes with local distinctiveness and a sense of place because they document the traditional agricultural activities and related rural technologies (2) (3) (4) (5).

In many European countries, technological innovation, agricultural mechanization and intensive livestock farming encouraged agriculture to shift from a system based at a farm and local community level, to one dominated and controlled by other elements of the agro-industrial sector (6). This favoured the abandonment of many TRBs which, due to their morphologic, technical and constructive characteristics, could not be adapted to new production systems.

In the last two decades, the growing dissatisfaction with the quality of city life has often led people to favour the use of the countryside for residential purposes, recreation and non-agricultural enterprises (4) (7). Furthermore, the European Union's rural development policy (Council Regulation, 2005), which aims at the diversification of the rural economy, has promoted the re-use of TRBs for purposes other than those originally intended.

These driving forces have led to an increasing demand for TRBs' adaptive reuse which could give them renewed life, but may also create potential threats to their cultural and environmental characteristics (2) (4) (8) (9) (10). Moreover, improper building rehabilitation works carried out on TRBs may possibly be one of the major causes of landscape deterioration. Therefore, special care must be taken with respect to the form, materials, colours and textures used in the restoration of the external envelope to avoid undesirable visual contrasts with rural landscapes (11).

Recently, also thanks to the efforts of international organizations (12) (13), the European Union has devoted increased attention to issues related to TRB preservation through policies that aim at their adaptive reuse, according to the needs of the territory in which they are located (14). However, to preserve rural built heritage and landscape continuity, functional, typological, and stylistic characterization of TRBs is required. Therefore, as also observed by García *et al*. (2006), in addition to financial support for TRBs, it is necessary that local governments define appropriate guidelines based on an exhaustive TRB characterization to accurately plan their rehabilitation.

However, TRB characterization may involve considerably intricate activities, especially with reference to detailed metric documentation that entails time-consuming fieldwork and data collection (15) (16) (17). Therefore, the higher the number of TRBs located in a region, the more difficult it will be to obtain a comprehensive TRB characterization.

As a result of these difficulties, in a number of Italian regions building interventions are carried out on the basis of TRB knowledge obtained by previous research that is still today the major point of reference for Italian rural architecture. Such research, made up of a series of regional studies, was carried out at the end of the 1970s by the National Research Council and pertained mainly to Italian rural housing (18). In Sicily, as in other Italian regions (19), these studies (20) (21) were capable of highlighting the need to conserve and protect rural architectural heritage but they were conducted on a scale far greater than that required for a TRB characterization suitable to plan their rehabilitation works. In more recent years, in-depth building characterization was carried out in a number of rural areas in Sicily (22) (23) (24) (25) (26) (27) (28) (29). However, the adopted methods were not homogeneous and were applied only to a limited number of buildings which represented only a few TRB typologies.

Today, the greatest risk that TRBs run is represented by such patchy knowledge. Therefore, the challenge of this study was to contribute in overcoming this limit by developing a method, based on TRB characterization, that can be applied to increase knowledge of TRBs. In detail, by combining the information obtained by a broad survey of TRBs located in a study area with TRBs' typological analyses, this study aimed at acquiring a in-dept knowledge of a number of architectural features which characterize the external envelope of TRBs and that influence the visual aspect of the surrounding landscape.

The proposed method was applied to the TRBs located in a study area of the eastern Sicily, within the Etna Regional Park, one of the richest Italian territories with regard to cultural heritage, and one of the most subject to human pressure.

As part of the overall objective of the study, an analysis of the most common types of building restoration works carried out on Etnean TRBs was performed to determine to what extent the technical norms of the Etna Park's Territorial Plan of Coordination (TCP) were respected by the property owners. Results of this analysis were used to investigate the possibility of completing the typological classification contained in the TCP with the types found in the course of this study.

2. MATERIALS AND METHODS

2.1. TRBs as defined within the Territorial Plan of Coordination of the Etna Park

A review of the Etna Park's TCP was performed to identify the method used by the planners to characterize TRBs located in the area of the park and to analyse the rehabilitation works that could be carried out with regard to the architectural features that characterize TRBs' external envelopes. Within the technical norms contained in the TCP, the following definition of "traditional rural buildings" was found: "Buildings of historical and cultural relevance, expression of the Etnean traditional agricultural and pastoral activities". Along with that definition a TRBs' characterization based on both materials which characterize only the TRBs' bearing structure and TRBs' functional destinations was reported. TRBs were divided into the following classes:

- Class a): TRBs built with stone and mortar lime masonry.
- Class b): TRBs of small dimensions built with dry stone masonry.

To the first class belong the buildings named *casedde* (the landowners' homes), *palmenti* (wine making plants), wine cellars, oil mills, and other buildings used for processing agricultural products. Buildings which were temporarily used for agricultural and pastoral activities belong to the second class.

Table 1. Building interventions, permitted (P) or not permitted (NP), for each architectural feature analysed in the study subdivided into the two classes of TRBs listed in the GDs contained in the TPC.

BUILDING INTERVENTION	TRBs	
	CLASS	
ROOF	A)	B)
Building of the roof covering by using traditional roofing materials such as baked-clay tiles, called 'coppi'.	P	NP
Preservation of the original form and slope of the pitches.	P	P
Making use of the original wooden bearing structure, or as an alternative, applying new wooden beams if the original ones are not usable.	P	P
Construction of reinforced concrete curbs completely immersed inside the original masonry.	P	NP
MASONRY	A)	B)
Restoration of collapsed walls to the original height with the same materials and building techniques as the original walls.	P	P
Using of mortar with the same hue, texture and surface treatment as the original.	P	NP
WINDOWS AND DOORS	A)	B)
The openings must be built with blocks of Etnean basalt or with block of white stone originating from Comiso and Syracuse. They must have a thickness of not less than 15 cm and be treated or bush-hammered.	P	P
EXTERNAL PLASTERS	A)	B)
The colours must be compliant with the traditional coulors of Etnean rural buildings such as gray (with reference to the original use of volcanic sand) or red (with reference to the colour obtained by the use of Monterosso sand).	P	P

A list of 'permitted'/ 'not permitted' building rehabilitation works (Table 1) were included in the general dispositions (GDs) contained in the technical norms of the TCP.

2.2. TRBs as defined in the present study

The rural buildings considered in this study (Figure 1) are located in an area which has an extension of about 818 ha and is entirely

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1. Localization of the study area within the Etna Park (Province of Catania, Italy).


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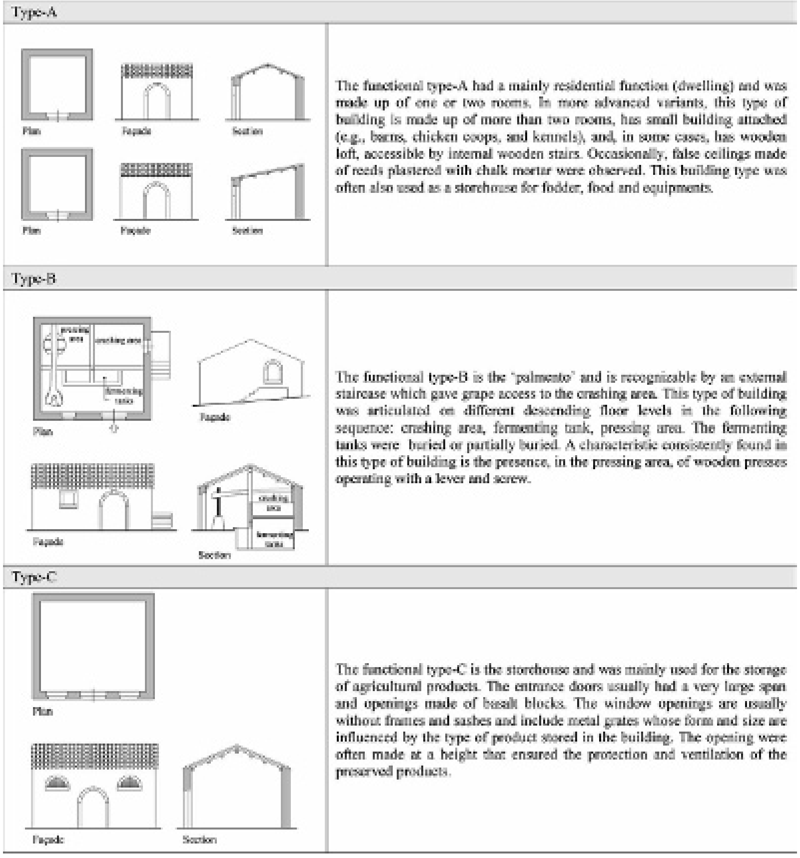

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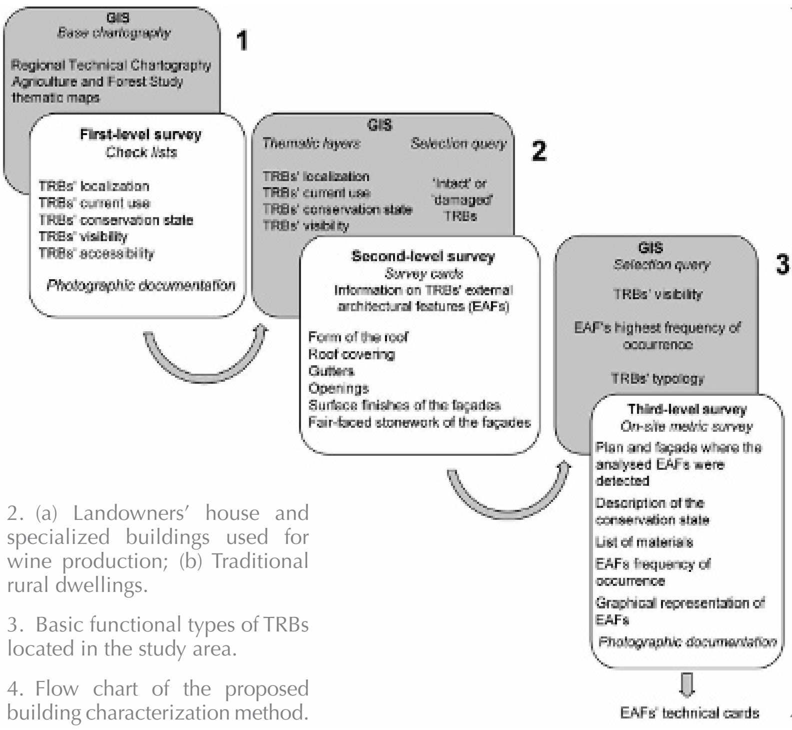

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2. (a) Landowners' house and specialized buildings used for wine production; (b) Traditional rural dwellings.

3. Basic functional types of TRBs located in the study area.

4. Flow chart of the proposed building characterization method.

located in the North-eastern side of the Etna Park (Italy) (30), within the municipal boundaries of Piedimonte Etneo in the province of Catania. Such an area was chosen as is the home of historically-rooted agricultural activities, mainly devoted to vineyards, and, to a lesser extent, to orchards and olive groves. In this area the geomorphology of the site and the socio-economic status of the population have strongly characterized rural buildings built between the XVII and the XVIII century, making them homogeneous in terms of:

- **Functional destinations:** rural dwellings and specialized buildings, mainly devoted to wine production (Figure 2).
- **Building materials and techniques:** *e.g.*, lava stone masonry for the bearing structure, baked-clay tiles for roof covering, traditional plaster characterized by mortar lime and *azolo* for the surface finish of the façades, chestnut wooden purlins and rafters for the bearing structure of roofs.
- **Building typologies:** aggregation of basic functional types identified in a previous study (31) (Figure 3).

By following analogous approaches adopted by other authors in previous studies (32) (33) (34) (35) (36), the sample of TRBs, subject to detailed metric documentation, was selected after carrying out different levels of survey (Figure 4). The rural buildings which showed the characteristics reported above in terms of functional destinations, buildings materials and techniques, and typologies are classified as TRBs in the latter part of the paper. Though this definition of a rural building as a traditional one, is coherent with that considered in the TCP of the Etna Park, the TRBs' classification reported in the TCP is lacking in relation to materials, building techniques, and typologies.

2.2.1. The first-level survey

A Geographic Information System (GIS) was developed by combining basic information contained in the Regional Technical Cartography drafted in 1999 (*i.e.*, information regarding rural buildings, municipal boundaries, hydrography, main and secondary roads and contour lines) and in the Municipality's Agriculture and Forest Study's technical maps (*i.e.*, homogeneous areas within the Etna Park and municipal zoning), with data produced by means of checklists and photographic documentation in the first-level survey conducted on TRBs. The maps used in the research were time-consistent and had the same scale, seeing that the Agriculture and Forest Study technical map is based on the Regional Technical Cartography.

This first-level survey made it possible:

1. To distinguish TRBs from other more recent rural buildings characterized by a bearing structure made of reinforced concrete or concrete masonry walls, a roof covering made of corrugated fiber cement panels or brick roof tiles, a surface finish of the façade made of industrial plasters, and a bearing structure of roofs made of reinforced concrete or other type of wood different from chestnut. In the study area, to date, the number or TRBs is still not known at the technical bureaux. In literature, although a method to recognize rural buildings from remote sensing images was put forward by González *et al*. (2006) (37), it did not discern between traditional and modern buildings. Therefore, such a method was not applied in this study and the distinction between traditional buildings and more recent one was made by means of field surveys conducted by using check-lists and photographs. A surveyed building was considered as a 'traditional rural building' if, through a visual analysis, it showed the original functional units for traditional wine storage and wine production; it was built by using traditional materials and construction techniques coherent with those reported in the section 2.2.; and it appertained to one of the aggregations of basic functional types identified in a previous study (31). These characteristics were to be found simultaneously in the surveyed TRBs buildings.

2. To identify the current state of usage of TRBs (*i.e.*, 'in use', 'in partial use', and 'unused'). In the considered area, over time, the geomorphology has favoured the maintenance of traditional farming methods characterized by aged trees, promiscuous cultivation, and low yields. As a consequence, several marginal areas and TRBs, which are not easily accessible, were abandoned. The attribute 'in use' was assigned to TRBs currently in use, even if not for agricultural related activities (*i.e.*, buildings used for residential, tourism and cultural purposes); the attribute 'in partial use' was assigned to TRBs that had less than half of their building units still in use; and the attribute 'unused' was assigned to all other cases. Only in a few cases did an interview of the property owner or neighbours allow for the assessment of this last characteristic, considering that most of the TRBs under study were not permanently inhabited. In the other cases, some recurrent conditions made it possible to assign, with rather good precision, this last characteristic to each TRB. For example, severe external envelope degradation, walled windows and doors of unused rooms, uncultivated land, absence of agricultural machinery or equipment in the neighbouring areas of the building which would have indicated its agricultural use, as well as lack of external furnishings which would have indicated other types of use.

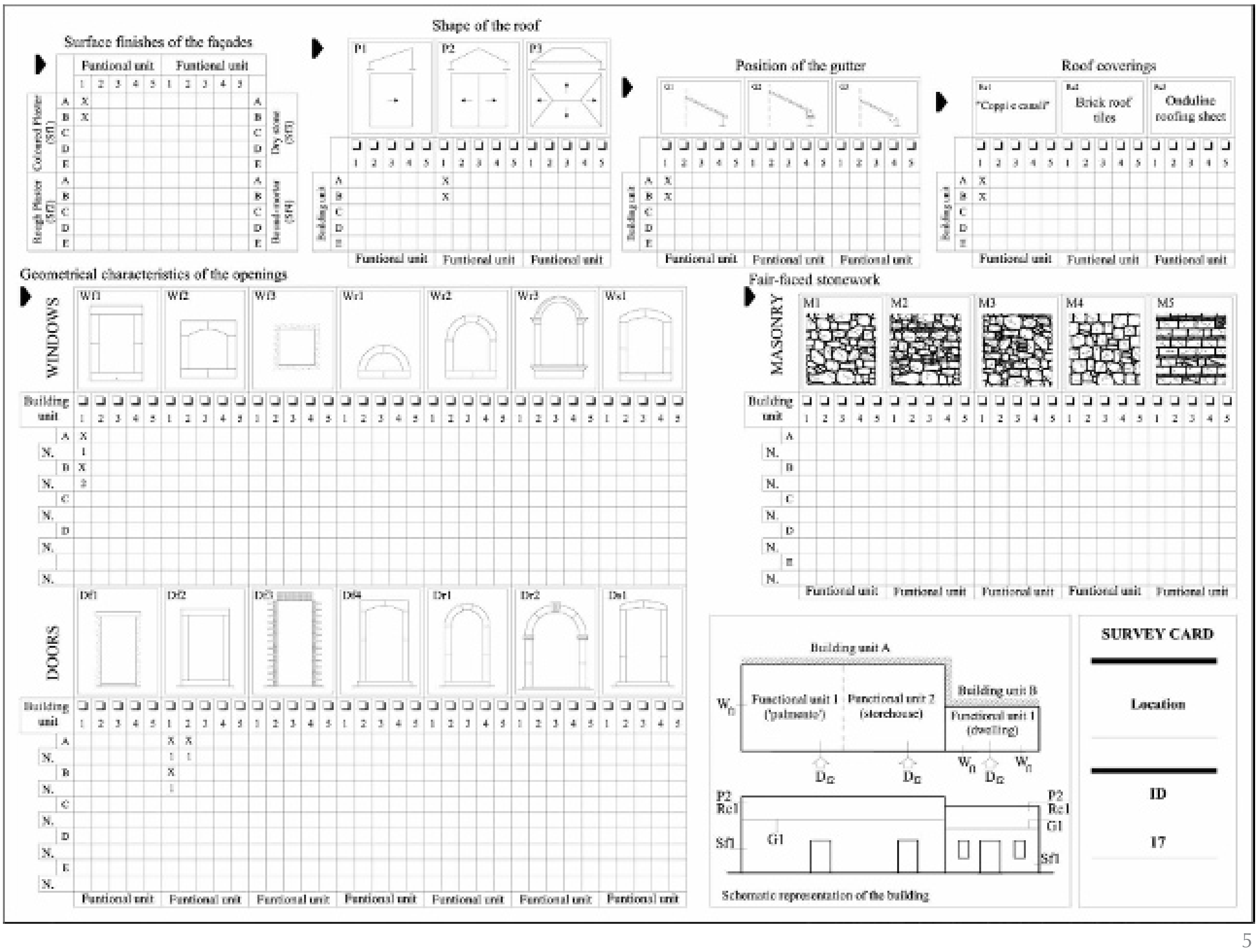
3. To ascertain the state of conservation of the TRBs' external envelope. Three categories, *i.e.*, 'intact', 'altered', 'damaged' were used to classify the TRBs. The attribute 'intact' was assigned to TRBs that have been restored or are in need of restoration and that show minor modifications of the original morphological characteristics of the external envelope; the attribute 'altered' referred to TRBs which have been subject to inappropriate tampering; the attribute 'damaged' regarded neglected TRBs which preserve their original characteristics, but have been dramatically damaged by earthquakes, vandalism, and other destructive events. The survey of intact and damaged TRBs made it possible to examine their original characteristics, whereas the survey of altered ones was carried out to verify if modifications made to the buildings were compliant with the GDs. Results of previous research on Etnean rural architecture were considered (38) to assess the original morphological characteristics of the TRBs.

4. To verify the visibility (*i.e.*, 'visible', and 'not visible') and accessibility of the TRBs from main and secondary roads. The attribute 'visible' was referred to TRBs whose all façades were visible from neighbouring roads, whereas the attribute 'not visible' was assigned to all other cases. The visibility of all the façades of each surveyed building was a basic requirement to record the information related to the external architectural features (EAFs) (see section 2.2.2.) characterising the external envelope of the surveyed TRBs and perform the related frequency analyses.

2.2.2. The second-level survey

The second-level survey was carried out on a subset of TRBs which were included in the first-level survey and were not subject to previous rehabilitation, *i.e.*, classified within the GIS as 'intact' or 'damaged'.

Information on the external envelope of this group of TRBs was gathered by means of a record card (Figure 5) that made it possible to classify each surveyed TRB into the basic functional types: 'type-A', 'type-B', 'type-C' and their possible aggregations.



5. Example of a record card compiled for one building during the second-level survey.

The record card was also used to obtain information regarding the EAFs, *i.e.*, form of the roof, roof coverings, presence and position of the gutters, geometrical characteristics of the openings, surface finishes and fair-faced stonework of the façades.

With regard to building typologies, the record card made it possible to draw up a schematic representation of the surveyed buildings which illustrated each building unit and the related functional units.

The information acquired from the photographic documentation obtained in the first-level survey allowed each record card to contain the definition of the main EAFs. In particular, the forms of the roofs were divided into three classes, *i.e.*, mono-pitched roof (P1) double-pitched roof (P2), and pavilion (P3). Roof coverings were also grouped into three classes, *i.e.*, those using traditional tiles (Rc1), using other types of tile (Rc2), and corrugated roofing sheet (Rc3). The gutter, when present, could be found simply running the length of the façade (G2). Alternatively, the gutter included a channelling system that directed water down along the wall (G3). With regard to the geometrical characteristics of the building openings, these were subdivided into two main classes, *i.e.*, windows and doors, which in turn were subdivided into sub-classes which differ by the form of the lintel, *i.e.*, flat arch (Wf1, Wf2, Wf3, Df1, Df2, Df3, Df4), segmental arch (Ws1, Ds1), and round arch (Wr1, Wr2, Wr3, Dr1, Dr2, Dr3). The surface finishes of the façades were subdivided into four main classes, *i.e.*, coloured plaster (Sf1), rough plaster (Sf2), dry stone masonry (Sf3), mortar-bound masonry (Sf4). Fair-faced stonework was subdivided into five classes: dry stone (M1), dry stone with rows of mortar (M2), rough-shaped stone with lime mortar (M3), squared stone with lime mortar (M4), and *a sacco*, a type of masonry created by two lines of mortar-bound squared stone spaced by a cavity filled with a loose heap of basaltic stones (M5).

As in other previous studies (32) (33), the information acquired in this phase of research was stored in a database linked to the GIS. The information was then processed to assess the frequency of each EAF within the building typologies of the study area, *i.e.*, type-A, type-B, type-C, and their aggregations.

2.2.3. The third-level survey

A third-level survey was carried out to characterize building materials and techniques used in TRBs located in the study area. This phase of research required a detailed metric documentation of TRBs which were subject to the second-level survey, that possessed the most frequently found EAFs, and were representative of the building typologies of the study area. Furthermore, since the general visibility of a TRB is an important technical aspect when carrying out direct or indirect metric documentations, only visible TRBs were included in this third-level survey. However, since also TRBs which can not be seen from roads may be reused or visited by tourists, further inspections of such buildings were performed by means of photographs and metric documentations to highlight any substantial difference between their EAFs an those found in the visible TRBs.

Several technical cards for each analysed EAF were created by using information obtained from on-site surveys and photographic documentation. Each card contained the following data: the plan and the façade of the building where the analysed EAF was detected; the description of the building techniques; the description of the most frequent types of deterioration supported by photographic details; a list of construction materials; the frequency of occurrence of the analysed EAF; the graphical representations of the EAF.

3. RESULTS

3.1. The first-level survey

Data were processed by performing various spatial queries within the GIS. The thematic layers of the Regional Technical Cartography related to the buildings and municipal boundaries, and the thematic layer of the Agriculture and Forest Study related to the homogeneous areas of the Etna Park, were used to perform a spatial query that returned the number of rural buildings located in the study area. This was equal to 89.

Among the 89 buildings, thirteen were excluded because they are inaccessible due to lack of roads, thus 76 were subject to the first-level survey. Among these, 48 are TRBs. Of those buildings, 26 are still in use or partially used, whereas 22 are not used. Approximately 58% of the TRBs that are still in use present signs of inappropriate alterations of EAFs. Of the TRBs that are not in use, approximately 54% are in a good general state of conservation, 19% have been inappropriately tampered with, and 27% are damaged. This data revealed that, among the 48 TRBs under study, a large number (approximately 40%) have not retained their original building characteristics and approximately 13% have been dramatically damaged and are in danger of being lost forever.

The analysis of the photographic documentation revealed that TRBs show significant deterioration of their EAFs and the following most common building modifications were recorded: the replacement of traditional baked-clay tiles, called *coppi*, with other industrially produced brick tiles or corrugated fibre cement roofing panels; the replacement of the original wooden frames and sashes with others made of different materials (*i.e.*, aluminium or iron); creation of new openings that interrupt the continuity of the external building walls; replacement and/or removal of the stone copings; new elevations; substitution of original rainwater disposal systems with gutters made from sheet metals or Polyvinyl chloride (PVC); painting of the external walls with industrial colours that do not blend with the surrounding landscape; building alterations that offer protection against possible intrusions, such as walled windows and doors of unused rooms or the addition of gates and metal gratings to openings.

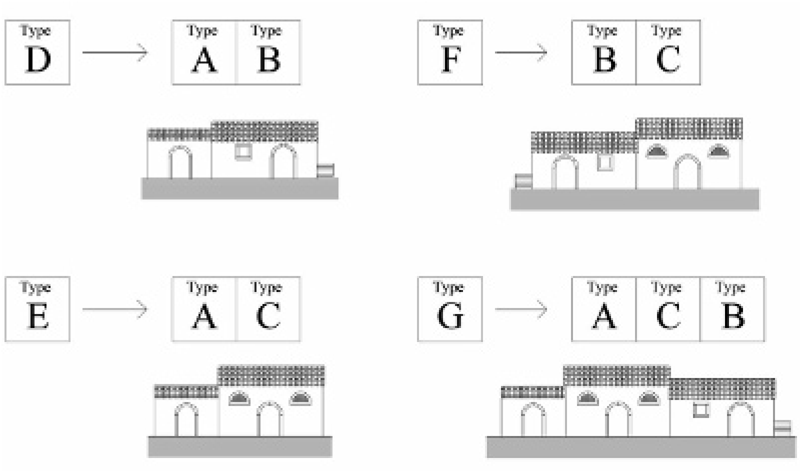
Besides damaging the cultural value of TRBs, such inadequate building alterations threaten the quality of the rural landscape. In fact, data showed that about 42% of TRBs that are not well conserved are also highly visible from the main and secondary roads.

By comparing these first outcomes of the study with the building interventions reported in Table 1, it emerged that the GDs were quite often not respected.

3.2. The second-level survey

A selection query was performed to localize TRBs that were not subject to previous rehabilitation works, *i.e.*, previously classified within the GIS as 'intact' and 'damaged'. The selection query provided 29 TRBs that were further surveyed by using the record card shown in Figure 5. Among the buildings selected by the query, four were excluded from the analyses shown below because their high level of decay did not allow for the recognition of their original typology.

Sixteen buildings belonged to the basic functional types reported in Figure 3. In particular, six buildings belonged to type-A, three belonged to type-B, and seven belonged to type-C.



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6. Linear aggregations constituted by juxtapositions of the basic functional types.

7. Forms of the roofs recorded for the linear aggregations of the basic functional types.

8. (a) Openings recorded for the basic functional types; (b) Openings recorded for the linear aggregations of the basic functional types.

9. (a) Surface finishes of the façades recorded for the basic functional types; (b) Surface finishes of the façades recorded for the linear aggregations of the basic functional types.

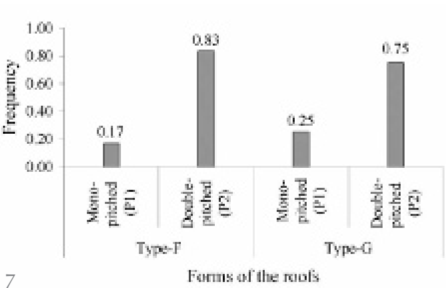
10. (a) Type of fair-faces stonework recorded for the basic functional types; (b) Type of fair-faces stonework recorded for the linear aggregations of the basic functional types.

Nine buildings, that represent 36% of the surveyed buildings, were juxtaposed buildings that were classified as shown in Figure 6. Only one building appertained to type-D, which derived from the linear aggregation of type-A (dwelling) and type-B (*palmento*); another building belonged to type-E, which was a result of the linear aggregation of type-A (dwelling) and type-B (wine-cellar); three buildings were classified as type-F, which resulted from the linear aggregation of type-B (*palmento*) and type-C (wine-cellar); and four buildings belonged to type-G, deriving from the linear aggregation of the three basic functional types.

Due to the scarce relevance of type-D and type-E within the 25 remaining buildings, the EAFs' frequency analyses reported in Figures 7 to 10, were carried out for the 23 buildings appertaining to the basic functional types and the linear aggregations, type-F and type-G.

3.3. The third-level survey

Of the 25 TRBs recorded by means of the record card, only 10 were classified within the GIS as 'visible', and four were inaccessible because of the owners' unwillingness to grant access to the building. Therefore, six of the 25 TRBs were subject to detailed metric documentation. Among these buildings, one belonged to the basic functional type-A, one to the basic functional type-C, two to the linear aggregation type-F, and the remaining two to the linear aggregation type-G. These surveys allowed for the



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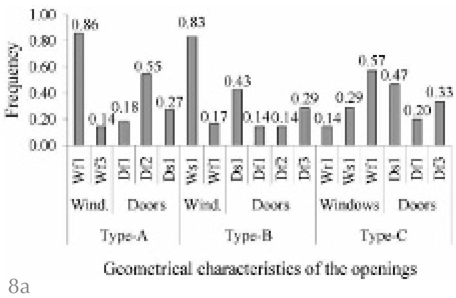

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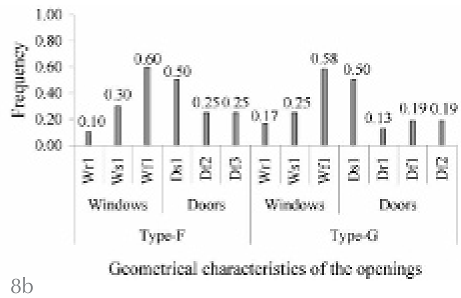

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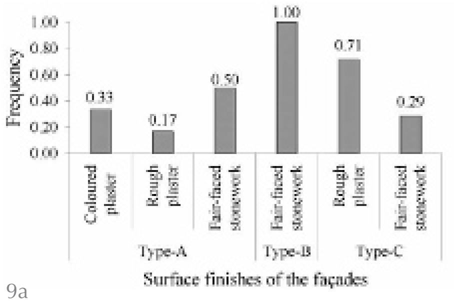

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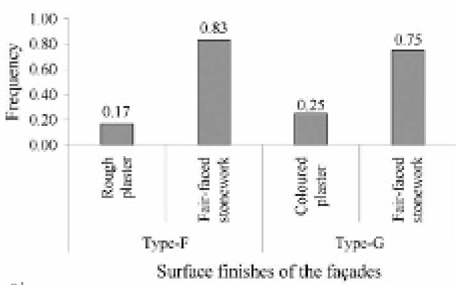

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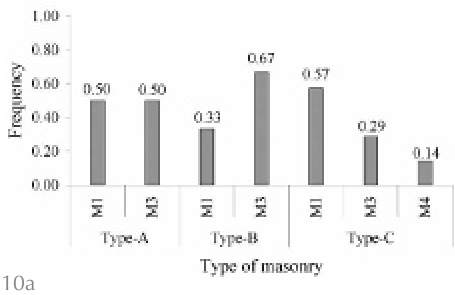

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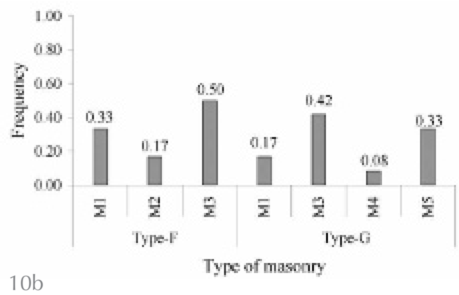

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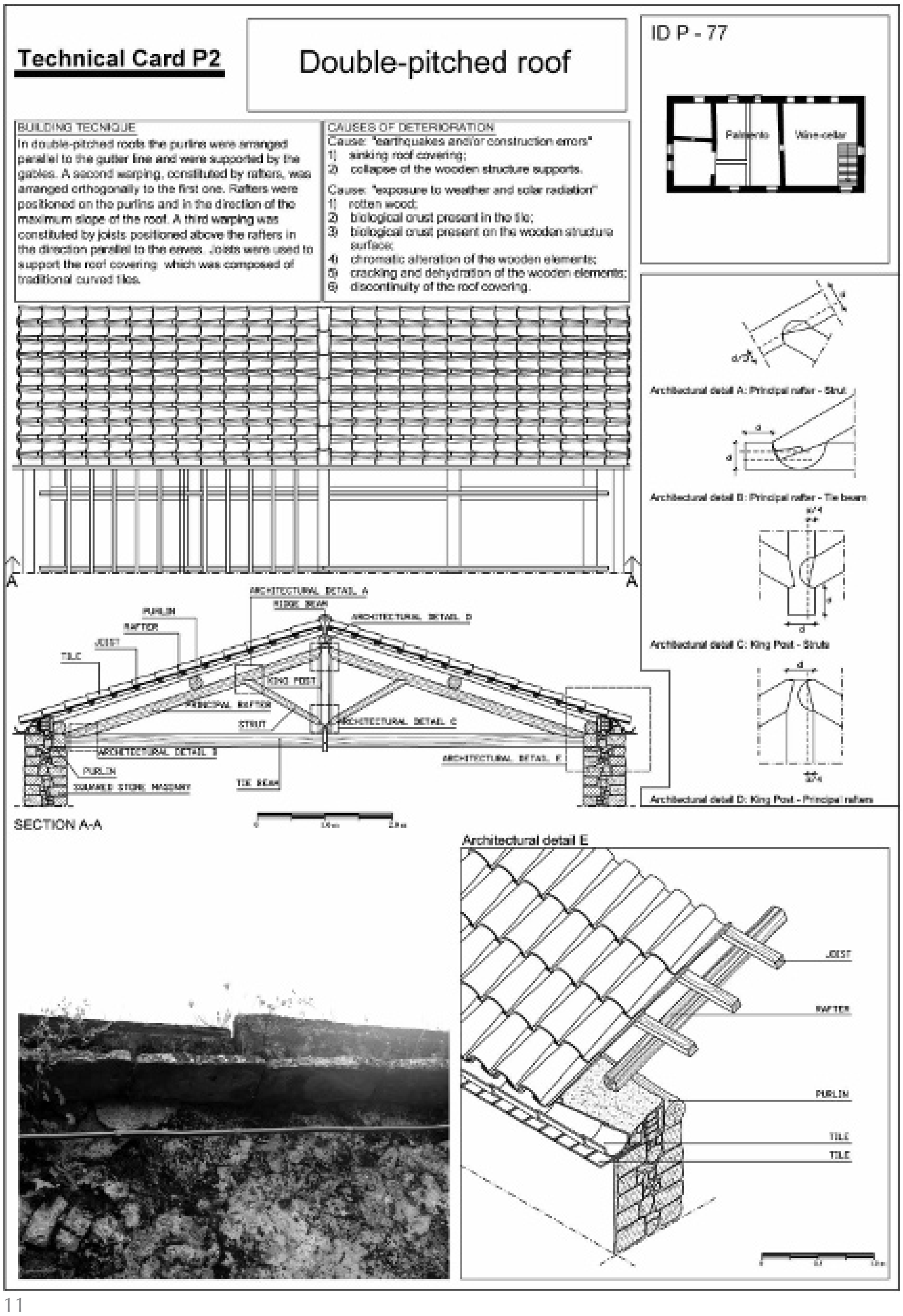
characterization of the building materials and techniques used in the most recurrent EAFs. A technical card was created for each EAF. Since no substantial differences between the EAFs of the six selected buildings and the remaining TRBs were found, the obtained technical cards can be considered representative of the TRBs located in study area.

The basic contents of these technical cards, which pertain to building materials and techniques, are summarized in the next section of the paper.

3.4. The characterization of the TRBs of the case-study

3.4.1. The double-pitched roof (P2)

Due to its fine mechanical properties and high resistance to weathering, chestnut wood was frequently used for the construction of the bearing structure of roofs and floors. In double-pitched roofs (Figure 11) the purlins were arranged parallel to the gutter line, at a distance of approximately 1.50 m, and were supported by the gables. A second warping, constituted by rafters having a generally circular cross section (section of the rustic wood φ ≅ 0.12 m),



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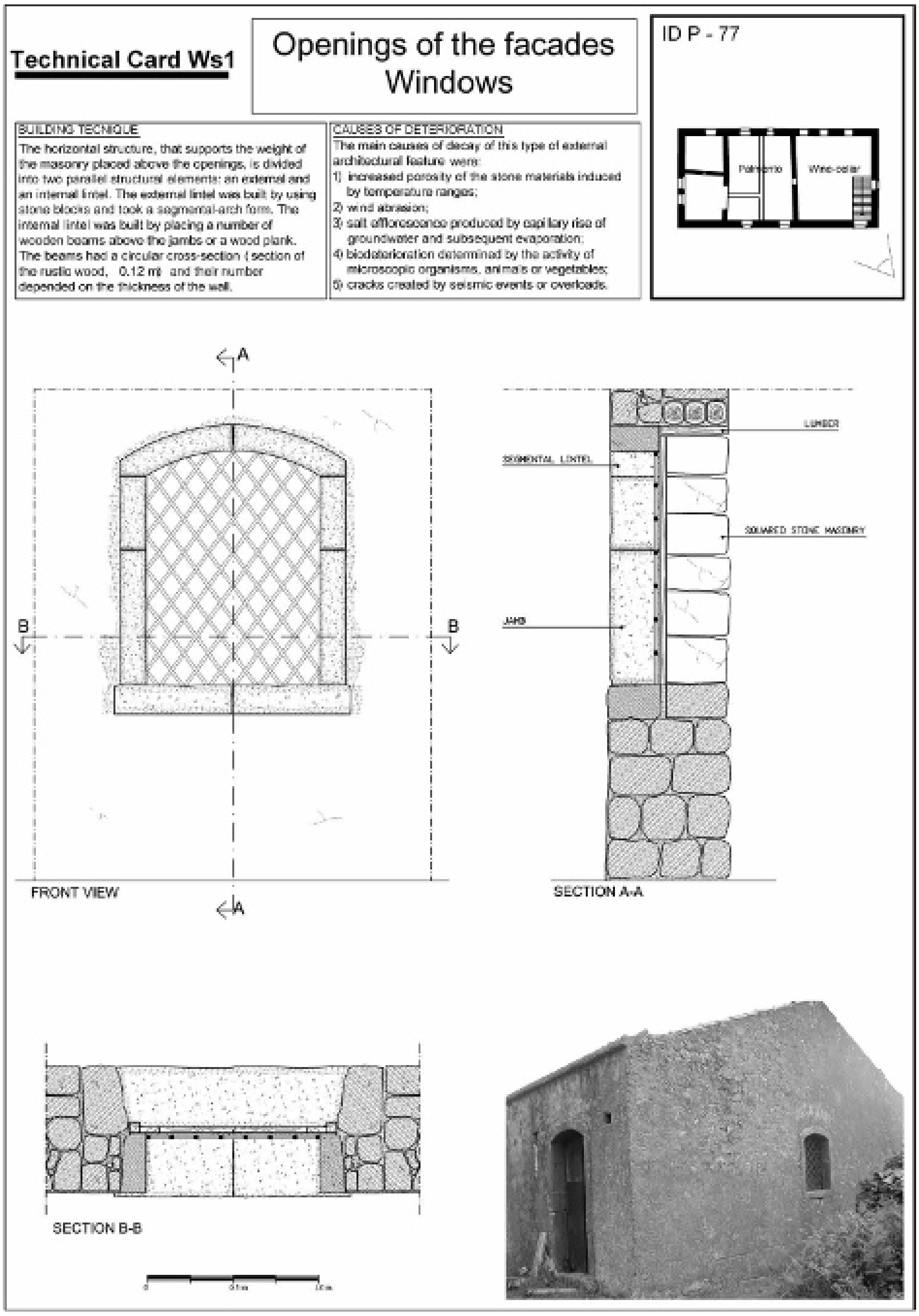
11. An example of the technical card that illustrates the external architectural feature P2.

was arranged orthogonally to the first one. Rafters were positioned on the purlins at a reciprocal distance of about 0.50 ÷ 0.60 m and in the direction of the maximum slope of the roof. A third warping was constituted by joists positioned above the rafters in the direction parallel to the eaves and at a reciprocal distance of approximately 0.25 m. Joists had a rectangular cross section of about 0.06 m × 0.04 m and were used to support the roof covering which was composed of traditional curved tiles made of baked-clay arranged with their length along the line of the maximum slope of the roof. The traditional curved tiles were positioned according to the traditional scheme *coppi e canali*; first, a row of tiles having upward concavity was arranged with their width along the line of the gutter and then a second row was arranged to cover the joints of the previous layer by positioning tiles having the opposite concavity on the first row. The first row of tiles that was positioned along the gutter line was usually placed on a bed of lime to prevent the tiles from sliding and falling.

The main cause of wood decay is water infiltration which occurs because portions of the roof have been damaged as a result of adverse weather conditions, earthquakes, construction errors, and poor maintenance.



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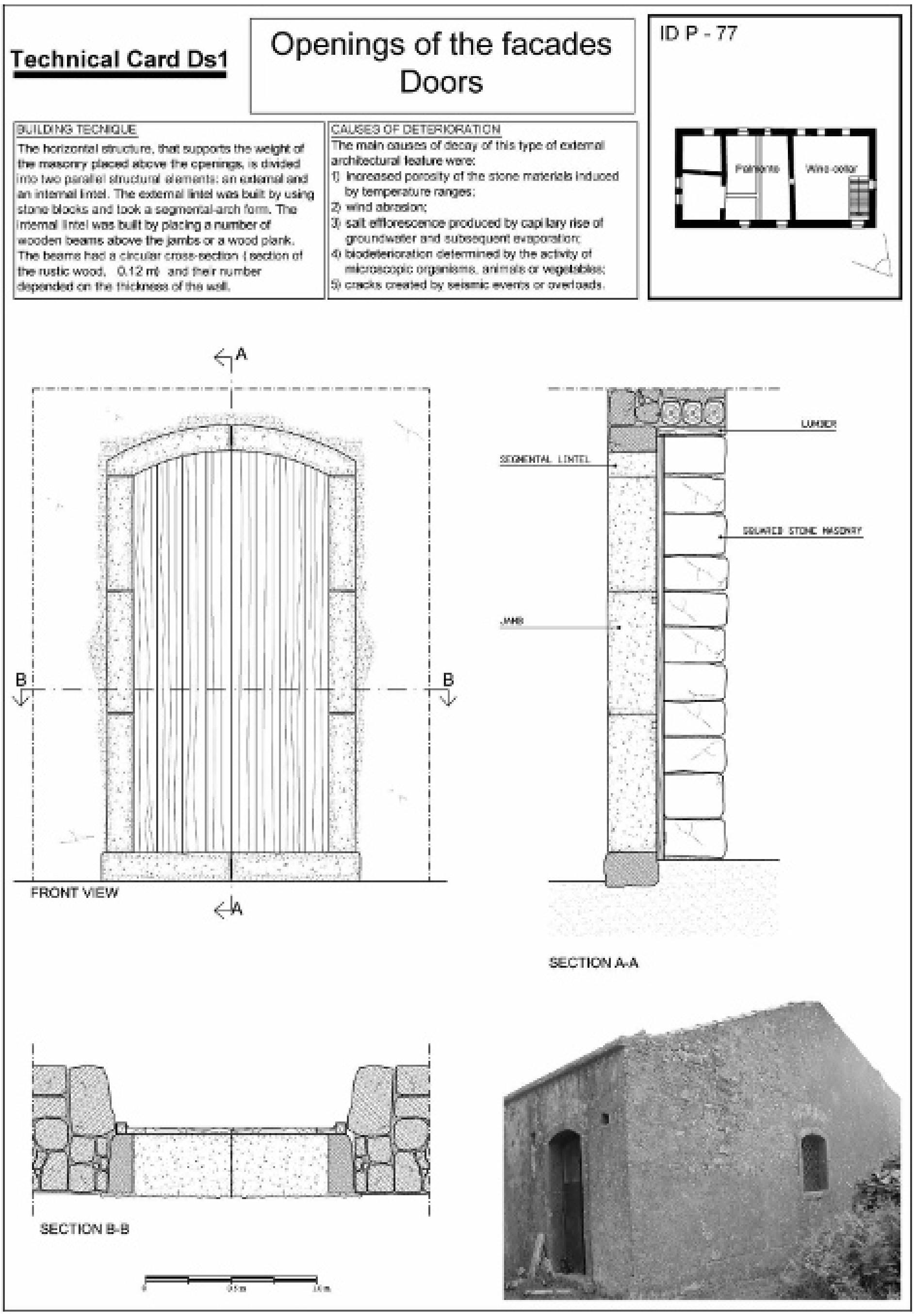
12. An example of the technical card that illustrates the external architectural feature Ws1.

3.4.2. Gutters (G2)

Gutters for conveying rainwater were found in about half of the surveyed buildings. They were built following two main building techniques that were widespread in the study area. The most common involved the arrangement of a row of traditional curved tiles fixed with a stratum of lime mortar above a row of flat tiles made of baked-clay previously positioned along the gutter line (Figure 11). The rainwater which flowed into the curved tiles was disposed of by a system of baked-clay tubular elements, having a truncated cone shape and, to date, integrally found in only a few TRBs. In an alternative to the above described system, flat tiles were replaced by curved ones.

3.4.3. Openings of the facades (Ws1, Wf1, Ds1, Df2)

The most common building technique for the stone frames of these kinds of geometrical characteristics involves the use of Etnean basalt or the white stones of Syracuse and Comiso. The horizontal structure, that supports the weight of the masonry placed above the openings, is divided into two parallel structural elements: an external and an internal lintel. The external lintel was built by using stone blocks and



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13. An example of the technical card that illustrates the external architectural feature Ds1.

took a segmental-arch form in the case of Ws1 (Figure 12) and Ds1 (Figure 13) opening types, and a flat-arch form in the case of Wf1 and Df2 opening type. The internal lintel was built by placing a number of wooden beams above the jambs or a wood plank. The beams had a circular cross-section (section of the rustic wood, $\varphi \cong 0.12$ m) and their number depended on the thickness of the wall.

The jambs were created from stone blocks following one of two methods of construction: the placement of the largest side of the quoin stone block orthogonally and/or parallel to the wall. The stone blocks employed were square and ensured good resistance and adherence to the adjacent wall. A variant of this building technique involved the use of clay bricks for the construction of the jambs and external lintel that were then plastered.

The main causes of decay of this type of EAF were the increased porosity of the stone materials induced by temperature ranges, wind abrasion, salt efflorescence produced by capillary rise of groundwater and subsequent evaporation, and biodeterioration determined by the activity of microscopic organisms, animals or vegetables.

3.4.4. Surface finishes of the façades

Type of fair-faced stonework (M1, M3)

In the M1 type of fair-faced stonework, rubble basaltic stones were arranged to give shape to the external walls. Empty spaces among stones were filled with small stone fragments, without using mortar. For the construction of the first row, rocks of larger dimension and consistent height, compared to those used for the following rows, were chosen. These rocks were then placed on a well-levelled and compact laying surface. The rocks were laid longways and crossways to ensure junction between the face of the wall and its internal construction. This alternation was carried out horizontally and vertically. It was preferable to use rough edged rocks rather than rounded and flattened ones for them to interlock. The poor resistance of these masonry-works called for a strong thick base. The dry stone walls obtained by applying this building technique reached a thickness of about 50 to 60 cm.

Even in situations of complete lack of maintenance, the M1 type was found rarely subject to damage.

In the M3 type, rubble basaltic stones were bound with mortar. The lava rock was roughly squared off to create even bricks which were then laid side by side to construct a level surface without having to insert an excessive amount of brick slivers or small rocks. Such a surface was obtained also by bounding each brick with mortar to create even seams. The joint angles of the curtain walls, which guaranteed toothing between the walls, were created with large 50-60 cm lava rocks. The thickness of the wall varies between 80 and 120 cm.

The main causes of deterioration of these type of architectural feature are moisture due to capillary rise of groundwater, efflorescence caused by weathering, and cracks created by seismic events or overloads.

Rough plaster

The most commonly found plaster does not have a finished surface layer. Such a finish was found primarily in buildings belonging to functional type-C and consists of a type of single-layer plaster called rough plaster, approximately 10-25 mm thick, made of lime mortar and *azolo*. *Azolo* is a pyroclastic sand that derives from lava flow debris. It is found in grains with rough edges and is of a dark grey colour. It was extracted and transported on site, then sifted and washed to eliminate dirt before its utilization for the slurry (39). From analogous studies conducted on rural buildings of the Etnean territory, one can hypothesize that the aggregate/binder ratio is that which is found in traditional plaster, that is, aggregate/binder 3:1.

4. DISCUSSION AND CONCLUSIONS

4.1. Application of the proposed method to the TRBs of the case-study

The current use of the surveyed TRBs (approximately 31%) for purposes other than those originally intended altered their EAFs because of inappropriate modifications that are often incompatible with traditional materials and building techniques. The first-level survey made it possible to identify and analyse the most common types of restoration works carried out on the TRBs that were classified as 'altered' to call attention to the actions of owners and technicians in charge of the recovery and re-use of TRBs. The analysis of the most common types of restoration works led to the conclusion that the building modifications carried out on TRBs were not always compliant with the guidelines contained in the GDs. This could be attributed to owners' unawareness of TRBs' value, to the fact that the restoration had possibly been carried out before the technical norms went into effect, or to the inadequacy of the technical information provided by the GDs. Therefore, on one hand it seems that it is necessary to raise awareness about issues related to the protection and enhancement of TRBs in local communities by using appropriate methods and tools, such as, for instance, those provided by heritage interpretation (7); on the other hand, the technical information provided in the GDs must be reevaluated and complemented with economically sustainable solutions that are more faithful to building traditions. In fact, building materials allowed by the technical norms, such as basaltic stone, other types of stone originating from Comiso and Syracuse, and traditional curved tiles, are often not employed by property owners because of their high purchase price.

The variety of building types that emerged from the different levels of the TRB surveys demonstrated that the classification of TRBs included in the Etna Park's GDs is not capable of exhaustively characterizing Etnean TRBs. Therefore, the GDs must be completed by the typological classification resulting from the first-level survey of TRBs, as well as by building restoration measures that are compatible with the characterization of the building materials and techniques obtained by the third-level survey. Such additions would protect TRBs located in the area of the Etna Park from inappropriate restoration, probably deriving from the scarce characterization of TRBs included in the GDs. In this regard, the survey of buildings classified as 'intact' and 'damaged', the analysis of the main EAFs, and the characterization of building materials and techniques, would constitute a first crucial step towards the clarification of the traditional architectural language of TRBs located in the study area.

The frequency of inappropriate restoration could also be related to the cost of traditional materials which, in modern day construction, are more expensive than ones that are currently utilized and require skilled workers for their use. In the case study, for instance, the GDs require the use of Etnean basalt which, despite its availability and excellent strength and durability, has high costs mainly due to its difficult mining and processing (40). Therefore, it would be appropriate to complete the information contained in the GDs to provide alternative modern materials that are more economically advantageous than traditional ones. In this regard, a study similar to that carried out by Guaraldo-Choguill (1995) (41) could be functional for examining several issues related to the supply-chain of building materials for traditional buildings located in the area of the Etna Park. A first solution could be the drafting of a recycling regulation, resulting from agreements between local authorities and TRBs owners, regarding building materials originating from 'damaged' TRBs. In fact, information gathered during the study, revealed that approximately 12% of rural architectural heritage was in ruin. Therefore, a reasonable amount of building materials could be recycled such as stone blocks used to create the jambs and the lintels of frame openings, traditional baked-clay tiles, basalt stone used in masonries, etc. The use of second-hand building materials can be interpreted as a 'traditional way' of building because it can be considered a response to sustainable building regulations, which are now social and environmental requirements (13). Such locally available building materials are easily obtainable and do not require excessive economic or environmental costs associated with transportation. In this context, the sustainability of the building activity embodies the 'reason for doing' that in the past constituted the deep structure of the 'traditional way' of building (42). However, construction techniques employing this type of material should be shared among the local communities to confer the same distinctive characteristics to all rehabilitated TRBs.

Training of highly qualified restoration staff and TRB restoration projects could create new job opportunities. Research results can therefore contribute to achieving one of the objectives of multifunctional agriculture that concerns the socio-economic development of rural areas.

Local authorities should implement information campaigns on funding opportunities to reduce the financial burden of property owners who restore TRBs. A great financial channel could be that provided by the European Union (EU), which shows great interest in maintaining the cultural identity of places. Among the measures of the Axis 3 of the EU Rural Development Policy (RDP) 2007-2013 (14), which aims towards the diversification of the rural economy and the improvement of the quality of life in rural areas, Member States are encouraged to promote the conservation and upgrading of rural heritage (art. 52). Given that TRBs continue to be an expression of important cultural characteristics of local communities, they could be supported by the measure which strives for the conservation and upgrading of rural heritage (art. 57). Within the territorial area of the Etna Park, European funds assigned to the measures cited above are destined mainly towards 'intermediate rural areas' and 'rural areas with development problems' that were defined within the Rural Development Programme 2007-2013 of the Sicilian Region.

Finally, the cost of implementing the method proposed in this study for extending TRB characterization to the entire Etna Park area could be supported by the previously cited Axis 3 of the RDP, as it includes studies regarding the maintenance, restoration and upgrading of cultural heritage.

4.2. Further utilizations of the method and improvements

The advancement of EAFs' knowledge deriving from the application of the method proposed in this study, could contribute towards defining criteria regarding the preservation, restoration and functional rehabilitation of TRBs that must be contained within programs developed by local authorities which, as in Italy (43), could be mandatory to access the financial support foreseen by national and/or regional laws. In detail, local authorities could define handbooks of traditional building materials and techniques which, completed by graphical details regarding building techniques and materials, would represent the first step towards the definition of guidelines for comprehensive building restoration. In turn, this would provide yet another contribution to multifunctional agriculture. In fact, the application of guidelines for restoration and adaptive reuse of rural buildings would contribute towards the preservation of the anthropic impact on the landscape of the territory analyzed in this case study.

The proposed method could also be used for the development and implementation of territorial coordination plans of protected areas. The achievable advancement of TRBs' knowledge could be used as an additional input for the implementation of territorial coordination plans, and related technical norms and building codes which require thorough knowledge of the characteristics of the territory, in terms of natural and cultural resources (44).

The information obtained by means of the method proposed in this study could be used within document management systems developed with the aim to organize and visualize data related to the conservation projects in cultural heritage buildings (45).

Further in-depth analyses of the study regard the advancement of TRB characterization for the acquisition of information regarding internal characteristics of the buildings. These analyses could lead to the application of methodologies that have been previously developed (46) (47) (48) and are finalized towards the identification of adaptive reuse potential, compatible with typological and morphologic characteristics of TRBs as well as with the multifunctional vocations of the agricultural area under study.

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