ANALYSIS OF THE RURAL BUILT HERITAGE
THROUGH THE FarmBuiLD MODEL

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ABSTRACT

The paper refers to the FarmBuiLD model (Farm Building Landscape Design), developed as a tool for the meta-design of farm buildings. The work focuses on the implementation of specific modules of FarmBuiLD, aimed at the physiognomic characterization of the rural built heritage through survey sampling. The goal of this paper is to define and test a repeatable and flexible methodology for defining suitable samples of rural buildings for the typological analyses, and to work out a proper procedure for surveying the data about their architectural features. The method developed involves the integrated use of stratified sampling techniques and photogrammetric surveys. With reference to an Italian study area, we defined a pilot sample of historic rural buildings, acquired a geodatabase of photographic orthoimages of their architectonic envelopes, and surveyed the main metrics through inferential analysis. The method proved suitable to perform building analyses taking account of the main characteristics of rural landscape and traditional building typologies.

Keywords: Rural built heritage, landscape analysis, architectural design.

1 INTRODUCTION

Nowadays, the design of new farm buildings often subordinates architectural quality and aesthetic features to economic aspects, thus leading to poor landscape consistency and compatibility (Ruda, 1998). Modern rural constructions are mainly characterized, on the one hand, by spatial layouts imposed by functional needs of a mechanized agriculture, and on the other hand, industrial building techniques and solutions. The development of quality-oriented guidelines aimed at making the rural architecture consistent with the landscape context proves thus crucial also given the need to identify and improve the landscape resources highlighted by the European Landscape Convention and considered by the Common Agricultural Policy as well, and by the most recent land-use management and planning regulations. Nevertheless, the development and calibration of sound analysis and planning tools are still topical research themes, given the lack of well established and shared methodologies.

The paper refers to the FarmBuiLD model (Farm Building Landscape Design), a research model developed by the authors as a tool for the analysis of the architectural...
characters of both historical and modern rural buildings, as well as the meta-design of new construction and transformation of contemporary farm buildings (Tassinari et al., 2010). The work focuses on the implementation of specific modules of FarmBuiLD, aimed at the physiognomic characterization of the rural built heritage through survey sampling. The goal of this paper is to define and test a repeatable and flexible methodology for defining suitable samples of rural buildings for the typological analyses, and to work out a proper procedure for surveying the data about their architectural features.

2 MATERIALS AND METHODS

The proposed research model - whose goal is to identify historical-typological consistency criteria for rural building design (HTC) - considers several interconnected analytic and interpretative phases, organized into groups representing the main modules of the model. The modules of physiognomic characterization (P) and functional characterization (F) of rural buildings aim at providing the in-depth analyses focusing on a case study (CS) with fundamental analysis tools; moreover, they directly contribute to the above-mentioned goal, by means of their more general value (Tassinari et al., 2011). The case study module (CS) consists of two phases: the typological analysis (TA) and the analysis of needs and performances (PA), in consideration of the close relation between the form issues and the functional needs. This work focuses on the phase of typological analysis (TA), with particular reference to its application historic rural buildings.

The authors refer to the Italian context, where the above-mentioned theme proves particularly topical also due to the high density of rural settlements in broad areas of the national territory. The work focuses on the municipality of Imola (province of Bologna), considered representative due to its landscape features, the characters of the agricultural sector, and the presence of a high number of historic rural buildings, largely still used for agricultural activities, albeit within farmsteads that have undergone several transformations and expansions. Both flat and hilly lands are broadly represented within the study area (205 km²). It is highly anthropized with the presence of a town of nearly 70,000 inhabitants and several other centres and villages. The agricultural sector consists of over 1200 farms with average agricultural land of 13 ha (Province of Bologna, 2006).

Organized databases of historical rural buildings for any considered study area are necessary to develop the method proposed in this study. They are achievable as the results of systematic censuses of architectural data gathered on georeferenced (or fit to be georeferenced) information platforms. For a long time our workgroup has been performing manifold analyses of the rural built environment (Tassinari and Torreggiani, 2005). Since the first phases of methodological formulation, the research group has taken part to the analyses for the buildings censuses, the study of the built heritage, and the definition of hypotheses for its restoration, consistently with the principles of land-use planning regional laws. (Emilia-Romagna Region, 2000)

The process has led to the definition, in the study area, of a database of 634 rural buildings with acknowledged historic value. The purpose of analysing in detail their physiognomic characters calls for on-site surveys and subsequent processing of the acquired data, which would entail excessive costs if performed on the whole database.
Therefore it resulted necessary to select a proper sample representative of the whole population of buildings. For this purpose we adopted the stratified random sampling technique. Stratification is the process of grouping elements of a population into various subgroups (called “strata”) that are internally homogeneous and differentiated from one another. Each subpopulation stratum is then independently sampled, in order to obtain a set of samples that is representative of the characteristics of the population as a whole. In stratified sampling differences between the strata means do not contribute to the sampling error of the estimate for the population (Snedecor and Cochran, 1967). Thus, stratified sampling allows more precise estimation of parameters for any given sample size to be obtained when compared with a non-stratified simple random sampling design. Moreover in stratified sampling researchers can choose the sample size that is to be taken from any stratum. This freedom of choice gives the scope to do an efficient job of resources allocation to the sampling within strata. Further, when different parts of the population present different problems of listing and sampling, stratification enables these problems to be handled separately.

We acquired the buildings geometric data necessary for processing the parameters through photogrammetric survey by means of perspective rendering of single photograms with known metric references (Docci & Maestri, 2005). Such rendering has been performed through digital image processing with PhotoMetric® (GEOPRO) software. In particular we adopted the geometric rectification method, that calls for the identification on the picture of two couples of lines which are the representation respectively of vertical and horizontal lines, and the knowledge of the distance of two couple of points along the same directions. This method proved more efficient than the analytic rectification, based on the coordinates of known points surveyed by means of topographic instruments, and at the same time suitable to provide results with precision levels compatible with the study aims. For each building we processed the images of the fronts, thus obtaining their rendering properly rectified and scaled. On the basis of such documents we surveyed, through digitalisation in CAD environment, the plan and elevation overall dimensions of the building, the size of the enclosed and open portions of its volume, and of the openings. The procedure thus allows to further reduce the survey costs, both limiting the on-site phases only to photograph shooting, and basing metric data calculation on post-processing through desk analyses, also in a subsequent moment. The method developed and applied has allowed us to obtain the orthogonal projection of the photographic images of every single front of the buildings (Fig. 1), and therefore to build up a database from which it is possible to draw any information about the dimensional aspects of the architectonic envelopes.

Figure 1. Two phases of the image processing of a sample building.
RESULTS AND DISCUSSION

The stratification was based on the combined use of two variables, one of architectural and one of geographic nature. The first one is represented by the typology class, defined on the basis of the original functions of the historic rural buildings, as it has been identified in the censuses. As several authoritative researches have underlined (Biasutti, 1938; Gambi, 1950), such functions are closely related to the historic rural types. The following classes were formulated, aiming also at keeping as low as possible the number of strata, thus contributing to maximize the efficiency of the sampling process:

A. rural houses;
B. farm buildings;
C. buildings with combined residential and farming functions;
D. country villas.

It is well known that the geographical location crucially influences the process of constitution and evolution of the physiognomic features of rural buildings, as it has been documented by several scholars like Gambi (1977), Caniggia & Maffei (1979). Among the main local factors affecting such process of differentiation of architectural features, we can mention the availability of local building materials, the environmental characters, such as regional climatic conditions and topography, and the spatial diversification of the productive structure and the organization of agriculture. Thus the second variable adopted for stratification purpose is the altimetry class. It allowed indeed to identify areas with comparable morphological characteristics. In particular, we have subdivided the study area into the following two classes, defined in a previous study (Tassinari et al., 2008) and considered as significant to draw the main morphologic features:

1. class of altitudes not greater than 50 m above sea level, consisting in the plain lands;
2. class of altitudes between 50 and 300 m above sea level, including all the hill-foot and hilly lands.

The stratification of the database of rural buildings has been carried out based on the possible combinations of the two variables. The goal of arriving at a subdivision of the whole buildings population under analysis that is representative enough in terms of size of each stratum and at the same time made of a number of strata as small as possible, has brought to aggregate combinations A1 and A2, as well as D1 and D2, respectively into the single strata A1,2 and D1,2. The buildings have resulted therefore arranged according to six strata.

As the variability of the studied parameters within the various strata was not known, we lacked an essential piece of information for determining the sample size required for estimating the parameters to a given degree of accuracy, and for optimally apportioning this sample size among the various strata. We therefore decided to extract a pilot sample with sampling rate of 10%, thus adopting a sample size $\frac{n}{L}$ = 60, that can be surveyed in order to obtain this information. The allocation was done in proportion to the size $N_s$ of each stratum, and with the constraint of selecting at least two elements per stratum.

The selection of the sampled buildings was made through the permanent random numbers technique (Ohlsson, 1995): each unit in the list frame is assigned a random number drawn independently from the uniform distribution on the interval [0,1], then
the buildings within each stratum are sorted in ascending order of the random number; the sample for each stratum is composed of the first \( n_h \) buildings in the ordered list. The adoption of the permanent random numbers allows us to coordinate the pilot sample with further wider samples, in order to maximize the overlapping and, consequently, minimize the survey costs.

The first results obtained through the application of the proposed methodology regard the overall dimensions of rural buildings: length \( (L) \), width \( (W) \) and height \( (H) \). Their frequency distributions within the sample are reported in Table 1 and these data represent the starting point of the parametric analysis of traditional rural architectures. These first results provide a preliminary idea of the most widespread dimensional proportions. The most significant intervals of building sizes in fact result as follows: length ranging between 10 m and 25 m, width between 5 m and 10 m, height between 5 and 10 m. More in depth analyses of the geometric data are being performed also through the adoption of proper statistical estimators and the consideration of the buildings distributions into the strata.

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<th>Interval (m)</th>
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<td>0-5</td>
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**Table 1.** Frequency distributions of the first results about the overall buildings metrics.

### 4 Conclusions

The analysis method developed and described in this work has proved suitable for the investigations on historic rural buildings defined within the FarmBuiLD research model. The method, here tested with reference to a study area, has been developed on the basis of a general structure, that makes it suitable also for different geographic areas, provided that the appropriate variations required according to the arrangement of the basic information are made. In fact, with particular reference to the identification and preliminary classification of historic buildings, such information can be organized into several different forms. These may depend on the specific provisions of the relevant regional laws, on the different ways of their implementation at the local level of planning policies for the rural landscape, and on the different study approaches considered by the experts in the field as well.

In particular the integrated use of stratified sampling techniques and photogrammetric surveys, that represents the bearing framework of the proposed method, has proved suitable:

- to perform building analyses taking account of both the main characteristics of the study area, and the typological and functional ones of the buildings themselves;
- to systematically acquire a geodatabase of photographic orthoimages of the architectonic envelopes, suitable for complex and structured considerations about the architectural and typological features;

- to define, through the preliminary analysis of an appropriate pilot sample, both the size of a set of rural buildings and their allocation into the various strata, that result optimal for the purpose of achieving given precision levels of the estimates.

The described method and the obtained results, besides having proved suitable for the specific application to the typological analysis of the physiognomic features of form, can usefully apply to the study of the other physiognomic characters considered in the FarmBuiLD model, i.e. materials and colours.

The general structure of the investigation methodology proves suitable to be considered as a possible foundation for the development of analysis processes appropriate for different national and regional contexts, also within international research platforms on the themes of analysis and planning of the rural built environment in the framework of integrated planning of landscape resources.

REFERENCES