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Housing building typology definition in a historical area based on a case study: The Valley, Spain

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A B S T R A C T

This paper introduces the problem of the abandonment of historical housing located in city centres. These constructions are usually excluded from the cultural heritage conservation processes, and therefore a large quantity of them is currently unlivable, and because of this there is an urgent need to propose solutions. However, the extent of the existing building stock and the additional difficulty of protecting its patrimonial value requires an accurate analysis. This work makes a contribution to the definition of historical housing areas by cataloguing the different dwellings, hence it underlines the need to define building typologies in order to simplify the multiparametric analysis and identify the main vernacular characteristics on such a wide scale. This definition of typology may include all the parameters which value and characterize a historic house through an approach which combines a territorial, urban, architectural, and construction perspective. Likewise, data processing will enable the selection and definition of building typology. The methodology proposed serves as a policy guideline for analysis of buildings in historical centres, prioritising the preservation of the cultural heritage value and the recovery of the historic use of urban space. This method has been tested in a previous case study of the Jerte Valley (*Valle del Jerte*), located in The Central System, Spanish and Portuguese: Sistema Central. This study approaches the analysis of a vernacular housing stock of three thousand dwellings by: first, taking into account the complexity of the historical area analysing the territory, landscape, architecture and urban variables; then, by selecting the representative building typologies; and, finally, by defining information sheets. The culture heritage of the Valley, based on adequate information, will be protected.

1. Introduction

Before now, European culture heritage conservation has been nearly limited to the protection of monumental architecture, without consideration for some of the simplest and most popular buildings that comprise the historical cities (Commission, 2007), hence historical housing stock has not been regarded in urban development policy, leading to a gradual abandonment over the years. Urban Development Fund programs have been carried out by the European Union in order to promote and fund urban regeneration plans (Commission, 2000). However, only a few of them refer to heritage or cultural sites.

Some of the serious consequences of this abandonment are summarized below (Tuan & Navrud, 2008):

- oversight of cultural values, the historical link with the past and the social and cultural traditions are of great importance, in order to give the current cities and societies meaning and character;
- waste of material resources and traditional crafts and techniques, which rely on the design skills of local tradesmen;
- worsening of space problems and loss of construction land belonging to city centres, which entail the waste of urban services already in place;
- increasing energy expenditure, owing to the fact that the existing building stock constitutes the sector with the greatest potential energy savings;
- historic population centres and economic activity are both in decline as current proposals to revitalize them do not exist.

For these stated reasons, there is an urgent need to increase proposals for urban heritage, preserving their outstanding patrimonial value (Nyseth & Sognnæs, 2013). Aside from this, the analysis becomes a complex task due to the large size of the housing stock, multiple case studies, and the difficulty in performing individual studies, it is necessary to carry out a housing stock simplification for an extensive approach in the analysis at large scale.

The objective of this paper is to apply a methodology to identify the

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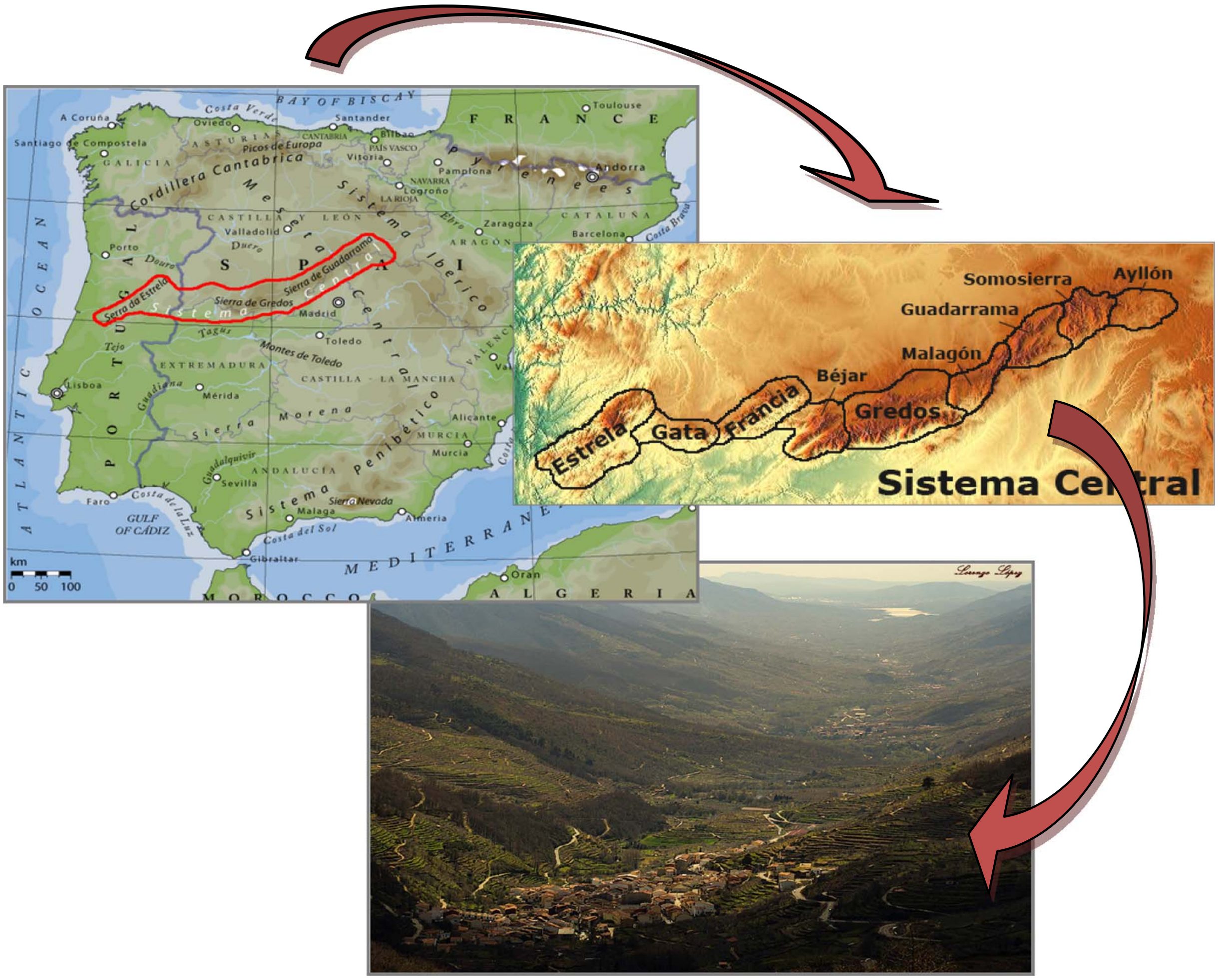

Fig. 1. Research area: The Valley, Spanish Central System mountain range (*Sistema Central*).

dominating building typologies (BTs) in a historic dwelling stock. The BTs definition allows for examination of multiple historical buildings. These studies will be used in urban regeneration process: improvement of strategic policies for economic development and re-use (Yung, Langston, & Chan, 2014), (Yıldırım & Turan, 2012), building appraisal and refurbishment (Vicente, Ferreira, & Mendes da Silva, 2014), (Theodoridou, Papadopoulos, & Hegger, 2011), energy performance assessment (Filogamo, Peri, Rizzo, & Giaccone, 2014), environmental and economic sustainability assessment (Barbero-Barrera, Gil-Crespo, & Maldonado-Ramos, 2014), or support for risk reduction (Santos, Ferreira, Vicente, & Mendes da Silva, 2013). Some others will refer to: planning regulations, revitalisation of vulnerable neighbourhoods, and/or improvement of the quality of life.

To sum up, this paper describes the development of a practical case study presented in the Jerte Valley (The Valley hereinafter) (Fig. 1), situated in The Central System, Spanish and Portuguese: Sistema Central. The Valley holds eleven villages and a stock of three thousand historical dwellings. Different types of dwellings may be found in the area and, as the houses are in a critical state of semi-abandonment, urgent and protective refurbishment actions are required.

2. Material and methods

Previously, different methodologies have been developed to determine BTs with definition of standards, based on general data collection (Cetiner & Edis, 2014), (Pellaquim Radice, 2014), (Brandão de Vasconcelos, Pinheiro, Manso, & Cabaço, 2015), (Heo, Augenbroe, Graziano, Muehleisen, & Guzowski, 2015), (Lu, Im, Rhee, & Hodgson, 2014). However, the historic cities research should be widened: the links between the building and plots are based on sociocultural, economic and historical contexts. Consequently, a gradual approach from the city implementation to the construction process in the territory is proposed. The key features are identified on four levels: the territory, urban planning, architecture and construction (Table 1). Data has been obtained through fieldwork, literature, or municipal planning regulations of the area. Other available data has been published by the National Statistical Institute, the cadastre or the land registry.

2.1. *Territory and landscape parameters*

The historic settlement in the geographical space is studied in this first level. It refers to two features that have determined the foundation of the town and its rooting in the territory: physical variables (altitude; latitude and longitude; configuration and layout; predominant orientation; relief and topographic position; soil and vegetation; climate and microclimate) and human (historic events; population; origin and foundation economy) (Barbero-Barrera et al., 2014), (Silva & Henriques, 2014), (Rodríguez Algeciras, Gómez Consuegra, & Matzarakis, 2016) (Table 1).

In The Valley an information sheet was designed in each village (e.g. collection of territory and landscape data in Navaconcejo in Fig. 2). This data enabled us to differentiate the building typology into two zones: the large core in the valley bottom and the small one in the mountain. The first villages (Zone 1) of 1000–2000 inhabitants are arranged linearly, following the course of the river, which is characterized by gentle gradients (< 5%), warmer temperatures in both

Table 1
Processes of data collection and identification of parameters in a historic housing stock. Case study of The Valley.

Levels	Variables		Case study: The Valley differentiation of building types	
Territory-landscape (Fig. 2)	Physical	Altitude	ZONE 1	ZONE 2
		Latitude and longitude	Linear configuration	Level set adapted
		Configuration and layout	Bottom of the valley	In mountainside
		Orientation	Gentle slope	Steep slope
		Relief and position	Warmer in summer	Cooler in summer
		Soil and vegetation	Warmer in winter	Cooler in winter
		Climate	Large	Small
	Human	Historic events	Agrarian economy	Husbandry and forestry economy
		Population		
		Origin and economy		
Urban (Fig. 2)	Vials	Street Orientation	ZONE 1	ZONE 2
		Alleys Slope	Vials with linear configuration according to the river	Vials with variable configuration depending
		Width/length	Long, wide vials with gentle slope	upon topography
	Squares	Size	Big blocks with alleys	Short and narrow vials with steep slopes
		Shape		Small blocks without alleys
	Blocks	Number		
		Size		
		Shape		
Architecture (Fig. 3)	Plot	Number	ZONE 1	ZONE 2
		Size and shape	Large and long plots	Small plots
		Width/length ratio	High edifications	Low edifications
		Orientation	More than one facade	One facade
		Number of facades	Principal orientation NW–SE	Variable orientation
	Edification	Floors number	With balconies and projections	Without balconies or projections
		Singular elements		
		Distribution		
Construction	Materials		ZONES 1 & 2	ZONE 2
	Construction systems	Timbered frame	Half-timbered:	Masonry architecture:
		Masonry wall	MASONRY walls in ground floor and timber frame	Masonry stone walls in every floor
		Wooden slab	walls in upper floors	
		Floors		

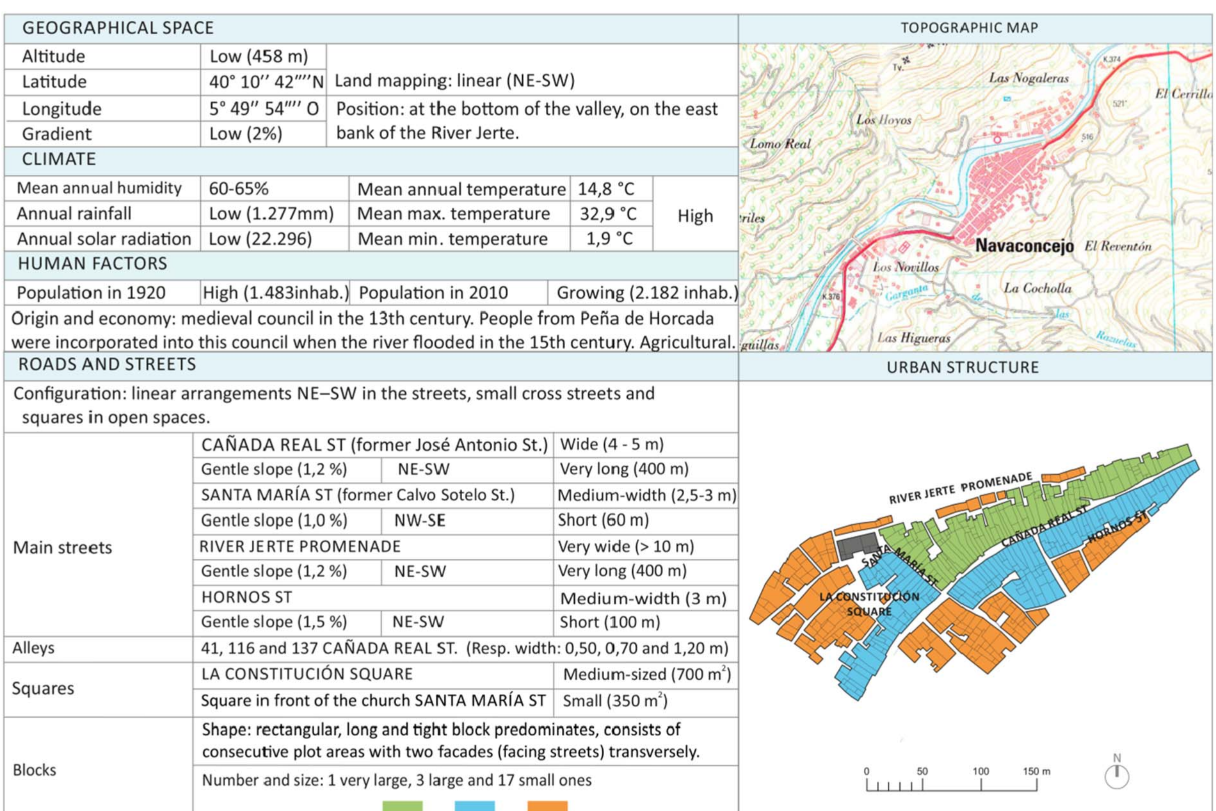

Fig. 2. Sheet with information of territory, landscape, and urban development parameters Individual case in Navaconcejo, the Valley.

summer and winter (32–33/0–1 °C), and an agrarian economy. The second ones (Zone 2), of 500–1000 inhabitants, present steep slopes (> 5%), the layout is adapted to the level set, present cooler temperatures in summer, and winter (30–31/1–0 °C) and a husbandry and forestry economy (Table 1) (Pizarro Gómez, 1983), (Flores del Manzano, 1985), (Ninyerola, Pons, & Roure, 2005), (Carrasco González, 1999).

2.2. Urban development parameters

These parameter refer to the arrangement of buildings in the settlement. The variables studied in this second level are those regarding streets (orientation, width, length or slope), squares (size, shape) and blocks (number, shape or size) (Fig. 2) (Filogamo et al., 2014), (Dascalaki, Droutsa, Balaras, & Kontoyiannidis, 2011), (Özdemir, Tavşan, Özgen, Sağsöz, & Kars, 2008).

The information sheet designed in The Valley (e.g. collection of urban data in Navaconcejo in Fig. 2) differentiates between two typological urban areas: Zone 1 and Zone 2. On the one hand, Zone 1 is characterized by villages with long (100–400 m), wide vials (3–7 m), gentler slopes (< 3%) and few large blocks (20–80 plots, 3000-9000 m^2) in need of intermediate alleyways. On the other hand, Zone 2 is representative of mountain villages with short (< 100 m) and narrow (< 3 m) streets, steep slopes and many small blocks (< 20 plots, < 3000 m^2) (Table 1).

2.3. Architecture parameters

This data depends on the building geometry, which defines the volumetric and spatial aspects in the plot, as well as on the use of the dwelling that identifies the activity and space in the house. The variables analysed are the plots (number, orientation, shape, size, length/width ratio, number of facades), and the building itself (floors number, singular elements or distribution) (Cetiner & Edis, 2014), (Dascalaki et al., 2011), (Fuentes Pardo & Guerrero, 2006), (Santa Cruz Astorqui, 2012), (IDAE., Industria, Turismo y Comercio, & España, 2011).

The architectural data collected in The Valley (e.g. block 1 in a village of The Valley, Navaconcejo in Fig. 3) consists of two differentiated areas. In Zone 1, the plots are mainly large and elongated (125 m^2, proportion to 1/7), have high buildings (2–3 floors), more than one façade, and with a predominant NW–SE orientation. In Zone 2, plots are mainly (50 m^2 and proportion 1/1) composed of low-rise buildings (1–2 floors) with one façade, and variable orientation (Table 1). The period selected to the stock definition is the years preceding the 1920s, the dates in which the construction typologies changed from local forms, with thick stone walls and wooden structures, to a universal or global design with bricks walls and light concrete structures. The distribution type is identified by an analysis of functions (Junta de Extremadura, 1997), (Cano, 2012) (Fig. 3).

2.4. Construction parameters

This section presents a review of the construction systems and materials. It contains data on the fundamental properties: physical (such as density, thermal conductivity, specific heat, or thickness), mechanical (such as compressive strength; energetic: thermal or acoustic resistance), and chemical (composition or incompatibility). This information can be obtained from field testing or theoretical data (Fuentes Pardo & Guerrero, 2006), (Bastos, Batterman, & Freire, 2014).

In the case study, the different building typologies have been divided into two: half-timbered buildings (Zones 1 and 2) and masonry buildings (Zone 2). In both cases structures and floors are made of chestnut and include heavy granite masonry walls on the ground floors. In contrast, the half-timbered walls are employed on the upper floors in the first case, and the heavy walls are kept in the second case (Table 1).

2.5. Processing data and representative BTs

The next stage is to process the data and identify the representative BTs. From the beginning, the building stock is adequately simplified in

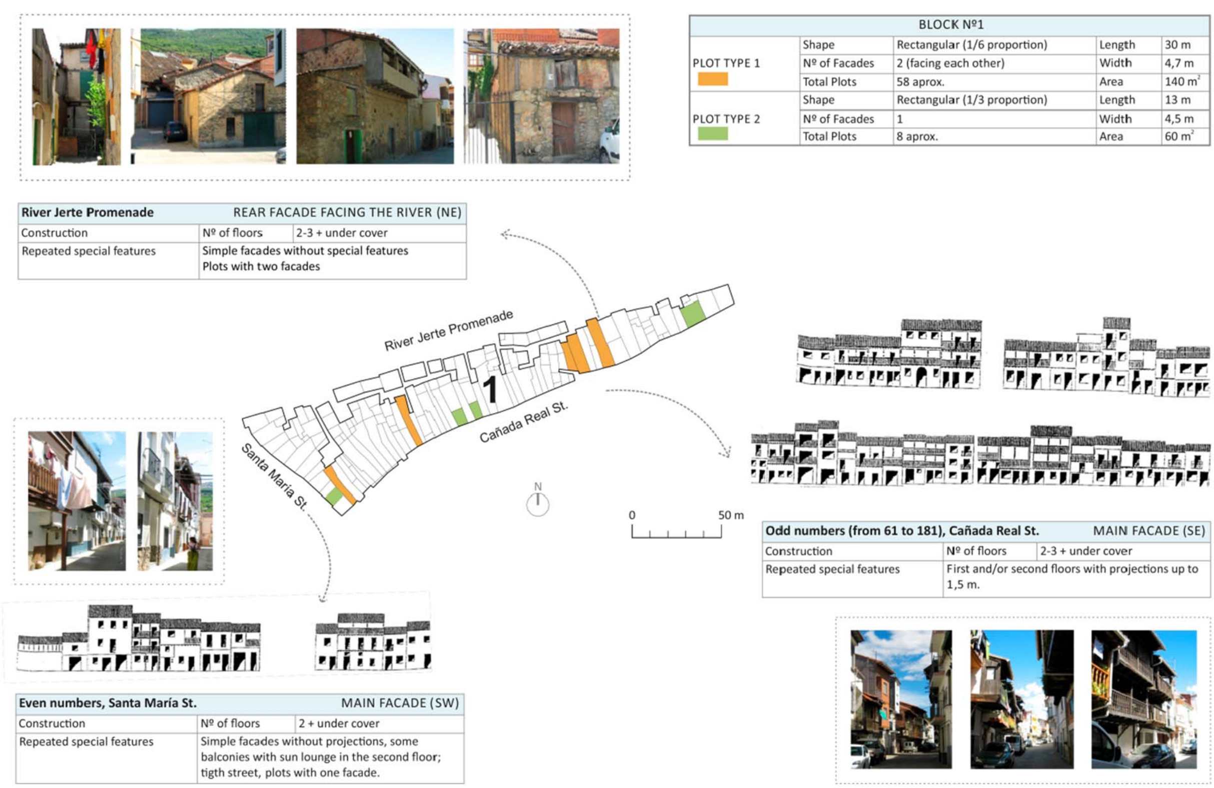

Fig. 3. Architecture datasheet. Individual case of block 1 in Navaconcejo, The Valley.

Table 2
Set parameters to systematise the existing BTs in The Valley.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Timbered **T**	Two floors **2Fl**	1 facade, **F1**	Small **S**	6,5	6,5	1/1	40	1 y 2	**T_2Fl_F1_S**
			Medium **M**	5	13	1/2,5	65	1 y 2	**T_2Fl_F1_M**
		2 facing facades, **F2**	Medium **M**	5	13	1/2,5	65	1 y 2	**T_2Fl_F2_M**
			Large **L**	5	25	1/5	125	1	**T_2Fl_F2_L**
	Two floors and mezzanine **2Fl + M**	2 facing facades, **F2**	Large **L**	5	25	1/5	125	1	**T_2Fl + M_F2_L**
	Three floors **3Fl**	1 facade, **F1**	Medium **M**	5	13	1/2,5	65	1 y 2	**T_3Fl_F1_M**
		2 facing facades, **F2**	Medium **M**	5	13	1/2,5	65	1 y 2	**T_3Fl_F2_M**
			Large **L**	5	25	1/5	125	1	**T_3Fl_F2_L**
Masonry **M**	Two floors **2Fl**	1 facade, **F1**	Small **S**	6,5	6,5	1/1	40	2	**M_2Fl_F1_S**
			Medium **M**	6,5	8	1/1	55	2	**M_2Fl_F1_M**
		2 facades forming corner, **C2**	Small **S**	6,5	6,5	1/1	40	2	**M_2Fl_C2_S**
			Medium **M**	6,5	8	1/1	50	2	**M_2Fl_C2_M**

(1) Construction typology.
(2) Number of floors.
(3) Plot layout in the block and number of facades.
(4) Average plot size plot.
(5) Average plot width (m).
(6) Average plot length (m).
(7) Width/length plot ratio (w/l).
(8) Average plot area (m^2).
(9) Situation in territory (zone).
(10) Identification code of the BTs.

order to unify and select a manageable number of architectural types. In The Valley, the following parameters have been selected to identify the existing BTs (identified by codes to simplify the reading) (Table 2):

- construction typology (T for timber or M for masonry);
- number of floors (2Fl for two floors, 2Fl + M for two floors and mezzanine, 3Fl for three floors);
- block plot layout (F1 for one facade, F2 for two facades, C2 for forming corner);
- average plot size: width, length, and area (S for small, M for medium, L for large);
- situation in the territory (Zone 1 or 2: altitude, configuration, relief, climate, predominant orientation).

Thereby, 2.000 vernacular houses among the 3.000 existing in The Valley are classified into twelve BTs. At that point, the existing BTs are easily characterized: e.g. T_2Fl_F1_S, which means a **T**imber construction with two **F**loors, one **F**acade, and **S**mall size (Table 2).

3. Results and discussion

At the end of the methodology, each BT is completely defined taking into account the preceding parameterization. In The Valley, information sheets, which describe thoroughly the models, have been designed using the collected data in the four aforementioned levels. BTs, which define the historical construction in The Valley, allow us to highlight every variable identifying the cultural heritage in the area, and are repeated throughout the building stock. The input parameters addressed, in this case, the following issues:

– layout in the territory and differentiating features: the width and orientation of the streets, or the typical parcelling of the blocks,
– main features of the plot: size, length/width ratio, area, and/or number of facades,
– geometrical definition and characteristic distribution of houses: detecting singular elements like long balconies, eaves, gradient of the roofs, traditional uses, etc.,
– construction variables: systems and materials, thickness, or thermal conductivity as significant factors to calculate energy exchanges (information sheet example in Fig. 4).

Hence, this data sheet can be used for different implementations. Firstly, the information sheet will be a useful tool for the preparation of urban planning regulations. In this way, it will allow us to point out the constructions that present different characteristic from those on the sheet, and therefore, should not be taken as belonging to historical heritage, but addressed in another field. In this case, the data sheets will help to set bounds to the heritage area and isolate the housing stock, which must be protected in each center.

In addition, the results obtained will enable, on the one hand, to detect the problems that arises when adapting historical building to current requirements and uses, and, on the other hand, to come up with global solutions. Guaranteeing habitability in The Valley dwellings is seen as a major drawback in the case study. This is due to the impossibility, among other aspects, supplying lighting and natural ventilation to the back rooms of the plot. In the same way, accessibility will have to be analysed because of the steep stairs characterizing these vernacular dwellings. In the light of the results, it will be necessary to discuss the reinterpretation of historical variables from each setting. If the rehabilitation of the area is aimed for the aforementioned variables should not be considered fixed but debatable and changeable.

The analysis conducted also permits us to catalogue the existing materials in the building stock or its general advantages for its optimum use. As a result, the thick stone walls or the beams of chestnut wood of this case study can be reused. Moreover, passive bioclimatic strategies can be discovered in the compactness of buildings, the street orientation (mainly southwest in our study), or the possible inertia benefit of the construction of thick walls.

This data sheet can, consequently, be used in software tools, such as modelling simulations, as it contains all the geometrical, occupational, and constructive data required by simulation programs. In The Valley case study, the sheets have served as a basis for analysing the energetic performance in Design Builder of the architectural typologies (Montalbán Pozas & Jiménez Espada, 2016), (Montalbán Pozas & Neila González, 2016).

4. Conclusions

The analysis of the historical building stock can be easily carried out according to the proposed method. The main contribution of this paper is the development of a comprehensive methodology that allows the identification of one particular construction, located in a historical area,

SITUATION			
Zone 1		Street width: 4 m	
Orientation	Nº of facades	Nº of floors (height till eaves)	
SE	1	2 (5,25 m)	
PLOT			
Area	Width	Length	Width/ length ratio
65 m^2	5 m	13 m	1/3
GEOMETRIC DEFINITION			
Roof slope: 30%		Eaves: 0,6 m	
Balconies length: 1,50 m		Overhang: 1,00 m	
Double bay: corridor and rooms.		Single access. One or two stairs (straight dict).	
Floors	Clearance height	External doors and windows	
Ground floor	2,80 m	Single access door (1,3 x 2 m) and small window (0,5 x 0,5 m)	
First floor	2,40 m	One balcony door (2 x 0,9 m)	
Under roof sp.	From 0 to 3,70	No doors or windows	

CONSTRUCTION CHARACTERISTICS		
Construction elements	Thickness (cm)	U-value (W/m^{2}K)
M2+R. Granite mansory wall in ground floor rendering lime mortar in the internal face (including internal walls)	70+5	1,713
M3+R. Timber framework wall in the remaining floor rendering lime mortarin the internal face (incl. internal walls)	20	1,924
S1. Dirt floor in the larder **S2.** Dirt floor and lime mortar in the hall **S3.** Dirt floor with straw and dung in the stable	30 30+10 30+30	2,178 1,954 0,956
F1. Wooden floor structure with chestnut beams **F2.** Idem with grain on the floor of the under cover floor **F3.** Idem with terraccota tiles and lime mortar on the K floor **F4.** Idem with wooden boarding in the kitchen (K) ceiling	4+4 4+4+20 4+4	1,548 0,763 2,172
F5. Slope roof with chestnut beams and wooden boarding	2+2,5	3,542
D. External chestnut door (10 cm)	10	1,169
W. Single glazed wooden windows (3 mm)	3	5,894

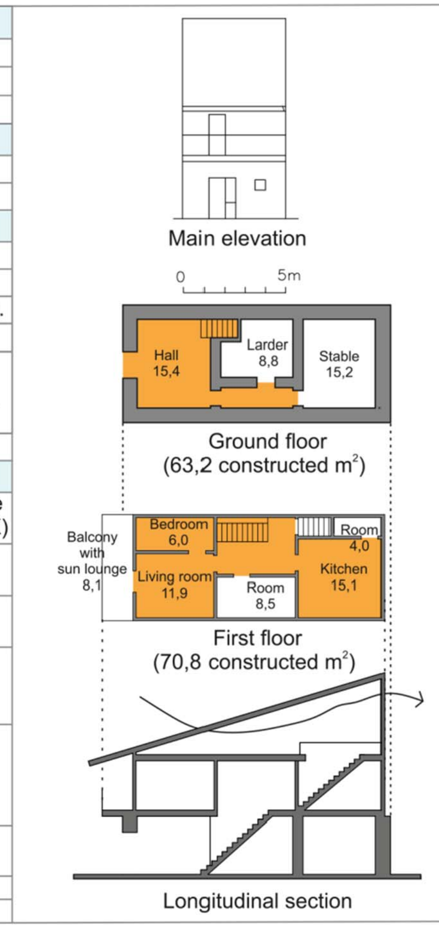

Fig. 4. Information sheet of T_2Fl_F1_M building type.

by selecting the representative building typology (BT). This paper provides a simplified data collection method for proper cataloguing of cultural heritage. It is important to note that the data exist in most cities, and only a simplified organisation is required.

This catalogue can be produced on a city scale, or taken (as a sample) a group of municipalities with similar heritage characteristics, as in the case study. Furthermore, this method can be applied to the study of other building typologies different from heritage dwelling, such as a more recent building stock. It could also have industrial, agricultural, or religious uses, among others.

This method should be applied in each specific historic area having regard for the importance of its own, stated context. The results obtained should be studied individually, bearing in mind the specific circumstances of each building instead of drawing general conclusions. Both analysis parameters and levels should be selected and adjusted to each situation, extended, as necessary, with the introduction of other archeological, sociological and cultural aspects. However, the catalogue will always have to be comprehensive enough as to allow the study of the building stock from different intervention approaches.

As a result of applying this methodology, decision-making in multi-parametric studies will be easier, and protection of cultural heritage can be approachable provided the correct decision-making process is followed. This knowledge will promote heritage protection, ease decision-making and cost-evaluation, and, in addition standardize the intervention proposals to any action suggested in the historic area. Historic cities must be rehabilitated with joint and compatible actions, while solutions involving scattered buildings in the city center must be avoided.

The goal of this paper is to encourage politicians to plan actions aimed at recovering the abandoned cultural heritage in historic centres.

In the light of the results achieved, it can be concluded that it is possible to systematise the building typologies in a complex historical area by defining information data sheets.

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