Large Scale Building Refurbishment Strategies in Italy: A Proposal of "Geocluster" Characterization

Emilio PIZZI*, Giambattista DE TOMMASI, Antonella Grazia Maria Immacolata Romana GUIDA***, Renato Teofilo Giuseppe MORGANTI****, Angelo SALEMI*****.**

* Emilio PIZZI (emilio.pizzi@polimi.it), Department of Architecture, Built environment and Construction engineering (ABC), Politecnico di Milano, Italy.
** Giambattista DE TOMMASI (g.detommasi@poliba.it), Dipartimento di Ingegneria Civile, Ambientale, del Territorio, Edile e Chimica (DICATECh), Politecnico di Bari, Italy.
*** Antonella Grazia Maria Immacolata Romana GUIDA (antonella.guida@unibas.it), Dipartimento delle Culture Europee e del Mediterraneo (DiCEM), Università degli Studi della Basilicata, Italy.
**** Renato Teofilo Giuseppe MORGANTI (renato.morganti@univaq.it), Dipartimento di Ingegneria Civile, Edile-Architettura e Ambientale (DICEAA), Università degli Studi dell'Aquila, Italy.
***** Angelo SALEMI (asalemi@dau.unict.it), Dipartimento di Architettura (DARC), università degli Studi di Catania, Italy.

Keywords: Refurbishment, Sustainability, Design Approach.

Field of Interest: Refurbishment and Rehabilitation; Topic of Interest: Sustainable retrofitting.
Main paper focus: General Framework; Paper Content Classification: Technical.

Abstract

The issue of building refurbishment asks for an integrated design approach balancing multiple requirements and multiple goals. It's based on the assumption that the management of requirements on existing buildings, both prescriptive and performance-based, should encompass social, environmental and cultural responsibility.
This would require the definition of an holistic design approach, aiming at the identification of strategies that are optimized at a large scale but adapted to local conditions and specificities. In this context, the EU concept of "geo-cluster" has been adopted being a virtual homogeneous trans-regional areas where strong similarities are found in terms of climate, environmental context, culture, construction typologies, etc. .
A recent Italian research project focuses on the identification of common parameters and requirements for building refurbishment across regions, so to trigger large scale actions and overcome the "case by case" analysis.
This paper shows the outputs of the preliminary research work for the implementation of a tool characterizing different "geo-cluster" areas in Italy. Five research groups across Italy, involved in a national-funded research project, experiment with the "geo-cluster" approach in the Italian context to promote a large deployment of innovative

methodologies for energy retrofitting and performance upgrading of the existing building stock.

1. Introduction.

In the nearly future, the major challenge affecting the construction sector will be the refurbishment of the existing building stock.
The target of nearly zero energy building fixed by European Union has put in evidence the low energy performances of the existing building stock compared to the new standards. The overall poor conditions of these buildings in meeting contemporary expectations and life styles are generally the reasons of a major retrofitting. When energy saving is also a goal of such renovations, the potential for energy reduction could be largely exploited. Many exemplary renovation projects have been carried out, but the experience gained has not been systematically analyzed and the relevant know-how gets lost in a case-by-case process.
Besides, the refurbishment represents approximately 60% of all the building construction sector and it could reach, according with the forecasts, 80% in 2020, being not only a reduction potential of energy consumption, but also an economical growth and an occupational increase.
Therefore, a common general reference framework could help the store, share and dissemination of knowledge; at the same time, innovative tools could help the management of a large amount of data considering the local specificity.
In this context the geocluster notion grows, being a virtual trans-national and trans-regional area where strong similarities are found in term of climate, culture and behavior, building typology, construction technologies, standards to name a few [1]

2. Geoclusters' Characterization

Aiming at the development of an holistic approach to cost-effective, energy efficient retrofitting of existing building envelope, a recent research work funded at national level exploited the potential of geocluster in the Italian context [2].
The research work involved five research groups - representing five different regional contexts - and aimed at the implementation of a national geocluster reference method by identifying common parameters to evaluate the potential of application of energy-efficient retrofitting solutions.
The research helps to define a comprehensive knowledge of all the issues concerning the application of energy efficiency strategies to the refurbishment of the existing building stock [3], specifically:

- Energy assessment and classification of the existing building stock;
- Identification of innovative technological solutions for the energy efficiency and self-sufficiency;
- Integration of renewable systems, respecting the original historic, architectonic and environmental features.

The research groups focused on five Geocluster areas:

- Large social housing complex in Milanese suburbs (Politecnico di Milano) [4];
- Historical centres in the Italian Mediterranean area (Politecnico di Bari) [5];
- Historical and modern buildings in the volcanic area of Etna (Università degli Studi di Catania) [6];
- Historical buildings in the areas devastated by earthquake in Abruzzo Region (Università degli Studi de L'Aquila) [7];

- Vernacular buildings in Basilicata Region (Università degli Studi della Basilicata) [8].

The characteristics of target building stock of each geocluster area are quite different: from minor historical building to large post-war complexes. The main research effort has been dedicated to the set up of framework for the collection and management of data in such a way to be compared.

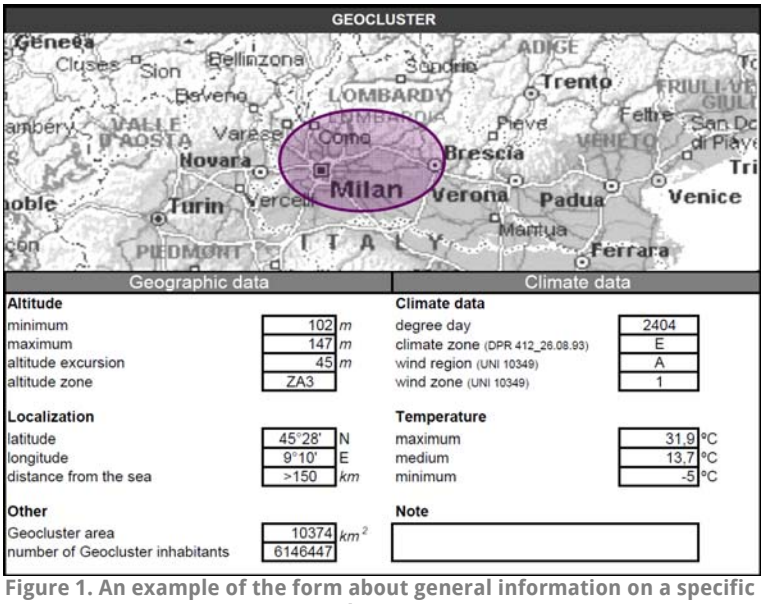


Figure 1. An example of the form about general information on a specific geocluster area

3. How to Identify a Geoclusters' Case Study

For each geocluster area, some representative case studies have been identified and classified according their characteristics. All the data were collected in a dynamic database.

The form implemented for data collection includes the following information:

- technological context: concerning about the detailed aspects of the building in relation to the resources, the constructive and management praxes available and diffuse in the area of the project.;
- geographical context: constituted by the environmental and geographic conditions related to the position and the characteristics of the territory;
- environmental context: concerning about the climatic conditions and the relationship between nature and building;
- urban context: linked to the infrastructures and the building construction of the urban context (*Fig.2*);

- social / economical context: associated to the users requirements and the continuous changes of the lifestyle and the economical fluctuation of the market;
- historical context: concerning about the area construction and management of the case study;
- architectural context: linked to the constructive traditions of the context and its dynamic variations due to the time;

In some cases, the collection of data didn't regard only a single building but a cluster of buildings, especially in the historical urban context. Here, the impact of climatic and environmental factors has been related to the articulation of full and empty urban spaces.

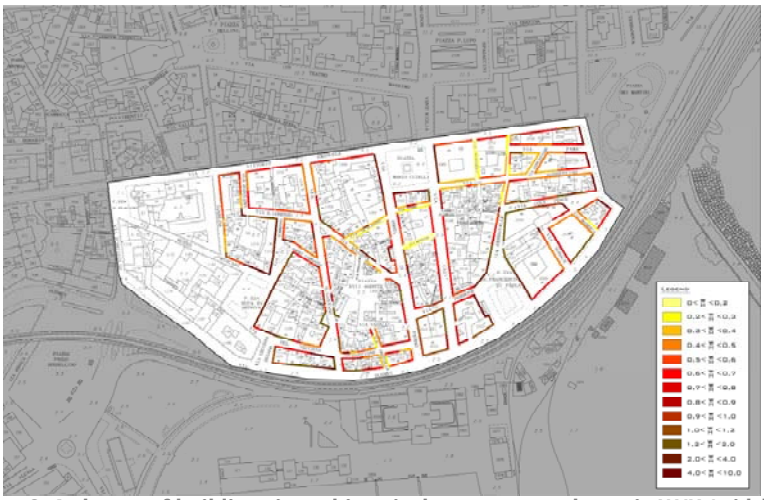
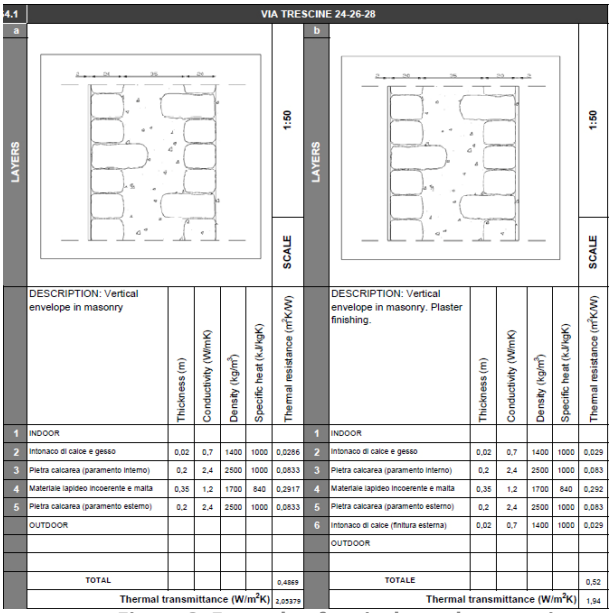


Figure 2. A cluster of buildings in an historical centre were the ratio W/H (width of the road and height of buildings) is highlighted. The areas filled with blue are buildings selected for further analysis.

About the single building, the following data have been collected and analysed as they could have a direct effect on the choice of retrofitting solution:

- Architectural features: general dimensions, stairways and passages, ratio between transparent envelope surfaces and opaque envelope surfaces, loggia, balconies;
- Building technology: structural typology, envelope, partition walls, organized according UNI 8290; for each typical envelope section the U-value has been also considered according UNI 11300 (*Fig.3*);



4.1	VIA TRESCINE 24-26-28											
a							b					
LAYERS						1:50	LAYERS					1:50
						SCALE						SCALE
	DESCRIPTION: Vertical envelope in masonry	Thickness (m)	Conductivity (W/mK)	Density (kg/m³)	Specific heat (kJ/kgK)	Thermal resistance (m²K/W)		DESCRIPTION: Vertical envelope in masonry. Plaster finishing.	Thickness (m)	Conductivity (W/mK)	Density (kg/m³)	Specific heat (kJ/kgK)	Thermal resistance (m²K/W)
1	INDOOR						1	INDOOR					
2	Intonaco di calce e gesso	0,02	0,7	1400	1000	0,0286	2	Intonaco di calce e gesso	0,02	0,7	1400	1000	0,029
3	Pietra calcarea (paramento interno)	0,2	2,4	2500	1000	0,0833	3	Pietra calcarea (paramento interno)	0,2	2,4	2500	1000	0,083
4	Materiale lapideo incoerente e malta	0,35	1,2	1700	840	0,2917	4	Materiale lapideo incoerente e malta	0,35	1,2	1700	840	0,292
5	Pietra calcarea (paramento esterno)	0,2	2,4	2500	1000	0,0833	5	Pietra calcarea (paramento esterno)	0,2	2,4	2500	1000	0,083
	OUTDOOR						6	Intonaco di calce (finitura esterna)	0,02	0,7	1400	1000	0,029
								OUTDOOR					
	TOTAL					0,4869		TOTALE					0,52
	Thermal transmittance (W/m²K)					2,05379		Thermal transmittance (W/m²K)					1,94

Figure 3. Example of typical envelope section.

- Energy performance: climatic data, solar gain and internal gain, transmission and ventilation heat loss, annual primary energy requirement, etc. according UNI-TS 11300.1 (*Fig.4*).

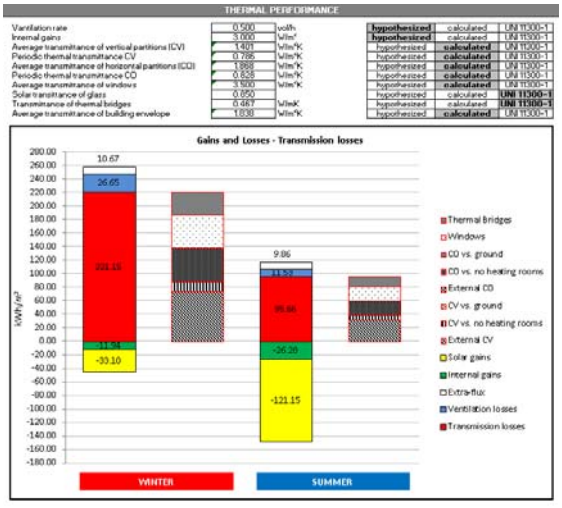


Figure 4. Example of energy profiling.

The major problems of characterization concern the energy assessment of buildings due to the unavailability of data about U-value of walls and degree of efficiency of installations. For this reason, the data have been extracted by national database or by experimental measurement on site.

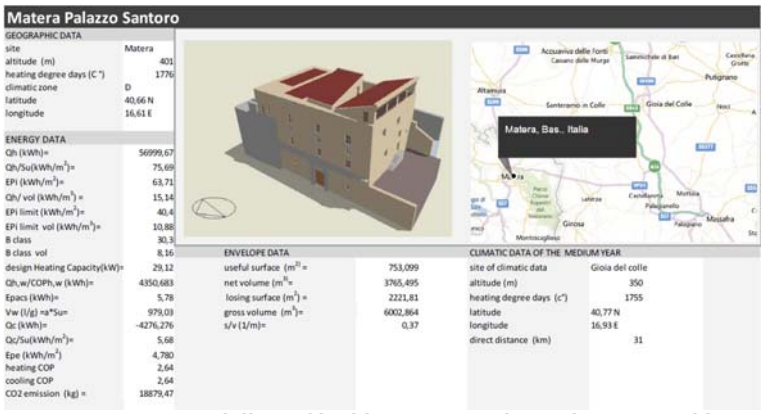


Figure 5. Energy modelling of building (Energy Plus and Design Builder).

For each case study, steady-state and dynamic simulations have been made (*Fig.5*).
By mean of steady-state analysis, the winter behaviour of the building during the heating season has been studied; by dynamic analysis the performance of the building under solar irradiation and high external temperature has been evaluated.
This approach allows to define the best solution for the building envelope during the whole year. The optimization of passive behaviour and the maximization of energetic performance have allowed the reduction of building consumption and the consequent emissions into the atmosphere.

4. Conclusion

The main aim of the research project was the definition of a methodology to build up a geographic cluster, able to identify areas that share similarities (climatic conditions, building typologies, construction technologies, architectural features, context, etc.) The following step of the research work will include a cluster analysis with the aim of grouping a set of parameters in such a way that objects in the same group are more similar (in some sense or another) to each other than to those in other groups (clusters) so to deploy a wide potential of application of cost-effective solutions for energy retrofitting in the Italian context.
The results are finalized to verify energy performance in order to support the technician in the adaptation or improvement of built heritage, where often the values imposed by the rules are not always obtainable.

5. List of References

[1] *EC. Energy efficient buildings PPP. Multi-annual roadmap and long term strategy.* European Union, Belgium, 2010 (online). www.ectp.org/cws/params/ectp/download_files/36D1191v1_EeB_Roadmap.pdf

[2] *EUROPEAN PARLIAMENT, COUNCIL. Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings, 2010, Official Journal of European Union, Bruxelles, Belgium.*

[3] FP7 NMP, GEO20, Geo-clustering to deploy the potential of Energy efficient Buildings across EU.

[4] Pugliese R. – *La casa popolare in Lombardia : 1903-2003.* Unicopli, Milano, 2005.

[5] De Tommasi, G. - *Qualità prestazionali per il recupero dell'edilizia storica. Una proposta metodologica per un codice di pratica.* Quaderno DAU Politecnico di Bari, ADDA Editore, Bari, 2001.

[6] Margani L.; Salemi A. – *Materiali e tecniche costruttive della tradizione siciliana. Tre studi su Catania.* Quaderni dell'Istituto Dipartimentale di Architettura e Urbanistica, n. 16, Catania, 1988.

[7] Zordan, L.; Bellicoso, A.; De Berardinis, P.; Di Giovanni, G., Morganti, R. - *Le tradizioni del costruire della casa in pietra: materiali, tecniche, modelli e sperimentazioni.* Gruppo Tipografico Editoriale, L' Aquila, 2002.

[8] AA.VV., (a cura di) Mecca, S.; Boti Briccoli, S.; Forlani, M.C.; Germanà, M.L. - *Earth/Lands - Earthen Architectures in Southern Italy / Architetture in terra nell'Italia del Sud*. Edizioni ETS, Firenze 2011.

6. Acknowledgments

The analysis described in this paper was part of a Italian research within the project Programmi di Ricerca Scientifica di Rilevante Interesse Nazionale, 2009 "Metodologie innovative per la riqualificazione energetica ed il recupero prestazionale del patrimonio edilizio esistente strutturato in geocluster". Special thanks go to the people of the different research group that worked to allow the development of the project.