Past and present of sustainability: the case of Castellana, an historical centre in South Italy

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ABSTRACT: While the environmentally conscious architects around the world make great effort to find solutions and strategies aimed at respecting both eco-sustainable and bio-compatible requirements, the big resources of valuable ancient settlements are often left unused, even though they contain many principles and technologies in harmony with the place and the natural environment, and represent a great patrimony of human history as well as of human inventiveness. The paper employs an experimental method for studying and thus finding a number of solutions for rehabilitating, requalifying and creating healthy and comfortable indoor and outdoor conditions within historical centres. The application to the ancient town of Castellana in the South Italian region of Puglia has been described, the dynamic simulation for the sun and wind climatic elements has been showed and then the selection of appropriate solutions has been outlined.

Keywords: environment, rehabilitation, simulation

1. INTRODUCTION

Rehabilitating small Historical Centres is a very sustainable action, for it includes energy and material resources saving, as well as safeguard of human cultural heritage, sign of the past, the history and the man's progress in various activities, last but not least the material and technical expertise.

Lately the rehabilitation had engaged a number of studies and interventions, aimed at re-using the ancient buildings and providing new values to the social as well as economical frames of the small towns, which – mainly in Italy – are often found very much decayed and abandoned by their original inhabitants.

Nonetheless the rehabilitation does not always bring with it an high level of quality, first of all because the present techniques, employed for improving material decay, are sometimes not compatible with the ancient structures and because very few times the environmental decay had also been taken into account.

The method we have been employing in the latest years is instead aimed at improving environmental quality and energy efficiency of the whole urban texture of the Historical Centre, trying to avoid as much as possible all the secondary and dangerous effects due to the use of hazardous materials and products, so as to improve at the same time the quality of life and the health of the new framework of the centre. The new design for rehabilitation should be carried out by applying great care to the existing situation as well as by selecting appropriate materials and techniques with high level of naturality.

The method, which starts from a very accurate analysis of the environmental, energy, material and cultural recourses of the site (made up also with dynamic simulations, so as to take into account the variation in the environmental phenomena acting around the buildings), leads to one of the possible solutions in harmony with the place and its history, including the material culture.

The application of this method has been made on a small centre in the South of Italy, Castellana, which showed a great number of ancient architectural traditional characters in the whole urban texture, and presented not an high degree of material decay.

Figure 1: Aerial picture of Castellana nowadays.

2. THE HISTORICAL CENTRE OF CASTELLANA

2.1 History of settlement

The preliminary task within a rehabilitation design is therefore to study all the possible correlation

between the small town and the territory, from the cultural, the geographical and environmental point of view. The first nucleus of the town had been born around the XIII century around a solid bell tower of the S.Leone Magno church. Following the requirements of the times, two other small houses have been settled near a cellar, where the monks stored wine, prepared oil and milled the grain: these fabrics gave birth to the first cloister and then to the construction of the Palace of the XVI century, destined to women's school. Since then a number of changes had occurred, eventually transforming the town in what it is now, which can be considered as the total of both the original medieval centre and the following second part of the XVI century great demographic growth which increased also the built area.

2.2 The applied method

The present configuration of Castellana, the result of all these changes (Fig. 1), can be read as a complex and articulated texture system, with bended roads surrounding the main squares: the environmental analysis of this frame has then been made, so as to show the relationship between climatic-morphological elements and the built texture, being also affected by land physiognomy and mountain presence.

Figure 2: The local white limestone technology

2.3 Traditional techniques

Technological and material analysis of the town at the second level of the study, the urban scale, had shown a number of peculiar examples of traditional techniques, made up with the local stone. Puglia, the region in which Castellana is located, is very notoriously called as "land of stone", for the great number of different kind of rock quarries found everywhere. The one employed for the construction of our town is a very white quality of limestone, strong, resistant and hard. Nonetheless it had been upon times worked up in many different ways, shapes and decorations, either for the "ornia" (the strong reinforced part of the wall which frames the holes of the envelope, made up usually with a unique portion of rock) of the entrance doors and windows, and for the walls themselves (Fig. 2).

2.4 Environmental analysis

The detailed knowledge of the construction techniques of the town upon time can help also to indicate environmental performance of each part of the building, both material and spatial. In fact climatic and other physical phenomena vary according to element and product property and performance and thus creates a different comfort situation. The kind of envelope, made up with very thick walls, few and small openings, very often with a double roof, as it occurs in the Castellana old fabrics, could in fact be considered very appropriate to respond to the climate, which in this region happens to be hot and humid in summer, but very windy and fresh during winter.

The study of the climatic factors, besides being evaluated by means of a number of visual and geometrical analyses, has also employed two software simulating programmes, for each of the main climatic factors: sun and wind. The shading analysis through winter solstice shows in fact a situation which allows part of the fabrics of the whole centre to be penetrated by the sun, due to the slow slope which characterise the east and west part of the urban texture. On the other hand during summer, thanks to the very narrow and bended roads which surround the main squares, the higher solar radiation cannot have access to the house facades and thus a slow mitigation of the heat is created (Fig. 3).

Figure 3: Comparison between winter and summer solstice shading on the town

3. DYNAMIC SIMULATION

3.1 Wind analysis at urban scale

Prevailing wind movement is an important phenomenon since air flows speed and direction greatly affect heat transfer mechanism. Observation as well as simulation of these effects have been carried out at district level, i.e. at half way from territorial analysis, aimed at defining air flows on the entire urban surface, and the analysis at the single building scale, aimed at defining pressure coefficients affecting each part of the fabric. This level then allows to evaluate wind speed and direction through each road, still keeping the calculation easiness needed for

modelling a vast land area with a great number of elements.
It results thus that the needed calculation tool should be made up with a sophisticated programme so as to solve the equations employed during the problem running, by means of the well known CFD system, which achieves a numerical solution through sequential interactions, refining the computation within each procedure stage.

3.2 The simulation model

The most appropriate modelling for the Castellana district has been processed by considering the actual parallelepiped area of 200 x 400 x 100 metres, (thus avoiding the turbulence effect near the simulating area border), with the long side parallel to the north-south direction; the latest choice of taking a "prolonged dominium" is due to the experimental observation of the prevailing winds, North and South, which, at 10 meters above soil level, acquires the speed of about 4 m/s.
Once the model dimensions have been established, the simulation requires the implementation of the wind profiles, following the classical exponential one, according to the variation law [v_z / v_{10} = (z / 10)$^{\alpha}$, where *v* represents wind speed and *z* the calculative height above soil, and selecting α = 0,34, according to the low density areas with more than one floor, i.e. within 390 m]. The air flow thus is simulated as entering from both south and north entrance to the district, while the air outlet goes through the opposite hole. Since the air flow is wholly developed before entering, the model happens to be coherent with the research aims: i.e. to find out whether or not the wind affects the comfort conditions of the district. The needed approximation regarded the geometrical shape and the height of the fabrics, the avoidance of thermal exchange between wind and single building, for the flow is turbulent and no floating phenomena occur. The roughness of the surfaces is on the contrary been taken into account, for it affects speed evaluation near fabrics.

3.3 Simulation results

The simulation then acts on the processed model, by allowing winds from North and South. In the case of the North wind, a number of fabrics preceding the district under analysis face the air flow by channelling it towards the lateral roads, thus losing a certain amount of fluid films speed. Due to the irregular plan of the buildings, a number of wind shading and spot with speed picks, corresponding to narrowing parts, can be observed on the East part of the district. The internal court remains nonetheless slightly stressed. The pictures show speed fields at growing height in sequence. (Fig. 4 and Fig. 5)

Figure 4: North Wind simulation through the Castellana district

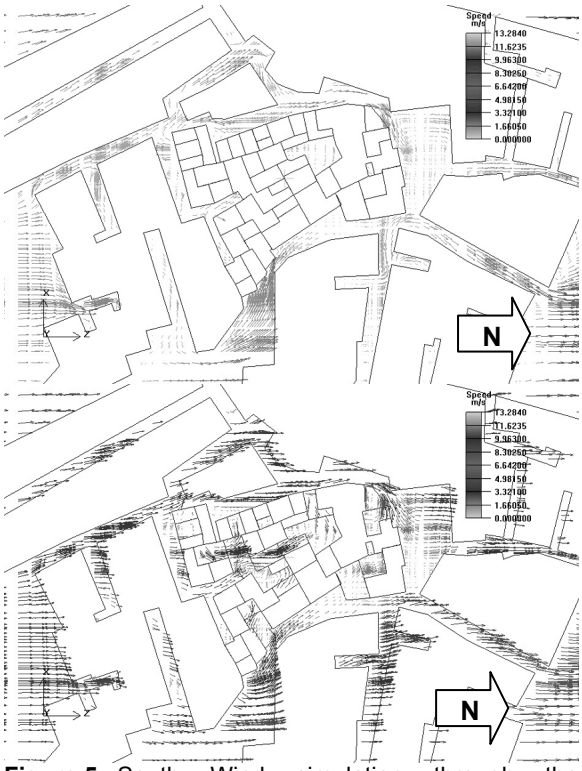

Figure 5: South Wind simulation through the Castellana district

Following the processing of the South wind simulation, the area appears clearly more protected, for a slight decrease of air speed can be observed within lateral roads: In this case in fact the fluid, rather than surrounding the obstacle of fabrics, tends to rise upon earth thus over passing the roofs; the section at

the height of 15 metres shows a reduced speed and turbulence in comparison with the North wind effect, due to the rear buildings curtain effect.

4. PRELIMINARY DESIGN

4.1 Mapping comfort zones

From the results of the shading and wind studies and simulations, the preliminary environmental design can take the start, so as to improve quality of life in the centre during winter, which had been proved to be the most problematic period of the year.

A graphic representation of these results has then been outlined for the district under analysis, so as to create a rapid and clear tool, in which the comfort areas and the more humid, shaded or cold rooms could be easily and quickly identified. This graphical format, the so called MAPPING, then shows that a number of rooms contain certain good vocation for being still re-employed for modern activities, others appear as having good potentiality for hosting different activities. (Fig. 6)

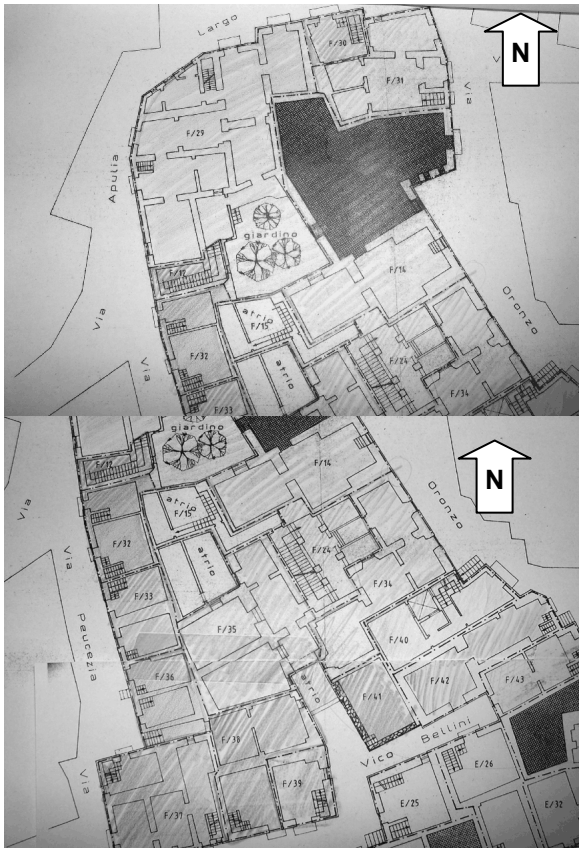

Figure 6: Mapping of the rooms with gradient of comfort levels.

4.2 Environmental performance and social requirements

Once the notation of mapping for thermal comfort has been made and thermal, acoustic and lighting performances of each room have been outlined, a study about the local social needs for a future development of the historical centre can clarify the number of activities which have to be inserted into the architectural spaces. The decision taken about Castellana regarded a possible development and improvement of arts and craft expertise in the sector of ceramic and embroidery; thus a comparison has been made between environmental performances of the various rooms and the requirements of each activity. When the requirements and the room performance matched, the room itself has been proved to be greatly compatible with the insertion of that activity and containing appropriate comfort conditions; in the case of differentiation, a small improvement is needed by integrating some bioclimatic devices and healthy techniques. (Table 1) This toll will help with the preliminary design for any rehabilitation and re-qualification design procedure, to locate the activities within the right and comfortable room, mainly when the aim of the project is that of environmental as well as climatic conditions improvement, rather than destruction of the original layout and vocation, to be replaced by new and non healthy conditions employing fossil fuel plants.

Table 1: Comparison between requirements for activity and environmental performance of room

	Design				
Perfor-mance of existing room	**Chosen activity**	**Activity require-ments**	**Existing perfor-mance level**	**Proposed solution**	**New preference level**
dry, fresh in summer, warm in winter, sunned	Informa-tion office	Dry for users, No-humidity,goo d ventila-tion	5	Openings for air inlet from garden	7
Warm in winter, well ventilated	Ad mini-stration and press	Good venti-lation and warmth	8	Matches	8

Table 2: Climatic data of Castellana

	winter	spring	summer	autumn
T max	12°C	16,5°C	28°C	15°C
T min	3,5°C	10°C	14°C	10°C
R.U.	78,5%	69%	61%	72,5%
Rain/month	62,8 mm	51,5 mm	36,3 mm	61,4 mm

4.3 Solutions for the rehabilitation design

Thus the final stage of the preliminary design establishes the number of improvement needed for the various rooms and areas of the district under study, by creating a number of technical solutions appropriate to host the activity and to create good comfort conditions, both in winter and in summer. The solutions applied to the Castellana Centre consisted mainly in the addition of a *green house* within the courtyard, which contributes to increase heat gains from the sun during the cold season, and, some small *Trombe walls* aimed at drying and heat up a number of rooms, where it was not possible to open new windows, for legal requirements, a number of *skylights* for natural light access in some very central and dark rooms; other solutions consisted in a new arrangement of the external urban areas, which could avoid car and noise roads pollution, so as to create a more healthy outdoor air.

5. CONCLUSION

The short description of the case study of Castellana rehabilitation design had shown then the possibility of extracting a good lesson from the past. Ancient architectures do contain great potentialities so as to be come again places for creating good and high level of quality of life and thus needed to be studied carefully. But it is also important to apply a careful rehabilitation design with indication of solution aimed at improving comfort, avoiding unhealthy situations, saving energy, and safeguarding ecosystems.

Sustainable development means, in fact, providing good comfort and high quality of life for inhabitant, reduce green-house and ozone-depleting gas emissions, but mainly it signifies to put a great respect and safeguard to the whole natural as well as cultural heritage.

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