EsriUsa2008p1504.doc

28TH ESRI INTERNATIONAL USER CONFERENCE
GIS: Geography in Action
San Diego Convention Center, San Diego, August 04-08, 2008

Paper # UC1504

GIS, ESSENTIAL TOOL TO FOSTER SUSTAINABILITY IN URBAN CONSERVATION

Domenico Enrico MASSIMO (1); **Antonino BARBALACE** (2); **Riccardo CEFALÀ** (3)
(1) Associate Professor of Urban Appraisal and Economics, SSD ICAR22
(2) Ph.D. in Conservation of Architectural and Urban Heritage, SSD ICAR22
(3) Computer Science Expert

(1-2) PAU-Gis, Geomatics and GIS Group, Dipartimento n. 1 Patrimonio Architettonico e Urbanistico (PAU)
Università degli Studi *Mediterranea* di Reggio Calabria
Address: Dipartimento PAU, 25 Via Melissari, 89124 Reggio Calabria, Italy.

ATTRIBUTIONS
Domenico Enrico MASSIMO conceived and set up the research and authored the Paper. Antonino BARBALACE coordinated the research works of PAU-Gis Research Group components. Riccardo CEFALÀ performed computer programming development and processing.

ABSTRACT

Paper concerns a long-term research which built-up a Decision Support System for sustainable urban conservation based upon ArcGIS framework coordinated with several tools: mapping, cost forecast, CAD, spreadsheet, regression, as well as energy-climate valuation and control.
Sustainability is a core goal in mankind agenda, given the empirical evidence of ecological disaster hanging over Earth.
Urban conservation is a partial strategy in avoiding further destruction of natural soil and additional energy consumption in building construction and management. It is out of ecological framework and green tools to solve-up the energy\efficiency issue in restoring large urban areas.
Case Study presents a survey of an almost urban neighborhood and a focus on restoration of buildings with two alternative conservation designs: usual *versus* sustainable with high energy efficiency materials. GIS tools for cost estimate give empirical evidence of superior results got by sustainable conservation on energy and monetary cost sides.

01. URBAN SUSTAINABILITY, CITY MANAGEMENT, TAX EQUALIZATION, VALUATION

The emerging of ecological issues at a large scale addressed the research to look for the causes of the rapid increase of environmental decay and to set-up strategies, today more and more shared, able to face-up critical problems.

It has been started a radical rethinking about the growth and the human presence on Earth in terms of settlements, mobility, production, space and landscape (Fusco Girard, 2006; Fusco Girard, Nijkamp, 2005; Fusco Girard, You, 2006). In the last decades the impact of the construction sector on energy consumption and pollution has increased considerably.

Ecological crisis and difficulties are worsened by recurrent petroleum cyclical crisis and by the rise of energy products prices. A heap of crisis makes desirable and urgent general mitigation measures as well as a strong stimulus toward architectural sustainability (Massimo, 2008) as addressed in Aalborg (2004) and reasserted by the Fourth Assessment Report of the Intergovernamental Panel on Climate Change (Ipcc, 2007, pp. 14-18; cfr. 1990, 1995, 2001). All this might improve significantly the ecological, landscape and energy conditions as well as the indoor quality of settlements and buildings (A Report on the Green Building Movement. Baglioni, 1995; Baglioni, Piardi, 1990; De Capua, 2002; Stanghellini, Cerreta, 2002; Massimo, Alberti, Giuffré, Vescio, 2006; Massimo, Castagnella, Giuffré, Vescio, 2007).

Research is addressed to the plurality of stakeholders and actors connected in some ways to the field of architectural sustainability and building energy efficiency: to private owners who might benefit in the medium run for their family budget by a sizeable cut back on energy bills; to Local Governments that might encourage virtuous behaviors and measure adoption among citizens thanks to urban governance tools as well as might put them into practice on their wide real estate properties; to large proprietors of real estate investment funds whose firm management might benefit by energy bills reduction; to Governments because the generalization of good practices might drive down petrol geo-strategic (political) dependence of entire economies.

Sustainability represents the key element of strategies aiming to new, ecological and lasting development and growth. It can creatively be practiced within urban settlements by supporting, among other things and measures, building energy amelioration and enhancement from climate and energy points of view, through urban governance regulations and tools, among which tax equalizations oriented toward sustainability (Crocco, Frezza, 2001; Fusco Girard, Forte, 1998, 2000; Fusco Girard, Forte, Cerreta, De Toro, 2003; Frezza, 2006; Stanghellini, 2005, 2007).

02. URBAN RENEWAL THROUGH SUSTAINABLE CONSERVATION. ALTERNATIVE SCENARIOS

Paper presents an approach of urban renewal through architectural conservation.

In the last decades Earth's pollution has increased considerably due, among other causes, to the increase of energy consumption for existing building management, in particular for winter and summer air-conditioning. Interventions of urban rehabilitation and architectural conservation could become an important opportunity of saving by the mean of building energy amelioration and enhancement.

All these measures, adaptations and interventions should be planned ahead and designed for safeguarding and treasuring urban patrimony. They might consist in two alternative scenarios: "common-usual" *versus* "sustainable". One of the distinguishing elements of the two approaches is represented by the different attention paid to the environmental and climatic dimension. The "sustainable" scenario pays attention to the energy efficiency of buildings. Then, the initial construction costs and the constant energy differential in consumption of the two alternative scenarios are calculated and compared. It is possible to verify the considerable saving of consumed energy resources, in particular for winter heating. This saving makes it possible a significant consequent emission reduction, in particular of CO_2.

Research presents the first results of a coordinated application to new urban planning of different tools for contextual analyses and valuations. Each of the tools helps to understand and valuate different aspects of urban renewal: quantity and consistence of built environment; architectural forms; decays; needs of interventions and connected alternative scenarios; energy and environmental impacts of different scenarios; energy consumption forecast; initial and management costs of investments; energy savings inferable by the comparison of the alternative possible scenarios and related resource consumptions.

03. URBAN SUSTAINABILITY AND EXPERIMENTATIONS. A CASE STUDY

Objective of the research is to introduce, test and coordinate a Decision Support System (DSS) made up of different analysis and valuation tools aiming to safeguard and treasure urban patrimony *i.e.* heritage to better city quality life through actions of improvement of the urban and architectural sustainability and also by enhancing energy efficiency of buildings.
The experimentation needs a close examination of the study area, localized in the urban center of Reggio Calabria. The coordinated urban and real estate analyses gave the hints of a neighborhood where coexist without harmony great urban and architectural values as well as economic and innovative potentialities, together with high decay and lack of interventions: a so-called Pareto sub-optimal condition. Many researches (Castagnella, 2007; Massimo, 1999, 2006, 2007; Massimo, Barbalace, Castagnella, Plutino, Principato, 2007; Massimo, Barbalace, Castagnella, Principato, 2007; Massimo, Barbalace, Castagnella, Vescio, 2005; Massimo, Castagnella, 2005, 2006, 2007; Mollica, Massimo, 2003; Roscelli, 2002; Vescio, 2004) detected as significant and Pareto sub-optimal the northern area of the city.
Case Study is therefore localized in the northern part of Liberty reconstruction of Reggio Calabria, built after the earthquake and subsequent seaquake of 1908.
At present time it is largely inhabited by university students of four Schools and for this reason called “Latin Quarter” *i.e.* “neighborhood surrounding University location”. Research detected a typical example to be the research focus. In fact, within the Latin Quarter boundaries, Urban Block #78 fits to be research focus, and in particular the focus of implementation is one of its buildings, *i.e.* the Cadastral Parcel #97 of the Cadastral Map #121.
The understanding and use of Cadastral information represent a useful tool of operativeness (Jodice, Roscelli, Simonotti, 2007) in urban management and will make it possible in the future to involve owners and stakeholders in participatory processes. Research starts with a complete survey of the urban blocks, and at a more detailed scale of the sample pilot building. The survey is accompanied by archive research of the original drawings of the architectural designs to make a comparison with actual buildings.
To perform an appropriate structural analysis, the technical reports of architectural designs have been looked up and then discovered in the archives, as well as the financial acts of the construction yard. The latter describe in detail all the technical elements and materials employed for the building.
Thanks to the survey of the form and the geometry of the building it is possible to derive total and net areas, total and net volumes, and areas to heating and cooling.
Tests carried out on structure and on geometry do not show any cracks. With a deep investigation of the external surfaces it has been possible to localize and quantify the decays that are just superficial and not deep. They are mostly plaster detachments from large areas and leaks from gutters and terraces due to a not appropriate maintenance. The thermal analysis is deepened with the application of the thermophotographic technology.

TABLE 1 – **Urban Block #78. Cadastral Map #121. Cadastral Parcel #97. Data for each Cadastral Unit**

Unit	Floor	Gross Area	Net Area	Heated Area	Gross Volume	Transmittance Volume	Heated Volume
		mq	*mq*	*mq*	*mc*	*mc*	*mc*
1	I floor	90,45	66,43	66,43	454,06	212,58	212,58
2	I floor	89,13	66,43	66,43	449,22	212,58	212,58
	Total	***179,58***	***132,86***	***132,86***	***903,28***	***425,16***	***425,16***

Unit	Floor	Gross Area	Net Area	Heated Area	Gross Volume	Transmittance Volume	Heated Volume
		mq	*mq*	*mq*	*mc*	*mc*	*mc*
3	II floor	89,22	71,69	71,69	447,88	229,41	229,41
4	II floor	89,70	72,09	72,09	452,09	230,69	230,69
	Total	***178,92***	***143,78***	***143,78***	***899,97***	***460,10***	***460,10***
	Total	**358,50**	**276,64**	**276,64**	**1.803,25**	**885,26**	**885,26**

04. ARCHITECTURAL CONSERVATION THROUGH ENERGY REHABILITATION

Direct, ortophotographic and thermographic analyses performed on site, highlight the need of interventions. The typologies of intervention might, at a first stage, concern a simple refurbishment of the facade and a replacement of the inadequate waterproofing of terraces. Particular attention has been given to catch the opportunity to reduce the strong phenomena of thermal dispersion which contribute to energy overconsumption and crisis, and to consequent environmental pollution.

It is a matter of fact that in the last decades Earth's pollution has increased considerably. Among the causes there is energy consumption due to architectural management, in particular for winter and mostly for summer air-condition. As above said, architectural conservation might represent an important occasion to ameliorate and enhance energy efficiency of buildings. All this is also supported at a normative and regulatory level (Direttiva 2002/91/CE; Decreto Legislativo 19.08.2005, n. 192; Decreto Legislativo 29.12.2006, n. 311). Case Study, as much as it is possible, tries to verify the possibility to contribute to energy conservation both for new construction designs and restoration of existing ones and therefore for "Sustainable Conservation". The aim is to verify the possibility to intervene for periodical maintenance with eco-conservation new technologies oriented to sustainability. The final goal is to guarantee an improvement of house thermal comfort, but also a better preservation of Earth fossil resources as well as of external environment both in terms of less energy resources consumed and less quantity of pollution introduced into the atmosphere (Cannaviello, Violano, 2007; Carotti, 2004; Cellai, Bazzini, Gai, 2007; Di Pietra, Margotta, 2007; Filippi, Rizzo, 2007; Enea, 2004, 2007; Green Building Council, 2003; Green Building Workgroup, 2004; Kats, Alevantis, Berman, Mills, Perlman, 2003; Politecnico di Milano, 2005; Provincia Autonoma di Bolzano, Ufficio Risparmio Energetico, 2007; World Business Council for Sustainable Development, 2007).

05. ALTERNATIVE SCENARIOS OF INTERVENTION: COMMON-USUAL *VERSUS* SUSTAINABLE

Case Study highlights the possibility to intervene on the same kind of decay with two alternative approaches: common-usual, employing common materials; sustainable *i.e.* high energy efficient eco-conservative, adopting innovative materials. In the case of sustainable scenario: plaster renovation makes use of "volcalite" *i.e.* mortar made of special inert elements, such as perlite and expanded vermiculite, with natural hydraulic lime (and clinker free); terrace waterproofing remake adopts aerating, ventilating and insulating groove panels made of natural materials such as fluted cork together with common membrane roofing; single glasses transparent surfaces are replaced by double ones with air spaces. All these interventions together reduce remarkably the heat dispersion toward the outside and contribute in reducing fossil fuels consumption and consequent CO_2 emissions.

The physical characteristics of natural hydraulic "volcalite" mortar, designed and used in the sustainable scenario, do not allow the passage of heat through masonry and consequently thermal bridges are reduced and neutralized. This kind of building material keeps high the masonry average temperature as well as that of the internal walls, insulating and in so doing fostering energy saving and a better internal environmental quality.

Cork then, thanks to its physical characteristics has a high elasticity, it is an excellent thermal and acoustic insulator, it has a high resistance to wear, fire, rats and insects, and it is also steam permeable. Special form, with groove in the upper part of the panel, allows air circulation in the top surface lowering temperature of terrace floor during the sub-Saharan summer of the city.

On the contrary, in the well known common-usual scenario, as in the prevalent practice, materials commonly used in the construction yards of façade refurbishment or maintenance are adopted. These materials are on one side cheaper and easier to install, but on the other side they do not have good thermal and insulating characteristics. To this list belong: mortars made only of sand and cement with a high value of transmittance, applied to vertical surfaces; epossidic membrane, in substitution of the old natural asphalt coating, roofing and coating for terraces and balconies waterproofing; single glasses for doors and windows.

06. COST ESTIMATE SYSTEM. BUILD UP OF THE GRAPHIC ESTIMATE OF THE QUANTITIES

In pilot building construction process and plan, first step is the analysis of the building technical characteristics and decays. Second step is the sketch-up of possible alternative scenarios: sustainable *versus* common-usual. Third step is the interventions design and appraisal.
The fieldwork for on-site survey makes it possible to take measures and then to create the 3D of a whole urban area and its architectures, while the analyses lead to the representation of decays on survey technical drawings (plot, plans, elevation, details), with the fundamental support of powerful spatial DataBases. The design of possible interventions can be done by choosing different alternative works, among which some are particularly recommended, and are consequently quantified. At this stage, GIS may have an importance787 and an experimental relevance, making it possible to map works on 3D and quantify them. GIS coordinates new appraisal, accountability and check tools of either the project and of the construction yard. The results of tools application can be called graphic estimate of the quantities (*Computo Metrico Grafico, CMG*). All this is possible and available in both scenarios thanks to GIS support. GIS is the framework coordinating cost appraisal, energy assessment approach and related software.
Urban rehabilitation projects by the mean of conservation and maintenance interventions consist in different kind of works according to different scenarios.
As it has been stated above, in real world construction yard works, in the common-usual scenario plaster based on cement and the common synthetic not-insulating and waterproofing membrane roofing are employed. In alternative, sustainable scenario introduces the cited innovative materials such as “volcalite” mortar based on natural hydraulic lime, which is thermo-insulating and transpirable, and also “genius” natural thermo-insulating, aerating and ventilating grooved cork panels.
Sustainable scenario implies: lower costs of maintenance; a significant and sensible physical saving in terms of energy resources (generally fossil fuels); a consequent monetary saving of annual energy management bills; a lower down of pollution and a diminishing of annual kilos of CO_2 for every kW not used and not consumed. Then, at the beginning sustainable scenario is economically more expensive than the common-usual one but it leads to a major energy efficiency of the buildings, which lasts for the intervention life cycle, through rehabilitation. Building works and consequent energy consumption of the renovated building must be assessed and valuated together. For this reason, it raises an issue in the construction sector: a lack of knowledge about new construction costs, about conservation of existing buildings, and also the not availability of databases that could support the running cost estimate of future energy consumption and management. Given this lack of information and the connected issues, Urban Appraisal has started to answer to the needs of construction sector with several researches and experimentations (Castagnella, 2007; Del Nord, Maffei, Petretto, Roscelli, 2002; De Mare, 2004; De Mare, Ferrara, 2004; De Mare, Morano, 1997, 2002; Fusco Girard, 1987, pp. 487-531; Guarino, 1996; Massimo, Barbalace, Castagnella, Mercuri, Vescio, 2006; Massimo, Barbalace, Vescio, Boncaldo, Plutino, Principato, 2007; Massimo, Musolino, 2005; Massimo, Musolino, Vescio, 2000, 2005; Massimo, Valtieri, Musolino, 2005; Mattia 1995; Mattia, Utica, 1993-1994; Miccoli, 1995, 1996, 1998; Mollica, 1995, 1996; Mollica, Massimo, 2003, 2004; Mollica, Musolino, 1994, 1999; Musolino, 1994, 1997; Orefice, 1994; Patrone, 1978, 1986, 1990; Realfonzo, 1995; Simonotti, 1994, 1997, pp. 384-420; Stanghellini, 1990, 2004).
It has been started a first estimate of the specific Case Study of both initial building costs of intervention, and of physical cost of energy management in terms of calories, joule, kW, considered either before and after the intervention.

07. COMPARATIVE COST APPRAISAL, MONETARY AND PARAMETRIC COSTS

A Case Study should build-up a systematic and efficient knowledge of detailed costs (physical; monetary; energy; environmental) of alternative scenarios of intervention. For this reason a specific and steady valuation system within a spatial DataBase has been conceived, started and set up based upon microeconomic analyses of the elemental inputs *i.e.* the relative production factors of works. Estimates are based upon elemental technical factors of production or inputs that represent the modular operations and works. An estimate of the intervention is done ranging

from the apartment scale to the neighborhood one. Estimate concerns at first the physical quantities and then the monetary ones. The basics are represented by real world costs of elemental technical factors surveyed on local market. These represent dated and localized cost lists. Building construction techniques are critically represented with a complete comparative series and the respective technical indexes, micro-economic analyses and their costs adopted in many contract works of southern and central Italian regions.
The synoptic anthologies are also compared to standard books of elemental technical factor analyses commonly known as “price analyses” (Castello, 1998, 2006, 2007; Città di Palermo, Assessorato al Centro Storico, 1998; Gieri, 2006, 2007a, 2007b; Grosso, 2005; Ministero dei Lavori Pubblici, 1948, 1966; Otero, 2002, 2006a, 2006b; Santini, Perinetti, 1984; Tinè, 1995; Tipografia Genio Civile, 2002; Utica, 1994-1995).
The micro-economic analyses oriented to a detailed cost estimate (Simonotti, 1997, pp. 384-420), are defined as Elemental Factor Analysis (AFE) and make it possible to contextualize costs in local markets.
The resulting final list of AFE corresponds to what is commonly defined as “price list”. The quantities of the works, usefully mapped on GIS, are summed up creating the georeferenced estimate of the physical quantities. The latter is multiplied by the unit costs of AFE and the final result is *Computo Metrico Estimativo* (Cost Sheet) of interventions. The total amount of the two alternative scenarios is the following: € 59.987,50, for the common-usual; € 69.885,20 for the sustainable one. The sustainable scenario implies a higher initial building cost of € 9.897,70.
Works are collected for typology and for interest focuses. It makes it possible to get the differential initial costs (the building ones, not yet running energy and management) of the two alternative scenarios.

TABLE 2 – **Restoration Total and Specific Costs for Alternative Scenarios of Intervention: “Common”; “Sustainable”**

Scenario	Total €	Facade €	Terrace €	Window Frames €	Iron Rod €	Rubble Removal €	Installations €
Common	**59.987,50**	30.336,16	9.144,79	7.768,16	219,54	1.247,14	11.241,71
Sustainable	**69.885,20**	34.023,92	15.354,73	7.768,16	219,54	1.247,14	11.241,71
Δ	***9.897,70***	*3.687,76*	*6.209,94*	*0*	*0*	*0*	*0*
Δ %	**16,50**	12,16	67,91	0	0	0	0

TABLE 3 – **Plaster Layer Different Costs for Alternative Scenarios of Intervention: “Common”; “Sustainable”**

Scenario	Scratch Coat €	Leveling Coat €	Finishing Coat €	Painting €	Total €
Common	2.870,98	4.957,85	3.528,49	3.140,52	14.497,84
Sustainable	4.398,36	8.890,65	4.896,60	0	18.185,61
Δ	*1.527,38*	*3.932,80*	*1.368,11*	*0*	*3.687,77*
Δ %	53,20	79,32	38,77	0	25,43

From the *Computo Metrico Estimativo* (Cost Sheet) and with the physical data of the buildings and of its single parts, it is possible to get approximate parametric costs.

TABLE 4 – **Approximate Parametric Costs of Analytic Derivation, for Each Scenario of Intervention: Building**

Building Scenario	Total €	Area mq	Height ml	Volume mc	Cost €\mc	Gross area mq	Cost €\mq
Common	59.987,50	196,08	10,04	1.803,25	33,26	358,50	167,33
Sustainable	69.885,20	196,08	10,04	1.803,25	38,75	358,50	**194,94**
Δ	*9.897,70*	*0*	*0*	*0*	*5,04*	*0*	*27,68*
Δ %	16,50	0	0	0	16,50	0	16,50

TABLE 5 – **Approximate Parametric Costs of Analytic Derivation, for Each Scenario of Intervention: Façade**

Scenario	Facades €	Facades mq	Facades €\mq
Common	30.336,16	408,39	74,28
Sustainable	34.023,92	408,39	**83,31**
Δ	*3.687,76*	*0*	*9,03*
Δ %	12,16	0	12,16

TABLE 6 – **Approximate Parametric Costs of Analytic Derivation, for Each Scenario of Intervention: Terrace Insulation**

Scenario	Terrace €	Terrace mq	Terrace €\mq
Common	9.144,79	149,89	61,01
Sustainable	15.354,73	149,89	**102,44**
Δ	*6.209,94*	*0*	*41,43*
Δ %	67,91	0	67,91

The estimates make it possible to get the differential of the initial building costs which is of 16,50%. In particular, it is of 12,16% for the intervention of the façades and of 67,91% for the intervention of floor-terraces.

08. ENERGY NEED ESTIMATE IN THE TWO ALTERNATIVE SCENARIOS

The question is if the experiment makes it possible to verify the considerable energy saving by only replacing plasters and floor substrates of common use, made of cement, with alternative sustainable works. To estimate in a documented way the savings due to a climatic rehabilitation, the research calculates the energy need of a Case Study pilot building, made up of four apartments, two for each floor, corresponding to the Cadastral Parcel #97 of the Urban Block #78. Different energy estimate software is comparatively used, and then the chosen one is reported by describing its four main sections.

General data
Climate zonal characteristics (Reggio Calabria) which affect the external building shell.

Structural data
Opaque and glass components, with the detailed quantity in squared meters for each element, which make the connection between the adjacent internal rooms and the external environment.

Heating system data
The software is set on a heating system chosen within a default archive. For the first experimentation the initial installation costs are not considered. It is assumed a low cost device for heating and an average cost of electric power.

Rooms
For each apartment of the Cadastral Parcel, the heated areas are calculated for each single room considering the exposure.

The energy need of the building is forecasted and calculated in order to estimate the effective consumptions, in both the alternative scenarios, only for winter heating.
Once that the climatic and structural factors have been input, the software calculates the dispersions determining the real amount of dispersed energy between the heated zone and the dispersant areas (not-heated areas). At the end, the collected data make it possible to estimate and calculate to total amount of seasonal energy required by the building.

09. MONETARY ENERGY COSTS IN THE TWO ALTERNATIVE SCENARIOS

The cost of a kWh of energy depends on different variables being also proportional to the consumption and to the time slot. An average and approximate energy cost taken and used for the Case Study, electric in particular, is of 0,15 €/kWh. Multiplying the seasonal energy forecasted consumption [December-March] of the Cadastral Parcel #78, expressed in kW for each mq for a year, by the area of each apartment of Cadastral Unit, and by the cost of 0,15 €/kWh, the final result is the total cost of energy management for one year.
The significant differential (Δ%) of energy need, or forecasted consumption, is articulated in alternative scenarios of interventions: common-usual *versus* sustainable. The consume differential is – 45,92% of the management annual energy cost of the common-usual scenario.

There would be (at least accordingly to the first valuations) a annual energy saving of € 1.964,61 in terms of running cost lasting for a life long cycle of eco-sustainable works. It is important to compare in sustainable scenario the lower running cost with the higher initial costs. The differential of initial building costs is larger of € 9.897,70 for sustainable physical conservation

TABLE 7 – **Urban Block #78. Cadastral Parcel #97. Energy Management Costs for Heating (December – March) for Alternative Scenarios of Intervention: "Common"; "Sustainable"**
Management Costs=Energy Need x Heated Area x Energy Cost (€\kWh)

	Common Scenario	**Energy Need**	**Heated Area (SR)**	**Total Energy Need**	**Energy Cost**	**Management Cost**
Sub	Floor	kWh/mq annual	mq	kWh annual	€/kWh	€
1	I floor	**78,256**	66,43	5.198,94	0,15	779,84
2	I floor	**69,354**	66,43	4.607,19	0,15	691,08
3	II floor	**124,530**	71,69	8.927,55	0,15	1.339,13
4	II floor	**135,178**	72,09	9.788,38	0,15	1.468,26
	Total		***276,04***			***4.278,31***

	Sustainable Scenario	**Energy Need**	**Heated Area (SR)**	**Total Energy Need**	**Energy Cost**	**Management Cost**
Sub	Floor	kWh/mq annual	mq	kWh annual	€/kWh	€
1	I floor	**52,673**	66,43	3.499,07	0,15	524,86
2	I floor	**66,949**	66,43	4.826,35	0,15	667,11
3	II floor	**58,519**	71,69	4.195,23	0,15	629,28
4	II floor	**45,540**	72,09	3.025,22	0,15	492,45
	Total		***276,04***			***2.313,70***

	Δ					**-1.964,61**
	Δ %					**-45,92**

10. FIRST COST VALUATIONS OVER TIME

Graphic estimate of quantities and then cost forecast quantify respectively the different physical resources and monetary costs of initial building intervention of the two possible alternative scenarios.

Results achieved show an initial building cost of intervention higher for sustainable scenario, mostly due to the high quality of materials employed such as volcalite plaster to insulate the external surfaces and the ecological cork panels to both ventilate and insulate for terrace-roof.

Winter thermal calculus, taken as preliminary proxy of building energy characterization, physically quantifies (in terms of kWh) the real advantage of energy saving. It is possible to transform into costs the quantity of energy required for winter heating. As stated before, knowing the annual consumption in terms of kWh/mq, it is sufficient to multiply this consumption by the heated area to know the respective physical costs. The physical result is the annual energy need expressed in kWh. Multiplying the total kWh by the unit cost of a kWh it is possible to obtain the monetary cost of the annual winter forecasted consumption of the Case Study.

Although the common-usual intervention is initially more convenient under the monetary point of view, to have a different thought it is enough to add up to the initial building costs the actualized running or management energy costs for winter heating of the whole Cadastral Parcel in the considered years.

In sustainable scenario the energy management costs diminish considerably and lead to a monetary saving that in a medium-long run is favourable and allows equalizing, in reasonable times, the percentage of higher initial building expenses.

It is possible to hint a preliminary financial estimate to this issue.

Assuming a rate of 4% to actualize the management costs, it is possible to estimate and actualize the approximate monetary saving in the medium-long run of the interventions. According to systematic observations of already made works, and also to laboratory tests, the specific works, designed for the Case Study, should last more than 40 years, thanks to high quality materials and reliability of techniques.

For example, given period of 20 years, approximately half of the life of volcalite plaster and cork insulation, it is possible to take into consideration the two different initial restoration costs of € 59.987,50 (common- usual restoration scenario) and of € 69.885,20 (sustainable restoration scenario), and of two different annual costs of energy winter management of € 4.278,31 (common-usual energy management scenario) and of € 2.313,70 (sustainable energy management scenario),and derive the following results.

The actualized cost of common-usual intervention (initial restoration cost + management annual winter energy cost) in 20 years is € 118.100,64.

The actualized cost of sustainable intervention (initial restoration cost + management annual winter energy cost) in 20 years is € 101.312,65.

Just a mere preliminary financial estimate highlights the convenience of sustainable scenario, not only in terms of energy saving, environmental protection, reduction of pollution and better indoor quality (Baglioni, 1995; Baglioni, Piardi, 1990) but also, in the medium-long run, even in terms of a better monetary result.

In a period of 10 years, approximately a fourth of the life of the intervention, it is possible to take in consideration the differential of the initial building cost of € 9.897,70, and to compare to the actualized energy saving that is € 10.292,40 at the sixth year, € 11.785,30 at the seventh year, € 13.220,65 at the eight year, € 14.600,79 at the ninth year, and € 15.927,88 at the tenth year. Therefore, the higher initial restoration cost in the sustainable scenario seems to be equalized by the parallel energy saving, in a period of time that could be considered as adequate and reasonable.

TABLE 8 – **Urban Block #78. Cadastral Parcel 97. Actualization of the Running Management Costs of Winter Heating in a Life Cycle of 10 Years. Rate i=4%**

Years	Common Scenario	Sustainable Scenario	Annual Saving	Coeff Actual	Actual Value	Actual Value	Balance	Balance Saving
	€	€	€	$(1+i)^{-n}$	Common	Sustainable	€	€
I	4.278,31	2.313,70	1.964,61	0,9615	4.113,60	2.224,62	1.888,97	1.888,97
II	4.278,31	2.313,70	1.964,61	0,9245	3.955,30	2.139,02	1.816,28	3.705,25
III	4.278,31	2.313,70	1.964,61	0,8889	3.802,99	2.056,65	1.746,34	5.451,60
IV	4.278,31	2.313,70	1.964,61	0,8518	3.644,26	1.970,81	1.673,45	7.125,05
V	4.278,31	2.313,70	1.964,61	0,8219	3.516,34	1.901,63	1.614,71	8.739,76
VI	**4.278,31**	**2.313,70**	**1.964,61**	**0,7903**	**3.381,15**	**1.828,52**	**1.552,63**	**10.292,40**
VII	4.278,31	2.313,70	1.964,61	0,7599	3.251,09	1.758,18	1.492,91	11.785,30
VIII	4.278,31	2.313,70	1.964,61	0,7306	3.125,73	1.690,39	1.435,34	13.220,65
IX	4.278,31	2.313,70	1.964,61	0,7025	3.005,51	1.625,37	1.380,14	14.600,79
X	4.278,31	2.313,70	1.964,61	0,6755	2.890,00	1.562,90	1.327,09	15.927,88
Tot					**34.685,97**	**18.758,09**		

11. CONCLUSIONS

Research verified and valuated an experimental approach, based upon a Case Study, of urban renewal by the mean of sustainable architectural conservation with particular attention to the environmental and climate dimensions and aspects, and to the "increase of building efficiency in use of energy and materials".

Case Study is localized in the so-called "Latin Quarter", the northern part of Liberty reconstruction after the earthquake of 1908 of Reggio Calabria city. The Quarter is so called because it is very close to four University Schools.

Case Study objective is the experimentation of sustainable conservation design in the study area: urban consistency; urban blocks; architectures and their decay also by the mean of thermophotographic techniques; typologies and location of decays and cracks; specific needs of intervention. Alternative conservation scenarios have been conceived, designed and simulated together with correspondent specific building works. It has been performed, in the local

markets, a collection of data concerning the availability and costs of the Technical Elemental Factors of the different designed interventions and works.
Data of the interventions designs have been input into a dedicated GIS, containing the spatial information of the works. It has been built up an approach, consisting in a steady DBMS software, to help and support valuation of: form and consistency of works; their Elemental Factors; amount and the totality of physical resources that have to be employed in the construction yard; related cost estimate. All the data for a "detailed cost estimate" (Simonotti, 1977, pp. 384-420) have been processed deriving the quantity of resources in physical terms, multiplied by the related costs. The results have given the total cost of the two alternative scenario interventions. From this analytical base it has been derived the first approximate parametric costs of the restoration for each scenario.
The energy requirements have been then estimated for a whole year heating for both scenarios and the subsequent energy saving differential have been calculated comparing two interventions: "Sustainable Conservation" *versus* common-usual.
Analyses performed show how the use of ecological materials with high insulating properties make it possible to have: improvement of house quality; higher thermal comfort; sizeable significant and sensible reduction of energy need and therefore of its consumption; parallel lower-down of pollution produced and introduced into the atmosphere; a reduction of the monetary costs of energy management.
Although, the initial building costs of the sustainable intervention are higher if compared to the common-usual one, the over-year results show how this differential is equalized thanks to the reduction of the annual energy management costs.
This result has been quantified by actualizing the annual energy saving in the life cycle of the intervention considering a current interest rate, and valuating the two alternative scenarios.
The quantification of the different initial building costs and energy management of the alternative interventions, for periods ranging from 10 to 20 years, show the over time convenience, both ecological and monetary of sustainable conservation.
In the future research agenda there are many aspects that need to be deepened.
First. Building initial costs as well as energy costs have been valuated. In the future there will be estimated maintenance costs and scrap value of the building at end of the economic cycles.
Second. It has been calculated and forecasted the winter energy need as partial proxy of the building thermal behavior. The need of summer air-conditioning represent one of the emergencies to be solved up along with the related installation of disturbing external air-conditioner units. In the future it will be estimated the energy need of summer cooling for both the alternative scenarios of intervention.
Third. Case Study is located within Latin Quarter, which has a high quality urban pattern, and a rich articulation of spaces which creates that are able to create a great relationship between insulations and shading. In the future agenda the urban function of shading in Mediterranean climates will have to be taken into consideration within the interesting theme of sustainability and into the urban planning both structural and operative.
Fourth. In the Case Study it is hinted the reduction of pollution due to the direct effect of energy consumption. The generalization of the effect provokes a positive impact at large scale in terms of pollution reduction. It is noticeable the consequent loosening of geo-strategic petrol dependence, which geo-economic dimension beyond the financial one, make it grow remarkably the real benefits, beyond the monetary ones, which are difficult to be quantified. All those remarkable benefits are produced by the Sustainable Architecture strategy and from the "Sustainable Conservation" proposed by the research.

ACKNOWLEDGEMENTS
Paper is based and contains GIS copyrighted material regarding "Urban heritage knowledge, 3D, treasuring, preservation" owned by Domenico E. MASSIMO, Italy: Copyright©1999-2008MASSIMODomenicoEnrico.

Many thanks to the Evaluation Team of PAU-GIs, Geomatics and GIS Group: Daniela BONCALDO; Antonia R. CASTAGNELLA; Roberta PLUTINO; Mariangela MUSOLINO; Michelangela VESCIO.

AUTHOR INFORMATION

Domenico E. MASSIMO
PAU-Gis Geomatics and GIS Group, Department # 1 Architectural and Urban Patrimony (PAU), *Mediterranean* University of Reggio Calabria, Italy

Address
Dep. PAU, 25 Via Melissari, 89124 Reggio Calabria, Italy

Preferred contact information
0039.360.997513 (mobile); massimo@unirc.it; dmassimo@mit.edu

Additional contact information [Rome time]
0039.0965.385.228-385.220 (University Office); 0039.339.448.4020 (cellular); 0039.0968.437.302 (August); 0039.0965.385.222 (fax); paugis@gmail.com

Biography
Domenico E. MASSIMO is Professor at *Mediterranean* University of Reggio Calabria, Italy, Department # 1 PAU, where he teaches Urban Appraisal, Economics of Project Evaluation, Environmental Economics at School of Architecture. He is Research Affiliate at Massachusetts Institute of Technology, MIT, Department of Urban Studies and Planning, DUSP (Cambridge, Ma, Usa). He is member of Scientific Committee of Ph.D. Program in Urban and Environmental Conservation at PAU Department.
He has been trained as research fellow at MIT, Department of Economics and Department of Urban Studies and Planning in the joint SPURS Program with Prof. Karen R. Polenske and Prof. Jerome Rothenberg, and at Northeastern University (Boston, Ma, Usa), Department of Economics with Prof. Gustav Shachter and Prof. Gregory H. Wassall.
He specializes in: urban heritage treasuring and preservation; environmental (bio-ecological, natural, landscapes) and cultural (urban, architectural, historic, artistic) heritage total census and account by the mean of GIS; specific monetary and non-monetary evaluation by the mean of appraisal methods and ordinal multi-dimensional assessment approaches linked to GIS tools; treasuring for local economic development with the help of econometric growth models. He studied at Harvard University (Cambridge, Ma, Usa) and Boston University (Boston, Ma, Usa). He has a Master of Art in Architecture (University of Rome, Italy), Diploma SPURS in Urban and Regional Studies (MIT, Cambridge, Ma, Usa), Master of Science in Economic Planning (Northeastern University, Boston, Ma, Usa), Ph.D. in Environmental Planning (University of Reggio Calabria, Italy).

FIGURES

Figure 1. Logical Chart. Sustainable Conservation. Design and Valuation

Figure 2. Reggio Calabria. Latin Quarter. 3D Representation at Urban Scale. TIN e 3D of the Whole Latin Quarter with GIS Tools. Vertical Exaggeration

Figure 3. Case Study. Latin Quarter. Urban 3D. Urban Block #78. Cadastral Map #121. Architectural 3D. Global Sight

Figure 4. Case Study. Latin Quarter. Urban 3D. Urban Block #78. Cadastral Map #121. Focus: Cadastral Parcel #97. Architectural 3D. Cadastral Unit Division

Figure 5. Case Study. Latin Quarter. Urban 3D. Urban Block #78. Cadastral Map #121. Cadastral Parcel #97. Thermophotographic Analyses: Thermal Dispersions (Different for Exposure and State of Deterioration)

Figure 6. Case Study. Latin Quarter. Urban 3D. Urban Block #78. Cadastral Map #121. Cadastral Parcel #97. Thermophotographic Analyses: Thermal Dispersions (Different for Exposure and State of Deterioration). The Higher Humidity Concentration is Evident in the Surfaces not Exposed to the Sun

Figure 7. Case Study. Latin Quarter. Urban 3D. Urban Block #78. Cadastral Map #121. Focus: Cadastral Parcel #97. Architectural 3D. Decay Analysis, Spatial Localization of the Advisable Works Connected to the DBMS that Make it Possible to Quantify the Elemental Factors and their Costs

Figure 8. Case Study. Latin Quarter. Urban 3D. Urban Block #78. Cadastral Map #121. Focus: Cadastral Parcel #97. Alternative Scenarios of Intervention: “Common-Usual”; “Sustainable”. Different Materials that Affect the Energy Requirement of the Building

Figure 1. Logical Chart. Sustainable Conservation. Design and Valuation

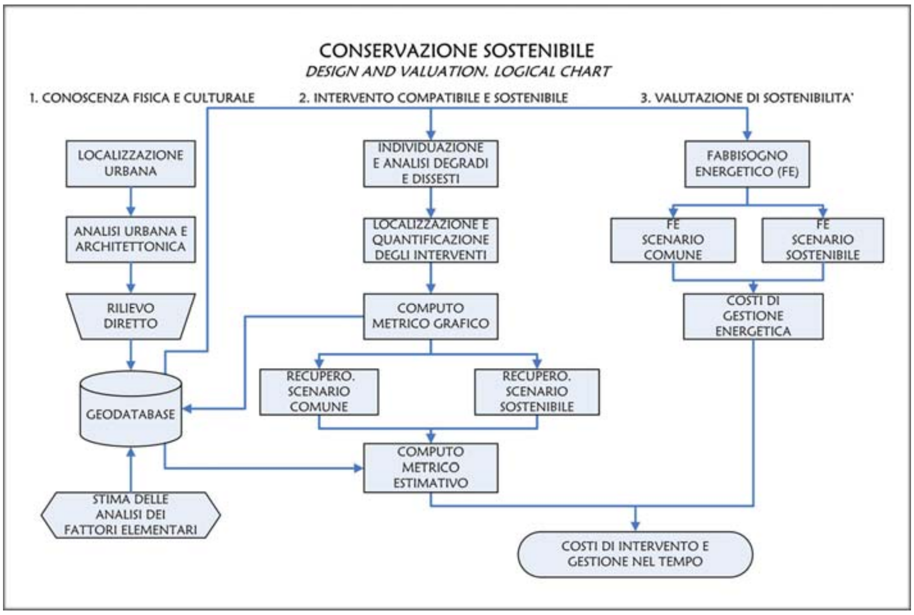


Figure 2. Reggio Calabria. Latin Quarter. 3D Representation at Urban Scale. TIN e 3D of the Whole Latin Quarter with GIS Tools. Vertical Exaggeration

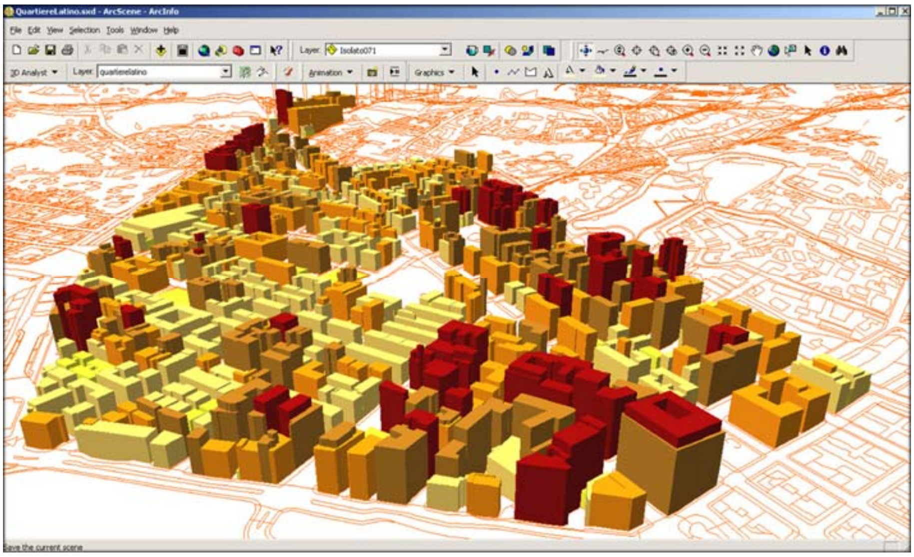


Figure 3. Case Study. Latin Quarter. Urban 3D. Urban Block #78. Cadastral Map #121. Architectural 3D. Global Sight

Figure 4. Case Study. Latin Quarter. Urban 3D. Urban Block #78. Cadastral Map #121. Focus: Cadastral Parcel #97. Architectural 3D. Cadastral Unit Division

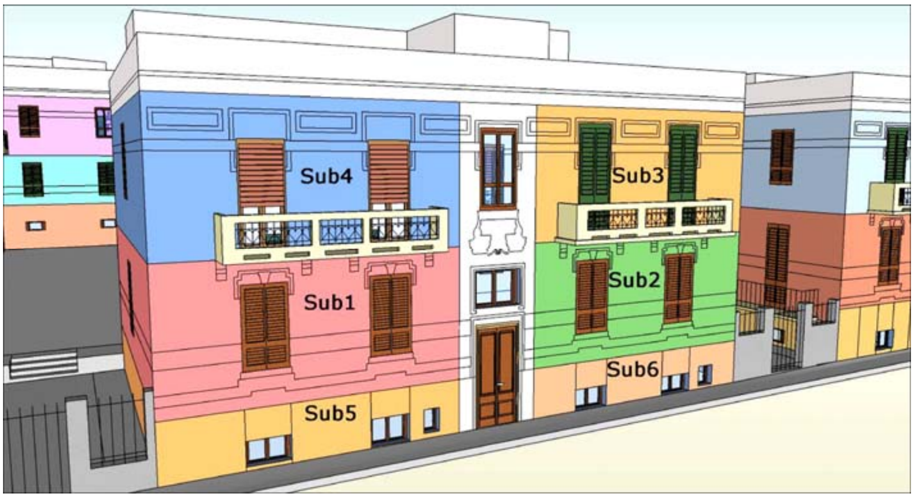


Figure 5. Case Study. Latin Quarter. Urban 3D. Urban Block #78. Cadastral Map #121. Cadastral Parcel #97. Thermophotographic Analyses: Thermal Dispersions (Different for Exposure and State of Deterioration)

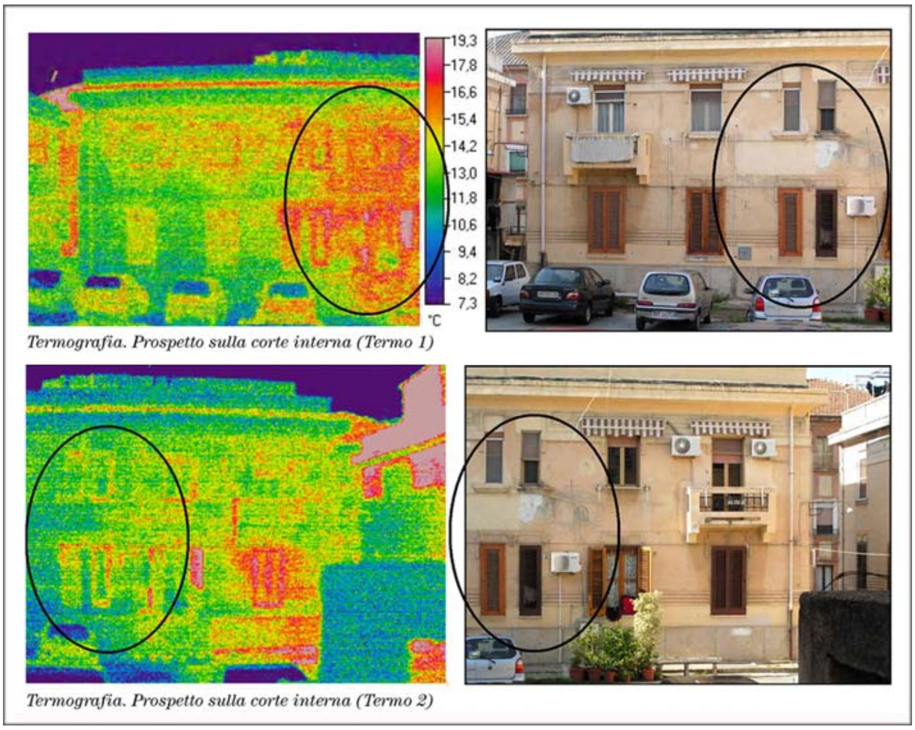


Figure 6. Case Study. Latin Quarter. Urban 3D. Urban Block #78. Cadastral Map #121. Cadastral Parcel #97. Thermophotographic Analyses: Thermal Dispersions (Different for Exposure and State of Deterioration). The Higher Humidity Concentration is Evident in the Surfaces not Exposed to the Sun

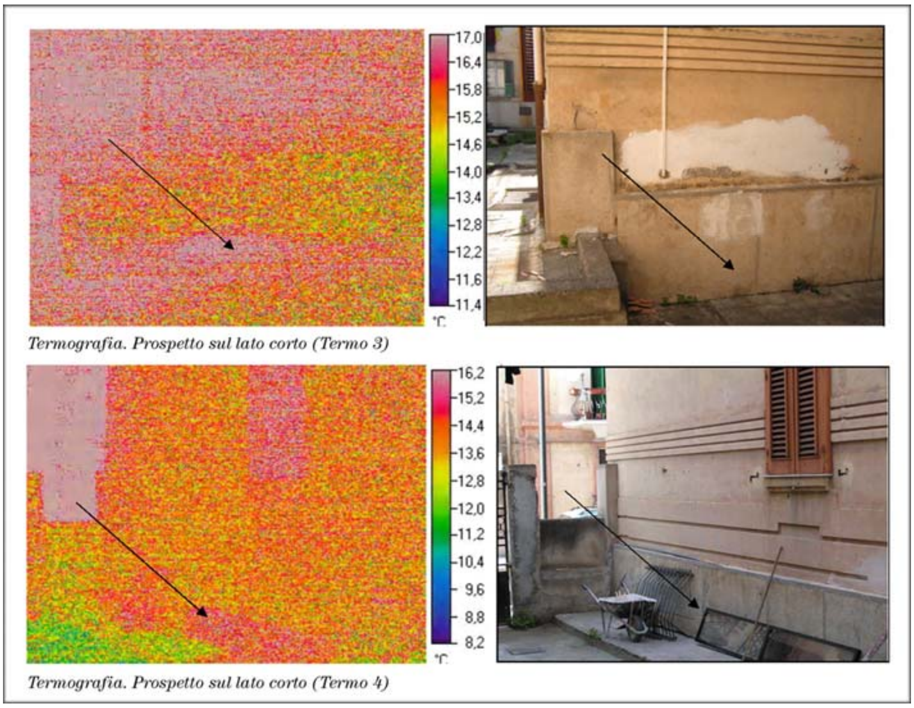


Figure 7. Case Study. Latin Quarter. Urban 3D. Urban Block #78. Cadastral Map #121. Focus: Cadastral Parcel #97. Architectural 3D. Decay Analysis, Spatial Localization of the Advisable Works Connected to the DBMS that Make it Possible to Quantify the Elemental Factors and their Costs

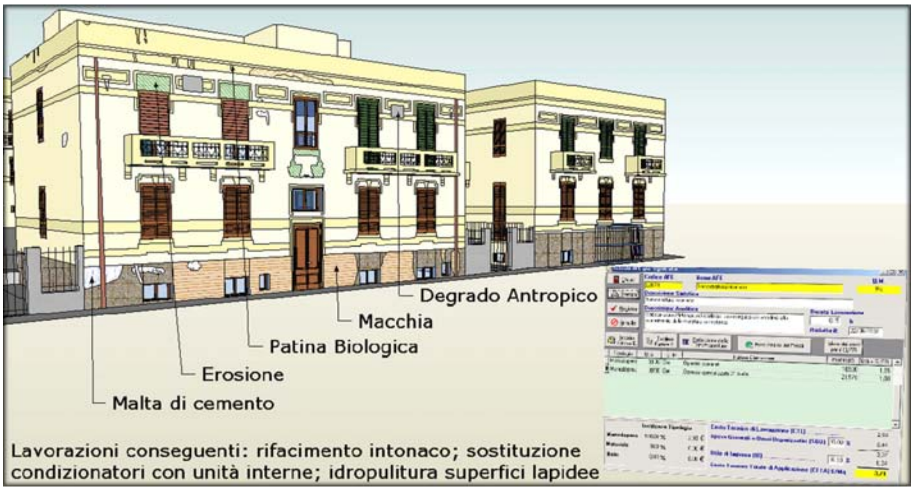
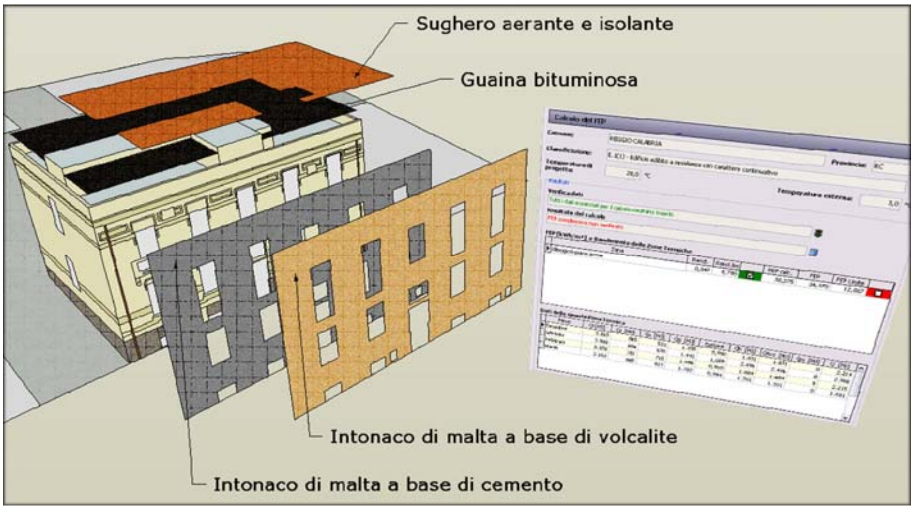


Figure 8. Case Study. Latin Quarter. Urban 3D. Urban Block #78. Cadastral Map #121. Focus: Cadastral Parcel #97. Alternative Scenarios of Intervention: “Common-Usual”; “Sustainable”. Different Materials that Affect the Energy Requirement of the Building



REFERENCES

References. Sustainable City, Energy, Equalization

Baglioni Adriana (1995) Qualità abitativa e compatibilità ambientale. In: Gottfried Arie (ed) *Manuale di progettazione edilizia: fondamenti, strumenti, norme*. Volume IV. Hoepli, Milano

Baglioni Adriana, Piardi Silvia (1990) *Costruzione e salute. Criteri, norme e tecniche contro l'inquinamento interno*. Franco Angeli, Milano

Crocco Maurizio, Frezza Alessandro (2001) *Principi per la pratica del costruire ecologico. Per un "nuovo" regolamento edilizio*. Seminario di Studi. Politecnico di Bari, Facoltà di Ingegneria, Bari. Mimeo

Fourth European Conference of Sustainable Cities & Towns (09-11.06.2004) *Aalborg Commitments*. Aalborg, Denmark

Frezza Alessandro (2006) *Metodi di valutazione per lo sviluppo sostenibile. Valutazione di sostenibilità ambientale: una proposta integrativa*. Tesi di Laurea. Università degli Studi di Roma 1 La Sapienza, Roma

Fusco Girard Luigi (2006) L'uso delle risorse ambientali, territoriali e urbanistiche nell'area vasta: strategie e strumenti. In: Marone Enrico (ed) *Area vasta e governo del territorio. Nuovi strumenti giuridici, economici ed urbanistici*. Atti del XXXV Incontro di Studio Ce.S.E.T.. Potenza, 14-15.10.2005. Firenze University Press, Firenze: pp. 75-91

Fusco Girard Luigi, Forte Bruno (2000) *Città Sostenibile e Sviluppo Umano*. Istituto Universitario Suor Orsola Benincasa. Franco Angeli, Milano

Fusco Girard Luigi, Forte Francesco (1998) *Valutazione per lo sviluppo sostenibile e perequazione urbanistica*. Clean Editore, Napoli

Fusco Girard Luigi, Forte Bruno, Cerreta Maria, De Toro Pasquale, Forte Francesco (2003) *L'uomo e la città. Verso uno sviluppo umano e sostenibile*. Franco Angeli, Milano

Fusco Girard Luigi, Nijkamp Peter (eds) (2005) *Energia, bellezza, partecipazione: la sfida della sostenibilità. Valutazione integrata tra conservazione e sviluppo*. Franco Angeli, Milano

Fusco Girard Luigi, You Nicholas (2006) *Città attrattori di speranza. Dalle buone pratiche alle buone politiche*. Franco Angeli, Milano

Ipcc (J. T. Houghton, G. J. Jenkins and J. J. Ephraums, eds) (1990) *First Assessment Report*. Cambridge University Press, Uk

Ipcc (1995) *Second Assessment Report*. Ipcc, Geneva, Switzerland

Ipcc (Watson R. T. and the Core Writing Team, eds) (2001) *Third Assessment Report*. Cambridge University Press, Uk

Ipcc (2007) *Fourth Assessment Report*. Ipcc, Geneva, Switzerland

Massimo Domenico Enrico, Alberti Elisa, Giuffré Maria Rosaria, Vescio Michelangela (2006) Deprezzamento immobiliare in presenza di inquinamento acustico in ambiente urbano. Stima del "costo di eliminazione del rumore". In: Asdrubali Francesco (ed) *Sviluppo Sostenibile, Tutela dell'Ambiente e della Salute Umana*. Atti del 6° Convegno Nazionale CIRIAF. Università degli Studi di Perugia. Perugia, 07-08.04.2006. Morlacchi Edizioni, Perugia: pp. 413-418

Massimo Domenico Enrico, Castagnella Antonia Rita, Giuffré Maria Rosaria, Vescio Michelangela (2007) Prezzi marginali immobiliari dei decibel differenziali di inquinamento da rumore. Un caso di studio. In: Asdrubali Francesco (ed) *Sviluppo Sostenibile, Tutela dell'Ambiente e della Salute Umana*. Atti del 7° Convegno Nazionale CIRIAF. Università degli Studi di Perugia. Perugia, 30-31.03.2007. Morlacchi Edizioni, Perugia: pp. 175-180

Stanghellini Stefano (2005) *I dispositivi perequativi nelle leggi regionali: una prima analisi comparata*. Second Real Estate Summer School, Scilla (Rc). Mimeo

Stanghellini Stefano (2007) Obiettivi e modelli dei piani urbanistici perequativi in Italia. In: De Carli Marcello (ed) *Strumenti per il governo del territorio. Perequazione urbanistica e Borsa dei diritti edificatori*. Osmi Borsa Immobiliare. Franco Angeli, Milano

Stanghellini Stefano, Cerreta Maria (2002) *La certificazione della qualità negli edifici*. Confedilizia, Roma

References. Green building and Energy Rehabilitation of Existing Buildings

Cannaviello Monica, Violano Antonella (2007) *La certificazione energetica degli edifici esistenti*. Franco Angeli, Milano

Carotti Attilio (2004) *Architettura e sostenibilità. La casa passiva. Costruzione e struttura*. Libreria Clup, Milano

Cellai Gianfranco, Bazzini Giovanni, Gai Marco (2007) *Le prestazioni energetiche degli edifici*. Maggioli, Santarcangelo di Romagna (Rn)

De Capua Andrea (2002) *Nuovi paradigmi per il progetto sostenibile: contestualità, adattabilità, durata, dismissione*. Gangemi Editore, Roma

Di Pietra Biagio, Margotta Francesco (2007) *Complesso residenziale popolare ATC Biella: intervento di riqualificazione energetica. Rapporto Tecnico*. Enea, Dipartimento Ter, s. l.

Filippi Marco, Rizzo Gianfranco (eds) (2007) *Certificazione energetica e verifica ambientale degli edifici*. Dario Flaccovio Editore, Palermo

Enea (2004) *Libro Bianco: Energia – Ambiente – Edificio*. Il Sole 24 Ore, Milano

Enea (2007) *DOCET Manuale Utente*. Consiglio Nazionale delle Ricerche, Istituto per le Tecnologie della Costruzione, San Giuliano Milanese (Mi)

Green Building Council (2003) *LEED, Green Building Rating System for Core and Shell Development*. U.S. Environmental Protection Agency, Washington, DC, Usa

Green Building Workgroup (2004) *Buildings and the Environment: A Statistical Summary*. U.S. Environmental Protection Agency, Washington, DC, Usa

Kats Greg, Alevantis Leon, Berman Adam, Mills Evan, Perlman Jeff (2003) *The Costs and Financial Benefits of Green Buildings: A Report*. California's Sustainable Building Task Force, Sacramento, California, Usa

Politecnico di Milano (2005) *Efficienza Energetica degli Edifici*. Milano. Mimeo

Provincia Autonoma di Bolzano, Ufficio Risparmio Energetico (2007) *Isolamento termico degli edifici*. Bolzano. Mimeo

World Business Council for Sustainable Development (2007) *Energy Efficiency in Buildings: Business Realities and Opportunities*. Conches-Geneva, Switzerland. Mimeo

References. Set of Rules

Direttiva 2002/91/CE, Parlamento Europeo e Consiglio Europeo: Rendimento energetico nell'edilizia

Decreto Legislativo 19 agosto 2005, n. 192, di attuazione della direttiva 2002/91/CE relativa al rendimento energetico degli edifici

Decreto Legislativo 29 dicembre 2006, n. 311, disposizioni correttive ed integrative al decreto legislativo 19 agosto 2005, n. 192, in attuazione della direttiva 2002/91/CE relativa al rendimento energetico degli edifici

References. Urban Renewal Costs

Castagnella Antonia Rita (2007) *Stima degli interventi di valorizzazione del patrimonio architettonico e urbanistico. Sviluppo di un Caso di Studio*. Tesi di Dottorato di Ricerca in "Conservazione dei Beni Architettonici e Ambientali". Dipartimento PAU, Università degli Studi *Mediterranea* di Reggio Calabria, Reggio Calabria

Del Nord Romano, Maffei Paolo, Petretto Alessandro, Roscelli Riccardo (2002) *I costi standardizzati delle opere pubbliche*. Autorità per la Vigilanza sui Lavori Pubblici, Osservatorio dei Lavori Pubblici, Roma

De Mare Gianluigi (2004) Riurbanizzazione dei centri storici. Un modello per la classificazione dei dati, la stima preventiva e la verifica della congruità dei costi. In: Stanghellini Stefano (ed) *La selezione dei progetti e il controllo dei costi nella riqualificazione urbana territoriale*. Alinea Editrice, Firenze: pp. 243-268

De Mare Gianluigi, Ferrara Biagio (2004) Reinfrastrutturazione del Rione Sassi a Matera. Misura degli effetti sulla propensione dei privati alla riqualificazione del patrimonio edilizio. In: Stanghellini Stefano (ed) *La selezione dei progetti e il controllo dei costi nella riqualificazione urbana territoriale*. Alinea Editrice, Firenze: pp. 269-281

De Mare Gianluigi, Morano Pierluigi (1997) I Sassi di Matera, modelli per la valutazione rapida dei costi preventivi di recupero. *Pagine di Estimo. Quaderni del Dipartimento PAU*, Gangemi Editore, n. 13-14: pp. 1-28

De Mare Gianluigi, Morano Pierluigi (2002) *La stima del costo delle opere pubbliche*. UTET Libreria, Torino

Fusco Girard Luigi (1987) *Risorse architettoniche e culturali: valutazioni e strategie di conservazione. Una analisi introduttiva*. Franco Angeli, Milano: pp. 487-531

Guarino Mario (1996) *Costi del recupero edilizio*. Arte Tipografica, Napoli

Jodice Marco, Roscelli Riccardo, Simonotti Marco (2007) Il Catasto dei Comuni. *Estimo e Territorio,* n. 7-8: pp. 9-14

Massimo Domenico Enrico (1999) Riqualificazione urbana e sviluppo economico. *Case Action* in Calabria. In: Camagni Roberto, Fazio Vincenzo (eds) *Politiche locali, infrastrutture per lo sviluppo e processi di integrazione euro-mediterranea*. Franco Angeli, Milano: pp. 279-296

Massimo Domenico Enrico (2008) Evaluation and GIS, essential tools to foster sustainability in urban conservation. Paper accepted at the 28th ESRI International User Conference. San Diego, California, Usa, 04-08.08.2008. ESRI Press, Redlands, California, Usa. In corso di pubblicazione

Massimo Domenico Enrico, Barbalace Antonino, Castagnella Antonia Rita, Mercuri Aurelio Silvestro Eugenio, Vescio Michelangela (2006) Stima dei costi di recupero urbano, estimo operativo, recenti sperimentazioni. Atti della 9a Conferenza Nazionale Utenti ESRI.Italia. *Geospatial knowledge*. Roma, 05-06.04.2006. ESRI.Italia, Roma. CD-Rom

Massimo Domenico Enrico, Barbalace Antonino, Michelangela Vescio, con Daniela Boncaldo, Plutino Roberta, Principato Paola (2007) Derivazione dei costi parametrici di recupero edilizio da stime dettagliate con l'ausilio dei GIS. Atti della Undicesima Conferenza Nazionale ASITA. *Federazione delle Associazioni Scientifiche per le Informazioni Territoriali ed Ambientali*. Torino, 06-09 11.2007. Asita, Milano. Volume II: pp. 1505-1510

Massimo Domenico Enrico, Marino Domenico, Vescio Michelangela (2000) Urban Conservation and Local Sustainable Development. Introductory Impact Analysis. Proceedings of World Meeting, *The human being and the city*. Naples, 06-08.09.2000. Università degli Studi di Napoli Federico II, Naples. CD-Rom

Massimo Domenico Enrico, Musolino Mariangela (2005) Urban Renewal Evaluation Using ArcView and Integrating CAD, Spreadsheet, DB. Proceedings of the 25th ESRI International User Conference 2005. *GIS helping manage our world*. San Diego, California, Usa, 25-29.07.2005. ESRI Press, Redlands, California, Usa. CD-Rom

Massimo Domenico Enrico, Musolino Mariangela, Vescio Michelangela (2005) Urban renewal cost evaluation. Atti della Nona Conferenza Nazionale ASITA. *Federazione delle Associazioni Scientifiche per le Informazioni Territoriali ed Ambientali*. Catania, 15-18.11.2005. Asita, Milano. Volume II: pp. 1487-1492

Massimo Domenico Enrico, Valtieri Simonetta, Musolino Mariangela (2005) Valutazione della riqualificazione urbana mediante GIS, integrando CAD-DB. Atti della 8a Conferenza Nazionale Utenti ESRI.Italia. *GIS the Language of Geoknowledge*. Roma, 20-21.04.2005. ESRI.Italia, Roma. CD-Rom

Mattia Sergio (1995) *La valutazione preventiva dei costi di costruzione*. Città Studi Edizioni, Milano

Mattia Sergio, Utica Gianni (1993-1994) *Il progetto operativo ed economico*. Università degli Studi di Firenze, Facoltà di Architettura. Centro Studi di Economia dell'Impresa e Territoriale, Ce.S.E.dI.T., Milano

Miccoli Saverio (1995) *Rilevazione e analisi per la valutazione dei costi di conservazione. Procedure per componenti tecnologiche*. Edizioni Kappa, Roma

Miccoli Saverio (1996) Alcune riflessioni sull'impiego della valutazione nel progetto di restauro. In: Carbonara Giovanni (ed) *Trattato di restauro architettonico*. UTET, Torino. Volume IV: pp. 3-109

Miccoli Saverio (1998) *Indici del costo di restauro architettonico: criteri e metodi di elaborazione*. Dipartimento di Caratteri degli Edifici e dell'Ambiente, Università degli Studi di Roma 1 La Sapienza, Roma

Mollica Edoardo (1995) *Principi e metodi della valutazione economica dei progetti di recupero. Applicazioni ai centri storici minori in aree marginali*. Rubbettino Editore, Soveria Mannelli (Cz)

Mollica Edoardo (1996) *Le Aree Interne della Calabria*. Rubbettino Editore, Soveria Mannelli (Cz)

Mollica Edoardo, Massimo Domenico Enrico (2003) GIS e valutazione dei costi negli interventi di riqualificazione urbana. In: *Urbanistica Dossier n. 58* "Sistemi informativi territoriali: dalle banche dati a strumento di governo del territorio". Inuedizioni, Roma. CD-Rom

Mollica Edoardo, Massimo Domenico Enrico (2004) Investimenti sul territorio, sistema generale di valutazione, GIS, *Decision Support System*. In: Stanghellini Stefano (ed) *La selezione dei progetti e il controllo dei costi nella riqualificazione urbana territoriale*. Alinea Editrice, Firenze: pp. 217-242

Mollica Edoardo, Musolino Mariangela (1999) Metodi e strumenti applicati alla conservazione ambientale e culturale. *Pagine di Estimo*, *Quaderni del Dipartimento PAU*, Gangemi Editore, Roma, n. 16-18. Allegato: pp. 1-36

Musolino Mariangela (1994) Principi di stima dei costi negli interventi di recupero. *Quaderni del Dipartimento PAU*. Gangemi Editore, Roma, n. 8. Allegato

Musolino Mariangela (1997) Metodo di stima rapida dei costi di recupero Mer 60: principi teorici e applicativi. *Genio Rurale*, n. 7-8: pp. 23-32

Orefice Marcello (1994) Le economie di scala applicate al recupero del Centro Antico di Napoli. *Genio Rurale*, n. 10

Patrone Pietro Domenico (1978) *Individuazione dei costi di ricostruzione per edifici di antico impianto*. Edizioni Culturali Internazionali Genova, Genova

Patrone Pietro Domenico (1986) *Estimo edilizio ed urbano*. *Applicazioni*. Edizioni Culturali Internazionali Genova, Genova

Patrone Pietro Domenico (1990) *Sulla stima dei costi del recupero edilizio*. *Valori parametrici e incidenze delle voci d'opera*. Edizioni Culturali Internazionali Genova, Genova

Realfonzo Almerico (1995) Riqualificazioni ambientale come motore dello sviluppo. Il problema delle valutazioni. *Genio Rurale*, n. 12

Simonotti Marco (1994) La stima della funzione del costo di recupero e nella valutazione dei progetti. In: Mollica Edoardo (ed) *Studio Tipologia Piano Quadro Aree Interne Calabria*. Dipartimento PAU, Università degli Studi *Mediterranea* di Reggio Calabria, Reggio Calabria. Mimeo

Simonotti Marco (1997) *La stima immobiliare*. UTET, Torino: pp. 384-420

Stanghellini Stefano (1990) *I costi di riurbanizzazione*. Franco Angeli, Milano

Stanghellini Stefano (ed) (2004) *La selezione dei progetti e il controllo dei costi nella riqualificazione urbana territoriale*. Alinea Editrice, Firenze

References. Choice of the Neighborhood for Experimentation and Valuation of Sustainable Conservation

Massimo Domenico Enrico (2006) Qualità dei dati e prospettive di spazializzazione nello studio dei mercati immobiliari. Recenti aggiornamenti. In: Curto Rocco, Stellin Giuseppe (eds) *Estimo e Valutazione. Metodologia e Casi di Studio*. Atti del Primo Incontro della Società Italiana di Estimo e Valutazione, SIEV. Venezia, 16.11.2005. DEI, Roma: pp. 227-238

Massimo Domenico Enrico (2007) Analisi dei prezzi e delle quotazioni immobiliari nella città di Reggio Calabria. *Estimo e Territorio*. In corso di pubblicazione

Massimo Domenico Enrico, Barbalace Antonino, Castagnella Antonia Rita, con Plutino Roberta, Principato Paola (2007) Stima immobiliare a larga scala con il supporto di un sistema generale di informazione e con l'ausilio dei GIS. Atti della Undicesima Conferenza Nazionale ASITA. *Federazione delle Associazioni Scientifiche per le Informazioni Territoriali ed Ambientali*. Torino, 06-09.11.2007. Asita, Milano. Volume II: pp. 1511-1516

Massimo Domenico Enrico, Barbalace Antonino, Castagnella Antonia Rita, Principato Paola (2007) Valutazione di impatti di localizzazioni universitarie. Un Caso di Studio. Atti della XXVIII Conferenza Italiana di Scienze Regionali. *Lo sviluppo regionale nell'Unione Europea. Obiettivi, strategie, politiche*. Bolzano, 26-28.09.2007. AISRe, Milano. CD-Rom

Massimo Domenico Enrico, Barbalace Antonino, Castagnella Antonia Rita, Vescio Michelangela (2005) *Stima immobiliare georeferenziata e valutazione di effetti-impatti-esternalità di localizzazioni universitarie. Il Caso di Studio del Sistema Generale di Informazione e Valutazione (SGV) di Reggio Calabria*. Second Real Estate Summer School, Scilla (Rc). Mimeo

Massimo Domenico Enrico, Castagnella Antonia Rita (2005) Studio dei mercati immobiliari, analisi di regressione multipla, modelli geostatistici. Atti della Nona Conferenza Nazionale ASITA. *Federazione delle Associazioni Scientifiche per le Informazioni Territoriali ed Ambientali*. Catania, 15-18.11.2005. Asita, Milano. Volume II: pp. 1481-1486

Massimo Domenico Enrico, Castagnella Antonia Rita (2006) Analisi dei mercati immobiliari della Calabria. Applicazioni di *parsimonious models* a Reggio Calabria. In: Oppio Alessandra, Tartaglia Andrea (eds) *Governo del territorio e strategia di valorizzazione dei beni culturali*. Libreria Clup, Milano: pp. 67-93

Massimo Domenico Enrico, Castagnella Antonia Rita (2007) Paralleli sul 38° parallelo. La conservazione sostenibile e il distretto energetico come strategia di valorizzazione della città ricostruita. In: Valtieri Simonetta (ed) *La grande ricostruzione dopo il terremoto del 1908 nell'area dello stretto*. Nuova Argos, Roma. In corso di pubblicazione

Mollica Edoardo, Massimo Domenico Enrico (2002) Analisi dei mercati immobiliari della Calabria, Applicazioni di *parsimonious models* a Reggio Calabria e Lamezia Terme. In: Roscelli Riccardo (ed) *Mercato immobiliare, innovazione e gestione dei catasti urbani*, Ce.S.E.T., Firenze. Quaderno 8, Volume II: pp. 472-529

Roscelli Riccardo (2002) Presentazione. In: Roscelli Riccardo (ed) *Mercato immobiliare, innovazione e gestione dei catasti urbani*, Ce.S.E.T., Firenze. Quaderno 8, volume I: pp. 1-5

Vescio Michelangela (2004) *Valutazioni dei mercati immobiliari a scala urbana anche in relazione alle caratteristiche storiche e di conservazione degli ambiti omogenei delimitati*. Tesi di Dottorato di Ricerca in "Conservazione dei Beni Architettonici e Ambientali". Dipartimento PAU, Università degli Studi *Mediterranea* di Reggio Calabria, Reggio Calabria

References. "Price Analysis"

Castello Graziano (1998) *Prezzario informativo per opere edili di nuova costruzione in Italia*. Dario Flaccovio Editore, Palermo

Castello Graziano (2006) *Manuale del preventivista con prezzario informativo e computo metrico*. Dario Flaccovio Editore, Palermo

Castello Graziano (2007) *Manuale del preventivista*. Dario Flaccovio Editore, Palermo

Città di Palermo, Assessorato al Centro Storico (1998) *Analisi dei prezzi per ristrutturazioni, recuperi e restauri*. Grafill, Palermo

Gieri Vincenzo (2006) *Analisi dei prezzi unitari in edilizia*. Maggioli Editore, Repubblica di San Marino
Gieri Vincenzo (2007a) *Analisi dei prezzi unitari in edilizia*. Maggioli Editore, Repubblica di San Marino
Gieri Vincenzo (2007b) *Edilizia civile. Tecniche, soluzioni e materiali innovativi*. Il Sole 24 Ore, Milano
Grosso Luigi (2005) *Analisi dei prezzi in edilizia. Opere civili*. Il Sole 24 Ore, Milano
Otero Antonio (ed) (2002) *Analisi dei prezzi in edilizia*. Grafill, Palermo
Otero Antonio (ed) (2006a) *Analisi dei prezzi in edilizia*. Volume I. Grafill, Palermo
Otero Antonio (ed) (2006b) *Analisi dei prezzi in edilizia (ristrutturazioni, recuperi e restauri)*. Volume II. Grafill, Palermo
Ministero dei Lavori Pubblici (1948) *Circolare n. 663*. Roma
Ministero dei Lavori Pubblici (1966) *Analisi dei Prezzi in Edilizia*. Roma
Santini Antonello, Perinetti Umberto (1984) *Analisi dei prezzi per l'edilizia*. Istituto Geografico De Agostini, Serie Gorlich, Novara
Tinè Sergio (1995) *Analisi dei prezzi nel recupero edilizio: conservazione, ristrutturazione, ripristino filologico*. Dario Flaccovio Editore, Palermo
Tipografia Genio Civile (2002) *Elenco ed analisi prezzi in edilizia*. DEI, Roma
Utica Gianni (1994-1995) *Elenco dei prezzi unitari nella conservazione e nel recupero edilizio*. Università degli Studi di Firenze, Facoltà di Architettura. Centro Studi di Economia dell'Impresa e Territoriale, Ce.S.E.dI.T., Milano