XLI Incontro di Studio del Ce.S.E.T.: 499-510

Sergio Mattia

*Dipartimento di Architettura e Pianificazione (DiAP), Politecnico di Milano*
E-mail: *sergio.mattia@polimi.it*

Alessandra Oppio

*Building Environment and Science Technology (BEST), Politecnico di Milano*
E-mail: *alessandra.oppio@polimi.it*

Alessandra Pandolfi

*Dipartimento di Architettura e Pianificazione (DiAP), Politecnico di Milano*
E-mail: *alessandra.pandolfi@libero.it*

Key words: *sustainability, regional and urban development, assessment*

# Developing the Green Building Challenge (GBC) evaluation model: a multidimensional framework for the assessment of regional and urban regeneration interventions*

The enhancement process of urban systems is currently developed by interventions with increasing complexity, as they should achieve the economical and social requirements of sustainability, beside the environmental ones. This is a central issue that is growing in importance also at the neighborhood level. Within the present sustainability assessment tools at neighborhood level, this paper suggests the Local Sustainability Index (Lo.S.I.) evaluation model in order to measure the efforts to achieve a satisfying degree of sustainability in regional and urban regeneration interventions, both enhancing/transferring new knowledge about the present condition and the possible development options of abandoned urban areas.

## 1. Introduction

The enhancement process of urban systems is currently developed by interventions with increasing complexity, as they should achieve the economical and social requirements of sustainability, beside the environmental ones.

Changing cities and regions under the perspective of sustainability means to point out the options that can satisfy the real needs of people by a deep analysis of the local complexity and also through a multidimensional evaluation procedure of the effects of interventions (multi-goal approach), definitively overcoming the mono-dimensional approach to urban planning (Archibugi and Nijkamp, 1990; Archibugi, 1997; Fusco-Girard and Nijkamp, 1997; Gowdy, 1994; Norgaard, 1994).

The call for the improvement of quality of life in European cities, launched in the last recent years by different international organizations engaged on enhancing and fulfilling the principles of sustainable development, needs to be recognized by the political will. The balance between economic growth, environmental quality and social equity, that at urban level is managed better than at different

* The version of LoSI2006 was defined by Sergio Mattia, Alessandra Oppio and Federico Guarlotti. The 2009 and 2011 update process was carried out by Sergio Mattia, Alessandra Oppio, Alessandra Pandolfi and Andrea Gabardi (who has implemented the mathematical elements of the tool). The paper is the result of a common elaboration of the three authors. More in detail, S. Mattia has developed the first paragraph, A. Oppio the second, A. Pandolfi the third. The conclusions must be ascribed to all of the three authors.

ones, can be more effectively achieved if local governments are committed in integrating the demand for the evaluation of sustainability in the local policies and in the decision making processes.

Actually in our country a good chance to address the urban regeneration interventions to high quality requirements is given by the article 5 of the law 106/2011[1], that introduces a national regulations on the rehabilitation of abandoned urban areas supported by incentives and administrative procedures' simplification. More in detail, the law assigns to the regional governments the task of encouraging the redevelopment of incoherent and uncompleted urban areas with disused buildings.

Such provisions of the law should be deeply developed with reference to the Juridical Institution of the Urban Planning Competition[2], since it can ensure that the urban planning process is carried out according to a wide preliminary knowledge of the context of interventions by procedures that are consistent to the principles of the economy of the sustainable development. As it is found on a competition, this Juridical Institution encourages the definition of a plurality of options for the development of a single urban context, in order to achieve the goals of fair, transparent and rational decision making processes. If choices are carried out starting from a shared vision of future alternative actions built on the real willing of local communities to recognize themselves in specific values[3], it could be possible to get to a fair allocation of benefits, increasing the agreement of local communities. At this level the evaluation, considered as a constructive and exploring activity, co-extensive to the decisional making process, plays a crucial role. The evaluation, such as the multicriteria analysis[4], can indeed promote the integration between different and controversial visions, interests and values, increasing the degree of legitimacy of decisions.

In this context the paper proposes the Local Sustainability Index (Lo.S.I.) evaluation model in order to measure the efforts to achieve a satisfying degree of sustainability in regional and urban regeneration interventions, enhancing/transferring new knowledge about the present condition and the possible development options of abandoned urban areas.

---

[1] Legge 12 luglio 2011, n.106. Conversione in legge, con modificazioni, del decreto legge 13 maggio 2011, n.70. Semestre Europeo – Prime disposizioni urgenti per l'economia (G.U. n.160 del 12 luglio 2011).

[2] In Italy this Juridical Institution is called "urbanistica concorsuale". See the draft of the law on the use of project financing in urban regeneration interventions on the following website: http://www.societalibera.org. This proposal encourages the free competition between economic operators without disregarding the fulfilment of the environmental quality's improvement.

[3] The co-existence of different systems of values is a typical character of pluralist societies. The principles of representative democracy have been weakened by the fast evolution of the current society. Political delegates generally are not able to catch the different values an interests of their voters. Consequently, the construction of a shared vision should be found on the inclusion of different points of view.

[4] Among the evaluation tools applied in increasingly complex decisional contexts the AMC, since it is an open and verifiable processes, can be considered an effective aid in order to make satisfactory choices.

## 2. The Local Sustainability Index (Lo.S.I.): background and first version

The instance to carry out the principles of sustainable development at the local level and to assess the degree of their fulfillment by the use of sets of indicators is not new, but only in the last recent years a particular attention has been paid to the relationship (mutually dependence/integration) between different dimensions of sustainability (Njikamp et al., 1993; Fusco Girard et al., 2003). This kind of vision is found on network systems, whose complexity is given by: a) the structure of wiring diagram; b) the dynamism of the network over time; c) the diversity of the links between nodes that could have different weights, directions and signs (Strogatz, 2001). According to a systemic approach (Bertalanffy, 1968) the Lo.S.I. model provides that the analysis and the value judgment are found on the idea of interaction between different evaluation levels.

Starting from a broad idea of sustainability as well as it has been defined by the Green Building Challenge (GBC) process, the Lo.S.I. model is based on 12 classes of sustainability criteria (R – Resource consumption; C – Loadings; I – Indoor environmental quality; S – Quality of service; E – Economics; G – Management; T – Commuting transport; P – Participation; M – Regional marketing and branding; K – Cultural topics; L – Local development; A - Virtuous circles) and on the connections between them. Most of the requirements classes[5] has been directly assumed by the first version of the evaluation framework defined by the GBC team (GBTool version 1.81) that has been developed in order to include variables that should be appropriate to describe the effects of intervention not only on buildings, but also on their contexts. More in detail, the research group has considered as appropriate to verify if the interventions being evaluated have enhanced actions for the local development (L – Local development), involving unexpected effects with long-term positive outcomes (A - Virtuous circles), through the use of recognition and communication strategies about cultural and local values (K – Cultural topics and M – Regional marketing and branding) by the involvement of stakeholders and citizens in the decision-making process (P – Participation).

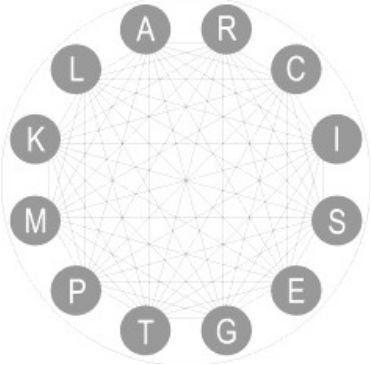
The first version of the Lo.S.I. model (LoSI_2006) has been found on the circuitation index, that in the field of landscape ecology is a measure of the efficiency of network systems (Haggett ,1977; Forman & Godron, 1986; Gibelli, 1997; Campeol, 2000). More in detail the circuitation index was created as connectivity indicator in order to analyze the connections between corridors and ecotopes in the context of the study of ecological networks. The circuitation index ($\alpha$ in 1), suitable both for anthropic and natural systems, is calculated as the ratio of the existing circuits ($L-V+1$) and the maximum number of circuits in a system ($2V-5$)[6].

---

[5] Resource consumption, Loadings, Indoor environmental quality, Quality of service, Economics, Management, Transport.

[6] Generally too low values were considered as sign of problems in the interaction between the considered elements, while very high values must be compared to the fragmentation degree of the landscape structure.

Figure 1. Outline of the connections defined by the circuitation index.




R: Resource consumption
C: Loadings
I: Indoor environmental quality
S: Quality of Service
E: Economics
G: Management
T: Commuting Transport
P: Participation
M: Regional marketing and branding
K: Cultural Topics
L: Local Development
A: Virtuous Circles

As regards the circuitation index, the LoSI_2006 model provides a double weighting system: both at the level of the classes of requirements and at the level of links between them. Consequently the LoSI_2006 model is calculated as follows:

$$LoSI = \frac{\left(\sum_{i=1}^{n} L_i w_i - \sum_{j=1}^{k} V_j w_j + 1\right)}{2\left(\sum_{j=1}^{k} V_j w_j - 5\right)} \quad (1)$$

where L stands for the number of links, V for the number of classes of requirements and w for the weights' system. The weights' assignment has been carried out according to the GBTool approach: most of the importance has been given to the following classes: Resource consumption, Loadings and Indoor environmental quality[7].

Coherently with an ecological approach, the Lo.S.I. model takes into consideration not only the sustainability classes but also the links between them. At this level, the weighting system has been defined by considering as less important the links that are essential.

To this purpose, the research group has defined a matrix for a pair comparison of the links. The value judgment given by a semantic scale goes from "ordinary", for the connections that in a sustainability perspective are considered as minimum requirements for the urban regeneration intervention, to "high profile", for those

[7] More in detail the weights of the classes are: Resource consumption: 5; Loadings: 5; Indoor environmental quality: 5; Quality of service: 3; Economics: 4; Management: 4; Transport: 4; Participation: 3; Regional marketing and branding: 1; Cultural topics: 1; Local development: 3; Virtuous circles: 2.

interactions that represent a considerable effort to settle in a system physical, economic, social and institutional resources[8].

The first experimentation of LoSI_2006 has been carried out with the aim of providing for a synthetic overview of the enhancement process for public goods in Italy with a particular focus on the attitude of Local Authorities to adopt innovative approaches in the definition of urban development policies and strategies, as well as on the evaluation of their interest for the principles of the sustainability[9] (Oppio, 2007).

The evaluated experiences consist mostly in the redevelopment of brownfield sites or disused buildings, with the aim of carrying out an effective integration between different instances such us the improvement of quality of life in the cities, the preservation of the cultural heritage, as well as the fullfilment of a socio-economic balance according to both the public and the private interest.

The case studies that achieved the best score have the highest number of connections and vertexes: there is a widespread homogeneity in the number of connections for case studies that have the same number of sustainability classes. The difference in the final score, therefore, is strongly conditioned by the weights of connections and vertexes. As the value obtained from the weighted sum of connections increases, the final score increases, whereas an higher value for the sustainability classes with the same weighted number of classes and connections influence in a negative way the weighted score. In details, the results of the LoSI_2006 model to this sample have highlighted that the 46% of the analyzed case studies obtained a value that is lower than 1, the 46% a value between 1 and 2, and only the 8% goes above 2. Actually, the highest value was 2.05, whereas the minimum value was 0. These first outputs have given important suggestions for the redevelopment of the evaluation model, starting from the weights assignment stage.

---

[8] The translation of the judgments in a semantic scale is as follows: ordinary = 1; common = 2; good = 3; excellent = 4; high-profile = 5.

[9] The case studies has been selected through a questionnaire, sent in a preliminary screening stage to Regional, Provincial and Local Authorities, which have been asked to report the public assets enhancement projects considered as relevants. The evaluated case studies were: Valle d'Aosta: renovation and enhancement of the Fort and the village of Bard; Piemonte: S. Croce block in Turin, Venaria Reale Castle and the Mandria village (Turin); 3) Lombardia: the European Library of information and culture (BEIC) in Milan, La Filanda complex in Asola (Mantova); Veneto: re-use of the complex of Conterie in Murano (Venezia); Friuli Venezia Giulia: Villa Ritter in Gorizia, the new Verdi Theater in Pordenone, the new Regional Administration building in Udine, Giacomelli Palace in Udine; Liguria: the reuse of the Cotton Warehouses in Genoa; Emilia Romagna: the Modern Art Gallery, the Department of music and spectacle of the Dams and the the reuse of the Tamburi mill in Bologna, Niccolò Paganini Auditorium in Parma; Toscana: the reuse of the Ilva foundry in Follonica (Grosseto); Lazio: New Esquilino Center in Roma; Marche: the ecological house in Belforte del Chienti (Macerata); Campania: City of Science in Napoli; Calabria: the historical complex of S. Giovanni in Catanzaro, Rivocati neighbourhood in Cosenza, Ecolandia, the fun-environment-technology park in Reggio Calabria; Sardegna: the reuse of the old Hospital and of the glassworks in Cagliari.

## 3. The development of the assessment model: from Lo.S.I._2009 to Lo.S.I._2011

In the light of the outcomes of the first application of LoSI_2006, the authors considered as significant to redevelop the evaluation model starting from an optimization of the circuitation index, in addition to a review of the weights' system.

More in deep the evolution from the LoSI_2006 to the LoSI_2009 version is found on the connectivity index with reference nevertheless to the maximum number of vertexes. In the circuitation index formula *Lmax* corresponds to the maximum number of links in a complex system, as the ecological networks[10], where the maximum number of links, from a statistical point of view, cannot go over the quantity calculated by 3(V-2) according to the concept of minimally connected network.

With reference to the calculus of probability, instead, the maximum number of existing links in a close system without ties (as the framework of LoSI_2006 itself suggests) is given by the following formula:

$$L_{\max} = \frac{V_{\max}(V_{\max} - 1)}{2} \tag{2}$$

where the most importance is given to the maximum number of links that may be checked.

Furthermore, the evolution from LoSI_2006 to LoSI_2009 is strengthened by the comparison with the planar graphs of connections which have led to a new method found on the measurement of the proportional variation of the number of existing links.

Looking also at the specificity of the accessibility index and at the measures used to verify the efficiency of infrastructural networks from a functional point of view, it has been clear that the weakness of the 2006 version of the model could be overcome by a new definition of the circuitation index focused on the degree of connectivity of the network without considering the presence of potential circuits, which in the LoSI framework are not so relevant in the weights' assignment of the ratio between the maximum number of vertexes and links. The research group has also taken into account the indexes that generally measure the efficiency of infrastructural systems, such as the Cyclomatic Number $\upsilon$ (which represent the number of circuits linearly indipendents in a road graph, equal to the number of links in the model of network with minimum connections; the Circuitation Index $\alpha$ in an infrastructural system (corresponding to the variable having the same name in the landscape ecology), the Redundancy Index $\gamma$ (aimed to measure the so called "relational cohesiveness" of infrastructural systems) and the Connectivity Index $\beta$. The Redundancy Index corresponds to the ratio between the number of

[10] The ecological network can be defined as semi-open systems with various ties to the definition of the links.

existing arches (a) and the maximum potential amount of links ($a_{max}$), equal to $n\,x\cdot(n\text{-}1)$, as follows:

$$\gamma = \frac{a}{a_{\max}} = \frac{a}{n(n-1)} \tag{3}$$

while the Connectivity Index measures the capacity of relationship into the same network:

$$\beta = \frac{a}{n} \tag{4}$$

As the framework of the LoSI index is not a network system with fixed connection (circuites), but a structure with free connections, the LoSI_2006 formula has been reviewed as follows (LoSI_2009):

$$\gamma = \frac{L}{L_{\max}} = \frac{2L}{V_{\max}(V_{\max}-1)} \tag{5}$$

With the aim to increase the relevance of the LoSI_2009 version, a greater weight has been given to the completeness of the framework regarding the effective number of classes:

$$\alpha = \frac{L}{L_{\max}} \cdot \frac{V}{V_{\max}} = \frac{2L}{V_{\max}(V_{\max}-1)} \cdot \frac{V}{V_{\max}} = \frac{2LV}{V_{\max}^2(V_{\max}-1)} \tag{6}$$

where a relationship between the number of connections and the amount of vertexes has been defined, according to the Connectivity Index as it has been stated by the theory of graphs, considering both the existing and the potential elements. This new definition of the evaluation model provides that $V_{min} = 1$, and therefore, $L_{min} = 0$: consequently the lower limit of the existence field of the variable is equal to 0. At the same time $V_{max} = 12$ (as the number of classes of LoSI) and $L_{max} = 66$ (calculated by the following formula), therefore $\alpha = 1$:

$$L_{\max} = \frac{V_{\max}(V_{\max}-1)}{2} \tag{7}$$

According to this version of the model, the most efficient cases were that ones that will have more vertexes, existing links being equal, because they have taken into account a greater number of issues than the 12 of the Lo.S.I. model; whereas, number of classes being equal, those case studies that will be characterized by a high number of links will get a better score.

In this version of the model the Lo.S.I.'s range goes from 0 to 1. The finite domain makes the results simpler to be understood and reduces the degree of subjectivity in identifying the links and their weights.

At this level the research group has decided to modify the weights' distribution in their matrix, bringing the domain of the weights' vector to a discrete set, consisting of odd numbers that vary from 1 (ordinary links) to 7 (excellent links, very innovative). The transition from LoSI_2006 to LoSI_2009 assures a greater resilience in the priority scale definition, a lower likelihood to fulfill ex-aequo results as well as a greater robustness of the model to the potential variation of the variables considered.

Although this progress of the evaluation model, the systematic use of the Lo.S.I. model as a decision aid tool in the regional and urban regeneration processes requires to identify a set of criteria for each of the sustainability classes in order to get to a systematic assessment of the project, since the first step of the decision making process until its fullfillment. According to this instance, the last step of the update process has lied in the definition of a multicriteria evaluation matrix, structured in 12 classes and including 84 criteria – 7 for each performance class – chosen partially from the existing literature on the evaluation of sustainability at district level[11], partially from the GBTool and SBTool criteria set and partially defined ex novo for this specific analysis[12]. In order to create a user friendly tool,

---

[11] See Deakin et al, 2007.

[12] Resource consumption: R1_Re-use of existing construction materials off-site, R2_Re-use of existing construction materials on the site, R3_quality of off-site materials, R4_minimization of land use, R5_minimization of the consumption of non-renewable energy, R6_minimization of the water consumption, R7_protection of biodiversity; Loadings: C1_minimization of $CO_2$ emissions, C2_minimization of emissions of GHGs from building production and operations, C3_minimization of waste resulting from construction process, C4_minimization of solid waste, C5_reduction of thermal losses; C6_reduction of energy use, C7_reduction of energy use for transports; Indoor environmental quality: I1_air quality, I2_minimization of the use of materials containing VOC, I3_minimization of radon, I4_natural illumination, I5_ventilation, I6_building layout and orientation, I7_neighborhood layout and orientation; Quality of service: S1_neighborhood services,S2_mixed-income community, S3_quality of services, S4_quality of public spaces, S5_visitability, S6_information and communication, S7_safety and security; Economics: E1_financing renewable energies, E2_financing social housing, E3_enhancement of the purchase of sustainable buildings, E4_reduction of construction costs, E5_reduction of operation costs, E6_enhancement of employment, E7_supporting private investment in public services; Management: G1_maintenability of private spaces, G2_maintenability of public spaces, G3_efficiency in management; G4_ infrastructure energy efficiency, G5_enhancement of an active use of public city by the communities, G6_ enhancement of maintenance of public city by the communities G7_district heating and cooling; Transport: T1_public transports, T2_reduction of parking footprint, T3_walkable streets, T4_cyclable streets, T5_carsharing/carpooling, T6_network of streets, T7_transportation demand facilities; Participation: P1_community outreach, P2_involvement, P3_deliberative processes, P4_education, P5_accountability and transparency, P6_access to information, P7_multiculturality; Regional marketing and branding: M1_real estate marketing, M2_territorial marketing, M3_internal and external auditing, M4_communication

all the 84 criteria are measured by Boolean (dichotomous) variables[13]. More in detail, the evaluation matrix, built on an Excel spreadsheet, has been based on a dichotomous choice ("yes" or "no") for every single criterion. Therefore for each case study to be evaluated, it is possible to assign a score (between a minimum level of one and a maximum of seven) according to the outcome got by each indicator of each performance class. The final result is closely connected both to the amount of affirmative responses (referring to the ranked classes starting from the scores sum: R, C, I, S, E, G, T, K and V), and to the maximum level reached in the scale of ranked indicators (referring to classes of ranked indicators on a priority scale: P, M and L). The score of each case study for each performance class, added to the scores that the case study obtained from other classes, has led to the overall score of the case study itself, starting from which the research group has determined the priority scale:

$$LoSI_{st} = \sum_{i=1}^{12} \frac{(P_i \times w_i)}{\left(P_{i\max} \times w_i\right)} = \sum_{i=1}^{12} \frac{(P_i \times w_i)}{\left(7 \times w_i\right)} \tag{8}$$

where $P_i$ is the score obtained by each class, $w_i$ its weight and $P_{imax}$ the maximum score for each class.

Furthermore, in order to carry out an in-depth analysis, both the scores for each class and the overall score have been standardized.

The LoSI_2011 version has been applied to assess the degree of sustainability of 10 case studies selected among those considered as relevant by the international debate on sustainable neighborhoods in Europe[14]. First of all the results of the 84 indicators measurement highlight that this last version of the evaluation model has been able to effectively measure the performance of the different neighbourhoods in terms of sustainability.

To test the results' consistency of the model and its internal variability, the research group has applied a system of sensitivity analysis based on different

---

of values, M5_long-term vision, M6_cooperation with Local Authorities, M7_improvement of quality of life; Cultural topics: K1_recreational services, K2_cultural services, K3_libraries, K4_musems, K5_cultural events, K6_ protection of cultural heritage, K7_access to schools; Local development: L1_new economic development at regional level, L2_ new economic development at urban level, L3_reinforcement of cultural identity, L4_reinforcement of vivacity of social life, L5_economic dynamism, L6_mixed land use, L7_increasement of local employment; Virtuous circles: A1_enhancement of public private partnership, A2_ improvement of actions for the environment preservation, A3_reinforcement of social mix, A4_multicultural integration, A5_integration of weak social classes, A6_encouragement of cooperation, A7_encouragement of voluntary service.

[13] In this sense, the authors reserve the opportunity of further implementing the evaluation tool by identifying different quantitative indicators, i.e. of discrete or continuous type.

[14] Vauban e Rieselfeld, Friburg, Germany; GWL Terrein, Amsterdam, Netherlands; Viikki, Helsinki, Finland; Gmv e BedZed, London, United Kingdom; Bo01, Malmo, Sweden; CityLife, Milan, Italy; CasaNova, Bolzano, Italy; Villa Fastiggi, Pesaro, Italy.

weights scales identified in 5 different ways: a) a first method focused on the relevance of classes with respect to the sustainable performance measurement of the different districts; b) a technique based on the balance between all the classes; c) a methodology that is based on the grouping of classes at different levels of significance, divided in three main groups; d) a greater differentiation procedure about distances between the different classes; e) a system based on tipping the scales of priority to measure the stability of the model[15].

## 4. Conclusions

The development process of the Lo.S.I. evaluation model has led to a significant improvement of the circuitation model upon which it was initially based. Furthermore it has pointed out its high operating flexibility, which supports its application in the different steps of decision making processes with reference to the role of evaluation (Bezzi, 1998) as tool for addressing (ex-ante evaluation) and monitoring programs/plans/projects (in itinere evaluation), as well as for assuming knowledge useful in different contexts (ex-post evaluation).

More in detail, the definition of a set of indicators could represent an effective tool for knowledge creation and transfer concerning the status and the development options for a specific area (Gibbons et al., 1994), with reference to the stakeholders that might be involved as key actors from the preliminary stages of the regeneration processes. As in these contexts the stakeholders typically have different or conflicting interests and goals, the use of multicriteria decision-making analysis (Mcda) could help to explore and negotiate the multiple interests at stake. In order to support the discussion by scientific knowledge and to generate forms of collective learning (Turnhout et al., 2005), the criteria weights' assignment process can be opened both to the experts with the task of clarifying, from a technical point of view, the different positions (Functowitz et al., 1993), and to a group as broad ad possible of different stakeholders. Furthermore when the decisional con-

[15] As evidenced by the final results, the model is rather stable and less sensitive to the variation of one of the fundamental parameters, namely the system of weights, in fact, two case studies on 10 (Freiburg Rieselfeld and Pesaro Villa Fastiggi) never change their positioning in the 12 sorted scales (even with the inverted weights array), other 2 change their position of an only unit (Freiburg, Vauban and Amsterdam GWL-Terrein), whereas the Helsinki Viikki case changes of more than 2 units. The other case studies vary their positioning on average within a range of 2 or 3 positions, with the exception of the inverted weights array, which caused, of course, greater internal variability in model. Nevertheless, there are clusters of case studies that have similar behaviour, i.e.: a) the cases of Freiburg Vauban, Amsterdam GWL-Terrein and Helsinki Viikki, which are always positioned within the first 4 positions; b) London Gmv and Freiburg Rieselfeld, permanently positioned in the central part of the distribution and with a tendency to be placed in the middle-high rank; c) the districts of London BedZed and Milan CityLife, permanently in the lower end of the priority scale; d) Malmo Bo01 and Bolzano CasaNova, stably in low-mid range, except in the case of the reverse weights array; e) in the case of Pesaro Villa Fastiggi regularly at the last place.

texts are characterized by uncertainty, conflicts between values, strong interests and urgency of action, the improvement of the quality of the decision making process must be considered by scientists, decision makers and the whole society (Munda, 2004).

In addition to the future definition of a software for facilitating the reporting phase, supporting the systematic testing of the first results and improving the level of transparency, a standardized evaluation process should be defined. This could allow an effective coordination of different parts involved ensuring the achievement of an integration between participatory techniques and multicriteria decision aid methods.

## Bibliography


Archibugi F., Nijkamp P. (1990). *Economy and Ecology: Towards Sustainable Development*. Kluwer. Dordrecht.

Archibugi F. (1997). The Ecological City and the City Effect. Ashgate. London.

Bertalanffy L. (1968). *General System Theory. Development, Applications*. New York. George Braziller, Serie Research Memoranda, 70.

Bezzi C. (1998). *Valutazione 1998*. Giada. Palermo.

Brusa G. (2006). *La percezione del valore*. Milano. Clup.

Campeol A. (2000). Percorsi di fruizione e corridoi ecologici in un'ottica di città sostenibile. In: Diappi, L. (a cura di). *Sostenibilità urbana*. Torino. Paravia.

Cerreta M. (2004). Strategie integrate di sostenibilità: le valutazioni ex post per la costruzione dell'alternativa ecologica. In: Fusco Girard L. Nijkamp P. *Energia, bellezza, partecipazione: la sfida della sostenibilità*. Milano. Franco Angeli.

Deakin M., Mitchell G., Nijkamp P., Vreeker R. (2007). *Sustainable Urban Development: The Environmental Assessment Methods*. London. Routledge.

European Commission, Interservice Group on Urban Development. *The urban dimension in Community policies for the period 2007-2013*.

Haggett P., Cliff A.D., Frey A. (1977). *Locational analysis in human geography*. New York. John Wiley & Sons.

Ingegnoli V. (1993). *Fondamenti di ecologia del paesaggio*. Milano. Clup.

Forman R.T.T., Godron M. (1986). *Landscape ecology*. New York. John Wiley & Sons.

Funtowicz S.O., Ravetz J.R.. (1993). Science for the post-normal age. *Futures*. pp. 739-755.

Fusco Girard L., Nijkamp P. (1997). Le valutazioni per lo sviluppo sostenibile della città e del territorio. Franco Angeli. Milano.

Fusco Girard L., Forte B., Cerreta M., De Toro P., Forte F. ( 2003). *L'uomo e la città*. Milano. Franco-Angeli.

Gibbons M., Limoges C., Nowotny H., Schwartzman S., Scott P., Trow M. (1994). *The new production of knowledge: the dynamics of science and research in contemporary societies*. New Delhi. Sage Publications, London Thousand Oaks.

Gowdy J.M. (1994). *Coevolutionary Economics: The Economy,Society and the Environment*. Kluwer. Boston.

Haas P.M. (1989). Do regimes matter? Epistemic communities and Mediterrrean pollution control. In: *Int. organ. 43* (3). pp. 377-403.

Mattia S., Pandolfi A. (2007). L'analisi multicriteria come strumento di supporto alle decisioni nelle politiche pubbliche. In: *Costruzione e valutazione della sostenibilità dei progetti*. Milano. FrancoAngeli.

Morin E. (1980). *La méthode II. La Vie de la Vie.* Paris. Le Seuil.

Nijkamp P., Van Oirschot G., Oosterman A. (1993). *Regional development and engineering creativity: an international comparison of science parks in a knowledge society.* VU University Amsterdam. Faculty of Economics, Business Administration and EconometricsNorgaard, R.B. (1994). *Development Betrayed*. Routledge, London.

Ombuen S., Ricci M., Segnalini O. (2000). *I programmi complessi*. Milano. Il Sole 24ore.

Oppio A. (2007). Approcci, metodi e tecniche per la promozione della partecipazione. In: *Costruzione e valutazione della sostenibilità dei progetti*. Milano. FrancoAngeli.

Oppio A. (2007). La valutazione delle prestazioni ambientali degli edifici: il GBTool. In: Capolongo S., Daglio L., Oberti I. *Edificio, salute, ambiente. Tecnologie sostenibili per l'igiene edilizia e ambientale*. Milano. Hoepli.

Palmeri F., Gibelli MG. (1997). Indicatori ecologici e valutazione ambientale nello studio del paesaggio. In: Ingegnoli V. (a cura di). *Esercizi di ecologia del paesaggio*. Milano. Clup.

Pandolfi A. (2007). Introduzione alle tecniche di analisi multicriteria. In: *Costruzione e valutazione della sostenibilità dei progetti*. Milano. FrancoAngeli.

Strogatz S.H. (2001). Exploring complex networks. *Nature*, 410, pp. 268-276.

Turnhout E., Hisschemöller M., Eijsackers H. (2005). Ecological indicators: between the two fires of science and policy. *Ecological Indicators*. 7. pp. 215-228.