Towards Urban Sustainability: Trends and Challenges of Building Environmental Assessment Methods

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ABSTRACT: Many countries have developed their own building environmental assessment methods or customized existing ones. International standardization is also underway to ensure a common framework.
These methods present some similarities in scope, intent and structure; yet they may differ substantially in many core aspects including the environmental criteria considered, the quantification of performance, and the management of the whole assessment process.
The present paper compares, both in form and technical content, a number of these systems (e.g. HQE®, BREEAM, LEED®, CASBEE, GBTool) with focus on their trends and perspectives and their capacity to move to the ultimate target of urban sustainability. This paper addresses the critical and current issue to know how to manage increasing complexity, i.e. induced by the extension from a single building to urban scale and by including the socio-economic dimension, together with ensuring more transparency, accuracy and reliability within simple assessment schemes.

1 INTRODUCTION

Numerous studies have been dedicated to building environmental assessment methods, either by comparing several methods or by analysing thoroughly one specific method (e.g. GBC). The focus was put alternatively on their relevance, content, initial and evolving intentions and roles, differences, perspectives, etc. (see e.g. Cole 2005). The author justly addressed a number of critical issues in the essence of such tools which are as many paths for re-thinking them. He states that current rating systems are facing the challenge to evolve in terms of simplicity, refining performance measures and indicators, improving verification methods, streamlining the certification process, the necessary support documentation together with their capability to manage more complexity in a simple and practical form. So, the present paper will not duplicate such studies but focuses on one of the most unaddressed challenging issues: The urban scale as new emphasis.

2 BUILDING ENVIRONMENTAL ASSESSMENTS METHODS

Prior to handle the urban issue, a brief review of the most mature and successful assessment methods was exemplarily undertaken, together with the French method HQE® tertiaire. These are the British, American, Japanese and international reference products, respectively: BREEAM, LEED®, CASBEE, GBC (GBTool). In the following analysis, the focus is put on the structuring of criteria because of their profound implications on the process and final evaluation of the building as an “ecological” product. A short statement of the convergences vs. divergences of these systems is drawn, with the ultimate task to commit a reflection whether it is

relevant to extend these tools to urban scales and if so, how to achieve that goal. The review criteria were:

i. Applicability: Scope & Scale, Type of Project / Building.
ii. Development Approach: Intention, Update and Management of the method.
iii. System Maturity: Age, Stability, Representativeness, Versatility.
iv. Technical Content: Performance Topics, Thoroughness, End User, Aim of the tool, Decision Aid Means.
v. Communicability: Rating System's anatomy, Performance criteria's anatomy, Clarity.
vi. Measurability: Quantification, Benchmark, Weighting, Results Representation.
vii. Usability: Availability of Information, Assistance to user, Cost of assessment.
viii. Verification & Certification: The assessor, Required Documentation, Phases of assessment, Final Report & Certification.

Only a few of them are discussed here. More details are available from the author on request[1].

2.1 *Applicability: Scope and Type of projects and buildings*

The building is the main object of study of these methods. However, a noticeable trend for an extension to an urban scale is visible:

- The GBC takes into account explicitly the urban issue in one specific topic of its building assessment scheme i.e. "Site selection, project planning and development".
- HQE® and LEED® are developing new independent rating systems exclusively dedicated to the neighbourhood scale, i.e. *HQE aménagement* and *LEED-ND*.
- CASBEE : i) by extending comfort and well-being issues to the open spaces surrounding the building, ii) in CASBEE-H (where H refers to Heat Island) which is an adjusted version of CASBEE applied to large cities like Tokyo or Osaka, and iii) in "CASBEE for districts and regions" which is under development.
- "BREEAM Developments", on the other hand, provides an assessment framework to guide the sustainable design of developments, to allow developers to demonstrate the sustainability features of their proposals to the local planning authority.

At a national level, the building rating systems are differentiated depending on i) building type (residential, offices, schools, etc.) or on ii) the life phase of the building (planning, operation & maintenance, etc.):

– CASBEE differentiates between each phase of building life in form of Tools 0 to Tool 3 (pre-design, new construction, existing building, renovation), however all building types are taken into account in one tool.
– BREEAM handles all building life phases in one rating system; whereas each rating system is dedicated to one building type.
– LEED® portfolio includes i) rating systems for specific building types, and ii) for new and existing buildings.
– HQE® tertiaire approach is dedicated to tertiary activity including offices and educational buildings. Further tools are under development.

By contrast, the GBC (GBTool), which is exclusively academic and not commercial, has developed a generic system such, which explicitly recognizes regional specificities and offers a versatile possibility of use.

2.2 *Development Approach*

All investigated national rating systems (HQE®, BREEAM, LEED®, CASBEE) are commercial tools. They are more or less supported by their governments or private industry, sometimes within an academic frame. Their sensitivity to market imperatives explains the multiplicity of use-specific tools as mentioned above. By contrast, GBC is a primarily research project and by

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implication a voluntary tool. GBC suffers no limitations induced by marketing considerations.

For instance, the strong commitment of the industry and federal agencies in the LEED project, explains partly its rapid growth and expansion in comparison to other tools. CASBEE in turn clearly displays the aim of its implementation in Asia. This calls attention to the necessity of a careful analysis according to market contexts. BREEAM as well as LEED® are particularly effective in the management of their products thanks to numerous technical committees and in the latter case to the consensual approach based on the vote of the large LEED-membership.

2.3 *Technical Content and Management*

Figure 1 shows a comparison of the structure, i.e. the main topics of each of the environmental assessment methods under consideration. The two columns on the right side show respectively i) a summary of the analysed methods and ii) the draft proposed by the international Standard ISO under development on the subject.

Basically all these systems handle the major environmental issues of Energy, Water, Materials & Waste and Indoor Environmental Quality. However, differences are noticeable from one system to another in the consideration of the:

- Physical context (site, land use, open spaces, transport, etc.)
- Quality of service (Functionality, durability, long-term performance & maintenance, etc.)
- Human dimension in terms of social and economic aspects.
- Environmental loadings as main indicators of performance (greenhouse gases, pollution).

For example, BREEAM focuses on the environmental loading indicators favoured by the consideration of topics such as "transport", "land Use & ecology" rather than solely in terms of energy consumption. The HQE® approach is structured in 14 targets which is a more fragmented scheme in comparison to other systems, yet still covering the main performance issues. GBC is a more flexible tool and the successive versions may vary largely as can be noticed between GBTool 2000 and GBTool 2005 as no trademark stability concern exists.
CASBEE applies the recent ideas introduced by GBC 2000 of differentiating between the building as product and as services, by evaluating separately the environmental loadings on one hand and the quality of services on the other hand. CASBEE also pays more attention to the surroundings of the buildings and to socio-economic dimensions and hence initiates, at a national level, the extent of assessment boundaries to urban scale and sustainability matters as a whole.
The Management of the project involves more stakeholders than the only design team and requires an explicit commitment. This issue is included differently depending on the system:

- As a separate topic such in BREEAM, including all pre-design, construction, operation & maintenance.
- Included in the main topics of the rating systems such in LEED® (e.g. commissioning in the topic Energy). Yet, all management aspects are not taken into account.
- As a combination between a chapter “Environmental Management System: EMS” and single environmental targets (e.g. Targets 3 and 7).

2.4 *Communicability*

Two main types of structure were identified:

- A linear structure, as in BREEAM or LEED® where environmental performance is listed in form of individual checklists. Each of them consists of the aim or intent, awarded credits, compliance requirements and necessary documentation. This structure presents the advantage of clarity and ease of use.
- An arborescent structure as in GBC project, where the performance criteria are organised in a series of topics and sub-topics. First intended for versatility, this structure presents the disadvantage to be less transparent. Both HQE® and CASBEE are inspired from this model.

Comparative analysis of the structure of building environmental assessment methods

Topics		HQE®	BREEAM	LEED®	CASBEE-NC	GBC		Synthesis for the Building		ISO/TS 21931-1 (ISO / TC59 / SC17)	
						GBTool 2000	GBTool 2005				
Management	**A**	Env.Managt.Sys: EMS(*) Target 3 - Construction site Target 7 - Maintenance	M Management	distributed into the 4 main topics	Q2 Quality of Service	M Management (pre-operations)	E Functionality	Management [Commitment, Construction Site Operation & Maintenance]	Quality of Service	Building Management	
						S Quality of Service	F Long-Term Performance			(+) Performance / Life Cycle	
Site	**B**	Target 1 Surrounding Environment	LE Land Use & Ecology	SS Sustainable Sites	Q3 Outdoor Environment on Site		A Sie selection, Project Planning & Development	Urban Design	Sustainable Sites		
			T Transport			Transport		Transport			
Indoor Environment	**C**	Comfort Targets [8, 9, 10, 11] Health Targets [12, 13]	HW Health & Wellbeing	IEQ Indoor Environmental Quality	Q1 Indoor Environment	Q Indoor Environmental Quality	D Indoor Environmental Quality	Indoor Environmental Quality		Indoor Environment	
Resource Consumption	**D**	Target 4 - Energy	E Energy	EA Energy & Atmosphere	LR1 Energy	R Ressource consumption	B Energy & Resource Consumption (Materials & Water)	Energy		Primary Energy Use	Waste production
		Target 5 & 14 - Water	W Water	WE Water efficiency	LR2 (Water) Resources & Materials			Water		Water Use	Land Use
		Target 2 - Products Target 6- Waste	MW Materials & Waste	MR Materials & Resources				Materials & Waste		Material Use	Local Impacts
Environmental loadings	**E**	*see* Target 4 Energy	Pollution + *see* Land use & Ecology		LR3 Off-Site environment	L Loadings	C Environmental Loadings	Environmental Loadings		Environmental Impacts	
Socio-Economic aspects	**F**				*see* Q3 Quality of Service	Economics	G Social & Economic Aspects	Social Dimension	Economic Dimension		
Creativity System's Openness	**G**			Innovation & Design process (Bonus points)				Innovation & Design Eco-Education, etc.			

(*) EMS : Environmental Management System

Dotlines state for issues which are implicitly taken into account or parts of other topics

Figure 1: Comparative analysis of the structure of building environmental assessment methods, together with the related ISO project

2.5 *Measurability*

All systems combine quantifiable and prescriptive criteria. All systems but HQE® tertiaire use a quantitative scale in form of cumulative points achieved for each performance criterion. In GBTool and CASBEE two partial totals are calculated which correspond to i) Quality and ii) Loadings, respectively. CASBEE reports a final score which is a ratio of both. This gives the possibility to a finer analysis of the building real impacts. A ranking or a building profile is then used to communicate final results.

In GBTool the interpretation takes into account the regional and local specificities, since the benchmarks can be managed separately by national teams, with the assessment system remaining identical. Several levels of weightings are also possible in GBTool. This issue is critical, yet variable from one system to another and confirms the relative value of the final results provided by each method. In order to guarantee the compliance to performance criteria, the verification means must be explicitly defined. Here, the British and American tools provide more links to decision-aid sources. As well, the clear formulation of the required documentation makes the assessment easier and more reliable. This latter point also suffers some divergences from one system to another. All these aspects are major improvement areas of these tools.

2.6 *Trends and perspectives*

The issue of sustainability assessment is strategic, either in Europe or at a wider international level. Most countries have developed their own tools or adjusted existing ones to their specific context. Yet, a common language is lacking, and several projects are underway which seeks to act as a common theoretical background for forthcoming methods. Figure 2 shows the two main frameworks presently under development: ISO/TC59/SC 17 and CEN TC 350 projects, together with one example of country local standards, i.e. France. These projects are still limited to the building scale.

3 SUSTAINABILTY ASSESSMENT AT AN URBAN SCALE

3.1 *A climate-conscious urban design method*

One main issue of increased complexity in assessment methods is the extension of their scope to urban context. The concern of sustainability of cities has focused the interest of several research fields for decades. Yet, the lack of a framework which coordinates all findings in readily understandable performance criteria prevents their effective implementation. Hence, the proposal of an "*urban sustainability assessment method*" inspired from existing building assessment methods is one way for bridging the gap between theory and practice at urban level, and between diverse disciplines on sustainability matters. The following material discusses some relevant points to build this new methodology.

The starting point in building environmental design (1970's) was the concern for optimising the use of natural energies, the so-called bioclimatic architecture. Later in the assessment methods, the importance of energy is confirmed by its high weighting (For energy criteria: BREEAM 15 points, LEED® 10 points and HQE® high or very high level).
Similarly, at urban level, the first attempts for structured design methods also dealt primarily with the climate and energy, see e.g. Ali-Toudert (2000) for a review of published methods. This is because of the critical issues of energy savings, human comfort, health and safety issues, all related to the availability of solar and wind access which are compromised by the urban density and to the formation of particular urban microclimates, etc. For instance, Ali-Toudert (2000) proposed a conceptualized methodology for integrating the climate in urban planning and urban design.

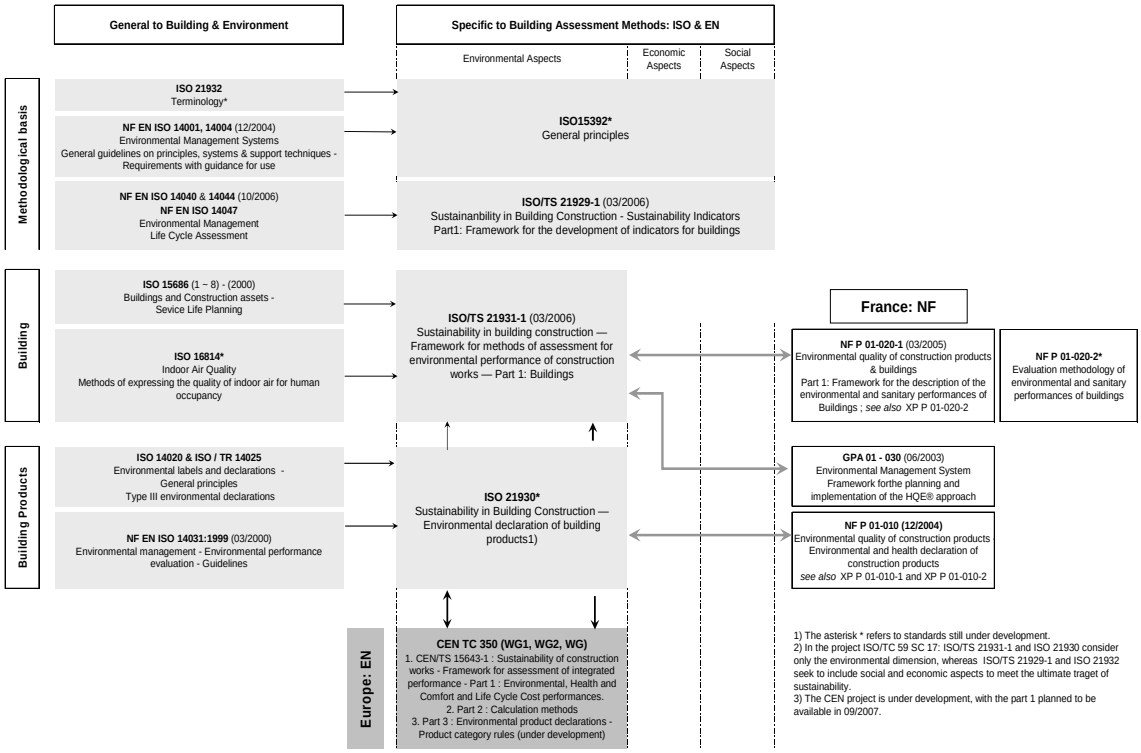

Figure 2: Standardization of environmental issues applied to the building: ISO - EN – NF

1. Urban Planning :
   i. *The Climate* at regional & local levels to determine the basic design recommendations.
   ii. *Site Selection* to gain the optimal advantages from appropriate urban locations.
   iii. *Urban Permeability* (to wind) to keep connection with the natural environment and energies, and avoid the overheating of the city (Urban Heat Island UHI mitigation).
   iv. *Land Use* in terms of integration versus segregation of activities (residential, working areas, leisure, industry, etc.)
   v. *Landscaping* which summarizes the positive effects of green at a large scale.
   vi. *Urban geometry* as a link to the next design stage, as follows:

2. Urban design :
   i. *Openness to the Sky* for solar and energetic control, i.e. to ensure solar access / protection.
   ii. *Urban Porosity* which governs the ventilation rates in the urban spaces and hence indoors.
   iii. *Directionality* which discusses the optimal orientation of the street and buildings according to solar and wind needs.
   iv. *Urban Reflectance* which governs the heat storage potential in the urban fabric: Buildings & surfaces (UHI mitigation)
   v. *Building Envelope* which acts as an interface between architectural and urban design strategies:
   vi. *Urban Vegetation* which explains how the green may be the most useful for enhancing human comfort and energy savings.

At design scale, the focus was put on geometrical indicators to ensure operative guidelines. These have been refined in a later research (Ali-Toudert 2005).

3.2 *Towards an Urban Sustainability Assessment Method*

The interest for sustainable cities as a generic keyword is manifold and combining all information sources for elaborating new appropriate rating systems is necessary:

1. The so-called environmental urban architecture, mainly supplied by architects and urban designers, and which progressively extends its physical limits (see e.g. Thomas 2003).

2. Urban climate research which provides tremendous information on the specific climate of urbanized sites and especially the urban heat island which is the main expression of climate change. These findings rely on a strong physical basis.
3. The current design practices where practitioners and other stakeholders try to extend "intuitively" building assessment methods to urban neighbourhoods by paying more attention to building's surroundings.

As previously mentioned, some attempts are made to bring on the market rating systems which scope is the neighbourhood or even the city as a whole, e.g. LEED-ND. Yet, these tools are in an experimental stage and need verification and feedback.

To give a picture of such an approach, Figure 3 is a proposal of a basis structure for a sustainability assessment method at an urban scale.

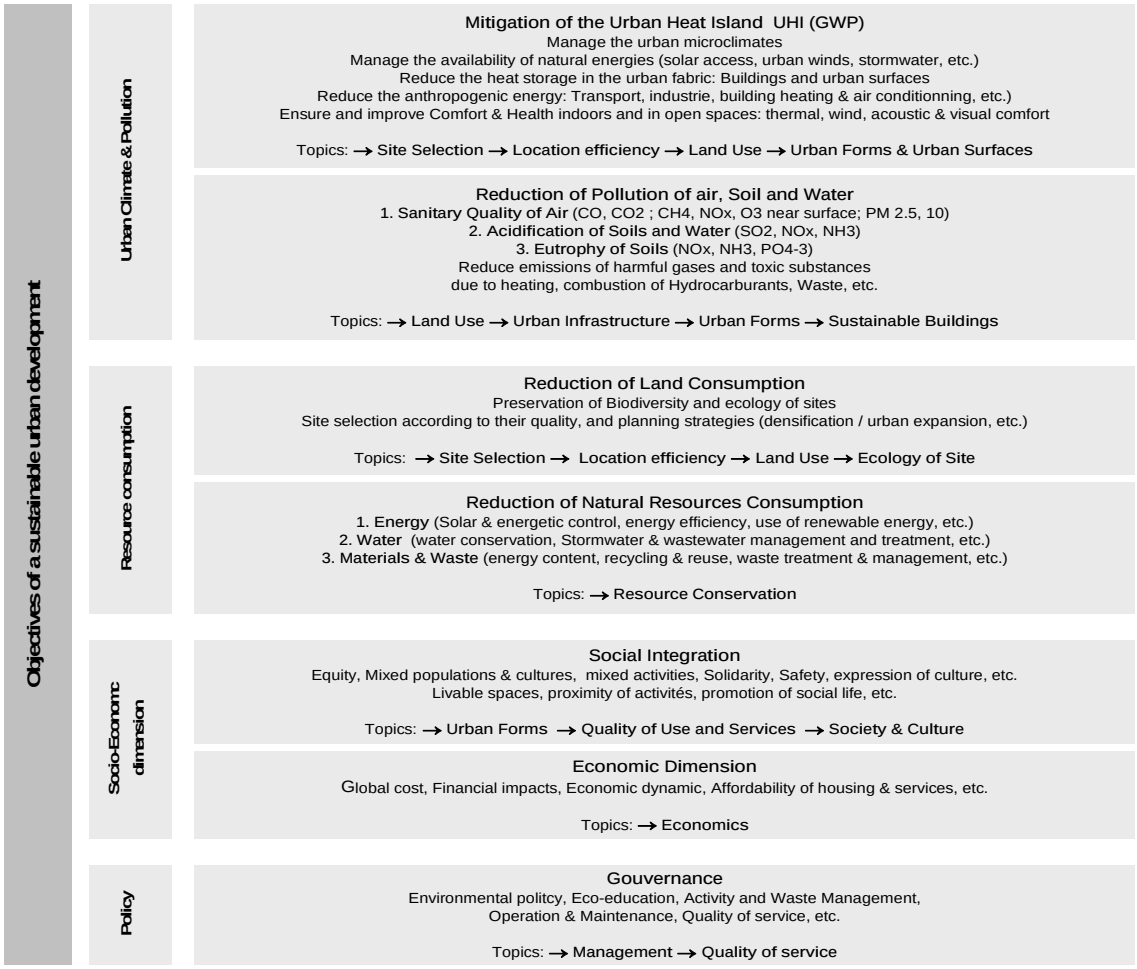

Figure 3: A framework for an urban sustainability assessment method

Basically, there will be continuity and no rupture on an environmental level, while moving from building to urban scale assessment, because the indicators of environmental loadings are identical: global warming potential GWP, Resource Consumption, Ozone depletion ODP, Pollution of air, soil and water. Hence, the major topics applied to environmental building assessment are expected to be reused at urban level, such as the efficiency in energy or water resources use. Yet these topics need to be addressed differently according to the specificity of the current object of interest: the "urban fabric". The content will be revised according to a number of major differences:

1. The object « city » consists of indoor spaces (buildings) and open spaces (streets, places and parcs): Both are living spaces and support human activities, which require a high environmental quality, as well as they both effect more or less negatively the environment.

2. The urban climate and more precisely the urban heat island (UHI) is the main phenomenon characterizing the city from an environmental point of view. Consequently, a key issue for implementing a powerful assessment method at urban scale is to understand the mechanisms which lead to the formation of the UHI together with their dependence on planning and design choices.
3. The consumption of land as precious resource takes here a much more dominant place in comparison to building scale, since the site selection as well as the whole land use strategy relies on the availability of land (expansion, densification, infrastructure, etc.) These in turn will affect the need for other natural resources such energy, water or materials.
4. The social and economic dimensions assume an important role, since the city is by definition an organized framework for human activities and a concentration of capitals. This means that an extension of performance assessment to urban level extends automatically its limits beyond the environment to include all sustainability issues.

A number of topics can be pre-defined as a working basis:

- *Site Selection*, *Location Efficiency*, *Land Use* and *Ecology of Sites*: to avoid hazardous locations, improve site and climate quality, and preserve ecosystems.
- *Urban forms & Surfaces*, *Urban Infrastructure* and *Sustainable Buildings*: which include the optimisation of urban density, street network and pedestrian areas, Building forms and arrangements, an integrated community development, based on diversity and a balanced mix of activities, proximity Work/ Habitat, etc.
- *Quality of Life* including the *Human Wellbeing & Health*, *Social & Economic integration*.
- *Conservation of Resources*: Land, Energy, Water, Materials and Waste.
- *Management* and *Quality of Service* including commitment and eco-education, construction, operation and maintenance.

4 CONCLUSION

Building assessment methods offer a good basis for elaborating new a scheme for urban scale assessment. Yet, attention must be called to some precautions, already observed at building level, from which the necessary clarity and accuracy in quantitative assessment, scoring, context specificities, double counting, as well as a careful definition of the prescriptive criteria related to qualitative issues, etc. It is essential to offer systems that serve as a common framework for all stakeholders, and particularly to design teams which face the great challenge to manage conflicting design issues and manifold interests. Moreover, a distinction between performance assessment and market interests is also important. Indeed the latter might effects negatively the objective and rigorous setting of performance criteria and scoring. A multidisciplinary work is essential to build this method and a close collaboration between all environmental fields, urban climatologists and planners/designers is crucial.

5 REFERENCES

Websites of the reviewed assessment methods: HQE®: www.assohqe.org ;
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