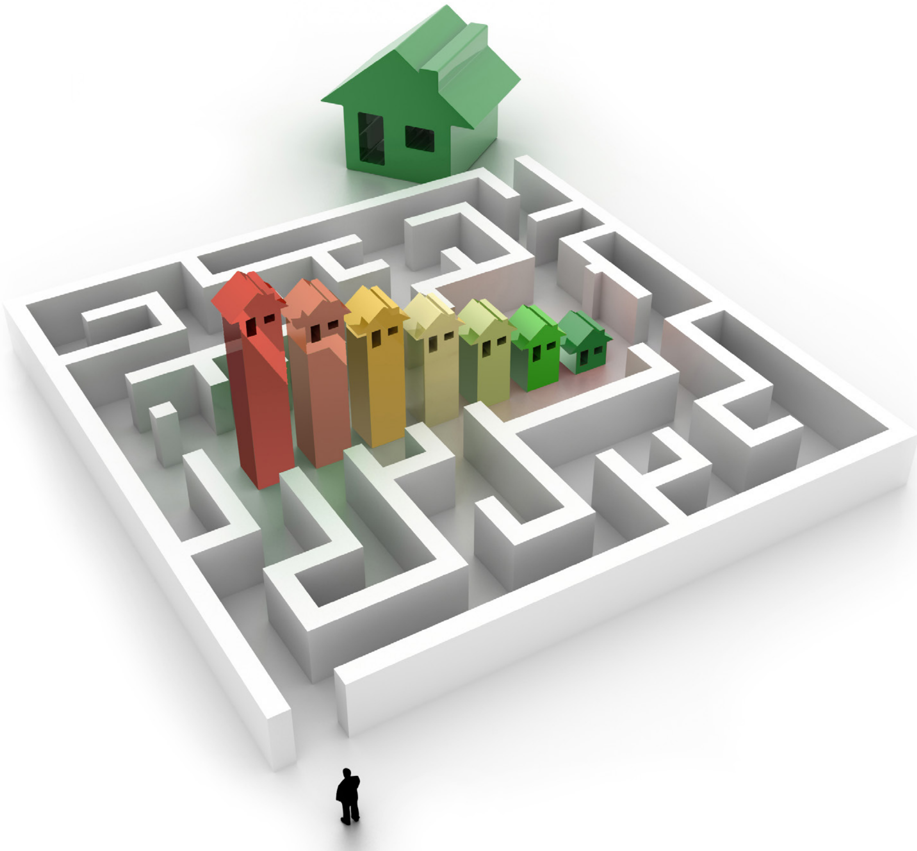
PORTUGAL SB13

CONTRIBUTION OF SUSTAINABLE BUILDING TO MEET EU 20-20-20 TARGETS

30 Oct > 1 Nov | 2013 | Guimarães | PORTUGAL



Editors

Luís Bragança
Manuel Pinheiro
Ricardo Mateus

Universidade do Minho

TÉCNICO LISBOA

iiSBE PORTUGAL

PORTUGAL SB13

CONTRIBUTION OF SUSTAINABLE BUILDING TO MEET EU 20-20-20 TARGETS

Organized by

Universidade do Minho

Instituto Superior Técnico

Partners

PORTUGAL SB13

CONTRIBUTION OF SUSTAINABLE BUILDING TO MEET EU 20-20-20 TARGETS

Editors

Luís Bragança

Manuel Pinheiro

Ricardo Mateus

ISBN 978-989-96543-7-2

Printed by Multicomp

1st edition, October 2013

Legal Dep. 365726/13

Scientific Committee

Albert Cuchí
Universidad Politécnica Cataluña, Spain
Aleksander Panek
University of Warsaw, Poland
Alexander Passer
Graz University of Technology Austria
Andreas Rietz
Fed. Inst. for Research on Building, Germany
António Tadeu
Universidade de Coimbra, Portugal
Appu Haapio
VTT, Finland
Charles Kibert
University of Florida, USA
Christian Wetzel
Calcon, Germany
Dimitrios Bikas
University of Thessaloniki, Greece
Dorota Chwieduk
Institut Techniki Cieplenj, Poland
Eduardo Maldonado
Universidade do Porto, Portugal
Emilio Mitre
GBC España, Spain
Fátima Farinha
Universidade do Algarve, Portugal
Fernando Branco
Instituto Superior Técnico, Portugal
Frank Schultmann
University of Karlsruhe, Germany
Gerd Hauser
Technical University of Munich, Germany
Helena Gervásio
Universidade de Coimbra, Portugal
Hipólito de Sousa
Universidade do Porto, Portugal
Jaume Avellaneda
Universidad Politécnica Cataluña, Spain
Jorge de Brito
Instituto Superior Técnico, Portugal
Luís Bragança
Universidade do Minho, Portugal
Luís Simões da Silva
Universidade de Coimbra, Portugal
Manuel Correia Guedes
Instituto Superior Técnico, Portugal
Manuel Duarte Pinheiro
Instituto Superior Técnico, Portugal
Manuela Almeida
Universidade do Minho, Portugal
Maria Teresa Barbosa
Universidade Federal de Juiz de Fora, Brasil
Marina Fumo
University of Naples, Italy
Maristela Gomes da Silva
University of Espirito Santo, Brasil
Mat Santamouris
University of Athens, Greece
Miguel Amado
Universidade Nova de Lisboa, Portugal
Natalie Eßig
Hochschule München, Germany
Nicolas Kerz
Fed. Inst. for Research on Building, Germany
Nils Larsson
iiSBE, Canada
Pekka Huovila
VTT, Finland
Petr Hajék
University of Prague, Czech Republic
Raymond Cole
University of British Columbia, Canada
Ricardo Mateus
Universidade do Minho, Portugal
Rogério Amoêda
Green Lines Institue, Portugal
Ronal Rovers
Zuyd University, The Netherlands
Said Jalali
Universidade do Minho, Portugal
Sungwoo Shin
Hanyang University, Korea
Tarja Häkkinen
VTT, Finland
Teresa Ponce Leão
LNEG, Portugal
Tomas Luetzkendorf
University of Karlsruhe, Germany
Tom Woolley
University of Central Lancanshire, UK
Vanessa Gomes
Universidade Estadual de Campinas, Brasil
Vasco Peixoto Freitas
Universidade do Porto, Portugal
Vítor Ferreira
Universidade de Aveiro, Portugal

Contents

Chapter 6: Building Sustainability Assessment Tools

Chapter 7: Renovation and Retrofitting

Chapter 8: Eco-Efficient Materials and Technologies

Chapter 9: Urban Regeneration

Chapter 10: Design for Life Cycle and Reuse

Chapter 11: LCA of sustainable materials and technologies

Chapter 12: Thematic Session - Smart Regions: which strategies?

The implicit definition of 'utility' in the sustainable building assessment methods.

J. Puyo Collet
Universitat Politècnica de Catalunya, Department of Architectural Technology I (Vallès School of Architecture), Sant Cugat del Vallès, Spain
joan.puyo@upc.edu

A. Cuchí Burgos
Universitat Politècnica de Catalunya, Department of Architectural Technology I (Vallès School of Architecture), Sant Cugat del Vallès, Spain
alberto.cuchí@upc.edu

ABSTRACT: The research is focused on the concept of 'utility' regarding the sustainable building assessment methods. The study presented is part of a wider research that analyses the sustainable building assessment methods regarding the challenge of sustainability. Keeping in mind that the condition of sustainability is the material cycles closure, we highlight the place that 'utility' occupies in the measure of the sustainability. We explore how the standards of LCA and sustainable building assessment deal with this question. Then we point out the impossibility of an objective measurement of utility and the fact that the methodologies adopt a conventional definition of this concept. Finally we contribute a formulation that has to allow us, in future works, analysing the definition of utility adopted by the different methodologies and the corresponding implicit judgment values.

1 THE SUSTAINABILITY AND THE LIMITATION OF THE AVAILABLE MATERIAL FLOWS

1.1 *Sustainability: our point of view*

The spreading of the use of the word sustainable in all the fields, from scientific literature to the daily speech, as well as its different interpretations, nearly require, in a research as this one, pay a minimum attention to establish the point of view adopted to avoid mistakes. Such as J. M Naredo (Naredo & Valero Capilla 1999) has explained, the word 'sustainable' appeared related with the environmental worries as an adjective of the idea of the 'sustainable development'. In fact 'sustainable' was not a strange word for economists devoted to development, because they have used this adjective to talk about the 'self-sustained growth'. For this reason it was easily acceptable. But this notion have a high degree of uncertainty because it links in a single expresión the worry about the economic development, normally defined in the economics file as growth of the production in monetary terms, with the intention to maintain the health of the ecosystems, without specifying how these would be compatible, which has caused a rhetorical use. In fact, the definition in the Brundtland report (Comissió Mundial sobre el Medi Ambient 1987, p. 41), became canonical, keeps this ambiguity. However, the original worry for the physical viability of the human systems has brought some authors to go more deeply into the research of the content of the sustainability notion.

«The greater part of the current lack of definition comes from the insistence of reconciling the economic growth (or development) with the idea of sustainability, when each of these aspects are referred to different levels of abstraction and reasoning systems». The notions of economic growth –and development– are based on the usual idea of economic system and work with the corresponding units of the homogeneous monetary aggregates of 'production' and their derivated units. However, the worry for the sustainability is based on the singular and heterogeneous physical processes (Naredo & Valero Capilla 1999, p. 60).

All the organisms, populations and ecosystems of the earth are alive thanks to the continuous degradation of the matter and energy involved in the material cycles. But as the earth has finite material resources, the maintenance of the life is only viable thanks to the fact that the biosphere is an open system which receives a continuous energetic flow from the sun which allows counteracting the degradation. Whereas the idea of the economic system is understood as a closed system and suppose that the flow of the investment can counteract the deterioration caused on its obtaining, following the model of a continuous movement machine. The conclusions are that as the opening of the system and the degradation of the matter, very important questions in the description of the biosphere, do not have reflection in the idea of the economic system, it is not possible, from this point of view, deal with the sustainability in a coherent way. And, on the other hand, that the sustainability can be defined as the condition of the closure of material cycles, which has as a corollary the need of basing all the processes on the solar energy flow. This last point of view, designed as a strong sustainability, is the one used here (Naredo & Valero Capilla 1999, p. 64).

Some authors have thought that the economic growth and the sustainability can be compatible through the idea of the decoupling. This idea supposes that even though the monetary aggregates which represent the production of the wealth carry on growing, the material support of this production can be reduced thanks to technological changes. Other authors, however, have demonstrated in an empirical way and with recent data the falseness of this hypothesis, showing that the absolute decoupling –the absolute reduction of troughput material at a global level– is just «a myth» (Jackson 2009, p. 67-86, cap. 5).

1.2 *Material cycles and flows*

Material cycles have been on earth since its origin and shaped life, while life deeply changed these cycles. This coevolution is the one that has determined the conditions of the environment which we all depend on. The deep and fast modification of the material cycles established like this supposes, from the point of view of the life and specifically the human life, the degradation of the environment. In fact, as R. Margalef points out (Margalef 1982, p. 325;Margalef 1992, p. 88) any pollution problem can be described as an illness of the transport of the ecosystems and the first step for the solution is recognize the disturbed cycle.

From a global perspective, the movement of materials in the biosphere appears as a cycle, in other words, it is like a journey of some materials tracing wide or short ways through the hydrosphere, the lithosphere, the atmosphere, or through their limits, and in a determined speed. From the point of view of a particular system, however, it is more useful to pay attention how this movement of materials crosses the borders of the delimited system and then represent it as a flow. Thus, when the sustainability of a system is considered, we can simply take into account if the inflows and outflows are compatible with the corresponding natural cycles. In this way we are taking into account the compatibility with the rest of the ecosystem.

All the living being are situated in any point of the material cycles in order to obtain a flow of utile resources for its life, either to use on its living structure or on external structures, which allow a higher control of the material cycles. If the human being is different from the rest of the living beings is because of the big proportion of the resources which uses for the external structures in comparison with its living structure (Margalef 1982, p. 307;Margalef 1991, p. 250). The increase of these structures has supposed an immoderate interference in the material cycles and the fast transformation of the environment, putting in danger the bases of its own existence. The evidences of different processes of environmental damages, exposed by the scientific community, are not more than concretions of the perturbation of each of the material cycles. It explains, therefore, the need of the establishment of limits of the flows involved in all the human processes, in each of the relevant areas from the point of view of each material cycle. Without going into detail about the discussion of the establishment of these particular limits, it is necessary to signal that it is from the best scientific knowledge of the moment that it is necessary to establish them. In the same way, as it has been done in concrete cases, it is necessary to consider the evolution of the limitations of the flows in the time, establishing target reduction scenarios (Zimmermann *et al.* 2005). In conclusion, the condition of sustainability supposes the control of the material flows of the human technical processes.

2 THE SUSTAINABILITY IN THE PARTICULAR PROCESSES

2.1 *Consequences of the sustainability for the particular processes*

It has been usual to talk about the sustainability as an attribute of an object, whether it is a sheet of paper, a building or a city. The indiscriminate use of the adjective 'sustainable', mentioned above (sect. 1.1), supposes that the word is used to highlight a pretended or real paid attention in environmental questions, in a particular process, in comparison to the usual practise. But this use is too generic and a little bit useful to deal with the environmental problems. In order to establish a more restrictive and operative use of the word 'sustainable' applied to any particular process –the particular sustainability– is necessary to establish the relation with the definition of general sustainability. General sustainability can be defined as the limitation of the total flows of a substance in the relevant area; and the 'relevant area' as the biospheric area involved in the material cycle in question, for example the local, regional, global field or the hydrographic basin,.... Thus, for example, the relevant area for the liquid polluting substances can be water down of a hydrographic basin and for GEH substances the global field. The definition of particular sustainability has to be coherent with the condition of general sustainability.

The condition of general sustainability, as we have said, is the closure of the material cycles, which can be expressed for each resource and emission as a total limit flow.

$$F \leq F_{lim} \tag{1}$$

Where F = total flow; and F_{lim} = total limit flow.

The total flow is the sum of the corresponding flows to the particular processes in the relevant area.

$$F = f_1 + f_2 + \cdots + f_n = \sum_{i=1}^{n} f_i \tag{2}$$

Where fi = particular flow ith.

The other side of a particular process, and that justifies it, is the satisfaction of needs through the utility. And utility is always provided by a physical support that we can call satisfier (Max-Neef *et al.* 1994) and that constitutes the material flows so-called from the point of view of economics as goods, either economic or free. For the moment we will not talk about the question of the definition of necessity and utility, just say that the utility cancels the need, and with the ordinary idea it will be enough. What interests us, in the first place, is that a particular process generates a satisfier able to contribute utility, so the utility is a dependent magnitude of the satisfier: $u(s)$. In this expression s has to be understood as a qualitative variable: a unit of a concrete type of satisfier and u as a utility that we will suppose that is a measurable magnitude. On the other hand, a particular process generates a flow of the studied matter in such a way that an intensity of flow in respect of the utility can be defined, and it can be called ecological cost – inverse magnitude of the ecological efficiency.

$$c_i = \frac{f}{u(s_i)}\ ; \quad f = c_i\ u(s_i) \tag{3}$$

Where c_i = ecological cost; and $u(s_i)$ = utility of a unit of the satisfier ith.

Substituting the expression of the particular flow (3) in the expression of the total flow (2) we have:

$$F = c_1 u(s_1) + c_2 u(s_2) + \cdots + c_n u(s_n) = \sum_{i=1}^{n} c_i\, u(s_i) \tag{4}$$

that indicates that the total flow of a material, produced with the objective of contributing utility, depends on the chosen satisfier and on the ecological cost tied to this satisfier. If now we substitute (4) to the condition of general sustainability (1), we obtain

$$\sum_{i=1}^{n} c_i\, u(s_i) \leq F_{lím} \tag{5}$$

that shows that the condition of general sustainability limits the quantity of utility and/or the type (i) and quantity (n) of the satisfiers.

The limitation of resources is imperative since the point of view of the sustainability (Jackson 2009), above and beyond the difficulties that we might have to determine it exactly, and therefore the right-hand member can be considered theoretically fixed. Therefore, if we want to deal with the question of the satisfaction of the human need, we have to pay attention to the factors of the left-hand member. A usual way and very necessary to address the subject is to modify the satisfiers in such a manner that a satisfier provides the same utility with less ecological cost: it is the way of the efficiency through the technological evolution. Another way to address the efficiency is to pay attention to the relation between the satisfiers and the contribution of utilities, ensuring that we make the most of all the potential contribution of utilities of a satisfier: it is the way of the efficiency in the use of the resources –that is the grandmother's wisdom: ‘turn off the light when you go out of the room’. This last treatment is related to the technology but overlaps the questions of behaviour and cultural factors. There is also the possibility to limit the consumption (*n*). But above and beyond the dimension of the satisfier, as showed in the left-hand member, there is the dimension of the utility –and its opposite: the need– and we have to remember that it has been left without defining and often remain defined implicitly and that is the factor that we deal with in this research.

2.2 *Indicators*

The structure of the methods of assessment and rating of the building is composed by a group of indicators. It is important to deal with this concept of indicator and some aspects of the classification of these. The review of the literature gives us some definitions of ‘indicator’ (Bossel *et al.* 1999;Castro Bonaño & Salvo Tierra 2001;OECD.Group on Environmental Performance 1993) mentioned in (Monterotti 2013, p. 73) (Agència Europea del Medi Ambient 1998;Malmqvist & Glaumann 2006). All the definitions incorporate the following aspects: it is a value that describes a more complex reality than its same magnitude and therefore synthesize the information. To highlight some aspects of the content of the term ‘indicator’, we are interested in telling the following definition, which is both descriptive, in the sense that takes into account the characteristics of what usually is understood as indicator, and normative, in the sense that the use that we do of the concept will be adjusted to this definition. An indicator is a –quantitative or qualitative– variable that is used for having a sufficient degree of correlation with one or different variables that determine the state of a system, which is the object of our interest. The fact that an indicator or a group are used instead of the group of variables that define the system is related to fundamental questions, as epistemological questions connected with the reality that we study, or with practical questions, as availability of data. In any event, a variable is never itself an indicator but it is used as an indicator when it is considered useful to do so.

The indicators that are part of the methods of sustainable building rating systems that interest us refer to the input and output flows of the system that is a building, with the limits that the methodology has marked for this system. If one describes the different causal steps that go since a particular process to the effects on the environment, a cause-effect chain can be described (Eriksson *et al.* 2005). The indicators, then, can be classified, as the place that occupy in this chain, with different names as state indicators, pressure indicators, response indicators,... (Bell & Morse 2012, p. 28) One can also form models of indicators choosing different points of the chain and defining in each an indicator. It is the case of the DPSIR model, Driving force (D), emissions to Pressure (P), midpoint changes to State (S) and end-point problems to Impact (I) of the European Agency of the Environment (Malmqvist & Glaumann 2006, p. 324). In any case, what interests us is that the indicator defined always has a causal connection, more or less close, to a flow generated by the process.

The other characteristic of the indicators used by the sustainable building rating systems is that always have to refer to what justifies the generation of a flow, in other words, the utility. This reference to the purpose is what makes possible the comparison between different cases and can let establish a measure of the sustainability. This question refers both to the field of the building sustainability assessment and to the most general field of the LCA methodology. In these two fields an effort of systematisation has been recently done through the formulation of standards, and therefore we are interested in studying how they deal with the question.

2.3 *The 'functional unit' and the 'functional equivalent'*

The UNE-EN ISO 1040:2006 and UNE-EN 1044:2006 standardise the LCA methodology. As it is established there, when a LCA of a product or service –i.e. of any process– is carried out it is done relatively to a unit of product designated as a 'functional unit'. «A functional unit is a measure of the performance of the functional outputs of the product system. The primary purpose of a functional unit is to provide a reference to which the inputs and outputs are related. This reference is necessary to ensure comparability of LCA results» (AENOR 2006a, p. 20). What is identified as a functional unit, therefore, is not necessarily a quantity of individual product but the quantity of a function identified that provides. It is necessary to highlight that this 'function' points out to the variable utility that we have defined above (sect. 2.1)

The standardisation of the building sustainability assessment is carried out in the set of standards UNE-EN 15643:2012. In that case we see that, in spite of the building sustainability evaluation supposes an analogous process to the LCA, here the concept of functional unit is not used but the 'functional equivalent', which is defined like this: «Quantified functional requirements and/or technical requirements for a building or an assembled system (part of works) for use as a basis for comparison» (AENOR 2011, p. 12). The concepts of functional unit and functional equivalent occupy the same place in each of the corresponding contexts. The relevant difference is that while in the first case a basic quantity of function or utility is isolated, in the second case a complete description of the types and level of corresponding utility to the process studied is done. We have to suppose that the different approach that the authors of the two standards assume, in each of the contexts, answers to supported reasons. We have to suppose that the difference is justified by the complexity of the utility that provides a building: the habitability.

In the LCA in general, when the comparison between two alternatives of product is treated, what is known as a 'comparative assertion', there is just the problem that one must to refer to the same functional unit of reference. In the same way, in the case of the assessment of the building, we will not find any problem in comparing two alternative projects of the same building that fulfil with the established functional equivalent. The problem of the reference to the utility appears when one wants to develop a measure of the sustainability of the building for any building. And it is necessary to remember at this point that the possibility to develop a measure of the sustainability of particular processes depends on the capacity of being applied in a general way (see equations (1) and (2)). In this case, the functional equivalent rarely coincides and therefore it is unavoidable a reference to the utility that allows not only the comparison between buildings –relative measure– but also the reference to the total flows that appears in the condition of sustainability.

When a methodology is formulated for a sustainable building rating system, it is obligated to define this reference to the utility. In fact, the indicators used in these methodologies, as we say in the section 2.2, always are a particular type: a quotient between an indicator and the unit of the defined habitability –operation that usually receives the name of 'normalisation' (Cole 1999, p. 8). The question that we set out in this research is to systematise the analysis of the definition of the unit of habitability used to let us analyse, in the future, the implicit judgment values in the chosen definition.

2.4 *The definition of 'need' and 'utility'*

In the section 2.1 we have not deeply talked about the symmetrical concepts of necessity and utility and we just said that the needs were cancelled by the utilities provided by the satisfiers. The development of the ideas has placed 'utility', and the possibility to measure it, as a central concept of the research, and therefore it is necessary to analyse it with more attention. In order to consider the question, we can go to the field of economics that has dealt deeply with it. The birth of economics was based in the study of the creation of wealth. Wealth was defined as all those objects that «are necessary, useful and pleasant to the human being» (Naredo 1987, p. 117). This link between wealth –as a production– and utility, what satisfies people, is the moral justification of the efforts for the increase of the production as well as for the study of the conditions that make this increase possible. This fact is what brought to the study of the utility and the reason why big efforts were done in order to define it as a measurable magnitude. However, as

J. M. Naredo shows, the idea of the measurability of the utility, either in cardinal or ordinal terms, was an illusion (Naredo 1987, esp. cap. 20).

In fact the impossibility of a strict definition and the quantification of the utility depend on the lack of definition of the concept of necessity. «As other concepts and words coming from the evolution of the human thought, the notion of necessity has become part of the common language, and even to the social sciences language, without defining its sctrict meaning: their limits are not exactly pointed out neither what is considered to extend or cut off them». This impossibility is determined by the fact that the needs are based on the human appetite and these depend on their social and ideological context. This is why it is not «possible to specify these limits through a fractional analytic effort which finally results in the formulation of a really objective theory of human needs» (Naredo 1987, p. 53-54).

Keeping references contributed in mind to justify the impossibility to work with a definition and an objective quantification of the utility. On the other band, the application of the condition of sustainability to the particular processes has brought us to establish the need to measure the utility, as the magnitude that justifies the allocation of resources. And in the concrete field of the sustainable building rating systems we have also seen the need to establish a unit of reference that defines and quantifies the habitability. The solution depend on understand that if we want to establish a measure of the sustainability of particular processes, we have to do a conventional definition and recognise that this definition will be based on a subjective value judgment. And we have to realise that all the sustainable building rating systems give a definition of this type and therefore they are based on a value judgment.

3 FORMULATION OF THE HABITABILITY FOR AN ANALYSIS

Having settled down the question of the utility of reference, we set out the notation and the methodology that will be useful –in future works– to analyse the definitions used by different methods or the definitions that are possible to use. This analysis will let us show the judgment values that are behind the use of the different definitions of utility used.

We have already commented that a need can be satisfied with different satisfiers and we have put aside the election of satisfier to focus on the question of utility. Suppose a need, a satisfier already selected, the particular process to obtain the satisfier and one of the flows that generates this process. We can conceive the satisfier in two parts. The first one is the detailed definition of all the physical conditions that the satisfier provides and we can express as a physical model (function σ). In the equation (3) we expressed the ecological cost as the quotient between the flow and the quantity of utility. But as we have seen in section 2.4 it does not have any sense to take the utility as an objectively measurable magnitude. Being realistic, we can substitute the expression of the ecological cost for a new one that has as a denominator the conditions of the satisfier, i.e. (σ), and we obtain:

$$c_s = \frac{f}{\sigma} \tag{6}$$

Where c_s = ecological cost of the satisfier; f = material flow; and σ = conditions of the satisfier.

The second part that defines the satisfier, therefore, is the defined environmental cost (c_s). So we have that the flow can be expressed as the product of the two expressions that define the satisfier: the cost and the conditions. And at the same time we can develop the σ function, usually as a product of different factors:

$$f = c_s \ \sigma = c_s \, \alpha_1 \, \alpha_2 \ \dots \ \alpha_{n1} \tag{7}$$

The (f) flow is an indicator that does not comply with the condition that we established for an indicator of a sustainable building rating system, which is being relative to a unit of reference of the utility (sect. 2.2). This condition is the one that would allow the comparison between different buildings (sect. 2.3). It is whereas a total flow of the analysed process, relative to the ‘functional equivalent’. Define a conventional utility of reference means that some factors of the conditions of the satisfier (α_i) have to be designed as legitimate representatives of the concept of utility.

$$ind. = \frac{f}{\alpha_j\, \alpha_k \ldots \alpha_m} = c_s\, \alpha_p\, \alpha_{\ q} \ldots\, \alpha_{n-m} \tag{8}$$

So the indicator of sustainability is defined as the quotient between the flow and these factors, which can be called 'defined utility' (u^*). On the other hand, the methodology of qualification, because of the condition of sustainability, will have to establish a restriction of this indicator, as a limit of the flow. In spite of not being the object of this research, we point out that some authors have worked in order to formulate methodologies to relate general limits and particular limits of resources (Zimmermann *et al.* 2005).

$$ind. = \frac{f}{u^*} = c_s\, \alpha_p\, \alpha_{\ q} \ldots\, \alpha_{n-m} \ \leq f_{lím} \tag{9}$$

Where u^* = defined utility; and f_{lim} = assigned flow limit.

Having this last expression obtained, we can describe the meaning of each part. The indicator will be subjected to a restriction ($\leq f_{lim}$). The defined utility (u^*) can be understood as what justifies the allocation of resources, in the sense that an increase of (u^*) allows an increase of (f) without the indicator varies, and therefore receiving the same rate. On the other hand, all the factors of the right-hand member, either the environmental cost of the satisfier and the rest of the factors of the conditions of the satisfier that have not been considered as a legitimate utility, became subjected to the restriction and its increase supposes the proportional increase of the indicator, giving a more unfavourable rate.

To deal with the analysis of the definition of utility used for a method, therefore, the development and the notation contributed can be used, isolating the defined utility and studying the factors included in this definition and then, we can study the implicit judgment values in the used definition of utility.

4 CONCLUSIONS

The condition of sustainability supposes the limitation of the available resources and, on the other hand, it involves the concept of utility that can be understood as the purpose that legitimates the allocation of resources. In spite of the centrality of the concept of utility for the sustainability, it is not possible to make an objective and measurable definition. That is why the sustainable building rating methods are doomed to use any conventional definition of 'utility' of the buildings or 'habitability' –often in an implicit way. With the aim of analyse the definitions of utility that the methodologies use we have developed, in this study, a theoretical framework and a formulation showing the factors that are considered as legitimate representatives of the utility, and the other ones that are submitted to restriction. The fact that the methods do not explain this definition is a factor of lack of transparency for the comparison of their results.

The theoretical framework and the formulation contributed let us, from now, analyse rigorously the definition of habitability used by the methodologies. It also let us uses the comparative analysis and reflect on possible alternative definitions. At the same time, this analysis will be useful to show the implicit judgment values in the definitions of utility used.

REFERENCES

AENOR 2006a. *UNE-EN ISO 14040:2006, Gestion ambiental. Análisis del ciclo de vida. Principios y marco de referencia*. Madrid: AENOR.

AENOR 2011. *UNE-EN 15643-1:2011, Sostenibilidad en la construcción. Evaluación de la sostenibilidad de los edficios. Parte 1: Marco general*. Madrid: AENOR.

Agència Europea del Medi Ambient 1998. *Medio ambiente en Europa: el informe Dobris*. Luxemburg i Madrid: Oficina de Publicaciones Oficiales de las Comunidades Europeas; Ministerio de Medio Ambiente.

Bell, S. & Morse, S. 2012. *Sustainability Indicators: Measuring the Immeasurable?* 2a ed. London: Taylor & Francis.

Bossel, H.; International Institute for Sustainable Development & Balaton Group 1999. *Indicators for Sustainable Development: Theory, Method, Applications: a Report to the Balaton Group*.: International Institute for Sustainable Development.

Castro Bonaño, J. M. & Salvo Tierra, E. 2001. *Bases para un sistema de indicadores de medio ambiente urbano en Andalucía: experiencias internacionales en la medición de la sostenibilidad en las ciudades*.: Junta de Andalucía; Consejería de Medio Ambiente.

Cole, R. J. 1999. Building Environmental Assessment Methodes: Clarifying Intentions. *Building Research & Information*, 27(4/5):230-246.

Comissió Mundial sobre el Medi Ambient 1987. *Our common future*. Oxford: Oxford University.

Eriksson, O.; Glaumann, M. & Assefa, G. 2005. Life cycle impact assessment. A damage-based weighting method for environmental impacts.In *SB05 Tokyo: Action for Sustainability - The 2005 World Sustainable Building Conference in Tokyo, Japan, 27 - 29 September 2005*. Tòquio: in-house publishing.

Jackson, T. 2009. *Prosperity without Growth: Economics for a Finite Planet*. London: Earthscan.

Malmqvist, T. & Glaumann, M. 2006. Selecting problem-related environmental indicators for housing management. *Building Research & Information*, 34(4):321-333.

Margalef, R. 1982. La teoría ecológica y la predicción en el estudio de la interacción entre el hombre y el resto de la biosfera. In: Sioli,H. (ed.) *Ecología y protección de la naturaleza: conclusiones internacionales*. Barcelona: Blume.

Margalef, R. 1991. *Teoría de los sistemas ecológicos*. Barcelona: Publicacions de la Universitat de Barcelona.

Margalef, R. 1992. *Planeta azul, planeta verde*. Barcelona: Prensa Científica.

Max-Neef, M. A.; Elizalde, A. & Hopenhayn, M. 1994. *Desarrollo a escala humana: conceptos, aplicaciones y algunas reflexiones*. Barcelona: Icaria.

Monterotti, C. 2013. *Análisis y propuestas sobre la contribución de las herramientas de evaluación de la sostenibilidad de los edificios a su eficiencia ambiental*. Cuchí,A. (dir.). Tesi doctoral, Universitat Politècnica de Catalunya, Depàrtament de Construccions Arquitectòniques I, [Departament Construcccions Arquitectòniques I, ETSAV].

Naredo, J. M. 1987. *La economía en evolución: Historia y perspectivas de las categorías básicas del pensamiento económico*. Madrid: Siglo veintiuno, Ministerio de Economía y Hacienda, Secretaría de Estado de Comercio.

Naredo, J. M. & Valero Capilla, A. 1999. *Desarrollo económico y deterioro ecológico*. Madrid: Fundación Argentaria.

OECD.Group on Environmental Performance 1993. *OECD Core Set of Indicators for Environmental Performance Reviews: A Synthesis Report*.: Organisation for Economic Co-operation and Development.

Zimmermann, M.; Althaus, H. J. & Haas, A. 2005. Benchmarks for sustainable construction - A contribution to develop a standard. *Energy and Buildings*, 37(11):1147-1157.