DEFINITION OF INDICATORS FOR SUSTAINABLE SOCIAL HOUSING: IN SEARCH OF A MODEL

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ABSTRACT

In developing countries, as Brazil, social housing is financed almost exclusively with public resources. Due to lack of planning of urban space occupation and the restriction of financial resources the emphasis is given to the reduction of quantitative dwelling deficit. Thus, nor always satisfactory benefits are provided with regards to the quality of life, social insertion, generation of income and local economic development. The challenge for developing countries is to establish means to reach economic and social growth with rational use of environmental resources, considering also the diversity of local peculiarities. In developed countries several methods are available for evaluation of buildings sustainability. However, there exist the needs for a more realistic approach directed to the developing countries, which consider, beyond the rational use of natural resources, its demands for social and economic development. The objective of this article is to initiate the discussion of social housing sustainability evaluation through the adequacy and definition of indicators that evaluate not only environmental questions but also social and economic ones. It is expected that this work may contribute for the beginning of the conception of

sustainability indicators oriented to the northeast region of Brazil, inducing improvements in social housing.

Introduction

It is estimated by the United Nations, that at the present time, the number of slum dwellers in the world is just under 1 billion. This is the reality that most developing countries have to face, where the high level of poverty raises meaningful difficulties to those who deserve to have access to a good adequate housing. In developing countries, such as Brazil, the access to an adequate housing is directly linked to several social and economical problems, such as the high level of unemployed people, low level of education, and others of political nature. The current demands of sustainable development have been adding new challenges to housing constructing projects. In those countries, the reduction of the housing deficit through the less-privileged social layers (social housing) almost exclusively depends on the governmental initiatives, in which funding is quite limited. The natural tendency is to prioritize the positive socio and economic impacts in detriment of some possible negative environmental impacts.

Establishing indicators for sustainable housing consists in an alternative of, first, diagnosing and then evaluating the level of sustainability, and guiding the decisions that must be taken. Those indicators are the results of an understanding of sustainable development and the housing role in this context; the values and relevance of what must be measured from them. This is the main objective of this work.

This work is the result of the beginning of the process of indicators definition, for a more sustainable housing, taking as reference the context of housing in the Recife (City) Metropolitan Region – RMR. Recife is the capital city of the state of Pernambuco, located in the northeast region of Brazil. This subject is far from ending, as some indicators are suggested with the main purpose of contributing with public managers in the conception of the guidelines for more sustainable housing projects in this region.

Sustainable Development – Searching for a Consensus

An oft-quoted definition of sustainable development is: "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (*Brundtland* Report, WCED, 1987). This concept was established to address the concern about economic development and environment deterioration. The *Brundtland report*, however, recognized that environmental problems can not be dissociated from the poverty and social disintegration. The United Nations Conference in 1992 (Earth Summit), held in Rio de Janeiro, contributed to the promotion of this concept of sustainable development, resulting in the Agenda 21. At Johannesburg Summit, in 2002, it become clearer the basic pillars — economic development, social development and environmental protection — at the local, national, regional and global levels, which give the guidelines to the sustainable development understanding.

It is noticed with the natural evolution of sustainable development understanding that this is still a developing concept, especially in the scientific point of view. (SACHS, 1997; KATES et al, 2005; MARTENS, 2006).

A system of indicators adoption consists in a commonly used alternative to measure sustainability, and many methods have been proposed. These indicators, then, reflect what is being considered as sustainable development. Comparing some of these methods Parris and Kates (2003) concluded that there are no indicators sets universally accepted that present a consistent theoretical basis, rigorous data collecting and analysis, and influential in policy. Amongst some other reasons, these authors have pointed out the plurality of objectives present in the methods and the ambiguity of the sustainable development comprehension. In another comparative analysis, Batterhan (2006) shows the absence of indicators effectively integrated that span all the sustainability levels proposed. Martens (2006), on the other hand, highlights that sustainable development idea may be understood and applied from various perspectives and points out its complex, subjective and ambiguous nature as a source of criticism from both social and scientific point of view.

At least two intrinsic characteristics to the definition of sustainable development can be pointed out as for its amplitude and complexity: (1) the multiplicity of domains (economical, environmental and social, amongst others, such as the political, cultural and religious ones) and (2) the geographical overall level – or scale – (local, national, regional or global). Thus, different economical sectors might present different points of view about sustainability, in relation to social, environmental, cultural, political and religious issues, in different location. Consequently, it results in different measuring methods. This difference tends to acquire greater proportions between developing and developed countries. The necessity of a consensus is then perceptible, in various scales, towards what it must be considered as sustainable development.

Sustainable Social Housing – Searching for an Agreement

The idea of sustainable housing comes from the concept of sustainable development. From an analogous analysis, it needs its own contextualization, guided by the adopted sustainability dimensions and local, regional and global specificities. Moreover, sustainability of housing, as a built environment, is strongly correlated to other areas as, for instance, the sustainable constructions, sustainable human settlement and sustainable cities, that present their own specific characteristics. The role of human settlement into the sustainable development is approached by the Agenda 21 and it has been specifically dealt in the Habitat Agenda - that stress the importance of the building industry to the sustainable human settlements. The Agenda 21 for Sustainable Construction was conceived having, among others, the objective to intermediate these agendas with the local agendas for building industry. The Agenda 21 for Sustainable Construction in Developing Countries (CIB, 2002) represents one more advance into the commonly accepted understanding about sustainable construction and built environment.

The existent systems for evaluation of building sustainability, initially formatted for developed countries, are mainly oriented to the buildings, taking as basis environmental indicators focused into the built environment. These indicators are defined from some concepts, like the environmental performance and life cycle assessment: *green building* (SILVA, et al, 2003). Even with such an oriented evaluation, these systems present different approaches (CARDOSO, 2006). A significant ongoing progress in the sense of defining a common ground for this evaluation, that can selectively draw ideas to incorporate local specifications, is the Green Building Challenge – GBC.

Developing countries require social housing, which is the focus of this work. Social housing is understood as: that one which is addressed to attend the housing deficit, commonly built with public funding, sometimes requiring the restoration of degraded areas due to irregular occupancy, addressed to the low-class poorest population, with low income (or hardly any), and with a low level of school education. As initiatives to attend these demands, a large number of housing units is required. Therefore, they still require the adequacy of the infrastructure when it comes to the water supply, drainage system, sewerage, power supply and transportation. They also include the need to offer some options to improve the income situation. Indeed, these undertakings consist of human settlement, with dwelling typologies strongly linked to the limited funding and space availability, in which quantities are still stipulated by its demand. On the other hand, to be considered as sustainable housings, they need to be ecologically compatible, socially acceptable and economically feasible.

In this context, it is not possible to think about housing as being something apart from the local urban development and from the region's or nation's economical development in a sustainable form (CHOGUIL, 2007). Therefore, social and

economical indicators should compose any housing sustainability evaluation system. In this manner, an additional challenge consists of establishing priorities to building social housings in order to make them more sustainable, as a directive of evolution (continuous improvement), mainly regarding the environmental goals. In South Africa, for instance, the social equity takes more importance on the Agenda 21 for Sustainable Construction than environmental concerns. Consequently, greater attention is addressed to the impact of construction on social and economical sustainability (CIB, 2002).

The Indicators Definition

Some works in Brazil deal with housing sustainability evaluation (BENETTY & SATTLER, 2002; KOWALTOWSKI et al, 2006, for instance). Silva (2007) in an interesting paper suggests a methodological basis to the creation and to the validation of the sustainability indicators for built environment in Brazil, however none of those indicators are proposed yet.

In this work a set of indicators for a sustainable building was chosen as reference: the SBTool, in which 2006 version included some social and economical indicators, suggesting the beginning of an evaluation from the sustainability point of view. Moreover, this choice is also based as follows: the GBC consists of an initiative that aggregates the international experience (Brazil also participates), its scientific investigation character contributes for new systems development (SILVA et al, 2003) and the data availability. The GBTool also has been adapted by other authors in the development of a building sustainability assessment scheme in Hong Kong (LEE & BURNETT, 2006).

Initially a critical analysis of all indicators proposed by SBTool was accomplished. In this stage of the research it was given priority to indicators that refer to the design and occupancy phases. This analysis aimed to verify: the understanding, the applicability, the importance and the technical viability of the indicators, focusing on the social housing and the specific conditions of the RMR. In this stage the measurement system (scoring scheme and benchmarks) has not been considered yet. However, weighting has been established as an option to expresses considerable relevance in each indicator.

The Agenda 21 of Pernambuco State (PERNAMBUCO, 2006) was thoroughly read, trying to identify possible guidelines towards the sustainable housing indicators more specific to the region of study. The research of post-occupancy evaluation developed by the authors (Azevedo et al, 2006) has also contributed for the adaptation and definition of indicators.

Once built the base of the indicators it was requested to the technicians from Recife and Olinda's City Halls (two cities of the Pernambuco state), who are responsible for housing design management and development within these counties, another analysis from the indicators, suggesting also weight values to each one of them.

Those indicators proposed by SBTool, which adopt life cycle assessment and greenhouses gases emission for activities and materials were excluded, because relevant, definitive and trustful data for these evaluations are not available to RMR. The other indicators were adapted to the local reality.

At the end some other indicators, not included in SBTool 2006 version, were also established, gathered accordingly to the environmental, social and economical characteristics of the RMR, taken also into consideration the PROMETROPOLE program.

The Prometropole Program

The PROMETROPOLE is a program from the State of Pernambuco's Government executed by the State Agency of Development and Research for funding of infra-structure and urban services in low income outskirts of RMR and it attends an estimate of 154.000 people in low income communities.

The PROMETROPOLE is an urban renewal project (has for objective to promote the improvement of the habitability conditions) for low income dwellers, near the Beberibe River Basin area – BRB, which introduces citizen-participation methodologies and it is conducted in the outskirts of Recife and Olinda. This renewal design contributes for poverty reductions and for a better environmental quality of RMR (PERNAMBUCO, 2007).

The fight against poverty takes place through the implantation of well developed structures in an urban physical infrastructure of paving, drainage, sanitation, (water, sewage and solid waste), land preparation and containment declivity, playground areas and the usage of community equipment, in the enlargement and improvement of the public services offered to those communities and on the enlargement of the funding regularization mechanism.

Because of its geographical localization, right in the center of the RMR, the BRB area has started to gather a great number of degradation signs in its major incidents as a result of the aggressive and non-planned settlements and also because of the land occupancy throughout the years. Because of these reasons the BRB has been chosen as area of implantation of the PROMETROPOLE program.

Local Characterization for The Indicators Adequacy

The total housing deficit (quantitative and qualitative) of the RMR, where the BRB is inserted, for those families whose average income is US$ 570,00 a month, reaches 88.3% what demonstrates a great effort that has to be done to heal this serious problem.

The city of Recife is the capital of the Brazilian state of Pernambuco. It is also the largest and most important city, in all aspects, in the state of Pernambuco. Its population has 1,422,905 inhabitants, with a density of 6,483 inhabitants per km^2. Besides the housing deficit, there are lacks in other areas, such as the public water supplies, that reach only 87,96% of the dwellings and mainly the sewerage public that goes through only 43% of all houses.

Olinda is the third largest city of Pernambuco state, with 367,902 inhabitants, and it was also the first capital of Pernambuco during the Portuguese colonization period; its demographic density is about 9,011 inhabitants per km^2. 44.96% of the heads of the families have a monthly income of about US$ 380.00.

One of the communities chosen in Olinda by the PROMETROPOLE program, called "Unidade de Esgotamento 07" – UE 07 will benefit with the improvement of transportation access and moving, paving and micro drainage. Also with implantation and recovery of the water and sewage system, public power supply, solid waste collection improvement, squares/playgrounds implantation and rehabilitation for community activities and leisure activities, declivity containment, implantation of social equipments (schools, day care centers, health clinics, bus stations, police stations, etc.) environmental education and communitarian strengthening (PERNAMBUCO, 2007). In the UE 07 a total of 2,300 families will be benefited directly or indirectly. It is also planned the building of 661 housing units and some trade/commerce rooms to offer local services, beyond the rehabilitation of 75,000 m^2 of environmental interest area.

Indicators' Proposition

As it was said before, the base for definition for indicators was the SBTool 2006, however, also some more indicators were added. These indicators are described below, and they are divided into the three sustainable dimensions:

Social Dimension:

- Proximity to the medical center/health unit:

A medical center must be understood as one or more public health unit that in an isolated manner or in a partnership action offers, at least, the following kinds of medical attendance: clinical, emergencies, and dental care. The proximity to these units is defined in function of those healthcare clinics within a specific radius from the outline of the undertakings.

- Proximity to the Educational center:
  An educational center must be understood as one or more public schools that in an isolated manner or in a partnership action offer, at least, the following kinds of teaching: Kindergarten (or day care center), Middle School and Junior High School (1st to 8th grades), and High School (9th to 12th grades). The proximity to these centers is defined in function of those schools within a specific radius from the outline of the undertakings.

- Accessibility for Visual Handicaps (based on National Standards):
  o The adequate sidewalk is the one which is obstacle free and allows the visual handicaps (blindness) a free, safe, and autonomous transit circulation. It is taken as a reference the legislation and the technical standards;
  o The adequate horizontal moving is the one that allows the horizontal circulation of the people who are visually handicapped (blindness) with autonomy and security. It is taken as a reference the legislation and the technical standards;
  o The adequate vertical moving is the one that allows the vertical circulation of the people who are visually handicapped (blindness) with autonomy and security. It is taken as a reference the legislation and the technical standards.

- Ambient to events and socialization:
  There must be an area addressed to events like meetings, gatherings, parties or other events which promotes the socialization of the undertaking users. This area is considered adequate when its dimensions, localization, and infrastructure provide appropriated controlled access of authorized people and vehicles, with the least comfortable and security conditions.

- Socio-environmental dwellers education:
  The dwellers awareness program contemplates socio-environmental issues, implementing awareness aiming the rational usage of energy and water, good practices of socialization and the usage of the private and common areas;

- Sentry box security (in case of gated communities):
  Area addressed to work as the sentry box security, to control effectively the in-coming and out-coming of people and vehicles. This area is considered adequate

when its dimensions, openings, location and infrastructure allow the appropriated conditions of controlling effectively the access of authorized people and vehicle, within the least conditions of comfort and security to the person who will work in it;

- Security against unauthorized people (in case of gated communities):
  Ways of monitoring those who come in and go out of the undertaking environment. These means are considered adequate when they allow the effective control of people and when it is possible to contact the local police department when or if necessary. It takes as a reference the internal and external communication system and when it takes for granted the existence of an adequate infrastructure (sentry box security);

- Security against fire (based on the Fire Department Code):
  It is taken as a reference the code, standards and technical laws related to protection in firing incidents. However, it allows other additional ways for the users' security and for the undertaking security into these situations;

- Private parking (in case of gated communities):
  Area designated to vehicle parking. This area is considered adequate when its dimensions, localization, security and infrastructure allow a number of minimum vacancies and adequate to the dwellers;

- Users satisfaction evaluation (only in the occupancy period):
  The satisfaction evaluation from the users is an important feedback to those designers and developers, because it gives the information of how the dwellers feel towards the undertaking, it gives both negative and positive aspects. There are several methods available for this evaluation: interviews and questionnaires over the phone, posted in letters, to be answered personally, online, including any other way of communication amongst those who are involved into this process.

Economics:

- Available resources to simulate energetic efficiency and/or environmental comfort:
  These simulations allow a better understanding of design alternatives, guiding a viability analysis from technical and financial perspectives.

- The cost relationship between conventional and more sustainable housing:
  This indicates how far the current government financial support to a more sustainable social housing is.

Environmental:

- Vulnerability of slope stability:
  The area to be considered adequate is the one that presents the smallest risk of damage to this real state undertaking as well as to its users, with no vulnerability of slope stability. The indicator is estimated by the undertaking's situation in relation to the declivities (hills) and the existing protection measures against sliding (slope stabilization). The protection against sliding has specific designs by qualified professionals.

- Sewerage final destination (proximity in relation to the water coursing):
  In case of not having sewerage public system, in the nearby area, not-treated sewage out-coming must be far away from the water coursing, in order not to pollute it. The indicator is quantified by the final destination of the sewage's distance in relation to how close the water stream is. The relating legislation must be considered under the indicator's definition.

- Sewerage final destination proximity in relation to the water reservoir:
  In case of not having a sewerage public system in the nearby area, not-treated sewage out-coming must be far away from the water reservoir, in order not to pollute the undertaking's nor the neighbourhood's. The indicator is quantified by the sewage final destination distance in relation to the nearest water reservoir. The relating legislation must be considered under the indicator's definition.

- Controlled water exploitation:
  In case of the undertaking having a well for a water complementary captivation, the well must attend specific legislation for the water stream management. The indiscriminate usage of deep wells may cause problems, such as the sea intrusion (water salt-works – in the coastwise area), subsidence, In the State of Pernambuco, a well is considered deep when its depth is superior to 20m, and the Pernambuco Company of Hydro-Resources – CPRH – is the public institution responsible for the management of all hydro-resources in the State.

- Material with no mixed environmental load:
  Materials considered environmentally adequate are those with no damage incidents to the environment with pollutants (CFC, asbestos, etc.) or that are not classified on the extinction list (many types of wood).

- Thermic transmittance capacity of the roof and inner walls (based on a Draft Brazilian Standard):
  Thermic transmittance is the quantity of heat which is transmitted through a structure when a thermic difference is noticed between the internal and external surface.

- Artificial electric illumination (based on a Draft Brazilian Standard):
  The adequate artificial electric illumination is the one which enables the person to accomplish the normal environmental activities, mainly indoors. This electric illumination may be originated from electric energy, gas and alternative sources, preferentially renewable energy.

Conclusion

It is clear that it is still necessary better understanding and quantification of environmental impacts originated from the social housing built in the RMR. Aspects like gas emission which contributes to the global warming, electricity conservation, water conservation, organic waste recycle, among others, seem to be far away from the reality of these undertakings, mainly when they are compared to positive socio and economic impacts. This turns the approach difficult in the design phase. Indeed, the limited financial resources already induce strong restrictions to architecture designing (MACIEL SILVA et al, 2007). More significant problems of larger scales seem to be at construction and occupancy phases. A preliminary analysis of estates housings design shows a significant degradation level, including environmental, as a consequence of socio and economic contexts. It is important to notice that some of these issues may be taken into consideration at design phase and they might require the continuous attention of those responsible (public agencies) for these undertakings post occupancy, including some basic awareness programs. Some observations regarding the sustainability of these housing projects can be reported as follow:

- **Precocious degradation**: The financial limitation and the lack of understanding that buildings maintenance, the living conflicts, and the irregular occupancy of public areas contribute for the precocious degradation of these undertakings, creating some other problems with the water supply system, sewage, irregular waste deposition, among others.

- **Unexpected changes**: The users' demands as income generation and dwelling unit amplification to suit the family growth, for instance, induce changes into the housing unit, as well as in the public space, which are incompatible to the architectural and structural solutions. These modifications are brought up as a consequence of a wide sense of what housing represents (AMORIM & LOUREIRO, 2003), a social issue not entirely considered in these designs. In this preliminary analysis, the solution for multi-familiar housing usually adopted, does not seem to attend these high social and economic demands, which are able to interfere within the condominium.

- **Urban degradation**: Different from what happened in the 1970's and 1980's, today social housing policy tends to bring the undertakings near the urban centers. The problems originated post occupancy started to exceed the condominium limits, interfering with the outskirts of the undertaking area.

- **Technical restriction**: Specific standards for building performance have not been concluded yet. The technical specifications for construction material and services do not refer to building durability, environmental impacts, recycling.

- **Legal restriction**: The legal skeleton that conducts the design and construction of social housing project impose that construction material and services acquisition has to be based on the lowest price . Therefore, construction materials with the least environmental impact or those which promote the local economical growth cannot be obtained if they do not have the best price range.

A set of indicators are introduced in this work, aiming at the evaluation of social housing from the sustainability point of view. It registers the starting point of this process in Recife's Metropolitan Region, which characteristics represent the urban areas from the Brazilian northeast region, very similar to those in developing countries. In this sustainability assessment tool, internationally accepted indicators are considered, besides some others were added which reflect the specificities of the RMR.

This work is been developed under an in-live participatory approach of those who are the social housing managers and designers from the Recife and Olinda's cities. This makes possible definition of indicators especially addressed to the RMR. Furthermore, the definition process of those indicators consists of a formation way and a self awareness process towards the role that housing plays into the sustainable development, in its local and global level.

For the intervention area of the PROMETROPOLE program, the UE 07, introduces some aspects related to the sustainable development, considering the quality of environmental improvement in the degrading occupancy, or by the living condition improvement, and still by the creation and improvement of office space. However, there is still a lot to be done regarding the three primary sustainability dimensions.

The tool that is being developed has as its primary goal, to give initial diagnosis and guide the decision making process in the futures designs. The technicians who are involved in the research register the importance of this work and help raise awareness of the people involved with financing the social housing. The next steps consist in the establishing punctuation levels, benchmarks and also making a wider consultation possible.

The social and economic realities in developing countries provide an inciting challenge for the sustainable development in the local, national and global scales. This brand-new focus brings new hope for the problem that it is old, however keeps on going with no solution. When the developing countries establish their own sustainability evaluation mechanism, they will need to take as a basis of a dynamic structure, establishing levels of priority to have compatible socio, economic and environmental demands.

In every scale, local, national, or global, the search for a consensus and the reduction of social inequality, in fact, will need a new era of cooperation, the so desired age of "culture of solidarity" and common interests. Maybe the Economy of Communion (Bruni, 2000) is a way to be considered.

<div align="center">References</div>

1. Azevedo, N. J. D. de; Maciel Silva, P. & Rêgo Silva, J. J. Contribuição do usuário na definição de indicadores de desempenho de edificação popular multifamiliar. In: XI Encontro Nacional de Tecnologia do Ambiente Construído (ENTAC), **Proceedings...** Florianópolis, 2006. p. 1040-1049.

2. Batterham, R. J. Sustainability – The next chapter. **Chemical Engineering Science**, v. 61, i. 13, Jul. 2006, p. 4188-4193.

3. Bennett, P. & Sattler, M. A. Indicadores de sustentabilidade em habitação popular. In: X Encontro Nacional de Tecnologia do Ambiente Construído (ENTAC), **Proceedings....** São Paulo, 2004.

4. Bruni, L. Comunhão e as novas palavras em economia. Vargem Grande Paulista, Cidade Nova, 2005.

5. Cardoso, F. F. Redução de impactos ambientais dos canteiros de obras: exigências das metodologias de avaliação da sustentabilidade de edifícios. In: XI Encontro Nacional de Tecnologia do Ambiente Construído (ENTAC). **Proceedings...** Florianópolis, Aug. 2006. p. 3560-3569.

6. CIB. **Agenda 21 for sustainable construction in developing countries** – a discussion document. Pretoria, 2002.

7. Choguill, C. L. The search for policies to support sustainable housing. **Habitat International,** v. 31, i. 1, Mar. 2007, p. 143-149.

8. Kates, R. W.; Parris, T. M. & Leiserowitz, A. A. What is sustainable development? Goals, Indicators, Values, and Practice. **Environment**. v. 47, i. 3, Apr. 2005, p. 8-21.

9. Kowaltowski, D. C. C. K. et al. Análise de parâmetros de implementação de conjuntos habitacionais de interesse social: ênfase nos aspectos de

sustentabilidade ambiental e qualidade de vida. In: SATTLER, M. A. & PEREIRA, F. O. R. (Orgs.). Coletânea Habitare - **Construção e meio ambiente**. Porto Alegre: ANTAC, v. 7, p. 128-167. 2006.

10. Lee, W. L. & Burnett, J. Customization of GBTool in Hong Kong. **Building and Environment**, v. 41, i. 12, Dec. 2006, p. 1831-1846.

11. Maciel Silva, P. M. W.; Rêgo Silva, J. J. & Azevedo, N. J. D de. Sustentabilidade da habitação popular: por onde começar?. In: XVIII Congresso Brasileiro de Arquitetos - Arquitetura e Urbanismo no contexto do desenvolvimento sustentável. **Proceedings...** Goiânia, Oct. 2006.

12. Martens, P. Sustainability: science or fiction? **Sustainability: Science, Practice & Police**, v. 2, i. 1, 2006, p. 36-41.

13. Parris, T. M. & Kates, R. W. Characterizing and measuring sustainable development. In: **Annual Reviews of Environmental and Resource**. v. 28, 2003, p. 559-586.

14. Pernambuco. **Agenda 21 de Pernambuco** - Fórum Estadual da Agenda 21 de Pernambuco. 2002. 255 pgs.

15. Sachs, I. Desenvolvimento sustentável, bio-industrialização descentralizada e novas configurações rural-urbanas – os casos da Índia e Brasil. In: VIEIRA, P. WEBBEER, J. (orgs). **Gestão dos recursos naturais renováveis e desenvolvimento**. São Paulo: Cortez, 1997.

16. Silva, V. G.; Silva, M. G. & Agopyan, V. Avaliação de edifícios no Brasil: da avaliação ambiental para avaliação de sustentabilidade. **Revista Ambiente Construído**. Porto Alegre: ANTAC, v. 3, n. 3. p. 7-18, Jul./Sep. 2003.

17. Silva, V. G. Indicadores de sustentabilidade de edifícios: estado da arte e desafios para desenvolvimento no Brasil. **Revista Ambiente Construído**. Porto Alegre: ANTAC, v. 7, n. 1. p. 47-66, Jan./Mar. 2007.

18. WCED. **Our Common Future**. Oxford University Press, Oxford, U.K. 1987.