TOWARDS A DESIGN OF SUSTAINABLE CITIES: INCORPORATING SUSTAINABILITY INDICATORS IN URBAN PLANNING

1. Introduction.

Urban planning is closely related both, to decision making processes as well as to the establishment of a further urban envisioning. Therefore, it is understood as a multidimensional and multipurpose managed change of the natural and built environment. [C.Carmona, 2003] Hence urban planning is a key element for the creation of sustainable cities by its influence on the production of quality spaces, urban patterns, support of environmentally sensitive development, and promotion of participatory processes to allow citizens empowerment.

The design of a framework for urban planning that forecasts the economic, environmental and social development, in order to even up the objectives of urban poverty diminishing, environmental conditions improvement and promotion of economic productivity of cities, requires a broad set of urban planning instruments towards sustainability. These instruments will result from a comprehensive methodology for generating, registering, analyzing, evaluating, and communicating the required information at the different planning stages. In this sense, sustainability indicators are useful instruments that shall be included, to guarantee urban sustainability in all its dimensions.

The recent use of sustainability indicators has emerged to measure and model sustainable development, as well as, for the monitoring of programs and policies implemented in past decades. Furthermore, these indicators have become decision making instruments, and have been extensively promoted by the spread of the sustainability paradigm.[C. Wong, 2006] This also corresponds to the great impulse given to the local agenda 21, which in its chapter 40, *Information for decision making*, highlights the need to put into service sustainable development indicators to provide a solid foundation for decision making, at all levels, that will contribute to the building of sustainable self-regulated systems in which development and environment can be integrated.[UNCED, 1992].

The present paper builds on this background by introducing a set of indicators and frames specifically selected for quantifying sustainability performance at the urban dimension. Furthermore, this work proposes the use of indicators in the early stages of urban planning, to advance the incorporation of sustainable considerations in the entire design and planning process. These indicators can then work as tools to provide not only information, but also as instruments to model urban sustainability and evaluate the challenges and opportunities in leading cities towards sustainable development.

2. Moving from the use of monitor indicators to the operativeness of sustainability: Bases of the proposal.

The magnitude and significance of sustainability indicators has received much attention in recent years. This theoretical and empirical effort stated by international organizations as well as local governments to define indicators that could be useful in assessing the evolution of environmental issues and to establish which are the main problems in cities, have broadened in scope over time. So, the number of possible indicators has grown to an extent where virtually all aspects of city performance can be covered. Consequently, a vast number of sustainability indicator systems are in use today.
As a result, we find sets of indicators used to understand the urbanization process, and which are the main problems faced by social groups. These modules are more centered in the social aspects of cities, so they include poverty, education, health, local finances, and governance indicators. [OMAU, 2001]

There are also some other indicators concerned by the evaluation of environmental impact of cities, these concrete indicators are centered on urban design and urban metabolism. [UNU/IAS, 2003]

On the other hand we find a great number of local indicators which are more oriented to evaluate the potentialities, and the environmental and social profiles of cities. [Bettini, 1998]

However, even if they can all be identified as urban sustainability indicators, their use has been limited to their specific areas, such as environmental, social or economic aspects in connection with the urban development process, all the more they are all monitoring and control instruments.

These observations reveal two aspects associated to the monitoring and evaluation of cities.

The first is that of monitoring and evaluating social, economic and urban trends, the set of urban indicators that are regularly employed by different international development agencies are useful. Their value relies on measuring the impact the effects in the long and medium run of economic, social, cultural and environmental initiatives developed in the field of sustainability. Also, the majority of these set of indicators are framed in the pressure-state-response model that undertakes the effect on environmental and natural resources caused by human actions. [OECD, 1992] Due to this it is possible to understand the relationship of subsystems that interfere in the city configuration and which determine its impact on the environment.

The second consideration refers to the incorporation of aspects and revision of topics related to the interconnections of urban and environmental systems, in particular those developed by the Local Agenda 21. This is a set of indicators for the diagnosis of social environmental issues, designed as input and perception indicators that can be used in territorial management.

These two aspects are, unquestionably, an advance in the generation of information, modeling and standardization of sustainability in the urban field. Due to that, they provide elements to reflect and support ideas and methods for the implementation of the sustainable development paradigm in the urban field.

Moreover, if sustainability is to be fully integrated into the future design of cities, tools need to be constructed to allow its insertion into the city fabric. This paper presents an alternative to reach this objective by moving indicators from the ex-post evaluation of cities' problems to an ex-ante stage in which they can be operationalized as planning tools. Indicators then will become auxiliaries in the design of policies, strategies, actions and programs for urban sustainable development.

3. Bridging the gap: Incorporating urban sustainability indicators to the planning process.

The incorporation of sustainability indicators within de planning process allows the implementation of sustainability at the local level. Since urban planning is the one that defines territorial models by establishing an urban scenario, detailed land use, zoning regulations, and building bye-laws and standards. Then, the use of indicators materializes the underlining concerns of urban planners who are interested in sustainability.

Therefore, the proposed use of sustainability indicators as ex ante tools in urban planning, will lead to:

- Connecting statistical, environmental, demographic, urbanistic, economic and social data to match the managerial urban local and regional needs.
- Integrating data according to the subject matter to generate information for the decision making process across the different stages of urban planning.

- Improving and smoothing information exchanges used in the planning process.
- Supporting stakeholders' analyses to manage the city in a sustainable way. An opening of communication channels for all subjects concerned with the city's life.
- Discussing and redefining the planning agenda.
- Proposing guidelines to achieve the objectives of a sustainable city along with the monitoring process.

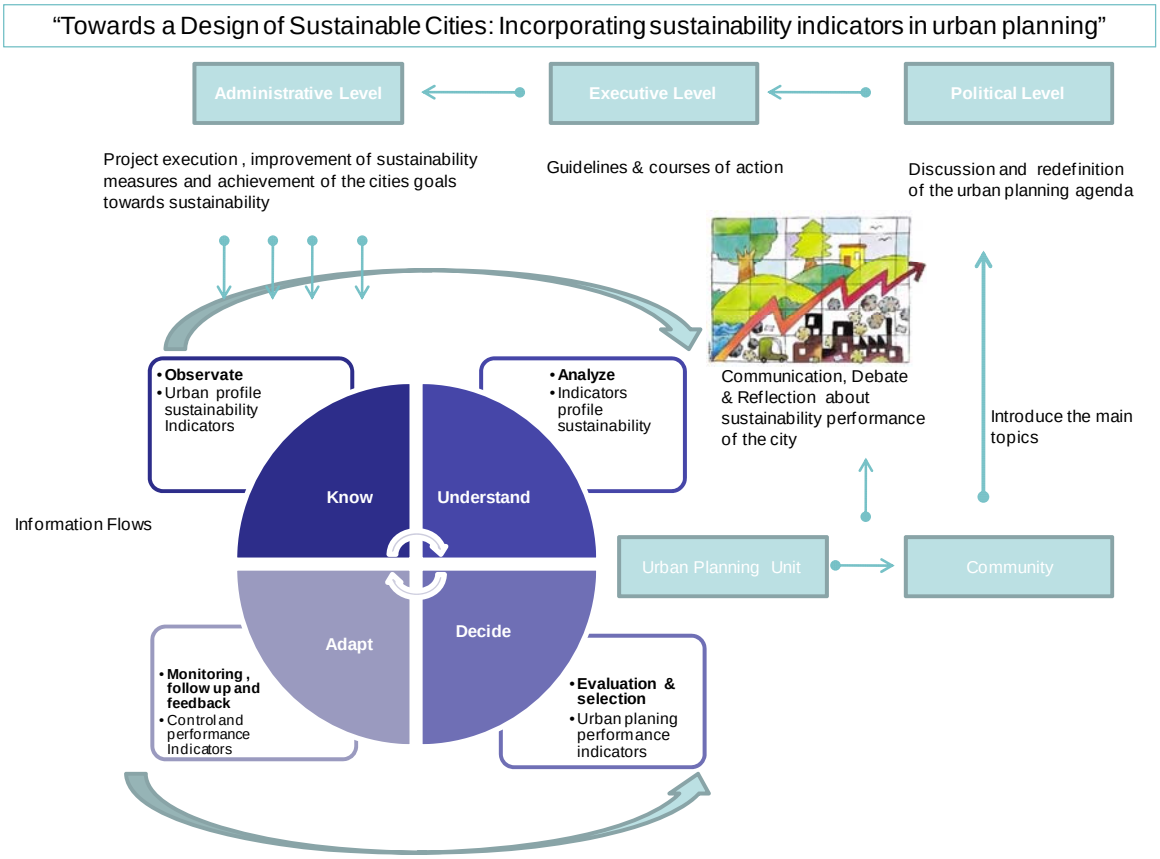


Figure 1.Flow chart on the process to design sustainable cities. Source: Author's elaboration

3.1 Urban Sustainable Indicator System for Planning

The approach proposed in this work is the *Urban Sustainable Indicator System for Planning* and stands for a conceptualization of urban sustainable planning in which land use and urban growth potential patterns are based on managing city demands according to the resources available, in a way that will satisfy the needs of current inhabitants, as well as a future demand, while taking into account the capacity of ecological limits.

Therefore it incorporates the principles of: inclusion, multidisciplinarity and integrality in order to achieve a social, environmental, economical and territorial balance. As a result, the set of urban indicators proposed conform an urban planning sustainable framework. This set is integrated by indicators of process, results, impact, and perception, which will provide the necessary information for envisioning the current and future key elements that will help build a city based on urban sustainability. The resulting *Urban Sustainable Indicator System for Planning* is presented in Figure 2.

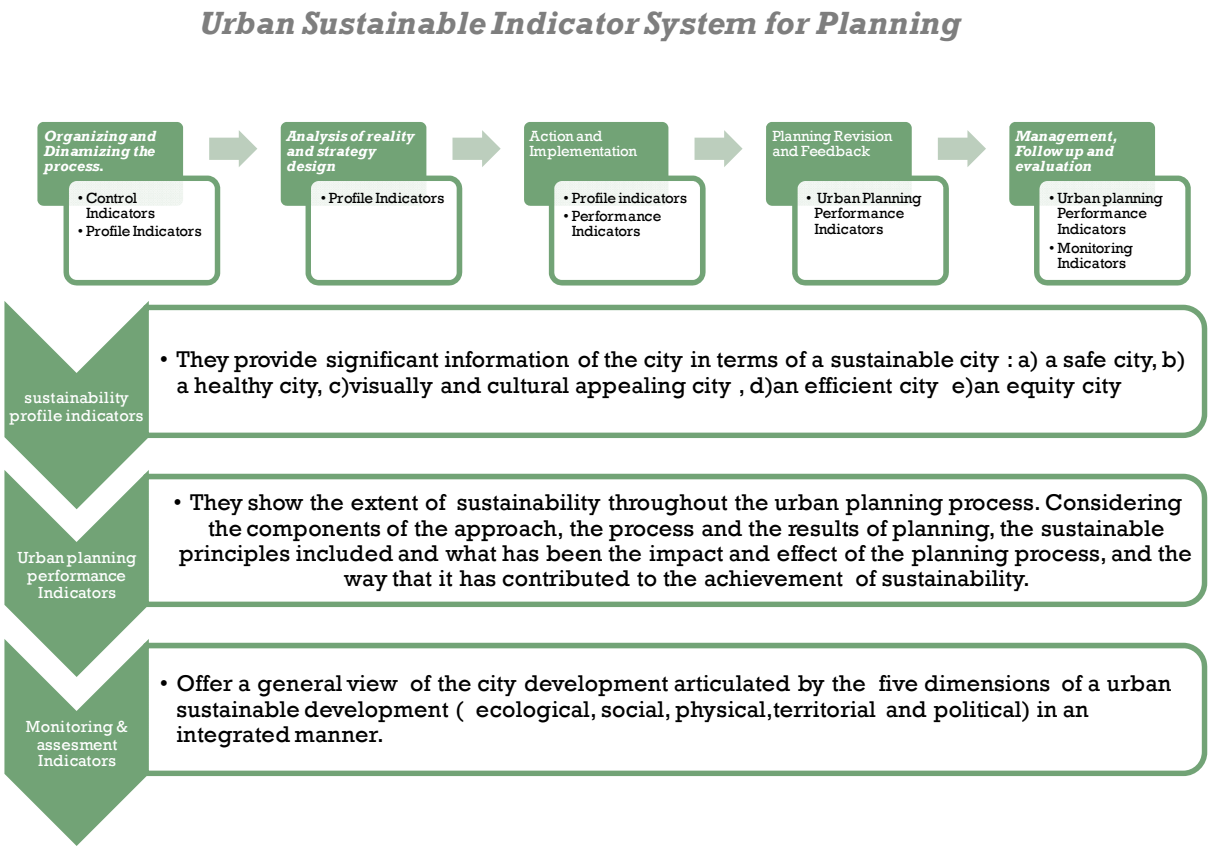


Figure 2.Structure of the set. Source: Author's elaboration

3.2 Categories of analysis

3.2.1. Sustainability profile indicators

Urban sustainability can be understood as the capacity of a city to generate and maintain environmental conditions for an adequate, safe, harmonious habitat, healthy and with a high environment quality that respects natural eco-systems that support it. A place, where the practice of democracy, justice, equity and the interchange of opinions are at the basis of society. [A. Atkinson, 1992] In this sense a city leads to sustainability when it is oriented to the achievement of the following objectives:

- To provide an adequate, safe and healthy habitat,
- To minimize ecologic impact on its territory
- To protect, preserve and rehabilitate its cultural, natural and historic patrimony heritage.
- To promote equity, the necessary cohesion and territorial and social integration.
- To promote the participation of all social agents involved in territorial management
- To provide adequate conditions for human development and a high quality of life for its population.

The definition and objectives above mentioned, can be identified by five general attributes:

a) A safe city; b)A healthy city; c) A visually and cultural appealing city;
d) An efficient and functional city and; e) An equity city.

According to these attributes and objectives, four modules were defined to measure and provide information about the degree of achievement of these goals towards the building of an urban dimension for sustainability.

The *Urban Safety Indicator Module.* Urban security includes a variety of issues going from the satisfaction of primary needs such as health, feeding, education, to the protection against crime as well as the impact of natural and technologic disasters.[UN Habitat, 2007]
The module performs safety in the city context and analyses human safety in cities trough urban vulnerability, land tenure and other urban safety indicators. In addition the module defines the underlying aspects of security safety in cities taking into account urban inequity, poverty and unemployment indicators.

The Urban Healthy Indicator Module. Refers to a city that has a healthy environment and that takes into consideration the environmental impacts of urbanization and urban development patterns, is also one of the characteristics of a sustainable city. *The module* addresses a healthy urban environment and the responsibility of a city with the global environment. It focuses on the OMS health concept that implies the recognition of diverse interactions between physical, behavioral, social and spiritual aspects in the constitution of health.[OMS, 1992]
This broad concept of health translated to a city context refers to the commitment, and the access to activities that allow the social interaction and balanced relationship among development patterns of the city and the environmental carrying capacity. Therefore, this module incorporates indicators related to quality of the urban environment, urban form, urban metabolism, and sustainability of the urban local system.

The Visually and Cultural Appealing City Indicator Module. Another significant matter in the achievement of a sustainable city refers to the spatial quality, because an appealing quality built environment, contributes to collective interaction and favors the social cohesion in cities.[Girardet, 2001]
The evaluation of this characteristic is closely related to the elements that contribute to enhance a harmonious environment and also promotes a better quality of life. This module addresses considerations of habitat and urban space quality through indicators of access to local services, quality of public space, the vitality of the city and urban landscape.

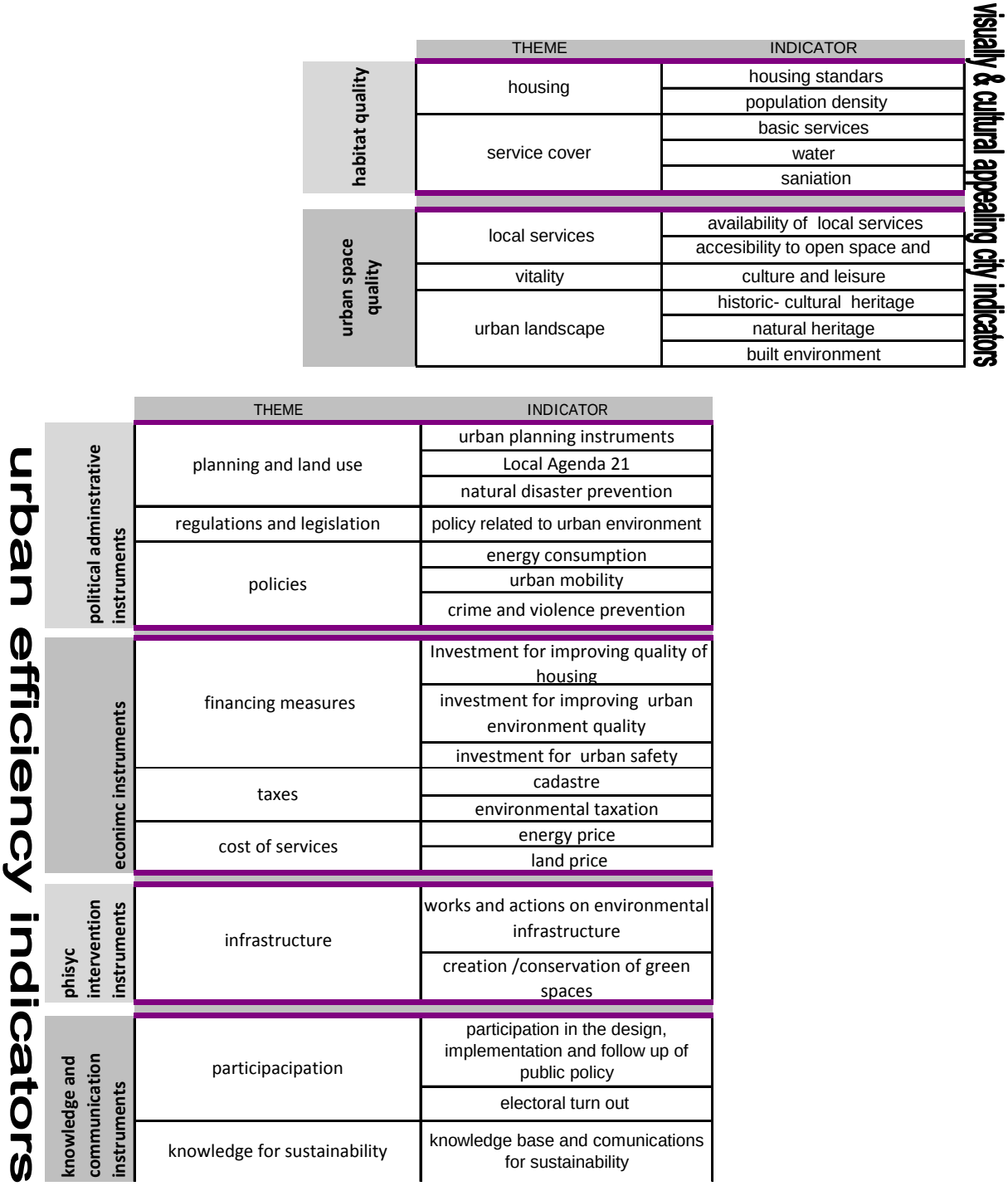
Urban Efficiency Indicator Module. Another approach towards sustainable cities includes an urban development that guarantees the protection of natural, historic, architectural, cultural and artistic heritage. This, implies the proper management and administration of resources on the short, medium and long run, and the implementation of adequate actions in order to solve the cities needs, and promote a quality urban environment.[PNUMA,2007]
The modules performs an analysis of the institutional capacity, providing indicators that reflect the existence and effectiveness of political, economical, financial, socio-cultural instruments for managing and administrating resources.

urban safety indicators

	THEME	INDICATORS
urban vulnerability	natural disaster risk	climate phenomena
		ecosystem
	population located in risk zones	housing standars
		population in informal settelments
land tenure	Tenure	tenure type
		household with secure lan tenure
		right to adecuate housing
		housing Price
		Secure tenure
		land acces
urban safety	security	urban violence
	underliying factors	urban poverty
		employment
		inequity

urban healthy indicators

	THEME	INDICATOR
urban environment quality	quality of the environment	noise level
		water quality
		wild life quality
	public spaces	green spaces
urban structure	urban form	urban area
		compactness of the city
		land use
		density
	urban development patterns	urban development patterns
		evolution of urban areas
		public open spaces
	movility	means of transport
		commuting time
urban metabolism	water	consumption
		sewage water
	energy matrix	energy consumption
		energy production plants
	materials and products	transport of goods
	waste	waste
		final waste disposal
		reciclyng
		waste treatment and disposal
sustainability of the urban local system	selfsufficiency	water selfsufficiency
		energy selfsufficiency
		agruiculture and food
	global/ local impacts	environmental deterioration
		carbon footprint
		water footprint
		environmental foot print
		impact on human health due to environmental deterioration


visually & cultural appealing city indicators
THEME
INDICATOR
habitat quality
housing
housing standars
population density
service cover
basic services
water
saniation
urban space quality
local services
availability of local services
accesibility to open space and
vitality
culture and leisure
urban landscape
historic- cultural heritage
natural heritage
built environment
urban efficiency indicators
THEME
INDICATOR
political adminstrative instruments
planning and land use
urban planning instruments
Local Agenda 21
natural disaster prevention
regulations and legislation
policy related to urban environment
policies
energy consumption
urban mobility
crime and violence prevention
econimc instruments
financing measures
Investment for improving quality of housing
investment for improving urban environment quality
investment for urban safety
taxes
cadastre
environmental taxation
cost of services
energy price
land price
phisyc intervention instruments
infrastructure
works and actions on environmental infrastructure
creation /conservation of green spaces
knowledge and communication instruments
participacipation
participation in the design, implementation and follow up of public policy
electoral turn out
knowledge for sustainability
knowledge base and comunications for sustainability

3.3.2 Urban planning performance indicators

The *urban performance analysis is based on a set* of sustainability indicator values to be included in the planning process. This section is integrated by the following check list-indicators:

Checklist Indicators
PROGRAMMATIC COMPONENTS
✓ Do the programmatic components of the urban planning scope include the sustainability principles of multidisciplinarity, inclusion, and integrality?
✓ Is there a sustainability envision of the city included in master plans and other planning instruments?
✓ Are the principles of multidisciplinarity, inclusion, and integrality built in the Urban Development Plan?
PROGRAMMATIC OBJECTIVES
✓ Are the notions of urban sustainability included as part of the objectives of the Urban Development Plan?
TERRITORIAL STRATEGY
✓ Are the notions of urban sustainability included as part of the territorial strategy?
PROGRAMMATIC EFFECTS
✓ Are the effects, consequences and impacts of urban planning presented in terms of urban sustainability?

3.3.3 The monitor and assessment Indicators.

Finally, the framework introduces a battery to evaluate the performance urban development sustainability is evaluated by a multi-criteria set of synthetic indicators presented in a harmonized way.
The multi-criteria evaluation indicators determine the sustainability of the city performance regarding the environmental, social, economic, territorial, and physical dimension and allows a general view of the sustainable city achievements and the comparison among cities using a Sustainable Evaluation Diagram.

	INDICATOR	COMPONENTS
Ecologic	Ecological footprint	energy consuption+ water concuption + materiales consumption+ green house gases emissions , total population , carrying capacity
Physical	Urban quality of life index	habitat indicators+ social indicators+economic indicators+perception of the city indicators
Social	GINI index	income distribution at urban level
Economic	City Development Index	(infraestructure+ waste+education+health+ city product)/5
Politic	Urban Gobernance Index	participation and civic engagement, transparency and accountability, subsidiarity and rule of law

monitoring indicators

4. Final remarks

The building of a sustainable city starts from the knowledge of certain characteristics of each city and from a deep understanding of the ecological reality; this is only possible if this kind of city is seen as an integrated objective, placed within a wide frame that includes an operational diagnosis which begins by taking into account a variety of elements. These elements comprise the environment, city vulnerability, the certainty of land tenure, safety, the quality of habitat, the metabolism of the city, the level of self sufficiency of the urban environment as well as the local and global impact that the development of the urban pattern and the urbanization process provokes.

As a result this paper sheds a new light on the field of urbanism by pointing out the need to bring sustainable indicators into the process of urban planning. It has also remarked the importance of providing and structuring data, in order to make an adequate decision based on the right information. Furthermore, it provides a methodology that leads to the setting of certain restrictions, as well as to redeploy objectives and actions which have become increasingly important for this complex process.

Thus, the incorporation of sustainable indicators in an urban context needs to be consider as a complement of the planning instruments to foresee the impact of human settlements in the future of development.

All these considerations on the basis of a deep reflection of the city, that does not ignore the interaction of the environment which it belongs to, and which also includes its function as a provider of human habitat.

Throughout this process it is important to remark the incorporation of elements that are not usually considered in traditional urban planning strategies such as the relationship among the urban configuration, the infrastructure and the urban metabolism among others.

Definitely, the use of indicators of sustainability contribute to a better design, proper intervention policies in favor of a sustainable development, and also provides a method to understand the urbanization process, as well as to measure the current level of sustainability in our cities.

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REFERENCES

Atkinson,A. (1992) *"The Urban Bioregion as Sustainable Development Paradigm", Third World Planning Review*, Vol.14, No.4.

Bettini, V. (1998)*Elementos de ecología urbana*, Madrid,Trotta.

Carmona, M. (2003), *Public spaces, the dimention of urban design*, Oxford,Oxford architectural press.

European Commission , (2007), "*Integrated environmental management guidance in relation to the thematic strategy on the Urban environment",* available on http://ec.europa.eu/environment/urban/home_en.htm

Girardet, H. (2001) *Creando ciudades sostenibles*, Valencia,Tilde.

OCDE, (1993), *Environmental Monographs*, *Nº 83:OECD core set of indicators for environmental performance reviews*. OCDE/GD(93)179. Paris: OECD. Available on http://lead.virtualcentre.org/en/dec/toolbox/Refer/gd93179.pdf

OMAU , (2001), Guía de aplicación: sistema Integrado de Indicadores urbanos Observatorio de Medio Ambiente Urbano, available en http:// www.omau-malaga.com

Rees W.,(1992) "Ecological footprints and appropriated carrying capacity: what urban economics leaves out",*Environment and Urbanization* Vol 4, No2.

UN Habitat Programme, (2007) *Global report on human settelments 2007 enhancing urban safety and security,* Nairobi, UN HABITAT,

UN Habitat Programme, Urban Indicators Guidelines, Monitoring the habitat agenda and the Millenium Development Goals, UN HABITAT, available en http://unhabitat.org

United Nations UNCED *,(*1992), *21Program.*

UNU/IAS Report, ,(2003), *Urban Ecosystem Analisys Identifying tools and methods*, United Nations University Institute of advanced studies available en http://www.ias.unu.edu,

Wong, C. (2006) *Indicators for urban and regional planning, the interplay of policy and methods*, New York, Routledge.

World Health Organization/United Nations Programme, (1992) *Towards a new planning process: a guide to reorienting urban planning towards Local Agenda 21*, European Sustainable development and health series:3, World Health Organization,

Indicators were obtained by the revision of different sources such as;

European Environment Agency. "Conceptual Framework: Our Approach"on http://org.eea.eu.int/documents/brochure2002/approach.html
Neighborhood sustainability indicators guidebook, (2000), The Urban Ecology Coalition's Neighborhood Sustainability Indicators Project (UEC-NSIP) on http//:wwwcrcworks.org,
OECD (1993), Environmental Monographs, Nº 83:OECD core set of indicators for environmental performance reviews. OCDE/GD(93)179. Paris: OECD:6 on http://lead.virtualcentre.org/en/dec/toolbox/Refer/gd93179.pdf
Rueda S. (2007), Modelos e Indicadores para ciudades más sostenibles, Taller sobre indicadores de huella y calidad ambiental urbana, Barcelona, Fundación Forum Ambiental,AEMA, y la Generalitá de Catalunya.
Society for Development Studies , Urban indicators, on http://www.sdsindia-urbanindicators.org/ ,
Sustain Lane (2007), City ranking, on http://www.sustainlane.com
Sustainable Seattle, Indicators of sustainable community, (2004) in http//:www.sustainableseattle.org,

UN Habitat Programme, (2007) Global report on human settelments 2007 enhancing urban safety and security, UN HABITAT,
UN Habitat Programme, (2007) Global report on human settelments 2007 enhancing urban safety and security, UN HABITAT,
UN Hábitat Programme, Urban Indicators Guidelines, Monitoring the hábitat agenda and the Millenium Development Goals, UN HABITAT available on http://unhabitat.org,
UN HABITAT-ROLAC, (2008), Derechos seguros al suelo para todos on http://www.onuhabitat.org/index.php?option=com_docman&task=doc_details&gid=8&Itemid=70
UN HABITAT-ROLAC, (2008), Derechos seguros al suelo para todos on http://www.onuhabitat.org/index.php?option=com_docman&task=doc_details&gid=8&Itemid=70
UNEP (2006) Cities Environmental Report On Internet, on http://www.ceroi.net/,
UNEP (2008) Global Environmental Outlook (GEO). Metodología para la elaboración de los informes GEO Ciudades, on http://www.pnuma.org/geociudades/
Vázquez L. (2001),, Indicadores de gestión urbana. Los observatorios urbano territoriales para el desarrollo sostenible. Manizales, Colombia, Serie Medio ambiente y desarrollo, CEPAL, División de medio ambiente y Asentamientos humanos
World Bank(2009), Indicators of urban poverty, available en www.worldbank.org
World Health Organization/United Nations Programme, (1992) Towards a new planning process: a guide to reorienting urban planning towards Local Agenda 21, European Sustainable development and health series:3, World Health Organization,