ECOSYSTEMS´ CLIMATE COMPENSATORY FUNCTION FOR INTELLIGENT LAND USE:

WATER, SANITATION AND HEALTH IN DEVELOPING COUNTRIES

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ABSTRACT

The conventional and traditional classification of "land use" from an univalent anthropic vision, conceive the "land use" as: human beings making use of their environment surface -or failing to do- based on the scientific study of land use scale, which was proposed by Sir (Laurence) Dudley Stamp, professor of geography at Rangoon and London University (1898-1966). (Dudley Stamp, 2004)

This study has been the main conceptual basis on the current classifications, which have complemented the study, but mainly have essentially maintained the anthropocentric approach to Stamp´s classification which was done according to the services that the society can identify; its implied that functional classifications do not incorporate the key relevant environmental dimensions.

Precisely, due to its one-sidedness anthropocentric, it is necessary to broaden the focus toward the conception of intelligent land use which, taking aside the natural essential balance to maintain different ecosystem functions, consider that urban spaces depend on them. Hence, it is necessary to expand the analysis to a two-dimensional view ambivalent approach, towards a "intelligent land use" including ecological criteria, especially related to ***climate balance****, known as “intelligent management urban land use”.*

*This analysis generates indicators that provide extensive parameters needed in planning intelligent urban land use. In the efforts to preserve ecosystem equilibrium, as a main strategy to reach climate change resilience in urban context, this paper contributes with some indicators, especially those related to identify priority conservation areas, areas with specially ecological value and climatic zones balances****.***

Key words: land use; water management, climate balance indicators; development world climate change.

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Resumen

La clasificación convencional y tradicional del "uso de la tierra" de una visión antrópica univalente, concibe el "uso de la tierra" como: los seres humanos que hacen uso de su medio ambiente superficial -o que no lo hacen- basado en el estudio científico de la escala de uso de la tierra Propuesto por Sir (Laurence) Dudley Stamp, profesor de geografía en Rangún y en la Universidad de Londres (1898-1966). (Dudley Stamp, 2004)

Este estudio ha sido la base conceptual principal para la actual clasificación de uso del suelo, que han mantenido esencialmente el enfoque antropocéntrico de la clasificación de Stamp, las mismas que fueron formuladas de acuerdo a los servicios que la sociedad puede identificar; esto implica que las clasificaciones funcionales no incorporan las principales dimensiones ambientales pertinentes.

Precisamente, debido a su unilateralidad antropocéntrica, es necesario amplia el enfoque hacia la concepción inteligente del uso del suelo la cual, aparte del equilibrio natural esencial para mantener diferentes funciones del ecosistema, considera que los espacios urbanos dependen de ellos. Por lo tanto, es necesario ampliar el análisis a una visión bidimensional de enfoque ambivalente, hacia un "uso inteligente del suelo", incluyendo criterios ecológicos, especialmente relacionados con el equilibrio climático, conocido como la "gestión inteligente de uso del suelo urbano".

Este análisis genera indicadores que proporcionan algunos parámetros necesarios para planificar el uso inteligente del suelo urbano. En los esfuerzos por preservar el equilibrio ecosistémico, como estrategia principal para alcanzar la resiliencia al cambio climático en el contexto urbano, este trabajo aporta algunos indicadores, especialmente aquellos relacionados con la identificación de áreas prioritarias de conservación, áreas con valores ecológicos y balance climático.

***Palabras clave**: uso del suelo; gestión del agua, indicadores del equilibrio climático; El cambio climático mundial*.

1. Introduction.

In 1960, approximately 22% developing countries population lives in cities; this percentage increases up to 34% in 1990 and, in 2015 the data reached up to 48%. (World Bank). Actually, in Latin America and the Caribbean approximately 80% of the population live in cities. (ONU-Habitat, 2012).

This accelerated population growth has inspired urbanization raising new challenges, especially with regards to water management, sanitation and land use.

These urbanization processes have been characterized by environment successive transformations due to several impacts and scales that mark the main cities´ characteristics, even more, theses impacts could determine ecosystems "foodprints". (Wackernagel & Rees, 1996)

The current deep footprints in ecosystems are determinate by how they are related and articulated to the use of natural environment as well as the conditions of the city's growth process, including the water demand shift in climate change scenarios, and the expansion of sanitations needs as the main climate change challenges.

Conventional and traditional "land use" parameters from a univalent anthropic point of view, considerer that "land use" as actually human beings make, or -they just stop doing it- is based on the scientific study of land use scale proposed by Sir Laurence Dudley Stamp professor of geography at Rangoon and London University (1898-1966) (Dudley Stamp, 2004), who led the compilation and publication land use survey in Britain (1944), which was disseminated worldwide. This classification was highly considered by the academic field, although it used just few land use´s classifications.

However, this current classifications[2] that have been complemented, essentially have maintained the anthropocentric Stamp´s classification approach, only according to the ecosystems 'services that the society can identify.

The profuse empirical evidence realizes obsolescence land use planning, because of their poor classification based only in anthropocentric point of view. The functional classifications do not take into account the major different environmental dimensions. Traditional and outdated visions of "land use" have been used as planning tools that occasionally serve as soil computers, based on socio-economic needs (Stainer, 2011)

[2] For example, The SNA asset classification distinguishes four types of land for collection of data on land in physical unit and in monetary value according to the services it is providing: • Land underlying buildings and structures • Land under cultivation • Recreational land and associated surface water • Other land and associated surface water. (Andreson, Hardy, Roach, & Witmer, 1976, pág. 2)

Due to its one-sidedness anthropocentric point of view, the conception of land use taking aside the natural essential balance, is not enough to preserve numerous ecosystem functions. It is the main weak of present land planning process.

2. Theoretical framework

Due to the efforts to preserve ecosystem equilibrium, as a main strategy to reach climate change resilience in urban context, in many countries have been defined **priority conservation areas.** Even more, due to the lengthy scarce habitat areas for species in urban systems, Polani, Merril and Chapman consider two untested approaches way to prioritizing conservation areas, which ones involve identification of “umbrella-species” and selection of large blocks of remaining natural vegetation. (Polani & Merril,M&Chapman,K., 2001).

The biodiversity´s extent and distribution are another criterion to know how accelerated and irreversible losses are occurring in an ecosystem. Using a geographic information system and spatially explicit modeling, it is possible to known land-cover and land-use patterns, like Menon et al., applied this modeling in northeast India (Menon, Gil, Rose, & Khan, 2001).

These approaches to define priority conservation areas include identification of hotspots of biodiversity. Those are only some, among many methods that could by applying to identify urban priority conservation areas. (Alcoforado & Matzaraquis, 2010)

Unprotected natural areas close to the cities, are the most susceptible to land-use change by virtue of their geophysical and socioeconomic characteristics. Those areas can be ranked as the highest-priority of conservation, because they are most likely to be absorbed by the urban sprawl.

Spector Sacha (Spector, 2002) consider that is a great strategy to achieve significant conservation areas by biogeographic crossroads, to identify areas of high species richness and beta diversity. These authors apply these conservation areas criteria in Bolivia (2001).

Biogeographic crossroads appear to be the best method to identify areas of high conservation priority in both, the short and long term, and this, according to Spector, requires increased attention in the process of setting conservation priorities to avoid being absorbed by urban sprawl.

Moreover, it is essential submitted the boundaries of the urban **areas with special ecological values**. The boundaries must be incorporated into the integral management cities plan. In addition to proposals for boundaries, it is important to identify the cities activities and their impact in natural services. (Lindeboom, Gurts van Kessel, & Berkenbosch, 2005). In traditional “land use plans”, the activities are not related to their ecological impacts, those plans just consider the increasing cities´ needs, and only tangentially consider the ecosystems ‘needs, where the cities are planted, even more so, in some cases it is not known.

As a reference, Germany has estimated the urban sprawl impact on areas with special fragile ecological values (Lindeboom, Gurts van Kessel, & Berkenbosch, 2005, pág. 68) and in order to protecting them. Ecosystem´s characteristics play an important role in the final description of the type of city and length area to stablished.

In the case of water, as resource with special ecological value, "*the future adequacy of freshwater resources is difficult to assess, owing to a complex and rapidly changing geography of water supply and use. Climate models outputs, water budgets, and socioeconomic information demonstrate that: (i) a large proportion of the world is currently experiencing water stress and (ii) rising water demands greatly outweigh greenhouse warming in defining the state of global water system to 2025*." (Vörösmarty, Green, Salysburry, & Lammers, 2000, pág. 284)

Furthermore, Alcoforado et al., identify the main climatic variations induced by settlements, and also they present the relevance of urban planning climate information. They emphasize appropriate measures for what they call "*planning and building with the climate"*. They consider that the "land use planning" could present significant disturbance according to the recently registered climatic changes, as well as the associated effects, such as urban radiation and energy imbalances, heat island, wind conditions, and air pollution. These authors identify some basic indicators in urban planning considering climate change. (Alcoforado & Matzaraquis, 2010)

"…*urbanized areas modify different aspects of climate, from radiation and temperature (the best documented example of human-induced climate change, Oke, 1987), to humidity, precipitation, wind, air quality, among others*…". (Alcoforado & Matzaraquis, 2010, pág. 6)

Related to these phenomena, and depending on the cities 'characteristics ', temperature increases in urban areas with densely built. This could be generated double impacts due to absence of green spaces, materials building, presence of gaseous and / or absence of ventilation areas. The combination of these factors leads to the so-called heat islands (heat buildup in cities by the immense mass of concrete and other absorbent materials heat), and additionally with the difficulty of heat dissipation during nighttime hours, increases significant rises of cities 'temperatures. This phenomenon of heat island is potentiated due to the size of the city and it is directly proportional to the size of the urban sprawl. (Alonso & Labajo J. L&Fidalgo, 2003)

On the other hand, according to Ruberto & Depettris, et al., the waterproofing that affect the runoff conditions caused impacts like: (i) reduction of the annual average of evapotranspiration and consequent changes in the water amount circulating in the basin, also affecting frequency and volume precipitations; and, frequencies and rates loading and unloading (ii) watershed delay due to the water circulates by surfaces less rough acquiring higher runoff velocity; (iii) the basin becomes more sensitive to intense short-term storms.

(Ruberto, Depettris, Prieto, Gbazza, & Zárate, 2006). These are also some parameters to estimate de ***climatic zones balances.***

Thus, the presence of heat islands and urban waterproofing in large and medium cities, define the relevant to identify airing areas, large areas of free waterproof surface, and **free decongestion spaces**, satisfying the "**compensatory climate function**" and contributing to climate balance in cities.

3. The ambivalent and two dimensional "land use" planning parameters.

It is necessary expect an extended dimension of the approach, in order to develop the two-dimensional point of view together with the ambivalent outlook, towards a "sustainable/intelligent land use" including ecological criteria, especially those related to water provision, and climate balance.

The intelligent design management of urban land use, from this ambivalent and two-dimensional point of view, bases its analysis on three groups of parameters: (i) fragile areas of great value, (ii) conservation priority areas (water sources, ecosystems, forest areas, others), and, (iii) decongestion free spaces and climatic zones balances. Based on this analysis several indicators provide information on planning sustainable / intelligent urban land use.

This analysis, based on a system of parameters/indicators, is the best way to study the evolution of socioeconomic, environmental and territorial interactions ever time to assess the sustainable trend, or not, of urban dynamics in climate change context.

These parameters information could help decision makers to monitor and to evaluate the status and possible changes in the "*fragile areas of conservation*", "*conservation priority areas*", and "*decongestion free spaces, and climatic zones balances*". These indicators allow observing the fate and evolution of these three areas, over time, as the main indicators of balance to deal with the impact of climate change and main adaptation measures.

These parameters also could communicate specific information about progress status of these three main areas. Indirectly, these parameters evidence the programs efficiency and policies designed to achieve the ultimate objective: conservation of ecosystem balances as the main adaptation to climate change.

The selection of ambivalent and two dimensional land use planning parameters, allow to structure and to integrate very diverse and dispersed information coming from several sources. The integration of the data will help to reveal the main associated problems and its synergistic effects in imbalances ecosystems and in its compensatory climate function.

The next chart N° 1 presents the principal parameters, among many possible, to land use planning in climate change context.

Chart N° 1

Ambivalent and two dimensional land use planning parameters.			
Ecosystems compensatory climate function area. (variable)	**Indicator**	**Parameter**	**Compute**
Fragile areas of great value	Endangered species habitat.	.Natural habitat in urban area (%) . Urban boundaries evolution. (Urban Sprawl Expansion).	$\frac{original\ habitat\ area (há)}{Invasive\ urban\ area}$
	Green patches [3]	. % Aquifers in protected area status. . % Interconnected drainage aquifers networks under runoff control [4]. . % Escape zones for species in urban area. .Natural shelters and biodiversity thresholds density in reference to total urban area.	$\frac{protected\ aquiferes}{total\ aquiferes}$ $\frac{Interconnected\ drainage\ aquifers\ networ\ under\ runoff\ control}{total\ de\ aquifers}$ $\frac{number\ of\ shelters\ and\ biodiversity}{total\ urban\ area}$
	Natural corridors inside the city [5]	. Density of human made structures. . Natural shelters and steps for interconnection with natural corridors.	$\frac{number\ of\ human\ made\ shelters\ and\ inte}{number\ of\ corridors}$
Conservation priority areas	Clean air and water Production.[6]	.Water volume generated in natural ecosystems within the urban area. % Recycled water. Reuse index (SDIA/Q)[1], Ratio of aggregate upstream water use relative to discharge.	$\frac{water\ volume\ generated\ in\ whithin\ the\ ur}{urbana\ area}$ $\frac{recycled\ water\ volume}{total\ sewage\ water\ generated}$ *SDIA/Q*
	Affected ecological areas. Interaction humans with sustainable water supply and local stress degree.	Index of water stress[2]: [Domestic and industrial sectors (DI/Q), irrigated agriculture (A/Q), and their combination (DIA/Q) on a mean annual basis].	$\frac{water\ withdrawal\ or\ water\ use\ to\ dischar}{runoff, accumulated\ as\ river\ discharge}$

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[3] The probability of extinction of local species is higher in isolated patches, depending on the distance and the resistance of the array between patches. Patches located nearby of others or, of natural areas, have greater probability of being colonized than patches isolated. (Romero, Toledo, & Ordoñez, 2001)

[4] The urban growth registered in the last years cause a greater superficial runoff due to the increase of watersheds impermeability, indeed, that could exceed the capacity of conduits drainage and generate temporary urban floods during the rain, or immediately after. These drainage ducts are actually dimensioned for a surface runoff defined by urbanization, although not necessarily thought in its expansion according to the population growth.

[5] The green areas include associated environmental services.

[6] For almost all cities such information does not exist or it is reduced to sporadic air or water quality observations.

	Endemic forest areas conservation.	.% Forest endemic area.	$\frac{endemic\ forest\ area}{total\ urbana\ area}$
Decongestion free spaces and climatic zones balances.	Atmospheric pollution Sewage treatment.	Air pollutants levels allowed. % of sewage treatment.	$pollution\ level$ $\frac{Volume\ of\ purified\ water}{total\ sewage}$
	Noise reduction and polluting sources insulation.	Noise level allowed.	*Noise level variation over time.*
	Waterproof surface	Waterproof surfaces percentage in urban areas.	$\frac{impermeables\ surfaces\ area}{Total\ urban\ area.}$
	Density built urban areas (Large areas with absence of green spaces). Ventilation areas	Built urban areas density allowed. Gaseous and pollutants levels allowed. Ventilation areas extension, Number of heat islands/ km^2	

1: This water reuse index (defined as the ratio of aggregate upstream water use relative to discharge) was constructed by Charles J. Vörösmarty *et,al.* (Vörösmarty, Green, Salysburry, & Lammers, 2000, pág. 284).
2: This ratio was constructed by Charles J. Vörösmarty *et,al.* (Vörösmarty, Green, Salysburry, & Lammers, 2000, pág. 284).
Source: (Stainer, 2011) (Romero, Toledo, & Ordoñez, 2001) (Wackernagel & Rees, 1996)
Elaboration: The Author .

Related to **fragile areas of great value**, regarding the number of patches, their reduction or loss, implies beyond of environmental services net loss, a decrease of these habitats´ populations and with them, biological diversity lost, decolonization capacity, population stability lost, and increasing the extinction risks. The maintenance of two large patches is the minimum requirement to maintain the biological richness of the landscape representative species. (Romero, Toledo, & Ordoñez, 2001).

Selection of conservation patches should be based on their contribution to the total system and the distinctive species´ features: rarity, threatened or endemic.

Conservation priority areas, including scenic areas with economic value identified, water sources, wooded areas, wetland areas, biological corridors, conserved ecosystems and so on. Integrated and preventive protection of these priority areas, which the cities depends on, constitutes the fundamental exes in plans and projects that aim to reduce the negative impact that the cities' dynamics generates.

Regarding to "**decongestion free spaces, and climatic zones balances**", while climate change affects differently to the distinct world´s regions; the origin of the changes is the same: an alteration in the composition of air which affects regulation temperature on the Earth. This change directly influences the strength and direction of the winds and in the process of evaporation and condensation of water, with a direct impact on the cycles of rain.

4. **Conclusion**.

It is necessary to analyze processes and strategies to manage urban land efficiently from both the ambivalent and multidimensional relationship, which approach achieves a strong impact on urban design, as well as spatial distribution of urban natural environment; consequently, local management policies must incorporate three group of parameters in three dimension in order to reduce the climate change urbanization effects: **fragile areas of great value**; c**onservation priority areas, and *decongestion free spaces and climatic zones balances.***

Each group of parameters allow observing the fate and evolution of these three areas over the time, as the main balance indicators to deal with the impact of climate change and improve ecosystem preservation as main measures of adaptation.

Only from this ambivalent and two-dimensional land use planning point of view, is possible to build resilience as the main strategy to deal with the present global changes related to climate change. This is the smart land use.

Some parameter in this context are formulate by Biology, Geography, Ecology point of view, and that is the great input in order to get total, thorough whole land use planning.

These group of parameters analyzed -the list is not exhaustive-, based on a system of indicators, is the best way to inquire the evolution of socioeconomic, environmental and territorial interactions, ever time to assess the sustainable trend, or not, of urban dynamics in the context of climate change.

Bibliography

Alcoforado, M., & Matzaraquis, A. (2010). Planning with urban climate in differet climatic zones. *GEOGRAPHICALIA, 57*, 5-36.

Alonso, M. S., & Labajo J. L&Fidalgo, M. (2003). *Characteristics of the urban heat island in the city of Salamanca, Spain.* Recuperado el 16 de 11 de 2016, de Scielo: http://www.scielo.org.mx/scielo.php?script=sci_arttext&pid=S0187-62362003000300001

Andreson, J., Hardy, E., Roach, J., & Witmer, R. (1976). *A land use and land cover classsification system for use with remote sensor data.* Washignton: United Sates Goverment Printing Office.

Dudley Stamp, L. (April de 2004). *Questia trusted online research.* Recuperado el 10 de 11 de 2016, de https://www.questia.com/read/1G1-115226006/sir-lawrence-dudley-stamp-1898-1966-the-chief-architect

Lindeboom, H., Gurts van Kessel, J., & Berkenbosch, L. (2005). *Areas with special ecological values on the Dutch continental sehel.* RIKZ / ALTERRA. Duchland: Ministerie van Verkeer en Vaterstaat.

Menon, S., Gil, R., Rose, J., & Khan, J. (8 de April de 2001). Identifying Conservation-Priority Areas in the Tropics: a Land-Use Change Modeling Approach. *Conservation Biology*, 501-512.

ONU-Habitat, N. U. (2012). *Estado de las Ciudades de América Ltina 2012.* Brasil: Pograma de las Nacines Unidas para los Asentamientos Humanos.

Orbea, T. (. (2014). CRECIMIENTO SOSTENIBLE DE LAS CIUDADES. XVI CONFERENCIA IBEROAMERICANA DE MINISTROS DE ADMINISTRACIÓN PÚBLICA Y REFORMA DEL ESTADO., (págs. 75-98). México.

Polani, K., & Merril,M&Chapman,K. (2001). Identifying Conservation-Priority Areas in a Fragmented Minnesota Landscape Based on the Umbrella Species Concept and Selection of Large Patches of Natural vegetation. *Conservation Biology*, 513-522.

Romero, H., Toledo, X., & Ordoñez, F. (2001). Ecología Urbana y Gestión Ambiental Sustentable de las Ciudades Intermedias Chilenas. *Ambiente y Desarrollo, VOL XVII* (Nº4), 45-51.

Ruberto, A., Depettris, C., Prieto, J., Gbazza, S., & Zárate, M. (2006). Impacto hidrológico por incremento de las áreas impermeables en cuencas urbanas.Subcuenca Cisterna, Resistencia, Chaco. *C omu n i c a c i o n e s C i e n t í f i c a s y T e c n o l ó g i c a s*, 1-4.

Spector, S. (2002). Biogeographic Crossroads as Priority Areas for conservation. *Conservation Biology, 16*(6), 1480-1487.

Stainer, F. (2011). Landscape ecological urbanism. (r. s. Weele, & T. Beatley, Edits.) *ELSEVIER*, 190-247.

Vörösmarty, C., Green, P., Salysburry, J., & Lammers, R. (14 de July de 2000). Global Water Resources: Vulnerability from Climate Change and Population Growth. *Science, 289*, 284-288.

Wackernagel, M., & Rees, W. (1996). *Nuestra Huella Ecologica.* Santiago de Chile: New Society Publisher.

Wikipedia. (s.f.). *The free Enciclopedia*. Recuperado el 10 de 08 de 2016, de https://en.wikipedia.org/wiki/Dudley_Stamp

World Bank . (s.f.). *Tasa de cercimiento poblacional*. (W. B. Group, Editor) Recuperado el 10 de 8 de 2016, de http://www.worldbank.org/depweb/spanish/modules/social/pgr/index03.html