










Combining ecological knowledge with Brazilian urban zoning planning

Combinando conhecimento ecológico ao planejamento do zoneamento urbano brasileiro

Tércio da Silva Melo^[a,b,c] , João Vitor Lino Mota^[a,d] , Nathália Diniz Bastos e Silveira^[a,b] ,
Alessandra Rodrigues Santos de Andrade^[b,c] , Marcelo Cesar Lima Peres^[b] ,
Magno Lima Travassos de Oliveira^[a,b,c] , Jacques Hubert Charles Delabie^[b,c] 

^[a] Universidade Federal da Bahia (UFBA), Programa de Pós-graduação em Ecologia, Salvador, BA, Brasil

^[b] Universidade Católica do Salvador (UCSal), Centro de Ecologia e Conservação Animal, Salvador, BA, Brasil

^[c] Laboratório de Mirmecologia, Convênio Universidade Estadual de Santa Cruz/Comissão Executiva do Plano da Lavoura Cacaueira (UESC/CEPLAC), Itabuna, BA, Brasil

^[d] Biocore Tecnologia e Soluções Ambientais, Salvador, BA, Brasil

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Abstract

Politicians and environmental professionals have pointed to the lack of scientific knowledge to support legislation for planning urban centers. Thus, this essay aims to provide ecological knowledge to assist politicians and environmental professionals in decision making regarding the Brazilian urban zoning. As a science, ecology provides the necessary knowledge to assist the creation of guidelines and standards for urban zoning. Specifically, landscape ecology shows different methods of work, which have as parameters the qualification and quantification of urban environments. These parameters can be used as criteria for planning sustainable cities. The field of urban ecology has demonstrated the importance of conserving green and blue areas (water bodies) in cities, as well as the need for the formation of multidisciplinary teams for urban management and elaboration of public policies pointed to zoning sustainability strategies. Generally, ecology show contributions that assist in the creation of guidelines and norms for Brazilian urban zoning. The suggestions provided through this essay are a starting point for improving the formulation of laws designed to develop and strengthen the legislation on Brazilian urban zoning.

Keywords: Environmental zoning. Environmental management. Urban planning. Landscape ecology. Urban ecology.

Resumo

Políticos e profissionais de meio ambiente têm apontado para a ausência de conhecimento científico para embasamento da legislação que dispõe sobre o planejamento urbano. Assim, o intuito desse ensaio é

TSM is master in Ecology and Biomonitoring, e-mail: terciosilvamelohotmail.com

JVLM is master in Ecology and Biomonitoring, e-mail: joaovitmota@yahoo.com.br

NDBS is master in Ecology and Biomonitoring, e-mail: nathydinizbio@gmail.com

ARSA is doctor in Ecology, e-mail: alessandrabiologia@hotmail.com

MCLP is doctor in Ecology, e-mail: marcelo.peres@pro.ucs.br

MLTO is master in Ecology and Biomonitoring, e-mail: magnotravassos@gmail.com

JHCD is doctor in Entomology, e-mail: jacques.delabie@gmail.com

disponibilizar conhecimento ecológico para auxiliar políticos e profissionais de meio ambiente na tomada de decisões relacionadas ao zoneamento urbano do Brasil. Como ciência, a ecologia disponibiliza o conhecimento necessário para auxiliar a criação de diretrizes e normas para o zoneamento urbano. Especificamente, a ecologia de paisagem aponta diferentes métodos de trabalho, que possuem parâmetros de qualificação e quantificação do ambiente urbano. Esses parâmetros podem ser utilizados como critérios para o planejamento de cidades sustentáveis. Já a ecologia urbana tem demonstrado a importância da conservação de áreas verdes e azuis (corpos de água) nas cidades, além da necessidade da formação de equipes transdisciplinares para uma gestão urbana e elaboração de políticas públicas que visem a estratégia de zoneamento sustentável. De modo geral, a ciência da ecologia demonstra contribuições que auxiliam na criação de diretrizes e normas para o zoneamento urbano brasileiro. As sugestões fornecidas através desse ensaio constituem um ponto de partida para a formulação de melhorias nas leis destinadas a desenvolver e fortalecer a legislação relativa ao zoneamento urbano brasileiro.

Palavras-chave: Zoneamento ambiental. Gestão ambiental. Planejamento urbano. Ecologia de paisagem. Ecologia urbana.

Introduction

The Ecological-Economic Zoning (EEZ) is one of the main environmental planning tools in Brazil (Brasil, 2012a). The EEZ directs territorial planning, supporting social and economic development without abandoning environmental issues related to sustainability (Santos & Ranieri, 2013). Although the EEZ aims to inform personal and companies' activities from public or private sectors, when it comes to the question of state or municipality management, politicians and environmental managers neglect this important environmental instrument (Rech, 2013; Santos & Ranieri, 2013).

The lack of interest to fulfill the EEZ is due to numerous and different normative regulations linked to it (Rech, 2013; Santos & Ranieri, 2013); mainly municipal laws (known as Master Plans), which are often not consistent in terms of the zoning of cities. Although the EEZ has been regulated by federal law, it is known that urban land planning is carried out locally, that is, by municipal applicability (Souza, 2013). As a result, municipal laws related to urban zoning are often not complementary to federal legislation, and can create ineffective legislation curbing the planning and management of urban zoning (Rech, 2013). The inefficiency of current public policies related to zoning allows economic and social interests that are not always compatible with environmental conservation to have greater decision-making power, causing severe damage to it (Leonelli & Campos, 2018; Rech, 2013).

Another factor related to a deficiency of the urban zoning in producing legislation beneficial to environmental conservation is the lack of scientific basis during the development of the guidelines and norms for Brazilian urban planning (Rech, 2013; Souza, 2013). In addition to supporting decision making related to zoning, scientific knowledge can assist in planning and management processes of Brazilian land occupation (Rech, 2013). Since urban zoning management is linked to the law, it is impracticable to conserve natural environment in cities without guidelines and norms (Rech, 2013). Thus, the acquisition of scientific knowledge can assist politicians in the drafting of legislation on urban zoning. In this context, ecological knowledge is essential when planning a sustainable city, through a structure of knowledge transmission that allows the integration of scientific, technical and cultural information (Leitão & Ahern, 2002). So, ecology can provide knowledge that will help the creation of guidelines and norms for a sustainable Brazilian urban zoning. Thus, this essay aims to suggest an ecological approach as a tool for public policies and planning of urban zoning in Brazil, helping decision makers and environmental professionals to make their choices about land planning of cities.

Public policies related to EEZ

In 1981, the fulfillment of environmental zoning was required by the Federal Law nº 6.938 (establishing the Política Nacional do Meio Ambiente – National Environment Policy), and at that time, the EEZ was primarily instituted as a Brazilian land planning tool (Brasil, 1981). In 2001, supported by Federal Law nº 10.257 (City Statute), environmental zoning was once more established as an instrument of territorial organization, but focusing on urban environments (Brasil, 2001). It was also in the City Statute that Brazilian cities became obligated to promote municipal laws to reinforce environmental zoning, known as the Master Plan (Brasil, 2001). The Law nº 10.257 also established an obligation to carry out Environmental Impact Studies as an instrument of urban planning (Brasil, 2001). In 2002 the Federal Decree nº 4.297 established the obligation of the EEZ to divide the land into zones of importance for environmental conservation, such as: (1) potential sites for ecosystem services provision and natural resources; (2) environments sensitive to biodiversity loss, soil and water resources; (3) Ecological Corridors and (4) Conservation Units (Brasil, 2002). Lastly, only in 2007 through Federal Decree nº 6.288, the scales of the EEZ at national, macro-regional, state and local levels were defined (Brasil, 2007). Despite the existence of these four federal laws, none of them established norms to regulate urban zoning in Brazilian cities, and guarantee environmental conservation or guidelines allowing the comparison of urban occupation between cities. This regulation flaw at federal level makes it difficult to develop sustainable urban zoning in Brazil.

From the environmental point of view, the creation of the four federal laws was positive, giving visibility to urban environmental issues (Brasil, 1981, 2001, 2002, 2007), but unfortunately there were no effective actions to protect the green areas in cities (Haddad, 2015; Huang et al., 2018; Leonelli & Campos, 2018; Figueiroa & Scherer, 2016). Nowadays, the inefficiency of federal laws in establishing norms for urban zoning is easily perceived by analyzing the Brazilian capitals Master Plans (Table 1). These plans lack standards for city zones classification, either because they do not define the scale at which zoning was planned, or do not adequately determine the environmental criteria for zone division, as proposed by federal laws (Brasil, 2002, 2007). Following this perspective of lack of minimum standardization in the zoning of Brazilian cities, it is important to highlight that Brazil is divided into three levels of government: federal, state and municipal, and there are conflicts of interest between them. Federal, state and federal laws have priority over state and local laws due to rules set by the constitution. That is, municipal laws cannot contradict state and federal regulations, nor can state laws counter federal laws. The problem is that federal laws related to urban zoning have indicative characteristics (Paiva, 2019) instead of normative, hampering the defense of environmental interests. This scenario makes the laws fragile in relation to urban territorial planning (both in regulatory quality and policy stability), which makes Brazil internationally classified as a country with a high risk of environmental losses due to urban growth (Huang et al., 2018). In this context, since federal public policies on environmental zoning established normative criteria, imposing changes in state and local laws, it is expected an improvement in the sustainable development of cities.

Table 1 - List of Master Plans of Brazilian capitals

State	Capital	Master Plans	Author and Year
Acre	Rio Branco	Lei nº 1.611 de 2006	Rio Branco (2006)
Alagoas	Maceió	Lei nº 5.486 de 2005	Maceió (2005)
Amapá	Macapá	Lei complementar nº 26 de 2004	Macapá (2004)
Amazonas	Manaus	Lei complementar nº 2 de 2014	Manaus (2014)
Bahia	Salvador	Lei nº 9.069 de 2016	Salvador (2016)
Ceará	Fortaleza	Lei complementar nº 62 de 2009	Fortaleza (2009)
Distrito Federal	Brasília	Lei complementar nº 803 de 2009	Brasília (2009)
Espírito Santo	Vitória	Lei 9.271 de 2018	Vitória (2018)
Goiás	Goiânia	Lei complementar nº 171 de 2007	Goiânia (2007)
Maranhão	São Luís	Lei nº 4.669 de 2006	São Luís (2006)
Mato Grosso	Cuiabá	Lei complementar nº 150 de 2007	Cuiabá (2007)
Mato Grosso do Sul	Campo Grande	Lei complementar nº 94 de 2006	Campo Grande (2006)

Table 1 – Continued...

State	Capital	Master Plans	Author and Year
Minas Gerais	Belo Horizonte	Lei nº 11.181 de 2019	Belo Horizonte (2019)
Pará	Belém	Lei nº 8.655 de 2008	Belém (2008)
Paraíba	João Pessoa	Lei complementar nº 3 de 1992	João Pessoa (1992)
Paraná	Curitiba	Lei nº 14.771 de 2015	Curitiba (2015)
Pernambuco	Recife	Lei nº 17.511 de 2008	Recife (2008)
Piauí	Teresina	Lei nº 3.558 de 2006	Teresina (2006)
Rio de Janeiro	Rio de Janeiro	Lei complementar nº 111 de 2011	Rio de Janeiro (2011)
Rio Grande do Norte	Natal	Lei complementar nº 82 de 2007	Natal, 2007
Rio Grande do Sul	Porto Alegre	Lei complementar nº 434 de 1999	Porto Alegre (1999)
Rondônia	Porto Velho	Lei complementar nº 311 de 2008	Porto Velho (2008)
Roraima	Boa Vista	Lei complementar nº 924 de 2006	Boa Vista (2006)
Santa Catarina	Florianópolis	Lei complementar nº 482 de 2014	Florianópolis (2014)
São Paulo	São Paulo	Lei nº 16.050 de 2014	São Paulo (2014)
Sergipe	Aracaju	Lei complementar nº 42 de 2000	Aracaju (2000)
Tocantins	Palmas	Lei complementar nº 400 2018	Palmas (2007)

Source: Authors.

Brazilian and international urban zoning

In Brazil, urban land occupation planning is performed by the Master Plan, which foresees zoning (Santos, 2018). However, due to City Statute not predicting environmental analysis in urban territory (Souza, 2013), proposals available in Master Plans are legislative speeches, which are not effectively applied in practice (Santos, 2018). Quantitatively, many Master Plans incorporate zoning, but qualitatively this tool incorporation (zoning) was performed disjointed of the law, not considering the municipality capability to manage territorial planning (Santos, 2018). Despite the time that laws were created to plan the growth of cities at different levels of government (federal, state and municipal), Brazilian legislation is considered of low quality in regard to urban zoning (Huang et al., 2018). Few recent studies evaluate the relationship between urban zoning and environment (Barbosa & Carvalho, 2010; Nakano & Guastella, 2015). These studies tackled qualitative analysis of laws relationships and effectiveness for the environment, without quantitative evaluative metrics. Currently, there are reports of law violation (Master Plans) that aimed to protect the environment, such as: non-preservation of Permanent Preservation Areas (APP) (Ataide & Melo, 2019; Koury & Cavallari, 2018; Nunes et al., 2017), Conservation Units (UC) (Ataide & Melo, 2019), and areas for calamity prevention (Figueiroa & Scherer, 2016); as well as lack of integrated management between municipal and state interests (Master Plans vs River Basin Plans) (Peres & Silva, 2013). However, there is also positive elements since the municipality of Teresina, capital of the state of Piauí, anticipates in its planning the promotion of economic growth associated to ecological awareness (e.g. concern with waste management and green areas, river conservation, environmental zoning, urban drainage and sanitation sewage) (Nascimento & Gomes, 2018). In Rio Claro, municipality of the state of São Paulo, the use of urban hydrography as spatial scale of zoning unit was tested, predicting environmental impacts (Barbosa & Carvalho, 2010). Similar applications were made in other municipalities in the state of São Paulo, despite the inefficiency of Master Plans in zone cities, where there is an integration between the executive (managers) and legislative (politicians) powers, discussing points of improvements in the urban zoning during the revision of the plans (Santos & Ranieri, 2013).

Besides Master Plans, other legal instruments are used to assist land use planning in Brazilian cities, as the Watershed Plan, Integrative Coastal Management Plan, and local Agenda 21. Just as Master Plans, Watershed Plans and Integrative Coastal Management Plans diverge from legislation in different government levels, in addition of execution and management difficulties (Gomes-Junior, 2014; Malheiros et al., 2013; Oliveira & Nicolodi, 2012; Porto & Porto, 2008). Nevertheless, the elaboration of these documents has shown an integrative advance between society and government during its elaboration (Gomes-Junior, 2014; Malheiros et al., 2013; Oliveira & Nicolodi, 2012; Porto & Porto, 2008). Evaluations

carried out related to local Agenda 21 have demonstrated the potential of this tool to implement the Master Plans and strengthen environmental policies at the municipal level (Brasil, 2011).

Even in other countries, with better regulatory policies related to land use planning (Huang et al., 2018), there is a lack of standards among municipalities, which also influences zoning quality (Gurran et al., 2015). As in Brazil, other countries have urban zoning as a planning tool in which cities are divided into geographic zones according to land size and use, avoiding land use incompatibility. However, unlike Brazil, in these countries (e.g. United States, Mexico, New Zealand and Uruguay), urban zoning is implanted and executed, ensuring proper land use and environmental protection (Delion et al., 2015; Huang et al., 2018). Yet, these countries are dedicated to the conservation of natural environments; provide investments on these areas' rehabilitation/regeneration, also promoting ecological connection increase (Attwell, 2000; Clarkson & Kirby, 2016; Romero et al., 2001; Li et al., 2005). Thus, as important as generating more normative federal laws, is the fact that, at the municipal level, the Master Plans are effectively executed in compliance with environmental laws, ensuring environmental sustainability in Brazilian cities.

The ecology in zoning

Since the existence of Brazilian laws does not guarantee a sustainable urban zoning, due to lack of guiding principles, it is required to use scientific information that ensures the effectiveness and efficiency of cities urban planning (Rech, 2013). According to Brazilian law, the EEZ must be established at large spatial scales (Brasil, 2007) and the solutions suggested by ecology as a science for environmental planning and management of zoning must be applied at the same levels (Leitão & Ahern, 2002). Thus, landscape ecology is an approach that provides the necessary knowledge to assist in the creation of guidelines and norms that help planning of urban zoning. This branch of ecology aims to utilize spatially explicit models, through the qualification and spatial quantification of landscape units (habitats), supported mainly by geotechnologies (Leitão & Ahern, 2002). In this perspective, the landscape represents a set of habitats which offer favorable conditions for an organism or object of study (Metzger 2001). However, the set of landscape habitats can also be obtained based on territorial occupation plans, developed on broad spatial scales such as the ecosystem level (Leitão & Ahern, 2002; Metzger, 2001). In addition, landscape ecology focuses on the interactions between spatial patterns and ecological processes (Metzger, 2001; Turner, 2005), and is concerned with anthropogenic influences on landscape and land management (Metzger, 2001).

Urban ecology is another approach that covers several disciplines and practical applications, with an increasing focus on promoting sustainability (McPhearson et al., 2016). This science can provide information on complex relationships between social, economic and ecological aspects (McPhearson et al., 2016), allowing the integrated management of the urban environment in a more sustainable way. From the land occupation planning and management aspect, urban ecology is a science that works with multidisciplinary teams in several areas of social and natural knowledge. Urban ecology provides opportunities to identify important infrastructure and habitats that contribute to environmental conservation in urban areas (McPhearson et al., 2016; Pincetl, 2015). Thus, landscape ecology and urban ecology are convergent disciplines allowing integration into urban planning and management among politicians, managers and environmental and social scientists. This convergence allows more effective guidelines and norms for environmental sustainability to be included in the legislation of urban zoning.

Landscape ecology in urban planning

A first advance in environmental zoning of the city is establishing a spatial scale for analysis, essential for a sustainable planning (Leitão & Ahern, 2002). In Brazil, studies on environmental zoning have been firstly made in river basin scale (regional scale) (Rempel et al., 2008). Based on legislation, the EEZ in river basin proportion contemplates regional scales between 1:1.000.000 and 1:100.000 (Brasil, 2002,

2007), which are inadequate for urban zoning. It is crucial highlight that urban landscape management demand ecological knowledge at least on local scale when aiming to attend environmental requirements (McPhearson et al, 2016). As for local scales (cities) the law establishes a reference scale of 1:100.000 or higher (Brasil, 2002, 2007). Therefore, due to the incapacity of state and municipal legislation to normalize and standardize urban zoning, federal laws should establish a single scale for the whole Brazilian territory. It should be a mandatory parameter, due to the importance of standardized urban zoning scale, allowing then compare planning and urban processes among different cities of the country. This standardization would permit that managers provide useful information that allows scientists to investigate it and become legal parameters useful to politicians.

A large number of studies were developed with landscape ecology for Brazil's EEZ. The majority of these studies aim to classify and quantify zones (landscape blotches), mainly in regional scales. A few others were developed in local scales and generated some method contribution for urban zoning through landscape ecology (Table 2).

Table 2 - Literature on urban zoning with contribution of landscape ecology methods for city planning

Contribution	Author and Year
Methods for the creation of greenway	Giordano & Riedel (2008)
Indication of conflict zones with legislation	Rempel et al. (2008)
Selection of locals for recovering through Graph theory	Tambosi & Metzger (2013)
Integration of environmental and socioeconomic variables to classify landscape units	Freitas & Santos (2014)
	Sadeck et al. (2017)
Indication of the amount of native vegetation for conservation	Crouzeilles et al. (2014)
Prioritization index to conserve urban fragments	Mello et al. (2016)

Source: Authors.

For urban planning, landscape ecology has shown the importance of maintaining a minimum proportion of one or more habitat types responsible for biodiversity conservation and ecosystem services (Fahrig, 2013; Tews et al., 2004). Therefore, the establishment of rules and regulations for the conservation of a minimum extent within a set of urban habitats, even those not considered as native vegetation remnants (e.g. parks and squares) or natural water bodies (e.g. artificial lakes), guarantees environmental conservation in Brazilian cities. The simple maintenance of a habitat fraction in a landscape has demonstrated high relevance for conservation, even in comparison to other factors such as size and isolation of these habitats (Fahrig, 2013). Studies suggest that maintaining 20% to 30% of native vegetation in modified landscapes is enough to conserve fauna and ecosystem services (Banks-Leite et al., 2014; Fahrig, 2003; Metzger, 2010; Pardini et al., 2010), allowing a combination of economic, social and environmental use (Metzger, 2010). On the second hand, for cities, it is necessary to conserve 50% of native vegetation cover, or 30% cover when there is connectivity with natural areas (Crouzeilles et al., 2014). When native vegetation cover is below 30%, actions of ecological restoration must be carried out for maintenance of ecological interests (e.g. ecosystemic services) in urban environments (Crouzeilles et al., 2014). Based on this, we believe that the insertion of suitable laws in public policies obliging cities to maintain a minimum rate of native habitats (at least 30%) in these areas would improve the Brazilian EEZ and contribute to support sustainability goals.

At present, there are laws in Brazilian environmental legislation that partially guarantee the conservation of natural areas in such environments, such as Permanent Preservation Areas (APP) and UC (Brasil, 2000, 2012b). It is noteworthy that due to the importance of these areas (APPs and UCs), they must be fully maintained environments in cities, even if they represent more than 30% of the landscape. Studies in Brazil proposed an approach to maintain a proportion of native habitats in the landscapes as criteria for elaboration of the Brazilian forest code (Metzger, 2010) and greenway (Giordano & Riedel, 2008), as well as requests for deforestation (Rigueira et al., 2013) and maintenance of urban riparian vegetation (Castro et al., 2018). Landscape ecology has indicated these vegetation areas as priorities for conservation

within the urban environment, enabling unite human and environment demands (Mello et al., 2016). Despite a portion of areas of ecological interest are protected by law and although studies have shown the importance of natural habitats conservation, conflicts between legislation and landscape ecology in urban environments persist. Among these conflicts, there is no federal law that protects areas (habitats) threatened of ecosystemic resilience loss and still are explored (e.g. native habitats in regeneration) over cities. These threatened habitats can be classified by landscape ecology (Rempel et al., 2008) and its protection should be provided in legislation as in City Statute (Brasil, 2001). Thereby, the use of landscape ecology methods associated to legal impositions can reduce conflicts of interest between environmental and social areas, contributing to decision making by environmental managers.

To classify zones in cities, besides consider ecological information, it is necessary include social and economic variables in urban zoning (Freitas & Santos, 2014; Sadeck et al., 2017). The inclusion of this information can be done through data spatialization, with geotechnologies attached to landscape ecology that assist areas classification (Freitas & Santos, 2014). With an integrated data base (environmental, social and economic information), urban landscape can be categorized into four interest classes: consolidation, expansion, recovery and conservation (Sadeck et al., 2017). Zone categories in cities protects environmental interests (e.g. recovery and conservation), ensure social and economic benefits (e.g. consolidation and expansion), directing adequate places for services development and urban infrastructure, besides real estate speculation, avoiding environment degradation (Silva et al., 2013). Mapping interest zones integrating social and economic data allows reducing conflicts between environmental, social and economic sectors. In addition, integrated data reduces subjectivity in urban zoning proposals, aiding city planning standardization.

Furthermore, other methods (or metrics) that improve landscape quality for biodiversity, such as connectivity, for example, would be used. For connectivity, Graph theory has shown a particular importance in planning, indicating the most important areas to be maintained in the landscape (Forero-Medina & Vieira, 2007; Tambosi & Metzger, 2013). This method allows users to measure the effect of modifications on functional connectivity between fragments (e.g. the use of ecological corridors and/or steppingstones), or assess functional connectivity through loss or gain of habitats (Forero-Medina & Vieira, 2007). Graph theory can be used yet in Brazil to establish the restoration prioritization in local scale, contributing to planning habitats to be restored in cities (Tambosi & Metzger, 2013). Thus, it is an important tool for the consolidation and expansion of urban areas. Just as Graph theory aids connectivity in cities, greenways have important value by making the union between natural habitats, reducing the isolation between these environments (Frischenbruder & Pellegrino, 2006; Giordano & Riedel, 2008). Linked to environmental interests, the establishment of greenways across the city also demonstrates social utility, through cultural and aesthetic development, as well as the recreational use of these environments (Frischenbruder & Pellegrino, 2006; Giordano & Riedel, 2008). Thus, the use of tools such as Graph theory and the creation of greenways, besides improving the connectivity between natural habitats in Brazilian cities, also allow opportune issues related to culture and leisure in the urban landscape.

In short, studies in landscape ecology have indicated the necessity to define a spatial scale for urban zoning and allow the conservation of a minimal rate of natural habitats in Brazilian cities. In planning, it is important to include environmental, social and economic data in the analysis of landscape ecology, allowing a more precise classification of urban areas and avoiding conflicts of interest during decision making. Furthermore, landscape ecology tools should also be used to help improve connectivity between natural habitats in cities, determining areas to be preserved and restored. Due to the efficient processes of classification and quantification of habitats (Leitão & Ahern, 2002), landscape ecology can help urban planning by suggesting the configuration and proportion of habitats, then contributing to define guidelines and standards that improve the Brazilian urban zoning.

Urban ecology in cities management

Environmental degradation is generally a consequence of human occupation, and for that reason there is a necessity that Brazil plans with criteria its territory occupation (Rech, 2013). It is important to

emphasize that city management should not be done solely from the point of view of landscape structure, but human behavioral patterns should also be considered (Haddad, 2015; Pickett et al., 1997). Social scientists were ahead on this matter; however, the recognition of the urban landscape as a provider of many ecosystem services was delayed amongst natural history scientists, with studies of the urban environment increasing in recent decades (Wu, 2014; Pincetl, 2015; McPhearson et al., 2016). Most studies have focused on green spaces (non-waterproof areas of urban land, such as native vegetation patches, parks, squares, wastelands, yards and gardens) and blue spaces (water bodies such as rivers, natural and artificial lakes) (Pickett et al., 1997; Wu, 2014). These provide ecosystem services, habitats for organisms and economic and social benefits, positively impacting human welfare in urban environments (Wu, 2014). However, non-natural green and blue spaces in Brazil (e.g. public squares, wastelands, backyards, artificial lakes) have been rarely pointed as having some interest in conservation (Rech, 2013). Historically neglected at an environmental point of view, the importance of these spaces is generally related to social and economic issues (Benini & Martin; 2010; Loboda & Angelis, 2005). Nevertheless, even in strict urban landscapes, green and blue spaces are especially in preserving biodiversity and ecosystemic services (Bargos & Matias, 2011; Benini & Martin, 2010; Loboda & Angelis, 2005; Nielsen et al., 2014; Pickett et al., 1997; Wu, 2014). Thus, these non-natural habitats must have its creation and importance reinforced thanks to legislation, aiming to attend environmental, social and economic interests during urban zoning. Thus, during the planning of the use and occupation of Brazilian land, it is important that all categories of green and blue spaces appear as priorities for conservation, enhancing city sustainability.

The lack of integration and holistic management across the different sectors related to urban zoning is a contemporary problem, since most planning is focused on urban infrastructure (Brasil, 2001; Childers et al., 2014; Haddad, 2015). As a consequence, urban ecology has become transdisciplinary in terms of goals (sustainability-oriented), methodologies (from the natural and social sciences) and actors (scientists, managers and politicians) (Brasil, 2001; Wu, 2014), attempting to generate a more sustainable city. The current challenge for city management is to understand urban ecosystems through several approaches, but also to form a new generation of people able to think in interdisciplinary and multidisciplinary ways (Collins et al., 2000; McPhearson et al., 2016), enabling a sustainable creation of the EEZ. However, we need to make effective use of the knowledge already produced in cities so that research in urban ecology could suggest to politicians and managers the better way promoting biodiversity and ecosystem services conservation (Haddad, 2015; McPhearson et al., 2016). For that, a conceptual framework allows a better comprehension of how urban ecology may assist Brazilian city's zoning (Figure 1).

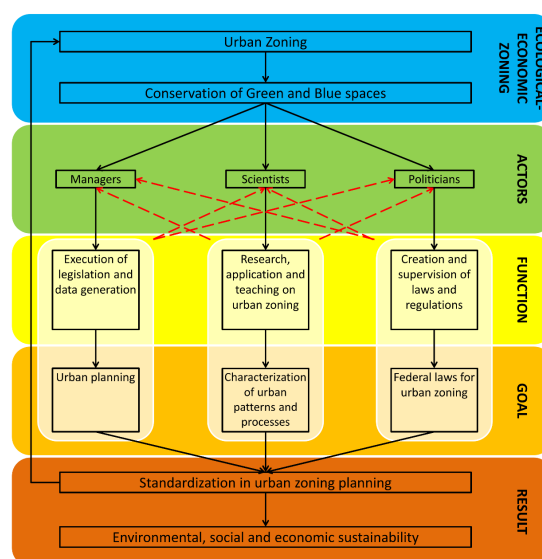


Figure 1 - Conceptual framework of how Brazilian urban zoning can be managed by different actors. Dashed lines indicate the expected transdisciplinary by urban ecology on the investigation process, development and execution of urban zoning among different actors.

Although the urban zoning in Brazil is mainly the result of public policies, technical and scientific knowledge are essential for zoning to be adequate to the environmental and social reality of the city (Peres & Silva, 2013; Souza, 2013). Within the EEZ, legislation related to urban zoning should prioritize the conservation of green and blue areas, regardless of the origin of the habitat (natural or artificial). For that purpose, managers, researchers and politicians must know and use information from other actors involved in the zoning, to properly exercise their functions and reach their goals. The joint work of the actors allows characterizing and standardizing urban zoning, supporting the planning of cities in a legal, technical and scientific manner. The data generated by the characterization and standardization of zoning support the formulation of laws related to planning. The final effect is the creation of unified legislation at national level establishing a minimal standardization of city planning that ensures the maintenance of social and environmental interests of the country and making the result of urban zoning prosperous (Rech, 2013). However, since the urbanization process is spatially and temporally dynamic, it is especially important that all obtained data are revised by those acting on cities' zoning (Peres & Silva, 2013; Wu, 2014). This will allow ecological and social patterns to be uncovered, thereby helping to guide decision-making related to urban planning. Thus, a conceptual framework is an important tool of urban ecology that support standardization and comparison of zoning results between cities (McPhearson et al., 2016). Therefore, it is important that a minimum standard of the zoning exists for Brazilian cities, and that comparative criteria on urbanization in the country can be obtained to generate knowledge for planning and management of land use and occupation.

Conclusion

As a tool for a sustainable city planning, ecology allows relevant contributions, assisting in the creation of guidelines and norms for the Brazilian urban zoning. Notably, the field of landscape ecology has shown how geotechnologies, through the qualification and quantification of landscape elements, assist with territory occupation planning. In this section, the studies carried out in Brazil indicate its importance: (1) in the selection of a single spatial scale for Brazilian zoning; (2) maintenance of a minimum proportion of green and blue areas; (3) classification of zones in cities (consolidation, expansion, recovery and conservation); (4) methods of landscape analysis that improve connectivity (Graph theory and greenways) between different green areas in cities. Urban ecology has focused on promoting sustainability in cities, integrating several disciplines. This section of ecology integrates the management of urban zoning (through different political actors, managers and scientists), relating social, economic and ecological aspects. Through integrated information management, it is possible to identify Brazilian urban infrastructure and habitats important for the conservation of the environment and zoning of cities. Thus, broadly, ecology helps in urban zoning suggesting the types, proportions and configurations of urban habitats to be conserved, as well as helping in decision making for urban land planning.

This essay did not aim to modify the cities in the form they exist today since we recognize that this would present several huge challenges. Our main goal was to present a general overview for decision makers, such as environmental professionals and politicians, allowing highlighting the available research and scientific knowledge that could support the development of guidelines and minimum standards for a sustainable Brazilian urban zoning. The ideas presented herein are still schematic, but could provide a starting point for further improvements in urban zoning legislation.

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