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JOINT ECOLOGICAL, GEOGRAPHICAL AND PLANNING VISION OF THE COMPONENTS OF URBAN SOCIO-ECOLOGICAL COMPLEXES

Alexandru-Ionuţ Petrişor[1]

Abstract. Since geographers, ecologists and planners study the same reality, their opinions must somehow converge despite the different languages used. Starting from this premise, the present article attempts to build up a model of the urban socio-ecological complexes, including the components identified by each of the three disciplines through its primary focus, and re-interpret sustainability through this joint perspective. The model is based on four quadrants resulting from the two dichotomies characteristic to each discipline: natural vs. anthropic in geography and biotic vs. abiotic in ecology. The new vision allows for seeing the city as a connected green infrastructure providing ecosystem services which meet the human needs. If the connections are broken, biodiversity is reduced and the level of ecosystem services decreased, resulting into the dissatisfaction of people; proper planning, accounting for the environment, can increase biodiversity and its interconnectedness, growing the level of ecosystem services and welfare of the inhabitants. The model is used to analyze sustainability, which results from the intersection of the vertical pillars (economic, social, cultural, and environmental) with the multiple horizontal dimensions and projects itself unto the territory.

Keywords: system, territory, urban environment, model, sustainability

1. Introduction

The same territorial reality is described in different terms by the discipline dealing with it. For instance, Mândruţ (2013:65) considers that geographers focus on the human society, while ecologists and biologists are more concerned with the living realm (fauna and flora). Planners have, similarly to the geographers, a primary interest in the human society (Petrişor, 2011:5).

As a consequence of it, after embracing the systemic theory in the 1970', the three different disciplines used different terms for the base unit, but also exhibit different understandings of its structure and functions.

The base unit in geography is the geosystem, defined as "*complex geographical system resulted from the evolution of relationships between relief, water, air, soil, organisms and man,*

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and characterized by openness, oneness, organization, functionality, hierarchy and self-regulation" (Institutul de Lingvistică Iorgu Iordan, 1998) or "*territorial unit hierarchically individualized in time and geographic space by the relationship between the geographical elements composing it (inserted in its own functional structure) through a specific landscape physiognomy and a certain energy potential and biological productivity*" (Mehedinţi, 1900:38).

In ecology, the base unit is the ecosystem, defined by Arthur Tansley in 1935 as "*system... including not only the organism-complex, but also the whole complex of physical factors forming what we call the environment*" (Tansley, 1935). However, the interest of ecologists shifted in time towards the complexes of ecosystems (Petrişor, 2012), or "socio-ecological complexes".

In spatial planning, the base concept is "socio-spatial system" – sub-class of ecological systems characterized by the presence of people and their activities (Botez, Celac, 1980). Nevertheless, the concept of "landscape" is also used and defined as unit formed by the interaction of man and nature over time and its perception by population (IUCN, 1994; Petrişor, 2013b).

Several previous studies attempted to find correspondences and link the different perspectives (Petrişor, Sârbu, 2010; Petrişor, 2011, 2012; Nemeş and Serac, 2012) and found out that the dialogue is possible, and the main concepts can be 'translated' by each discipline from the language of the others. However, the correspondences should be used only as a starting point to build up a joint approach (Petrişor, 2011). Therefore, this article aims to present a joint model of the urban socio-ecological complexes starting from the ecological, geographical and planning visions of their components. The choice of the urban environment was due to the fact that geographers and planners are mainly focused on the human society (Mândruţ, 2013:65), and the visions of the natural systems do not vary as much across the three disciplines.

2. The joint model of urban socio-ecological complexes

Ecologists are still debating whether cities are ecological systems or not, due to the strong anthropic influence, which alters their structure and functions (Petrişor, 2010, 2013a). The concept of 'urban ecosystem' is also debated, partially due to scale and complexity issues (Petrişor, 2013a). Two models, one produced by planners (Sârbu, 1999) and the other by ecologists (Petrişor, 2013a) were used as building blocks of the joint one (Figure 1).

Nevertheless, the main premise is that geographers and planners focus on the human society, and divide the reality into "*natural* vs. *anthropic*", and ecologists, concerned with the fauna and flora, divide the same reality into "*abiotic* vs. *biotic*". Therefore, the joint model (Figure 1) places the components of interest to each discipline in the four quadrants resulting from the two binary splits of reality.

Species are situated in the biotic area according to the ecologists; however, their classification depends on the relationship with humans; those species that cannot exist in the presence of human, called hemerophobous (Petrişor, 2013a) can be found only in the natural systems. At the antipode, hemerophile species, seeking for the human presence, and particularly the synanthropic ones, joining the man throughout the expansion of human settlements (Petrişor, 2013a), are characteristic to the anthropic realm. There are some species which manifest indifference to the humans, called hemerodiaphore, but also species classified from different perspectives as ubiquitous, opportunistic, invasive, or random, which can be found in both natural and anthropic systems.

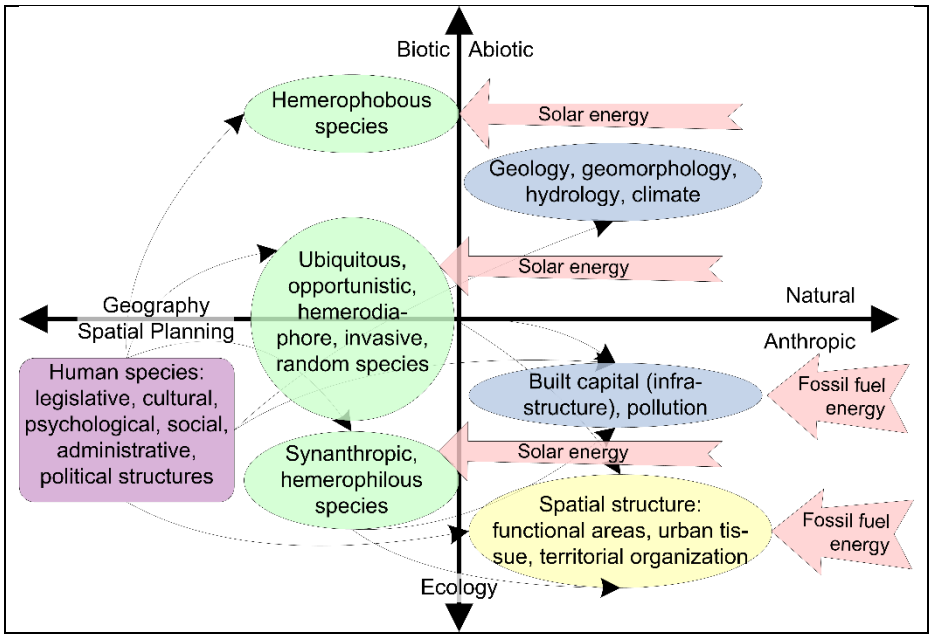

Figure 1: Schematics of a joint ecological, geographical and planning vision of the components of urban socio-ecological complexes

The human presence is manifested form a biotic perspective by the human species, but also through its characteristic structures, since the human being is a social species (Petrişor, 2008b) and through structures resulted from the noo-trophy (Petrişor, 2012); the first ones include psychological (*e.g.*, the packing habit), social and cultural structures, and the second includes legislative, administrative and political structures. All of them set their fingerprint over the abiotic component, resulting into the built (infrastructural) capital and pollution due to the human activities, and spatially into the spatial structure: functional areas, urban tissue and territorial structure.

The natural abiotic component consists of the geology, geography, pedology, geomorphology, hydrology, atmosphere and climate characteristic to the place, but modified and the micro-scale by the effects of human activities (*e.g.*, heat islands, wind canyons, soil sealing etc.).

Functionally, the urban systems have a reduced biodiversity (which alters their stability), and due to this fact they cannot generate the primary yield (Petrişor, 2013a). Therefore, despite the availability of solar energy, the anthropic structures rely on outer energy (Sârbu, 1999), obtained at large from the fossil fuels. In general, cities can be considered sinks or consumers of ecosystem services (Andrade *et al.*, 2013).

3. An economic perspective

In an article published in 2013, Sarah Taylor Lovell and John R. Taylor described the urban landscape as a mosaic of natural corridors and small fragmented natural areas (Taylor Lovell and Taylor, 2013). This feature is explained by the fact that today, when urban development is the result of a controlled process named spatial planning, the urban shape is the output of negotiations between planners, local authorities and citizens (Lacaze, 1990). The existing idea that the natural capital provides to the human society goods and services, recently

brought back to the public discourse through the concept of *ecosystem services* (Zakri and Watson, 2003; Watson and Zakri, 2005) provided by the *green infrastructure* (European Commission, 2013) provides solid arguments for pleading in favor of the urban biodiversity during the negotiation process (Clergeau, 2015). More exactly, in a socio-ecological complex, the green infrastructure represents the ecological foundation providing goods and services to the humans (the concept of *ecosystem services* embeds goods through the provision service). Biodiversity, preserved in the cities by the green infrastructure (Tzoulas *et al*., 2007), depends on the spatial structure of cities – more exactly, on the size and connectivity of natural areas (Melles *et al*., 2003) – and, in its turn influences the level of ecosystem services (Niemelä *et al*., 2010).

From a historical perspective, socio-economic systems extended in space under the demographic pressure seeking for new resources. Moreover, the anthropization and urbanization are a manifestation of the tendency to organize the adjacent territories in order to meet the basic needs (Petrişor and Sârbu, 2010; Petrişor, 2017). Since the share of urban population is increasing continuously (Grimm *et al*., 2008), the expansion of settlements and need for their interconnections through the road infrastructure resulted into the replacement of natural systems by artificial ones, and simplification and fragmentation of the remaining ones (Marzluff and Ewing, 2001; Petrişor and Sârbu, 2010; Petrişor, 2012), and ultimately in the '*global changes*' (Dale, 1997; Dale *et al*., 2011): land cover and use changes, climate changes and alteration of energy flows. Although these changes were attributed to demography (Li *et al*., 2015) or economy (Jongman, 2002; Petrişor, 2015b; Petrişor *et al*., 2010, 2014, 2016b), fragmentation appears to be a more prominent cause of fragmentation than agriculture (Marzluff and Ewing, 2001), inducing land cover and use changes (Grimm *et al*., 2008; Crăciun, 2014; Gavrilidis *et al*., 2015; Vâlceanu *et al*., 2015), leading to environmental conflicts (Herspeger *et al*. 2015; Grădinaru *et al*., 2014; Tudor *et al*., 2014; Iojă *et al*., 2011, 2014) and decreasing the overall resilience (Andersson *et al*., 2014).

The fragmentation process, associated to the urban sprawl (Razin and Rosentraub, 2000; Fernández-Juricic and Jokimäki, 2001; Melles *et al*., 2003; Irwin and Bockstael, 2007) takes place in a similar way in natural and anthropic systems (Cumming, 2011). Thus, urban sprawl is the main threat to the natural areas (La Greca *et al*., 2011), but also to the cities. As a result, the low connectivity of natural parcels, low biodiversity, rapid succession and presence of invaders are the characteristic to urban ecological systems (Niemelä, 1999; McMahon, 2000; Benedict and McMahon, 2001; Gibb and Hochuli, 2002; Luck and Wu, 2002; McKinney, 2002; Schneider and Woodcock, 2008; Poelmans and Van Rompaey, 2009; Niemelä *et al*., 2010; Taylor Lovell and Taylor, 2013; Andersson *et al*., 2014; Petrişor, 2015a; Petrişor *et al*., 2016a).

Fragmentation reduces the nature of cities to four categories: remains of natural systems, their extensions, landscaped areas and spontaneous, invasive, or ruderal species (Qureshi and Breuste, 2010; Breuste *et al*., 2013). The low biodiversity impedes primary yield and reduces stability (Petrişor, 2015a; Petrişor, 2017). However, the few natural areas are crucial for maintaining the ecosystem services required by the human population (Acasandre and Crăciun, 2015; Enache and Popa, 2015), especially if they are connected by corridors (Clergeau, 1999, 2015, 2016; Niemelä, 1999). Responsible urban planning and management, paying respect to the environment (Ianoş *et al*., 2009, 2010), can provide lessons for reconciling with the nature (Fernández-Juricic and Jokimäki, 2001; Ersoy *et al*., 2015; Mierzejewska, 2015; Badiu *et al*., 2016). Last but not least, the interdisciplinary dialogue is a condition for achieving this goal (Wu, 2006; Ungureanu and Bănică, 2008; Bănică, 2010; Ianoş *et al*., 2013; Constantinescu and Platon, 2015; Frone and Constantinescu, 2015).

This conceptual framework provides the grounds for a prudent planning, able to improve the relationship between the natural and anthropic systems (Fernández-Juricic and Jokimäki, 2001), increasing the level of ecosystem services and contributing to the growth of human welfare, resulting into sustainable communities (ODPM, 2006). Fig.-ure 2 presents the schematics of the theoretical concepts and their relationships; the circle can be equally vicious or virtuous, depending of the inclusion of environmental criteria into the planning process. If planners ignore the need of connectivity in order for the green infrastructure to provide ecosystem services, the result is a city with low biodiversity and citizens whose needs are not satisfied. If the biodiversity is increased 'honestly' (*e.g.*, not using alien species or favoring the intrusion of invaders) and its connectivity ensured by green corridors, the result is a 'biodiversitary city' (Clergeau, 2015) with citizens able to benefit upon the ecosystem services.

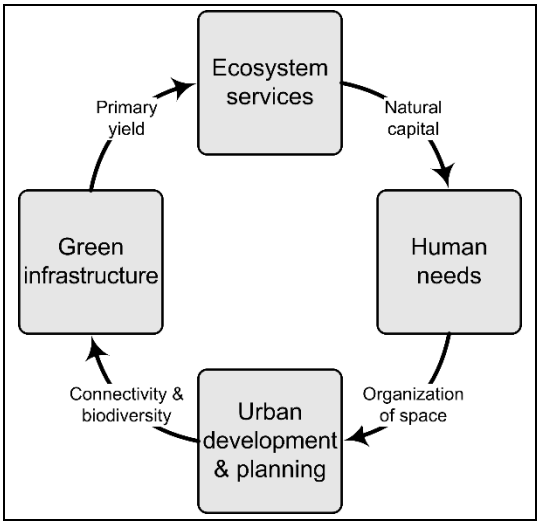

Figure 2: Schematics of the vicious and virtuous planning circles, depending on the level of biodiversity and its interconnectedness

4. Sustainability as dynamic of coupled socio-ecological systems

In order to harmonize the anthropocentric perspective of development, often focused on economy only, and ignoring societal and environmental consequences, usually adverse, dr. Gro Harlem Brundtland defined sustainability as "*development that meets the needs of the present without compromising the ability of future generations to meet their own needs*" (Brundtland, 1987); according to the author, the definition does not require a revision, but only fine tuning consisting of refocusing on the integration of pillars instead of overemphasizing each of them (Bugge and Waters, 2003). In relationship to the economic theory presented in the previous chapter, sustainability, presuming the ecological restoration of the systems affected by the anthropic impact, allows for a co-development of the human and natural capitals (Vădineanu, 2001).

Although most authors recognize only the traditional pillar – economy, society and environment (Basiago, 1999; Littig and Grießler, 2005; Gibson, 2006; Murphy, 2012; Petrişor and Petrişor, 2014), some authors add a fourth cultural pillar, recognizing its potential for economic growth (Hawkes, 2001), as a result of the lobby of United Cities and Local Governments (Petrişor and Petrişor, 2014; Todoran and Patachi, 2015). In addition to the pillars, sustainability has dimensions corresponding to the administrative/economic categories (Bottero

and Feretti, 2010; Péti, 2012; Petrişor and Petrişor, 2014): management, design/ planning, transport, housing, agriculture, infrastructure, science, education, governance, ethics, health, technology, energy etc., and a territorial component (Mierzejewska, 2017), called spatial sustainability, and defined as "*development providing for a territorial balance of satisfying at the same rate the economic, social and environmental needs of present and future generations*" (Petrişor, 2008a), and ensures the coherence of socio-economic objectives in relationship with the territory and its ecological and cultural functions, aiming to enhance the quality of present and future generations' life by creating sustainable communities able to manage and use resources efficiently, exploiting the innovative ecological and social potential of the economy and guaranteeing the welfare, environmental protection and social cohesion (Collignon, 1998). The resulting concepts are polycentricity, cohesion and sustainable communities (Petrişor, 2017), although it is arguable whether spatial sustainability is a concept similar to the spatial dimension of sustainability (Petre, 2016; Mierzejewska, 2017).

In summary, sustainability emerges at the intersection between the vertical pillars and horizontal dimensions, acting like a prism which projects development unto the territory through the multiple facets resulting from the synergic interactions between its pillars and dimensions (Figure 3).

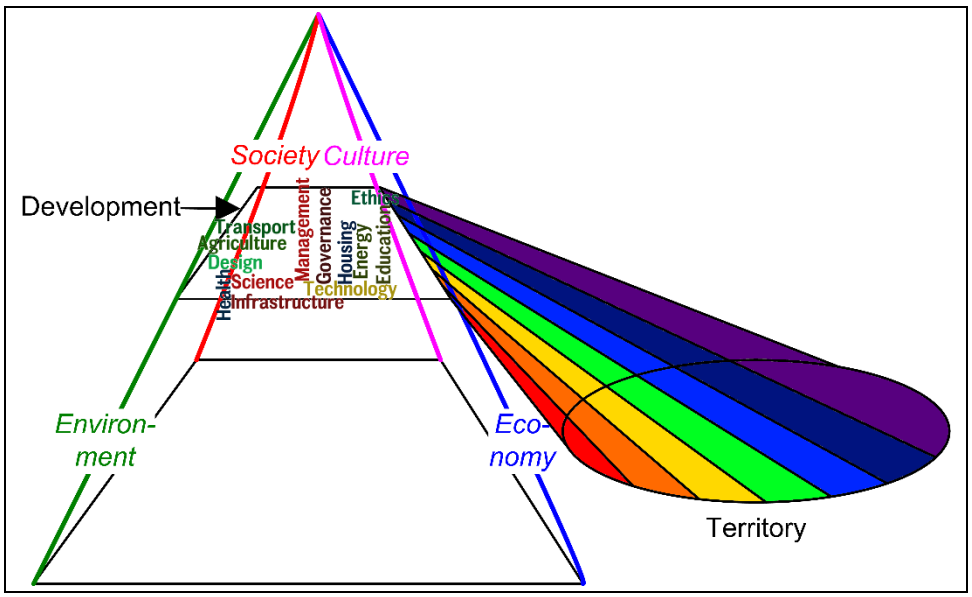

Figure 3: Sustainability results from the intersection of the vertical pillars with the horizontal dimensions and projects unto the territory

Conclusions

This article attempted to build on the premise that, since geographers, ecologists and planners study the same reality, their opinions must somehow converge despite the different languages used, a model of the urban socio-ecological complexes. The exercise was successful and showed that the different perspectives can be harmonized if the components identified by each discipline are placed within the epistemic quadrants defined by the "*natural* vs. *anthropic*" and "*abiotic* vs. *biotic*" understandings of reality.

The new concepts allow for seeing the city as a connected green infrastructure providing ecosystem services which meet the human needs. If the connections are broken,

biodiversity is reduced and the level of ecosystem services decreased, resulting into the dissatisfaction of people; proper planning, accounting for the environment, can increase biodiversity and its interconnectedness, growing the level of ecosystem services and welfare of the inhabitants.

From a dynamic perspective, sustainability ensures the co-development of the natural and anthropic components of the environment, placed conceptually at the intersection of the vertical pillars (economy, society, environment and culture) with the horizontal dimensions, and reflected from a spatial perspective in the territory.

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