Autonomous re-naturalization of cities in a context of degrowth

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Abstract

Planetary urbanization is considered to be one of the leading causes of the current global process of the degradation of nature, and a reduction in urban consumption becomes, therefore, a crucial goal for degrowth. Three fundamental premises underly an investigation of these issues. Firstly, territorial management underpins global environmental justice through the implementation of conservation policies; Secondly, degrowth narratives must operate in the urban context; and thirdly, there is a need for a paradigm shift at an economic, social and nature-relational level. This article presents two research approaches. Firstly, it sets out a theoretical framework in the field of 'urban degrowth', collecting arguments from political ecology, urban planning, deep ecology and degrowth thinking; and secondly, it proposes a preliminary line of investigation towards the process of urban de-occupation and re-naturalization through a bibliographic analysis of urban-ecological variables fostering natural recovery. The aim of the study is to stir up discussion about urban degrowth, as an essential mechanism to counter increasing land consumption, and global habitat and biodiversity loss. Anthropized landscapes require care for nature, conservation, collective action and initiatives at the practical and experimental level, and further research.

Key words: degrowth, urban degrowth, planetary urbanization, paradigm-shift, spontaneous plant colonization

Résumé

L'urbanisation de la planète est considérée comme l'une des principales causes du processus mondial actuel de dégradation de la nature, et une réduction de la consommation urbaine devient donc un objectif crucial de la décroissance. Trois prémisses fondamentales sous-tendent l'étude de ces questions. Premièrement, la gestion territoriale sous-tend la justice environnementale mondiale par la mise en œuvre de politiques de conservation; deuxièmement, les récits de décroissance doivent s'inscrire dans le contexte urbain; et troisièmement, un changement de paradigme est nécessaire au niveau économique, social et relationnel avec la nature. Cet article présente deux approches de recherche. Premièrement, il établit un cadre théorique dans le domaine de la "décroissance urbaine", en rassemblant des arguments issus de l'écologie politique, de l'urbanisme, de l'écologie profonde et de la pensée de la décroissance; et deuxièmement, il propose une ligne d'investigation préliminaire vers le processus de désoccupation et de re-naturalisation urbaine à travers une analyse bibliographique des variables urbano-écologiques favorisant la récupération naturelle. L'objectif de cette étude est de susciter un débat sur la décroissance urbaine, en tant que mécanisme essentiel pour contrer la consommation croissante de terres et la perte globale d'habitat et de biodiversité. Les paysages anthropisés nécessitent de prendre soin de la nature, de la conserver, de mener des actions et des initiatives collectives au niveau pratique et experimental, et de plus amples recherches.

Mots clés: décroissance, décroissance urbaine, urbanisation planétaire, changement de paradigme, colonisation végétale spontanée

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Resumen
La urbanización planetaria es considerada una de las causas principales del actual proceso global de degradación de la naturaleza. La reducción del consumo urbano se convierte, por lo tanto, en un objetivo fundamental en un contexto de decrecimiento para un futuro inmediato. El razonamiento de este artículo se construye en base a tres premisas principales. En primer lugar, la gestión territorial juega un papel fundamental en la justicia ambiental a través de la implementación de políticas de conservación; en segundo lugar, la necesidad de respuesta de las narrativas del decrecimiento en el contexto urbano; y en tercer lugar, la necesidad de un cambio de paradigma a nivel económico, social y de relación con la naturaleza. Asimismo, este artículo presenta dos enfoques de investigación. En primer lugar, establece un marco teórico en el campo del "decrecimiento urbano", recogiendo argumentos de la ecología política, la planificación urbana, la ecología profunda y el movimiento del decrecimiento; y en segundo lugar, propone una línea preliminar de investigación hacia el proceso de desocupación y renaturalización urbana mediante un análisis bibliográfico de variables urbano-ecológicas que favorecen la recuperación natural. El objetivo del artículo es levantar discusión sobre el decrecimiento urbano, como campo fundamental para afrontar el actual proceso de aumento del consumo de territorio y su consecuente pérdida global de hábitat y biodiversidad; además de elevar la conciencia sobre el cuidado y la conservación de la naturaleza en paisajes antropizados a través de fomentar una mayor investigación académica en el campo, así como el apoyo necesario de acciones e iniciativas colectivas a nivel práctico y experimental.

Palabras clave: decrecimiento, decrecimiento urbano, urbanización planetaria, cambio de paradigma, colonización vegetal espontánea

1. Introduction

This article questions the current growth discourse paradigm, and its manifestation in urban planning, calling for a deep ecological approach to the urban field. To develop alternatives requires the implementation of urban degrowth. I use a similar urban analytical methodology that has been shaping cities over previous decades, but I include a major focus on fostering 'natural recovery' in the urban context.

I begin with a multidisciplinary review of degrowth and urban studies, deep ecology, and political ecology. A degrowth discourse materializes physically in the urban context, through urban de-occupation and by considering the intrinsic value of nature. I then ask: what ecological variables could influence the process of spontaneous plant colonization in cities? Can we apply knowledge of ecological and urban variables in a real process of urban degrowth? I describe these ecological variables, using three studies, and map them.

The aim is to link several fields of research, and in particular, urban degrowth and deep ecology. Political change can be articulated through ecological discourse, and knowledge of the ecological dynamics of the non-human in cities could be applied more appropriately in urban management to foster a real urban degrowth process. The present article sets out the preliminary steps to orient further research in this field.

2. Key concepts

Degrowth and the urban

The logic of infinite growth has been jeopardized by decades-old evidence that the relentless production of the current economic system has far exceeded the capacity for regeneration of natural processes (Latouche, 2007), seriously threatening and overrunning the seven planetary boundaries of the Earth System (Rockström *et al.,* 2009). Among them, biodiversity loss has been vastly transgressed, leading to the mass extinction of a variety of living forms. There are inter- and intra-generational environmental costs to humans, and also to other species (Martínez-Alier *et al.,* 2014). Ecological realities, still ignored by the mainstream as an inherent consequence of the current socioeconomic model, have led to increasing interest in the 'degrowth' movement (Latouche, 2007; Demaria *et al.,* 2013; D'Alisa *et al.*, 2014). Nourished by grassroots projects and decisions, it argues that reducing Western consumption is required to diminish demand for natural resources, also reducing breaches of human rights where resources are extracted are produced, now concentrated in the Global South (Martínez-Alier *et al.,* 2014). Degrowth initiatives address global environmental justice by promoting greater local and sustainable use of resources.

Planetary urbanization, as part of an uneven but global transformation process (Roy, 2016), is a key component of the Anthropocene transition, and of economic growth (Barau & Ludin, 2012; Pincetl, 2017; Elmqvist *et al.,* 2021). Urbanization drives global ecological change (Swyngedouw & Kaika, 2014; Seto *et al.,* 2013). It mobilizes nature socially, physically transforming it (Swyngedouw & Kaika, 2014; Tzaninis *et al.,* 2021). Urbanization is also multi-scalar (Keil, 2003), a combined political-economic and socio-environmental project (Swyngedouw & Kaika, 2014). Key issues are the intrinsic relationship between the urban and the interests of the state (Lefebvre, 1970); the blurred boundary between architectural forms and maintenance of order (Davis, 1992); and how urban areas are key sites for concentrating capital and global economic development (Pincetl, 2017).

Power relations and rights to nature

Political ecology, in its simplest form, interrogates competition for access and control of natural resources, led by social actors with asymmetrical political power (Bryant & Bailey, 1997). Some authors argue that conservation policies establish exclusionary rights to resources as they are often implemented by powerful social and institutional actors (Vaccaro *et al.,* 2013). Therefore, they represent a tool to control nature, socially and politically (Bromley, 1991). Indeed the dominant utilitarian theories behind conservation justice (Sikor *et al.,* 2014) are theories that focus exclusively on improving overall human well-being (Chan & Satterfield, 2013).

A utilitarian relationship towards nature does not consider the rights of multi-species. And hence, following political ecological reasoning, embedding a multi-species approach of justice in conservation (Sikor *et al*., 2014), this article exposes an even more complex level of asymmetrical access to natural resources, as environmental justice includes non-human species (Shoreman-Ouimet & Kopnina, 2015). Recent studies highlight the more-than-human ecological processes happening within cities, and the unsettling of traditional understandings of cities as ontological entities separated from nature. These are concerns of urban political ecology (Tzaninis *et al.*, 2021). If there is a "right to the city" (Lefebvre, 1970), then whose rights, and which city? The recovery of nature within the city suggests 1) cohabitation with many other different living entities, shifting the nature-relational paradigm from hierarchies to webs (Capra, 1997); and 2) urban degrowth as a crucial process for the recovery of fertile soil and habitats in urbanized landscapes. The traditional conception of cities, as entities separated from nature, becomes blurred by a multi-species approach, which comprehends land and landscapes as a set of complex living processes and beings.

Urban degrowth and spontaneous re-naturalization

The major assumptions guiding this study are:

1. Biodiversity conservation in a global scale is urgently needed in order to maintain the world as we know it (Wilson, 1993). The liberation of enough land for other living beings to exist is a fundamental action to tackle extinction.
2. Biodiversity loss is the consequence of the global processes of planetary urbanization and anthropogenic transformation of landscapes. Cities are the key sites where anthropogenic ecosystems can be conciliated and opened to other species, aided by degrowth.
3. There are intrinsic natural dynamics of change in every living entity or system, that a non-instrumentalist and multi-species approach requires in urbanized landscapes (Callicott, 1980; Leopold, 1949).

Urban degrowth and 'spontaneous re-naturalization' are complementary (Figure 1). Urban degrowth permits the spatial application of the principles of the degrowth movement in planning urban space, but the need for a dialogue between degrowth and urban planning has been largely neglected in existing degrowth narratives (Xue, 2021). Some studies have been published in the last few years addressing this recent field of research (Xue, 2015, 2021; Florentin, 2018; Lehtinen, 2018; Nelson & Schneider, 2018; Trainer 2019; Cristiano *et al.,* 2020; Cucca & Friesenecker, 2021), and a review (Krähmer 2022). Wächter (2013) and Xue (2021) highlight the potential for urban planning to provide spatial instruments in a degrowth transformation, hence facilitating a down-scaling of the economy with environmental benefits and potentially, urban de-occupation. The second term, spontaneous re-naturalization, refers to the ecological dynamics of spontaneous plant colonization, and the recovery of nature itself. These two concepts complement each other and set a preliminary line of investigation towards the potential for spontaneous re-naturalization of the urban landscape.

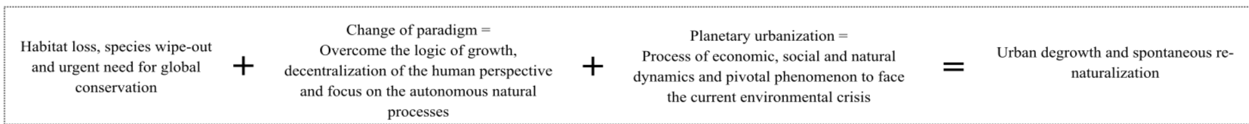

Figure 1: The concepts of urban degrowth and spontaneous re-naturalization.

2. Methodology

In order to identify the main ecological variables that foster natural recovery (e.g spontaneous plant colonization) in the built environment, my literature review develops the findings from the following three studies, to guide a mapping and GIS exercise discussed later:

- 'Lichens and higher plants on stone: a review' (Lisci *et al.,* 2003);
- 'Typologie de l'implantation de la flore spontanée en ville dense, regard croisé écologue-architecte' (Lagurgue *et al.,* 2019), and
- 'Evaluation of natural colonization of cementitious materials: Effect of bioreceptivity and environmental conditions' (Manso *et al.,* 2015).

These three articles focus on spontaneous plant colonization in the urban environment, and were chosen as lenses through which to understand the intrinsic potential of this process in cities. The study by Lisci *et al.* (2003) is focused on the settling of lichens and higher plants in archaeological sites around the Mediterranean, with the aim of preventing and controlling damage to buildings. The study by Lagurgue *et al.* (2019) links the architectural characteristics and the surrounding features (orientation, light, water and wind exposure) of non-historic buildings in Paris to the functional traits of spontaneous vegetation (its establishment, development and interactions). The study by Manso *et al.* (2015) is focused on the spontaneous colonization by bacteria and fungi on different kinds of concrete, in three locations with contrasting climatic conditions (Barcelona, Montseny and Ghent). The authors aim to foster more research on construction materials that can stimulate biological growth. Each study offers some conclusions about the ecological conditions that favor spontaneous plant colonization in different urban contexts.

The variables assessed, which determine the direction of a spontaneous restoration process, can be classified into the four following categories:

a. environmental conditions;
b. physical characteristics;
c. vegetation structure;
d. anthropogenic or anthropic pressures.

Table 1 presents a list of the selected variables, with a description referring to the findings from each of the three studies regarding the corresponding variable. In order to address *How to apply the knowledge of such variables in a real process of urban degrowth?*, the last part of the study presents a mapping of the assessed variables in the village of Montblanc in Catalunya, as an example of an urban settlement (Figure 2). The mapping was done using of the *Topographic Map of Catalunya 1:25000* (2005-2016), the *Geologic Map of Catalunya 1:250.000*, and historical aerial images, all of them retrieved from *Institut Cartogràfic i Geològic de Catalunya*. The assessed variables are represented in four maps (Figure 2), following the same categories presented in Table 1.

3. Theoretical framework

What is nature?

Habitat loss, triggered by land-use change, is considered the main driver of terrestrial biodiversity decline globally (Pimm & Raven, 2000; Foley *et al.,* 2005; Jantz *et al.,* 2015). It is expected that by 2030, more than 25% of all endangered or critically endangered species will be threatened by urban expansion (Seto *et al.,* 2012; Güneralp & Seto, 2013; Elmqvist *et al.,* 2013). The current pace of land exploitation threatens the survival of half of all species by 2100 (Vettese, 2018).

Land, in all its intrinsic complexity, is not an empty resource for future exploitation. There are two controls needed. Firstly, an agreement on land governance for planetary conservation (Huang *et al.,* 2018) is urgently needed although its form is still much debated. The "Half-Earth" program (Wilson, 2016), is to foster a global network of wilderness left as nature's domain, extending over half the land surface of the planet. Supporters of natural geo-engineering at a global scale have also favored such an approach (Vettese, 2018). Wilson argues the half-Earth model would stabilize habitat for more than 80% of species (Wilson, 2016), but the concept is heavily critiqued by prominent political ecologists, who deem it unrealistic, failing to blame or punish the real culprits found in the expanding capitalist economies of the Global North, and distrustful of human capabilities in the Global South (Kothari 2021). This is particularly the case on lands managed for millennia by indigenous groups (Büscher, *et al*., 2017). Secondly, a redefinition of values commonly attributed to nature becomes crucial in order to embody the aforementioned purpose: What category of "rights" do all species that inhabit a specific territory have in order to be preserved? The concept of ecosystem services[2], broadly used in the field of territorial management, focuses its key target on improving human well-being. Such an approach underpins the prevailing instrumentalist relationship with nature, on which the process of urban expansion relies. This process allows the transformation from material natures into "seemingly self-expanding circulations of fictitious financial capital" (Swyngedouw & Kaika, 2014).

There are other concepts in the field of environmental economics that try to assess nature's value in a very different way: *non-use value* is defined as "the benefit arising from knowledge that nature exists and will continue to exist" (Davidson, 2013); and *intrinsic value,* "the right not to be treated as mere means to other ends" (Davidson, 2013). These refer to nature's mere existence without relying on human understanding of it. According to different authors the subject of these "rights" varies from "all experiencing subjects of a life" (Regan, 1987), "all individual living entities" (Taylor, 1986) or "ecological wholes such as species, communities and ecosystems" (Callicott, 1980; Leopold, 1949). Also, the term *Wild Law* (Cullinan, 2003) embeds the rights of nature and all its elements in law and governance. From this broader point of view, decisions such as land conversion would not be acceptable, since an economic valuation of nature is only feasible from a narrow human perspective (Davidson, 2013).

Similarly, the introductory remark with which Rabhi (2008) starts the *Charte internationale pour la terre et l'humanisme*, sets as a fundamental premise the necessity to take care of the planet, and also to respect any other form of life. The 2010 Cochabamba Conference for Climate Justice included as a demand, the universal declaration of rights of Mother Earth to ensure harmony with nature (Martínez-Alier *et al.,* 2014). At the same

[2] Ecosystem services are defined as "the aspects of ecosystems utilized (actively or passively) to produce human well-being" (Millennium Ecosystem Assessment, 2005).

time in the field of Deep Ecology, Naess (1973) insisted on the interconnection of all phenomena in the biosphere, and the interdependence of everything which is part of it, and hence the assumption of a shift from hierarchies to webs for social organization (Capra, 1997). The concept of "multi-species sustainability" assumes the necessity of recognizing the interdependence of the needs of multiple species for current and future generations (Rupprecht *et al.,* 2020). This would be a major paradigm shift, accompanied by an economic, ecological and social transition. Or even more, as Berry (1984) argued "Any recovery of the natural world in all its splendor will require not only a new economic system, but also an experience of profound conversion in the psychic structure of the human being."

Due to the strong and extended impact of humankind on Earth over the last few decades, "wild nature" – the pristine nature exempt from any human intervention (Naess, 1973) – has been considered extinct by some authors (Witoszek, 1996; Riechmann, 2020). However, Naess (1973) also identified the existence of "autonomous nature", defined as a healthy, diverse and functional nature that keeps the basic interactions within an ecosystem. Recalling this distinction, urbanized landscapes can also be conceived as shelters for autonomous natures, which to a certain extent can be considered congruent with human presence. Urban species are mostly cultivated, domesticated and opportunistic. They establish in small patches which can be surrounded by different ecosystems, and with which constant interaction occurs. Unlike mostly native species which belong to more steady, old and unaltered ecosystems, urban species do not receive a consistent ecological value from the mainstream anthropocentric conservation stance. However, the right to life of all species and living forms must be cherished, while recognizing the harshness of planetary Anthropogenic assaults, as well as the current difficulty of preserving a human-unaltered state of nature. The universal right of every life form to unfold and to retain intrinsic value should be respected (Naess, 1990). Moreover, urban-nature patches also provide habitats for the fulfilling of ecological functions (Deng & Jim, 2017).

Some ecologists have begun to question the long-accepted assumptions regarding the ecological condition of urban areas, and are suggesting more accurate ways of studying them (Burkholder, 2012). The potential for cities to develop wildlife habitats has already been studied by many authors (Spirn, 1984; Hough, 1995; Le Roux, 2014; Deng & Jim, 2017), and urban wilderness is now also a part of the urban agenda (Kowarik, 2018). In their study on spontaneous plant colonization on green roofs, Deng and Jim (2017) confirm the potential for urban ecology and biodiversity enhancement and conservation in densely developed urban areas. Also, Clergeau (2015) sustains the definition of a "new urban biodiversity" to refer to a group of species which have not co-evolved together but can fulfill a function within the urban ecosystem (Arrif *et al.,* 2011; Juvillà *et al.,* 2019; Lagurgue *et al.,* 2019; Deng & Jim, 2017). This new urban biodiversity approach considers all kinds of "autonomous natural" gaps, existing in the built environment: parks, public and private gardens, brown-fields, road verges… And these have been given different names: *Espaces à caractère naturel* (Lagurgue *et al.,* 2019); Urban Green Spaces (Deng & Jim, 2017); and *Tiers Paysage* (Clément, 2004). Assuming a broader multi-species approach (Shingne, 2020), it is important to highlight that these natural gaps don't need to have a precise dimension which could be considered significant by planners: rather, all gap sizes are potential niches for the establishment and development of other living entities.

What is the urban?

Urbanization refers to the increase of percentage of population living in urban areas and to the total area occupied by urban settlements (United Nations, 2019). Between 2001 and 2018 the global built-up area increased at a rate of 0.7ht per day (Sun *et al.,* 2020), a fact which might produce a near tripling in the global urban land area between 2000 and 2030 (Angel *et al.,* 2011b; Seto *et al.,* 2012). Moreover, studies show that today cities are growing notably faster in terms of land area than population (Angel *et al.,* 2011a; Elmqvist *et al.,* 2013; Liu *et al.,* 2020), indicating that urban land area already exceeds what is needed to sustain population growth (Liu *et al.,* 2020).

The instrumentalist relationship with nature emerges from 20th century discourses that circulated on the roles of city and nature. As Swyngedouw and Kaika (2014) argue, during this period urban thought and practice "became de-naturalized." The Industrial Revolution accelerated landscape changes and their sociological consequences, and the main role of urban planning consisted of providing a solution for spreading disease and meeting productivity needs (Juvillà *et al.,* 2019). Architecture and urban planning were crucial disciplines treating urban regions as a *tabula rasa*. The principles of modern architecture, exposed in "The functional city", the 1933 Charter of Athens, identified the four functions of the city: dwelling, recreation, work and transportation. At the same time, perhaps due to conceptions dating from the romantic-idealistic movement, nature was conceived as something wild and pristine, relegated to the outskirts (Swyngedouw & Kaika, 2014), away from the frenetic pace of the growing city (Escobar, 2019). This fact was described by Lefebvre (1970) as a process of dominance, replacing the chaos of natural spontaneity with a coherent rationality. Swyngedouw & Kaika (2014) see it as an expression of the intrinsic "success" of the human over the non-human. The rationality of the 1933 Charter of Athens and Corbusier-inspired urban expansion plans have endured for decades (Martínez-Alier, 1995). Burdett (2018) also refers to urban rational paradigms as "an urban ideological model 80 years out-of-date" and Sennett (2015) refers to the contemporary city when he says, "we don't make them true to life, we make them into factories." The ensuing exponential growth in production, population and settlement globally, which has contributed to the current ecological crisis, is manifested in the built environment with, for example, flooding, droughts, the urban heat island effect, air pollution and concentration of disease vectors (Foley *et al.,* 2005; Juvillà *et al.*, 2019).

Although mainstream urban planning still does not deal effectively with a slowdown in urban metabolism (Lehtinen, 2018), urban initiatives have been implemented in order to face climatic change. In this sense, the EU Green Infrastructure strategy[3] aims to provide a wide range of ecosystem services (including climate mitigation and adaptation) flowing from nature to people, through the implementation of the Natura 2000 Network (European Commission, 2019). Other initiatives, such as smart cities[4] are focused on providing solutions to mitigate the urban consequences of the rapid increase of urban population in recent and upcoming decades. The SDG 11[5], which seeks to introduce sustainability and resilience as a basis for urban development, is conceived primarily from a social and human well-being perspective. In the same way, the global 2030 Agenda for Sustainable Development assumes that economic, technological and social progress can occur in harmony with nature[6] (United Nations, 2015).

The underlying reasoning behind these initiatives overlooks the fundamental causes of the current environmental-urban situation, skirting around long-term sustainability, and retaining a utilitarian view of nature. Similarly, 'sustainable development' doesn't contemplate a reduction in production, consumption and urban expansion, but signals that economic growth and innovation can address their effects. In a nutshell, the utilitarian valuation of nature (Rupprecht *et al.*, 2020) is still prevalent in the mainstream in Western countries, and the ultimate goal is to enhance human well-being, while fostering economic growth, under a society characterized by a growth discourse. Krähmer (2021) highlights the ineffectiveness of a green city strategy for ecological sustainability, due to the impossibility of decoupling environmental impacts and economic growth. Similarly, Xue (2015) outlines the long-term incompatibility between growth in housing stock and environmental sustainability.

Other initiatives, such as 'Biophilic cities'[7], capitalize on the innate attraction of the human species towards nature (Beatley, 2017). The concept of a 'multi-species' right to the city (Shingne, 2020), also responds

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[3] The Green Infrastructure strategy is a strategically planned network of natural and semi-natural areas designed and managed to deliver a wide range of ecosystem services in order to provide environmental, economic and social benefits (European Commission, 2019).

[4] Smart cities have emerged as a strategy to mitigate the problems generated by the urban population growth and the rapid urbanization. The main new technical, physical and material problems generated by rapidly growing cities are waste management, scarcity of resources, air pollution, human health concerns, traffic congestion and aging infrastructure (Chourabi *et al.,* 2012).

[5] SDG 11 from the *2030 Agenda for Sustainable Development* states: "Make cities and human settlements inclusive, safe, resilient and sustainable" (United Nations, 2015).

[6] In the vision of the 2030 Agenda for Sustainable Development, an elusive mention of the protection of wildlife and other living species is given, as well as the sustainable use of natural resources, yet at the same time assuming economic, social and technological 'progress' (United Nations, 2015).

[7] Biophilic cities refer back to the concept of Biophilia (Wilson, 2016), and are defined as "Cities that are nature-abundant, that seek to protect and grow nature, and that foster deep connections with the natural world" (Beatley, 2017).

to a deeper, respectful and non-utilitarian relationship with the natural world. A real "associative interaction" (Martínez Espinal, 2016) between human settlements and nature can be glimpsed in the concept of 'Ecopolis', referring to a set of local territorial systems, each with a strong capability for self-sustainability (Downton, 2009). Ostrom's much-debated work on institutions for collective governance and common property signaled the positive organizational principles held by ancient indigenous communities worldwide (Ostrom, 1990).

In this sense, some authors argue cities cannot become self-sufficient, since they are dependent on peripheries and broader networks, as well as driving exploitation and exclusion (McKinnon *et al.,* 2017). However, many local initiatives, developed in response to urgent and common necessities, have arisen. The Transition Towns movement aims to assist towns and communities envisioning self-reliant futures (Connors & McDonald, 2011; Dion & Laurent, 2015; Transition Network, 2016); there are movements for degrowth, with activism aimed at reclaiming urban spaces and growing food locally (Lloveras *et al.,* 2018; Lehtinen, 2018); as well examples of 'guerrilla gardening' (Berni, 2009; Hardman *et al.,* 2018). These all highlight the necessity of reclaiming fertile urban soil. The local scale of action is fundamental for nourishing a paradigm shift towards nature-care. It is also worth mentioning the study by Reese (2016) which showed that the more strongly people identified with a common human ingroup, the more concerned were they about nature protection, and the less they believe in the idea that humans have unprecedented power over nature. Yet at the same time, there needs to be a reconciliation between macro- and micro- levels of reality and the possibility of action (Kipfer, 2009; Loftus, 2018). In this sense, Beatley (2009, 2017) points out many urban management decisions which have been carried out by local governments strengthening the Biophilic Cities discourse; while Cohen and Bakker (2014) recall the importance of the ecological scale, such as bioregions, for decision making. Bringing together the local and the global, and the more-than-urban and the more-than-human world, is vital (Tzaninis *et al.,* 2021).

4. Urban ecological variables fostering natural recovery

The set of ecological variables that foster spontaneous plant colonization in the built environment are collected in Table 1, and they refer to the three studies mentioned in Section 3. The table presents the variables assessed, their corresponding category (a. *environmental conditions;* b. *physical characteristics;* c. *vegetation structure;* d. *anthropic/Anthropogenic pressure*), and the findings of each of the three studies regarding these variables. Figure 2 presents the assessed variables from Table 1 transposed to four mapping exercises for the community of Montblanc in Catalunya. Each one of the maps corresponds to each one of the four categories. The first depicts the environmental variables; map b), physical characteristics; map c) refers to vegetation structure and d) to human pressure. Figure 2 contributes to the materialization of a real urban degrowth process. This exercise provides an example of how the assessed variables could be represented geographically for an urban settlement, in order to bring together the theoretical research outlined above, and the practical requirements of visioning the re-vegetation of a territorial unit.

The technical terms used

These are several. *Ecological variable*: this means a factor concerning the interactions between living beings and their environment, which can influence the dynamic processes in communities of organisms.

Spontaneous plant colonization: refers to the process by which a species spreads to new areas following the dynamism of the successional process itself. The process of colonization of a previously altered habitat is called secondary succession (Terradas *et al.,* 1987).

Successional process: The natural dynamic process of transformation of communities of organisms over time. Some communities are replaced by others which are more stable and efficient in their use of resources. The general successional process for plant communities is as follows: 1. Increase in total biomass; 2. Increase in total primary production to maintain the system; 3. In the initial stages, diaspore-producing species predominate, and in the final stages, few-seed-producing species of zoochory dissemination (dispersed by animals); 4. Increased complexity and diversity of communities, greater stability of mature communities and greater ability to respond to external disturbances; 5. In the early stages of secondary succession, the composition of the communities exists within very wide limits, but moving to more and more defined and concrete final stages (Terradas *et al.,* 1987).

Biotic and abiotic factors: Biotic factors are those referring to any activity of a living organism which has an effect on the ecosystem, such as competition and facilitation interactions between species. Abiotic factors are the non-living parts of an ecosystem which have an effect on the environment, such as temperature, sunlight, water, wind, atmospheric conditions and soil.

Weathering processes: The physical process which changes solid rocks into sediments. Once these sediments are separated from the rocks, erosion is the process that moves the sediments away from their original position, by means of the four forces of erosion: water, wind, glaciers, and gravity (Dastrup, 2020).

Variable type	Variable	Description
a. environmental conditions	Precipitation	High levels of precipitation favor plant growth. The number of plants decreases in environments in which there is little precipitation and relative humidity is low all year round. Rain washes nitrates over the stone (coming from the bird excrement), which enriches the substrates and favors lichen colonization. Micro-sites at ground level favor rainwater accumulation, which together with natural substrate collection, favors plant growth (1). Direct exposure to rain favors the following plant functions: installation, germination, hydration, reproduction (2). Rain favors the deposition of air borne particles (3).
	Relative humidity	High levels of relative humidity favor plant growth (1). Also provides moisture, which stimulates the growth of microorganisms (3).
	Temperature	In the study by Manso *et al.*, Ghent (with lower average temperatures than Barcelona or Montseny), showed a higher amount of microorganisms on specimens. This fact may be due to its higher relative humidity and the even rainfall distribution throughout the year. Also another influencing factor to these results is time. All specimens were exposed for only one year in all locations. This short period allows higher biological growth in a location with oceanic conditions, while Mediterranean vegetation grows more slowly (3). Therefore, this variable is really related to water availability, but no conclusions can be drawn regarding the studies analyzed.
	Solar exposure	Sunshine is one of the abiotic factors which affect firstly built surfaces, by initiating the weathering process of the substrate for the later biological growth (1).
	Wind exposure	Wind is also one of the abiotic factors which affect built surfaces, initiating weathering process of the substrate for later biological growth. Wind works as a dispersal agent which allows some seeds to reach cracks or small cavities in the building material. Disperses lichens' reproductive structures in the atmosphere (1). Exposure to prevailing winds brings humidity and precipitation (2). Contributes to the spread of fungi. Light wind favors the deposition of air borne particles. Influences the maintenance of the organisms on built surfaces, although it could provoke the detachment of the most superficial organisms on vertical orientations (3). Wind exposure is related to other factors like temperature and humidity and hence together with high temperatures or low levels of humidity, it can be a limiting factor for biological growth, since it increases evapotranspiration. Also, wind speed is a factor which can biological growth negatively or positively.
	Other forms of water exposure	Lichens may grow along paths of water run-off. Retained water in pores or cavities favors lichen growth, hosts mosses and higher plants (1).
b. physical characteristics	Material pH	The pH of the substrate influences the first selection of lichen flora: neutral and alkaline favors calcicolous species; and acid favors silicic species (1). Substrate pH affects the following vegetal functions: installation, protection, hydration (2). High pH values (>12) are related to low bio receptivity; middle pH values (9-10) are suitable for biological colonization; low pH values (5-7) are suitable for fungal colonization. The presence of bacteria in the environment may cause a local drop in pH (3).

Variable type	Variable	Description
	Material porosity	Porous stone retains water and hosts mosses and higher order plants. Favors lichen growth. Stone surfaces which have become porous, after their transformation by air substances and bacteria, facilitate lichen growth (1). Porosity of materials favors the following plant functions: installation, protection, hydration. It favors spontaneous plant colonization (2).
	Presence of joints and fissures in materials	As well as pores and cavities, fissures and cracks favor the retention of water, the shelter of seeds, and therefore lichen and plant growth (1). Fissures and joints constitute favorable situations for the spontaneous plant colonization. The presence of joints and fissures favors the following plant functions: installation, protection, hydration (2).
	Material texture	Together with the chemical composition, texture of material determines the resistance of a building to atmospheric agents and colonization by forms of life (1). Rough textures favor the following plant functions: installation, hydration (2).
	Material type (besides material porosity, material pH and texture)	Porous materials or those with cracks, like travertine and red bricks, provide good microsites (1). Material's type can favor or deter the following plant functions: installation, protection, hydration. Petro-physicochemical characteristics of the material influence the establishment of living forms. For example, gritstone, old coatings and mortar surfaces may allow rare species to grow on flat surfaces, due to the high porosity (2). Ordinary cement is not feasible for the rapid development of a biological patina (due to high alkalinity) and low porosity. Despite this, its reaction with the atmospheric CO_2 causes a pH drop which is suitable for biological growth (due to the carbonation process) (3).
	Number of visible materials	The alternation of different construction materials allows multiplication of the possible settling points for vegetation within a building, regardless of the type of materials. The presence of materials with different physical characteristics as well as the consequent presence of joints between such materials imply favorable conditions for biological growth (2).
	Access to topsoil	The more access to substrate in the building micro-sites, the better conditions for plant growth (1). Good access and volume to topsoil favors the following plant functions: installation, protection, hydration, reproduction (2).
	Antiquity of construction	Favors biological growth, when other factors as the material type and other environmental and physical variables are also supportive. For example, certain Roman marbles are still in perfect condition, and only biological growth can be found where restoration has been performed with the use of modern materials (1). Antiquity of construction favors the following plant functions: installation, protection, hydration (2).
	Orientation	Orientation to the sun affects the following plant functions: installation, protection, respiration, hydration, photosynthesis (2). Horizontal surfaces offer better conditions for plant growth (more water and substrate); they offer more chance for seeds landing; a good perch for birds that excrete seeds; a good site for ant nests where seeds are stored. Horizontal surfaces in buildings host the greatest number of plants (1). Horizontal dihedrals favor plant growth due to protection and the greater deposition of organic matter. Horizontal surfaces favor the following vegetal functions: installation, photosynthesis (2). They offer a better deposition of bacteria, spores, and organic matter, as well as a greater exposure to climate conditions (rain, wind, sun) (3). Vertical orientations offer more limited conditions for biological growth than horizontal (1), hosting a lower presence of microorganisms (3). Moisture conditions due to condensation on the north sides favor lichen growth (1) North orientations favor more suitable conditions for biological growth (3).
c. vegetation structure	Proximity to a biodiversity reserve	Favors plant colonization and the arrival of seeds from elsewhere. The proximity to a biodiversity reserve favors the following plant functions: installation, reproduction (2).

Variable type	Variable	Description
	Presence of biological dispersal agents	Frugivorous birds, bats or mammals that eat fruit, as well as humans, pollinator insects, and ants can favor the dispersal of seeds/propagules and act as dispersal agents (1). These agents affect the following vegetal functions: installation, protection, reproduction (2). Human activity strongly influences species dispersal.
d. anthropic pressure	Air pollution	High pollution concentrations, particularly SO_2, impede lichen growth (1). Atmospheric pollution may not favor the following plant functions: installation, protection, respiration, hydration, photosynthesis, reproduction, and may favor respiration and hydration (2). Air pollutants such as fertilizers and atmospheric dust, favor nutrient enrichment and the formation of substrates. SO_2 forms sulphuric acid due to the oxidation process. Also, dry deposition of NO_x contributes to such process, favoring substrate formation for bacterial colonization. CO_2 contributes to the drop of pH in cementitious materials (the carbonation process that is of particular concern for ocean pH), which may be related to high bio-receptivity. Large amounts of pollutants favor bacterial presence (3).
	Trampling	Trampling may not favor the following plant functions: installation, protection, respiration, hydration, photosynthesis, reproduction, and may favor installation and reproduction, through the release of seeds or displacement (2).
	Vehicle circulation	Infrastructure like roads are a barrier for the dispersal of species. At the same time movement of mechanized vehicles can contribute to seed dispersal. Vehicle circulation may upset the following plant functions: installation, protection, reproduction (2).
	State of the building	The maintenance and use of a building determines its speed of deterioration, together with the other influencing factors mentioned, like wind and rainfall (1). States of abandonment favor biological growth. Maintenance works may affect the following plant functions: installation, protection, hydration, and reproduction (2).

Table 1: Variables influencing spontaneous plant colonization in urban environments. From studies by Lisci *et al.* 2003; Lagurgue *et al.* 2019 and Manso *et al.* 2015.

5. Discussion

Urban degrowth and spontaneous re-naturalization

Considering human activity to be the main target of justice-related mitigation and adaptation responses (Reese, 2016), the urban degrowth stance endorsed above is vital in the urban field, with all its complexities. Research in ecology and the natural sciences, as well as degrowth approaches from different disciplines are needed (Haase, 2008; Varvarousis & Koutrolikou, 2018). A necessary reversal of priorities entails urban reasoning and action, including consideration of ecological variables and the dynamics of other living beings. The more we learn about the ecological dynamics of cities, the more we can influence development patterns and grassroots processes and initiatives. The 'urban degrowth agenda' is rooted in alternative thinking about the fate of our economies and cities, but that is no reason that it should not also be informed by efforts to regreen and vegetate urban space (Lehtinen, 2018; Xue, 2021).

Political change can be articulated through ecological discourse (Cohen & Bakker, 2014). Knowing more about key ecological variables, and supplying this information to urban planners and other stakeholders, makes sense on a number of levels. The ecological layers of the city can be used as a tool to overlap with the existing urban plan to influence its gradual change over time, deducing future potential gaps in the de-occupation of anthropogenic activity, and contributing therefore to the settling of a network of "autonomous natural" spaces in the built environment, as well as to the connection of biodiversity reservoirs on a larger scale. The multi-species right to the city (Shingne, 2020) can be shaped through urban degrowth processes and the consequent liberation of fertile land for growing food and other purposes, which at the same time contributes to global environmental justice by fostering more local access to natural resources.

Ecological variables of the urban context fostering natural recovery

The natural successional processes that characterize every ecosystem, are also present in the urban context. Rapoport (1993) made useful studies of plant colonization in small settlements and large cities. In their study of spontaneous plant colonization on roofs, Deng and Jim (2017) confirmed the potential for more biodiversity enhancement and conservation in densely developed urban areas. I take the three studies as a lens through which to understand the intrinsic potential of spontaneous plant colonization in cities. These differ in terms of their locations and biota, as well as the goals of each study, meaning that no final conclusions can be drawn. However, the four assessed ecological categories, influencing the pace and direction of the plant colonization process, are described in Table 1. Of course, high levels of precipitation and relative humidity may favor vegetation colonization. Also, the incidence of the abiotic agents which contribute to the weathering process of the substrate, such as solar radiation, wind and other forms of water exposure, may accelerate biological growth. The type of material influences a greater pace of plant colonization in buildings, particularly, low pH substrates with high levels of porosity, rough textures, joints and fissures. The antiquity of a building favors plant growth, but its pace will be determined by other influencing variables. Horizontal flat surfaces with northern orientations (in the northern hemisphere) are more suitable for spontaneous plant growth.

As for vegetation structure, the proximity to a biodiversity reserve favors colonization by plants, since it is usually a main source for the arrival of external seeds. Bochet *et al.* (2007) found neighboring vegetation acts as a seed reservoir for spontaneous colonization of adjacent road corridors. Moreover, the presence of dispersal agents, even human, favors seeds dispersal. Also, Deng and Jim's study of green roof designs (2017), showed that the propagules of the established plants were brought primarily by birds and wind, and secondarily inherited from the soil seed bank. In a study by Bochet *et al.* (2007), wind-dispersed plants were over-represented in the process of spontaneous plant colonization along roads. Regarding anthropic pressure, high levels of atmospheric pollution do not favor biological growth, although some pollutants may contribute to the formation of substrate for bacterial colonization. Human management of weedy and other species obviously reduces spontaneous plant colonization.

A description of each of the four diagrams in Figure 2 requires clarification of the different ecological categories, as given in Table 1 (a. environmental conditions, b. physical characteristics, c. vegetation structure and d. anthropic pressure). Note that these descriptions correspond to the specific case of the particular urban settlement studied in each research project.

a. *Environmental conditions*: The topographic level +400m is represented, as it can operate as a barrier for the prevailing westerly winds. Watercourses, also shown, are humid veins which can favor the process of spontaneous re-naturalization. The other environmental factors in Table 1 are key factors that shape areas with a greater potential for plant colonization within the city.

b. *Physical characteristics*: Topography directs the path of watercourses. Natural watercourses can become future green corridors (Downton, 2009), and the orientation of steep slopes directly influences plant colonization. The geology of urban areas defines the characteristics of the substrate. The map illustrates the different buildings of the old town and to the Roman times; ceramic constructions, corresponding to urban expansions mostly from 18^{th} to 20^{th} centuries, and the arrival of concrete from the end of the 20^{th} century. The use of metals for construction are also recent arrivals.

c. *Vegetation structure*: What Linglart *et al*. (2016) call Spaces of Natural Character are biodiversity reserves, creating opportunities for plant colonization. These can be classified as primary and secondary biodiversity cores and corridors, according to their size, shape and vegetation density. Abandoned agricultural plots are included in the second category.

d. *Anthropic/Anthropogenic pressure*: These are several, as described in Table 1, but the map focuses on corridors. Road infrastructure is the main creator of atmospheric and noise pollution. They are also a barrier for plant colonization. The map shows highways, railways, regional roads, smaller roads and paths. It also shows the extent of the built environment, as well as active agricultural holdings.

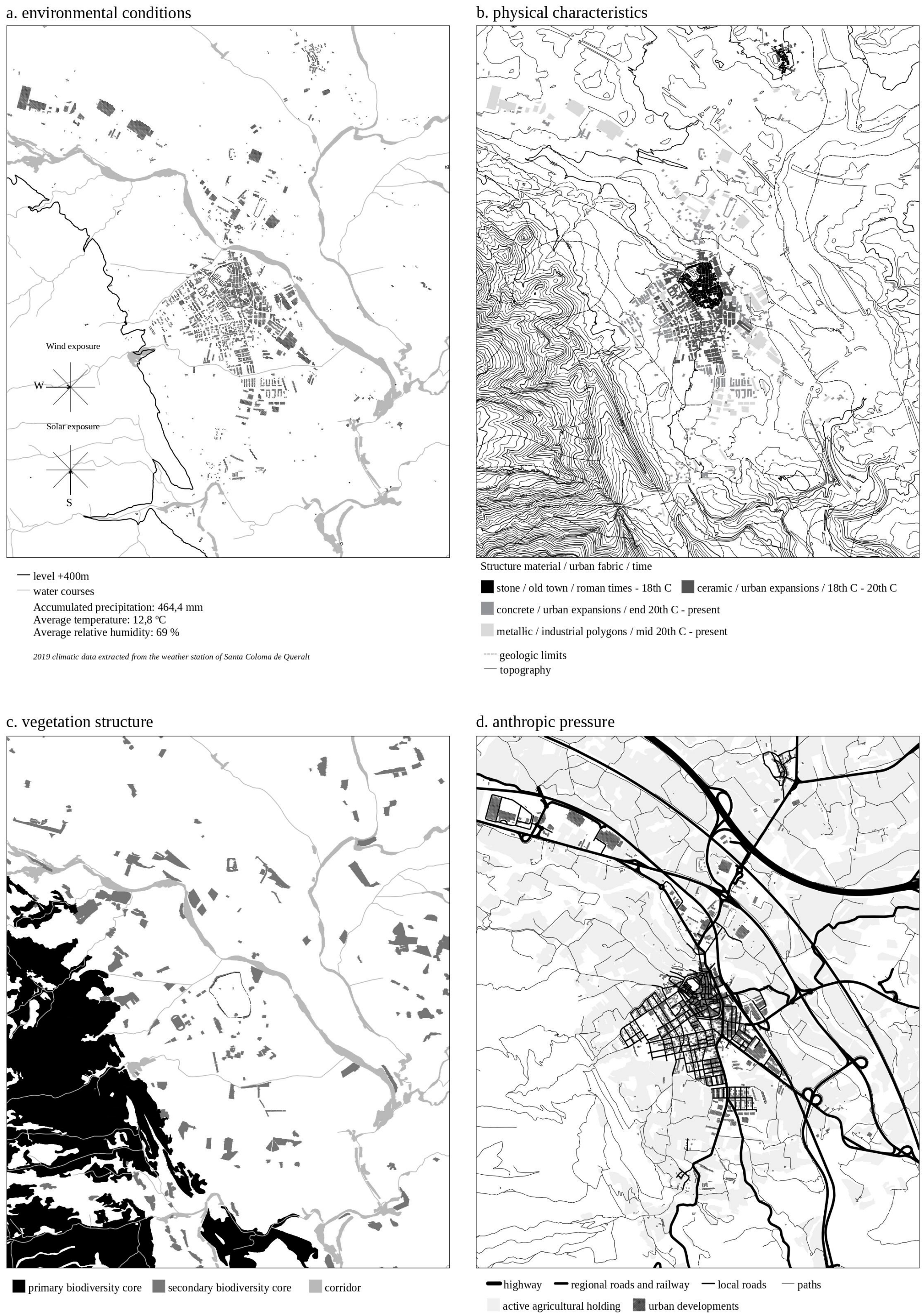

Figure 2: Mapping of the ecological variables that influence spontaneous plant colonization in an urban settlement, Montblanc in Catalunya.

6. Conclusion

Ecological variables and other living beings have been ignored in the intrinsic valuation approach prevalent in architecture and urbanism in previous decades. To support the non-human world, urban de-occupation and spontaneous re-naturalization are required, as well as the re-localization of food and agriculture in cities referred to above (Trainer 2019; Krähmer, 2022). This article has elaborated an initial descriptive approach that supports an ecological position that is an alternative one; that as part of urban degrowth, a process of urban de-occupation and spontaneous re-naturalization should occur. I presented a theoretical framework from political ecology, urban planning, deep ecology and degrowth thinking, before proposing a preliminary investigation into the spatial materialization of spontaneous re-naturalization. The main ecological variables that influence spontaneous plant colonization in the urban environment were identified, and then mapped for one urban settlement. This is a fundamental step, because it links theory to the practical question of spontaneous re-naturalization and its policy implications.

A new economic, social and nature-relational paradigm takes elements of urban degrowth, and appeals to some of the core tenets of political ecology, pushing practitioners to include ecological variables in envisioning and constructing a better future. Political change can be articulated through ecological discourse, and hence the knowledge of ecological dynamics and of other living beings in cities could be applied to territorial management in order to foster a real urban degrowth process at different scales. The article recognized urban degrowth as an essential goal, in the context of caring for nature. New global and local conservation policies could involve practical collective actions and initiatives that promote it. This goal can only be reached from a conception which assumes us, human beings, as one thread more in the complex whole life system of this planet.

References

Angel, S., Parent, J., Civco, D. L., Blei, A., & Potere, D. (2011a). The dimensions of global urban expansion: Estimates and projections for all countries, 2000-2050. *Progress in Planning*, 75(2), 53-107. https:/doi.org/10.1016/j.progress.2011.04.001

Angel, S., Parent, J., Civco, D. L., & Blei, A. M. (2011b). *Making room for a planet of cities*. Policy Focus Report. Lincoln Institute of Land Policy.

Arrif, T., Blanc, N., & Clergeau, P. (2011). Trame verte urbaine, un rapport Nature–Urbain entre géographie et écologie. *Cybergeo: European Journal of Geography,* 574. https://doi.org/10.4000/cybergeo.24862

Barau, A. S., & Ludin, A. N. (2012). Intersection of landscape, Anthropocene and fourth paradigm. *Living Reviews Landscape Research,* 6, (1). http://dx.doi.org/10.12942/lrlr-2012-1

Beatley, T. (2009). Biophilic urbanism: Inviting nature back to our communities and into our lives. *William & Mary Environmental Law and Policy Review,* 34, 209. https://scholarship.law.wm.edu/wmelpr/vol34/iss1/6/

Beatley, T. (2017). Biophilic cities and healthy societies. *Urban Planning*, 2(4), 1-4. https://doi.org/10.17645/up.v2i4.1054

Berni, F. (2009). Una resistenza "verde" contro il degrado urbano: il Guerrilla Gardening. *Ri-Vista: Research for Landscape Architecture,* 12(2), 79-84. https://doi.org/10.13128/RV-17350

Berry, T. (1984). *The Twelve Principles* [Video]. http://thomasberry.org/publications-and-media/thomas-berry-the-twelve-principles.

Bochet, E., García-Fayos, P., & Tormo, J. (2007). Road slope revegetation in semiarid Mediterranean environments. Part I: seed dispersal and spontaneous colonization. *Restoration Ecology*, 15(1), 88-96. https://doi.org/10.1111/j.1526-100X.2006.00193.x

Bromley, D. W. (1991). *Environment and economy: Property rights and public policy.* Blackwell.

Burdett, R. (2018). Contemporary urbanism. In UN Habitant & Sennett, R. (Eds.), *The Quito Papers and the New Urban Agenda.* Routledge. Pp. 140-149.

Burkholder, S. (2012). The new ecology of vacancy: Rethinking land use in shrinking cities. *Sustainability*, 4(6), 1154-1172. https://doi.org/10.3390/su4061154

Bryant, R. L., & Bailey, S. (1997). *Third world political ecology.* Routledge.

Büscher, B., Fletcher, R., Brockington, D., Sandbrook, C., Adams, W. M., Campbell, L. *et al*. (2017). Half-Earth or Whole Earth? Radical ideas for conservation, and their implications. Oryx, 51, 407-410. https://doi.org/10.1017/S0030605316001228

Callicott, J. B. (1980). Animal liberation: A triangular affair. *Environmental Ethics*, 2(4), 311-338. https://doi.org/10.5840/enviroethics19802424

Capra, F. (1997). *The web of life: A new scientific understanding of living systems*. Anchor.

Chan, K., & Satterfield, T. (2013). Justice, equity, and biodiversity. In Levin, S. A. (Ed.). *The Encyclopedia of Biodiversity*. Pp. 434-441. https://dx.doi.org/10.14288/1.0132712

Chourabi, H., Nam, T., Walker, S., Gil-Garcia, J. R., Mellouli, S., Nahon, K. & Scholl, H. J. (2012). Understanding smart cities: An integrative framework. In 45th *Hawaii International Conference On System Sciences* (pp. 2289-2297). IEEE. https://doi.org/10.1109/HICSS.2012.615

Clément, G. (2004). *Manifeste du Tiers paysage*. Sujet/Objet.

Clergeau, P. (2015). *Manifeste pour la ville biodiversitaire*. Apogée ed.

Cohen, A., & Bakker, K. (2014). The eco-scalar fix: Rescaling environmental governance and the politics of ecological boundaries in Alberta, Canada. *Environment and Planning D: Society and Space*, 32(1), 128-146. https://doi.org/10.1068/d0813

Connors, P., & McDonald, P. (2011). Transitioning communities: community, participation and the Transition Town movement. *Community Development Journal*, 46(4), 558-572. https://doi.org/10.1093/cdj/bsq014

Cristiano, S., Zucaro, A., Liu, G., Ulgiati, S., & Gonella, F. (2020). On the systemic features of urban systems. A look at material flows and cultural dimensions to address post-growth resilience and sustainability. *Frontiers in Sustainable Cities*, 2, 12. https://doi.org/10.3389/frsc.2020.00012

Cucca, R., & Friesenecker, M. (2021). Potential and limitations of innovative housing solutions in planning for degrowth: the case of Vienna. *Local Environment*, 1-15. https://doi.org/10.1080/13549839.2021.1872513

Cullinan, C. (2003). *Wild law: A manifesto for earth justice*. Revised 2011. Green Books.

D'Alisa, G., Demaria, F., & Kallis, G. (Eds.) (2014). *Degrowth: a vocabulary for a new era*. Routledge.

Dastrup, R. A. (2020). Geography as a Science. In Dastrup, R. A. *Introduction to world regional geography*. OER textbook. https://slcc.pressbooks.pub/worldgeography/chapter/1-2/

Davidson, M. D. (2013). On the relation between ecosystem services, intrinsic value, existence value and economic valuation. *Ecological Economics*, 95, 171-177. https://doi.org/10.1016/j.ecolecon.2013.09.002

Davis, M. (1992). *Beyond blade runner: Urban control, the ecology of fear*. Open Media.

Demaria, F., Schneider, F., Sekulova, F., Martinez-Alier, J. (2013). What is degrowth? From an activist slogan to a social movement. *Environmental Values* 22 (2): 191-215. https://doi.org/10.3197/096327113X13581561725194

Deng, H., & Jim, C. Y. (2017). Spontaneous plant colonization and bird visits of tropical extensive green roof. *Urban Ecosystems*, 20(2), 337-352. https://doi.org/10.1007/s11252-016-0596-3

Dion, C., & Laurent, M. (2015). *Demain* [Documentary]. France: Move Movie; Mars Films; Mely Productions; France 2 Cinéma.

Downton, P. F. (2009). *Ecopolis: Architecture and cities for a changing climate*. Springer.

Elmqvist, T., Andersson, E., McPhearson, T., Bai, X., Bettencourt, L., Brondizio, E. & Van Der Leeuw, S. (2021). Urbanization in and for the Anthropocene. *NPJ: Urban Sustainability*, 1(1), 1-6. https://doi.org/10.1038/s42949-021-00018-w

Elmqvist, T., Fragkias, M., Goodness, J., Güneralp, B., Marcotullio, P. J., McDonald, R. I., ... & Wilkinson, C. (2013). *Urbanization, biodiversity and ecosystem services: challenges and opportunities: a global assessment*. Springer Nature. http://doi.org/10.1007/978-94-007-7088-1

Escobar, A. (2019). Habitability and design: Radical interdependence and the re-earthing of cities. *Geoforum*, 101, 132-140.

European Commission (2019) *Review of progress on implementation of the EU green infrastructure strategy*. 24.5.2019 COM(2019). Report from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. https://ec.europa.eu/environment/nature/ecosystems/index_en.htm [accessed 03 September 2021]

Florentin, D. (2018). The challenges of degrowth in cities. *Field Actions Science Reports* 18, 16-19. http://journals.openedition.org/factsreports/4674

Foley, J. A., DeFries, R., Asner, G. P., Barford, C., Bonan, G., Carpenter, S. R., ... & Helkowski, J. H. (2005). Global consequences of land use. *Science*, 309(5734), 570-574. https://doi.org/10.1126/science.1111772

Güneralp, B., & Seto, K. C. (2013). Futures of global urban expansion: Uncertainties and implications for biodiversity conservation. *Environmental Research Letters*, 8(1), 014025. https://doi.org/10.1088/1748-9326/8/1/014025

Haase, D. (2008). Urban ecology of shrinking cities: an unrecognized opportunity? *Nature and Culture*, 3(1), 1-8. https://doi.org/10.3167/nc.2008.030101

Hardman, M., Chipungu, L., Magidimisha, H., Larkham, P. J., Scott, A. J., & Armitage, R. P. (2018). Guerrilla gardening and green activism: Rethinking the informal urban growing movement. *Landscape and Urban Planning*, 170, 6-14. https://doi.org/10.1016/j.landurbplan.2017.08.015

Hough, M. (1995). *Cities and natural process.* Routledge.

Huang, C. W., McDonald, R. I., & Seto, K. C. (2018). The importance of land governance for biodiversity conservation in an era of global urban expansion. *Landscape and Urban Planning*, 173, 44-50. https://doi.org/10.1016/j.landurbplan.2018.01.011

Jantz, S. M., Barker, B., Brooks, T. M., Chini, L. P., Huang, Q., Moore, R. M., ... & Hurtt, G. C. (2015). Future habitat loss and extinctions driven by land-use change in biodiversity hotspots under four scenarios of climate-change mitigation. *Conservation Biology*, 29(4), 1122-1131. https://doi.org/10.1111/cobi.12549

Juvillà, E., Beatley, T., Castell, C., Clergeau, P., Boada, M., Maneja, R., *et al.* (2019). *Renaturalització de la Ciutat/ Renaturing cities*. Diputació de Barcelona. https://floraornamentaldebarcelona.files.wordpress.com/2019/06/renaturalitzacic3b3-de-la-ciutat.pdf and http://docplayer.net/161806864-Town-planning-and-housing-series-renaturing-cities-estudis-collection.html [accessed Feb. 2022]

Keil, R. (2003). Urban political ecology. *Urban Geography*, 24, 723–738. https://doi.org/10.2747/0272-3638.24.8.723

Kipfer, S. (2009). Why the urban question still matters: reflections on rescaling and the promise of the urban. In Keil, R. & Mahon, R. (Eds.). *Leviathan undone*. (pp. 67-85). University of British Colombia Press.

Kothari, A. (2021). Half-Earth or Whole-Earth? Green or transformative recovery? Where are the voices from the Global South? *Oryx*, 55(2), 161-162. http://doi.org/10.1017/S0030605321000120

Kowarik, I. (2018). Urban wilderness: Supply, demand, and access. *Urban Forestry & Urban Greening*, 29, 336-347. https://doi.org/10.1016/j.ufug.2017.05.017

Krähmer, K. (2021). Are green cities sustainable? A degrowth critique of sustainable urban development in Copenhagen. *European Planning Studies*, 29(7), 1272-1289. https://doi.org/10.1080/09654313.2020.1841119

Krähmer, K. (2022). Degrowth and the city, *City*. In press. http://doi.org/10.1080/13604813.2022.2035969

Lagurgue, X., Mayrand, F., & Clergeau, P. (2019). Typologie de l'implantation de la flore spontanée en ville dense, regard croisé écologue-architecte. *VertigO: la revue électronique en sciences de l'environnement*, 19(2). https://id.erudit.org/iderudit/1071328ar

Latouche, S. (2007). *Petit traité de la décroissance sereine*. Mille et une nuits.

Lefebvre, H. (1970). *La révolution urbaine*. Gallimard.

Lehtinen, A. A. (2018). Degrowth in city planning. *Fennia*, 196 (1) , 43-57 http://dx.doi.org/10.11143/fennia.65443

Leopold, A. (1949). *A Sand County Almanac*. Oxford University Press.

Le Roux, D. S., Ikin, K., Lindenmayer, D. B., Blanchard, W., Manning, A. D., & Gibbons, P. (2014). Reduced availability of habitat structures in urban landscapes: implications for policy and practice. *Landscape and Urban Planning*, 125, 57-64. https://doi.org/10.1016/j.landurbplan.2014.01.015

Lisci, M., Monte, M., & Pacini, E. (2003). Lichens and higher plants on stone: a review. *International Biodeterioration & Biodegradation*, 51(1), 1-17. https://doi.org/10.1016/S0964-8305(02)00071-9

Liu, X., Huang, Y., Xu, X., Li, X., Li, X., Ciais, P., ... & Zeng, Z. (2020). High-spatiotemporal-resolution mapping of global urban change from 1985 to 2015. *Nature Sustainability*, 3(7), 564-570. https://doi.org/10.1038/s41893-020-0521-x

Lloveras, J., Quinn, L., & Parker, C. (2018). Reclaiming sustainable space: A study of degrowth activists. *Marketing Theory*, 18(2), 188-202. https://doi.org/10.1177/1470593117732458

Loftus, A. (2018). Planetary concerns. *City*, 22(1), 88-95. https://doi.org/10.1080/13604813.2018.1434304

Manso, S., Calvo-Torras, M. Á., De Belie, N., Segura, I. & Aguado, A. (2015). Evaluation of natural colonisation of cementitious materials: effect of bioreceptivity and environmental conditions. *Science of The Total Environment*, 512, 444-453. https://doi.org/10.1016/j.scitotenv.2015.01.086

Martínez-Alier, J. (1995). Urbanismo y ecología en Barcelona. *Temes de Disseny*, (11), 67-81.

Martínez-Alier J., Anguelovski I., Bond P., Del Bene D., Demaria F., Gerber J.-F., Greyl L., Haas W., Healy H., Marín-Burgos V., Ojo G., Porto M., Rijnhout L., Rodríguez-Labajos B., Spangenberg J., Temper L., Warlenius R. and I.Yánez. (2014). Between activism and science: grassroots concepts for sustainability coined by Environmental Justice Organizations. *Journal of Political Ecology* 21: 19-60. https://doi.org/10.2458/v21i1.21124

Martínez Espinal, H. (2016). *Del hábito, al hábitat y al habitar: el origen de la contradicción entre el comportamiento espacial unitario y sistémico del mundo natural y el comportamiento espacial fragmentado y errático del mundo civilizado occidental*. Universidad del Valle, Programa Editorial.

McKinnon, I., Hurley, P. T., Myles, C. C., Maccaroni, M. & Filan, T. (2017). Uneven urban metabolisms: toward an integrative (ex) urban political ecology of sustainability in and around the city. *Urban Geography*, 40(3), 352-377. https://doi.org/10.1080/02723638.2017.1388733

Millennium Ecosystem Assessment, M.E.A. (2005). *Ecosystems and human well-being*. Washington, DC: Island Press.

Naess, A. (1973). The shallow and the deep, long-range ecology movement. A summary. *Inquiry*, 16(1-4), 95-100. https://doi.org/10.1080/00201747308601682

Naess, A. (1990). *Ecology, community and lifestyle: Outline of an ecosophy*. Cambridge University Press.

Nelson, A., & Schneider, F. (Eds.). (2018). *Housing for degrowth: Principles, models, challenges and opportunities*. Routledge.

Ostrom, E. (1990). *Governing the commons: The evolution of institutions for collective action.* Cambridge University Press.

Pimm, S. L., & Raven, P. (2000). Biodiversity: Extinction by numbers. *Nature*, 403(6772), 843–845. https://doi.org/10.1038/35002708

Pincetl, S. (2017). Cities in the age of the Anthropocene: Climate change agents and the potential for mitigation. *Anthropocene*, 20, 74-82. https://doi.org/10.1016/j.ancene.2017.08.001

Rabhi, P. (2008). *Manifeste pour la terre et l'humanisme.* Actes Sud.

Rapoport, E. H. (1993). The process of plant colonization in small settlements and large cities. In McDonnell, M.J. and Pickett, S. T. A. (Eds.). *Humans as components of ecosystems*. (pp. 190-207). Springer. https://doi.org/10.1007/978-1-4612-0905-8_16

Reese, G. (2016). Common human identity and the path to global climate justice. *Climatic Change*, 134(4), 521-531. https://doi.org/10.1007/s10584-015-1548-2

Regan, T. (1987). The case for animal rights. *Advances in Animal Welfare Science 1986/87* (pp. 179-189). Springer. https://doi.org/10.1007/978-94-009-3331-6_15

Riechmann, J. (2020). No hay naturaleza? Filosofia enfront de l'ecocidi [Conference presentation, February 3 – March 2]. Institut d'humanitats de Barcelona. https://www.instituthumanitats.org/index.php/ca/cursos/filosofia-enfront-de-l-ecocidi

Rockström, J., Steffen, W., Noone, K., Persson, Å., Chapin III, F. S., Lambin, E.,... & Foley, J. (2009). Planetary boundaries: exploring the safe operating space for humanity. *Ecology and Society*, 14(2). http://www.ecologyandsociety.org/vol14/iss2/art32/

Roy, A. (2016). What is urban about critical urban theory? *Urban Geography*, 37(6), 810-823. https://doi.org/10.1080/02723638.2015.1105485

Rupprecht C. D. D., Vervoort, J., Berthelsen, C., Mangnus, A., *et al.* (2020). Multispecies sustainability. *Global Sustainability* 3, e34, 1–12. https://doi.org/10.1017/sus.2020.28

Sennett, R. (2015). *Uncomfortable spaces: Richard Sennett on Urbanism* [Video]. The Architectural Review. https://www.architectural-review.com/films/interview-richard-sennett

Seto, K., Güneralp B. and Hutyra, L.R. (2012). Global forecasts of urban expansion to 2030 and direct impacts on biodiversity and carbon pools. *Proceedings of the National Academy of Sciences* 109, 40, 16083-16088. https://doi.org/10.1073/pnas.1211658109

Seto, K. C., Parnell, S., & Elmqvist, T. (2013). A global outlook on urbanization. In *Urbanization, biodiversity and ecosystem services: challenges and opportunities: a global assessment*. (pp. 1-12). Springer Nature. http://doi.org/10.1007/978-94-007-7088-1

Shingne, M. C. (2020). The more-than-human right to the city: A multispecies reevaluation. *Journal of Urban Affairs*, 1-19. https://doi.org/10.1080/07352166.2020.1734014

Shoreman-Ouimet, E., & Kopnina, H. (2015). Reconciling ecological and social justice to promote biodiversity conservation. *Biological Conservation*, 184, 320-326. https://doi.org/10.1016/j.biocon.2015.01.030

Sikor, T., Martin, A., Fisher, J., & He, J. (2014). Toward an empirical analysis of justice in ecosystem governance. *Conservation Letters*, 7(6), 524-532. https://doi.org/10.1111/conl.12142

Spirn, A. W. (1984) *The granite garden: Urban nature and human design*. Basic Books.

Sun, L., Chen, J., Li, Q., & Huang, D. (2020). Dramatic uneven urbanization of large cities throughout the world in recent decades. *Nature Communications*, 11(1), 1-9. https://doi.org/10.1038/s41467-020-19158-1

Swyngedouw, E., & Kaika, M. (2014). Urban political ecology. Great promises, deadlock… and new beginnings? *Documents d'anàlisi geogràfica*, 60(3), 459-481. https://doi.org/10.5565/rev/dag.155

Taylor, P.W. (1986). *Respect for Nature: A theory of environmental ethics*. Princeton University Press.

Terradas, J. (1987). Ecosistemes terrestres. La resposta als incendis i a altres perturbacions. *Quaderns d'Ecologia Aplicada*, 10, 201.

Trainer, T. (2019). Remaking settlements for sustainability: the Simpler Way. *Journal of Political Ecology* 26(1), 202-223. https://doi.org/10.2458/v26i1.22972

Transition Network team (2016). *The essential guide to doing transition. Getting Transition started in your street, community, town or organisation.* Transition Network. https://www.transitionnetwork.org

Tzaninis, Y., Mandler, T., Kaika, M., & Keil, R. (2021). Moving urban political ecology beyond the 'urbanization of nature'. *Progress in Human Geography*, 45(2), 229-252. https://doi.org/10.1177/0309132520903350

United Nations. (2019). World urbanization prospects: The 2018 revision (ST/ESA/SER.A/420). Department of Economic and Social Affairs, Population Division, United Nations.

United Nations. (2015). Transforming our world: the 2030 Agenda for Sustainable Development. A/RES/70/1. United Nations General Assembly. https://www.refworld.org/docid/57b6e3e44.html [accessed 11 June 2021]

Vaccaro, I., Beltran, O., & Paquet, P. (2013). Political ecology and conservation policies: some theoretical genealogies. *Journal of Political Ecology*, 20(1), 255-272. https://doi.org/10.2458/ v20i1.21748

Varvarousis, A. & Koutrolikou, P. (2018). Degrowth and the city. Overgrowth. *E-flux Architecture*. October 23. https://www.e-flux.com/architecture/overgrowth/221623/degrowth-and-the-city

Vettese, T. (2018). To freeze the Thames: Natural geo-engineering and biodiversity. *New Left Review*, (111), 63-86.

Wächter, P. (2013). The impacts of spatial planning on degrowth. *Sustainability*, 5(3), 1067-1079. https://doi.org/10.3390/su5031067

Wilson, E. O. (1993). *The diversity of life*. WW Norton & Company.

Wilson, E. O. (2016). *Half-Earth: our planet's fight for life*. WW Norton & Company.

Witoszek, N. (1996). Rethinking Deep Ecology. Proceedings from a Seminar at SUM, University of Oslo, 5 September 1995. Center for Development and the Environment, Oslo.

Xue, J. (2015). Sustainable housing development: decoupling or degrowth? A comparative study of Copenhagen and Hangzhou. *Environment and Planning C: Government and Policy*, 33(3), 620-639. https://doi.org/10.1068/c12305

Xue, J. (2021). Urban planning and degrowth: a missing dialogue. *Local Environment*, 1-19. https://doi.org/10.1080/13549839.2020.1867840