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The Importance of the Holistic View in Urbanism: The Role of Physical Geography in the Sustainable City of the 21st Century

A. M. Rochette Cordeiro
University of Coimbra
Centre for Interdisciplinary Studies
http://orcid.org/0000-0002-8648-3204

ABSTRACT

The need for an interdisciplinary approach to urban planning is an undeniable fact in the 21st century vision of sustainable cities. Although in geography studies urban planning has always been regarded as a field of human geography, resilience to climate change and the importance of ecosystems in increasingly populated territories offer new perspectives to physical supports, in particular in urban design and in its relevance in environmental aspects of sustainable urban planning. This study takes an integrated approach to physical geography in order to understand urban environments through urban landscapes from a socio-natural standpoint. In the last decade, both at global level, through the Sustainable Development Goals (SDGs), and at European level, through directives and environmental programmes, such as the Urban Agenda for the EU and the European Climate Law, the adaptations of urban climate, air quality, and sustainable land-use contingent to nature-based solutions brought about new challenges and perspectives to the 21st century city. In this framework, the energy efficiency and decarbonisation issues were brought into the equation, being key elements in sustainable urban development. Adapting the sub-areas of physical geography to the different mosaics in urban spaces in a holistic manner by analysing endogenous factors – "morphological system" – and exogenous factors – climate –, as well as all those interconnected thereto downstream – hydrology, natural hazards, or the different environmental management and land-use and occupation instruments provides physical geographers with opportunities for the urbanisation of nature, in a temporal matrix, showing the trajectories of transformation of urban settlements.

Keywords: Urban Ecosystems; Physical Geography; future city; Sustainable urban design.

INTRODUCTION

The consequences of rapid urban growth and related boom of population living in cities in the latter half of the last century, which should see a hike in this century (Angel *et al*., 2005), can be as beneficial as detrimental for people and the environment (United Nations, 2014; 2018). As urban areas replace natural environments with anthropized materials and surfaces, forming their own environmental and territorial mosaics, serious comprehensive and integrated knowledge of the environment and urban ecosystems is required.

Although urban and spatial planning and its relationship with the understanding of the environment appeared primarily in the early 1960s with the publication of "*Design with nature*" by I. McHarg (McHarg, 1961), this topic gained momentum in the subsequent decade. In this

regard, the importance of the analysis of the urban ecosystem in UNESCO's programme published in the 1970s should be emphasised: "*Man and Biosphera*" (UNESCO, 1975). In the late 1970s and in the spirit and follow-up of previous works (Mumford, 1938; Geddes, 1904: cfr. Higuerras, 2006) Manfredi Nicoletti published "*El ecossistema urbano*" (Nicoletti, 1978). The study of the city as an artificial ecosystem then appeared on the media agenda and this is the time when the urban environment came to be discussed and analysed (Douglas, 1983 [1]; McDonnell, 2011).

It should be noted, however, that the conservation of nature and ecological networks dates as far back as the 1st half of the 19th century, with forerunners George Catlin, George Perkins Marsh and John Wesley Power, who upheld conservationist theories to "mitigate" human activity. At the time, Henry David Thoreau wrote about "…*the importance of preserving some portions of unspoiled nature by applying its ideals to urban design*" (Meneguetti, 2007: 23). Many of these works influenced the ideas of, inter alia, Frederick Law Olmsted, who in the latter half of the 19th century developed a number of plans – Yosemite Valley (California), Riverside (Illinois) and Fens and Riverway (Boston), the latter already at the end of the century (1891), which resulted in the first metropolitan park system planned on the basis of ecological and hydrological features (Meneguetti, 2007: 24). The ideals of planning in keeping with nature were vital to the works of many contemporary or early 19th century landscape architects. In Europe, and particularly in England, Ebenezer Howard posited the idea of Garden Cities in the sense of balancing the growing post-industrial revolution urbanisation and the needs of nature, in a clear regenerative way of thinking (Lyle, 1994: cfr. Meneguetti, 2007: 25). However, many others addressed these themes on both sides of the Atlantic, an example of which is the concept of the "*natural continuum*" embedded in the 1929 Berlin plan, coordinated by Martin Wagner (Magalhães, 2001: 107), or the "*greenways*" of the second half of the 20th century (Fabos, 1991; Little, 1990: cfr. Machado e Ahern, 1997), which had as guiding principles the work of Olmsted and being implemented in a variety of sectors in the USA and Europe (Cordeiro, 2005).

Thus, today it seems entirely accepted that territorial management instruments should consider the integration of interdisciplinary biophysical knowledge in planning processes, especially those associated with human settlements: maps with overlapping and integrated biophysical information that identify, from an ecological viewpoint, the sensitive sectors which the territory should preserve (as McHarg stated "as far back as" 1969), protecting and clearly involving environmental resources and physical supports in urban or spatial planning, acting as fundamental pieces in the current planning, have only been around for a few decades.

Against this background, it is therefore not surprising that, within the "specialisation" in geography, human geographers have always considered urban planning with implicit reservation (Ashmore & Dodson, 2017). It seems clear that physical geography was, for decades, viewed as an ancillary discipline in the urban environment, associated by choice to matters of detail, or later, in the Portuguese case, in the definition of maps with restrictions in municipal master plans. However, the transformation associated with the need for urban sustainability due to population growth due to the growth of cities, and in particular through

[1] Indeed, the foregoing situation regarding the weight of the social environment in the context of urban planning seemed so evident that he even stated, somewhat provocatively, that learning about the cities without considering both the biophysical and the social environment "was absolutely non-academic" (Douglas, 1983: 206)

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the UN Sustainable Development Goals, namely Goal 11 "Sustainable cities and communities" (PNUD 2015; Cabaço, 2017), offered great potential to urban physical geography, changing the way in which physical geographers were viewed in relation to the sustainable and healthy city, even though the urban environment and ecology had already foreseen that need.

Following the European Commission's guidelines on the promotion of urban regeneration, in a smart and sustainable city framework, and materialised through substantial financial contributions, such regeneration is presented through an interdisciplinary vision which should include not only the environmental approach through *nature-based solutions* (NBS) but also the process of co-creation in the social approach, which will serve as the cornerstone in the entire process. Financing projects have been aiming not only at research projects, but also at supporting broad and applied innovation activities for transferring research from universities to communities, thus promoting the establishment of "living laboratories" (Brears, 2020; Moniz & Ferreira, 2019; European Commission, 2021).

In this sense, the planning and management of a territory requires a careful analysis of all its constituent elements, having due regard to physical, human, social, economic and cultural aspects so that the planning thereof is not called into question and, at the same time, does not cause conflicts when spaces are built or regenerated. Sustainable urban planning should therefore involve a holistic vision that integrates not only the different fields of human geography and related sciences, but also the relevant physical geography and related sciences (McPhearson *et al.,* 2016), in an integrated perspective taken on by urban environment (Douglas, 1983) and urban ecology (McPhearson, 2016; Douglas *et al.,* 2020).

It is very clear that the strong trend towards urbanisation observed in Portugal in the latter half of the 20th century, notably in the Portuguese coastal areas, led to the destructuralisation of space, with the sealing of large land surfaces which significantly transformed rural and periurban spaces, downgrading the public space as a result of the change in the relation between rural and urban spaces that characterised Portugal in the last half century.

In view of these powerful changes, it was crucial to provide for instruments aimed at preserving the biophysical environment, namely soils and riverside and coastal areas, such as the National Ecological Reserve in 1983[2] (which was in fact only regulated a decade later through Decree-Law No. 93/90, of 19 March). The requirements for Portugal to join the European Union called the country to conform its environmental, agricultural and forestry policies and to mitigate many of the errors that had been made in spatial planning and management. The current legal framework – Community, national and municipal law – require careful examination of natural supports in planning (national regional, urban or local), and in particular where it defines the purposes and general principles of the policy, introducing a number of pillars that seek the preservation and maximisation of spaces through biophysical supports in urban management and planning, in a different approach to the sustainable city (Cordeiro, 2017).

Alongside these legal instruments, partnerships have been developed under the Urban Agenda for the EU (UAEU, 2016) and the European Climate Law, in which changes in urban climate, air

[2] As regards rural areas, the National Agricultural Reserve was only defined and implemented years later through Decree-Law No. 196/89, of 14 June.

quality, sustainable use of soil based, for example, on NBSs, or even issues related to energy efficiency and decarbonisation (among others), are central to the sustainable urban development described in the SDGs.

In the light of the foregoing, at the turn of the century there has been a political change in how the relation between urban planning and environmental areas are viewed, which subsumes physical geography, seeking at the same time to provide spaces of fruition to populations in communion with nature (Partidário & Pereira, 2015). While up to that point the relationship between the physical support and land use transformations had been somewhat neglected, the transformation encompassed an environmental rationale of the process of land use transformation, calling for a different view of these topics based on a holistic analysis (Cordeiro, 2017).

It is against this backdrop that the interdisciplinary document coordinated by physical geographer Ian Douglas is presented – "*The Routledge handbook of urban ecology*" (Douglas *et al.*, 2020). Large parts of this handbook are dedicated to biophysical topics, presenting the contribution of many physical geographers to urban ecology, which in many territories implies having a disciplinary and integrated vision through an interdisciplinary stance.

It seems unquestionable that the study of sustainable urban planning goes far beyond the disciplinary visions of isolated biophysical sub-areas, encompassing disciplines that have long been at the heart of the study of urban spaces. Social sciences have also been addressing them through an integrated vision, as referred to by Carlos Fortuna, who states that the city must be *"…*a multifaceted reality that can hardly remain enclosed within the limits of conventional social and/or human science disciplines. It is essential to have a reading that transgresses the barriers of the disciplines in order to capture the complex nature of and intensity of changes in cities" (Fortuna, 2016: 154). This social approach, however, is hardly enough when we fail to grasp what lay at the roots of the urban space settlement, as well as the relations between communities of people and nature, now in a post-settlement perspective.

Cities must necessarily be understood as complex adaptive systems composed of interconnected socio-economic-political systems, ecological-biophysical-climate and technological infrastructure systems (McPhearson *et al.* 2016), thus being shaped by different researchers and interacting system components (Alberti *et al.* 2018). These interdependent systems have dynamic, often unpredictable, non-linear and emergent properties. The fact that such self-organising processes are uncertain constitutes a challenge for urban planning, urban policy and ecology to make sense of complex dynamics, harnessing such complex situations to improve the people's well-being and liveable urban environment (Cook & McPhearson, 2020). It is in this context that, from the perspective of geography and in an integrated vision, the interaction between geography and the different related sciences – social, human and earth sciences (Figure 1) – accommodated in the study of sustainable urban planning. An integrated and sustainable urban planning should have a strong component associated with the different areas of physical geography, both in a future planning and prevention approach according to climate changes and having in mind the pandemic issues that have recently affected our planet. Indeed, because physical geography has considered the designed and built forms of the city as being artificial rather than natural, this has meant that they have not usually been considered as eligible for analysis under the objectives and paradigms thereof. Speaking hypothetically,

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this seems to be the reason why some physical geographers were reluctant to think more generally about the city as landscape, environments, and urban processes (Francis *et. al.,* 2012). Kenneth Gregory, on the other hand, offers the central idea about the role and aims on which physical geography should focus, the latter taking on, in urban planning, a "character of, and processes shaping, the land-surface of the Earth and its envelope, emphasises the spatial variations … and the temporal changes necessary to understand the contemporary environments of the Earth … and understand how the Earth's physical environment is the basis for, and is affected by, human activity" (Gregory, 2000: 9).

Some physical geographers have addressed their role in the urban setting to realise that human beings should be seen as disruptors and modifiers of nature; this, however, is not a barrier to physical geography *per se*, as urban environments offer at the same time places where new approaches to the aims of physical geography can be developed and an expanded role in urban geography.

The aim is to show how research and the application of the different sub-areas of physical geography can play a growing role in sustainable urban planning, not individually but through an integrated vision in which the different urban physical supports can help cities be more resilient to the changes brought about by their exponential growth. As there seems to be no doubt that cities are complex interactions of biophysical, social, economic and political processes and systems, the planning, design and materialisation thereof become highly complex and necessarily holistic processes. The very implementation of an urban space should be based on its topography and lithology, showing how they are at the core of the *locus* of any urban space. However, and despite these frequent calls to connect the biophysical to the social, physical geographers have rarely made this socio-natural connection (Francis *et al.*, 2012).

THE INTERDISCIPLINARY VISION OF THE CITY AND THE ROLE OF PHYSICAL GEOGRAPHY IN URBAN SUSTAINABILITY

What one desires as sustainable cities (and territories) should be the result of human settlements globally formed by a society aware of its role as a space transforming agent, whose relationship should be seen through the synergies between environmental protection, energy efficiency and inclusive social space (Romero, 2007; Farr, 2013). Although urban ecologists take integrated work into account, increasingly collaborating with researchers from other scientific areas – engineers, geographers, designers, architects, planners, and industrial ecologists (McPhearson *et al.* 2016) – there is still a long way to go in the integrated study of sustained urban planning.

The whole process of building a humanised space should encompass an interdisciplinary and truly holistic approach, although at first such approach may (or should) be broken down into the different physical and environmental components that globally make up the complex systems that are part thereof (Cordeiro, 2021). The research agenda on ecology and urban sustainability must, for that reason, embrace the unique and synthetic nature of urban ecosystems, but always integrating human and natural components and science into urban design and management (McIntyre, 2020).

These integrated approaches add to the understanding of the structure and functions of the urban ecosystem, including how the green (nature-based), grey (designed and watertight) and

blue (water-based) infrastructures can offer services and benefits to city residents. Urban landscapes should be viewed as real and natural as any other (Cook & McPhearson, 2020). However, rather than looking at them as degraded forms of what is natural, urban landscapes can simply be analysed as an object of study open to conceptual, empirical and theoretical knowledge as any other landscape, while offering new features and processes (Francis *et al.* 2012).

The different planning processes for a sustainable territory embody an analysis of a variety of complex units and systems associated with physical geography, which according to Christofoletti (2015) are key components for the formation of environmental systems and should be analysed through a comprehensive holistic vision of the elements of which they are part, and addressed according to their various thematic areas, albeit in different scientific areas (Figure 1).

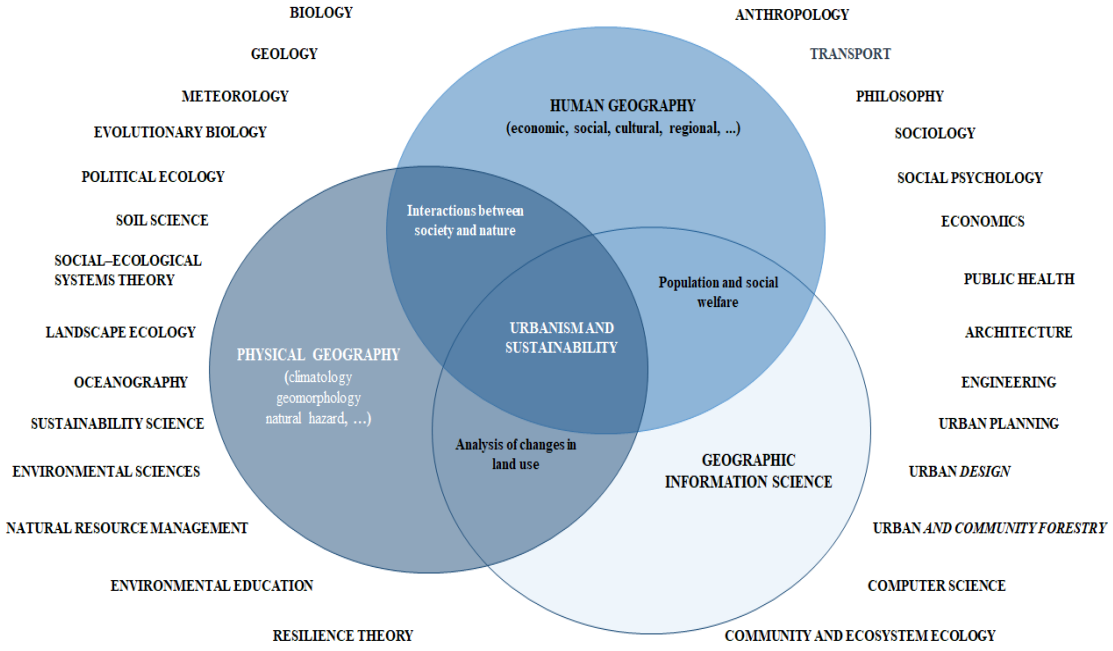

Figure 1: Geography and sustainable urban planning. Integrating disciplines and theories (modified from McPhearson et al. 2016).

To understand this vision, which is rarely sought, integrated interdisciplinary work is required (Abreu, 1989; Magalhães, 2001; Ashmore & Dodson, 2017; Cordeiro, 2017; 2021). As regards physical geography, such work should consider most of its sub-areas in the construction of a sustainable city, albeit at first based on isolated sub-areas, many of which are usually overlooked in such studies (Douglas *et al.* 2011; 2020; Faeth *et al*. 2012; Ashmore & Dodson, 2017).

THE PHYSICAL GEOGRAPHER IN THE FRAMEWORK OF SUSTAINABLE URBAN PLANNING

The need for the comprehensive analysis now considered for the implementation and consolidation of the idea of sustainable city aims at objectively highlighting the different components of what has been called "physical supports in urban and land-use planning". These

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are key in the systemic study of the physical constraints (or enhancers) to urban planning (Grove *et al*., 2016; Cordeiro, 2017). How landscapes present themselves and identify social, cultural, economic, technological and political processes of land-use is, inter alia, the consequence of a variety of physical supports, in particular morphological structures (Partidário, 1993; Fadigas, 2007; Cordeiro, 2021).

This approach builds on the assumption that there are two sets of structuring factors providing physical support to planning (Cordeiro, 2021): "*endogenous*" factors (directly or indirectly associated with the morphological structure) – geomorphology; geology/lithology; tectonics (and seismicity); slope gradients and their exposures; morphometry of slopes and drainage basins; soil structure – and "*exogenous*" factors (climate-related), such as radiation, temperature, wind and rain, to name a few (Figure 1). Other factors underlying natural restrictions to urban planning and land-use management seem to be clearly (to a lesser or greater degree) related to the interconnection between two structuring factors – hydrological and cyndinic factors – in urban spaces, reinforcing the idea of interdisciplinarity, the latter factors showing evident relations with base factors (and with related sciences). Other factors associated with the different environmental management instruments and land-use analysis encompass much of what was referred to as the first moments of the relationship between urban planning and understanding the environment, somewhat following on from what was considered for urban ecology (Douglas *et al.*, 2020). This becomes more evident when physical geographers are involved in the design of urban environments, for example by increasing urban green areas, taking due care of ecological restoration, or considering carbon sequestration by the different natural elements (green and/or blue), or even considering the implementation of *greenways* or NBSs, always having in mind the environmental management instruments associated with land use and occupation (Kabisch *et al.,* 2017).

In this context, the analysis of urban settlements requires sound knowledge of the territorial basis on which the city is built. When Aldo Rossi contextualises the architecture of a city in relation to the dialectics between built environment, natural environment, and culture, the "*locus*" comes up as an essential component of the city (Rossi, 1965). In historical terms, a city undeniably evolves as a result of (pre-) existing favourable conditions: defensible territorial position, trade, movement of resources and, more recently, the environment itself (Waller e Waterman, 2010). Therefore, the analysis must primarily be guided by issues concerning the "*locus*" and the regional contexts. Many European cities developed based on their morphostructural bases – geomorphology and lithology – to be interpreted in this framework (Ennen, 1979; Benevolo, 1995; Rossas, 2001; Oliveira, 2013; Rita & Häuber, 2015; Cordeiro, 2021) although these physical supports are only rarely mentioned.

Understanding the ground on which urban settlements are built is of utmost importance to the quality of life of city residents. It seems evident that much of the bedrock in urban spaces is composed of endogenous rocks and soils, but also by anthropic deposits with varying degrees of stability and risk of contamination (Douglas, 2020). But while slopes and geomorphological mapping help understand the potential risks encountered by any new space to be built, geomorphology is also a pivotal player in the relation between climate and the quality of life of urban residents, e.g. through the ventilation and sun exposure of ridge or valley floor areas (Cordeiro, 2021).

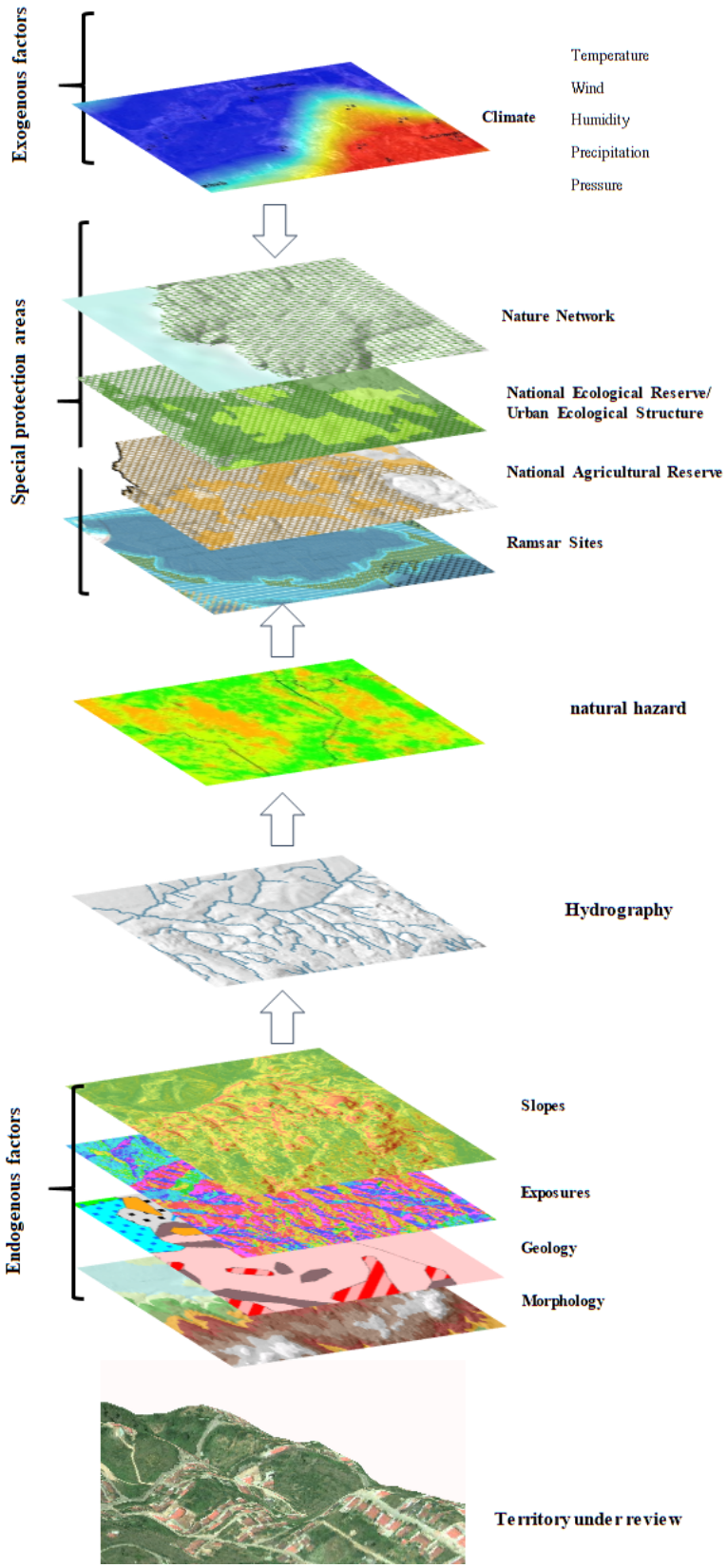

Figure 1: General framework on the connections between different physical supports in land-use management (modified, Cordeiro, 2021).

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Although urban space covers only a small fraction of the Earth (<2 per cent of the Earth's surface), an increasing share of the world's population lives in cities, showing that the share of resources used by urban residents is very disproportionate. The main sources of anthropogenic emissions of carbon dioxide come from the daily activities of city dwellers associated with changes in the urban surface. Cities are thus assumed to be one of the main drivers of global climate change (Oke *et al*., 2017; Grimmond, 2020). Urban climatologists commonly characterise cities in terms of height, width, density of buildings, share of green (and blue) space and amount of heat released by human activities, generating distinct local-scale and even micro-scale climates (Ganho, 1998; Stewart e Oke 2012). Understanding these exchanges and the effects of a given urban environment on its spatial and temporal dynamics are essential for understanding urban climates at city, neighbourhood, square, and street level (Alcoforado, 1999; Alcoforado *et al.,* 2005; Marques *et al.,* 2008; Hathway& Sharples, 2012; Rosenzweig *et al*., 2018; Roth, 2020; Reis & Lopes, 2019;),

Cities therefore influence most weather variables affecting humans, such as temperature, humidity, wind, precipitation, or solar radiation. In this regard, temperature changes have attracted wider interest due to their practical effects on human comfort, morbidity, air pollution, ecology, or energy use, being potentially linked to the generation of greenhouse gases. Accordingly, it is hardly surprising that the urban island phenomenon, which characterises district warming, sustained compared to its rural surroundings, has become an emblematic feature of urban climate. Apparently easy to define, understand and measure, this phenomenon is the most studied effect of urban climate, albeit with subtleties and intricate complex aspects that are often overlooked by researchers and practitioners not working in the field when applying urban climate knowledge to urban planning and management-sensitive projects (Oke *et al*., 2017; Rosenzweig *et al*., 2018; Roth, 2020).

Regarding the precipitation observed in the different areas of the city, hydrography is another field of physical geography seen as the result of the transformations taking place in the urban space. Either by draining into impermeable surfaces, into artificial water reservoirs, into streams or water lines, or alternatively being intercepted by vegetation in green areas or in green belts (water returned to atmosphere by evaporation), urban hydrography results from a number of factors associated with the changes occurring on the land surface due to the "concretisation" of the urban space. The urban space mosaics lie somewhat in this dichotomy between the impermeable areas and those with more or less significant infiltration, linked to the drainage of rainwater. Urbanisation thus changes the hydrological cycle (Douglas, 2020).

Thus urban hydrology is not only influenced by geomorphology (and lithological substrate), climate and vegetation, but also by the materials of building components, and the dimension and topography of the urban surface, which works as an impermeable watershed (Grimmond *et al.* 2010). These transformations arise from the way in which water flows are diverted through natural and artificial channels to meet urban needs and avoid encroachment into buildings and other spaces, and by the way in which impermeable urban surfaces, such as roofs and streets, accelerate water velocity across urban surfaces (Douglas, 2020).

Urban areas thus present a dual hydrological system, i.e. on the one hand a modified natural drainage system associated with canals and diversion of rivers and, on the other hand, the artificial water supply and sewerage system. This causes problems in runoff management,

especially when large covered and paved areas feed combined sewers that are designed to overflow into rivers after heavy rainfall. The type of sewerage network and any stormwater drainage system in any city affects both the formation of flood flows and the contamination of rivers into which stormwater and treated wastewater flows (Douglas, 2020).

The consequences of soil sealing and of the intrinsic relationship with the morphology of urban watersheds and with times of intense precipitation can be seen in many cities in the form of local floods. These are the result of endogenous and exogenous intersections in the urban space (cf. Figure 2), which encompass one other sub-area traditionally associated with physical geography and which should be borne in mind in urban planning – natural hazards. In addition to the aforementioned local floods other natural hazards must be analysed in the scope of urban space-related problems. Urban geomorphological hazards and how relief (and soils) responds to urban planning have been the topic of many works on the characteristics of anthropogenic landforms (Thornbush, 2015). In morphology, mass landslides are the most frequent geomorphological risks in urban spaces, in particular where slopes are markedly steeper and the plasticity of materials are high (Lourenço e Lemos, 2001; Lemos, 2007). Also related with the substratum, tectonic hazards can also be found, such as those observed in Haiti, Ecuador, Nepal, Italy, Japan, or magmatic hazards, as in Helgafell (Iceland), La Palma (Canary Islands, in Spain). With regard to climate hazards, while cyclones affect areas (urban or otherwise) of general characteristics – the southern part of the USA, the Caribbean, Indochina and the Far East, Australia –, the largest and most frequent forest fires have been recorded the most in the middle latitudes – the southern part of Europe, the USA (California) and Australia[3], even though they affect latitudes ranging from equatorial forests to the circumpolar taiga-tundra ecotone.

Land-use and occupation is another topic that should be considered in an integrated urban space vision. This sub-area requires a twofold approach: the green and blue urban spaces and their relation with impermeable space, and environmental management instruments, many of which include some of the sub-areas previously analysed and catered for in many integrated cases. As mentioned earlier, the relation between the grey (built) areas and green and blue areas (shrub, tree cover, and water surfaces) are associated with many of the sub-areas of physical geography as factors that explain the differences in the urban environment.

When analysing urban green areas (which, as mentioned, can be central in the interrelationship with other sub-areas), they can vary greatly in structure, extent, functions, history and management, and can range from planted forests, to areas of semi-natural vegetation, formal gardens (with few species), which also include flowerbeds, simple lawns, permeable sports spaces (Pickering e Hermy, 2020), or even what can be called road easement green spaces. When Farr (2013) refers to biophilia as one of the pillars (plus compactness and energy efficiency) in the creation of sustainable cities, he immediately implies the role of these spaces in urban design that should lead to this sustainability – that associated with the aforementioned ecological-biophysical-climate systems.

[3] Although not always referred to in the context of urban ecology, natural hazards are one of the sub-areas of geography where physical geographers have acted on the most, for instance, in the post-event phase – analysis of the outcome of phenomena – or even in the urban design phase, which should consider, anticipate and minimise hazards.

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In high density cities, non-sealed spaces may be scarce; therefore, vegetation cover, especially trees, is often overlooked in public spaces. Natural vegetation and permeable soil are being replaced by concrete and asphalt, and it seems unquestionable that natural green areas have downsized as a result of urban growth. The negative impact of an insufficient green infrastructure in a city translates into poor air quality, recurring floods and increased urban heating, resulting in urban heat islands. Vegetation itself is integral to making cities more pleasant and resilient and provides many positive benefits. Urban vegetation enhances biodiversity in the city, the scenic aspect of the urban landscape, provides recreational spaces and can have a mitigating effect on the aforementioned natural hazards and impact on the urban space microclimate (Emmanuel, 2016). Providing vegetation in urban areas is one of the most researched adaptation measures and also one of the most beneficial in terms of public health (Gill et al., 2007; Bowler et al., 2010; Gago *et al.,* 2013).

In the past, several studies have been carried out to investigate the potential of adaptation measures to influence urban climate, especially in reducing high temperatures, among which the use of vegetation, in particular trees (Oke, 1989; Gill *et al.,* 2007; Bowler *et al.*, 2010)[4]. Some examples of vegetation in urban areas include urban parks (which have a greater effect on climate regulation – (Reis & Lopes, 2019; Nastran *et al.,* 2019; Yu *et al.*, 2020) or street trees, although more recently green roofs and green walls have also been observed (Francis e Jensen, 2017; Lalosevic et al., 2018; Gromke *et al.,* 2015). It is in this sense that sustainable urban planning has been developing new opportunities for space planning and organisation through the creation of "*greenways*" (Fabos, 1991; Little, 1990) – for conservation purposes – and more recently in the different "*Nature-based Solutions*" (European Commission, 2021).

In the Portuguese case, the 2014 Law of Public Policy on Soil, Land-use Planning and Urban Planning, when defining its purposes and general principles introduces a number of considerations for the preservation and enhancement of urban planning and management. Further to this national legal instrument, partnerships were established under the European Urban Agenda (UAEU, 2016) and more recently the European Climate Law in which many of the factors – adaptations of urban climate, air quality, sustainable use of soil and nature-based solutions, or even energy efficiency issues – are some of the key elements to a desirable sustainable urban development. Again as regards the Portuguese case, the Sustainable Cities 2020 strategy (MAOTE, 2015) serves as the guidelines on the implementation of sustainable urban development plans for Portuguese cities in early 21st century.

European and national legislation, in addition to other legal instruments and easements, such as the National Agricultural Reserve (RAN), Natura Network, Corine Biotope project, Ramsar Sites, protected areas, National Ecological Reserve (REN) and the Municipal and/or urban Ecological Structure (EEM) have considered forest areas, public water domains and even natural hazards as the main constraints to natural environments. Accordingly, the different sub-areas associated with physical geography should be considered as key elements in the development of a constraints map of any urban or natural land-use or land management plan (Cordeiro, 2017).

[4] Some other adaptation measures have also come to light: the use of bodies of water (Montazeri *et al.*, 2016), rethinking the urban form through the orientation of streets or buildings (Perini e Magliocco, 2014); Jamei *et al*., 2016), or even through the use of alternative building materials (Santamouris, 2013).

Objectively speaking, and simplifying the different types of constraints, these can be divided into two major classes of intervention areas: "*environmentally sensitive areas and the remainder of the territory*" (Fidelis, 2001: 57). Thus, and although other broader analysis is practicable, the analysis has been limited to the themes grouped as natural resources (biophysical), such as water resources, geological resources, agricultural resources, ecological resources, and natural hazards (Grove *et al*., 2016; Cordeiro, 2017).

SOME REFLECTIONS

The exponential growth of the urban population (and at the same time of the actual urban space) in recent decades has led to the publication of many regulating acts, laws, documents and academic papers, whose growing concern is the medium and longer term sustainability of the Earth in general, and of the different territories in particular. As many of us are increasingly aware that *there is no plan B for the global warming problem, as there is no planet B*, an intensive approach to the many overall environmental problems is required, which has been at the heart of the discussions on the future of humanity.

Although this is not a full-scale detail of all these instruments, two blueprints must be referred due to their different scales and specificities: the UN "Sustainable Development Goals – SDG"), in 2015, and the "2021 European Climate Law". The first one addresses a variety of topics at global level, proposing 17 objectives to be achieved in the near future, which should be considered in a clearly interdisciplinary way, while the second one sets the targets that should be achieved by European Union countries and defines resilience to climate change and decarbonisation.

In this framework, there is an urgent need for physical geography to gain prominence that has been lacking in studies concerning cities, since it is somewhat surprising (or perhaps not) that urban geography has been viewed, in the framework of geography, as an implicit human geography specialisation. Given the foregoing and the objectives of sustainable urban planning, it is clear that there is an urgent need to promote urban physical geography.

When Jorge Gaspar (1996) characterises spatial planning as the "*art of adapting people and wealth production to the territory with a view to development*", he implicitly states the need for dovetailing the potential and the limitations to the occupation of territories (seen as strongly restrictive), to ultimately achieve a conflict-free coexistence between institutions and citizens. Although these constraints exist, the attributes of each territory may, in line with what Gaspar calls "art", not only limit but also enhance resources towards the much desired sustainable urban space development and, consequently, urban design (Cordeiro, 2017). This could mean building following on from inherited patterns, being open to new opportunities and effects (Marshall, 2011; Ellis, 2015), much in line with what Alexander Argyros referred to as " *the delicate dance between innovation and conservation*" (Argyros 1991: 315).

The relations that have always been envisaged between the rigid planning system, based on the reading and interpretation of plans, and the territorial development needs have often led to conflicts between urban ecology (environmental preservation) and development, which are not always well understood by citizens. In the approach between relation and conciliation of these two objectives, it is our understanding that one of the key objectives of those working on the processes to transform land-uses in interaction with the environment is laid out in the

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Portuguese Framework Law on the Environment: to achieve an "*integrated organisation of the biophysical space, aiming at the use and transformation of the territory, according to its capacities and aptness, while maintaining the values of biological balance and geological stability, with a view to increasing life capacity*" (Law No. 19/2014, of 14 April). In this context, the relationships between biophysical supports in land-use planning and urban development, usually associated with restrictions laid down in different legal regimes, and the enhancement of the sustainable development of territories, in particular urban spaces, should be considered in a comprehensive way, as has been done in many successful cases in the country and how it should be viewed in the sustainable city strategy.

In the analysis of the urban system and its interactions in the framework of natural and social sciences, geography is viewed as a key element in the implementation of a sustainable urban development plan and considered in a comprehensive way in its different sub-areas. This study, however, posits that physical urban geography has been sidelined in urban studies over the years. In this context, and as aforementioned (Cordeiro, 2021), morphostructural, climate, hydrological, cyndinic and land-use and occupation sub-areas should be considered in an integrated way, as should their different disciplines, elements and systems (Figure 3). Based on this, and by sub-area, their relation and interaction will result in thematic maps – building load capacity, climate, urban, natural hazards, urban ecological structure, inter alia.

The objective of combining all these maps developed by physical geographers, among others, should be the charting of physical constraints maps for urban planning, essential for the drafting of Municipal Spatial Plans, also providing conditions for enhancing nature-based urban design (Cordeiro, 2017).

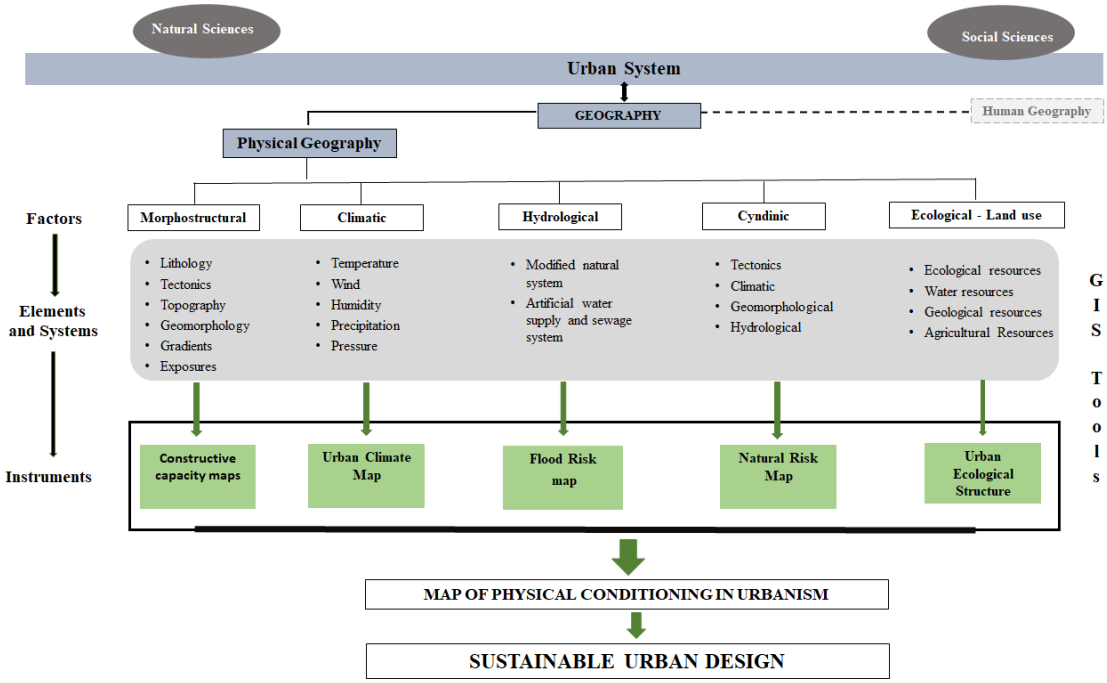

Figure 3: The role of physical geography in sustainable urban design.

In theory, each of these possible directions falls within what is conventionally understood as 'urban', even if they advocate that physical geography goes beyond the exclusively natural and the very limits of the city, as stated by E. Swyngedouw and M. Kaika (2014: 462): *"We are, therefore, not so much concerned with the question of nature IN the city, as it is with the urbanization OF nature, understood as the process through which all forms of nature are socially mobilized, economically incorporated and physically metabolized/transformed in order to support the urbanization process".* Besides reasons of social relevance and political urgency, there are scientific reasons for carrying out further investigation on the sub-areas of physical geography in thematic urban contexts, but through a holistic vision, integrating sociopolitical issues in the study of urban environments and expanding the scale and purpose of urban physical geography beyond cities.

It is in this general context of different themes that a physical geographer can (and should) act in the construction of a sustainable urban planning, through the interventions of the different sub-areas of geography – being key elements in the holistic organisation and development of ecosystems –, the result of which should allow for the assessment of weaknesses and potential of the use of territories. This should lead to increasing urban sustainability and the way towards greater resilience to urban climate change, or even to the contribution to a greater decarbonisation of territories. All these contexts need to be urgently addressed in the context of the planet, as became evident with the extreme weather phenomena observed during the first months of 2022.

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