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Sustainable Urban Transect Modeling for Applied Social Sciences: Merging Green and the Urban in Sustainable Urban Cells into a New Resilient Energy Transect Model

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Abstract

The global city of the 21st century faces significant challenges & crises, including social and economic stratification, wasteful consumption of resources, transportation congestion, and environmental degradation with the omnipresence of global climate change. Our cities, communities, and neighborhoods are undergoing rapid transformation and retrofit in terms of energy efficiency and climatic adaptations, almost to the point of drastic environmental determinism. This paper's discussion explores ways to raisethe quality of life and the standard of living in a new modern era by creating better and more viable places to live through sustainable urbanism approaches. The assertion is that the Green (Sustainable) Urbanism approaches offer an environmentally sound way to plan and design more ecologically stable communities. Sustainable Urban Cells within the idea of the Urban Energy Transect are presented here as a new quantitative and qualitative modeling approach and analytical methodology in working with the planning of sustainable urban communities, compatible with other analytical tools such as Space Syntax and other GIS tools. The empirical Swedish case shows how a better understanding of an integrated zoning system in a complex community urban setting can contribute to more precise planning and energy efficiency of buildings. We see the resilience in the context of sustainable development and city planning as the capacity of a city or urban system to withstand and recover from a wide range of shocks and stresses, such as natural disasters, climate change, economic fluctuations, and social challenges, while continuing to function effectively and sustainably.We raise the following questions: How can we combat and reconcile urban growth with sustainable use of resources for future generations to thrive? Where and how Urbanism comes into the picture? And what role "sustainable" urban forms can play in light of these events. These and some other issues are tackled in this paper, whose conclusions point to the predisposition that beyond being a system of classification, the cell and the transect model we present in this paper also have the potential to become a complementary instrument for planning and design for better places tolive and presents an innovative study and model for applied social sciences.

Keywords: Sustainable Urban Planning, Morphology, Transect, Energy, Land Use; Urban Design; Urban Cells

INTRODUCTION: ENERGY ISSUES AND NOWADAYS CHALLENGES IN URBAN AREAS

The complexities of contemporary global urban, political, economic, and environmental issues are evident. We are facing the consequences of accelerating and rapid urbanization, the scarcity of natural resources and their mismanagement, the impact of significant errors in ourresponses to natural and man-made disasters, and the increasing demand for and complexityof greatly expanding transportation flows (Haas, 2012). Our societies have also undergone rapid andradical shifts in age and class, increasing inequities between the rich and the poor, and intense demand for affordable and high-quality housing. These significant challenges require immediate solutions from architects, urban planners, urban designers, landscape architects and urbanists; we need the combined efforts of all good people concerned with our cities' physical condition and future (Haas, 2016).

Cities worldwide are looking for new ways to incorporate urban green space into their sustainability agendas - but what can green, more sustainable cities look like, and how can we work to realize these ideas? How can concepts such as green infrastructure, green and sustainable Urbanism, landscape urbanism, and biophilic cities be vehicles in this development? Our cities, villages, communities, and neighborhoods stand at a significant turning point - critical nexus of the most pressing issues of our time: rapid population growth and massive urbanization, energy inefficiency and scarcity, unbalanced resource consumption, growing air and water pollution, global and micro-climate change, social exclusion and economic decline, unsustainable development of built environment at all scales and the relentless destruction of natural habitats which all degrades the quality of life (Calthorpe and Fulton, 2001 and Haas 2008). Sustainable Urbanism, green Urbanism, and smart growth are theoretical and practical concepts developed to counteract these processes and steer the development to sustainable forms. As Peter Calthorpe (2011) points out, cities are not fixed elements and remake themselves by demolishing and rebuilding all the time, which is an essential part of Urbanism. This process is the basis of the resilience of the urban fabric, an element that can be continuously renewed and redone. However, a greater sensitivity to history and historic-cultural resources has to be part of Urbanism to couple it with new designs that can offer alternative energy supplies, conservation, and sustainability of the urban fabric in the longrun.

Conservation, both in terms of the environment and in terms of culture and history; *human scale*, which translates into creating pedestrian environments that work; and *diversity*, which means you have to create mixed-use communities for a full range of people, are the three principles expressed by Peter Calthorpe when discussing the resilient city of the future. The principles closely relate to the two key concepts in contemporary discussion of raising the quality of life: *livability* and *sustainability*. Even though livability and sustainability may operate on different levels, scales, and contexts, both can achieve similar outcomes. Both livability and sustainability support economic development and environmentally sustainable travel options and address social equity issues and human health (Rue and Rooney et al., 2011).

Sustainable Urbanism and community livability are viable platforms for seeing and realizing integrated urban design projects. As the Victoria Transport Policy Institute recognizes, “Community Livability refers to the environmental and social quality of an area as perceived by residents, employees, customers, and visitors.” This includes safety and health (traffic safety, personal security, and public health), local environmental conditions (cleanliness, noise, dust, air quality, and water quality), the quality of socialinteractions (neighborliness, fairness, respect, community identity, and pride), opportunities for recreation and entertainment, aesthetics, and the existence of unique cultural and environmental resources (e.g., historic structures, mature trees, traditional architectural styles) (VTPI,2013). Sustainable Urbanism has three fundamental aspects: *environmental, social, and economic*. An urban form that is environmentally sustainable enables its inhabitants to adopt a more ecologically aware, lower carbon lifestyle; in social terms, sustainable Urbanism involves an appropriate mix of dwellings of different tenures, sizes, and types, and a variety of spaces and buildings for recreational and community activities, as well as for service providers and commercial enterprises; and in economic terms, sustainable developments contain business activities and opportunities capable of providing jobs for many of their inhabitants across the social and economic spectra (Prince’s Foundation for the Built Environment, 2007; Haas, 2008; Steuteville and Langdon,2009).

All the discourse on resilient cities contributes to putting the focus on the critical element of the community – the neighborhood and housing as being a primary node for the carrying capacity of sustainable transformations and consolidation, one founded around the human aspects of form and traditional, timeless practices of good city building. Looking at the physical environment that sustains the communities, block, and neighborhood city network design has a considerable influence in balancing the urban energy demand and production through adaptation to local climatic conditions and identification of the most suitable morpho-typological structures (Ratti *et al.*, 2004). A coherent organization of the city and its functional mix can largely contribute to reducing energy needs (Jenks and Burton, 2000) for producing goods and services, mobility, indoor climate control, and decreasing local energy peaks.Our cities need to achieve a higher integration between urban and energy design (Droege, 2006), adopting cycle approaches to energy and materials within the larger framework of resilience concepts to optimize local resources and social-urban environments (Walker and Salt, 2006).

RAISING URBAN ENERGY QUALITY THROUGH URBAN PLANNING AND DESIGN

Urban design, urban and regional planning, and the control of urban and regional development still present a significant deficiency, especially concerning neighborhood development and the housing sector. As for the energetic reorganization of city regions, the approaches oriented to creating compact, de-centralized housing spaces, the complex.Economic handling of resources or the minimization of auto-dependency – are practical requirements in future urban developments to create a truly unique model of integrated cities (Calthorpe and Fulton, 2001; Beatley, Newman, and Boyer, 2009).

Sustainable Urbanism, a phrase used widely and combined with ecological and green connotations, is a relatively new and complete framework for interdisciplinary planning and design of contemporary cities, neighborhoods, and settlements. It explores more holistically sustainability and urban design in a rapidly urbanizing world by focusing on the processes that shape the form and function of our built environment: infrastructures, land developments, built landscapes, social networks, systems of governance and economics, and facilities that collectively make up metropolitan regions (Farr, 2008; Haas, 2008; Newman, Beatley and Boyer, 2009).

The applied sustainable urbanism – to whom this paper refers– focuses on identifying small-scale catalytic interventions that can be applied to urbanized locations, ultimately leading to an overall shift towards sustainable neighborhoods, districts, and regions (Newman and Jennings, 2008). In its most entire meaning, Sustainable Urbanism is made up of the following key concepts: building and growing more densely and compactly; creating walkable mixed-use urban environments that permit and encourage walking and bicycling; investments in public transit and transportation; creating closed-loop urban eco-metabolism and a self-sustaining agricultural system - local production of foods, goods and materials (food, building, materials); and investment in and commitment to sustainable, renewable, and passive technologies integrated into the built form (e.g., solar, wind, biomass, etc.) as well as solar design to reduce the need of artificial light and heat (Congress for the New Urbanism, 1999 and 2013; Farr, 2008; Beatley, 2000; Newman and Beatley,2008).Doug Farr, in his *Sustainable Urbanism: Urban Design with Nature* (2008), sums this up in five value points of urban design, resilience & sustainability:

- Increasing sustainability through density andcompactness;
- Integrating transportation means, patterns, and landuse;
- Creating sustainable neighborhoods, including housing, car-free areas, locally-owned stores, walkable neighborhoods, and universal accessibility;
- The health and environmental benefits of linking humans to nature, including walk-to open spaces, neighborhood stormwater systems, waste treatment, and food production (permaculture);
- High-performance buildings and district energysystems;

Raising urban energy quality through urban planning and design is a multifaceted challenge, and several key issues need to be addressed to ensure a sustainable and efficient urban energy landscape. A primary concern is the improvement of building energy efficiency. According to the International Energy Agency (IEA, 2022), buildings account for a significant portion of urban energy consumption and as pointed out in research done by Santamouris et al. (2020), energy-efficient building design and construction practices are crucial for reducing energy consumption and greenhouse gas emissions in urban areas. Utilizing advanced materials, insulation, and passive design strategies can significantly enhance the energy performance of buildings.The integration of renewable energy sources is another central issue in urban planning. Research by Su et al. (2021) emphasizes the importance of incorporating renewable energy technologies into urban infrastructure, such as solar panels, wind turbines, and green roofs. These innovations not only contribute to cleaner energy production but also enhance the resilience of urban grids and reduce reliance on fossil fuels.Transportation is a significant component of urban energy quality. The study by Zhao et al. (2019) highlights the need for sustainable transportation planning to reduce energy consumption and environmental impacts. Expanding public transit systems, promoting non-motorized modes of transportation, and transitioning to electric vehicles are critical steps in achieving energy-efficient urban mobility.In conclusion, addressing the main issues related to raising urban energy quality through urban planning and design involves improving building energy efficiency, integrating renewable energy sources, and promoting sustainable transportation. These efforts are essential for creating energy-resilient and environmentally friendly urban environments.

Furthermore, many kinds of 'values' can be considered – economic, environmental, social, or even cultural, as the fourth pillar of sustainability. Viable urban design, or good urban design as some authors refer to (Haas, 2012), can significantly benefit the community by providing a high-quality public realm based on the mixed-use-density principles, now integrated with the *energy efficiency principle*. Achievinga more resilient urban structure can be obtained via integrated decision-making. Still, it is also based on the capacity of buildings, neighborhoods, spaces, and communities to adapt to changing needs.Urban planners need to develop well-connected and accessible transportation networks that reduce the need for private car usage, thereby decreasing energy consumption and improving urban air quality (WHO, 2021).

URBAN PLANNING AND DESIGN FROM AN ENERGY PERSPECTIVE

Urban development – the size of cities and spatial distribution – has,from a historical perspective, been strongly influenced by the availability of resources, where complex social and economic systems emerged and found their strength in the control and storage of resource flows, with energy – solar, biomass, animal, and human – playing a pivotal role (Basalla, 1980 and Smil, 1994). The historical relation between urban growth, economic development, and impact on nature (biomass exploitation) has been recognized longsince as "[Ancient writers observed that] forests always recede as civilizations develop and grow […] Conversely when a society declines, forests tend to regenerate" (Perlin, 2005). With the advent of the fossil fuels society, previous growth limits have been removed, and the structures of cities changed to the so-called "oil city model" (De Pascali, 2008), where low cost broadly available energy sources radically modified urban relations and morphology towards dispersed and highly specialized organizations (Burchell and Listokin, 1982). The design of cities and settlements without resource restraint, seen initially as a sight of progress, is now profoundly criticized due to its long-run unsustainable and undesirable model. As human settlements have moved from a concentrated use of scattered energy resources (biomass, wind, water, animal/human) to a scattered use of concentrated resources (fossil), our next step is again to adapt our urban environments to the local conditions, combining urban form with available renewable energies, thus creating global cities based on local resources (Troglio, Martschenko, Haas, 2012). As cities update their urban structures through inner growth, there is the occasion to adapt morphologies to the new low-carbon and resilient needs. Althoughmany former industrial areas have been released during the last 15-20 years after the structural economic changes,manyEuropeancitieshavenotfullyexploredtheopportunitytoupdatetheir structures towards sustainable urban forms. Nevertheless, infill and inner-growth redevelopment processes are ongoing and constitute fundamental occasions to rethink the urban environment – based on the local social-economic and geo-morphologic characteristics - and the connections with the regionalenvironment.When cooling or warming needs prevail, energy saving from counteracting or increasing the heat island effect can substantially affect the energy demand at the urban scale and significantly improve indoor and outdoor well-being. The combination of green and blue elements, choice of construction materials (albedo characteristics, permeability, etc.), and urban morphology have proven effective in several projects. For example, in the SolarCity district in Linz (Austria) or the Western Harbor development in Malmö (Sweden), the heat island effect has been maximized to reduce energy losses (heat) during the winter months.

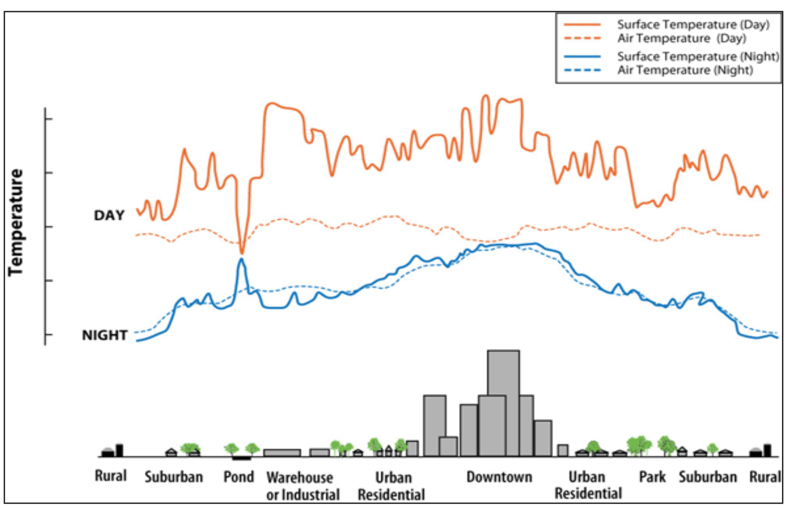

Figure 1. Scheme of the Heat Island Effect profile according to urban morphology; the temperatures shown refer to a late summer afternoon (EPA modified from Voogt, 2002)

Similarly, the siting, spacing, and building shape can significantly affect the amount of potential solar gain and wind effect. Depending on the local environment, buildings, and urban forms can be designed to optimize sunlight – passive solar gain – or increase energy production by improving roof quality for photovoltaic panels. Largely debated, the exploitation of wind power in urban areas still finds scarce integration in building or neighborhood design. Nevertheless, with increasing dependence on alternative power sources, interest, and installation costs should drop significantly to make urban-based wind power generation viable (Grant *et al.*, 2008). Besides the energy production factor, wind power can be passively exploited to improve indoor-outdoor micro-climate and air quality.

As this paper argues, adapting the urban morphology to respond to local climatic and geo-morphological conditions and identifying energy-conserving strategies should thus be explored before recommending high-tech solutions. Understanding the connections between urban morphologies and their energetic outcomes can be difficult due to human and natural elements' multiple and complex interrelations. We have further developed the transect concept to integrate energy issues to facilitate this process and support the actors involved in policy and design development towards more sustainable and resilient cities.

MATERIALS AND METHODS: A NEW APPROACH AND ORIGINAL MODEL: THE ENERGY TRANSECT

Urban planning and design choices must be interrelated to reach sustainability goals. Issues of reduced car use, energy efficiency, increased density, and mixed-use development become pertinent and cross-connected (Farr, 2008; Haas, 2012). When focusing on the complexity of our environment, more flexible methods and classifications should be used, providing a better understanding of the interlinks to citizens, planners, and developers and helping create more livable places. As an evaluation and assessment system for design, the Transect categorization empowers communities to create and maintain sustainable places (Emerson, 2007; Low, 2010; Thadani, 2011). The transect model uses a descriptive approach and a categorization system to identify and divide land use into a sequence of human habitats from rural to urban zones (Coyle, 2011). Each habitat has a specific character and unique attributes, yet is also part of a network of other habitats that form a sustainable, cohesive system spatially, environmentally, traffic, and energy-wise. In general, the Transect recognizes six zones, each of which can be adapted to local goals and character: 1) Rural Preserve, 2) Rural Reserve, 3) Sub-Urban, 4) General Urban, 5) Urban Center, and 6) Urban Core (Duany, 2002 and Thadani, 2011). Each zone addresses critical planning elements such as land use, roads, infrastructure, development, open space, energy, wastewater, and vegetation (Duany and Talen, 2002, Duany, 2002, Bohl and Plater-Zyberk, 2006).1. Rural or Natural Zones: These areas have little to no development, characterized by open spaces, agriculture, parks, and natural habitats.2. Rural Residential or Suburban Zones: These areas have low-density housing and larger lot sizes but are still influenced by urbanization.3. Suburban Zones: These areas feature medium-density housing with residential, commercial, and light industrial uses.4. General Urban Zones: These areas include medium to high-density mixed-use developments, such as townhouses, apartments, and a more comprehensive range of commercial and retail activities.5. Urban Centers: These are the most intensely developed areas, often characterized by high-rise buildings, dense commercial cores, and vibrant urban activity.Interconnected design aspects must be included, whether working on a new development or existing urban patterns. The transect diagram can then help explainthe intertwined components of coherent urban patterns in adapting to sustainable principles (Troglio, Martschenko, Haas, 2012). The urban Transect is typically represented as a linear scale, with rural or natural environments at one end and the most urbanized and intense development at the other. Along this Transect, different zones or "transect zones" are identified, each reflecting distinct patterns of land use, building types, and levels of human activity. The specific divisions may vary based on local context, but the general concept remains consistent.The role of energy in urban morphology is analyzed here by starting from the minimum size component of the city; the typologies. In a simplified – thus reliable – analysis, the heat energy performances of buildings are related to form/dimension, age, and siting. The first parameter – which includes concepts of compactness and complexity of the building form (Olgyay, 1973) – describes the heat exchange relations between a structure and the surrounding environment. The second parameter shows the role of materials, technology, and energy regulations from a historical perspective. At the same time, the third one refers to the spatial configuration of buildings and their mutualrelations.In Table 1 are reported the estimated heat energy demand data from sample buildings in Uppsala (Sweden), a medium-sized north European. A representative city transect has been chosen to include the most representative morpho-typological configurations. As the data shows, both form (typology) and materials (technology) have an apparent influence on heat energy reduction, and even more apparent is the role of compact morphologies. Although technologies play an essential part, the form effect is noticeably readable. Low-mass/complex-shaped buildings (i.e., detached houses) consume twice the resources compared to more compact ones (i.e., towers or courtyard buildings).

Year built	Courtyard blocks	Low slab buildings		High slab buildings		Low tower buildings		Tower buildings		Row houses	Detached houses
	Close	Open	Close	Open	Close	Open	Close	Open	Close	Mid-Close	Open
1910-1930	167	235	179	166	143	295	243	195	156	N/A	288
1931-1975	143	215	189	142	127	208	174	147	120	221	307
1976-1995	72	113	107	72	67	94	78	71	63	98	123
1997-2007	59	68	65	66	62	107	100	50	48	90	126

kWh/Sq m/year	
	255-310
	220-254
	185-219
	150-184
	115-149
	80-114
	66-79
	<65

Table 1. Estimated average annual heat energy demand (kWh/Sq m/year) based on building form and urban morphology in Uppsala, Sweden (Source: Troglio, 2012).

Identifying the role of age, technology, and building form constitutes only the starting point for a sustainable city's analysis and design. We have juxtaposed five major analysis issues to the transect model to describe the relations between different urban morphologies and their energy and environmental performances – and, thus, the interactions between buildings, open spaces, and the urban grid.The "Energy Transect" is developed as a supporting design tool for analyzing urban areas and defining sustainable and holistic visions for settlements, applicable at different scales and contexts. The identified five categories of analysis – morphology, land use, mobility, urban natural areas, and block energy characteristics – define a first toolkit for reading and understanding the connections between urban morphologies and their main impacts on energy. The different cells (morphologies) define our units of analysis, which allow a constant overview of the existing relationships and provide a guide to the design process. The understanding and control of the existing local and global interactions is increased using cell categorization.

Starting from the transect zones described by the New Urbanism, we have identified and analyzed five recurrent urban patterns in the contemporary city: city core, dense city, modernist 1980s-2000s, special districts, and suburban areas. Each urban pattern represents a different stage of the city's evolution and different approaches to energy and environment, embodied in the morphologies and the concepts that generated them.

The first analysis area, morphology, is conceived as a traditional Transect, highlighting the main conceptual characteristics of the urban patterns, section, and relations between buildings, open spaces, and greenery (Figure2).

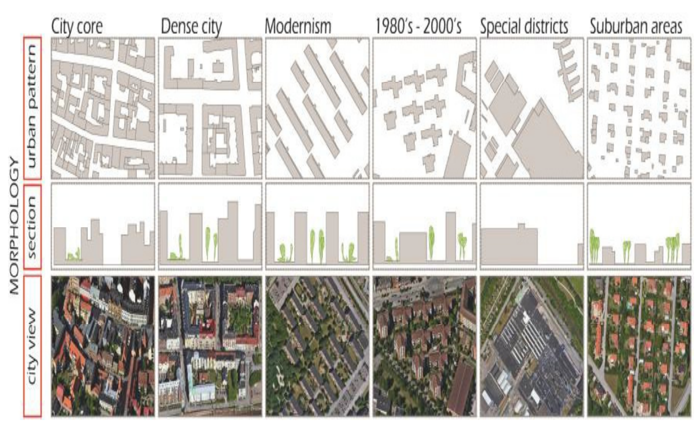

Figure 2. Different morphologies included in the Transect, from the dense central areas to the scattered suburban developments (Troglio, Martschenko, Haas, 2012).

Land use (Figure 3) aims to describe the size, mix, and spatial distribution of functions in the different patterns and the related role for energy peaks control and feasibility for distributed energy resources (Holden and Norland, 2005), as well as support for sound social life and activities (ESCTC, 1994). These schemes highlight the complexity of the distribution patterns and ease the comparison between different systems. Thanks to the inclusion of the land cover factor, built density and footprint effects on heat island effect (Oke, 1982) and runoff phenomena (Fiumi and Rossi, 2007) are highlighted.

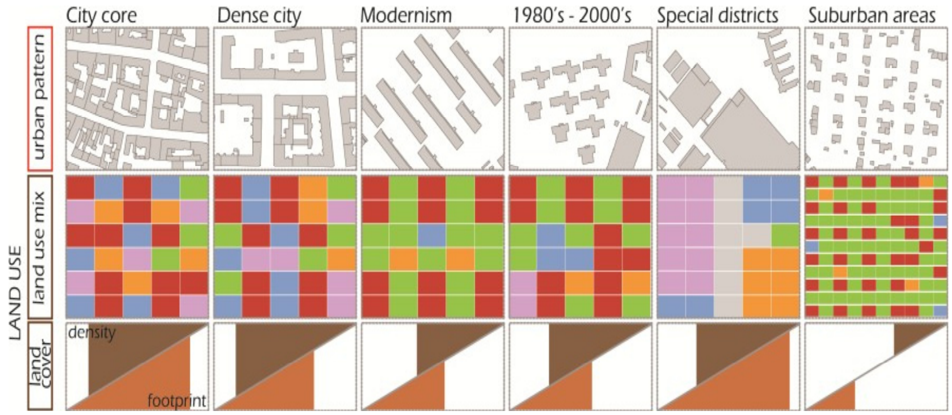

Figure 3. Visualization of the land use mix, parcel sizes, and land cover mostly recurrent in the different morphologies (Troglio, Martschenko, Haas, 2012).

The proportion of the different transportation modes is outlined in Figure 4. A common characteristic and trend in numerous dense European city cores is high walkability and public transport service. At the same time, cars are often kept away to improve the quality of life and public spaces and to control pollution. On the contrary, suburban areas have shown difficulties in supporting walkability and collective transport due to the dispersed pattern and predominant mono-functionality (Newman and Kenworthy, 1999). Though morphology influences transport choices, social-economic characteristics of the population strongly affect the modal split and need thus to be considered in the policy system to produce effective car usage reduction (Dieleman *et al.*, 2002).

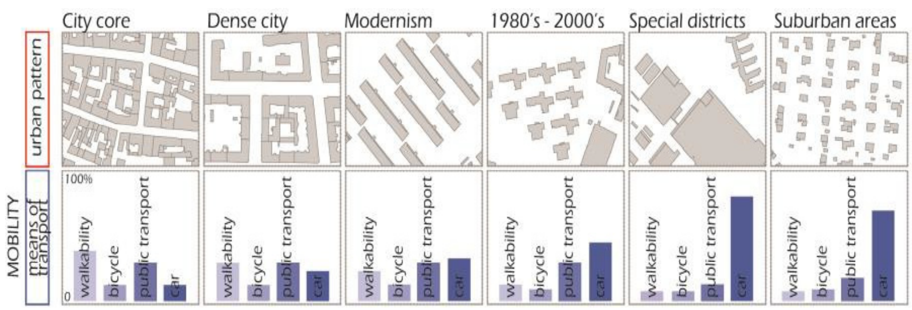

Figure 4 . *Modal split can be analyzed for each morphology, evaluating the sustainability potential of different configurations and posing the basis for cross-connection networks within the city (Troglio, Martschenko, Haas, 2012).*

Energy performances and microclimate of urban settlements can be influenced by the type and extension of green and blue elements as they affect transpiration, heat exchange, air flows, and pollution. Figure 5 describes the recurrent patterns that characterize eachmorphology,aiming to summarize the three main features – quality, size, and compactness/ network – that primarily determine a decrease in the used energy and improve the microclimate.

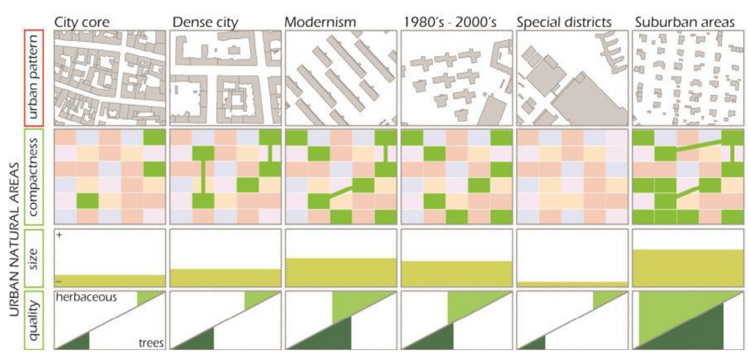

Figure 5. Visualization of green areas in urban settlements by connectivity, size, and quality (Troglio, Martschenko, Haas, 2012).

Identifying the compactness, extension, and quality of urban natural areas morphology makes it possible to set a clear framework for actions that maximize the benefits of an interconnected net of green areas. Trees and gardens, as well as green roofs, contribute to reducing the summer heat (thus reducing the need for cooling) by controlling the microclimate (Arnfield, 2003, Akbari *et al.*, 1992), protecting from winds (Givoni, 1998), reduce the air pollutants (Ratti *et al.*, 2005), and prevent runoff effects and floods (Girling and Kellett, 2005). Nevertheless, it has to be noticed that lawns, despite their contribution to increasing permeable surfaces and reducing the risk of floods, have inferior value to trees, as energy and water consumption for their maintenance is high and the ecological and energy balance effect low.

As previously discussed, buildings' energy performances can be easily estimated and categorized by looking at form, surface complexity, and materials if considered single elements. Since constructions are not separated by the urban context in which they lay and interact, the energy performances of cities are strongly influenced by their specific evolution, depending thus not only on the characteristics of the single elements (the buildings) but also on the urban grid – the morphology – and the adopted retrofit/upgrades policies. Figure 6 exemplifies, starting from the results obtained for the city of Uppsala, the average block characteristics of European cities and the influence on energy performances. Older buildings, high density, and compactness of the built environment often characterize city centers, which correspond to low solar radiation, characteristics that progressively change towards the outskirts and suburban areas of the city.

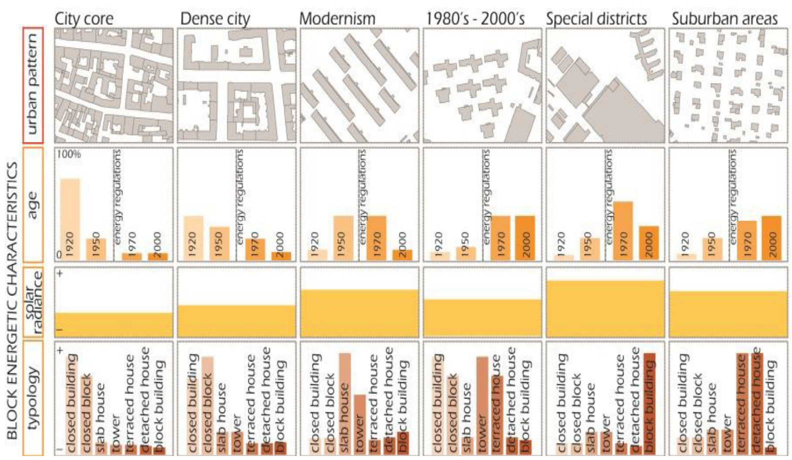

Figure 6. Age, solar radiance, and typology mix of the different urban morphologies can significantly influence the overall energetic performances (Troglio, Martschenko, Haas, 2012).

SOME MAJOR CONCLUSIONS: USE AND INNOVATION IN THE PLANNING AND DESIGN OFCITIES

Cities are not static; they constantly change and evolve in new directions. Any new development challenges the current situation, as it can transform the status quo unprecedentedly (Madanipour, 2006). In neighborhoods, housing, and real estate markets, this transformation is evolving in all kinds of emergent ways, not least sustainability. Achieving true sustainability and resilience to raise the quality of life through urban design will not happen without promoting energy efficiency in each neighborhood and housing area. Furthermore, the maintenance, management, and refurbishment of housing stock and affordability are paramount and go hand in hand with the renewed interest and need for social and low-cost housing. Overall, in sustainable urban development, raising the quality of life through livability will be carried on the way we treat resilience vis-a-vis to climate change and the way we decide to increase the density and efficiency of urban areas – making them truly smart, lean, green, and livable cities based on sustainable urbanismprinciples.

Energy planning plays a pivotal role in urban planning and design, as it is a critical component of achieving sustainable development goals. The availability, sources, and efficiency of energy resources greatly influence the environmental, economic, and social dimensions of urban areas. Incorporating sustainable energy solutions in urban planning is essential for reducing greenhouse gas emissions, enhancing energy efficiency, and ensuring the long-term resilience of cities (Smith & Brown, 2017). This involves designing and retrofitting buildings for energy efficiency, promoting public transportation and sustainable mobility options, and integrating renewable energy sources into urban infrastructure. Furthermore, energy planning supports economic development by reducing energy costs, creating jobs in the renewable energy sector, and attracting investments in sustainable technologies (Johnson, 2019).

The importance of addressing energy issues in urban planning and design is further underscored by the need to enhance the quality of life for urban residents. Sustainable energy solutions can lead to improved air quality, reduced noise pollution, and increased access to affordable and reliable energy services, thus positively impacting public health and well-being (Williams, 2020). By prioritizing energy efficiency and renewable energy integration, urban planners can contribute to mitigating the effects of climate change, enhancing energy security, and building more resilient and livable cities.

Global climate change – with its social, economic, political, cultural, and ecological dimensions (and the impact on our spatial, physical, and planning patterns) – is one of humanity's principal challenges. Today's cities are the most remarkable assemblage of material resources, human capital, and goods and services the planet has ever seen. More than half of the world's population lives, and about three-fourths of world resources are being consumed. One-fifth of the emission is produced (IPCC, 2007). Urbanization is the defining phenomenon and process of this century. The impact of rapid urbanization coupled with population growth will be felt most acutely in developing countries, where the built-up area is expected to increase threefold. In contrast, the urban population will double by 2030. Forecasts show that cities will use 75% of the total energy produced (IEA, 2008). Since human activities are mainly located in buildings, they are crucialin energy demand, using over 40% of the global primary energy. Despite the opportunities coming from technologies and passive house solutions to reduce the energy demand at the building level, most of the potential within the building sector remains unused (IEA, 2008). From this troubling perspective, city sustainability and cities' resilience become the main issues.In the last century, we have, as citizens as well as professionals working with urban development and planning, developed a disconnection from nature that has contributed to the greatest crisis in the history of humankind and the greatest threat to the natural eco-balance of our planet and our built environment – to our cities. There is no doubt in the mind of any urbanist that, to avoid the looming environmental disaster, one of the most significant cultural and technological transformations that we (as citizens, not consumers) must undertake pertains to the way we plan, design, build, maintain, govern, and use ourcities.

Understanding and visualizing the energy characteristics of urban morphologies by adopting a transect approach contributes to focusing attention on the need for interdisciplinary planning to fully understand and exploit the potential of urban areas to reach a more sustainable development(Farr,2008).ByadoptingSustainableUrbanismastheoreticalbac kground,the energy transect aims to contribute to planning, designing, and managing cities and districts by helping the processes that shape forms and functions of the built environment.The internal organization of a city and its relations with its region are essential elements to be analyzed in their mutual connections to create the necessary environmental and socio-economic conditions (Nijkamp and Perrels, 1994) which support urban services and functions (Hardoy*et al.*, 1992).

The synergy of physical urban form, transportation patterns, natural resources, land use, and socio-economic aspects became crucial for creating livable cities and communities, elements of a sustainable metropolitan-regional city network (Haas,2012).Throughout the last 20 years, severalprofound theories, approaches, models, and ideologies – paradigms – have influenced the practice of urban planning and design,such as Sustainable Urbanism (Farr 2008), Green Urbanism (Beatley 2000; Lehmann 2010), Ecological Urbanism (Mostafavi 2010), Landscape Urbanism (Waldheim 2006),Biophilic Cities (Beatley 2010) and Resilient Cities (Newman, Beatley, and Boyer 2009).The urban transect concept is based on the idea that urban environments should be designed to create a seamless and gradual transition between the different zones. This approach aims to achieve a more sustainable, walkable, and inclusive urban fabric that accommodates various land uses and allows people to live, work, and play nearby.The urban Transect is often used in the context of New Urbanism and innovative growth principles, which advocate for compact, mixed-use, and pedestrian-friendly cities that promote social interaction, reduce automobile dependence, and enhance the quality of urban life (Talen, 2002). It provides a valuable tool for urban planners and designers to guide land use regulations, transportation planning, and the overall development of cities and regions.

SUMMARY AND FINAL REFLECTIONS

The transect model in urban and regional planning divides areas into zones, ranging from rural to urban, along a linear path (Smith, 2005). New Urbanism and Smart Growth principles are used to guide development in each zone, with specific regulations and guidelines to ensure that new projects align with the desired character of the area (Johnson, 2010). This approach aims to create sustainable and context-sensitive development patterns (Smith, 2005) while preserving rural and natural elements (Jones, 2012). It promotes walkable neighborhoods, reduces automobile dependency, and fosters a sense of community (Brown, 2018). In summary, the transect model helps planners create diverse and sustainable urban and regional environments (Johnson, 2010).

The value of using our new, innovative energy transect becomes particularly important to explain the components of coherent urban patterns and improve their energy performances, define density and human access to nature as well as design and energy saving schemes, and provide new parameters to overlay with the city morphology (Farr, 2008). In the end, perhaps, there will be an emergence of a more synthesized urban design theory, adjusted to deal with a range of complex realities facing us, operatinga more complete technical and planning repertoire, but also a socio-economic-cultural, energy as well asa natural one. Until then, we need to console ourselves that even though there is a consensus onthe main burning issues of climate change and built environment manifested through sustainableurban design approaches, no real consensus exists in the current paradigms and toolkits; theylive lives of their operations in different contextual settings, but work towards a commongoal – urban ecology and sustainable urbanism as a way of life (Haas, 2016). The Urban Transect is constructing an approach that reconciles urbanism and environmentalism; teh theoretical and methodological the tool also enables choice and equity in how and where individuals live. Understanding the Transect is like knowing the DNA code for human habitat (Falk and Duany, 2020). The energy transect model can be considered a constantly updated urbanism strategic tool that cities and developers can use to define and calibrate development and management policies, achieving better results in the planning for sustainability and reducing energy costs. For most urbanists, the radical transformation of how cities work implies a radical change in how they plan and design. At the same time, we cannot forget that the human aspects of urban form remain essential, maybe more now than ever before. We need to plan, design, and maintain various places - foremost through understanding their identity (individuality), structure (physical pattern), meaning (practical-emotional impact), and setting (relation to the environment) (Haas, 2012).

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Endnotes

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