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Efficiency Towards Urban Systems

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ABSTRACT: Processes and expansion related to urban development put pressure on their natural environment. This pressure is translated into negative consequences for ecosystems, such as climate change, the reduction of the ozone layer and consequent loss of ability to absorb anthropic impacts from support system. The volume of emissions and impacts on support systems depends directly from the lifestyles of citizens and the management model of each city, the urban organization. This essay explores two attitudes towards the urban system, an interventional approach that seeks to optimize exploited resources, and a proactive approach, to reduce the consumption of natural resources, reaching the energy efficiency of cities and, simultaneously, reducing the inherent ecological footprint. The aim is to understand how the destructors phenomena can be reversed in order to correct and stabilize the deterioration caused upon the support system and how to plan and rehabilitate urban systems in order to reduce environmental impacts.

1 INTRODUCTION

Current urban context concerns the extent of the risks cities are exposed to, as a result of their expansion. Cities become the largest consumers of energy and the biggest polluters of the world, they are unsustainable organisms in the landscape, devouring and contaminating it. Population growth of cities has greatly enhanced; between 1950 and 1990 the urban population has multiplied by ten, rising from 200 million to 2000 million (Rogers, 2000), thereby leading to its development/expansion.

Urban development has the effect of modifying the conditions of cities, which if not properly reflected upon can cause significant, permanent and destructive effects on the environment. The preference of people for urban areas implies greater land use, construction, infrastructures and traffic congestion increase; consequently, these places become consumers of large amounts of energy and generators of waste and pollution, emitting gases into the atmosphere therefore destroying biodiversity and the urban ecosystem. The survival of society depends on healthy balance between the variables of population, resources and environment.

While reflecting upon the effects that cities have on the world it becomes urgent to reverse its impact, in order to absorb the amount of people and continue to ensure adequate conditions. Strategies to reduce environmental changes are needed when planning a city, these include worries on waste production and consume of natural resources like water, vegetation and soil; urban design skills should enforce sustainable policies in order to reduce the energy waste and its impact in the world. Cities should be planed to absorb the urban growth while being sustainable, offering living adequate conditions without mortgaging ones future or those of coming generations.

2 URBAN METABOLISM

Urban metabolism is a process of exchange between the city and its surroundings - its support system; the relation between the two entities is mediated by each city management model.

Cities operate on their support systems, extracting materials and energy and putting pressure on it; this exploitation has an impact on the natural environment and on its natural resources, according to the intensity of exploitation and the fragility of the environment. The materials and energy arrive in town in the form of raw materials or consumer goods in order to maintain and improve the organization of the urban system, its complexity. At the other end of the process, the city emits organic and inorganic waste, air pollution, chemical effluents and require a natural area capable of assimilating them. Impact areas, such as those created by either resource extraction or by waste deposition, form the local footprint. The flows and resource consumption are regulated by the models of urban organization, which determine the degree of environment exploitation and the impact that urban system will have on the support system (Image1).

This process is likely to become unsustainable if we do not consider two important aspects: the reduction of pressure on the support systems (E) and the increase of urban organization (H), represented by diversity (Rueda, 2002). This relation can be represented by the equation E / H, which is more efficient the smaller the E and the higher the H.

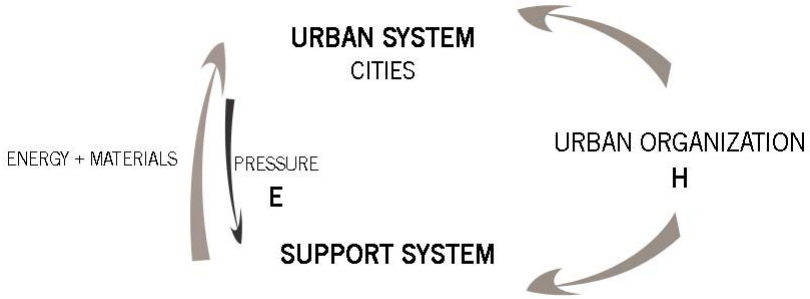

Image 1. Scheme: relation between E and H

Urban systems put pressure on their support systems, either by the extraction of natural resources for the entry of materials and energy, whether by waste deposition contaminants in the environment. Reducing the pressure on the support system is the leading way to a more efficient city and it depends on the organization of urban systems (Rueda, 2002).

E, as one can see at image 1, stands for a variable responsible for the pressure on the support systems, as such, one needs to increase information to correct the behavior of current excessive consumption of resources. In order to reduce this variable and obtain a more energy efficient urban system, it is necessary to define strategies to decrease energy consumption. These strategies should be defined in urban planning while considering the passive behavior of buildings, bringing them closer to energy self-sufficiency within thermal comfort and illumination, considering the orientation and insulation of buildings, the characteristics of walls and their linings, favoring outside shadowing, cross ventilation, obtaining better energy efficient results. The transport must be planned in an intermodal system and well connected, as well as city streets, providing a favorable mobility and reducing the need for motorized transport, encouraging green transport such as walking or cycling. Public spaces should also be planned taking into account the passive strategies of comfort and lighting, to reduce spending. Models of urban organization should consider the energy spent on waste and water management, seeking a method capable of balancing the resources (Rueda, 2002).

H, on the other side of this relation at image1, refers to the urban organization, in other words, its ability to prevent deterioration of ecosystems through better use of resources and reuse programs; urban organization relates to the concept of diversity or complexity based on the synergy between the multiplicity of urban uses and functions, pathways and elements of the city, providing better conditions for agglomeration and urbanization.

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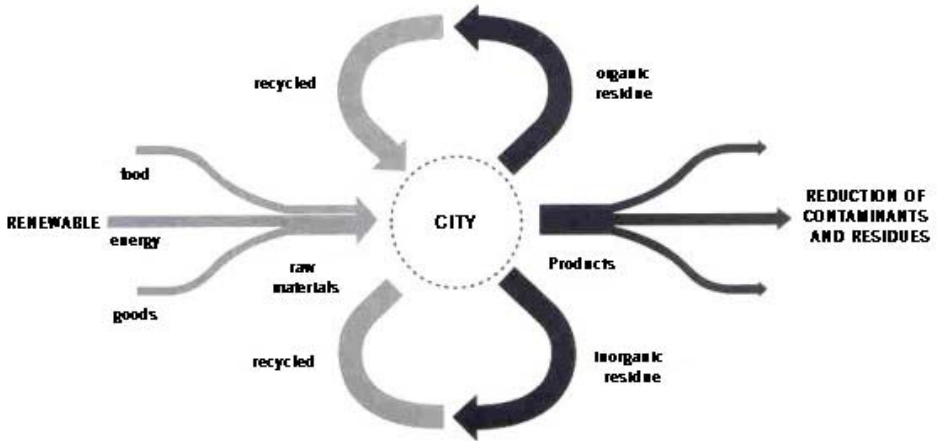

Image 2. Cyclic Urban Metabolism (source: image adapted from Rogers, 2000)

The urban organization (H) is related to the concept of cyclic urban metabolism, by Herbert Girardet, and argues that the consumption of energy (E) is reduced by improving performance and increasing the re-use of resources. The urban system should organize itself around the recycling of materials, cost reduction and conservation of non-renewable energy, taking advantage of renewable energy; it is a cycle process of use and re-use that increases the city income and reduces its impact on the environment, i.e., in its support system (Rogers, 2000). Throughout the process of cyclic urban metabolism, material and energy input in cities is reduced, as is the waste deposition and pollution of the atmosphere. Part of the waste produced by the urban system is treated, recycled and reused as raw materials while the other part is used for energy production, thus constituting a cyclical process. Hence it is possible to reduce the impact on the support system either by the extraction of resources, whether by waste disposal, reducing the ecological footprint.

3 INTERVENTIVE ATTITUDE: INCREASING THE H

To increase the variable H is to increase ability of the city to organize itself. It is necessary to adopt measures to promote energy saving and still maintain the efficiency of the city. A shared vision is needed, considering the components of the city as the principal agents, and getting the most out of them, trying to preserve the support system; its all about considering the urban system and its environment, as well as their interactions, understanding the problem and seeking appropriate solutions.

3.1 *Efficient Urban Models*

Energy is fundamental to the functioning of urban systems, these consume more or less energy depending on the building typologies, on the models of mobility and on the technology and efficiency of the city model, it should move towards increased efficiency.

A dense and compact city model is the one which allows a better relation of both variables E and H. This model is associated to urban sustainability, allowing social, ecological and economic advantages, increasing energy efficiency, reducing resource and energy consumption, producing less pollution and avoiding the consumption of rural land (Rueda, 2002), providing a more stable system. The concentration of different activities into a limited area allows more efficient use of the city. It is important to mention that the more a city expands, less profitable becomes their public transport system and citizens become more dependent on motor vehicles.

An efficient city model promotes mobility and accessibility of its citizens, favoring and encouraging the use of green transport, balancing the use of public spaces and favoring pedestrians and community life. Another relevant point to the efficiency of an urban system is the planning of public spaces and green areas, those related to the amortization of environmental noise, absorption of carbon dioxide, mitigation of the pollution and production of oxygen, absorbing rainfall, and increasing the diversity of fauna and flora.

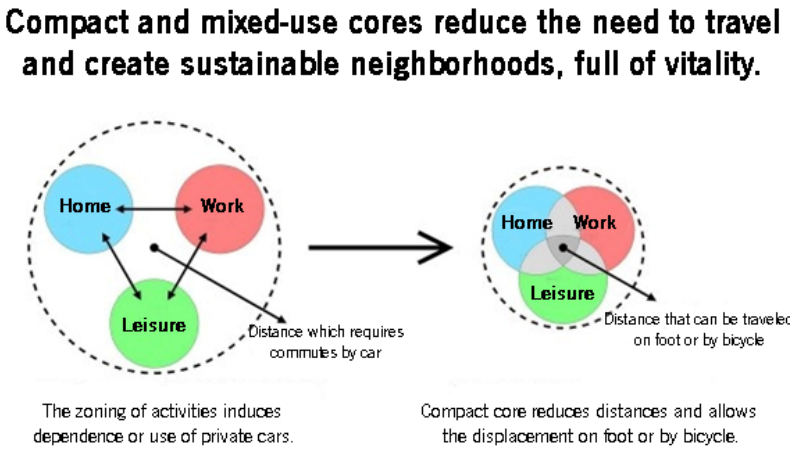

Image 3. Models of Compact and Dispersed City (source: image adapted from Rogers, 2000)

A city based on a core compact model facilitates the clear separation of rural areas, allowing a contrast to the complex natural systems, forming a different structure that provides the necessary balance between exploration and succession.

3.2 *Urban Efficiency at Three Levels*

Speaking of efficiency means speaking about the relationship between expended effort and obtained results; in this case, energy efficiency provides a measurement through which we can quantify the power supplied (E) to the urban system (removed from the support system), and the energy or well being that the urban system can produce, through urban organization (H). This relation continues to be represented by the equation E / H in the same terms mentioned above.
In the scope of environment rehabilitation and preservation, energy efficiency is the optimization of the urban system or of its diversity (H) using the least resources possible (E), re-using and availing them to the fullest. In this context three levels of the city can be considered (rooftop, surface and underground) as exploitable bases, permitting a full advantage of each layer (Rueda, 2002). Most development plans are only concerned with the surface level, neglecting the top level constituted by the rooftop, and the underground level.

The considering of all three levels of planning is related to the profitability of the entire city space, considering the capacity of its elements to collect, use and accumulate energy. The top level of the city is its buildings rooftops and can be used as the energy pickup level; one can install at this level micro wind turbines, photovoltaic systems, solar thermal systems, rainwater collection with the aim of capturing power for later use of the urban system. Still at this level, a new layer of biodiversity, consisting on green roofs can be created, and can be related to the surface level, contributing to the reduction of temperature and absorption of emissions (Rueda, 2002).

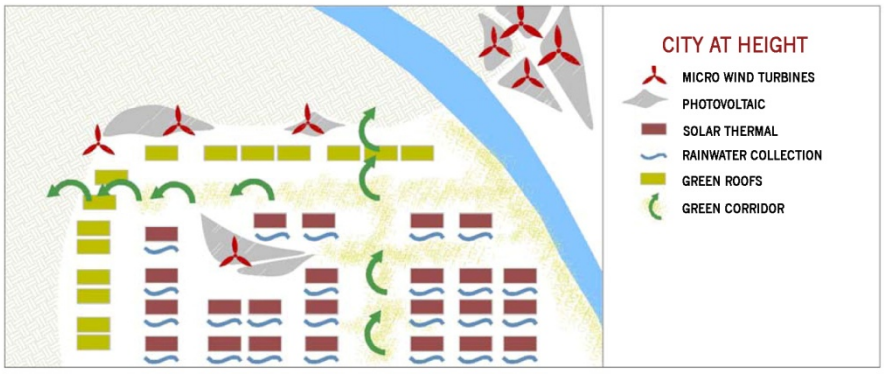

Image 4. City at Height (source: image adapted from Rueda, 2002)

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The surface level is the most explored in urban planning, this layer is related to the consumption of resources and with the realization of urban life. Also at this level one can apply strategies to minimize the impacts, such as land use management in a compact urban system, planning of green and pedestrian routes, increased public and ecological transport and bioclimatic control through the planning of vegetation, water and shadows zones, even defining soundproofing and green facades strategies. Regarding urban design, cities should be designed to improve insulation and reduce spending on air conditioning.

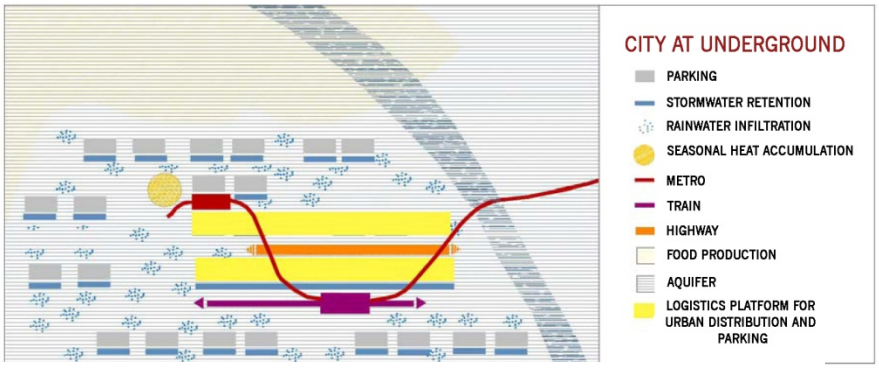

Image 5. City at Underground (source: image adapted from Rueda, 2002)

The underground level plays a decisive role related to the accumulation of unused energy and with the urban distribution and parking logistics. At this level, parking solutions and mobility infrastructures for public transport and for urban distribution routes (tunnels) can be developed, helping the mobility at the surface and releasing these soils for community life. This layer plays a key role in waste management through sub-soil solutions and as storage of energy captured on top level as the rainwater deposits or the seasonal heat; this level is also important in the context of the infiltration of rainwater, avoiding its excess accumulation in the surface (Rueda, 2002).

The relation between layers is obvious, an integrated planning of the three dimensions can bring benefits by making production processes more efficient and releasing part of the support system, moving towards a sustainable development.

4 PREVENTIVE ATTITUDE: REDUCING THE E

On the one hand the urban system should be able to organize itself in order to reduce and reuse the amount of waste it produces, on the other to define strategies to reduce consumption of natural resources, using recycling and reuse of sources techniques and taking advantage of renewable energy, increasing the efficiency of the urban system. The implementation of sustainability in the city requires a change of citizens habits as well as its ways of thinking in order to minimize the strength of the impacts in general.

4.1 *Reducing Ecossystems Disturbance*

In this sense it is necessary to reduce pressure on the ecosystem (E). The planning of a city (urban system) should be accompanied by the use that it has upon its support system. The established relation between the two systems should be studied and planned in order to provide a maximum resource efficiency and minimum disruption of ecosystems (Rueda, 2002 - efficiency). Articulating energetic degradation and the transformation of materials with the renewable energy flows and recycling and reuse techniques are the way to a reversal of the deterioration of support systems.

According to the cyclic model of metabolism, waste produced by the urban system should be recovered and re-entered in the urban system in the form of compost, raw materials or energy (Vendramini, 2005).

Also the use of overblown and irresponsible drinking water leads to the concern about the depletion of this resource. Drinking water should be used only for functions that require its qualities, other activities should be carried out with lower quality water. Urban planning should include strategies for the reuse of stormwater and wastewater for non potable uses, meeting the concerns of sustainable conservation of drinking water in urban areas. Strategies in this area al-

low you to increase water resources and reduce the required flow of treated wastewater discharged in the receiving water resources, protecting ecosystems and reducing the amount of pollutants released to the environment, it also facilitates public drainage systems and wastewater treatment, and a lower consumption of this resource.

The reduction in power consumption translates into greatly reduced disturbance of the support system, however this change requires a complete transformation of the current energy crop, which means understanding the changes of regional planning, urbanism, architecture, water management, waste, mobility, in other words, the urban reality (Rueda, 2002b). This change can be based on increasing energy efficiency so that they underestimate the losses, seeking a balance between the amount of energy produced by renewable and nonrenewable sources, maximizing the production of clean energy with less pollution effects, it is important to adopt appropriate ways of life for citizens, consuming less energy.

The atmospheric pollution is a direct consequence of energy consumption, factors such as increased traffic and the expansion of cities throughout scattered models are responsible such. This type of pollution has negative consequences on urban systems such as heat island effect, global warming and the reduction of the ozone layer. Reducing the exploitation of urban systems to their support systems is one goal to achieve.

5 FINAL CONSIDERATIONS

The current development of most of the cities is moving towards unsustainability, the increase in urban population means a greater exploitation of resources, leading to a situation of imminent breakdown. In this sense, cities should be rethought looking to minimize negative impacts and decreasing the degradation process. Action should be taken to reduce these impacts, considering the city as an ecosystem, defining principles and rules that dictate the operation of the urban system and move towards reducing the ecological footprint.

This paper is based on the relation between two variables, E and H, which define two attitudes needed in the urban development process, an attitude of prevention related to the reduction of exploitation of the support system, and an attitude-based intervention upon organizational systems designed to monetize the urban system. These attitudes are related and together seek to achieve a model of urban organization more sustainable, more efficient and more capable to absorb growth without degrading your support system.

While analyzing the urban metabolism of an urban system it is possible to see how each society uses energy, materials, water and soil for their maintenance and reproduction, and see where action is required; it is a valid tool for assessing the sustainability the cities. The cyclic process of metabolism can serve as a guide to support the planning of cities, favoring energy efficiency conditions and reducing consumption of resources: soil, water, materials and energy, minimizing waste flows and the incorporation of the cyclic idea - cyclic metabolism - on the processing of materials and energy moving towards a change of attitude (Rueda, 1995). The purpose of this paper was to provide an overview of the mechanisms to take into account when planning or rehabilitating a city, while reducing their environmental impacts, reversing the current situation, moving towards sustainable development.

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