

SUSTAINABLE PLANNING IN CATALONIA: CASE STUDY

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ABSTRACT: Assuming the challenge of sustainable urban development, as was proposed for the first time in the 1987 Brundtland Report, carries with it the need to stop doing some “unsustainable practices”.

The city growth over the last 150 years is a perfect example of one of our most destructive habits, especially during the period beginning in the 1950's, when consequently to global population growth, and post-war economic welfare, one extraordinary urban development took place across the globe. This paper will present a case study: the plan for the Cifuentes Polygon in the city of Sabadell (Barcelona), in which a methodology has been developed to become a reference for the growth of Mediterranean cities. Combining density and urban outlines based on the traditional Mediterranean city, with bioclimatic design, active use of renewable energies and minimization of waste, the environmental impact is significantly reduced on the urban environment, therefore advancing towards the goal of low carbon cities.

Keywords: Examples of sustainable architecture and urban design

1. THE URBANIZATION PROCESS AND ITS ENVIRONMENTAL IMPACT

Urban development in first world countries has mainly followed a diffuse city growth model which consumes many resources and produces great quantities of waste; presently, these cities are responsible for over 50% of the emissions that are contributing to global climate change. For this reason, one of the greatest challenges we're faced with at the present moment is modifying this dynamic through the processes of sustainable urban development.

The environmental impact formula or IPAT of the urbanization process such as it was formulated by Paul Ehrlich in 1968 [1] is the resulting product of three factors: Population, Affluence and Technology, factors that coexist and feedback each other mutually.

Environmental impact (I) = population (P) x Affluence (A) x Technology (T)

These three factors, which have increased extraordinarily throughout the 20th century, are at the basis of the urbanization process:

This apparently unstoppable growth, generates an increasingly unsustainable pressure over the support systems, and therefore has increasingly negative consequences over the planetary equilibrium.

The environmental impact can be resumed in four types of effects:

1.1. Contribution to the Global Climate Change:

Already, in the first Earth Summit (Rio de Janeiro 1992), the direct relation between urbanization degree and contamination processes of the Planet had been manifested, as well as the global reach of their grave consequences. Emissions of greenhouse gases that come from the combustion of non-renewable fossil fuels (carbon, petroleum and gas) that in turn come from the urban environment (more

than 50% of the total) collaborate to the progressive increase of the proportion of particles deposited in the atmosphere (measured in parts per million) and are causing global climate change in the same proportion.

Of the four main gases that generate the greenhouse effect (CO₂, CH₄, NO₂ and SF₆) as well as fluorocarbons, the CO₂ is closely linked to the emissions of buildings and urban transportation.

1.2. Disproportionate consumption of useful land.

The extraordinary expansion of the city over the territory that began 150 years ago with the coming of the industrial revolution and that has accelerated extraordinarily in the developed world after the second post-war era, consumes great resources of soil and energy.

Even in our country, Spain, the traditional Mediterranean model of compact city is changing for one of disperse urbanization, in a time in which there has been no significant increase in population, but yes in the economical level, which demonstrates that this imported model is related to the increase in wealth

1.3 Increase of the ecological footprint

The ecological footprint as it was defined by Wackernagel and Rees in 1996, ...*The bio productive terrestrial soil that the city depends upon for its operation...* is the indicator that best quantifies the impact that the urban developments, attending a specific life style (consumption level, habits, mobility, etc.) have over the territory in a globalized society such as the current (near environment – distant environment) even reaching the planetary scale in the case of great metropolis. [4]

The footprint measured in has/hab allows the understanding that, for its operation, a city depends of a territory of influence from which it extracts soil, food, water, materials, manufactured products, etc. and spills residue. Its calculation is not easy and it is based in the evaluation of various factors [5]

The dissolution of the city in the territory through the dispersion of the residential suburbs, as well as

the segregation of the urban uses, from the principles of the "Athens Charter" provokes a great deal of daily journeys, from the dwelling to the workplace, to the great commercial zones, to recreational zones, a situation that negatively conditions the way of living, the way of relating and the satisfying of daily needs of great part of the population, enormously increasing the ecological footprint.

The ecological footprint, is also a reliable indicator of the different environmental impact of cities in developed and developing countries, such is the case, that while in 1996 the footprint of a U.S. Citizen was 9.6 has, the footprint of an Ethiopian was 0.7 has.

1.4. Increasing Inefficiency of the urban model

The urban model based in the disperse city, as it has been previously indicated, generates an enormous energy consumption to feed the needs of transportation. It is well known that there is a direct relation between consumption of fuel that comes from non-renewable fossil resources and the quantity of journeys in a private vehicle.

2. PRINCIPLES AND STRATEGIES OF SUSTAINABLE URBAN DEVELOPMENT

2.1 Principles and strategies

For their application in sustainable territorial management and planning and particularly the new urban developments these objectives of sustainable development can be specified in four principles: [2]

1 Control of their ecological footprint considering urban soil as a valuable resource and decreasing the consumption of energy, soil and general resources.

2 Closure of the energy and matter cycles of the urban ecosystem, control of the extensive urban expansion, and recycling of built patrimony with rehabilitation politics in the consolidated city and decreasing the production of residue and non-reusable waste.

3 Bet on the singularity of urban developments, adapting them to their climate and context, using the principles of bioclimatic urbanism and designing and building the new neighborhoods *and new buildings with strategies of maximum savings and energetic efficiency.*

4 Increase and improvement of social cohesion.

These principles can be transformed in useful guidelines for the planner specified in a Decalogue

of good practices that are partially or totally applicable to any sustainable urban development.

3. CIFUENTES PLAN

The Cifuentes Plan in Sabadell, an intermediate city located in the metropolitan area of Barcelona constitutes an example of applied research carried out in the Department of Architectural Projects of the UPC in which strategies based in these principles have been applied.



Figure 1: Cifuentes Plan , Eco-neighborhood in Sabadell ,Barcelona ,surface 2,8 ha./ density 60dwellings / ha

3.1 Urban density and expansion control of urban soil.

Moderate urban density is a key factor: it establishes the relation between the number of dwellings and the area they occupy in the territory. Low density (less than 20 dwellings per ha.) consumes much useful soil and energy and is inefficient and costly, because:

- It increases the cost of roadwork infrastructure, as well as the execution and maintenance of every supply and evacuation network.

- It encourages mobility systems based in the private automobile for daily activities and penalizes public transportation, generating congested urban networks in peak hours.

- It increases the consumption of energy as it increases individual journeys.

- It conditions the endowment equilibrium because it prevents the placement of equipment near every resident.

The adequate density should be situated between a minimum of 55-65 dwellings per ha., and a maximum of 100 dwellings per ha., combining building morphologies and typologies, diverse familiar programs, with endowment equilibrium, equipment and green areas and with a compactness index. [6]

Densities should be complemented with the expansion control of urban soil to limit the excessive consumption of useful soil.

3.2 Solar passive design and the active use of renewable energies.

Bioclimatic strategies are not new, they have been a part of the traditional city, and were in the base of hygienist principles of the modern movement.

In the same way in which orientation and shape of a building are fundamental to optimize the passive response to a specific climate environment, in an urban scale, planning must anticipate that the urban trace and structure and the position and shape of buildings through the study of cast shadows, allow their correct orientation and the optimization of natural ventilation.



figure 2: Solar design, sun and shadows December 21 / 9:00/12:00/15:00 hrs.

From an layout that allows a correct orientation of buildings, architecture must be built according to the principles of energy saving and efficiency, using natural illumination and ventilation to its maximum and the active use of solar charges in cold climates and endowing the facades and roofs of a multilayer finish to avoid unwanted thermic charges in warm climates and use the appropriate thermic inertia (high in temperate climates, low in tropical climates) and evaporative cooling through ventilation.

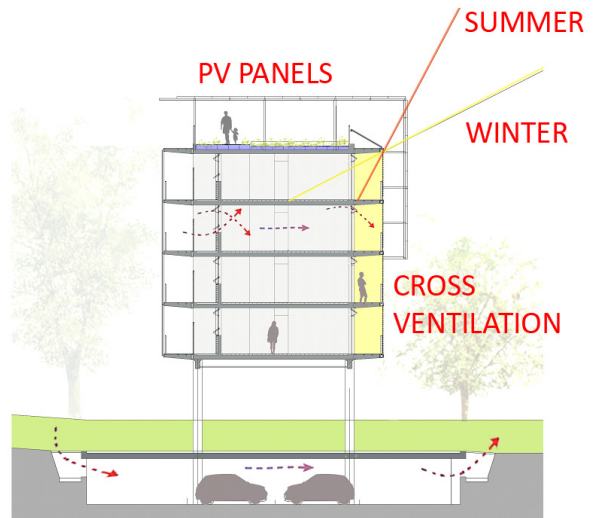


Figure 3: Bioclimatic design of buildings

Buildings must also incorporate technologies for the production of energy from renewable sources: solar, eolic, geothermal, and to avoid the squander of resources, built preferably with regenerative materials like wood or inexhaustible materials like earth (for bricks) or sand (for crystals)

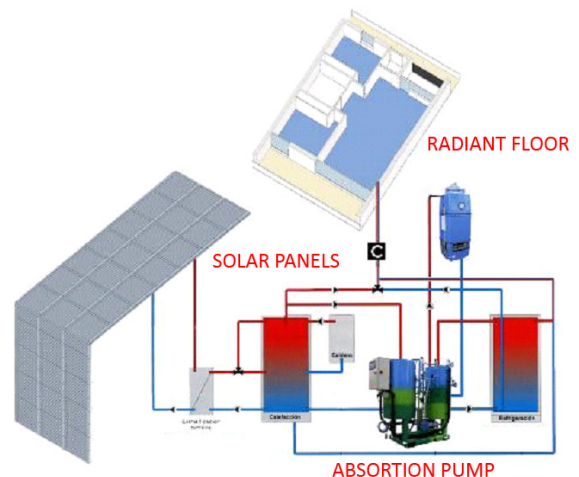


Figure 4: Renewable energy and energy efficiency

Unfortunately in most urban peripheries built in the last decades, the initial optimistic postulates of the urban culture of post-war have been distorted, and the objective of correct solar exposure and adequate ventilation has been forgotten.

Many European cities have filled themselves with uniformed neighborhoods with very mediocre architectural results and constructive solutions of poor quality that also consume much more energy than necessary.

3.3 Embebed in place

Urban design must determine not only the disposition of roadwork trace and Street dimension, but also precise form and position of wooded areas, wind turbulence control, water body disposition, treatment of surfaces and pavements, and the use of landscape and vegetation to minimize the “urban heat island” effect. [6]

The variety of architectural shapes allows the best adaptation to topography and site conditions.

Equilibrium of urban activities must be achieved with a mix and variety of uses, building typologies and morphologies in urban structures.

This enables the workplace to be near the dwelling, and that avoids mono functional neighborhoods or dorm neighborhoods.



Figure 5: Embedded in place: Green buildings, help reintegrate and minimize negative impacts upon their settings

3.4 Cyclic management of energy, materials and waste

To reduce the ecological footprint, it is necessary to act over the flows of matter and energy and to achieve an energetic balance (zero emissions) and for this, we should:

- Evaluate the life cycle CO₂ of the building to decrease incorporated energy using efficient and industrialized building systems.

- Encourage the use of renewable energies, for public transportation, street lighting systems, the production of sanitary hot water and electricity in buildings, because this reduces the emissions to the atmosphere, and depending less of fossil fuels, decreases the ecological footprint and improves the energetic balance of the city.

- It is also important to close the water cycles, with separation of clean water, grey waste and black waste and their appropriate management and treatment (for example grey waste for irrigation of parks and gardens) promote the use of rainwater, to reduce the necessities of clean and treated water for every urban use, and so finally decrease the total cubic meters extracted from the natural environment.

- Implementation of reduction, reuse and recycling of solid urban waste in every scale, from domestic garbage to urban rubble generated from construction work.

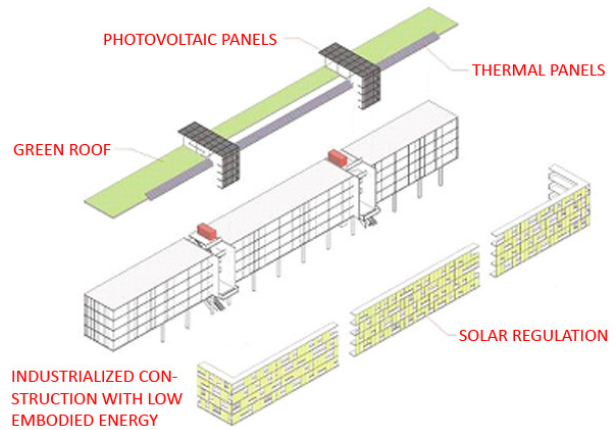


Figure 6: Total Life Cycle Costing

Green buildings must be built with materials that endure and improve with age

3.5. Social Cohesión and community

Social Cohesion constitutes the key to encourage citizen participation in urban processes, in addition, the social economic scenery must be complemented with an adequate formal solution of public space that reflects the diversity and the blend of uses and functions of the urban tissue.

Equilibrium of activities must be achieved with mixture and varieties of use, building typologies and morphologies in urban structures, for it helps structure and enrich urban space, endowing it with references and singularities. Mixture of use, combining residential activity with compatible commercial and industrial activity, allows the workplace to be located near the dwelling, and that avoids mono-functional neighborhoods, dorm neighborhoods.

Variety of architectural shapes allows better adaptation to topography and to site conditions.



Figure 6: Community and connection:

Green buildings must regenerate a sense of community and connection with the natural world



3.6. Health and happiness

The majority of our cities in which people inhabit most of their lives, are not only detrimental to their natural environment but also to the people that live in them.



Figure 7: Natural light, fresh air and absence of toxic materials and off-gassing combined with the contact outdoors and community life make people healthy and happy

Their inhabitants work in spaces deprived of natural illumination and that artificially climatized, they can't enjoy fresh air, nor can they control the artificial ventilation, they don't have visual contact with exterior open spaces.

Sustainable urban design must encourage their buildings to have natural lighting, fresh air and absence of toxic materials, free of smoke and visually open to exterior garden areas and promote community activities; this will improve health and wellness of their inhabitants. [8]

4. C ONCLUSION

In the climatic change era the urban planning must incorporate sustainable strategies if we want to step on through a liveable city.

The use in the urban project of tools as bioclimatic design, energy efficiency with renewable energies and cyclic consideration of materials and waste is the appropriate way to reduce the carbon footprint and it isn't an obstacle for designing, rather it is an opportunity for creativity.

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5. REFERENCES

- [1] P. EHRLICH, The population Bomb , Ballantine Books ,1968.
- [2] E.HIGUERAS - El reto de la ciudad habitable y sostenible, DAPP publicaciones jurídicas , Madrid 2009
- [3] J. TERRADAS – Ecologia d'una ciutat , Ed. Ayuntamiento de Barcelona ,1987
- [4] M. WAKERNAGEL and W. REES – Our ecological footprint. Reducing human impact on Earth , Gabiola Island , New Society Publishers ,1996
- [5] H.GIRADOT – Ciudades sostenibles , Coleccion Gorgola , Valencia ,2001
- [6] S.RUEDA -- Barcelona ciudad mediterránea compacta y compleja . Una vision de futuro mas sostenible. Ed. Ayuntamiento de Barcelona , Barcelona 2002
- [7] M. HOUGH . Naturaleza y Ciudad . Planificación urbana y procesos ecológicos , Ed Gustavo Pili, Barcelona 2002.
- [8] P.BUCHANAN - Ten shades of GREEN, Architecture and the natural World , The Architectural League of New York, 2005