Available online at www.sciencedirect.com

ScienceDirect

Energy Procedia 74 (2015) 1476 – 1489

Energy Procedia

International Conference on Technologies and Materials for Renewable Energy, Environment and Sustainability, TMREES15

Construction of a sustainable island city: The case of Cape Verde

Rui Vera Cruz[a]*, Miguel P. Amado[a]

[a] *FCT, University NOVA of Lisbon, Campus da Caparica, Caparica 2829–516, Portugal*

Abstract

The continental urban clusters followed models based on rules and standards that influenced the environment, which were in turn the result of consolidated growth and available technology. The successful models tend to be replicated, with examples seen in urban island clusters which adapted these guidelines, giving rise to a unique morphology resulting from models that *à priori* were not suited to the region.

The urban fabric of these clusters maintained regular and sustainable growth until the last quarter of the 20th century, when the increase in immigration made it difficult to control the urban space. This phenomenon was responsible for the impact on the constructed as well as the social environment, resulting in the degradation of the quality of life for the communities.

In the island regions, works were implemented in urban areas, using imported models, in the expectation of attaining a better quality of life.

The constant changes that emerged in the cities of continental and insular regions, with the results observed deemed as excellent, encouraged entities in charge to follow guidelines that would foster social inclusion, although this led to a weakening of the local identity.

This research focuses on the identification of the parameters that should constitute the basis for the construction of the sustainable insular city. The parameters identified were applied to two case studies related to two neighbourhoods on the northern outskirts of the city of Praia with different terrains with distinctly different characteristics in terms of their genesis, terrain and infrastructure systems.

The application of the parameters resulted in the conclusion that it is possible to apply them to the local reality and that they are simple enough to be widely implemented in the context of developing insular countries.

Peer-review under responsibility of the Euro-Mediterranean Institute for Sustainable Development (EUMISD)

Keywords: Sustainable City; Parametric Elements; Urban Fabric; Sustainable Development

* Corresponding author. Tel.: +3512948540; fax: +351212948398.
E-mail address: rnvc@fct.unl.pt

Peer-review under responsibility of the Euro-Mediterranean Institute for Sustainable Development (EUMISD)
doi:10.1016/j.egypro.2015.07.797

1. Introduction

Cities are the location of choice for most people who desire to live in community. Currently, more than 50% of the world's population lives in cities [1]. The choice to live in urban areas requires societies to make efforts in order to achieve economic and social improvements, all within a context where the conditions are right for harmonious integration into the environment. The development of cities is going forward without our being able to determine a common set of factors in which the globalization of the economy does not prevail. However, it is possible to identify factors connected to the morphology and outline of the urban fabric, the functional distribution of buildings and equipment, and the creation of free spaces, strategic mobility intersections, culture in community and other social aspects that make the comparative study of different urban realities possible.

We note, then, that the elements need to formulate measures adapted to the needs of society are being designed so as to ensure the consolidation of the urban morphology. This can be seen in the historic centers, even those that are obsolete in light of the requisites that modern society has imposed [2] [3].

However, the evolution of the city and its morphology did not always respect the principles that are considered today as the foundations of sustainable development [4] [5]. Due to exogenous factors, the morphology of the city was adapted to economic and industrial interests, compromising not only the way of thinking of the city, but the attainable quality of life in that city, as well. It is understandable that solutions should emerge of the type, the Neighbourhood Unit, by Clarence Perry (1929), or the city-garden, by Ebenezer Howard (1902), visionaries in terms of the resolution of problems and discrepancies identified at the beginning of the 20th century in social, environmental and economic aspects that resulted from the industrial revolution and the lack of alternative models to capitalism [6] [7]. In this respect, the interventions developed were found to be inadequate to effectively respond to the needs and ambitions of the people, ignoring the real context of the cities and neglecting what Jacobs (2000) described, "Cities are a huge lab of trial and error, failure and success, in terms of construction and urban design" [8].

Expansion like an oil slick, informal and unorganized, comes as a result of the difficulty that entities have in controlling growth due to the fragility of urban planning. This gap ends up being exploited by residents with no viable alternatives, resulting in a spontaneous expansion that hinders the implementation of any infrastructure networks and compromises public health and the well-being of the community [9] [10].

In a similar context, the theories of classic urbanism also define the methods of occupying the soil for urban use, always framing the phenomena of expansion by physical contiguity and the continuity of infrastructures, or through the creation of new cities as units of development, not wishing to confront the problem of containing growth and move in the direction of the aggregation model [11] [12]. The definition of parametric elements aids in the establishment of priorities in planning and assisting in the choice of most appropriate responses for the set of constructed buildings and the territory [13].

The morphology of cities differs from country to country and even within the context of each country. Cities may include areas from residential with formal characteristics (planned, equipped with basic infrastructures) to informal areas (unplanned – with disorganized construction, even marked by illegal occupation, and lacking basic infrastructures), including socio-economic and cultural inequalities that can be reflected in the quality of life of the inhabitants. The urban clusters in Africa face a set of interlinking threats: informal dwellings in vulnerable areas; precarious housing (overcrowding and lack of basic infrastructures), plus a growth in violence and insecurity. All these factors underlie the urban morphology that characterizes the cities and revert to the precarious conditions of life of the inhabitants [14] [15].

In Cape Verde, the phenomenon of urbanization has been increasing, partly as a result of demographic growth, as well as due to the people's search for better living conditions. The result is characterized by urban expansion and the occupation of areas not suitable for construction [16]. The pressure placed on the land has directly resulted in environmental and social problems, which put the inhabitants' quality of life at risk. Standing out in terms of the environment and the territory are the vulnerability of the land and the climate changes with storms and more intense and frequent torrential rains, in conjunction with the pressurizing factor of urbanization, the consequences of this have put the more exposed urban areas at risk.

The importance that the study of city areas brings to the construction of new approaches in terms of land requires that the preservation of natural resources be considered as a concern to be factored in by the scientific and civil community.

The possibility of understanding the reality of cities could be enhanced through the reinterpretation of the concept of landscape units of Escada and Alves, (2003), based on their division into smaller homogeneous parts, which enable the understanding of the system of relationships where environment and social actors intervene and where there is an economy generated by human activity [17].

On the other hand, the experimental work by Mitchell, at the end of the 90s, allowed for the understanding of the potential for applying parameters to urban design, in its relationship with the development and management of cities.

The introduction of information technologies in the planning process brought greater efficiency in the application of parametric elements, through the simulation of alternatives for urban expansion, specifically in the choice of different morphologies, models of densification and in the optimization of basic infrastructures [13].

In order to support the identification of the factors that are determinant in the formulation of the parameters, it is seen that an analysis and interpretation of the best practices suited to urban clusters is needed [18] [4].

The case study of suburban neighborhoods of a tropical island agglomeration allowed us to identify the worst resource management problems in light of the lack of means, which requires an efficient systemization of the problem and the construction of solutions that are possible, even if not ideal at times.

The objective of this research focuses on the choice of the elements to be parameterize, which best contribute to the sustainability of an urban island cluster, not in its main nucleus but in its area in expansion. For this purpose, the neighborhoods of Paiol and Achadinha Pires, in the city of Praia, on Santiago Island were chosen [19].

2. Methodology

The methodology was composed of a sequence of actions that made it possible to measure the parameters to be considered in the formulation of sustainable solutions for the insular urban clusters.

In its first approach, the research was done at the level of the presuppositions for the creation of a City within the scope of Sustainable Development, by which the main factors were identified for its efficient performance, as well as the set of indicators considered relevant for the implementation, assessment and monitoring of appropriate solutions. In order to gain an understanding of the current state of the cities and the existing urban morphologies, mainly in the island territories, the research considered the study of the changes of the urban clusters, the resulting transformations and the link between all the elements that make up the City as an organism. In this way, it was possible to gauge the genesis of the first insular cities and the external influences that oriented their conception in terms of zoning and the types of construction adopted [10] [20] [13].

Considering the presuppositions identified as suitable for applications, examples related to island regions were studied, in the first approach to the case studies, specifically the analysis of a set of cities in the islands of Macaronesia, Madeira, the Azores, the Canaries, Cape Verde, and São Tomé e Príncipe. It was therefore possible to develop and establish a comparison between various operational modes and measure the limiting conditions and the opportunities these territories present. This study resulted in the identification and formulation of the parametric elements with a potential for implementation in insular regions, supported by the research done by Mitchel in the area of parametric systems.

The selection of the neighborhoods of Paiol and Achadinha Pires in the city of Praia for the case studies resulted from the delimitation for reinterpreting the concept of Units of landscape, so that they formed two homogeneous zones with distinct realities [21].

In order to effectively adapt the parametric elements to the case studies, a description was made of them in terms of models of occupation and all the inherent urban elements, specifically the type of constructions, the number of storeys, the width of the streets, the study of the urban indices and parameters and other elements considered important in the application of the parametric model. As the urban morphology and all its components are inherent to a certain population, the social and economic analysis of the surroundings were also considered, in order to identify needs and opportunities on which the model should operate.

The proposed intervention in the neighbourhoods of Paiol and Achadinha Pires consisted of the formulation of a parametric model for the constitution of a sustainable insular city. The validation of the model was done through

simulations, using various computer programmes. The process made it possible to evaluate in advance the levels of performance of the initiatives and the intentions for controlled growth and the regulations of the municipal zoning ordinance in effect.

This is methodological structure followed (Figure 1):

- In the first step, the goal was to list the factors that were considered pivotal in the models that would have influenced the development of tropical island cities, specifically the European influence on the geographical choice for the implantation of the city and the model adopted for its planned growth.
- Next, and through each model, the factors of the implemented legacy and the resulting adaptations were identified, according to the objectives of each context. At this point, the goal was to choose the relevant elements that influenced the morphology of cities studied;
- In the third point, and based on the general elements identified, the research focused on the degree of influence that each parameter would have on the urban setting, thus trying to create the set of elements that are most significant for the region in the case study (outlying island). The parameters identified as having potential for being implemented were chosen based on criteria built on the local reality in order to respect the context in which they are included, taking into consideration the culture and local social, environmental, physical and economic conditions;
- During the fourth step, the choice of two suburban neighbourhoods of an island city was made for a case study, and upon them was implemented a set of parametric elements built for the concrete reality, in order to measure their applicability to the context of the island city in a tropical region.

The sequence of actions related to the methodological analysis followed in the actual research is given below.

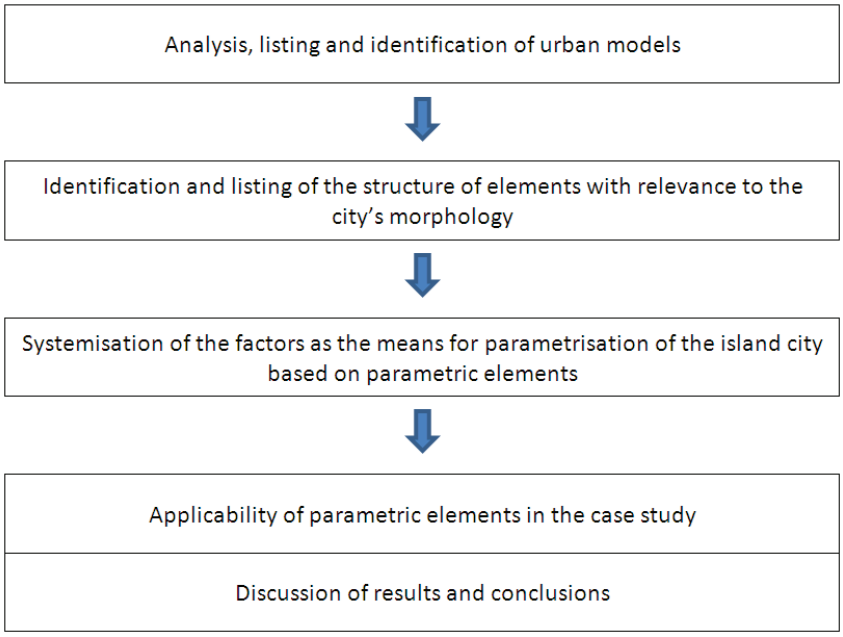


Fig. 1. Steps of Methodological Structure.

3. Parameters and criteria for the island city

The city, as a result of many years of sedimentation of urban forms, created and moulded according to social, commercial, economic, military and political needs, bases itself on characteristics that define the evolution of society and which determine how to "make a city" [22].

The creation, establishment and subsequent development of the agglomerates follow rules and guidelines that range from the choice of the "ideal location", to the search for the most efficient fabric to accommodate the pressures of society and the interests of the time, adapting to the orography and to other elements that in the end contribute to the strengthening of the agglomerate.

Societies develop models according to its own parameters, such as the construction method, the culture and the local climate conditions, parameters that, due to the success achieved, are reproduced at times without concern for the differences in climate, location or cultural aspects [10] [14].

Based on successful models, many were repeated but did not attain the expected results, leading to growth but compromising local development. A similar error would be made in other regions, economically debilitated but hopeful for results that could ease the economic and social conditions deriving from their outlying insular situation.

It is in this setting that we see the emergence of the urban clusters in the Atlantic islands and the tropical islands, in particular. The occupation of islands always starts on the coast, in a format that is based, initially, on provisional occupation and that later follows the rules and laws that are come from the exterior with adaptations to local conditions. The occupation of the coastal area also proceeds to the interior, almost always following a linear development deriving in large part from the terrain and accessibility.

The parameters implemented for the consolidation of the insular city almost always respected local conditions. However, the most recent population growth led to an acceleration of the degradation of the urban environment, compromising its development. This situation was accompanied by problems such as social and economic segregation that degenerated into impacts on the environment, compromising urban planning steps and the organisation of the city.

Urban agglomerates of the insular regions of the Atlantic area were heavily influenced by Portugal and Spain, since these were the countries that assumed the political and territorial control in the past, exporting characteristics that defined growth and the development of these urban concentrations. [23] [24].

The definition of elements to be parametrised in the intervention of insular cities was developed based on stereotypical models, carried out but adapted to the local climatic conditions. The introduction of endogenous variables implemented by local technicians and entities interfered in the urban morphology, influencing its architecture and fabric. However, natural resources were not always used wisely, which led to the situation of the cities today, characterised by a significant expanse of informal areas [13].

Before defining the determining elements for parametrising the urban agglomerate, it is important to analyse the following sequence:

An urban space, or agglomerate, takes on a certain importance in the territory, attracting the population of the surrounding region as they search for better living conditions. This attraction leads to an increase in the population, starting with individuals or communities with deep rural roots, many times confined to ghettos where they transfer their rural life habits. This migration leads to an increase of local economic activities which, in turn, demand more constructed space that, if viable, will accommodate the migrating population. The capacity of the ground available for this hosting influences the population and housing density and will require more attention from local entities in order to preserve the national heritage and to boost improvements for the entire resident community, including the newcomers. Density is on the mind of those who analyse it Acioly & Davidson, (1998) and can be discussed according to the local environmental needs. The appropriate density of an urban area is a variable that adapts according to the location, depending on factors that range from the culture of each society to the intervention capabilities of these societies [18]. These authors mention the likelihood of congestion, faulty housing policies, the incorrect and insufficient distribution of green spaces and public areas, among other, as justification for the lower quality seen in some cities.

Hence, resolving the occupation of the urban space, taking into consideration the suggested density for the agglomerate and respecting the habits and local culture, should be an integral part of the objectives in intervening in the sustainable city.

The densification of urban areas and the resulting vertical expansion of the city has been considered as a solution for profitability of the urban space, both in the use of the land as in the optimisation of basic infrastructures and the public transportation network, for example. Whilst high density is presented as the most economically viable solution, some constraints may be placed for strictly social reasons, seeing as a highly dense city adversely affects social relations, becoming merely a cluster of strangers living side by side. Mumford (1998) mentions that "(…) until the current urbanisation period, cities still had only a small fraction of the human species" [23].

But the horizontal expansion of the city is not in line with the equilibrium that is currently sought in distributing the land space between urban and rural. The scarcity of land, in light of the demographic growth, forces an increase in urban density due to the needs of agricultural areas and the control of infrastructural cost. At the same time, the conveniences of urban projects are being questioned, in light of their real contribution to the Sustainable Development process [10].

The study of which parametric elements assume the most importance to outlying insular regions and which ones adapt best to the location, climate and way of life in local communities helps not only to show the importance of contributing better but also to show the correct implementation of the concept, within the specific context of the insular (outlying) city [4].

The concern for the urban fabric shown in the creation, from the ground up, of the city of Praia in Cape Verde in 1615 (2) is revealed in the implementation of the orthogonal grid in highlands, orienting it according to the diagram of prevailing winds in the region (Figure 3).

Fig. 2. Original outline of the insular city of Praia, Cape Verde [15]

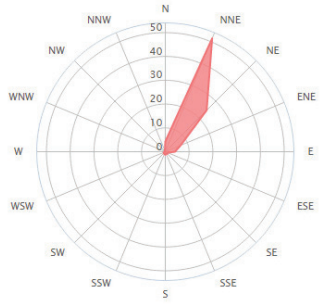


Fig. 3. Diagram of the prevailing winds in Santiago. Source: www.windfinder.com [15-09-2014]

4. Parameters and criteria

From the analysis of European models which, directly or indirectly and because of their influence, contributed to the creation, growth and development of insular cities, without being greatly concerned with adapting to the local conditions of most of them, it is possible to summarise a set of factors. However, their outlying position in relation to their countries and the difference in terms of opportunities greatly conditioned the level of access to material technologies, compromising local resources on all levels. The need to implement the sustainability aspect of development becomes urgent and indispensable to the success of any and all interventions where the parameters identified for use are tested.

To that end, the parametric elements should be carefully checked to ensure that their implementation contributes to a reduced need for resources from outside the city.

For this, a list of the parameters identified for implementing the expansion of the insular city was drawn up through analyses related to spatial components of parametric modelling, the application of which results in the creation of places and spaces with environmental quality and promotes urban contexts:

It is important then, that we identify the framework of each of the parameters listed (Table 1):

Table 1. Parameters for expansion of insular city.

Parameter	Framework application
1 - Orientation of the urban fabric based on exposure to prevailing winds	Orientation of the urban fabric based on exposure to prevailing winds contributes to the correct ventilation of the urban space, horizontally sweeping the air, contaminated by different types of gases toxic to urban populations.
2 - Orthogonal outline and availability of lots intended for family housing	The orthogonal outline facilitates the implementation of infrastructure networks, both in terms of streets and sanitation; the urban lots for housing contribute to a diversified occupation of the urban space.
3 - Relationship between the height of the buildings and the width of the street with pedestrian pavements	Depending on the latitude, access to solar light on the façades of buildings enables thermal comfort; in tropical regions that comfort is linked to shading on the roof and in the pedestrian areas, seeking to achieve shading by the positioning of the volumes of the urban buildings.
4 – Network and size of isolated and disperse spaces of tree planting	Shading from trees planted here and there in the street is a comfort factor of great importance to the passer-by and reinforces the socialising of the city's residents.
5 - Solar access guaranteed by the relationship between the height of buildings and the spacing between them	In tropical regions it is essential to avoid direct exposure to the sun, and therefore the spacing between buildings should promote ventilation and the privacy of the resident, whilst shading the façade at the same time.
6 – The use of volumetric solutions to provide shading for passers-by	The shading of the street resulting from the volumetric solutions of the buildings encourages its occupation by the residents (fixed or commuters) fostering greater social intercourse.
7 – Zoning and ratios for equipment, housing, commerce and services	Zoning that is able to distribute space, in a balanced manner, for housing, services and commerce, can contribute to the development of an urban agglomerate, avoiding dormitory neighbourhoods or a nocturnal urban desert. The efficient distribution of commerce will also contribute to cultural dynamics and a reinforcement of social relations.
8 – Public tree planting in streets and public gathering places and in private areas such as lots and gardens	Public tree planting contributes to thermal comfort by day as well as for the casual gathering of residents; in lots and private gardens, it is not only an element for stabilising fluctuations in temperature but also for consolidating and settling the soil and subsoil.

9 - Solar orientation of the buildings in direct relation to the prevailing winds	The horizontal sweeping of the urban air by the prevailing winds may greatly contribute to the cooling of the building façades and may even help in cooling the roofs through construction techniques for fixed or moveable elements attached to the building.
10 - Fixed densities and flexible densities capable of being exchanged.	The location of the population in regard to housing, employment and ease of access to services or commerce may be foundational for public entities in the sense of better defining zoning for the agglomerate in order to meet basic needs and to minimise commuter movements, whether by pedestrians or by those who use various transportation methods, individual or otherwise.

The previous table points us to a few important parameters in the development of an intervention in an insular city.

The orientation of the urban fabric based on prevailing winds, is the first item to be considered, followed by other elements to be inserted, such as support for the ventilation that aids in the hygiene of the environment and the urban space. At the same time other factors are inserted in the study: the dimensions of street profiles, the heights and volumes of buildings, elements considered essential to guarantee a good quality of life. (Figure 4)

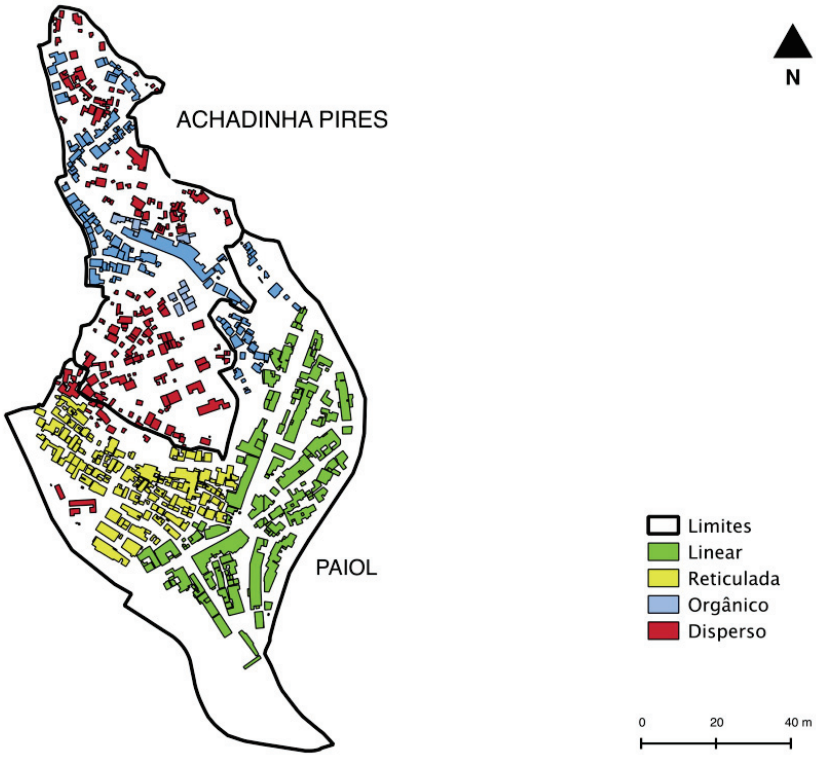


Fig. 4. Current occupation in the parishes of Paiol and Achadinha Pires in Cidade da Praia.

The choice of the parameters of Table 1 allowed them to be summarised in a table (Summary table) with the identification of the application of each one, listing the units of measure used, shown in Table 2.

Table2. Summary table of parameters for the construction of a sustainable city.

Parameters	Unit	Application
Climatic conditioners		Urban structure
Type of urban fabric		Urban fabric, blocks
Structure of the property		Urban fabric and lots
Width of streets	[m2]	Streets and pavements adapted to topography
Plazas	[unit]	Urban fabric and environmental comfort
Squares	[unit]	Urban fabric and environmental comfort
Type of settlement	[unit]	Urban fabric
Urban installations	[m2 per inhab]	Area of installations per capita
Building setbacks	[m]	Alignment adapted to topography
Average number of floors	nm =∑Aj/A0	Urban fabric
Maximum number of floors	[unit]	Urban fabric
Building height	[m]	Adapted to width of street
Building volume.	[m3]	Urban fabric
Urban lighting	[unit]	Urban fabric and social comfort
Volumetric index	[Iv=∑Vj/S]	Urban fabric
Population density	[dwellings/ha]	Urban population
Housing density	[dwellings/dwelling]	Urban population
Household	[inhab/dwelling]	Lots/block
Tree planting	[unit]	Urban fabric and green area
Per capita ratio of green areas	Cv=Sv/P	Plazas, gardens
Urban void	[m2]	Urban fabric
Wind	[m/s]	Urban fabric
Solar exposure	[lux]	Urban fabric

The implementation of tree plantings in the urban space is essential in controlling the temperature of the environment and also, to the socialisation that the population may enjoy, based on the shading that is so crucial for exterior spaces. Tree planting, in conjunction with the size of buildings, will allow for an increase in the irregularity of the built surfaces, thus increasing the wind velocity.

The zoning will mean making the most of commuter movements, seeking to minimise them in order to decrease or control superfluous energy costs both by people and vehicles, for the good of the region's sustainability.

5. Discussion

The development of cities is tied to the growth of their economies, especially in emerging societies that focus little on the aspect of sustainability. For this reason, as we have seen in the recent past, the option for economic development, placing the burden of urban interventions on the private sector, both in concept and in construction.

The outlying regions earned some prominence thanks to the tourism sector which, seeking exotic alternatives for a market in expansion, enabled the recognition of those destinations, with an improvement in living conditions for residents. This improvement in living conditions also enabled entities to better understand the urbanistic plans from abroad and allowed the access to standards and new methods of intervening in the city. However, their status as an outlying region did not always enable a more suitable implementation of those standards, since they are not adapted to the region and its economic reality.

The temptation to copy the solutions considered successful in exterior regions has not worked in some insular territories, due to the diversity of culture, climate conditions and distinct construction solutions. The participants then must define their urban programme according to the local reality and requirements.

One of the elements influencing urbanism in continental regions in the parallels between the tropics of Cancer and Capricorn and the poles is the solar orientation of the buildings' façades. The need for solar exposure is an essential factor in thermal comfort, which is not as important in the tropical areas.

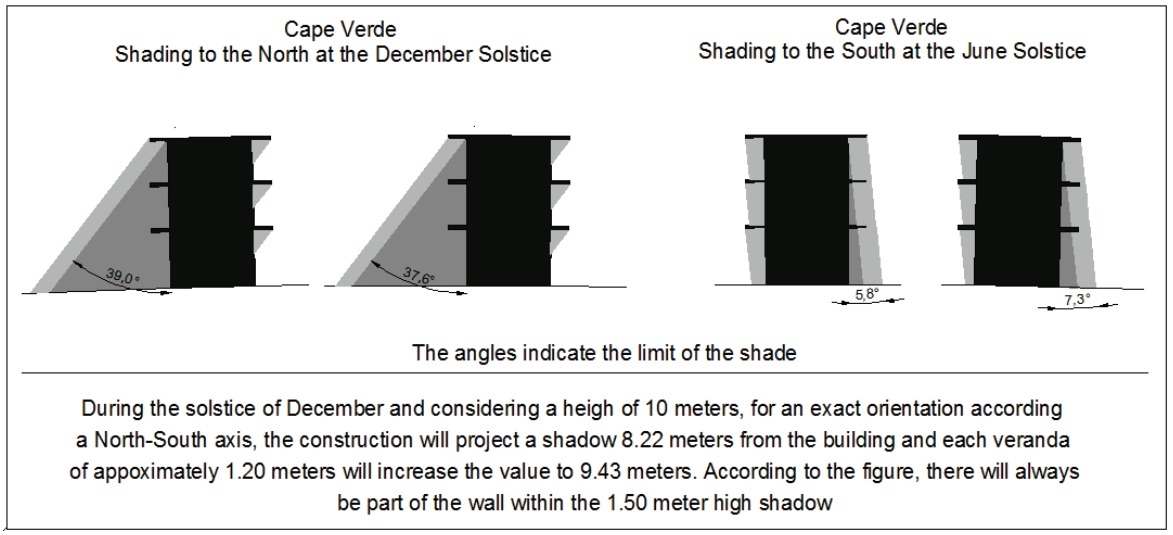
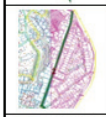
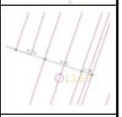
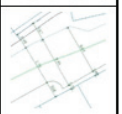


Fig. 5. Shading of the façades during solstices, in Cape Verde.

In parallel to this factor (solar), the width of the streets should be adapted to the need for shading the urban space, focusing on the need for ventilation and the minimum space between façades in order to maintain some privacy. In the particular case of a tropical region (City of Praia in Cape Verde), the angle of the shade projected at noon from the building above the street is around 7°.36' and 37°.6', minimum and maximum values, meaning that the Sun hits the roof more frequently than the façades of the building (Figure 5).

The distance between buildings should be treated carefully in order to guarantee adequate ventilation that can contribute to sufficient sweeping of the air for the purposes of guaranteeing effective urban hygiene, which can be parameterised, based on the dimensional analysis of Figure 6.

STREET SECTION	PAIOL & ACHADINHA PIRES	Street dimensions			Ped. Pavements - Left			Ped. Pavements - Right			LOCAL
	STREETS W/O PED. PAVEMENTS	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	DETAIL
	Section 1: Total absence of trees to make shade. Partial lengths of 190 m and 138 m. PAIOL	Section at South entrance to neighbourhood, heading N and NNE									
		7,65	7,70	7,74	1,90	2,72	3,53	2,06	3,65	5,24	
		Section at South entrance to neighbourhood, heading NNW & N									
		5,39	5,68	5,97	1,13	4,99	8,85	1,01	3,66	6,31	
	Section 2: Significant absence of trees, runs in NNE-SSW direction. Total length of 305 metres. PAIOL	Section heading NNE-SSW, length = 125 m (of 305). 1st part									
		5,65	5,89	6,12	2,09	2,94	3,78	2,03	3,59	5,15	
		Section heading NNE, length = 185 m (of 305). 2nd part									
		5,15	5,85	6,55	6,36	8,78	11,20	1,32	1,64	1,96	
	Section 3: Absence of trees. Important artery. Runs ENE-WSW, Total length of 144 m. PAIOL	Section 54.0 m (of 144 m), heading NNE-WSW. 1st part of Section									
		5,94	6,62	7,30	0,92	1,93	2,94	1,69	2,16	2,63	
		Section 90 m of 144 m). Heading NNE, 2nd part of Section									
		4,66	7,33	9,99	0,53	2,10	3,67	0,78	1,98	3,18	

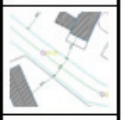
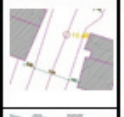
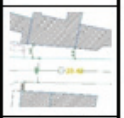
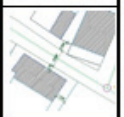
STREET SECTION	PAIOL & ACHADINHA PIRES STREETS W/O PED. PAVEMENTS	Street dimensions Min.	Aver.	Max.	Ped. Pavements - Left Min.	Aver.	Max.	Ped. Pavements - Righ Min.	Aver.	Max.	LOCAL DETAIL
	Section 4: Absence of trees. Irregular outline, rectilinear, alongside water course. Elevation 9.13 to 10.29. PAIOL	Section heading NW-SE, length 120.66 m.									
		4,50	5,88	7,25	0,60	0,75	0,90	0,60	1,80	3,00	
		Street dimensions			Ped. Pavements - Left			Ped. Pavements - Righ			
	Section 5: Occasional tree on street. Runs NW-SE, connecting Sections 3 and 4. Length 141.86 m. PAIOL	Section									
		2,88	3,67	4,45	1,50	1,60	1,69	1,94	2,50	3,06	
		Section									
		4,64	5,34	6,04	0,57	0,98	1,39	0,00	0,70	1,39	
	Section 6 - Absence of trees, line follows water course. Length 182 m. PAIOL	West Section towards exit from neighbourhood									
		Street dimensions			Ped. Pavements - Left			Ped. Pavements - Righ			
		4,48	5,45	6,42	1,80	5,26	8,72	1,70	4,35	7,00	
	Section 7 - Irregular outline, scattered groups of trees and in public zone. Length 330m. PAIOL	Street dimensions			Ped. Pavements - Left			Ped. Pavements - Righ			
		4,00	7,50	11,00	0,43	2,72	5,00	1,60	3,10	4,60	
	Section 8 - Crosses totally built-up zone, trees only very occasionally. Length 215 m. PAIOL	Street dimensions			Ped. Pavements - Left			Ped. Pavements - Righ			
		4,10	6,50	8,90	1,06	2,33	3,60	1,00	3,65	6,30	
	Section 9 - Line of street sloping downwards, with occasional trees and in unbuilt area. Length 215 m. PAIOL	Street dimensions			Ped. Pavements - Left			Ped. Pavements - Righ			
		4,03	4,52	5,00	0,62	1,54	2,46	1,00	1,42	1,84	
	Section 10 - Crosses densely constructed area. Length 115 m	Street dimensions			Ped. Pavements - Left			Ped. Pavements - Righ			
		3,10	4,43	5,76	0,19	0,95	1,70	1,54	3,41	5,28	
	Section 10/2 - Idem, no trees. Length 50 m. PAIOL	Street dimensions			Ped. Pavements - Left			Ped. Pavements - Righ			
		1,87	3,19	4,50	0,40	1,89	3,37	1,14	2,30	3,45	
	Section 11 - Irregular outline, densely constructed zone and no trees for shade. Length 141 m. PAIOL	Street dimensions			Ped. Pavements - Left			Ped. Pavements - Righ			
		2,90	3,62	4,34	1,15	1,43	1,70	1,95	2,05	2,15	

Fig. 6. Dimensional analysis.

Figure 6 refers to a dimensional analysis of part of Figure 8. In the left column of the table, colors and numbers are used to represent existing sections of streets identified in Figure 8, of the Paiol neighborhood, with minimum, average and maximum dimensions of the existing streets, and in the right column, details of a street considered to be an example for the local dimensions.

From this information, one can gauge the irregularity of the streets and the constructions, as well as the lack of trees and some pedestrian pavements.

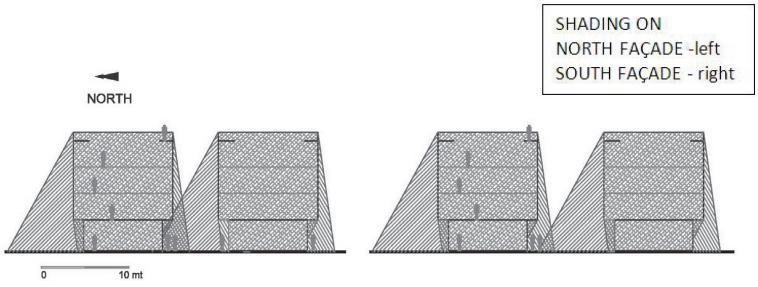


Fig 7 - Simulation of the shading in a tropical urban space, Cape Verde.

Another important factor is the height of the building. If the option to grow vertically is seen to be a viable solution for the current cities, the economic and technical aspects must be considered as priorities in order to avoid problems that may occur further down the road, caused by cultural shocks or even malfunctions that compromise the residents' quality of life in those new areas of the cities. (Figure 8)

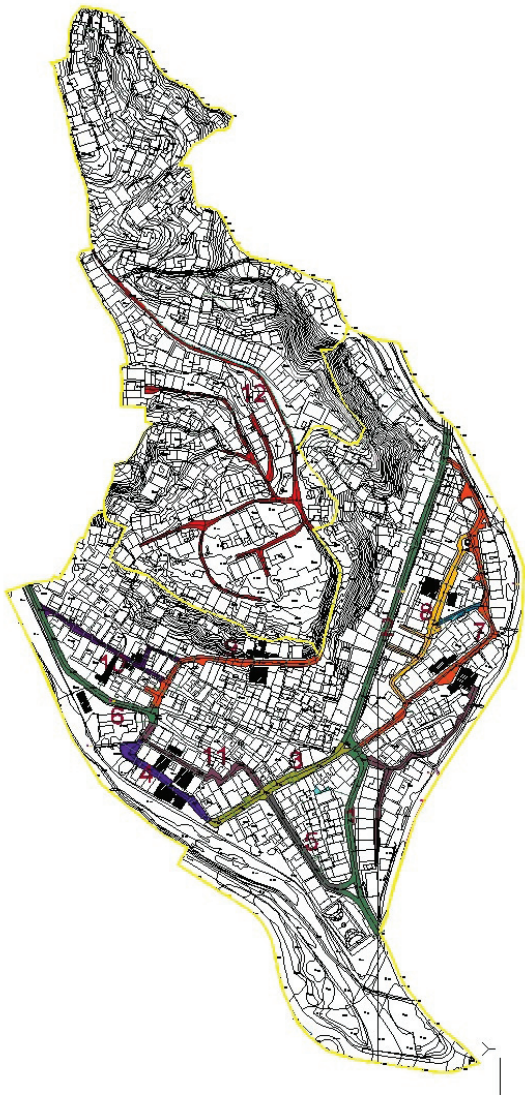


Fig. 8. Colored sections of streets, in the neighborhoods of Paiol (below) and Achadinha Pires

The results, then, should correspond to a balance between the technical analyses and experience. This is the task the urban planner ought to ensure through a collaborative work of a multi-disciplinary team.

The definition of some elements that serve as parametrization of the development of agglomerates may be helpful not only to the local agents themselves but also public entities in the support of future interventions.

Figure 8 presents an outline on the dimensioning of the street, taking into account an offset between buildings that preserves the privacy of residents, aids in urban ventilation and the shading of public areas.

6. Conclusions

Diversity and environmental sensitivity have not always led to differentiated urban solutions, which makes it evident that the space for applying parameters and urban indexes cannot continue to be observed without taking into consideration other factors.

The need to see implemented another way of planning the city leads to the operational process itself being, obligatorily, structured in "another way". The inevitable continuation of the development of human activities, in light of demographic and economic growth, requires the assuming of new attitudes in the face of the necessary expansion and urban renovation.

On the other hand, the urban planning process must start to be seen as the privileged way of leaving a legacy for future generations, a sort of "well-being" and use of common resources available on the planet, within the context of Sustainable Development.

Through that development process, it is possible to determine the potentials, weaknesses and opportunities that the location for intervention has, enabling both the inhabitants and the territory to benefit, thanks to the guidelines resulting from the planning process.

One aspect that should not be overlooked is the density that is intended for the location and its alignment with the notion of density that each culture sees as appropriate.

We therefore conclude that it is not through the process of simplifying the planning process that we are able to integrate the concept of sustainable development but rather by the compatibility and reinforcement of the content of information and collection of data for the support of the design phase, for the purpose of achieving a greater responsibility on the part of all those participating in the process, keeping in mind that what is in question is the improvement of the quality of life of the inhabitants and its preservation throughout the coming generations.

References

[1] United Nations. Report of 05 August 2008 – World Population Prospects: the 2004 revision population, New York: United Nations, 2008.
[2] Robinson J. Global and World Cities: A view from off the map. International Journal of Urban and Regional Research 2002, 26(3) 531-554.
[3] Lefebvre H. Le droit `s la ville, Société et Urbanisme, Paris: Ed. Anthropos, 1989.
[4] Wu F, Webber K. The rise of foreign gated communities in Beijing: Between economic globalization and local institutions, Cities 2004, 21(3), 203-213.
[5] Leichenko R, Solecki W. Mudanças Climáticas, em Suburbs: Uma Exploração dos principais impactos e vulnerabilidades. Urban Climate 2013, 6: 82-97.
[6] Choay F. "A regra e o modelo." São Paulo: SP: Perspectiva 1, 1985.
[7] Le Corbusier. Maneira de Pensar o Urbanismo, Mem Martins: Publicações Europa-América, Lda., 1995.
[8] Jacobs J. Morte e vida de grandes cidades. São Paulo: Martins Fontes, 2000.
[9] Graizborg et al. Mexico City as a peripheral global player: The two sides of the coin. The Annals of Regional Science 2003, 37 501 –508 2003.
[10] Amado MP. Operative Process in Sustainable Urban Planning, International Conference on Sustainable Development and Planning, WIT Press, n. 48 – 181-191, DOI: 10.2495/SPD050181
[11] Jenks M., Burgess, R. Compact Cities: Sustainable Urban Forms for Developing Countries. London and New York: Tailor & Francis. 2000
[12] Ladd HF. Population Growth, Density and the Costs of Providing Public Services. Urban Studies 1992, 29 (2), 273-295.
[13] Mitchell WJ. E-topia:" urban life, Jim--but not as we know it". Cambridge: MIT press, 2000.
[14] Lamas JMRG. Morfologia Urbana e Desenho da Cidade, Lisboa: Fundação Calouste Gulbenkian, 2010.
[15] Fernandes J., Cidades e casas da Macaronésia. Evolução do território e da arquitectura doméstica nas Ilhas Atlântidas sob influência portuguesa. Quadro histórico, do séc. XV ao séc. XVIII. Lisboa:Afrontamento, 2010.
[16] Silva TMM. As cidades das ilhas atlânticas de origem portuguesa e a transferências de modelos urbanos do continente europeu. Anais: Seminário de História da Cidade e do Urbanismo 2011, 11.5.
[17] Escada M., Alves D. Indicadores para a Compartimentação da Paisagem em Unidades de Ocupação em uma Região de Fronteira Agrícola em Rondônia. Simpósio Brasileiro de Sensoriamento Remoto, Anais. São José dos Campos: INPE 2001: 1099-1106.
[18] Acioly C, Forbes D. Densidade urbana: um instrumento de planejamento e gestão urbana. Rio de Janeiro: Mauad, 1998.
[19] Silveira E. Áreas Residenciais Clandestinas na Cidade da Praia. Lisboa: Instituto de Geografia e Ordenamento do Território da Universidade de Lisboa, 2011.
[20] Robinson J. Global and World Cities: A view from off the map. International Journal of Urban and Regional Research 2002, 26(3) 531-554.
[21] Amado MP., and Poggi F. Solar Urban Planning: a parametric approach, Journal Energy Procedia 2014, 48, 1539-1548.
[22] Le Goff J. O apogeu da cidade medieval. São Paulo: Ed. Martins Fontes, 1992.
[23] Mumford L. A cidade na história: suas origens, transformações e perspectivas. São Paulo: Martins Fontes, 1998.

[24] Salgueiro TB. A Cidade em Portugal: Uma Geografia Urbana. Porto: Afrontamento 2012.