Riparian Vegetation In Urban Areas: Is It Possible?

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ABSTRACT: Inadequate land use during the process of urbanization causes the extinction of riparian vegetation and consequently destroys headsprings and subterranean waters. When considering urban areas, it seems absurd to imagine the existence of riparian vegetation alongside creeks, rivers, ponds and even shores, due to the cultural, social, and economic interests involved. However, the importance of vegetation can be proven in its participation in the control of floods, the avoidance of heat islands and the preservation of ecosystems and biodiversity in urban areas, including human ecosystems qualified by the built environment. This article intends to present an alternative adaptation of the riparian forests in urban areas with the intent of preserving living conditions. Furthermore, this study highlights the importance of inventories of riparian species, the comprehension of the dynamics of watersheds, as well as urban strategies of design that consider people oriented environments.

Keywords: riparian vegetation, urban areas, riparian forest, native species, reforestation

1. PRESUPPOSITIONS FOR A PROJECT

In the process of urbanization in Brazil, many areas have been occupied without planning, without responsibility, without projects for public spaces and architecture, without preservation of the vegetation and without projects for sanitary infrastructure. This has generated serious environmental, landscape and urban problems, which are further aggravated by a lack of resources and knowledge as well as by the population's lack of education.

The natural solution of preserving the vegetation along rivers and waterways in urban areas, as a way of keeping hillsides intact and obtaining drainage, is efficient and environmentally appropriate as well as more economical than engineering and construction solutions.

Often seen as a road with no return by urban planners and landscape architects, the recovery of rivers and streams' landscapes at times is solved through the construction of these elements, in the form of artificial springs, creeks and waterfalls that are powered by sophisticated mechanisms that consume a great deal of energy, leaving an unsolved problem behind. Therefore, environmental awareness, technical knowledge and political interest to execute appropriate projects are preponderating factors for the appreciation of environmental characteristics of a site. We must discard artificial solutions, which, besides breaking the life cycle, act in parallel to the ecosystems, serving as elements that indeed have nothing to add.

The work of Roberto Burle Marx, even when imitating nature, in general obtains admirable results, visually integrated with the landscape and the environment. "*At first sight, the private gardens that Burle Marx designed are impressive for their aesthetic value: they transmit an intense sensation of beauty. Generally constructed in marvellous landscapes, their integration to the environment is such that they seem to have existed there forever.*" [2].

There are, indeed, ways to occupy the land without destroying it and in order to implement these, procedures that consider the subjacent structure must be employed by way of a sensitive urban exploration of the environmental and landscape characteristics of the land's physical support. **Urbanization is not a negative phenomenon**, as long as the physical environment is preserved. By taking advantage of physiographic characteristics in the elaboration of urban and architectural projects, optimal landscape and environmental results can be obtained [1].

2. THE CONSERVATION OF NATURE IN URBAN PUBLIC SPACES

2.1 Seasons and climatic variables

"Man's attitude toward life and social and cultural obligations influences his perception of space." [6]. With nine months of stable weather and mild temperatures, the Greeks could spend most of their

leisure time outdoors. The Mayas lived for more than one thousand years in Central America. They constructed cities and elaborated irrigation systems (Fig 1). Climatic changes followed by long dry spells are the main reason that the Maya civilization collapsed more than a thousand years ago in Central America, according to research [3].

Climatic alterations over the seasons of the year can also cause great transformations in the rhythm of development of species with strong alterations in landscape, in terms of volume, colour, texture, aromas, sounds, etc.

It is important to understand that the seasons mark life cycles of the landscape and of people. In Brazil, we can cite, for example, the great droughts of the semi arid northeastern region that do not occur annually but follow greater cycles, remain for months and can be forecasted through meteorological instruments. It is known that the great droughts return every 12 to 14 years and remain for two to three years. The biggest droughts registered in Brazil's Northeast occurred in 1724, 1877, 1984 e 1998 [5]. It is supposed that the process through which an area becomes a desert can be caused by large-scale deforestation that is caused by the construction of cities.

Figure 1: Chichen Itza: The Cenote where a ritual for the rain god took place and in the background the pyramid known as " El Castillo" [4].

2.2 Orientation

A correct urban orientation requires insulation and adequate ventilation by controlling the incidence of solar rays in different seasons of the year and possibly utilizing breezes and wind.

In the Southern hemisphere orientations facing the North are privileged due to a greater number of hours of solar exposure and to the presence of beneficial winds. In the street plan, a slight inclination to the Northeast can allow all edifications to enjoy some hours of sun daily, by avoiding orientations directly facing the South. [1]

In the case of hills the difficulties multiply due to a predominately downhill orientation. Constructions that are situated on slopes facing the South, in cities like Florianópolis, are the most unfortunate, because they only enjoy sun during the Summer, and they are frequently punished by polar winds, which amasses additional problems in relation artificial energy used to elevate the temperature to the standards of thermal comfort. Slopes turned to the North are the most fortunate because they enjoy sun in the winter and shade during the height of the summer. Slopes facing the east and west have shorter days, first because the Sun sets much earlier and then because the Sun rises much later, with significant variations in the winter and summer. On slopes, we can take advantage of the constant changes of level not only to increase the hours of solar exposure but also to utilize interesting views. [1].

2.3. The Brazilian morph climatic dominions

The fact that there is an "expressive superimposition of the great morph climatic dominions over the main phytogeographic Brazilian provinces." has instigated researchers, like Aziz Ab'Saber [7], to carry out a series of studies in order to understand the scientific cause of such coincidences. It could be said that the "main Brazilian landscape, physiological and structural frames" are the result of a "combination of geomorphic, climatic, hydrological and pedological facts." It is impossible to delimit them cartographically, for "each morph climatic dominion possesses a core area and a transition zone", where "complex mosaics" interpenetrate one another in two or more contact areas. The existence of exceptions is explained by the local existence of "factors of a lithological, microclimatic, hydrological, topographical and paleobotanical nature, in an "excellent example of exceptional ecological conditions" within a mechanism of converging landscapes. The 'families' of landscapes that define the physiographical frame of each one of the country's sectors, can be divided into six large morph climatic dominions (Fig.2 eTab I):

The terms employed here in the description of these dominions mean: mamelonar= rounded; anastomosad= intercommunicated; inselbergs= mountains isolated in an arid or semi arid climate; diaclased = fractured; laterita= relative to red soils, rich in aluminum or iron, originating from hot and humid climates; dale= small valley.

The "current mosaic of the dominions is the final result of a series of climatic and phytogeographic fluctuations from the South American Quaternary" and the "superficial structure of the landscape helps to restore this chronological frame". There have been periods of "slow evolution of the landscape", periods of "erosion, responsible for the retreat of correlating vegetation covers and for the advance of new ecologies that invaded diverse floras and faunas" There has been a "reduction of ocean and mountains landscapes and the installation of semi-arid landscapes", "the disappearance of meandrous drainage and the installation of anastomosad drainage", with a "re-activation of the riverbeds in mountainous sectors.

Table I: Morphoclimatic dominions in Brazil according to Ab'Saber [7].

Dominion of wooded low lands of the Amazon region:	Plateaus with labyrinth like or meandrous floods, extensive tablelands with semi mamelonized slopes, low mamelonar mountains in the adjacent crystalline areas, gravel terraces and or laterita, black rivers and incessant drainage
Dominion of semi arid interplanaltic depressions of the Northeast	Covered by different types of Caatingas, with weak decomposition, frequent rock emergences, stony ground, extensive intermittent drainages, local semi-anastomosad channels and numerous fields of typical inselbergs
Dominion of the seas of forested mountains	Extremely strong and generalized decomposition of rocks, dense incessant drainages, extensive mamelonization, occasional groupings of 'sugar loafs' in badly barely diaclased areas, plateaus with meandrous flooding, extensive sectors of superimposed earth
Dominion of tablelands covered by savannahs and penetrated by 'gallery forests'	Structurally complex plateaus, cloaked or not by apex laterita, sedimentary plateaus with slopes in mild ramps, almost total absence of mamelonization, drainages with large intervals and few ramifications, river heads in dales, flood channels of specific types
Dominion of 'Araucária' plateaus	Rock decomposition restricted in depth, discontinued superimposed earth, thick pockets of discontinued deposits of sediments, incessant drainages and particular types of subtropical soils, area strongly affected by mamelonization
Dominion of mixed Great Plains	Extensive sloped prairies, subtropical forests, weak rock decomposition, large marshes, heads of rivers in dales, slight mamelonization or pseudo mammalians due principally to sediment deposits

"Landscapes are fruits of a complex and integrated evolution, wherein their constitution involves the participation of a basic rocky ossature, with a cloak of products of intemperateness and soil, certain vegetable covers and a physiology related to the climatic and ecological dynamics.". "Regional complexes cannot be understood, in terms of Geomorphology, without evaluating the global landscape and ecological reality of the area" (land form, soil, climate, vegetation) [7]

Figure 2: Brazil's Morph climatic dominions[7].

2.4 The distribution of plants on the Earth's surface.

Phytogeography is the branch of Biogeography that studies the origin, distribution, adaptation and association of plants on the Earth's surface. Geomorphology, phytogeography and botany are important fields of knowledge for the knowledge of vegetation and should be studied in depth and considered by those who deal with landscape and the environment, in an attempt to utilize native vegetation in projects for the reconstitution of riparian vegetation in urban areas.

Among the physical factors, those of climate and geomorphology predominate: light, temperature, humidity, winds, altitude, exposition and slope. The action of these factors is perceived in the functions, form and preference of the plants, in their adaptation, photosynthesis, in the supply of water for the reproduction of the vegetable cycle, localization in different altitudes and slopes. Altitude is a compensating factor of latitude. Exposition is a determinant of light. Temperature and winds determine the possibilities for the development of various species. The level of acidity is expressed by the ph factor below 7 and alkalinity by a ph factor above 7. Plants develop on terrains with a ph between 4 e 9. Among the biological factors, vigor, vitality, fecundity and the dispersion of plants are included. Different types of vegetation impress upon the landscape special characteristics and from there springs the interest to study vegetation from its physiognomic view. [8].

One basic factor that influences the formation of plants is the availability of water, not only because of the quantity of precipitation of a region, but because of the relation between precipitation and evaporation: a) when the level is equal to or higher than 100, forests are formed; b) when the level is between 20 and 100, fields are formed; c) if the level is less than 20, deserts are formed. The temperature and the

number of hours of sunlight are fundamental in the determination of the species [9].

Although, many Brazilian and foreign researchers have contributed to the advance of knowledge in the area of botany and of the morphological dominions, the greatest expression of research in gardens in the twentieth century was the artist and landscape architect Roberto Burle Marx, who besides researching native flora and Brazilian flora in particular, stimulated the cultivation of these species in the use of garden projects, because he understood that this is the most adequate form of conservation of the landscape.

2.5. Classification of Vegetation from the island of Santa Catarina

Most of the classifications made divide the island's vegetation into two botanical regions: The Rain Forest of the Atlantic Slope, characterized by climatic conditions and Coastal Vegetation characterized by soil conditions, the last being made up of: Marsh Vegetation (Mangrove or Mangue), Salt Marsh Vegetation (Sandbank Vegetation or Restinga) and Dune Vegetation. The Rain Forest is divided into stratums: trees that reach more than 30 meters, trees between 6 and 20 meters, shrubs up to 3 meters and small shrubs (Fig. 2) [10]

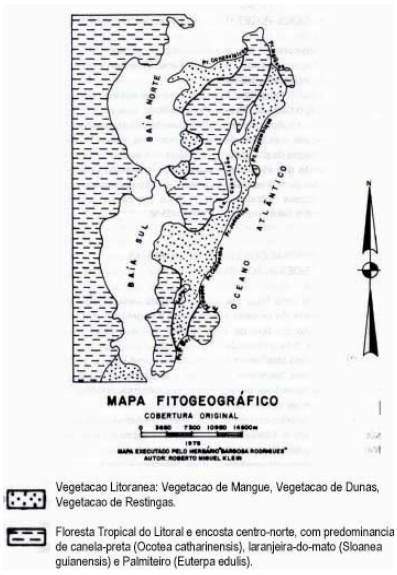

Figure 3: Phytogeographical Map – classification of vegetation according to KLEIN [11].

2.5.1 Marsh (mangrove or mangue)

The viscous characteristic of the marshes and the smell they give off is not pleasant; however this is a prejudiced and erroneous view, for in fact this is due to a natural chemical reaction of the marsh: the decomposition of organic material in nitrogen sulphide, which generates proteins and other nutrients. Marsh vegetation besides supporting high levels of salinity helps control the tides provides a means of survival of a large number of animals. Once the importance of the marshes for the coastal ecosystems is understood, we need only incorporate its rare beauty in the planning of the urban landscape.

The most representative species of the marsh is the Rizophora mangle, or red marsh, which shows its arching roots (prop roots). Another very interesting example is the Avicennia sp., a siriúba. This species consists of pneumatofars, aerial roots that allow the plant to breath above the water [14]. Functionally, they play the same role for the micro fauna that the roots of the Rizophora play. The third species that stands out in the marshes is the Laguncularia racemosa (Mangue-branco), that also forms pneumatofors, though much smaller than the Avicennia, being that it occupies areas that are more distant from the ocean, where waters are more shallow [15].

We can cite a successful experience for this type of situation: Gleba E Park, in Rio de Janeiro, by Fernando Magalhães Chacel and Sidney S. Linhares [13].

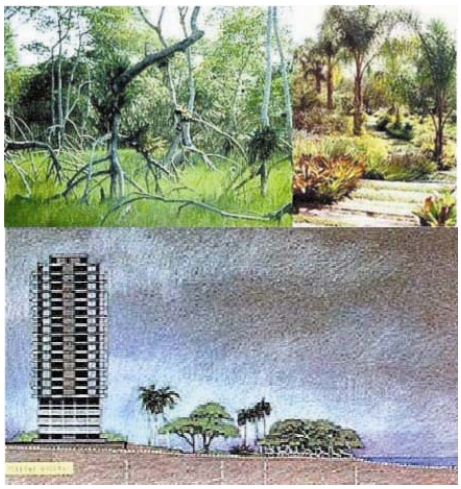

Figure 4: Marsh vegetation preserved in the real estate enterprise Gleba E, in Rio de Janeiro, RJ. [13].

2.5.2 Salt Marshes

The geographical conception of salt marsh refers to those sandy strips which were deposited by ocean currents and close or tend to close a re-entrance on the coastal line. There, vegetable and animal communities establish themselves with marked characteristics, due to conditions of the physical environment. Botanists use the term restinga to refer to vegetable formations of these ecosystems. Landscape architects have in it an infinite number of examples, sources of inspiration and suggestions 15]. In the next strip, on the first dunes there are cactus, gravatás, aroeiras (Schinnus sp.) and guriris (Alagoptera arenaria), a small creeping palm tree. The life forms are diverse: shrubs, climbing plants that give the group a structure of low thicket, yet very rich and complex. (Fig.5).

Species of Dune and Restinga vegetation at the real estate enterprise Jurerê Internacional, Florianópolis, SC: Spartina Ciliata, Panicum Racemosum, Ipomea, Eugenia Uniflora (Pitanga), Ocotea Pulchella (Canela do Brejo), Campomanesia Litoralis (Guabirobinha da Praia) and Eugenia Umbeliflora (Baguaçu) [10] Jurerê Internacional. Passeio dos Namorados. Available at http://www.jurere.com.br

Figure 5: Jurerê Internacional [22]

2.5.3 Mata Atlântica (Rain Forest of the Atlantic Slope).

With denominations like Coastal Pluvial Forest, Slope Perenifólia Pluvial Forest, Atlantic Forest of Slopes, Atlantic Forest and many others, these formations appear sparsely in 14 coastal states in Brazil (Fig.5). Being situated on highly valuable areas in terms of urbanization, they have been eliminated. [15]

In them, the richness of flora can still be observed. There is an enormous quantity of tree species, some gigantic, like the jequitibás, the fig trees and the angelins, many with handsome blooms, like the mulungus, the acácias, the quaresmeiras, the ipês, and the so characteristic tree like ferns or samambaiuçus, that form immense groups by bodies of water, almost always associated to also characteristic colonies of delicate palmiteiros that here and there, stick the woods with their presence. This flora supports an equally diverse fauna. [15].

The most significant example of Atlantic Rain Forest totally integrated to an urban area is the Tijuca Forest, transformed into a national park in 1961. The slopes of Tijuca had been deforested for the cultivation of coffee and were abandoned. To save the area from future degradation, in 1856 properties near springs were dispossessed, and later members of the imperial government managed to effectuate the planting and conservation of the Tijuca Forest. [16].

2.6 Riparian Forests

We understand riparian forests as types of vegetation that exist along bodies of water present in diverse ecosystems. The importance of the preservation or restoration of forests along rivers and around lakes and reservoirs rests in the wide spectrum of benefits that this type of vegetation brings to the ecosystem, serving as a protector of natural biotic and abiotic resources.

By native species, it is understood to be the exemplars originally found in the different climatic zones that differentiate themselves depending on the altitude and geographical latitude. In the case of primary vegetation having been diminished by fires or cutting, it is worthwhile to verify in the proximity the existence of remnants that could multiply through reproduction of seedlings in greenhouses. In the case of there being substitution by exotic plants, the situation must be studied in order to verify the possibility of maintaining them or substituting them with specified native ones. There are technical orientations and legal support for the recovery of forests with the utilization of native species. The use of native species returns an ecological equilibrium more effective because it matches the maintenance of the fauna [17](Fig. 6).

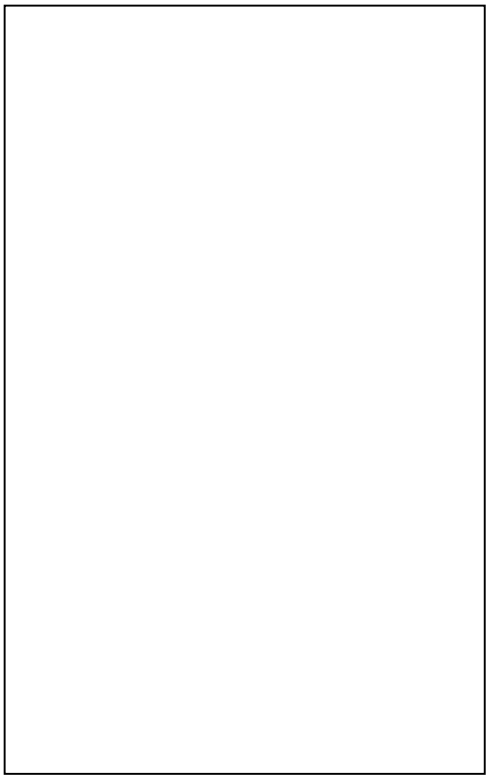

Figure 6: Atlantic Rain Forest Vegetation in a real estate enterprise in Pantanal, Florianópolis SC: Photos: Alana Scheller, Talita Abraham

Native forests (mainly riparian) in developed agricultural regions serve vital roles in the quality of spring waters by absorbing and filtering contaminated rain water with residues of fertilizers and agro toxics that drain into the soil and thereby avoiding contamination of the springs. Secondly they increase the supply of unpolluted water to the subterranean aquifers. [18].

The presence of native forests especially on steep slopes, mountain and hill tops and along rivers, streams and dikes serves as an obstacle to the free flow of water from heavy rains, reducing its velocity and enabling its infiltration into the soil to be absorbed by plants and to feed the subterranean aquifers. Consequently, it contributes decisively to avoid sandbars in riverbeds as well as in streams, estuaries, lagoons and riversides [18].

Considering that the large coastal cities of the world are implanted within estuaries, the maintenance

of riparian forests used as a form of impeding sandbanks from inlets and bays is a rational way to avoid floods and the destruction of the estuaries' ecosystem.

For urban planning, its delimitation is made in sections of variable width on each side of the deepest point of the riverbed, according to the following criteria [19]:

* in continual courses, the entire section above the flood plains is delimited;

* in seasonal courses the entire section where flanked by slopes with a declivity above 30% and only the upper sections when flanked by slopes with declivity below 30%.

The Forest Code is the federal law that deals with the protection of riparian vegetation nationwide.

According to Article II of the Forest Code forests are considered to be under permanent protection as well as other forms of natural vegetation located:

a) Along rivers or any course of water as long as its highest level at the marginal strip has a minimum width of (See tableII):

Table II: Size of preservation strips relative to the dimensions of bodies of water

Width of the body of water (in meters)	Minimum width of the strip of preservation (in meters)
Less than 10	30
10 – 50	50
50 – 200	100
200 – 600	200
More than 600	500

b) a strip between 50 and 100 meters around lagoons, lakes and natural or artificial reservoirs;
c) in a strip or diameter within 50 meters of springs;
f) in salt marshes in order to fix dunes and or stabilize marshes.;

Exclusive paragraph – in the case of urban areas, defined by municipal law, the respective master plans and laws concerning the use of soil must be observed, in respect for the principals and limits referred to in this article [20].

3. CONCLUSION

Because engineering presents a solution for almost all problems, people tend to forget that natural resources are finite, and thus act in contradiction, inverting values.[1]

An awareness program that develops interest in adequate conservation of urban vegetation can also contribute towards the strengthening of an environmental awareness that is still incipient. [1]

Through this study we could verify that it is possible to have riparian vegetation in urban areas, inasmuch as the master plans consider the recommendations of the Forest Code. In technical terms, we can emphasize the importance of choosing native vegetation as a form of reconstitution of the riparian forest of each locale, even in urban areas. Therefore, we recommend that the characteristic ecosystems of each situation be observed. In the case of coastal Florianópolis the marshes, dunes, salt marshes and Atlantic Rain Forest stand out as needing a selection of pioneer species for the initial reconstitution and subsequently the planting of more complex species, respecting stratums as well, or another words, the characteristic height of each species so that diversified environments are obtained that are similar to those of the original situation that existed at the time of domestication. By avoiding deforestation, climatic imbalance and consequently the process of desertification we can economize energy and provide for the survival of the species.

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