

THE ECOSYSTEMIC VIEW OF THE URBAN OCCUPATION OF FERNANDO DE NORONHA ISLAND IN BRASIL

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ABSTRACT

The archipelago of Fernando de Noronha in Brazil is extremely representative regarding the natural ecosystems and presents not only a high degree of complexity but also an intense metabolism in both the marine and terrestrial ecosystems, resulting in high productivity and biological diversity. Paradoxically, the occupied area, inserted in the Environmental Protection Area, presents a low level land use performance. **Due to the lack of urban planning, which led to wrong patterns of urbanization**, the Island needs an area far greater than its territory could endure, once it imports resources and exports residues to Brazilian mainland. The absence of urbanistic rules reflects the *growing urban disorganization sprawl* into fifteen low density settlements, consequently leading to environmental impacts and socio-environmental conflicts between the managing institutions. The Handling Plan prioritizes the occupation of urban empty spaces, once the environmentally fragile areas are spared and the rate of natural soil is kept at 65%. However, the Law Ante Project for Land Use and Occupation proposes an Urban Expansion Zone. Therefore, in this study is developed a comparative reflexion about the existing model of occupation and the model of Ecocities to establish parameters. An analysis about the present day urban empty spaces was conducted in order to evaluate its real occupation potential. Results so far have pointed to a situation, based on strangulation indicators, where the support capacity was already exceeded. Therefore, a solution for future sceneries seems to be the adoption of an ecosystemic view for the villages, which transcends the current disciplinary and conceptual boundaries of the anthropocentric and ecocentric views of the managing institutions.

Keywords: parameters of ecocities; empty spaces; ecosystemic view ; Fernando de Noronha, Brazil .

INTRODUCTION

The urban agglomerates are inserted within ecosystems with an specific load capacity, that is established based on the relation between the various biological cycles which compose them. The urban evolution of Fernando de Noronha will interfere in the destiny of many other species. In case the occupation continues happening at the present rate, the collapse of the terrestrial habitats and the extinction of some marine species is bound to occur. On the other hand, if a new conduct based on sustainability is adopted, mankind can be responsible for restoring an ecosystem which has been conducted to imbalance for over 500 years. The systems shall follow the complexity of the existing relations in the natural environment, with the implementation of this new conduct.

Fernando de Noronha Island, covering a total area of around 17 square km, is extremely representative regarding the natural ecosystems and presents not only a high degree of complexity but also an intense metabolism in both the marine and terrestrial ecosystems, resulting in high productivity and biological diversity. The last traces of Insular Atlantic Forrest and the only oceanic marsh land of the Tropical South Atlantic are found in the island, being an

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area of paramount biological importance for the conservation of the Marine Zone. It represents a great food source and reproductive area for all the marine fauna of the Brazilian northeast. The island is the visible part of a chain of submerged east-west volcanic mountains, which stretches from the dorsal Atlantic to the Brazilian continental platform at the Ceará coast.

Paradoxically, the archipelago's occupied area, (with approximately 2 337 to 4000 inhabitants), presents a growing urban disorganization, due to the lack of general urbanization and building rules, the result of which can be seen in environmental impact. The population who resides in the area is spread in fifteen small agglomerates along the highway BR 363. The sparse and low density occupation (1 family per plot of land) leads to a shortage of land and represents a low degree of efficiency when it comes to the use of the soil. The absence of an urbanistic project with adequate typologies associated with the landscape is thus proved.

The urban area of Fernando de Noronha is located inside the Environmental Protection Area (Área de Proteção Ambiental – APA) of 8 km, created in 1986, and the Zone of Marine National Park (Zona de Amortecimento do Parque Nacional Marinho) – PARNAMAR, created in 1988, both managed by the Brazilian Institute of Environment and Natural Resources (Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais) IBAMA. The activity of dividing the land into plots is exclusively a competence of ADEFN (Administration of the State District of Fernando de Noronha - Administração do Distrito Estadual de Fernando de Noronha), connected to the state of Pernambuco. This situation generates conflicts between both green and brown environmental agendas when it comes to establishing the support capacity and a proposition for zoning in the Handling Plan and the Law Ante Project for Use and Occupation of the Soil, once not even the limits imposed for urban occupation along river shores have been respected by the irregular settlements.

Since it was discovered, in 1503, the island of Fernando the Noronha has suffered changes in its natural environment. According to SILVA (*s.d*) due to the strategical position of the island in the route of the great navigations, in the first centuries of the Brazilian colonization, it worked as an intermediary post for the dangerous crossings of those days. There, the ship's crew could reload them with drinkable water, wood to burn in the furnace and food – fruits, roots, eggs, birds and turtles. From the XVIII century on, with the occupation of the Captaincy of Pernambuco, the island's natural physical characteristics were altered, with the systematic introduction of exotic plant species and the raising of cattle and poultry. The urban space was built by the hands of the inmate population, using the stones available there and other brought by the ships.

The destruction of all the large trees of the island was due to preventive measures to avoid the prisoner's attempts to scape by constructing *jangadas* (a brazilian watercraft) and, the chopping of the small trees, to ward off their use as hideouts. These measures contributed, in fact, to reduce the rainfall rate and provoke terrible droughts, forcing the forthcoming governments to try and find solutions for the shortage of water in the island. Nowadays the changes in the natural environment start by the removal of natural vegetation, the construction and destruction of a draining system, watertightness of the soil, extinction of animals from the local fauna, alteration in the pattern of solar energy absorption, heat emission through reflective surfaces, introduction of toxic residue, pollutant gases, sewage and liquid waste.

The complexity of the urban systems of Fernando de Noronha cannot be reduced to a linear thinking, or a particular analysis of its components. It's necessary to seek new paradigms based on an *ecosystemic view of the village structure* (codependence of the social, cultural, biological and physical phenomena) thus transcending the current disciplinary and conceptual borders of the *anthropocentric and ecocentric* views.

The analysis here presented was based on a study developed by Andrade (2005), about environmental principles for the design of urban settlements, capable of mediating the conflicts between the particular features of both Green and Brown environmental agendas in Brazil. The study shows an environmental approximation for those working in the constructed environment, and an urbanistic approximation for the professionals who work in the natural environment. Such principals are based on authors who worked with the ecosystemic view in human settlements and cities, like Capra (2002), Mollissom (1998), Rueda (2000), Rogers (2001), Register (2002) and Dancey and Peck (2002).

Based on the above mentioned study and the analysis of a group of conditioning factors, the present article shows a parametrical reflection which compares the current urban occupation model of the island of Fernando de Noronha with the models of Ecocities (spaces for pedestrians, tri-dimensional thinking of the planes, whole system patterns and future scenarios), encompassing the various territorial scales of the island. An analysis about the empty urban areas was carried out, aiming to evaluate the island's real occupation potential without losing site of the support

capacity limits. Therefore, strangulation indicators and future scenarios were established based on the principals of environmental sustainability.

THEORETICAL AND METHODOLOGICAL APPROACH

An ecosystemic view of the settlements in the island of Fernando de Noronha

The natural ecosystems present a dynamic balance in the environment which is maintained by the codependence of its physical and living elements, by the flow of energy and the natural cycles within a biophysical structure. According to Capra (2002), the direct application of ecological knowledge in reformulating the foundations of our communities, through means of environmental projects, is a way of overcoming the barrier that separates the human ecosystem from the environmentally sustainable systems found in nature. The principles of ecological design reflect the principles of organization found in nature, such as nets, cycles, solar energy, alliances, diversity and dynamic equilibrium.

Mollisson's Permaculture principles (1998) are derived of the application of ecology and ethics, which stimulates the creation of balanced and productive environments, abundant in food, energy, shelter and other material and non material needs, which include social and economical infra-structure. It's a new way of developing living standards from nature standards, used by communities that live sustainably, the Ecovillas.

Curiously, most of these communities were implemented in hostile or degraded places, aiming to restore or transform the environment. It's important to learn from these lessons to recuperate urban settlements in environmentally protected areas which are already degraded. However, in spite of contributing to the establishment of basic principles for human settlements, most of these Ecovillas are in rural areas, where the problems and challenges are very different from those found in the urban environment or in touristy places, where a lot of people interact.

Therefore, it's necessary to study the ecosystemic representation of the cities, which is based on the interactive movements of circulation, exchange and transformation of traffic resources. The urban metabolism balance model has the appropriate adjustment to the flow and stock of matter, energy and information, with the peculiarities of the human beings, involving other aspects (cultural, social and economical) and presenting a much more intense metabolism per unit of area. There is a greater need for materials coming in and going out, leading to a higher influx of energy between the city and its surroundings.

According to these principles, the cities must be considered as complex ecosystems with a dense network of metabolic processes and exchange of *materials, energy and information*, which constitutes a non-linear organization. Their metabolism must be seen as circular, which integrates the components of a system in a variety of ways. However, there is a clear difference between the ecosystems and the way humans organize the production and sale of goods and services, once the ecosystems don't do that.

Rueda (2000), considers the cities as ecosystems which are codependent of another system, their surroundings, and the intimate unit *city-surroundings*, which interact by means of a flow and exchange of energy. The complexity of the urban system depends on its anticipation capacity and, thus, the complexity of the surroundings depends on its sensibility. That's how the load capacity of a given location is determined.

The diagnosis that takes place before possible interventions must rely on the principles and rules associated to the metabolic process and consequently to the functioning of a given urban ecosystem. In a natural ecosystem where the systems are open and codependent, the flow exchange with the environment depends of the complexity and diversity of products. This way, in an urban ecosystem, as the internal complexity increases in order to maximize the internal *energy exchange*, the projected entropy for the surroundings decreases.

Rueda(2000) states that the model which most interpret the usage of entropy is the *compact and diverse city*. The proximity of the elements leads to a reduction in the consumption of materials, energy, time and soil, at the same time it provides mechanisms of regulation and control, stabilizing the whole system: *dynamic balance*. According to this point of view, *compactness and diversity* are crucial to maintain the complexity of the exchange.

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In the same line, Rogers (2001) believes the creation of more sustainable and compact cities demands the rejection of the mono functional development model and the prevalence of the car. It's necessary that the cities provide their inhabitants with an ideal habitat based on a community that emphasizes human contact.

The increase in urban density is one of the basic goals of the environmental approach applied to urbanism, provided that the support capacity of a bioregion be attended. Gathering people means reducing distances, which in turn reduces the necessity for displacement and energy expense for transportation, besides lowering the pollution levels and the area of paved land. However, the degree of compactness of each city will depend on the proportion of structured elements in the urban space and of a series of factor to be considered such as weather, kind of soil and resources capacity of each region. Due to high density, many resources are not available within the urban ecosystem, and must be obtained from the external environment, increasing the cities ecological footprint.

The understanding of the compact city is paramount to the sustainability of the Urban Zone of APA, proposed by the Handling Plan, which detains, rigorously, the constructed areas of today. The plan prioritizes the occupation of the empty urban spaces, provided it doesn't occupy environmentally fragile areas and maintains the natural soil rate of 65% minimum and 35% of the total area divided into plots be destined to public free areas. Nonetheless, the Law Ante Project for Use and Occupation of the Soil proposed an Urban Expansion Zone which comprehends the adjoining area to the present Urban Zone, considering it environmentally sound to hold the extra urban activities, which come from the vegetative growth of the local population. Paradoxally, it proposes the conciliation of the District Director Plan with a study of the load capacity.

If analyzed from an environmental only point of view, the occupation of Fernando de Noronha needs an area far greater than its territory can endure, once it imports resources and exports residues to the main land. Therefore, it presents an *environmental deficit*, for it depends of an area outside its borders to attend its demands. The island needs increments to maintain its population and its productive processes: energy in a variety of ways, such as electrical or fuel for cars; food, being it fresh or industrialized; products like household appliances or construction materials; raw material and water. The production or extraction of these products out of its territory causes a rather intense impact where it is located. These impacted areas join the group of elements that define the *ecological footprint* of the city.

At the same time, the urban settlements produce residues, pollute the air, generate liquid effluents, solid residues and chemical products. These settlements need a natural area capable of absorbing these residues, which, put together, are another ecological footprint.

Apart from depending of another territory, the urban settlements of Fernando de Noronha depend on other ecosystems from the surroundings, such as the forests and vegetation to cultivate the soil and keep it coherent and to regulate the water supply through the preservation of the capitation basins and the underwater beds, even if the sea water is the main source. Therefore the ecological footprint must also be analyzed within the island itself, around the villages and in the micro basin inside the APA.

The following table illustrates a simulation about the *urban ecosystems* in Fernando de Noronha

	ECOSYSTEMS	URBAN ECOSYSTEMS	URBAN ECOSYSTEMS IN FERNANDO DE NORONHA
Networks	<p>Ecological Codependence The interactions between the part are as or more important than the parts themselves.</p> <p>Complexity The bigger the autonomy, the bigger the codependence or the intensity of relations – bigger communication network.</p>	<p>Life Style Continuous interactions with living systems. Codependence of the systems: city-surroundings Codependent neighborhoods: subsystems with complex overlapping networks, organized and associated to the infra-structure. Public spaces, pedestrian pathways, draining basins, etc.</p>	<p>There are no integration networks between the villages: absence of pathways with shadows, cyclovia, local commerce, orchards and vegetable gardens. There is no Director Plan of urban drainage integrating the urban systems to their respective micro basin.</p> <p>No village is autonomous regarding the tripod: work, housing and leisure. There is dependence on individual motorized transportation. The highway BR363 which connects all the smaller roads, does not have a pedestrian pathway. Only a few areas present sidewalks. Most of the secondary roads are not adequately paved, making the access for busses or other kinds of public</p>

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			transport very difficult.
Cycles	Recycling of materials and energy exchange	Circular metabolism can transform residues in resources – water, garbage and biomass energy cycles	Garbage: daily production in Fernando de Noronha: 3,5 tons average (30% of compostable organic material and 70% of potentially recyclable material) The garbage at Fernando de Noronha is picked up all mixed and taken to the Composting and Treatment plant and later to the mainland by ship, at a high cost for ADEFN, instead of being recycled in the island itself. Water: there is no concern about keeping the hydrological cycle – rainwater is badly used: the drainage is canalized and only a small percentage of houses make use of the rain water.
Solar Power	Transformed into chemical energy it is what moves the ecological cycles.	Solar energy, thermal comfort and renewable sources of energy.	Only a small percentage of people is supplied with renewable sources of energy (wind energy), the rest comes from the Energy Supply Unit, by means of generators which depend on diesel from the mainland. The use of solar energy is restricted to the heating of water in a few houses.
Alliances	The cyclic exchange of materials and energy between the ecosystems are sustained by <i>cooperation</i> between the members of the network.	In the human settlements, the partnership means democracy, but may lead to personal empowerment, due to the different social roles they play. An exchange of abilities must be established.	There is no noticeable exchange between the institutions, nor alliances among the environmental organs. The community does not feel represented by their counselors. Concrete guidelines to orient the decision making processes are lacking.
Diversity	Biodiversity – diversity of species, organisms Diversified Ecosystem = resilient ecosystem	>Urban diversity and density, < dependence on motorized transportation and impact on the surroundings. > Energy, materials and information exchange, < ecological footprint	The zoning proposed by the plans does not contemplate the diversity of usages. The existing agricultural potential in some plots of urban land is not stimulated, and is even curbed by the Handling Plan. The diversity in social classes should be incorporated to the dimensioning of the plots and in the conception of mixed use areas for housing and commerce.
Dynamic Balance	The flexibility of an ecosystem is what brings it to equilibrium after changes in the environmental conditions.	The system's balance and good functioning depend on a good positioning of the elements, which should be projected according to the socio economic needs, the necessary displacement and flexibility of usages.	There is a dependency on tourism for jobs in the Island. In the low season, the means of survival become very vulnerable, creating an unbalance in the system. There is neither local commerce, nor any incorporation for socioeconomic solidarity in the system.

Table1 – Comparative analysis of the natural and urban ecosystems of Fernando de Noronha
Source: Andrade 2005

The principles of environmental sustainability applied to the territorial scales

Register (2002) alerts to the way we design and execute the constructed environment, because it determines the way we should live. He adds that a precise evaluation of the urban environmental impacts must take into account, not only the population, but also assets and technology. It must also check the use of the soil, the city's infra-structure

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and the population's housing. The quality and content of the exchanges with the environment are determined by the urban space by means of its *physical shape and arrangement* of its parts, in a systemic understanding.

The design of the streets or, more precisely, the *urban morphology* is the structural element of this anatomy. The proximity of the structural elements related to the urban shape, like housing, work place, services and equipments, favor the optimization of the space, rational use of natural areas and the efficient organization of public transport. It's the designer's responsibility, then, to establish a series of strategies or guiding principles, associated to the morphology and infra-structure, in order to achieve environmental sustainability. The goal is to achieve an ideal way of building the Ecocities, which depend essentially of where they are.

According to Register (2002), the design of the Ecocities has as the main principle to introduce green areas in the middle of car dependent enterprises, recover the natural landscape, change the center focused density to a higher density based on ecological buildings (three-dimensional view), promote more diversity in the use of soil in small areas (mixed use enterprises, to avoid displacement) and incentivated the implementation of sustainable technologies to the cities physical infra-structure (sustainable construction and green infra-structure).

The urban design of the traditional cities and villages was focused on compact centers, and sometimes these centers constituted the city as a whole. The structure of the traditional village, characterized by building side by side, shaped the streets and public places. Register believes that Michael Hoag's idea of creating traditional villages as an alternative to the urban sprawl could be supplemented by the structure and technology of Ecocities. These villages or small towns would be connected by a network of public transportation.

The Ecovilas would be important for the surroundings of the Ecocities in its lower density areas, instead of the great rural areas, once the hierarchy of the density would be: higher density in the city center, medium density in its adjoining area, and last, in the surroundings, a lower density area, where the Ecovilas would be.

Dauncey and Peck (2002) investigate, in Canada, principles associated to the urban morphology which can direct the implementation and the recovery of urban communities, bringing significant long term impact in their economical, environmental and social health developments. Such principles are presented here: environmental protection (biodiversity), higher urban density, urban revitalization, implementation of neighborhood centers and local economy development, implementation of sustainable public transportation and economically feasible housing, communities with a sense of neighborhood, alternative sewage treatment, natural drainage, integrated water management, alternative energy sources and, finally, policies based on the three Rs (reduce, reuse, recycle).

These principles should not be modified according to culture, habits, styles or fashion, being a responsibility of the designer or architect to adopt local criteria depending on the place (bioregion or micro-basin) so that the urban interventions distinguish themselves from the prevailing urbanistic traditions, which establishes the relations between density and morphology, and adopt more sustainable urban design and planning strategies. According to Andrade (2005) different scales for analysis, contrasting and complementary must be applied, which must happen systemically in several urban shapes to examine the interaction of the constructed environment and the natural one. Four analytic scales were adopted for the island of Fernando de Noronha:

1. The scale of APA delimitation – it involves the urban systems and its surroundings, the environmental urban zoning and the support capacity. In the first analyses the following was done: overlapping of the proposed zonings, density and built mass continuity analysis, macro transport system with integration of the selected area and its surroundings, economy directed to the places and protection of water resources

With the overlapping of the zonings, some conflicts were identified in their delimitation:

- The Urban Zone from the Handling Plan is restricted only to the border of the constructed areas and the Urban Expansion Zone from the Law Ante Project for Use and Occupation of the Land encompasses the adjoining area to the Urban Zone, encompassing a part of the area reserved for agriculture in the Handling Plan.
- The Wild life Protection Zone proposed by the Handling Plan for the APPs and mixed with the Conservation Zone proposed in the zoning of the Law Ante Project for Use and Occupation of the Soil. The later only highlights that the occupation limits close to the waterbeds are of 30m on each side. At the same time, it proposes that, until the law goes into effect, the existing construction and uses in the Conservation Zone, be maintained. Once the APPs are invaded, there's no turning back.

2. The micro basins scale – it involves the issue of environmental sanitation¹ accounting for the support capacity of the micro basins in the aspects of infrastructure: drainage, sewage, water supply and solid residues. The limitation

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of the micro basins in the maps of the hydric resources from the Environment and Hydric Resources State Agency CPRH does not coincide with the delimitation from the Handling Plan, which shows the absence of a plan for the micro basins and a zoning of the hydrological regimen. The Agency has been working in the island since 2003, fiscalizing, but not planning.

Nowadays, the dams at Fernando de Noronha are with their APPs highly artificial, with sparse or sometimes no green coverage and with eroded shores, seriously compromising the hydric sustainability of the island and leading to economic losses such as the high cost for water treatment through desalination. Currently all the island depends on the desalination as a source of water supply, which is distant from the villages. Another important aspect to be considered in the issue of water cycles is the muddy nature of the soil which, associated with its thickness, makes it harder for the rainwater to penetrate and accumulate on the underground bed, not favoring its accumulation of water, even with the great storing capacity of the fractured aquifers.

The lack drainage evolution conditions in small surfaces (small basin with low inclination – 15%) and the absence of vegetation in the water resources lets the rainwater run quickly in the rainy season, when it is pouring, speeding up the processes of superficial erosion of the soil. Adding to that the watertightness of the soil and the drainage system used along the highway increase the velocity of the running of surface water, the pollution and sedimentation on the non-perennial river beds and of the natural drainage system. People live simultaneously with abundance in the rainy period and shortage during the dry season.

3. The scale of urban design (the scale of the villages) – after the overlapping of the zonings and the analysis of the water cycles were done, the urban occupation was analyzed locally in each village: the issues of infra-structure, the urban empty spaces aiming to revitalize them to create a sense of community through pleasant public areas implemented with adequate equipment, the possibility of using productive landscaping and the verification of the commercial centers, with walking distances to pedestrians.

Na observation exercise about the empty areas and the connectivity of the existing villages of Noronha was carried out, in order to evaluate its real occupation potential. It was verified that the present model of occupation is diffuse. Except for some areas in the historical area of the island, such as Vila dos Remédios and the fort at Vila Trinta, the other areas of Fernando de Noronha do not fit the model characteristic of the Brazilian colonial cities.

The typology of the semidetached house corresponds to the urbanization model of the traditional European cities and can be found in Brazilian colonial cities in their historical centers, where the group of houses is laid along the streets. The use of this typology results in a compact occupation, with higher density and small territorial extension. In what concerns the weather, the application of such a model results in benefits, provided that the cross ventilation is kept, because the houses only have two sides exposed to the sun.

The model of isolated housing in one plot of land, adopted in large scale by most North and South American cities, due in part to the amplitude of the American territory, has led to the multiplication of this model of diffuse occupation. In this typology, the empty space tends to be higher in proportion to the first model mentioned. The first examples of this typology were the pre-molded houses built by the North Americans. The ratio of constructed area to empty space is 2 to 1, with adequate permeability.

In a thorough evaluation, this last typology implies in an urbanization which occupies more territory. Noronha definitely should fit in the first group, due to its small territorial extension and great environmental vulnerability. A diffuse occupation means compromising the ecosystem and impacts in its landscape.

4. The specific scale of the edifications – it incorporates principles for the techniques which involve the use of renewable resources, improvement of the energy efficiency and the thermal comfort, and soundness of the housings, making the implementation of the three Rs easier, with the construction of wells for reusing the rainwater, the use of pre-molded, recycled or ecological construction materials and economic housing.

The typologies at Fernando de Noronha reveal part of the history of the anthropic occupation. A real architectural testimony, fruit of the demands and technologies available: wooden houses, pau a pique, metal plates, beer cans, conventional masonry, plasterboards, blocks of wood, pvc profiles, acrylic, glass fiber. Some demonstrate part of an architectural reality which is segregating and little environmentally efficient. If, on the one hand, the increasing demand for housing can be verified in the island, on the other hand it's possible to see the absence of an efficient housing plan which would involve not only the technology of more sustainable constructions, but also the demolition of inappropriate occupations in their urbanistic and environmental aspects.

INDICATORS AND FUTURE SCENARIOS OF THE ISLAND OF FERNANFO DE NORONHA

Strangulation indicators

The last population count, by the Brazilian Institute of Geography and Statistics – IBGE – in 2007, shows a total population of 2.801 residents in Fernando de Noronha – a number which is inferior to the calculations of ADEFN, whose count of permanent and temporary residents totaled 3.456 people. The numbers from IBGE were also inferior to those from the Handling Plan which considered in 2004 a population of 3.327. This difference may be explained by the fact that the IBGE does not count people who may not be currently living on the island.

If temporary labor (536 people) and an average number of daily tourists (750 people) are considered, it is estimated that the Island has to support from 4.000 and 4.250 people a day. If eventual incomes of tourists from ships are considered, the population nears 5000 in specific periods.

The Pernambuco Sanitation Company (Companhia Pernambucana de Saneamento – COMPESA) calculated 4000people daily in 2007, with a per capita consumption of 180l/hab/day. Thus, the island's demand daily is 720 m³, plus 20% of majoring coefficient, a demand of 864 m³ a day is reached, which corresponds to 36m³ per hour. The production capacity of the water resources to supply this demand could attend the greatest part of the population if not for the water shortage in the surface and underground water resources (which should produce at least 12m³ and 10m³ per hour respectively) affected by the reduction in rainfall.

It could then be said that the carrying capacity of the island is exhausted in relation to the surface and underground water resources. The historical documents researched by Silva (s/d) during the Second World War, the forced increase in the population (around 3000 soldiers were sent to the Island) aggravated the situation of the existing infra-structure for the water supply. There were eight or nine deep wells which provided inappropriate water, in quantities below the necessary. As it happens today, the shortage of water was the strategy adopted.

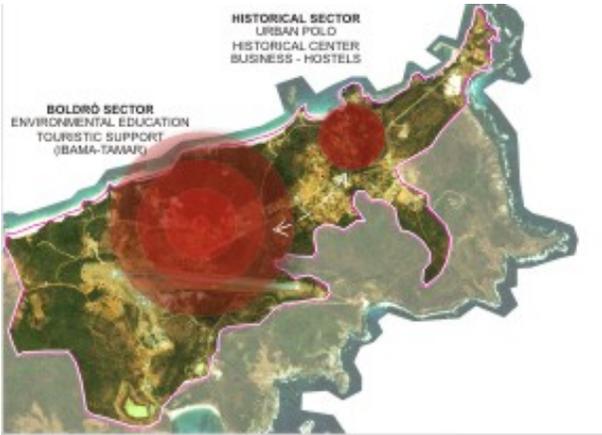
COMPESA proposed to increase the present production of the desalinator, from 20 m³/hour to 36m³/hour. If the carrying capacity of the island is analyzed from the point of view of supplying the demand using the desalinator, there are no limits. As the demand increases, so does the production of the desalinator. The location of the desalinator, however, at Boldró beach, a coral reef, can cause profound future impact.

According to the Handling Plan, the demographical density of the island within the limits of the 8km² APA is 290,1hab/ km². If only the liberated zones are considered for housing and visitation inside the APA, the density comes close to 1000 hab/km².

The Ecotourism and Sustainable Development Management Plan (2000) considers as possible areas for expansion: 142ha, 92ha for areas with access to the networks, with a density of 70 hab/ha being admitted and the remaining 50 ha a lower density for rural use. It indicates an increase of 30% in the infra-structure to assure the progressive population growth. It considers, however, the flexibility in the carrying capacity in function of the conditioning factors of the infra-structure, socio environmental impacts and quality management. It does not adopt the criteria of ecological sustainability limits, not considering the load capacity of the surroundings of the urban systems. The handling Plan also stipulates a density of 70 hab/ha but alerts to some strangulation indicators such as sewage systems and the impact of the system used

There is total dependency of motorized individual transportation. The inefficiency of pedestrian mobility is associated to three aspects: distances between sectors, topographical conditioners, and the quality of the urbanization of the public space (roads, squares and lookouts). The highway BR363 is the connection of all roads and it does not have a network of pedestrian pathways, only a few parts have sidewalks.

From the view of the local economy associated to the scattering of the activities, the island is divided in two main nuclei : the East side where the population is concentrated and the historical center, the commercial area and most of the hotels are located; and the West side where the environmental education and touristy support nucleus from the partnership TAMAR-IBAMA is located. Therefore there is an unbalance between the sectors.



Picture 1 - Tourist satisfaction levels

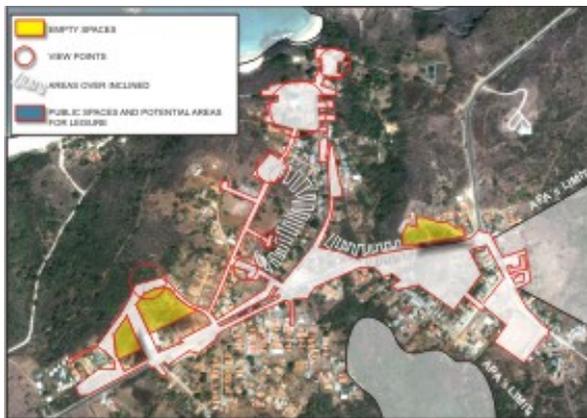


Picture 2 – Population Concentration: East Side 2.220 inhabitants; West Side 779 inhabitants

Projection of Future Scenarios

This study is based on the delimitation stipulated by the Handling Plan for the Urban Zone. Therefore, it supports the limits that were suggested, with a few exceptions. The idea of filling in the empty spaces in the residential areas (represented by the urban voids) is seen as a “correction instrument” towards a denser area, which can increase the occupation capacity of the villages.

The densification and suitable restructuring of the Historic District (Vila dos Remédios) would lead to a more balanced relationship between the urban and natural environments. Similarly, defining a polygon around the protected area of the Historic District would set a parameter for the establishment of infrastructure of this portion of the island, taking into consideration that its specific characteristics involve the various evaluation parameters of the adjacent areas. The carrying capacity where it refers to the population of the island shall limit itself to the present numbers. This way, there is the need to eliminate the present housing deficit of 100 plots of land, creating new habitation zones inside the constituted urban fabric itself. The increase in available residential areas will happen via physical interventions that will vary in intensity according to the degree of transformation in them.



Picture 3 – Re-qualification of the Historical District according to degrees of intervention of the East Side.



Picture 4 – Articulation of the Villages that encompass the Historical District on the East Side.

URBAN ENVIRONMENTAL MANAGEMENT: MORPHOLOGICAL ATTRIBUTES	
INDICATIVE OF STRANGULATION	FUTURE SCENARIOS
<p>DENSITY West side – The urban clusters present low density and are sparsely scattered over the area, with no correlation to each other, and having the Interstate Road as their only link. The Boldró neighborhood, despite presenting a number of fallbacks, shows a larger vitality: institutional and touristic vocations, which are connected to its natural heritage. East Side – Area that corresponds to the oldest occupancy – The Historical District – Vila dos Remédios – of commercial and hospitable vocation, linked to a built heritage. The ADEFN has proposed an inadequate housing area across from the cemetery, (which is also a look out). Being outside the urban zone and in a permanent preservation area, it is in irregular situation: plasterboard houses for low-income families.</p>	<p>DENSIFICATION West Side – The search for balance in the areas should be based on the use of the concept of Ecovillages in the Boldró village and in the agricultural area of Noronha, taking into consideration as a key factor the maintenance of the villages’ morphological and typological characteristics. This would highlight the important role that Boldró neighborhood plays in the interface between the natural and the manmade environment. (TAMAR Project– IBAMA). East Side – The concept of the compact city would be applied to the Historical District, with an emphasis on human occupancy. This would reinforce its residential nature, and, at the same time, its touristic potential. The empty plots in Floresta Velha, Floresta Nova and Vila do Trinta neighborhoods would be occupied.</p>
<p>MOBILITY AND NEIGHBORHOOD CENTERS East Side – The urban housing project Vila do Trinta – Historical District – Floresta Velha e Nova exhibits potential to become the real urban center of the island. However, there is clearly an under usage of road structures: internal access to neighborhoods and sights, and an absence of proper urbanization. There are no connections to the adjacent neighborhoods. The main access to the Historical District presents a declivity superior to 10% (almost 20%). In relation to the urbanization of public spaces, it is observable that, with the exception of some stretches along the Interstate where a few sidewalks and squares have been built, the interior of the neighborhoods remains deurbanized or precariously urbanized. East Side – Urban occupation is sparse, and the village has all its activity concentrated on one main street, which supplies it with a good usage of its road structure.</p>	<p>CONNECTABILITY BETWEEN NEIGHBORHOODS East Side Plan of Sustainable Motility Adjacent neighborhoods will be integrated by a system of pedestrian pathways and squares (lookouts). The connection between the Floresta Velha and the Vila dos Remédios neighborhoods is a key element in the rehabilitation of the neighborhood and the better use of its touristic potential to become a frequently visited and intensely used area. The dynamization of the neighborhood centers will depend on a restructuring of the local economy in each region. Taking the Vila dos Remédios, as example, the other streets and roads on the island must be urbanized and paved with interconnecting blocks. Leading off the interstate at the entrance to the Floresta Velha neighborhood there is an important route, which is now quite deteriorated, which cuts through the entire neighborhood, and heads downhill towards Vila dos Remédios. Along this route there are 6 lookouts: “<i>bridges between humans and the heavens</i>”.</p>
<p>URBAN REVITALIZATION Historical District – Vila dos Remédios Precariousness of building structures: 83% of structures are found in critical conservation stage, 72% have low standards of construction, 70% are in critically low standards of hygiene, and 43% of the buildings are used for economical activities. Public Spaces Presently, the public spaces in the Historical District and in the Vila do Trinta are found in a state of abandonment: sidewalks, squares, the old Army Headquarters, soccer field. In the Vila do Trinta, where occupancy follows traditional patterns, with small plots having a narrow front, this aids in laying out the urban space. Public Facilities The analysis of the support capabilities of the available public facilities, as well as of the unsafe places in Fernando de Noronha reveals a situation that is far from satisfactory. From its specific dimensions, to its location, management and state of upkeep, the series of the aspects analyzed suggest a program of interventions and general and specific guidelines for each facility, in view of its support capabilities.</p>	<p>SUSTAINABLE MANAGEMENT I - Substitution – Renovation: Vila dos Remédios An increase in the usage rates: current = X , future = 2X, maintaining soil permeability rates. Present number of homes = 48; number estimated in the future scenario = 96. Interventions will be made in those homes which are found in precarious state. Improvement in homes and the attraction of new dwellers will be promoted. New ways to use the land will be introduced. II – Free Land – Re-division New management and division of the urban voids; occupancy of irregular empty plots; 5,8 acres (equivalent to 58 1.000m² plots) III – Revitalization/Revegetation Heritage to be rebuilt; Location: Vila dos Remédios. Revegetation of all public spaces and of the Agroforestry Belt in the East and West urban nuclei. IV – Re-functionalization Buildings with adequate usage and enhanced patrimonial value - potential for new uses: Floresta Velha – doomed sports court. Inadequate location, near Morro do Pico – New use: Public area associated with the new land division. Military headquarters - New use: Public facility or Hotel. Carreira D’água Building - New use: Public facility. Warehouses near the soccer field – New use: Noronha Sports Center. V – Conservation Architectural: Up kept Buildings; Planning: Well-urbanized areas</p>

ECOLOGICAL MANAGEMENT OF THE WATER CYCLE		
	INDICATIVE OF STRANGULATION	FUTURE SCENARIOS
ENVIRONMENTAL SANITATION	<p>WATER SUPPLY Demand > Supply – exhausted water supply capabilities During WW2, with 3.000 soldiers, there was a water rationing. COMPESA data: 4000 people X 180L/per/day = 720 m³ + 20% = 864 m³). A demand of 36 m³/hour. Production of the desalinator in 2006 = 20 m³/hour. The desalinator is located far from the villages. There is a dependence upon a diesel-powered energetic system to supply the island with water. The rainwater collecting reservoirs are not considered a source of water supply due to reduced rainfall in the recent years. Low output from wells, which together should produce 10m³/hour. Collapsing situation of the surface and underground water pools. Xaréu Dam + Pedreira Dam should produce 12m³/hour. Water is wasted in the treatment of effluents and residual water is not reused in gardens.</p>	<p>WATER USE All homes should have a small supply system such as rainwater storage tanks (480 16.000 liter tanks), which would result in an additional 7.680.000 liters of water in the system. This supply system is insufficient, however. Therefore, it must be integrated with another system such as building tanks in public spaces, near residential areas, where the use of declivities would lead the water into large holding tanks. For such, it must be associated with the design of the new parks and squares. Self-sufficiency with renewable energy and water sources should contribute to the self-sufficiency of the urban colonies.</p>
	<p>TRADITIONAL DRAINAGE Inefficiency in soil infiltration capacity - carrying capacity of the system is exhausted Deforestation when the island was used as a penal facility. The dams are either in collapse of have their highly artificial permanent preservation areas, with little or no vegetation. Water levels in rivers and underground pools have fallen (low output from Vidal 1 and 2 wells).</p>	<p>NATURAL DRAINAGE The revegetation of the whole PPA with large trees and the construction of small infiltration lagoons with water-purifying plants along the preservation areas that have been artificialized. The new public spaces such as sidewalks, squares, and parks should be designed with infiltration areas such as forested floodplains, small lagoons and tanks for receiving water and agro forestry systems to slow water down and contribute to replenishing waterways. Construction of infiltration channels parallel to roads, provided that soil permeability is verified.</p>
	<p>SEWAGE TREATMENT Inefficient Treatment – exhausted carrying capacity (65,71 % of homes are connected to the system; 31 % have septic tanks; 3,29 % release sewage into the environment). The system covers only primary treatment, is inefficient and does not meet all the specification in the law; making the need for secondary and tertiary treatment evident. The treatment lakes present problems such as watertightness, rainwater drainage and animals grazing in the area. The efficiency of treatment in the isolated systems is approximately 67% and needs to be readjusted. Energy spent in the type of treatment used.</p>	<p>ECOLOGICAL SANITATION System association: wetlands and water-purifying plants as a post-treatment system, adding to the landscape. All septic tanks would have to be re-adapted to the natural treatment system with plants or bio-digesters. For buildings located in hard to reach areas such as stands and bars near the beach, if permanent, dry toilets are recommended. Implant urban-agricultural areas. Organic waste separated at its source could be composted in pre-established areas for growing vegetables in the urban areas.</p>
	<p>SOLID RESIDUE Production > Recycling – exhausted carrying capacity Daily production in Fernando de Noronha: around 3,5 metric tons - 30% of compostable organic material and 70% potentially recyclable materials. Imbalance in the system – waste is “exported” from the east side, where there is a higher concentration of people, to the west side, and then to the mainland.</p>	<p>INTEGRATING VIEW OF THE CITY-COUNTRY RELATIONSHIP. PERMACULTURAL DESIGN. Gardens and back yards provide spaces for growing food.</p>

Chart 2 – Synthesis Chart of Strangulation Indicators and Future Scenarios based on Environmental sustainability principles applied to urban design.

FINAL CONSIDERATIONS

This study was based on the mapping out of urban voids, which led to the identification of areas that were strategic

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in the qualification of urban space. Then, these areas were closely studied to identify the real vocation of each of them, through the study of their natural conditions, such as topography – water – vegetation, and of built spaces, such as residential architecture - historical buildings - squares.

In the urban scope, the parameters that establish the Carrying Capacity of the island are based on the articulated view of the areas and on the concept of Ecocity. This way, it is understood that the efficiency of the urban systems is associated with the logic behind the systems, on paths that articulate areas where the user is stimulated to interact with the built environment. From this viewpoint, this study identifies a significant shortcoming in the process of urbanization of the island, which compromises the local capability to self-support and generates devastating repercussions on the natural environment. It can be concluded that a change in this process represents a condition to the correct sage of the archipelago's natural resources. Only this way can a balance between the natural environment and the humanized environment be reached.

REFERENCES

- ANDRADE, Liza Maria Souza de, 2005. Agenda verde X Agenda marrom: inexistência de princípios ecológicos para o desenho de assentamentos urbanos. *Dissertação de Mestrado PPG-FAU/UnB. Brasília. (www.unb.br/fau/pesquisa/sustentabilidade)*.
- ANDRADE, Liza Maria Souza de, GABRIEL, Viridiana Gomes, DIAS, Marcos Borges, 2007. Conflicts of the Urbenvironmental Management of the Fernando de Noronha's Archipelago – Brazil. *II International Congresso Environmental anda Management Planning. Berlim. <http://www.urbenvironcongress.tu-berlin.de>*.
- ANDRADE, Liza Maria Souza de, GABRIEL, Viridiana Gomes, DIAS, Marcos Borges, 2000. Análise dos impactos da ocupação urbana na gestão ecológica do ciclo da água na ilha de Fernando de Noronha. *II Seminário de Regeneração Ambiental de Cidades – Águas Urbanas II. Londrina. <http://www2.uel.br/eventos/aguasurbanas/>*
- DAUNCEY, Guy e PECK, Steven. 12 features of sustainable community development: social, economic and environmental benefits and two case studies in sustainable community development in Canada. Disponível em < <http://www.peck.ca/nua/> > Acesso em: 15 de novembro de 2007.
- MINISTÉRIO DO MEIO DO MEIO ENVIRONMENTE/ARCADIS TETRAPLAN S.A, 2005. *Plano de Manejo da APA Fernando de Noronha – Rocas – São Pedro e São Paulo. Brasília, 2005.*
- MRS ESTUDOS ENVIRONMENTAIS, 2000. *Plano de Gestão do Arquipélago de Fernando de Noronha Ecoturismo e Desenvolvimento Sustentável – Fase 1, 2 e 3 (Capacidade de Suporte). Brasília, 31 de julho de 2000.*
- REGISTER, Richard, 2002. Ecocities, building cities in balance with nature. *Berkeley: Berkeley Hills Book.*
- ROGERS, Richard e GUMUCHDJAM, Philip, 2001. Cidades para um pequeno planeta. *Barcelona:Editorial Gustavo Gilli.*
- RUEDA, Salvador, 2000. Modelos de ciudad: indicadores básicos y las escalas de la sostenibilidad. Barcelona: [s.n.]. *Quaderns – D'arquitectura e urbanismo – Collegio D'Arquitetos de Catalunya.*
- SILVA, Marieta Borges Lins e, *sd.* Abastecimento d'água em Fernando De Noronha. *Programa de Resgate Documental sobre Fernando de Noronha. Recife.*