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Anthropic impacts on the mangrove ecosystem of Requenguela beach, in the municipality of Icapuí - CE

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Summary
The work identifies the main anthropic actions that degrade and unbalance the environment, especially the mangrove ecosystem, and presents a proposal for the recovery of a fragment of mangrove forest on the beach of Requenguela, in the municipality of Icapuí, state of Ceará, Brazil. To identify and analyze anthropic actions, a field visit was conducted to verify the preponderant factors for the environmental degradation of the ecosystem studied. It is noteworthy that the intensely anthropized area on this beach has an extension of approximately 12.86 hectares, where 213 planting units will be deployed in the model in "islands" throughout the extension, as a proposal for recovery, each consisting of 63 black and white mangrove seedlings. It is noteworthy that it was also proposed for this study a "Dense Seed Planting" at the edge of the consolidated vegetation and in the driest area, to maximize the efforts and promote a faster recovery of the area. For the edge of the mangrove, 5,760 red mangrove seedlings will be inserted, thus totaling a planting of 19,179 seedlings over the entire length of the area. The cycle of planting the seedlings will have a time interval of four months, because this is the period needed to start the preparation of the seedlings until they develop and are ready to be planted. Considering a survival rate in the field of 10% of the seedlings, it would take approximately 15 years for the entire area to be covered with established seedlings and thus promote the recovery of the dynamics of the local ecosystem.
Keywords: Mangrove. Recovery. Anthropization.

Impactos antropogénicos no ecossistema dos manguezais da praia de Requenguela, no município de Icapuí – CE

Resumo

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O trabalho visa identificar as principais acções antropogénicas que degradam e desequilibram o ambiente, especialmente no ecossistema dos mangais, para além de apresentar uma proposta para a recuperação de um fragmento de floresta de mangais da praia de Requenguela, no município de Icapuí-CE, Estado do Ceará, Brasil. A fim de identificar e analisar as acções antrópicas, foi realizada uma visita de campo para verificar os factores preponderantes para a degradação ambiental do ecossistema estudado. De notar que a área intensamente antropizada nesta praia tem uma extensão de aproximadamente 12,86 hectares, onde serão implantadas 213 unidades de plantio no modelo em "ilhas" em toda a extensão, como proposta de recuperação, sendo cada uma destas composta por 63 plântulas de mangue preto e branco. É também de notar que foi proposta para este estudo uma "Plantação de Sementes" no limite da vegetação consolidada e na zona mais seca, para maximizar os esforços e promover uma recuperação mais rápida da área. À borda do mangue serão inseridas 5.760 plântulas de mangue vermelho, totalizando uma plantação de 19.179 plântulas em toda a área. O ciclo de plantação das plântulas terá um intervalo de tempo de quatro meses, pois este é o período necessário para iniciar a preparação das plântulas até que se desenvolvam e sejam capazes de ser plantadas. Considerando uma taxa de sobrevivência do campo de 10% das plântulas, seriam necessários aproximadamente 15 anos para que toda a área fosse coberta por plântulas estabelecidas e assim promover a recuperação da dinâmica do ecossistema local.
Palavras-chave: Manguezal. Recuperação. Antropização.

1 Introduction

The mangrove is an ecosystem that is part of the Coastal Biome and is present in almost all of the Brazilian coast. Considered a transitional vegetation fragment, the mangrove is located between the terrestrial and the marine environments. Furthermore, it stands out for being an ecosystem rich in nutrients, organic matter, and with salinity variations, but with low oxygen content. Environmental conditions that favor the occurrence of a rich biodiversity and with the necessary adaptation for the survival of the populations.

Due to its location and the species that originate from this environment, the mangrove ecosystem has been suffering degradation from the use and irregular occupation in the locality called Barra Grande, in the municipality of Icapuí, especially summer houses and hotels, causing serious damage to the fauna and flora. It is also noteworthy that predatory fishing has aggravated the environmental balance and the disappearance of the

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fauna in this locality, among other important natural resources for the survival of the riverside population.

The region of the current community of Requenguela and Barra Grande used to be called Mangue Alto (High Mangrove) due to the extensive mangrove swamp. According to FBC (2005), the name of the community of Requenguela originated from the first inhabitant known as Severino and nicknamed "Requenguela" because he lived in a shack decorated with flags, cans, bags and straws.

The mangrove ecosystem of the Requenguela beach coastline, located in the municipality of Icapuí, currently has much of its area in a degraded state.

Thus, in order to conduct a survey on the anthropic processes causing the great degradation in environmental systems, to minimize the environmental degradation of this ecosystem and turn it back into a balanced environment, the research group of the University of Fortaleza (UNIFOR) elaborated a Plan for Recuperation of Degraded Areas (PRAD), which contains a series of programs and actions that allow the minimization of several types of anthropic impacts, such as pollution of marine waters, suppression of native vegetation, soil compaction, salinization in the soil, among others.

Thus, this study presents as its main objective to point out and discuss the various environmental problems generated by human activity on the environmental ecosystem, as well as to present a proposed plan for the recovery of the degraded area of mangrove vegetation on the beach of Requenguela. To achieve the main objective, techniques of area recovery were listed that will assist in restoring the mangrove ecosystem in the study area.

2 Methodology

The work was outlined from a technical visit to the site of the study area to obtain information regarding climate, relief, vegetation, hydrography, fauna, flora, as well as the

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interaction of the local population with this ecosystem. The recovery plan was also proposed based on technical works developed in other regions of the country and specialized references. During the field visit, characteristics of each system belonging to the area were identified, some of which are described below.

• Area Evaluation

To evaluate the area, a field visit was made, where georeferenced data were collected using a GPS (Global Position System) Garmim, GPSMap®62 and, from the geoprocessing tool Arcgis, the mapping and calculation of the area indicated for the realization of interventions were prepared (Figure 1). The entire study area was walked over for identification and analysis of anthropic impacts on environmental systems.

• Vegetation Cover Assessment

The survey and identification of the mangrove species that exist in the region was carried out based on on-site observations and specialized literature. The selected species were identified in this work based on their adaptive conditions.

• Substrate Evaluation

The substrate used for seedling production was collected from the study site itself, and this activity was performed with an articulated digger and taken to UNIFOR's soil laboratory for physical, chemical, and granulometric analysis.

• Planting Arrangement

The proposed planting models are of the "Island" and "Dense Seed Planting" types, according to the adaptive characteristics of each of the species indicated in the area recovery plan, in order to maximize the survival rate and efficiency of the effort.

• Nursery Sizing and Installation

The size of the nursery should be determined by the number of seedlings that will be produced and used in the planting of the degraded area. It is also noteworthy that the nursery will be installed in a strategic area that facilitates all the logistics and its management.

• Seedling Production

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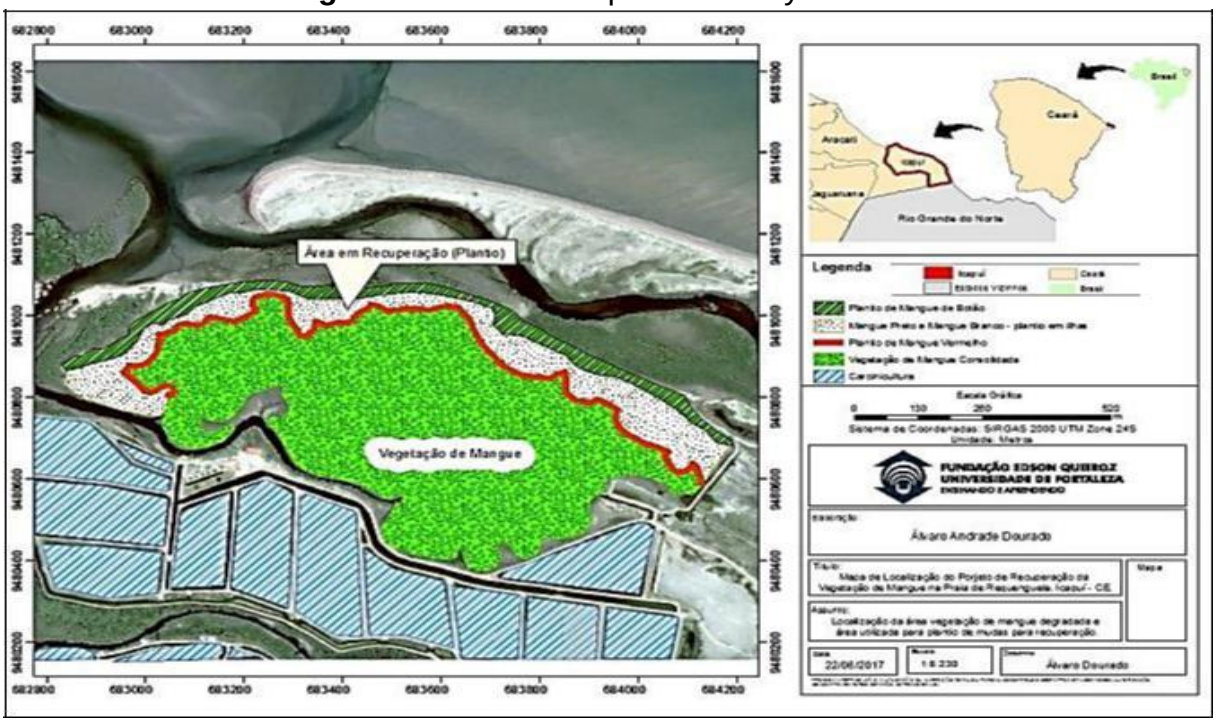
The production of seedlings will rely on the support and technical experience of professionals from a Non-Governmental Organization (NGO), Fundação Brasil Cidadão, active in the region, as well as information from literature that brings data on the production of mangrove seedlings.

Figure 1: Location map of the study area



Fonte: Elaborado pelos autores, 2017.

3 Results

➢ Area Evaluation

Observing the landscape along the region, it was possible to identify some activities that stand out as the main agent of economic movement in the area, such as carciniculture, salt marinas, lobster fishing, coconut culture, seaweed collection, shellfishing, and tourism. However, the carciniculture activity is the main anthropic agent that directly influences the environmental balance of the ecosystems present there.

For Silva (2012) the coastal area emerges as a potential agent of economic activities through high productivity and availability throughout the year. Thus, activities

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related to the sea are one of the main sources of income and survival of the regional population.

It was possible to identify a docking point for boats, figure 2, characterizing a port within the mangrove ecosystem, allowing the transit of small and medium-sized boats to be constant throughout the day. This port causes great environmental degradation, because it is a masonry structure built and installed on the bed of the channel formed by the movement of the tide. This construction is responsible for the compaction and depletion of the soil and silting of the channel bed (SILVA, 2012).

Figure 2: Boat docking point.

Fuente: Arquivo pessoal (2017).

The area where the planting of seedlings will take place is intensely influenced by tidal activity, as well as by anthropic activities over the years. The area has a mangrove vegetation cover, which is in the process of recovery. It is a floodable area when the tide reaches its maximum level.

Vegetation Cover Assessment

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The vegetation cover is composed mainly of mangrove vegetation, in which the species of red mangrove (Rhizophora mangle L.), white mangrove (Laguncularia racemosa), black mangrove (Avicennia germinans (L.) Stearn), and button mangrove (Conocarpus erectus L.) predominate.

The red mangrove species (Figure 3) is the most common and characteristic of this type of ecosystem. It can reach a height of 6 to 12 meters, and has anchor-roots or rhizophores that serve as support and respiration, through its lenticels. Reproduction occurs through propagules when they fall to the ground; during the dry tide they open and settle in the soil. The white mangrove (Figure 4), on the other hand, is smaller in stature, has pneumatophores, a radial, superficial root system, and is formed perpendicular to the ground. The leaves of the white mangrove have salt secretion glands to release excess salt.

The black mangrove is characterized by horizontal and radial roots a few centimeters below the surface. The trunk has smooth bark with a light brown hue. The red mangrove was chosen to be planted exclusively at the edge of the mangrove or wetter areas, because it is the species that showed the highest rate of success in catching compared to the white mangrove and the black mangrove.

Figure 3: Red Mangrove

Fuente: Arquivo pessoal (2017).

Figure 4: White Mangrove

Fuente: Arquivo pessoal (2017).

Substrate Evaluation

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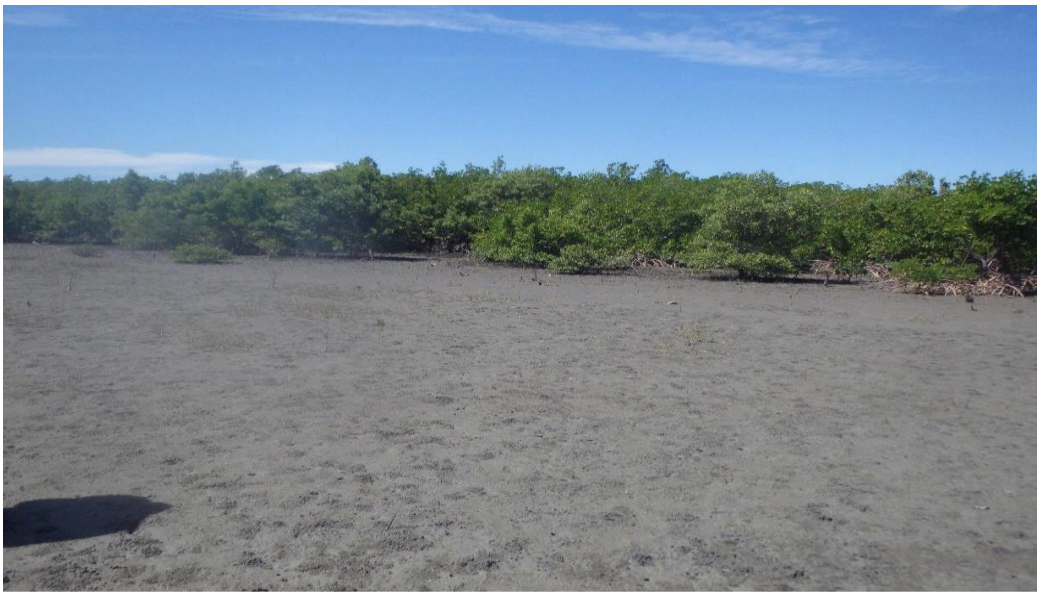
The substrates of the mangrove ecosystems are characterized by a high percentage of organic matter, high salinity, little presence of oxygen, small amount of sandy material. Although the substrate is rich in nutrients, it is hypertoxic and hypersaline. With this, the mangrove has developed adaptations for this type of environment such as: the aerial roots that allow gas exchange with the environment. They have a smooth, clayey texture, with some mottling of silty and sandy material. They are characterized by a dark coloration due to the large amount of organic matter (Figure 5).

Figure 5: Mangrove substrate



Fuente: Arquivo pessoal (2017).

Isolation of the Area

The isolation of the planting area is a fundamental part of the recovery plan for the area, because it is directly linked to the level of success of the planting of the seedlings. This isolation is important because it serves as protection against the access of animals such as sheep, goats and cattle that circulate in the area and people such as, for example, tourists who do not know the area and can easily step on the seedlings and damage them. The identification of the area with signs and information is also important for the population to know that this is an area that is in the process of recovery.

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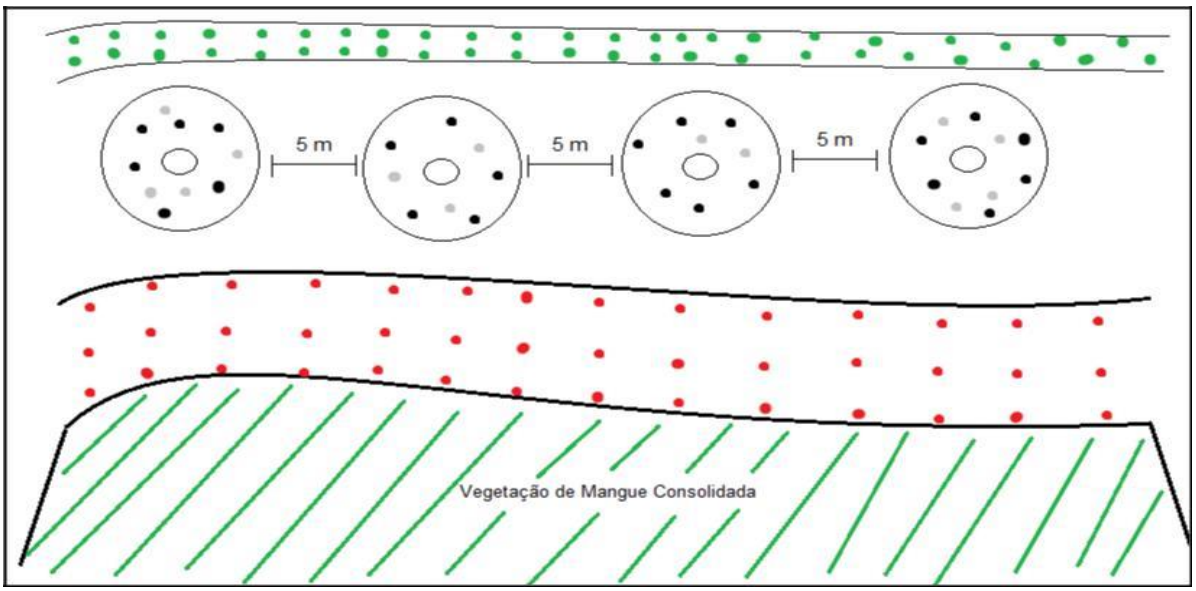
Planting Arrangement

At the edge of the mangrove will be planted the red mangrove species, where these seedlings will have a spacing of one meter between them, with the planting of approximately 5,760 seedlings (Figure 6).

The black and white mangrove species will be planted in "islands", where each island will have a radius of two meters, with spacing of approximately half a meter per seedling planted. Each island will have a total area of 12.56 m2, thus it will be possible to plant 63 black and white mangrove seedlings and 213 islands will be inserted for the recovery of the area, thus totaling a planting of 13,419 seedlings. A distance of five meters between each island will be adopted (Table 1).

In the driest part of the area and after the "islands", the technique of "Adensed Seedling Planting" of button mangrove species will be implemented. For this planting model, pits will be opened, where the seeds will be inserted and the average distance between the pits will be approximately one meter.

Figure 6: Planting arrangement in islands



Fonte: Elaborado pelos autores (2017).

Board 1: Planting arrangements on islands

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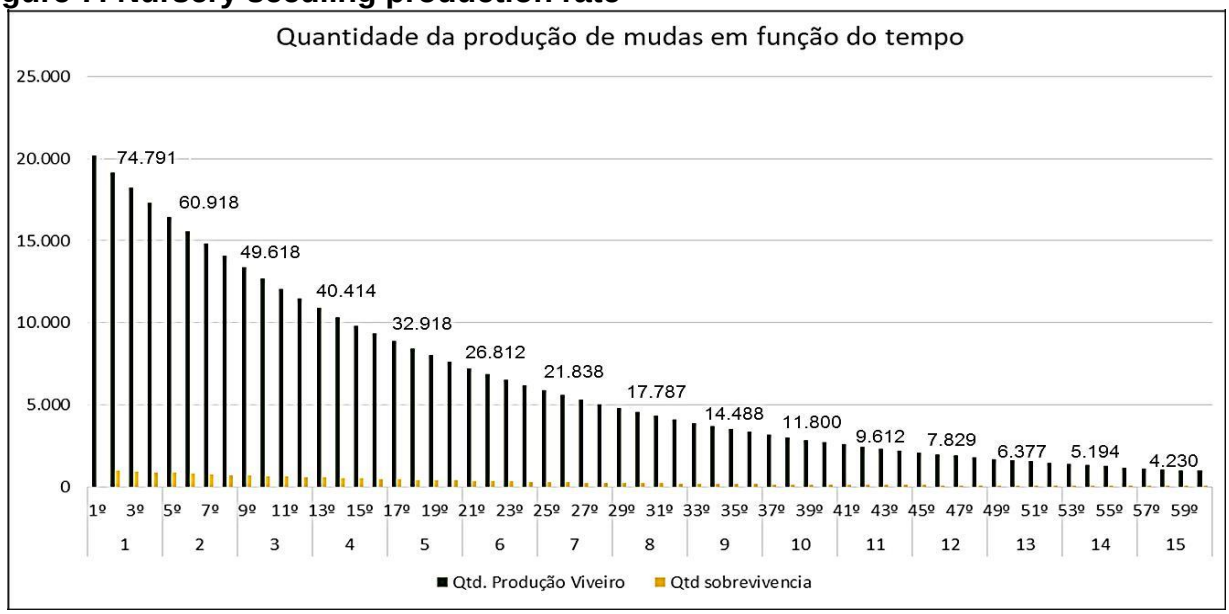
Type of Mangrove	Length (m)	N° of Seedlings	Distance between Seedlings (m)	Total Area (m2)
Black/White	12,56	25	0,5	12,56
Black/White	9,42	19	0,5	
Black/White	6,28	13	0,48	
Black/White	3,14	6	0,52	

Fuente: Elaborado pelos autores (2017).

Nursery Sizing and Installation

After verifying the quantity of seedlings used for planting on the edge strip of the mangrove swamp and planting on islands, it was possible to elaborate the size of the nursery. In total 19,179 seedlings will be used for planting. However, it is estimated to produce an additional 5% of this total, approximately 980 seedlings, as a safety margin, because there may be cases such as rupture of the plastic that surrounds the seedling, damage to the seedlings during transport, presence of fungus in the seedlings, difficulty in breaking dormancy, among others. Figure 7 shows the decay of production as a function of time according to the adopted survival percentage of 10%.

Figure 7: Nursery seedling production rate



Fonte: Elaborado pelos autores (2017).

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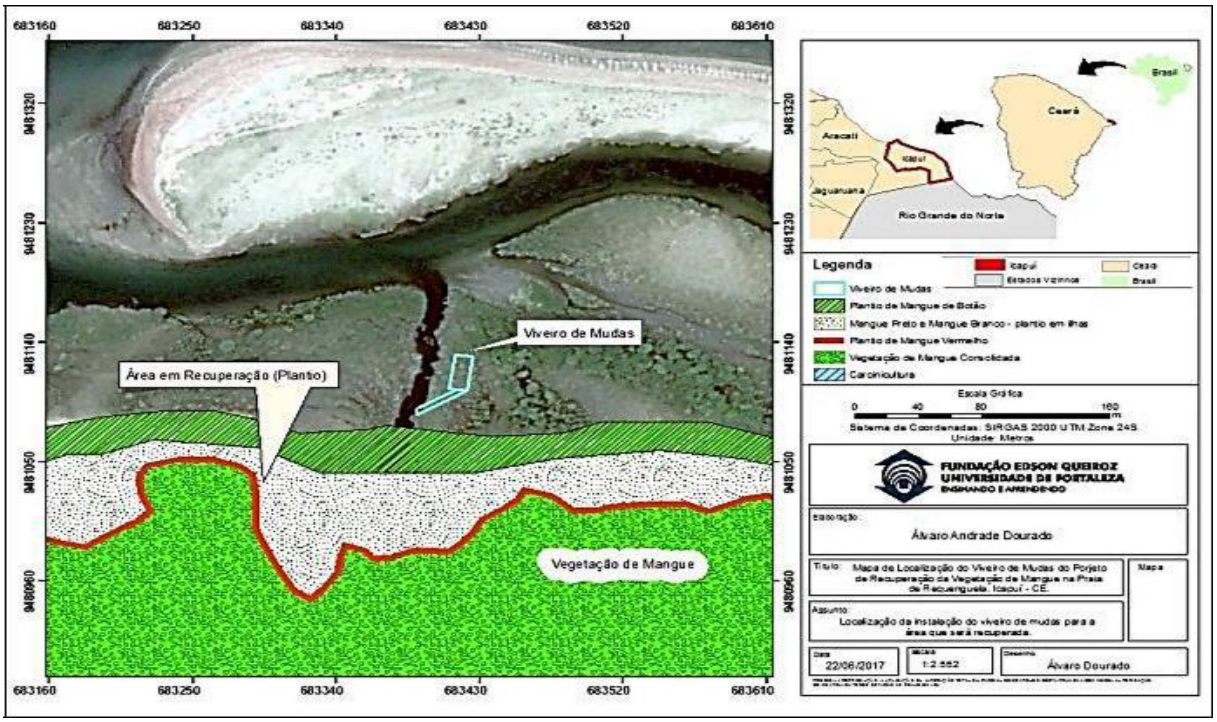
The seedling nursery will be built and installed in a semi-waterlogged area near the channel that floods the mangrove area under recovery. The site was chosen due to several favorable factors, among which are: availability of constant water due to the proximity of the canal, reduced distance for transporting the seedlings to the site, already brackish water, and favorable terrain for seedling development (Figure 8).

The seedling nursery will be built entirely with low cost and low environmental impact materials. For this, the nursery will be surrounded with wooden boards, to prevent water at high tide from flooding the nursery. Wooden rods will be placed in a vertical position to build a cover made of coconut straw to avoid too much sunlight on the seedlings. A wooden structure will be built to channel the water from the channel when the tide rises, this structure will be firm to avoid overflowing and compromising the seedlings.

Figure 8: Location of the seedling nursery



Fonte: Elaborado pelo autor (2017).

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The nursery area will be approximately 280m², with dimensions of 20m in length and 14m in width, with a depth of about 40 cm (Table 2).
The nursery will be divided into three rows, separated by 40 cm corridors, with one row for production of seedlings of the red mangrove species and two beds of the black and white mangrove species. Each row has the capacity to store 6,720 seedlings, i.e., the entire nursery will have the capacity to hold 20,160 seedlings at one time (Table 3)

Table 2: Dimensions of the seedling nursery

Dimensions (m)	
Length	20
Width	14
Spacing between beds	0,4

Fonte: Elaborado pelos autores (2017).

Table 3: Production of seedlings per bed

Production of seedlings per bed	
Bed 1 (Mangue Vermelho)	6.720
Bed 2 (Black Mangrove and White Mangrove)	6.720
Building site 3 (Black Mangrove and White Mangrove)	6.720
Total	20.160

Fonte: Elaborado pelos autores (2017).

➢ Seedling Production

The seedlings are covered with plastic material, have a good resistance to water and temperature, and are very efficient in reproducing an environment favorable to the growth and development of the plant. The seeds should be collected, then carefully separated by hand, visually separating only those that are in good condition. After separation, the seeds will be soaked in water with a combination of fresh and brackish water to try to reproduce the natural conditions as much as possible.

This process is called dormancy breaking, which serves to open the seed coat and release the seedling. After breaking seed dormancy, the plastic material must be filled with the substrate collected near the planting site and the seeds must be buried about ¼ in the substrate.

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Usually, two seeds are buried in a seed-bag to successfully grow at least one plant in the seedling, as seen in Figure 9. If the substrate is hard enough to introduce the seed, a hole should be drilled so that it does not break the seed root.

Figure 9: Seedlings from the Eye on the Water Project

Fonte: Arquivo Pessoal (2017).

4 Discussion

The activities carried out by the community of Requenguela Beach to generate income and circulate the economy, such as carciniculture, fishing, shellfishing, and tourism, are intrinsically linked to the degradation of the region's environment, especially the mangrove ecosystem. This structural heterogeneity is, according to AQUASIS/FBC (2003), a strong indication of anthropic pressures, characterized in the studied area by deforestation or by the dumping of hypersaline and/or eutrophicated effluents from salt marshes and shrimp farms.

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For the implementation of the proposal for the recovery of the degraded mangrove area, the red mangrove species was preferentially chosen to be planted around the mangrove, because it has a higher survival rate than the other mangrove species.

The black and white mangrove species were chosen to be planted on islands, as they will have a better chance of survival in relatively less humid environments. The seedlings of the button mangrove species are produced from direct planting of the seeds, which also contributes to the improvement of the germination rate.

The planting cycle of the seedlings, in the area to be recovered, will be four months, because this is the time needed for the seedlings to develop in the nursery. According to this planting cycle period, we have an estimate of four years for the entire intervention area to have living seedlings and approximately 20 years for the vegetation cover to have its biological dynamics reestablished and in balanced conditions..

5 Final considerations

O presente trabalho destacou a relevância do ecossistema manguezal para a dinâmica do meio ambiente e sua importância socioeconômica local, contudo ainda vem sofrendo com as intervenções antrópicas, mesmo sendo amparado por legislações rígidas.

A fiscalização desses ecossistemas é bastante comprometida em função da grande demanda dos órgãos ambientais. Dessa maneira, com o objetivo de minimizar os efeitos dos impactos negativos sobre esse ecossistema tão fragilizado, o trabalho apontou e identificou algumas ações antrópicas que influenciam diretamente no desequilíbrio e degradação ambiental dos ecossistemas na região e propôs a execução de algumas técnicas para recuperar a vegetação de mangue degradada na praia de Requenguela, indicando o plantio em Ilhas e o Plantio Adensado de Sementes das espécies de mangue como métodos mais indicados para o local, visando a uma recuperação mais eficiente.

No entanto, para se obter sucesso com o replantio das mudas, torna-se indispensável o monitoramento da área para que sejam tomadas medidas corretivas, caso

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assim sejam necessárias, além de trabalhos de educação ambiental junto à comunidade local, sobretudo nas escolas locais.

Ratifica-se neste estudo a importância do cumprimento da legislação ambiental vigente para que os fatores antrópicos não prejudiquem o equilíbrio e o bem-estar ambiental. Todavia, faz-se necessário a elaboração e a execução de um Plano de Recuperação de Áreas Degradadas (PRAD) para que estabeleça benefícios como a reintrodução de espécies estratégicas e ecologicamente importantes ao meio ambiente local.

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