The Extraction of Clay and its Environmental Impacts in Campos dos Goytacazes

Introduction

The Tia Telinda Environmental Preservation Center is a hub dedicated to research and development of solutions to protect and restore tropical peatlands, often affected by illegal clay extraction. With over 700 open clearings in the soil caused by local ceramics, most of them located in tropical peatland areas, the direct environmental impact on the ecosystem is alarming.

Through dedicated research, we have developed pioneering techniques to revitalize tropical peatlands. In some areas where water acidity reaches concerning levels, we explore new applications for this resource, such as its use in the mineral industry or in the development of organic preservatives. In other areas where physical and chemical parameters are within acceptable limits, we apply different forms of recovery, as we will see throughout this presentation.

We invest in continuous research to explore the potential of local biodiversity, seeking not only benefits for communities but also ensuring the protection of these sensitive ecosystems for future generations. The Tia Telinda Environmental Preservation Center is committed to leading efforts for the conservation of tropical peatlands and towards a more sustainable future for our planet.

Problems Caused by Clay Extraction

Soil Degradation: Clay extraction creates deep pits that can reach up to 4 meters, damaging the soil structure and exposing underlying layers with different physicochemical characteristics. This leads to fertility loss, erosion, terrain instability, and difficulty in recovery.

High Levels of Sulfur: The clay widely used by local ceramicists in the region has a characteristic yellow color and a high sulfur content. Tests have revealed that the total sulfur stored in the clay can reach up to 1800 decimeters per cubic meter. This high sulfur concentration represents a potential sulfate contaminant, which can be leached into the water during the extraction process and compromise the quality of local water resources.

pH	S-SO_4	P	K	Ca	Mg	Al	H+Al	Na	C	MO	CTC	SB	V	m	ISNa	Fe	Cu	Zn	Mn
H_2O	mg/dm³	mg/dm³	mmolc/dm³						g/dm³		mmolc/dm³		%	%	%	mg/dm³			
4,9	1800	11	0,70	88,00	59,50	1,80	44,60	40,70	11,00	18,96	233,50	188,90	81	1	17	443,10	3,38	5,14	64,93

Biodiversity Impacts: Soil degradation and acidification directly affect local biodiversity, reducing the variety of plant and animal species. The pits also fragment natural habitats, isolating populations and hindering animal migration.

Water Contamination: In certain locations, clay pits tend to accumulate water, either due to the water table or rainfall. In some areas, the water often becomes significantly acidic, influenced by the presence of organic matter in the soil's physicochemical composition. Additionally, sulfur leaching from yellow clay and other factors contribute to this acidity.

Especially during periods of heavy rainfall, these waters can overflow, transferring these unfavorable parameters to the soil and bodies of water connected by drainage channels built by DNOS.

Increase in Food Supply for Migratory Birds: This can result in the attraction of invasive species, as occurred in 2023 when we spotted and reported the presence of the "trinta reis" flock in our municipality. With the presence of more water bodies and the lack of predators for dragonfly larvae, the bird population tends to grow, which can attract a greater variety of migratory species. This increase in avian diversity can increase the risk of new pandemics, given the greater interaction between different groups of birds and the potential transmission of pathogens among them.

Organic and Clay Soils: These areas are also exploited by ceramicists for the extraction of kaolinitic clay used in brick making. This clay acts as a bonding agent when combined with yellow clay, contributing to improving the durability and quality of brick firing. It is known that this mixture results in the burning of organic matter rich in carbon; this burning process releases a significant amount of greenhouse gases, contributing to environmental emissions.

Imminent Risk: Many of the clay pits now represent real dangers. The water accumulated in these areas is not signaled, and there are no fences to prevent access. Tragically, there have been several deaths in these areas, and so far, no measures have been taken to protect lives.

A Lucrative Business at the Expense of the Environment

A clay extraction for the ceramic industry hides a dark side: the predatory exploitation of fertile land and large-scale environmental devastation. Small landowners, attracted by quick and seemingly advantageous payment, lease their land to ceramic companies, initiating a cycle of degradation that impacts the entire region.

The value paid by ceramic companies, R$1.00 per cubic meter of extracted clay, may seem negligible at first glance. Howe-

ver, considering an average extraction depth of 2 meters, this value translates to R$2.00 per square meter of devastated soil. On a hectare, the exploitation generates R$20,000.00 for the landowner, a significant profit in the short term.
The consequence of this predatory exploitation is large-scale devastation. It is estimated that about 7,000 cubic meters of soil are removed daily, equivalent to the degradation of 3,500 square meters per day (Costa Júnior, 1997). This alarming statistic reveals the devastating impact of clay extraction in the region, both environmentally and socially.
The exploited areas are rarely recovered, becoming permanent scars on the landscape. The lack of environmental licenses in many of the deposits contributes to the scenario of abandonment. Motivated by immediate profit, landowners show no interest in recovering degraded areas, and the extraction process, carried out empirically and without planning, leaves the soil in poor condition, with problems such as high salinity and proximity to the water table, making it impossible to reuse for agricultural purposes.

Recovery Through Aquaculture: Sustainable Alternatives

Fish farming emerges as a promising solution to rehabilitate areas degraded by clay extraction in peatlands. In addition to revitalizing the environment, this practice offers sustainable economic opportunities for local communities.

As established by Decree No. 97,632/89, the environmental recovery and stabilization of degraded areas after clay extraction is a legal obligation.
It has been found that it is feasible to reduce the amount of sulfates and chlorides through simple filters, composed of charcoal and sand, and operated under pressure. These filters, installed in 200-liter barrels and powered by gasoline or electric pumps, are capable of retaining most sulfates and contaminants, thus facilitating a subsequent process of water alkalinization.
In certain regions, agriculture may be viable, while in others, the high acidification of the water initially prevents fish farming. To overcome this challenge, research and studies have been conducted to explore the potential use of water in other functionalities, such as acidification for reducing Sulfuric/ Hydrochloric acid in mining processes, Textile Industry, Pulp and Paper, etc.

Bord Na Mona: Turf Restoration Process through Aquaculture

B"Bord na Móna, in partnership with Bord Iascaigh Mhara, is leading an innovative project called PEATAQUA, focused on the restoration of peatland areas through aquaculture. This project aims to explore the feasibility of using previously excavated lands for the sustainable production of freshwater fish.
A groundbreaking initiative is underway at the Mountlucas Wind Farm, located north of Offaly, near Daingean. This wind farm is situated on a peatland that was previously excavated for peat extraction. The project entails the creation of four tanks for the rearing of trout and perch, along with a tank dedicated to the cultivation of water lentils for sustainable water treatment.
The water required for the tanks will be sourced from a local surface water drainage system and a well, with reuse to minimize consumption, demonstrating a commitment to environmental efficiency and sustainability. Moreover, aquaculture in these areas will provide a unique opportunity to

restore the peatland ecosystem while driving sustainable economic activities in the region.
A diversity of approaches, such as fish aquaculture, aquatic plant cultivation, aquatic habitat restoration, and aquaponics, will be explored to maximize the environmental and economic benefits of the project. The reintroduction of native fish species and aquatic plants will also be a priority, aiming to restore the biodiversity of these areas.

Location and Context: The project is being implemented at the Mountlucas Wind Farm, located in the north of Offaly, near Daingean, Ireland. This wind farm is situated in an area of peatland previously used for peat extraction. The choice of this location demonstrates a commitment to leveraging lands already impacted by human activity and transforming them into spaces for sustainable production.

Aquaculture Infrastructure: Within the project scope, specific aquaculture infrastructure is being developed. This includes the construction of four tanks for freshwater fish rearing, focusing on species such as trout and perch. Additionally, the installation of a tank dedicated to water lentil cultivation, which will play a crucial role in sustainable water treatment, is planned.

Water Supply System: The water required for the tanks will be obtained carefully and sustainably. A local surface water drainage system will be used in combination with well water. This system will ensure the necessary water supply for aquaculture operations. Furthermore, water will be reused within the system, minimizing consumption and reducing environmental impact.
Diversification and Integration of Practices: The project aims to explore a variety of approaches within aquaculture. In addition to fish rearing, such as trout and perch, the cultivation of aquatic plants, such as water lentils, is planned. These plants not only help clean the water but can also be harvested for various purposes, including food, supplements, and pharmaceuticals.

Environmental Restoration: One of the central goals of the project is the restoration of the peatland ecosystem. This includes the reintroduction of native fish species and aquatic plants, aiming to recover the biodiversity of these areas. Furthermore, practices such as aquaponics will be explored, where fish waste is used as fertilizer for plant cultivation, creating a closed and sustainable system.

Economic and Social Impact: The project also aims to drive sustainable economic activities in the region. Aquaculture can create local jobs and provide a stable source of income for surrounding communities. Additionally, the restoration of peatland areas may have long-term benefits for the environmental and economic health of the region."

What are Peatlands:

Peatlands are wetland areas where plant material accumulates and decomposes, forming a carbon-rich material. They cover about 3% of the Earth's surface and store over 550 Gt of carbon, making them one of the planet's main carbon sinks.
Climate Change: Peatlands store more carbon than all the world's forests combined. One square meter of peatland in northern Europe stores five times more carbon than one square meter of Amazon rainforest. Restoring peatlands is essential for combating climate change.

Preservation and Restoration of Tropical Peatlands:

Challenges and Opportunities

Preservation and restoration of tropical peatlands play a crucial role in mitigating climate change and protecting biodiversity. These areas, composed of organic materials accumulated over thousands of years, face serious challenges due to clay extraction and other inappropriate land uses.

Countries like Finland, Denmark, Belarus, and Scotland, which previously used peat as an energy source, now recognize the negative impacts of this practice and are intensifying efforts to restore degraded areas. Laws are being implemented to protect peatlands, including proposals to ban their use as organic fertilizer.
However, in Brazil, tropical peatlands still do not receive the proper attention and protection. The lack of preservation and restoration of these areas results in significant environmental damage, including ecosystem degradation and greenhouse gas emissions during brick burning.

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t is crucial to catalog and develop projects to recover and protect these areas. Maintaining moisture is essential to prevent carbon emissions from peatlands, and strategies like sustainable agriculture can play an important role in the economic and environmental recovery of these regions.

Protecting undamaged areas, restoring already affected areas, and involving local communities in the recovery process are essential steps to achieve successful preservation and restoration of tropical peatlands. Although it is a complex challenge, it is a viable goal that can generate lasting economic and environmental benefits.

Carbon Credits: Challenges and Opportunities

Our project aims to preserve and restore tropical peatlands as an effective measure to reduce carbon dioxide (CO_2) emissions into the atmosphere and mitigate climate change. Through the conservation of these natural ecosystems and the restoration of degraded areas, we seek to contribute to carbon sequestration and promote global climate stability. (Nobre)

The assessment of soil carbon stock is crucial to understand and combat climate change, especially in ecosystems like tropical peatlands. However, it is not always feasible to conduct specific laboratory analyses to determine the concentration of organic carbon. In such cases, reference standards and alternative methods can be used to estimate soil carbon stock.
Sampling techniques are essential to obtain representative data from project areas, allowing for the analysis of carbon stored at different depths and locations.

The process involves multiplying the concentration of organic carbon by the soil volume, providing an estimate of the total carbon stock per unit area.
In parallel, techniques such as near-infrared spectroscopy (NIRS), total organic carbon (TOC) analysis, or similar methods can be employed to provide a reliable estimate of soil carbon stock. (Dr. Tim Moore)
The specific methodology for tropical peatlands is being developed by Verra and is scheduled to be launched in early 2025.
Consortium of Rural Producers and Joint Sale of Carbon Credits: We will join forces with local rural producers, forming a consortium committed to peatland preservation. This consortium will be essential to achieving common goals, sharing knowledge, and resources.
Monitoring and Certification: Using environmental monitoring technologies, we will track the progress of area restoration. This

will be crucial to obtain tropical peatlands certification, allowing for the sale of carbon credits.

Joint Sale of Carbon Credits: The consortium will have the ability to collectively market the carbon credits generated by the preservation and restoration of peatlands.

Preliminary Geological-Geotechnical Mapping Using Geoprocessing in the Municipality of Campos dos Goytacazes, State of Rio de Janeiro

Geotechnical Mapping involves representing geotechnical and geological components of significance for land and subsurface use and occupation in engineering, mining, and environmental problems on cartographic media. In this map, specific geotechnical units of each locality can be visualized, with pertinent information about soil type, substrate, and predominant relief.

Urban planning as a means of fostering development, through regulating urban land use and occupation and promoting territorial planning, should contribute to improving living conditions for the population, promoting administrative efficiency, and environmental quality.

Methodology: The methodology used was based on data acquisition, remote sensing techniques, field surveys, and the application of ArcGis9 GIS.

Data Acquisition: The following data were used: Soil Map (Compiled from CPRM-RJ by Costa, 2005b) at a scale of 1:100,000; Geomorphological Map (Compiled from CPRM-RJ by Costa, 2005b) at a scale of 1:100,000; Geological Map (Figure 2), compiled from DRM by Coridola, 2006) at a scale of 1:50,000. Geological and geotechnical data supplemented with information recorded in the field.

Field Survey: Field campaigns were conducted to identify different geotechnical units. In carrying out the mapping, some basic components of the geological environment were considered, such as rock outcrops, residual soils, slope deposits, Barreiras Formation deposits, and Quaternary deposits. All these units were investigated and described according to their characteristics.

Association of Organic and Clayey Soils - On fluvial-lagoon substrate (AO): This unit is present around Lagoa Feia and separated from the Atlantic Ocean by a small sandy strip. It consists of sediments deposited in freshwater to brackish water environments, formed by lake deposits, where the characteristic sediment is a plastic clay ranging in color from gray to blackish-gray, the latter with high organic matter content, and by marsh or swamp deposits, where the characteristic sediment is peat, predominantly organic material, with black coloration.

Also constituting this unit are sediments represented by mangrove deposits, where the characteristic sediment is kaolinitic clay, generally sandy, bioturbated, and black in color, and by lagoon deposits, where two types of sediments are present, greenish clay, highly plastic, possibly associated with shell deposits, and organic mud (former Lagoa Salgada), material with a reddish color, gelatinous consistency, formed predominantly of colloidal organic matter.

The soils composing this unit are Gleissol and Organosol and are characterized by extensive constantly flooded terrains, consisting of fluvial-lagoon origin sediments resulting from the modern drying of Lagoa Feia. Organosols are hydromorphic soils, formed in marshy environments, with organic layers at least in the first 40cm. And Gleis are mineral soils, hydromorphic, relatively recent, poorly developed, and originating from Quaternary sediments, with an A or H horizon followed by a glei horizon. They are poorly drained, occur on flat terrain, with altitudes between 0 and 20 meters and slopes of 0 to 8%. These soils have low load-bearing capacity; areas are in a permanently saturated state with constantly shallow groundwater; occurrence of soft and high organic content soils. They may present the following geotechnical problems: constantly flooded area, foundation settlement, damage to road pavements, widespread silting

In addition to being areas of crucial importance for the ecological balance of the region, mangroves play a very important role within the dynamics of these coastal areas, as they are retention elements for materials from the slopes surrounding the lagoons.

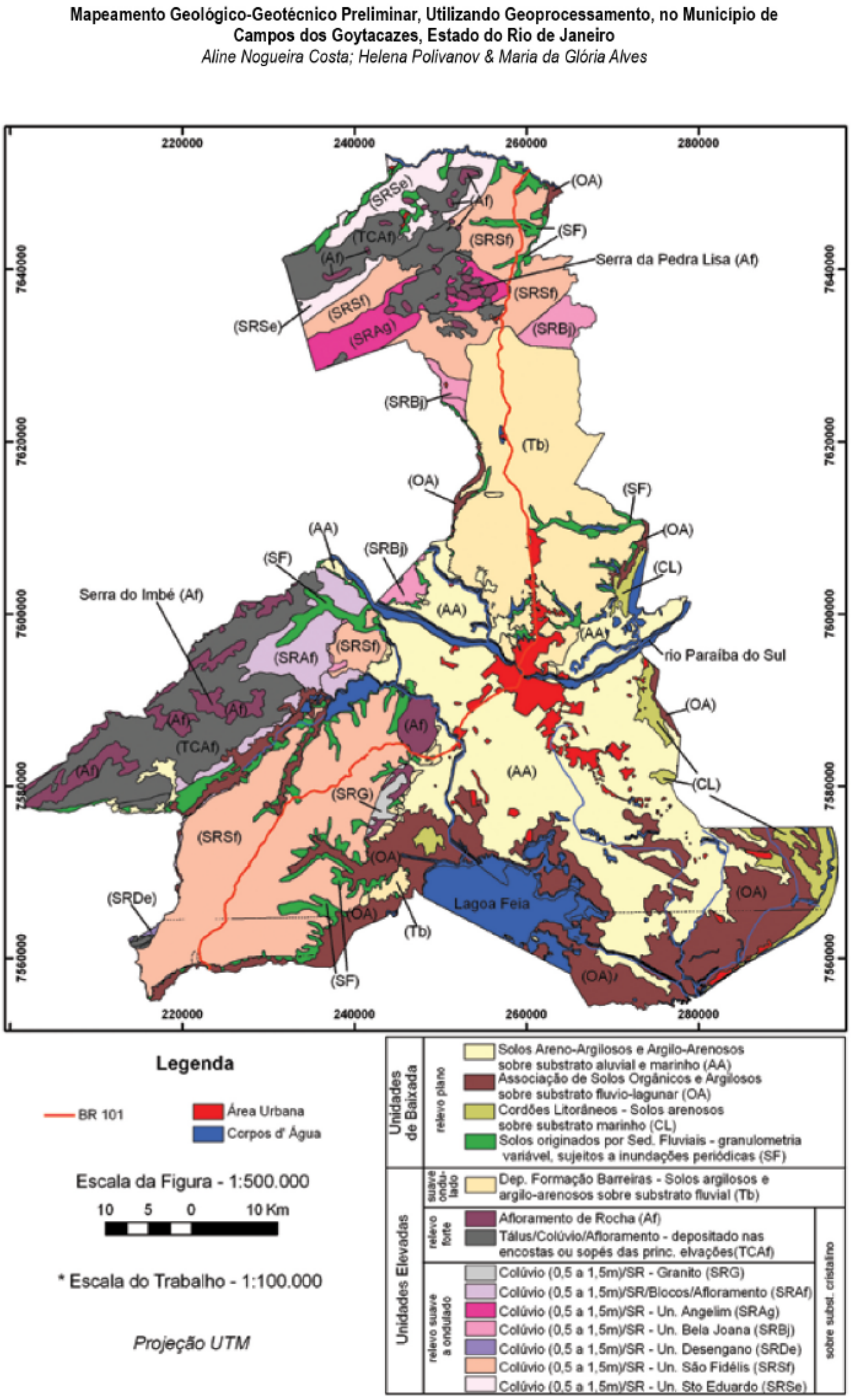

Figura 3 Mapa Preliminar de Unidades Geológico-Geotécnicas de Campos - RJ.

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