

# The Quest for land at Piranema sand cluster

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## João Pedro Martins da Silva

<http://orcid.org/0000-0002-3764-7540>

Doutor em Ciências

Analista Ambiental do IBAMA

Instituto Brasileiro do Meio Ambiente e dos

Recursos Naturais Renováveis

Superintendência no Estado do Rio de Janeiro

Rio de Janeiro – Rio de Janeiro - Brasil

[joaopedromsilva@gmail.com](mailto:joaopedromsilva@gmail.com);

[joao-pedro.silva@ibama.gov.br](mailto:joao-pedro.silva@ibama.gov.br)

## Humberto Kzure-Cerquera

DSc Professor

Universidade Federal Rural do Rio de Janeiro - UFRRJ

Departamento de Arquitetura e Urbanismo

Seropédica - Rio de Janeiro - Brasil

[humbertokzure@hotmail.com](mailto:humbertokzure@hotmail.com)

## José Mário Coelho

DSc Professor aposentado

Universidade Federal do Rio de Janeiro – UFRJ

Departamento de Geologia

Rio de Janeiro - Rio de Janeiro - Brasil

[zemario@geologia.ufrj.br](mailto:zemario@geologia.ufrj.br); [zemario@hotmail.com](mailto:zemario@hotmail.com)

## Abstract

The Piranema Sand Cluster, located between the Seropédica and Itaguaí counties of Rio de Janeiro Metropolitan Region, is responsible for 65% of the sand used in construction works of the region and is the home of approximately 47 small mining companies. The construction works in progress in this area make this mining district a critical success factor for these new or expanding ventures, for prices of construction sand increases tremendously with delivery distance. These undergoing works attract many people to the region, increasing the need for urban infrastructure to house them. This search for land comes from mining sites and causes difficulties in obtaining local permits, which are the first step in environmental compliance of the mining activities. The discussion of this paradox: “cheap aggregates for urban infrastructure and the displacement of mining to make room for the installation of these infrastructures”, must be based on a Future Use Project for this area, seeking consensus among communities, mining, government and other stakeholders. This enables the preparation of a Decommissioning Plan for the mines that reconciles the mineral reserves yet to be exploited to the needs of other land uses that development is promoting. By doing this, a regional planning proposition is established in order to recover the degraded area and ecosystems, ensure the well-being of the population, improve employment generation and income of the affected people, and keep the prices of construction sand at low levels, while showing great respect to the environment.

**Keywords:** cluster, construction sand, future use of depleted mined area.

## 1. Introduction

Aggregates for the construction industry are the most abundant mineral substances available and the most consumed in the world. Despite its low unit price, they are the most valuable mineral commodity, after oil and gas.

The Brazilian production of aggregates for construction exceeds that of iron ore, which is the flagship of mining. Production of iron ore was 335.63 million tons, in 2013 (BNDES, 2014). Sand produced for the construction industry in 2013 reached 377.248 million tons and crushed stone and gravel were 293.52 million tons (DNPM, 2014).

Aggregates are good indicators of regional development, because its use is reflected in infrastructure. They are everywhere: in children’s playgrounds, schools, houses, roads, hospitals, viaducts and bridges, dams to supply the population and the power generation plants, etc. revealing the dynamism and economic progress of society. No one can imagine the world

without them.

Its availability at low cost is one of the most important factors for urban expansion, but aggregates have their cost increased significantly by transportation, the most important component of the final price. For example, the freight of a sand truck from Piranema, to the center of Rio de Janeiro city, about 70 km away, costs little more than the equivalent of its cargo, 15 tons of sand worth about R\$490.00 (information collected directly by the authors in June 2016).

According to Aguirre (2008), transportation accounts for 88% of the final price of sand if it is delivered more than 100 km away from the production site (in São Paulo state). These two examples are shared by all the places where aggregates are exploited: Michigan, Campbell & Robers (2003) say that the economic limit of the distance from mine to site of use should not be more than 40 miles (64.4km); in Oregon, while Jaeger (2006) in a study

on relocation of mines states that the ideal distance is 15 miles (24.15km) between the mine and the site of use. Drew (2001) reports in a study about the relationship between mining natural aggregates and urban centers in the US that 90% of the aggregates are transported an average of 35 miles (56.35km). In 2012, the Regional District of Central Okanagan, British Columbia, Canada reports that the average transport distance was 17 km at a cost of \$10.00/t (EBA, 2013). In Aquitaine, France, the average price of the freight for a distance of 50km is 4.5€/t (R\$15.86 - exchange 12/10/2016) and doubles every 50km extra (CEBATRAMA, 2005).

Thus, producing aggregates at the nearest possible site to its consumer market, urban areas, reduces the high cost of transportation. On the other hand, this proximity causes a strong competition for land use: the urban center wants to occupy it with its expansion, but needs cheap sand and gravel to build its infrastructure. When

the structures are occupied, the users do not like mining activities as neighbors; it causes many annoyances, like heavy truck traffic, noise, dust, interference with the water table and the level of water wells, among others. The higher the aggregate production, the greater the pressure for land as urban structures are being built, expanding the area occupied by the city.

The difficult decision between the costs of aggregates, reflecting on the costs of construction and having mines as neighbors will depend on the political forces of the affected communities. Mining, which enabled the construction of the urban structure, is his own executioner. The society will claim the mining sites through new rules of land use and occupation.

This situation has happened in the São Paulo Metropolitan Region: locally, there is produced only 15% of the natural sand and 10% of the manufactured sand it consumes because of urban settlements that turned important areas of local sand reserves inaccessible. The remaining 75% of its demand of 3 million tons/year are brought daily by about 750 trucks from sites over 100 km away, using Via Dutra highway and other access roads including the Marginal Tiete and Marginal Pinheiros, promoting traffic jams and increasing the already high rate of accidents of the

region (MOREIRA, 2014).

According to HERMANN (2012), 86% of sand mining is done by small businesses; precisely those that have higher locational ease because they can remain in place, with smaller rejections, when urban sprawl comes to occupy the area.

Piranema is no exception to this rule. This Cluster occupies approximately 50km<sup>2</sup> of the hydrographic basin of the Guarda River in the counties of Seropédica and Itaguaí, in the Metropolitan Region of Rio de Janeiro, Brazil. This basin also houses part of the Piranema Aquifer, an important water reserve for human consumption.

Mining activities in this area began in the sixties, with mining restriction on the Guandú riverbed and the discovery that the local rural allotment of the Vargas government (1950) contained a large deposit of construction sand whose exploitation would be much safer and more profitable than rural activities. Sand mining has gradually replaced agriculture, growing or shrinking in close sync with the construction industry of Rio de Janeiro.

The sand exploitation is semi mechanized, with dredging in flooded pits. When digging starts, water fills the pit because the aquifer almost touches the surface. A pit, big enough to house a dredge is dug, and

the dredge takes over the sand extraction from that point on. The mining tailings: clay, pebbles and fine sand are thrown back into already exploited pits, in most cases.

There are approximately 47 small enterprises of sand mining in the cluster, creating about 300 direct and 4,500 indirect jobs. These companies are grouped around the Union of Sand Miners of Rio de Janeiro State (SIMARJ), the main interlocutor with regulatory institutions. They are responsible for providing 65% of the sand used in the construction works of Rio de Janeiro Metropolitan Region because of their proximity: only 70 km from downtown Rio de Janeiro.

This area, considered a *mineral interest zone* (MIZ) by the Master Plan of Seropédica, is about to have this status changed because of the amount of people attracted by the expansion of many important enterprises, ports and shipyards located in the area and the recent completion of the "Arco Metropolitano" highway, deviating the heavy traffic from the city of Rio de Janeiro directly to the Itaguaí Port. These people need infrastructure. This reality demands new housing facilities and so housing units are being offered in condominiums already installed or under construction in this area of mineral interest.



Figure 1  
Piranema Cluster Location in the Metropolitan Region of Rio de Janeiro.

## 2. Closing of mines

Although supplying society with a wide range of raw materials, some indispensable to modern civilization, the mining of natural resources is considered degrading to the environment and also a source of social, economic and cultural conflicts, especially in its neighborhood.

Mining should be understood as a form of temporary land use and a wealth generating activity, development diffuser and compatible with the rational use of mineral resources as it promotes the improvement and well-being of the population directly and indirectly affected by the activity. Is there a way that it could be considered sustainable?

A mine closure occurs when it is no longer possible to extract the ore, due to exhaustion of the mine or to technical and economic infeasibility of exploitation, such as the need of new technologies for the extraction of minerals, the replacement of the mineral by a cheaper product and also for urban occupation, appropriating the mining sites for the expansion of its infrastructure.

The impacts of mining activity closure affect not only the physical or biotic environment, but also cause local and regional changes in the structure and functioning of socio-economic and cultural orders. Thus, the mine closure concept becomes much broader than the simple closure of the undertaking and the recovery of degraded areas. It should incorporate actions to improve the levels of welfare of the affected population, which means better income, job generation and encouragement of cultural events and leisure opportunities. Successful closure plans were developed with active participation of all stakeholders during all phases of mining development, maintaining an

## 3. Results - the future use project

The kind of mining technology used in Piranema, besides being an environmental issue, is also an economic and social problem. It can be observed that the exploitation of natural resources in these areas is combined with insufficient infrastructure capital investment for compensation of environmental liabilities. The worsening of the problems, however, is related to "inaction and the political and institutional constraints in the formulation and application of regulatory tools for territorial and environmental management

open channel for discussion and claims between the company and community.

General regulations dealing with the rehabilitation of mining areas are found in mining law in several countries. In Brazil, the Federal Constitution of 1988, Article 225, §2 says: "Those who exploit mineral resources shall be required to restore the degraded environment, in accordance with the technical solutions demanded by the public agency, as provided by law." The more specific legislation, such as the Standard NRM 20 DNPM (Suspension, Mine Closure and Resume of Mining Operations) and Decree 97.632/1989 deal with the technical and environmental issues, but do not consider the socio-economic aspects of the business end nor the necessary provision of resources, during the time of exploitation of the mine, to cover the cost of decommissioning activities. A Degraded Area Recovery Program (DARP) is the only demand for mining closure.

Piranema has old environmental liabilities: many sites and pits abandoned years ago. Nowadays, illegal sand mining activities are carried out in certain locations which are then abandoned before being discovered by law agents, leaving the areas fully ravaged. Among the sources of environmental risks that stem from the abandon or inadequate closure of mining sites in Piranema, there are:

- disordered and dispersed disposition of all types of waste and scrap materials (metallic, organic, plastics, chemicals etc.);
- dust emissions originated from bare surfaces with fine particulate, capable of being carried by the wind;
- improper closing of mine accesses, exposing people to areas of high

physical risk;

• slopes and unstable ramps, creating risks of disruption or deterioration of terrain being affected by degenerative processes;

• contamination of soil and aquifer water originated from the abandoned facilities of collection and sewage treatment or abandoned oils and grease containers;

• destroyed and altered vegetation due to mine abandonment, modifying completely the natural drainage patterns;

• mixed and compacted soil with other excavated strata, making it unsuitable for agriculture and hindering the infiltration of rainwater, damaging the aquifer recharge system.

For the state and the counties that host Piranema, mine closure is the cessation of taxes, fees and royalties from mining companies and, indirectly, from mining service providers and the decrease in taxes originated from the local market as a result of the depletion of economically dependent community on mining (FLORES, 2006).

In places like Piranema, where many mining companies are operating at different mining stages without depleting their mineral reserves at the same time and in addition to that, the many new areas yet to be mined, the closure of the mines will be on a case by case basis and only a rigorous planning, followed by detailed implementation schedule for each mining company can ensure the success of future projects. If there isn't a good Future Use Plan shared between mining and society, the result may be a region shredded by flooded pits where activities that occupy continuum spaces are unlikely to be developed, as for example spaces for mechanized agriculture, sites for household construction, and areas for port support etc.

(SANTOS, 1996).

Studies of Territorial Ordering for Piranema Sand Cluster, conducted by a team of experts in urban planning from the Federal Rural University of Rio de Janeiro (UFRRJ), aimed to establish physical-spatial guidelines for the Future Use of this sand mining district, seeking to ensure comprehensiveness, environmental quality and social focus in the development of alternatives scenarios - spaces to ensure the improvement and expansion of socio-economic benefits, and provision

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of infrastructure services in these sand mining areas.

Successive relationships between man and nature in a localized manner and revealed by the landscape reinforces the importance of time and temporality: the moment concerns observation, the context in which looking and searching to understand it, highlighting the present landscape construction while the cross-temporality allows us to understand the history of spatial relationships. In any case, a spatial arrangement is worth the unequal appropriation of the goods produced, originated at the heart of socioindustrial sphere and whose dysfunction, as noted in the studies of Roberto Lobato Corrêa (1995), shape society through stratifications, ambiguity and collisions in different spheres of territorial domain.

The intervention scenarios for areas in such environmental degradation, like Piranema Cluster, are intended also to minimize or eliminate the resulting liabilities, as well as social barriers formed around these mining areas. Thus, the interventions are not limited to solve the previously diagnosed problems, but to mediate between the public sphere, the sand miners, the workers and the neighboring residents. Under this aspect, we need to incorporate the social, cultural,

political, economic, legal and environmental dimensions placed in the built environment as part of the Future Use which necessarily reflects the relationship that exists between these "places" and their surroundings, and the need to implement the development of public policies that address and gather the land use variables contained in economic production and in social relationships. Future urbanization therefore needs to be associated to new forms of socioeconomic guidelines that interfere with daily life. It is assumed, therefore, that there is a strong link between urban and regional planning and the current socio-economic and political processes. To recognize the heterogeneity and the conflicts imposed on the dynamics of this kind of territory indicates how essential is the approach of the various levels of government, the people and the productive sectors responsible for environmental liabilities, as prerequisites for ensuring a better quality of urban life .

In this research, the infrastructure is highlighted because it is a set of systems that articulates and defines the structuring and ordering elements of physical-territorial spaces as key elements to support and sets the means to provide functional facilities and services that ensure the best quality of built environment and local socio-economic development, providing

mechanisms to protect life. In general, the infrastructure defines and organizes projects for the road system, mobility, environmental sanitation, power supply, etc. that support the social and productive activity.

In general, the Future Use of Piranema Cluster consists of proposals that carry within them the concept of sustainability. In this regard, a Zoning Plan Environmental draft was prepared along with a "Mass" Plan with the urban settings concerning the territorial organization, establishing goals and guidelines for new local land use.

In this study, the Focus Area (Directly Affected Area) was considered to be the sand mining perimeter formed by the areas of mining, their access roads and available infrastructure, drawn with the yellow line on Figure 2. The Directly Influenced Area, or immediate surroundings, was set to include the neighboring communities, the limits to the campus of Federal Rural University of Rio de Janeiro, areas of rural activities and the limits with the Guandú River, which is delimited with the red line.

The Reference Area, or the Indirectly Influenced Area, in turn, was established by the interfaces of the Cluster with the counties of the Rio de Janeiro Metropolitan Region (Figure 1).

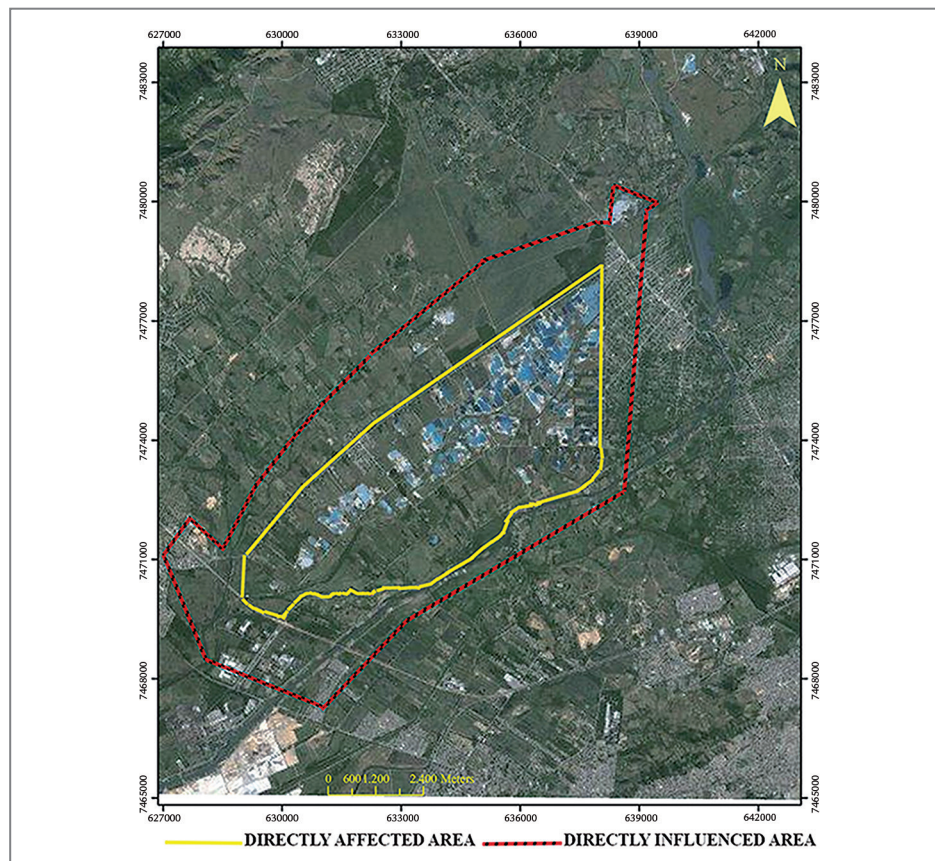


Figure 2  
Study of the Future Use Site: Focus (yellow) and Directly Influenced (red) Areas.

The Future Use Project adopted the following assumptions of physical intervention and territorial management for the future use of Piranema exhausted mine sites, always through the perspective of better environmental quality from the principles of sustainable development:

- Social mobilization around the full legitimacy of proposal implementations;
- Diverse urban scenarios in order to meet the multiple uses and local needs of land;
- Adequacy and democratization of instruments to control the use and occupation of urban land;
- Incorporation in the proposed Future Use Project of appropriate City Statute instruments (Federal Law

10.257/2001), highlighting the Neighborhood Impact Studies;

- Promotion of physical and spatial integration of the Focus Area and Directly Influenced Area;
- Establishment of regeneration parameters of the mining sand district through an urban design that promotes the formation of a new local image;
- Seeking of the preservation and/or urban and landscape restoration of the site, paying attention to issues related to security, comfort and spatial orientation;
- Prioritization of new space creation with emphasis on environmental conditions, landscape and socio-cultural issues;
- Appreciation and articulation to connect the forest fragments present on site;

- Promotion of mix and its appropriateness of uses for future local projects;
- Potential Suitability of the area to the provision of infrastructure and urban facilities;

Preliminary studies on the use and occupation of land were developed with alternatives for the future environmental zoning. In addition, the studies also point to the need of a new Road Network within the limits of Piranema Cluster. It should be mentioned, however, that these studies have been discussed with local entrepreneurs and government agencies.

The Figure 3 illustrate the urban and regional planning contents that is being developed for a possible Future Use in Piranema Sand Cluster:

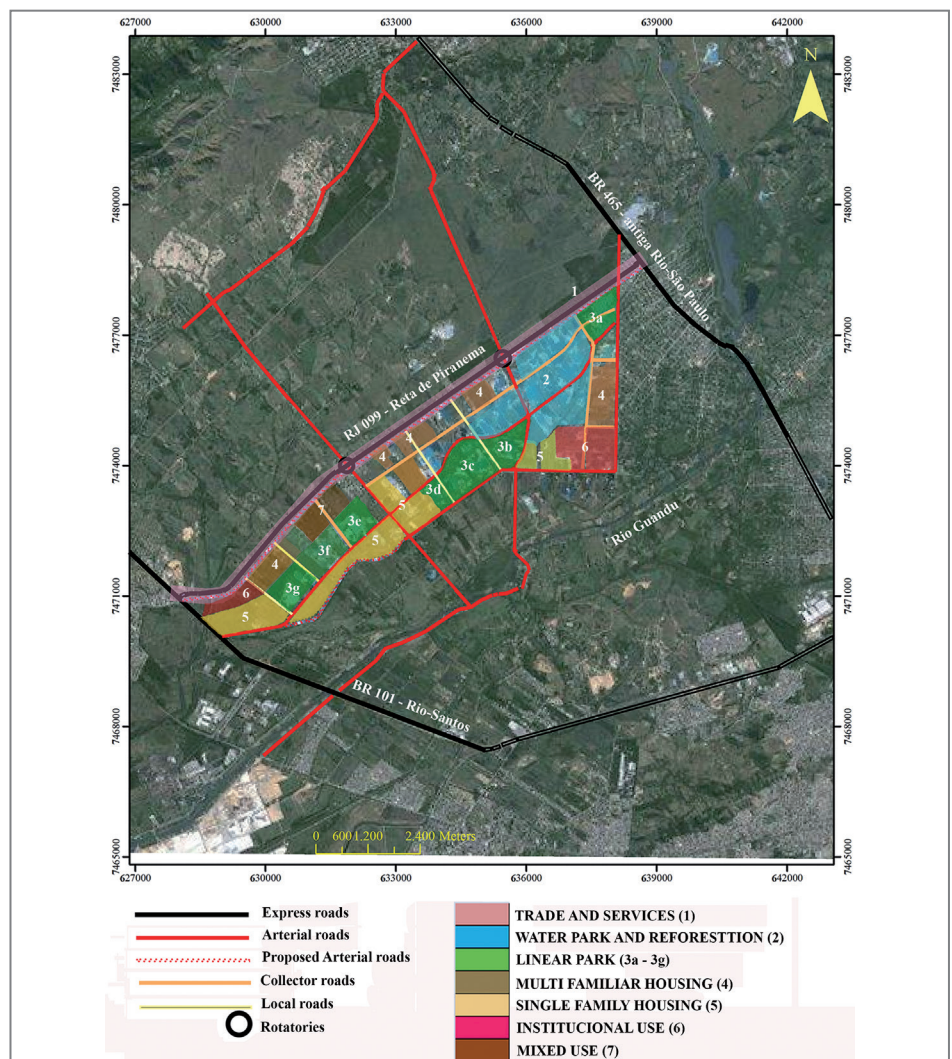


Figure 3  
Road Chart and Land Use proposals for Future Use of Piranema Cluster.

**Trade and Services** - commercial use areas for housing offices, shops and businesses in general, including shopping centers. It occupies the southern side of the RJ 099 road;

**Water Park** - area that can be used for people's leisure, reforested with native species for shade and fruit, suitable for

water sports like sailing and rowing. It occupies a heavily mined area, with companies that soon will close their activities. Possibly the first part of Future Use Project to be built, contributing to its promotion: everybody likes parks;

**Linear Park** - area for conservation of natural resources, whose main feature is

the ability to connect vegetation fragments and also other elements of a landscape, adding value due to use for leisure, mainly through cultural and sports activities, equipped with bike paths, trails, bandstands, picnic areas, amphitheater etc. It could be built in parts, like in the 3c area, which is almost fully mined;



**Single-family housing** - areas for construction of houses and condominiums, mostly located in unexploited areas;

**Multifamily housing** - areas for construction of residential buildings and high-rise condominiums, also mostly

located in unexploited areas;

**Institutional use** - areas for the installation of public institutions such as schools, hospitals, outposts of Government Departments, trade unions etc. They are located in areas not yet mined, but may

have a lot or two blocked to be dedicated to these institutional structures;

**Mixed use** - area for the installation of various types of institutions, NGOs, trade and services etc. located on not yet exploited areas, typically for future use.

#### 4. Conclusions

If sand mining in Piranema is to remain as the main source of construction sand to the Rio de Janeiro Metropolitan Region, it will be necessary to submit to society, specially to the neighboring communities, an attractive Future Use Plan, adherent to the principles of sus-

tainable development, that can be seen as a quality of life improvement, bringing employment and income to people who became workless with the closure of the mines and being at the same time, a pleasant place to be and to enjoy nature and cultural events.

The Future Use Project proposed herein may be an option, but needs to be discussed with all stakeholders so that it can meet the future expectations of society and specifically of the neighboring communities, as well as of the regulatory agents.

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