Guanabara Bay

Proposals for a Territory of Exclusion Born from Paradise — Part I, The Present-Day Mess

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Abstract: Exclusion Territories are geographical areas under the action of degenerative environmental phenomena of anthropogenic origin, which compromise quality of life in general. One of the greatest examples of such areas is the Guanabara Bay and its surroundings, the scene of some of the worst disastrous incidents and locale of frequent episodes of human misery. This article presents a brief description of the main characteristics of the region, providing some technological suggestions of biogeographic recovery to be adopted by public policies that intend to align themselves with the good practices of ecological economy, sustainability and quality of life. The work falls within the context of macro-engineering *cum* eco-innovation applied to the preservation and management of water sources and water bodies that serve productive purposes as natural niches and breeding grounds.

Key words: Exclusion Territories, Guanabara Bay, waste management, quality of life.

Resumo: Territórios de Exclusão são áreas geográficas sob ação de fenômenos ambientais degenerativos de origem antropogênica, os quais comprometem a qualidade de vida em geral. Um dos maiores exemplos de zonas desse tipo é a Baía de Guanabara e seu entorno, palco de alguns dos piores incidentes desastrosos e de frequentes episódios da miséria humana. O presente artigo descreve sumariamente as principais características da região, fornecendo algumas sugestões tecnológicas de recuperação biogeográfica a serem adotadas por políticas públicas que pretendam alinhar-se às boas práticas de economia ecológica, sustentabilidade e qualidade de vida. O trabalho se insere no contexto da macroengenharia *cum* eco-inovação aplicada à preservação e à gestão das fontes hídricas e dos corpos de água que servem a propósitos produtivos como nichos naturais e criadouros.

Palavras-chave: Territórios de Exclusão, Baía de Guanabara, gestão de resíduos, qualidade de vida.

1. Introduction

The 1979 James Bond epic ***Moonraker*** featured the awe-inspiring scenery of beautiful Rio de Janeiro as well a nearby secret locale X where aero-spacecraft transports are launched. Gathered genetically perfect youths (representative of all humankind) were to ride these craft and eventually dock with an Earth-orbiting space-station. There, they would await the impending deliberate extermination of all the unfit and ugly human beings isolated below before their triumphant return to Earth's biosphere for its repopulation! Brazil's ever-failing leadership might wish they could be isolated from those, both rich and poor, dwelling next to a polluted and offensive bay!

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The Guanabara Bay (in *Tupi* Indian language, Guanabara means “the breast of the sea”), the old postcard slogan of one of the most beautiful cities in the world, is today an aquatic chemical and rubbish dump, a great marine cesspool in the open. It is nowadays a symbol of social exclusion in Brazil, with 50 of its 55 tributaries becoming black ditches draining 15,000 liters of untreated sewage per second. Virtually all tributaries suffered corrections of flow, which accelerated the process of natural sedimentation. Among the more than ten million inhabitants living in its surroundings, it is estimated that at least one third live in slums (shantytowns), and another third live without basic sanitation and minimal urban infrastructure. This population makes Guanabara Bay (GB) one of the most important coastal environments in the country from a social, economic and environmental point of view [1-3]. Despite its beauty, importance as a tourist and economic center (Grande Rio megalopolis), GB sometimes stinks and often is an eyesore. Without a dry season, ~2.1% of Rio de Janeiro State — including the state capital and Niteroi — are blessed with Koppen’s Af climate [4]. Like most modern-day cities Rio de Janeiro is domed by an aerial heat island [5].

GB was also named *Rio de Janeiro* (“*rio*” is the Portuguese word for “river”) by André Gonçalves, Captain of the Portuguese fleet arrived at the waters of the *Tupis*. Obviously, it is foolish to think, as many people want, that Portuguese navigators would have confused GB with a river, since the word "*rio*" was used at the time to designate any mass of water, and that Portuguese navigators, highly competent and perhaps the greatest in history, were extremely experienced cartographers, cosmographers and observers, who would scarcely make such a mistake.

Guanabara Bay bathymetry resembles a sea-shell. It was filled with seawater first approximately 6,000 years ago as the post-Ice Age ocean rose [6]. The geographical beauty of the region has long been exalted. As Saint-Hilaire (1779-1853) said,

"*Qui serait capable de décrire les beautés de la baie de Rio de Janeiro, ce port qui, de l'avis de l'un de nos amiraux les plus savants, pourrait contenir tous les navires de l'Europe*?"

Why has an ecosystem of such importance and obvious charms been left aside, absolutely abandoned by the authoritative public power? There is a perverse combination of factors. On one hand, the low-level of education of the people precisely allows people with limited perhaps shriveled humanistic capacity to be raised to power, in addition to the constant presence of unbridled corruption. After years of anthropological and social studies, we are led to theorize that poverty imposed for a long time becomes a state of mind that completely dominates a population; malleable people adapt to misery in order merely to survive, as if they were made insensible by political morphine, by empty promises, and do-nothing concretely to change; they get used to the worst health and sanitation scenarios, and re-elect the most cynical politicians for crumbs called aid, but which are actually payoff-like handouts. We suppose this is how Latin governments impose their sovereignty: establishing poverty as a state of mind, while dominators do everything to keep things as they are or escape to far-pleasanter places, someday including a nearby Space Station or even a terraformed Mars. As Paulo Cezar Carrijo said in a news release on July 25, 2018,

"A legal imbroglio called Justice of Work costs 5 billion dollars a year to the country. Therefore, there is no lack of money to do what has to be done. What is lacking is shame in the face of all of us […]. The people who polluted streams, rivers and seas with their trash are also the same as electing inept and corrupt rulers”. (https://marsemfim.com.br/baia-de-guanabara-entenda-poluicao/; accessed on March 04, 2019).

On the other hand, cargo ships in Rio de Janeiro, whose unregulated and non-oversight companies, and their careless employees, show little zeal for the encompassing environment, which is one of the world's most eutrophic ecosystems, wash their infected basements within GB water without any authority condemning this fact. Indeed, people throw sofas, mattresses, sinks and all kinds of objects into the rivers, making the bay a true cesspool. This shows the more than obvious conclusion that education, law, health, and citizenship go hand-in-hand in a socially developed nation.

GB shoreline dwellers need wise marine spatial planning done by persistent and courageous planners and their coworkers uninterrupted by the nonsense instructions of ignoramus politicians and inept bureaucrats! There are exploitable opportunities for those endowed with vivid prospection visions and willpower. Fortunately, there are people whose voices seem to win listeners little-by-little. International pressure and personal networks have contributed to mobilize not only academics and intellectuals in general, but also the population. The purpose of this article is to expand the modest ranks of those who embrace socio-environmental causes, presenting a doable proposal for GB's recovery (and, please, do not ever say there is no money for the tasks needed!) [8]. The Petrochemical Complex of Duque de Caxias ought to be held wholly responsible, in perpetuity, for the long-term health maintenance of the mangrove region situated on the west side of the southward-facing GB. The upper estuary nearby is targeted by local fisheries of diadromous species.

2. Oceanographic Report

GB is in fact a fan-shaped lagoon in *cul-de-sac* (Figure 1). It is the result of a tectonic depression formed in the Cenozoic period. There is only a relatively strait access to the open sea, which narrows water circulation. Nevertheless, the resurgence phenomenon, strongly influenced by the wind tension and by the Brazilian Current (BC), may carry South Atlantic Central Water (SACW) into the GB up to 15 km, accordingly February 2001 thermohaline indices reported by Bérgamo [7]. The fact that SACW can be advected into the interior of GB only 15 km inside is not enough to bring relevant renewal, since such waters do not reach the more distant and polluted shores of the bay to the north and northwest. Moreover, the circulation of seawater in the most remote areas is almost totally restricted to the small speeds of tidal movements in the innermost estuary.

GB covers an area of 384 km^2, in maximum measures 30 km long from north to south against 28 km from east to west, containing >100 islands and still maintaining the little that remains of the ancient mangroves that characterized most of its perimeter border of about 131 km. There are 53 sandy beaches and a 30-40 m deep central channel (see Figure 2) [8]. As hinted above, the water circulation in GB is greatly influenced by tidal currents of semi-diurnal type, with a maximum amplitude of 1.4 m. With tidal current velocity of about 0.1 m/s in the shallower interior, an entrance 1.6 km wide, and a sandbank located in this entrance, the renewal of water at the GB's interior limits becomes negligible if contrasted with the volume of organic sewage discharged per second from the contaminated rivers.

The influence of wind is considerable in GB's fresh and salt water regimes. Carvalho showed that the wind field has fundamental role in the essential hydrodynamics of GB, changing the field of velocity of the northern portion and shifting the surface elevation field, demonstrating that the environmental management of GB must obligatorily consider the interaction between all water and the various winds [9]. Rio de Janeiro's population and infrastructure has never been blown by a tropical cyclone although this may change owing to global and regional climate

regime changes since the first recorded South Atlantic Ocean cyclone reached land in the State of Santa Catarina in March of 2014. Have Brazilian politicians and bureaucrats considered the catastrophic outcome of such future storminess?

3. A Socio-Environmental Conundrum

An intricate reality has offered difficult barriers to overcome in terms of environmental recovery and preservation in Brazil, notably in the State of Rio de Janeiro, perhaps the Brazilian federation unit most affected by corruption in the last 30 years. In this State, the disregard for waste management, especially solid waste, becomes evident when one overflies GB. In 2002, CONAMA Resolution 307, later amended by Resolution 348/2004, determined that the solid waste generator was responsible for its management. This determination represented an important legal framework, determining responsibilities and stipulating the segregation of waste into different classes, making their referrals for recycling or adequate final disposal mandatory. The greatest advance in terms of legislation came when the Federal Government, through Law N# 12 305/2010, instituted the National Solid Waste Policy (NSWP), by which it created the necessary instruments for Brazil to face the main environmental, economic and social problems that arise when the management of solid waste is done inappropriately [10-11]. However, the exercise of the law and of the recommendations instituted did not come close to being effective. The amount of garbage carried to GB made it impractical to fish in several locations. Typically fishing communities such as the former *Porto da Piedade*, whose fishermen are mostly descendants of slaves, are today in pervasive poverty. Only in some areas is it still possible to carry out a modest subsistence fishery (see Figure 3 in appendix).

Residential sewage dumps are the main aggressors of the GB biome. As is known, the disposal of domestic sewage in any aquatic environment causes reduction of dissolved oxygen, pH changes and turbidity, being these dumps treated or not. In addition, industrial heavy metal dumps have been reported since 1988. The many studies of the types of pollutants and their proportions present in GB are well-known, so that it is enough to emphasize here the near-absence of sanitary conditions and sewage treatment in the poorest areas around GB, thus reflected by the high infant mortality of 23.9% in some locales, compared to other areas where the infant mortality is 4% due to the effective working existence of sewage disposal systems [12]. It is also noteworthy that in 2000 the town of Tubiacanga was the community most affected by the oil spill in GB, considered the second worst environmental accident in the region, with 1.3 million liters dumped in the waters, mangroves and bay beaches. This environmental disaster, added to more recent ones involving suddenly breached waste-impounding dams belonging to rich mining companies, did not produce the national commotion that would be expected. It seems that government neglect, besides being a mark of Brazilian management, has already infiltrated the *modus vivendi* of the communities, configuring widespread popular indifference.

The most expressive GB recovery initiative was the cooperation between the Inter-American Development Bank, the Japan Bank for International Cooperation (JBIC) and the government of Rio de Janeiro State, which elaborated the Program for Remediation of Guanabara Bay (PRGB), begun in 1994. The program proved to be a fiasco, thanks to local corruption and typical discontinuity of Brazilian politics when there is a change of government. From the large set of sewage treatment plants planned, several unities were not concluded or not connected to the sewage collect/disposal system. Not even the 2016 Olympic Games left a positive legacy for society, since health and sanitary interventions were very close to the ridiculous. Although the international community has recognized the urgency of actions to effectively

conserve the marine and coastal ecosystems, mainly after the Rio+20 Conference, very little has been done from the practical point of view. “The Future We Want” document, from Rio+20 Conference, shall remain pure exercise of rhetoric if mankind does not seriously begin to think as a species, radically changing the current market model and combating the harmful effects of economic globalization. Until slightly more than a decade ago (that is, pre-2007), official maps omitted the shantytowns (slums called “favelas”)!

In short, characterized as a real territory of social exclusion, the GB is becoming the scene of an environmental devastation increasingly more difficult to reverse, especially in face of the apathy of the majority of the populace and the irresponsibility of the public power. Looking at the Brazilian reality, since it is a rich country, although burdened with one of the worst distributions of monetary wealth in the world, one should seek alignment with the UNEP Strategic Directions (2017-2020), and the Regional Seas Conventions and Action Plans, concentrating investments in the ecological protection of the coastal environments, guaranteeing quality of life and social development for those who live there.

In future, owing to anticipated future global sea-level rise, there might occur a 40 m retreat — a migration inland — of Rio de Janeiro’s famed beaches, meaning the *calçadão*, the bike-lane and the twin paths of sea-fronting Avenida will disappear beneath the high-tides. In other words, the remake of the 1984 movie ***Blame it on Rio*** will have to build a suitable new set for the eroded and submerged natural beach where the film-stars previously paraded[13]!

4. Technological Prospects

Several studies have been produced on GB, motivated mainly by the current situation of environmental degradation [14]. Such studies generally point to the more traditional measures of long-term solution since usually their authors are not macroproject minded! In fact, the conventionally designed depollution process, based only on a network of treatment plants, shall take a long time to show satisfactory results owing to the extensive replumbing of a large metropolitan region; there shall be a need for comprehensive educational programs to change the ingrained bad sanitary habits of the population, as well as vigorous enforcement measures regarding ship and industry evictions in GB. It is a very time-consuming task, too long to hope for any improvement for seaside communities to take place, considering that there is almost no truly effective environmental management in Brazil at the present time. This perception led us to conceive a macrosystem of pipelines transporting oceanic water under pressure to the generally stagnant shallow northern area of the GB, creating a suitable piped artificial current capable of accelerating, when it exits the pipe, the massive renewal of the seawaters and promoting a more immediate bubbled oxygenation for the reactivation of the artisanal fishery, bringing long-term economic relief to the upper estuary fishing communities.

Nowadays, large-scale engineering interventions to divert ocean water within intra-continental water bodies are not yet common actions, although there is a growing emphasis on inter-basin water transfer megaprojects for environmental, economic and social purposes because of noticeable climate regime change. Our megaproject is addressed to all of these purposes, with the reminder that ten million people today are affected directly or indirectly by GB's deplorable conditions. Of course, it must work with other devices and long-term measures. However, in Latin America one has to take great care to make things happen as they should be, since socio-political history of that world region’s countries is not among the most encouraging. For instance, Rodrigues *et al.* applied an interesting historical classification of water legal treatment in

Brazil [15], in which three distinct phases are identified as 1) the navigability phase, 2) the hydroelectricity phase, and 3) the environmental phase (the current phase). We note that in all of them management mistakes were evident and have been recognized at least by the Brazilian engineering community. In most cases, mistakes are made by neglecting the negative effects of geographically large-scale projects [16], which are announced only on the side of the benefits that unfortunately serve the dominant minorities more than civilians who need broad public policies. The poorest populations are those most affected by the negative impacts (expropriation, environmental pollution, etc.).

That is not the case with our proposal. The benefits of our presently defined macroproject to accelerate GB's seawater quality recovery are almost immediate for both fishing and tourism, and it could bring back the profitable activities that would occupy a large part of today's idle local working class. Here, it is worth noting that the Ipanema Submarine Outfall, first installed by 1974, still releases untreated waste-water that during flood tide enters GB! The periods of discharge of oceanic water would be articulated with the tidal cycles in order to counter-balance the acceptable levels of the GB seawater condition. The forceful current induced by the pipelines would act in anti-clockwise flow from the northeast shore of the GB, benefiting the most critical areas and forcing oxygenation in *Fundão* channel and *Praia de Ramos*. The favelas-bordered *Fundão* channel, an artificial mini-estuary created between 1949-1952 by the linking of eight islands with landfill, is characterized by oil and sewage-polluted seawater and mildly radioactive sediment. *Fundão* Island is home to *Cidade Universitária* campus and the Rio Science Park since 2003. Solid waste containment barriers, even simple racks, placed at river mouths would prevent garbage from flowing into the ocean, while an effective system of selective collection and recycling would direct the accumulated debris to proper disposal. As in Tokyo, it is possible to add polyester fiber screens in three layers for E. coli filtration in the estuarine zones. Strategically positioned biological stations would monitor GB's ecological dynamics, making periodic measurements on water quality and indicators related to the activity of micro-organisms, fauna and flora in general. Can we, someday in the near-future, expect technical counseling from technically knowledgeable mentors working, since 2015, at the *Museo do Amanhã* (Museum of Tomorrow)?

One negative aspect, however, should be studied cautiously. GB has a hybrid bed, partly consisting of mud in the inner mangroves and variable sizing sand on the banks of the islands and on the edges closer to the ocean. Thus, the transfer of ocean water should take into account a filtering process that prevents the traffic of large amounts of sand, so that the balance of mangroves is preserved. Over time, with the set of sewage treatment plants in operation, the stabilization of the freshwater/saltwater mix shall occur naturally. Only then shall we be able to await the results of education in the new generations of young people, certainly more engaged in questions of humanity's survival on this beautiful and mistreated planet.

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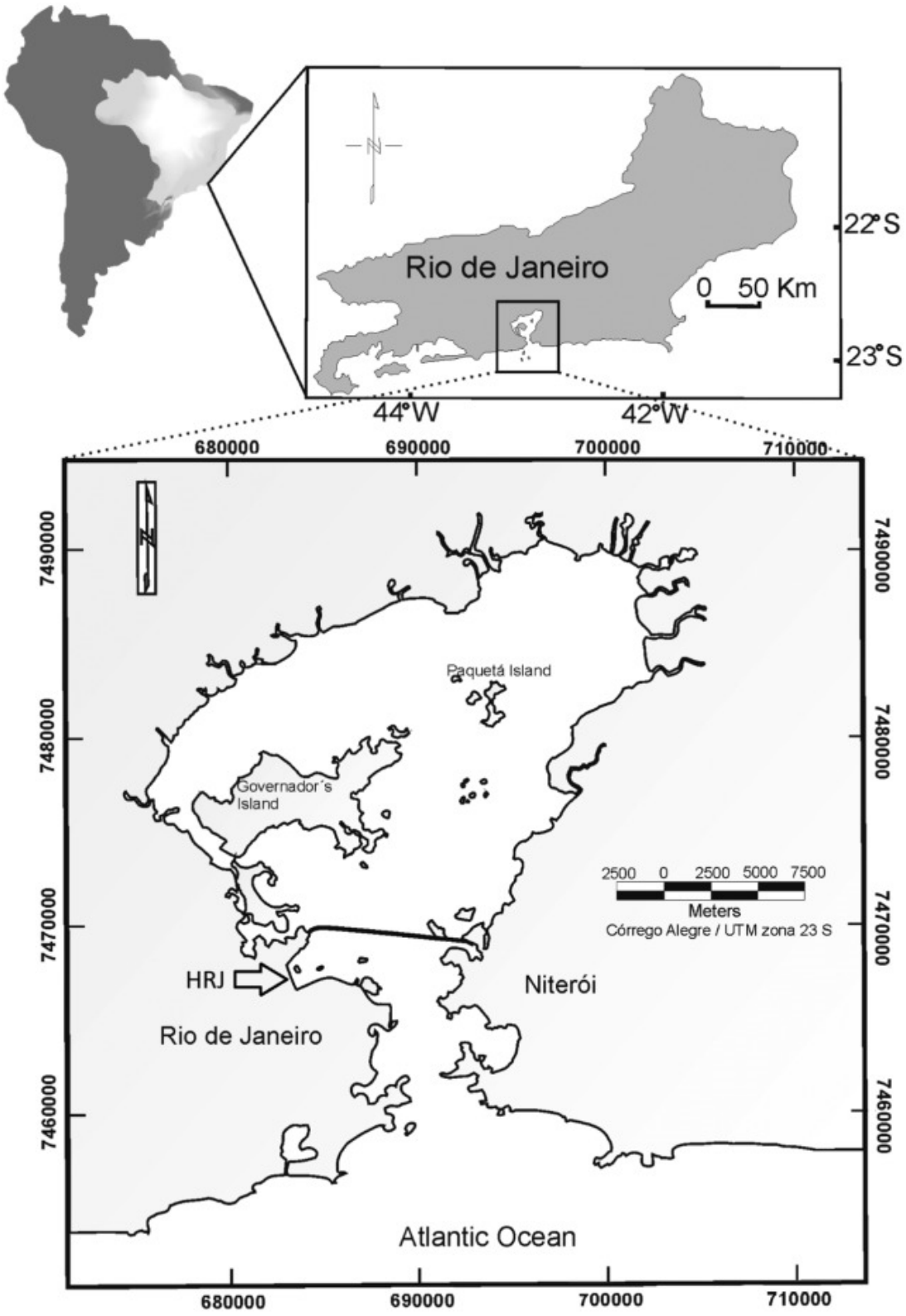

Figure 1 – Guanabara Bay location.

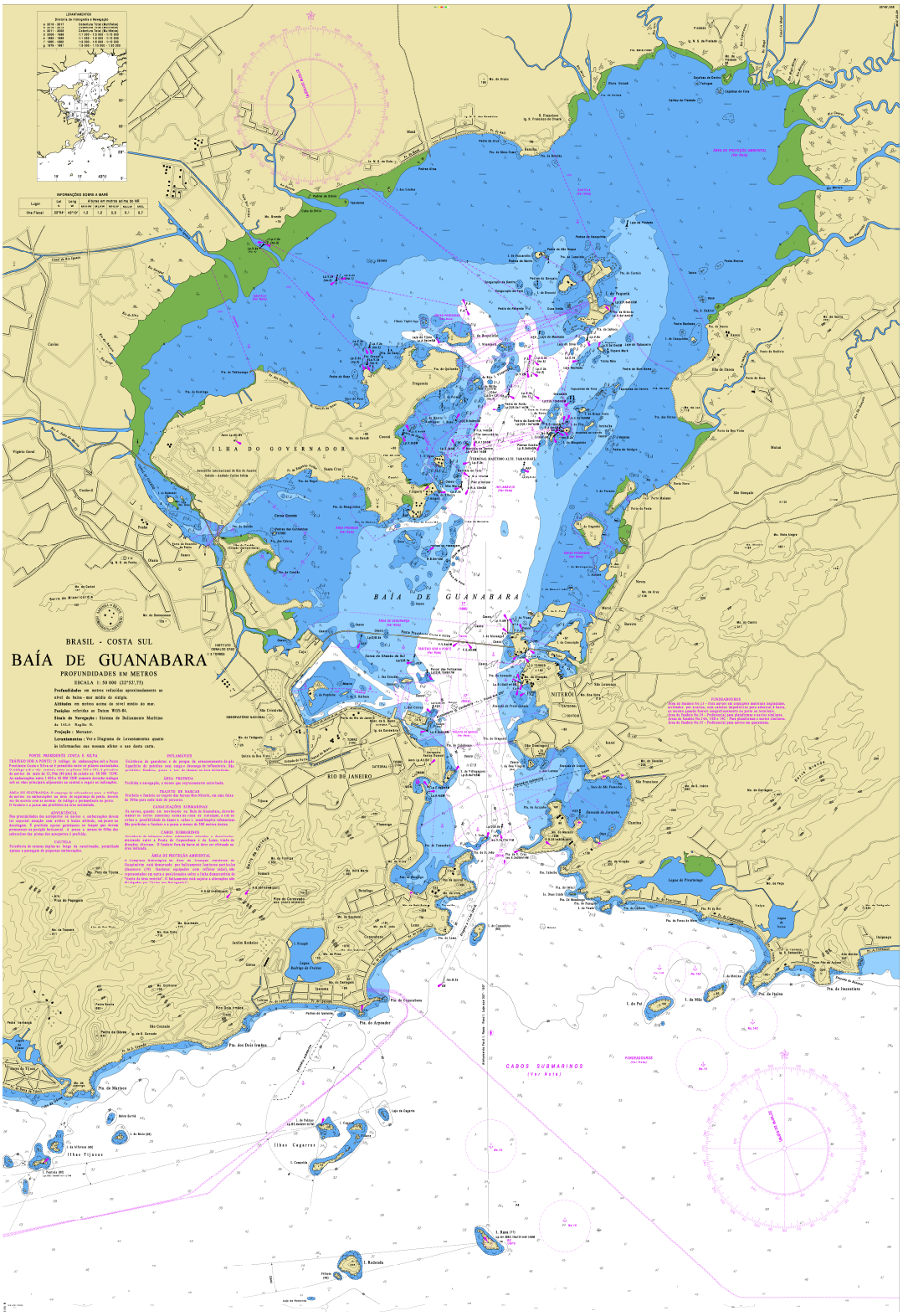

Figure 2 – Nautical chart of the Guanabara Bay (**Source**: Hydrography Center of the Brazilian Navy).

Appendix – *Mauá* Beach's selected portraits: traces of paradise






Figure 3 – Although unsuitable for bathing, *Mauá*'s beach, or *Guia de Pacobaíba*, still houses fishermen; friendly people, hopeful for a new beginning among the herons (Copyright ® 2019, Serpa and Cathcart).