WATER POLLUTION TRENDS IN GUANABARA BAY, BRAZIL

Rodolfo Paranhos, *Department of Marine Biology, UFRJ,*
✉ *prédio do CCS, Bloco A, Cidade Universitária, Rio de Janeiro, CEP 21944-970, Brasil.* 💻 *rodpar@ibccf.biof.ufrj.br*

Guanabara Bay is surrounded by the second largest metropolitan and industrialized area in Brazil. Potential uses of this water system mainly include navigation, fishing and leisure. However, disordered occupation and waste (domestic and industrial) dilution has been prevailing. Human interference has caused serious damage both in ecological and social-economical senses. Consequently, the bay is suffering from serious environmental problems, which are similar to the ones found in other densely urbanized areas in the world. In this way a recognized environmental degradation scenario is predominant. Despite this common knowledge, Guanabara Bay has several inlets and areas with different water quality standards.

Pronounced short-term variability in hydrobiological features (nutrients and phytoplankton) has been observed in Guanabara Bay: most of that variability is tidal induced. A Central Channel region is crucial for circulation patterns within the bay. Water renewal promoted by tidal cycles is associated to bathymetric profiles and thus pollution loads undergo a different degree of dilution.

Guanabara Bay is considered one of the most eutrophized among coastal ecosystems in the world, but still has an enormous living resources potential. An internationally funded clean-up project (U$$ 750 million from IRDB and OCFE) is in course aiming to recover the water quality within Guanabara Bay.

Aiming to drawn the trends of water quality, available data from different Institutions during the 1980-1990 period were used. Much of the data was obtained from Environmental State Agency (FEEMA), consisting of monthly measurements between 1980 and 1990. Complementary data was obtained from UFRJ diel sampling since 1986. Strategic sampling sites were selected, based on a pollution gradient and different circulation patterns already described. Available data were organized in chronological order of sampling, and linear regression analyses using the least-squares method of time on variables were performed. The significance of the regression coefficients was tested by ANOVA. Diel and seasonal variability of temperature, salinity and nutrients were also presented.

The population of the Rio de Janeiro metropolitan area increased 9% between 1980 and 1990, without any increment in sewage treatment. Hence the increase in organic matter input and the consequent decrease in water quality standards were expected results. The spatial patterns of salinity, turbidity, dissolved oxygen, nitrogen, phosphorus, and fecal coliforms are presented, as well as their trends between 1980 and 1990.

Rainy season lasts October-April, with high temperatures and highest salinity range due to precipitation on watershed, meaning high stratified water column. Dry season occurs May-September with low temperatures and high salinities.

Low oxygen levels, high nutrients (both phosphorus and nitrogen), chlorophyll a, and coliform levels characterize the Northwest region as the most impacted area. In contrast, the Central Channel and bay entrance regions can exhibit values as low as coastal waters, plus oxygen saturated waters. A decrease in salinity was found (average 5% within the whole bay, up to 21%, or -0.60 S $year^{-1}$ at Northwest region). Decreasing dissolved oxygen levels were found as well (average 5% within the whole bay, and up to 50% at Northwest area). Eutrophication process is exemplified by increasing Total Phosphorus (average 99% within the whole bay, and up to 177%% at Northwest area) and Total Nitrogen levels (average 31% within the whole bay). Water pollution microbial indicators, represented by fecal and total coliforms, presented an increase from 1,3 to 2,9% per year. The actual levels are around 10^3 up to 10^8 coliforms per 100 mL. A limited sampling frequency and irregularity of sampling introduced discontinuities in the data set. Therefore, the figures presented here should not be interpreted as absolute numbers, but as the best estimate possible with the available data. However they are useful to access the evolution of eutrophication within Guanabara Bay.

The trends found reflect the population increase without the respective improvement on sewage treatment. The main causes of the above mentioned trends are related to the disordered occupation on shore (landfills), destruction of slopes due to deforestation, and river rectification. The massive input of raw domestic sewage and industrial effluents must be emphasize.

Guanabara Bay has a high degree of spatial variability in physical (water depths, vertical mixing rates, suspended sediment concentration) and chemical (waste dumping, continental and marine contributions) properties that affect biological processes. Despite huge load input, Guanabara Bay has been able to regenerate the pollution introduced. Nutrients are recycled up to simple chemical forms (dissolved and inorganic) and are exported or used to increase primary production. Most nutrients are exported within the dissolved phase, and Guanabara Bay mainly exports simple phosphorus and nitrogen chemical forms.

In conclusion, the main reasons on degradation of Guanabara Bay water quality could be attributed to the increasing pollution input plus the restriction on water circulation (caused by landfills and shallowing). Monitoring programs for Guanabara Bay must be continued and should be improved, to allow more profound analysis based on uniform data set.

Despite its great socio-economical importance, this bay is relatively unstudied and the ecosystem functions are poorly understood. Our findings clearly reinforce the importance of tidal cycles on water quality variability. The short and long term trends must be certainly known and critically considered in any modeling attempt in estuarine systems such as Guanabara Bay. The results discussed here may provide a significant input in modeling its aquatic biogeochemistry. Consequently, prediction of living and exploitable resources will be more accurate, improving their management

Financial support by PRONEX-MCT, CNPq, FAPERJ, FUJB, and CEPG-UFRJ.