Project “Monazite sands of Meaipe, Guarapari, ES”

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RESUMO
As areias da praia de Meaípe (20°39'13"S, 40°30'07"W) em Guarapari (ES) são do tipo monazítica - areia com alta concentração natural de minerais pesados. Os efeitos da radiação ionizante na saúde humana têm sido estudados por muitos anos, mas ainda há muita controvérsia sobre o assunto, particularmente relacionada à taxa de baixa dose (LDR) de radiação ionizante em áreas de alta radiação natural de fundo, como encontrada na praia de Meaípe. Para mapear o deslocamento da radiação ionizante, este projeto propõe medidas da intensidade da radiação gama ao longo da areia de Meaípe, simultâneas a medidas observacionais de variáveis atmosféricas na camada limite superficial da região investigada. Além da parte observacional, também será utilizado um modelo numérico acoplado oceano-atmosfera (WRF com o módulo Noah). Dessa forma, será possível quantificar a intensidade da radiação ionizante, no tempo e no espaço, na região costeira da praia de Meaípe. Como parte do projeto será desenvolvido um simulador de radiação gama, a ser utilizado para investigação científica do efeito biológico das baixas doses de radiação associadas às areias monazíticas encontradas em Meaípe.

ABSTRACT
The sands of Meaípe beach (20°39'13"S, 40°30'07" W) in Guarapari (ES) are of the monazite type - sand with high natural concentration of heavy minerals. The effects of ionizing radiation on human health have been studied for many years, but there is still much controversy on the subject, particularly related to the low dose rate (LDR) of ionizing radiation in areas of high natural background radiation, as found at Meaípe region. To map the displacement of ionizing radiation, this project proposes measurements of the gamma radiation intensity along the Meaípe sand, along with observational measurements of atmospheric variables in the surface boundary layer of the investigated region. In addition to the observational part, a coupled model of oceanic atmosphere (WRF with Noah module) will also be used. In this way, it will be possible to quantify the intensity of the ionizing radiation, in time and space, in the coastal area of Meaípe beach. As part of the project will be developed a gamma radiation simulator, to be used for scientific investigation of the biological effect of the low radiation doses associated with the monazite sands found in Meaípe.

1. Introduction

Biological effects associated with low doses of natural radiation still generate controversies, as pointed out in the review study by [1]. There are no conclusive scientific studies on the curative or detrimental effects of this low-dose natural radiation [2, 3].

This lack of knowledge prevents the establishment of a more definitive medical protocol quantifying the effects of natural radioactivity on human health. Thus, the biological effect associated with low doses of radiation still arouses controversies in scientific circles.

Simultaneous measures of high frequency atmospheric variables (turbulent fluxes of moment, latent heat and sensible heat), of low frequency (radiation balance, wind, barometric pressure, air and surface temperature, humidity, soil heat flux and precipitation) and of local radioactivity in the surface boundary layer of the region will lead to the spatial and temporal understanding of gamma radiation variation on the Meaipe coastal region. It is also intended to use a coupled ocean-atmosphere numerical model (WRF with the Noah module) to study the local radioactivity intensity variation.

Therefore, the project contemplates three main areas interconnected by the ionizing radiation: (i) radioactivity (gamma radiation), (ii) atmosphere and ocean and (iii) health. The different areas are being coordinated by researchers of Nuclear Physics (Marcos Tadeu D'Azeredo Orlando, UFES), Physiological Sciences (Sônia Alves Gouvea, UFES) and Environmental Sciences (atmospheric sciences and physical oceanography, Jacyra Soares, USP). In addition to the area coordinators, other professors, technicians, undergraduate and graduate students from UFES and USP participate.

2. Methodology

There are disagreements regarding the threshold and linearity of the biological effects of low doses of radiation. Some scientists defend the idea that the risk of cancer or increased frequency of cancer incidence occurs linearly, without dose threshold, even at low doses [4]. It is called linear no threshold (LNT) model. Other experts, on the other hand, defends the hypothesis that low doses of ionizing radiation may be beneficial (hormesis), stimulating the activation of repair mechanisms that protect against diseases that would not be activated in the absence of ionizing radiation [3, 5].

The nuclear physics team has continuously measured the dose rate of gamma radiation along the Meaípe beach since 2017 (Fig 1a). It is interesting to note that the intensity of the radiation changes in time and space, reaching values greater than 20 μSv h^{-1}. Mean values along the beach during 2017 are shown in Figure 1b.

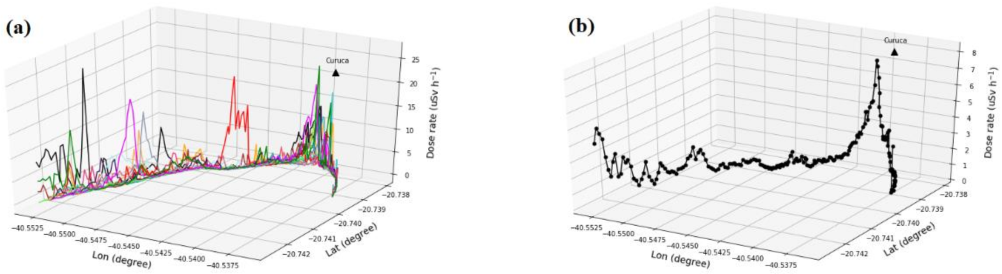

Figure 1: Dose rate of gamma radiation along the beach of Meaípe (μSv h^{-1}). Values observed from March to November 2017 every two weeks. (a) The colors indicate the different days of observation and (b) time average values.

Simultaneously with measurements of radioactivity are being carried out continuously measurements of air temperature, air humidity, wind and direction of the wind, soil temperature, soil heat flux, short and long wave radiations, high frequency measurements of air temperature, intensity and direction wind, water vapor and CO2 (Fig. 02). The idea is to relate the spatial and temporal variation of gamma radiation with the atmospheric properties.

Figure 2: Instrumented tower.

Using sand obtained on the beach of Meaipe, in a place with an extreme dose rate of gamma radiation of about 20 μSv h^{-1}, was constructed a physical simulator of gamma radiation (PS). The PS can be used as an accurate tool for in vivo research that seeks to understand the biological effects of low doses of natural continuous doses of gamma radiation on different biological systems.

An example of PS is shown in Figure 3, where different groups of wistar rats were exposed at an average radiation intensity of 20 μSv h^{-1} (or about 175 mSv y^{-1}) on the lower shelf. On the upper shelf, the animals are exposed to an intensity value around 3.6 μSv h^{-1} (~ 32 mSv y^{-1}). This study is still in progress and soon its results will be published in a scientific journal of the area.

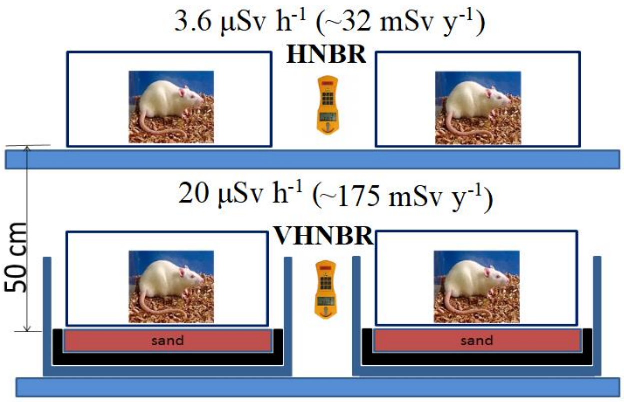

Figure 3: Schematic configuration of the physical simulator (PS) of gamma radiation.

Therefore, the PS environment may be monitored even keeping the characteristics of an open environment. This feature allows a closer study of the actual condition observed at Meaipe Beach.

3. Discussion

It is expected that the results of this scientific research allow the understanding of the temporal and spatial variation of the ionizing radiation present in Meaípe. It will provide a basis for future studies on the biological effect of low doses of radiation associated with monazite sands (from thorium). In view of the multidisciplinary nature of the project's research activities, it is intended to establish an experimental base in Meaípe, which will bring benefits not only to this project, but also to other research projects in the region. The linking of this observational base to the different educational institutions will give the project an ideal educational profile for the transfer of accumulated knowledge and the training of operational technical personnel in an area where there is a great shortage of researchers and specialized technical personnel.

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