ENVIRONMENTAL GAMMA SURVEY: METHODOLOGIES AND PATTERNS

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ABSTRACT

The objective of this work is to establish a methodology for gamma survey in order to have a radiation background map of Brazilian territory. This map will be used to estimate public exposure and to have a database for impact assessment from environmental releases of radionuclides and also for accident emergencies, in support for decision-making processes. The measurements are being performed using an AT6101C Scanner [1]. Different sites were chosen to gather information in order to develop a proper methodology. Results from water surveys have shown that similar results are obtained for different types of large water bodies (saline and freshwater). Measurements over land were performed by *manborne* and *carborne*. It was seen that vary mainly according to soil composition, particularly the composition of U and Th of soil or paving materials. Dose rates over land are higher than those over water, due to the natural radioactivity on soil, pavements and other building materials. It could be observed that the dose rate values on beaches are smaller than more inland locations, white sand shows lower dose rates than soil or landfill areas; the highest values could be observed over granite stone pavements. Public exposure due to external radiation will be assessed and mapped, in order to estimate average and ranges of public exposure.
Key Words: gamma survey, measurement methodology, external exposure.

1. INTRODUCTION

The determination of ambient dose rate which the population is exposed is the main objective of any environmental monitoring programs. The sources of radiation which contribute to this rate are of natural origin (cosmic radiation, radionuclides of the U and Th series, Radon and Thoron and K-40) and artificial (fall-out of nuclear explosions in the earth crust, Chernobyl accident, release of radioisotopes in nuclear facilities, use of radioactive sources in industries and in nuclear medicine – radiopharmaceuticals). Another source, which may be growing in recent years, is TENORM also contributes to the increase in dose in occupationally exposed workers.

2. MEASUREMENTS

The measurements made with the scanner AT6101C [1] were held in different parts of the Brazilian country, both in exercises and simulated emergency, and measures taken to evaluate the fields of environmental radioactivity range [2]. Freshwater areas and marine beach with presence of monazite sands, weathered acid soils and urban environments where the use of building material and paving roads and highways were measured during this work to providing dose values for the composition of a database range of natural and modified

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environmental radioactivity by socioeconomic activities. The AT6101C scanner can be transported on foot, by air, land or by boat. In previous work done during the survey of areas in Itaguai Bay, a small trawler was used and the dose rate was higher than similar results obtained during a campaign in Amazon River with the aid of speedboat.

3. RESULTS

3.1 Measurements over beach sands

The sand is composed mainly of quartz, but depending on the composition of the rock from which it originated, could add other minerals such as feldspar, mica, zircon, magnetite, ilmenite, monazite, cassiterite, among others. The presence of monazite increases significantly the radioactivity of natural sand. Isotopes of uranium and thorium were found in the sands of Praia Brava near the NPP at Angra dos Reis. The presence of these isotopes produces dose rate as high as 262 nSv/h for this type of material (Figure 1), while the sands of the Surfers Beach in Fortaleza show typical values, in the order 30-50 nSv/h (Figure 2). Moving away from the waterline toward the shore or due the presence of rocks, the value of dose rate increases, reflecting the chemical changing of the environment: from light elements of the water to heavier in soil as can be seen on left and right corner of Figure 1, Figure 2 , and also in Figure 3 .

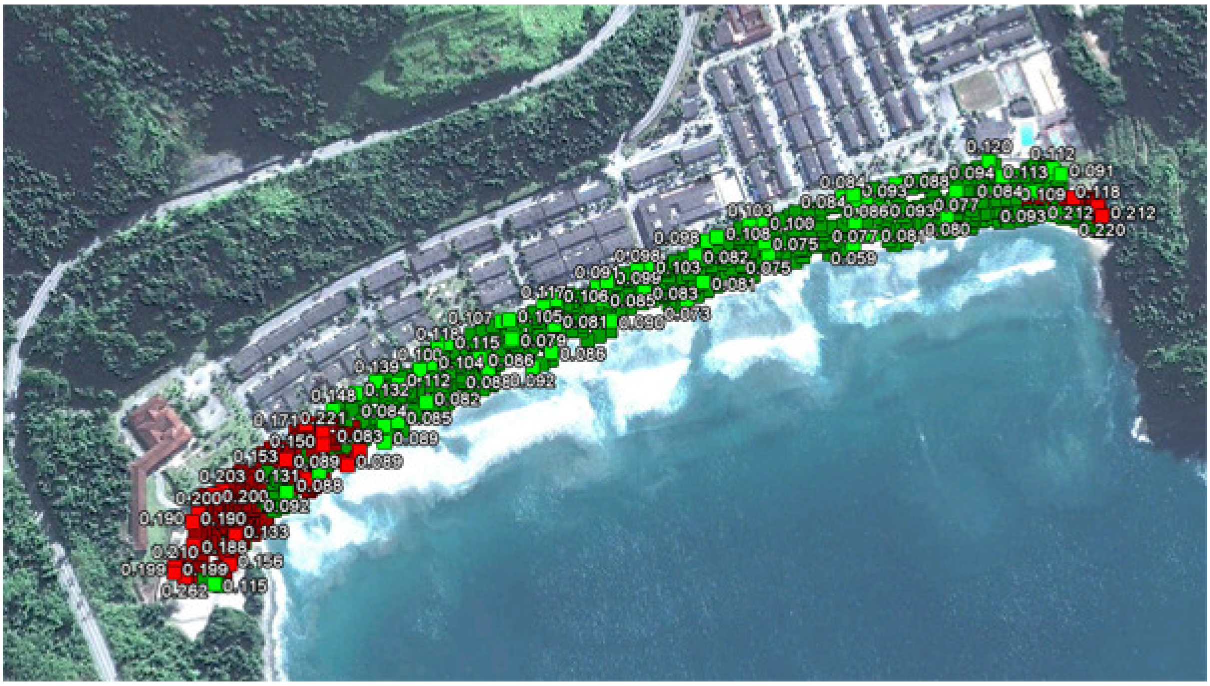

Figure 1. General overview of Praia Brava (Brava Beach) near Angra NPP, Rio de Janeiro (square marks shows dose rate- unit is µSv/h).

There is a direct agreement between the high dose rates (as show by the red dots) and the presence of rocks from the hills and the presence of monazite in the sands. On figure 2 below is showed a zoom, with the identification data provided by the Atas Scanner AT6101C (isotope identification, time and date and name of the data file).

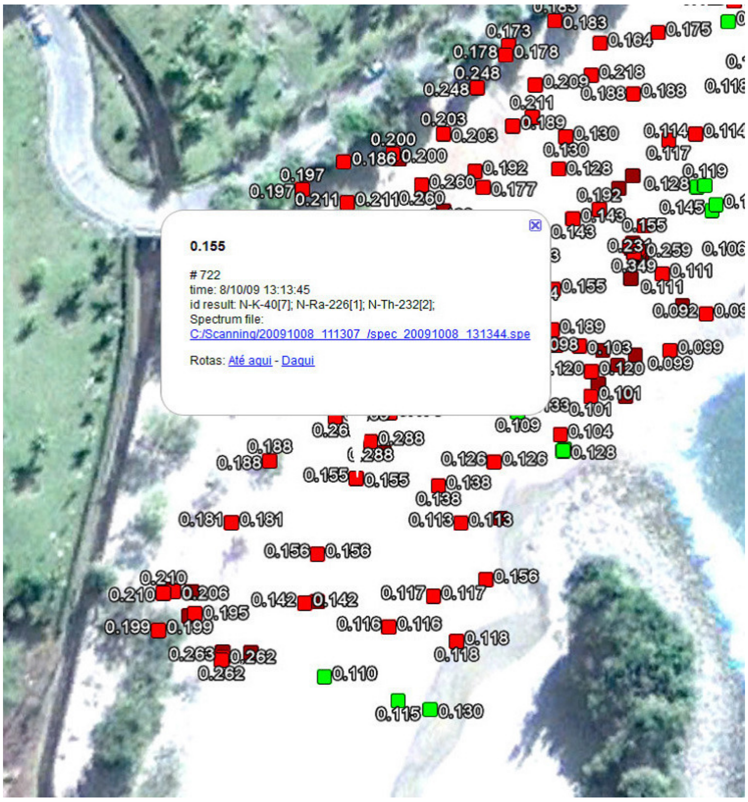

Figure 2. High level zoom at the corner of Praia Brava (Brava Beach) near Angra NPP, Rio de Janeiro (square marks shows dose rate -unit is µSv/h).

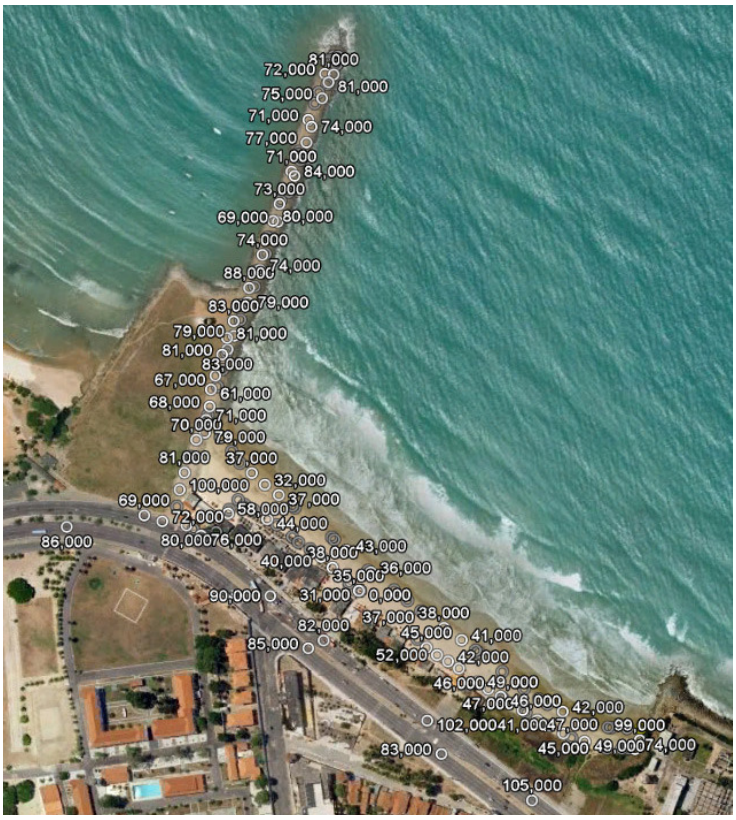

Figure 3. Praia dos Surfistas (Surfer's Beach) in Fortaleza-CE, were the results near the shore and pier are greater than the results over the sands (dose rate units in nSv/h).

3.2 Measurements over water

If the water column has sufficient height, at least 3 meters and if the distance of rocky bodies is far enough, water acts as shielding to the gamma radiation detector and the dose rate measured reflects mainly the cosmic radiation. Measure taken in the whole body counter of the IRD, show the intrinsic radiation AT6101C system is about 5-8 nSv/h, higher than the same value measured by Conti [3], Sachett [4] for the system GR820/GR320 and Souza [5,6] for the system GR135.

The values over Itaguai Bay are in the range of 16 - 19 nSv/h and close to Martin Island the dose changes to 20 to 27 nSv/h , that show the effect of land. The dose rate over Itaguai Bay is higher than Amazon River and this fact can be credited to the vicinity of the shore and the Island. It can also be observed in the center of the island that was identified points with higher values, quite distinct from the normal composition of the island, due to the use of building materials from the continent (granite and decorative stones) as shown in **Figure4.**

Figure 4. Survey over Itaguai Bay and Martin Island. The external perimeter was done by trawler, near the shore. In the middle of the island the Atas Scanner was used as *manborne* system. The high values are due decorative stones in fences and houses.

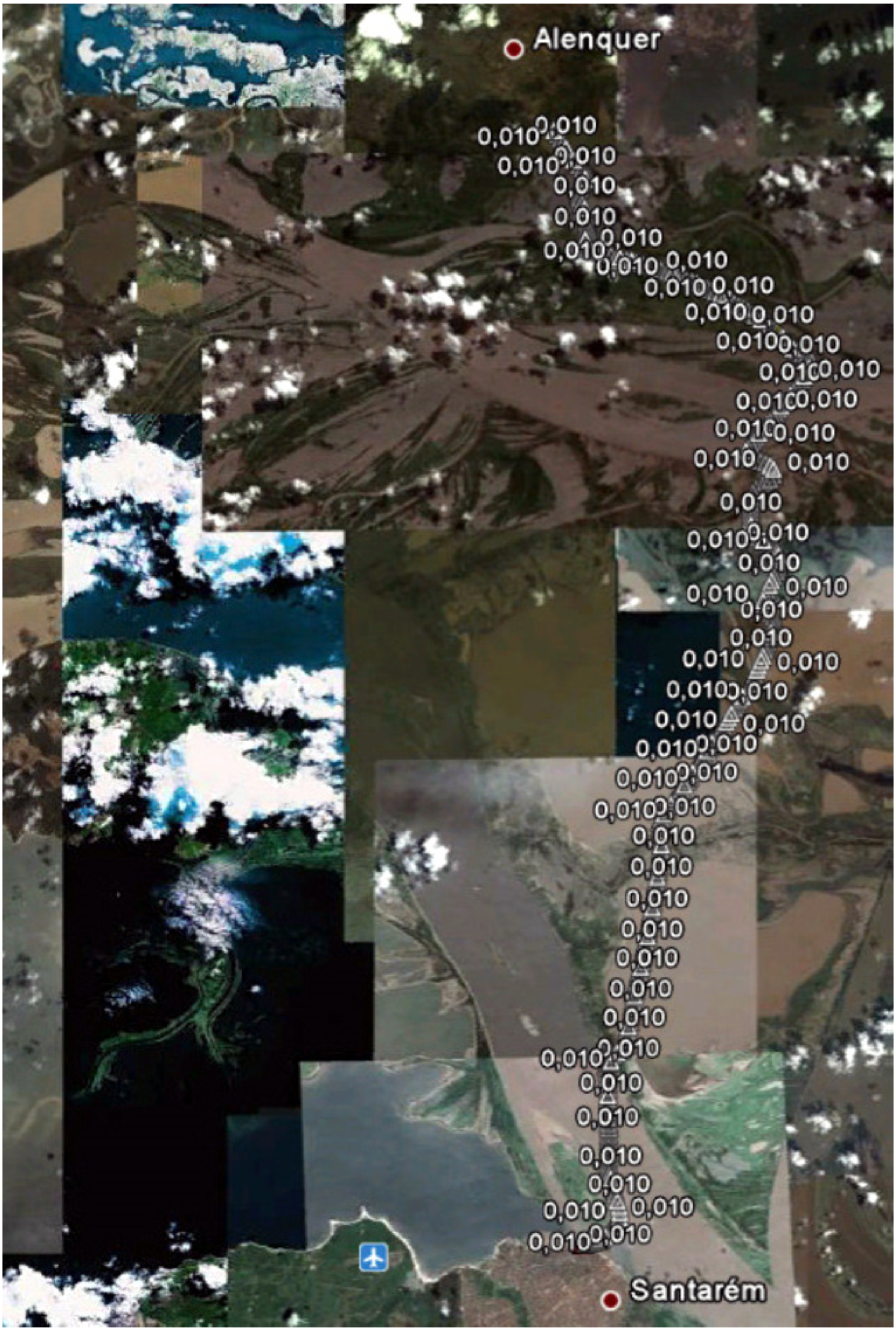

Figure 5. Survey over Amazon river, from Santarém to Alenquer PA, using a speedboat. The average dose rate is 10 nSv/h. This survey is 200 km longer. The values are smaller than the previous measurements done near Itaguai bay – Rio de Janeiro.

3.3 Measurements over land: urban areas

In urban areas the dose rate depends on the type of material, concrete, asphalt, bare earth, vegetation, presence or absence of artificial radioisotopes, whether by accident, use of radiopharmaceuticals, discharge, fall-out or release into the environment. The results obtained in an urban area should be analyzed in conjunction with several other factors, because the presence of different building materials may change the dose rate of a particular place, either by increasing the value after the addition of material with higher content of radioactive material rate or decreasing due to a shielding material. Concrete over sand, asphalt on granite paved streets substantially alter the pattern of radioactivity from the site. On Figure 6 can be seen that the biggest values are close to the land and the tunnels. The spectrometer is sensitive enough to detect the presence of radiopharmaceuticals like Tc-99m in urban area, even in the presence of NORM as shown in Figure 7. The values of dose rate usually obtained in urban areas vary in the range 70-200 nSv/h, but the presence of NORM can substantially alter the pattern.

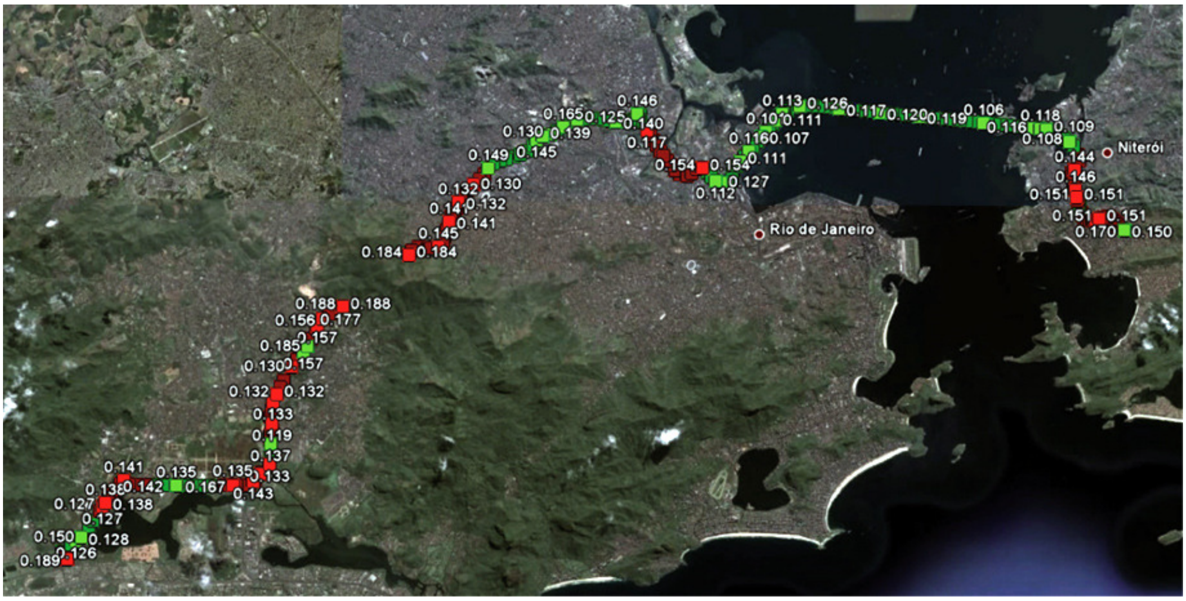

Figure 6. The terrestrial survey from Niterói-Rio de Janeiro till the IRD campus at Recreio dos Bandeirantes shows the mainly patterns found in urban areas: bridge over water, concrete and asphalt. Note the smaller values are over the water even in the presence of high amounts of concrete.

Figure 7. Identification of the presence Tc-99 from a Medical facility at Goiânia-Brazil. The stamp shows time, date and file identification of the spectra.

3. CONCLUSIONS

The survey areas submitted to radiometric scan must be well characterized because even in visually identical compartments as sand beaches of the chemical composition of the sand may have doses rates ranging from 30-35 nSv to 300 nSv/h (in the presence of monazite sands); the values for water bodies vary from 10 to 20 nSv/h and for land measurements we can find values as low as 30 -40 nSv/h in lateritic soils from Brazilian Midwest to 200 nSv/h in granitic pavements or mountains. If the objective is the determination of rates and fees environmental doses due to accidents all standards of soil must be analyzed together with the radiometric survey, which is facilitated by the rapid development of computer systems and geographic information systems **GIS**. This spectrometric system has enough sensitivity and sensibility to detect radiopharmaceuticals in urban environment. From nuclear or radiological accidents to security purposes the same methodology applies: first it is necessary measure the background and after look to dose rate or presence of radionuclides. If the background measurement could not be performed it can be used a similar environment. The presence of NORM, big mountains, tunnels and bridges as any surface of concrete increase the dose.

4. REFERENCES

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