EVALUATION OF RADIATION LEVELS IN NAIROBI'S METROPOLITAN AND THE INDUSTRIAL AREAS

B. W. Chege, E. G. Gatebe and C. Mundia
Department of Chemistry, Jomo Kenyatta University of Agriculture and Technology, Nairobi, Kenya

Abstract
Radiation is energy travelling through space. In Kenya, no data exist on radiation levels at various workplaces. Radiation sources are found in a wide range of occupational settings. Uncontrolled levels of radiation within permissible levels can be potentially hazardous especially to the health of the workers. Occupational health and safety is increasingly gaining attention due to advancing technological developments in the world. This may lead to increased exposures to high levels of radiations emanating from these new technologically enhanced instruments and facilities. The objective of this study is to evaluate the variation of radiation levels in the Nairobi Central Business District (CBD) and the Industrial Areas and the possible sources of these radiations. Portable radiometer devices were used to determine the levels of radiation. The collected data was stored for analysis directly on the field by connecting the radiometer devices to an ipad. Soil samples were collected from areas where high levels of radiation were recorded. Soil analysis was carried out qualitatively and quantitatively using gamma spectrometry so as to determine the presence of naturally occurring radioactive materials. Highest dose rates were found in the Industrial Area and Njiru mining site which ranged from 0.999-1.603 mSv/yr. Lowest dose rates were in Mavoko (0.333-1.042 mSv/yr). In most of the places the radiation levels varied between 0.622-1.2439 mSv/yr. From the soil samples the external and internal hazard indexes were 1.241 and 1.501 respectively for Mwiki and 1.739 and 2.170 for the Industrial Area. These values were higher than the standard value (≤1). Radiation dose rates were found to be higher than the permissible exposure limits (1mSv/yr).

Key words: Spatial radiations, pocket radiometer, radiation dose rates, norms

1.0 Introduction

Radiation is energy given off by matter in the form of rays or high-speed particles (Radiation Protection and NRC, 2006). The space environment contains two major biologically significant influences; space radiations and microgravity (Takahashi *et al.,* 2010). In the recent years the level of radiations in the environment has been found to be rapidly increasing due to increasing Technology. Knowledge of cancer risks in humans has advanced tremendously in the last half century. Much of this knowledge has come from studies of bomb survivors in Hiroshima and Nagasaki, who have now been followed for more than 50 years. Leukaemia was the first type of cancer found to be in excess among the Japanese survivors of the atomic bombings of Hiroshima and Nagasaki in 1945 (Wakeford *et al.,* 2009). In addition, there is now a wealth of data from studies of people who have been exposed for medical, occupational or environmental reasons (Gilbert, 2009).

Many studies have included extensive efforts to estimate doses for individual subjects making it possible to quantify risk as a function of dose, to evaluate how age at exposure and gender might modify the dose-response relationship, to examine how the risk changes as subjects are followed over time, and to investigate interactions of radiation and other exposures. Epidemiologic studies thus provide information that is needed for risk assessment and setting radiation protection standards, and also increase our understanding of the carcinogenic process (Gilbert, 2009).

There are two main types of radiation which are commonly differentiated from each other in the way that they interact with normal chemical matter. These are non-ionizing and ionizing radiation. Non-ionizing radiation (NIR) is Radiation with energy levels below that required for effects at the atomic level (Zamanian and Hardiman, 2005). UV exposure depends on environmental as well as individual factors related to activity. Sources of UV radiation are the sun, arc welding, oxy-gas welding, sun lamps, lasers (UV), sterilization (germicidal) lamps, low pressure gas discharge lamps, high pressure discharge lamps. IR radiation comes from hot processes such as steelmaking, glassmaking, welding, and also lasers (IR). The application of laser as a coherent light source is increasing rapidly. Medical applications include UV and neonatal phototherapy, surgical and therapy lasers, physiotherapy heat lamps .

Ionizing radiation contains sufficient electromagnetic energy to strip atoms and molecules from the tissue and alter chemical reactions in the body (Zamanian and Hardiman, 2005). Ionizing radiation falls into two broad groups; particulate radiations such as high energy electrons, neutrons, protons or alpha particles that ionize matter by direct atomic collisions and electromagnetic radiations or photons such as X-rays or gamma rays which ionize matter by other types of atomic interactions (Busby and Fucic, 2006). Each ionization releases approximately 33 electron volts (eV) of energy which is absorbed by the materials surrounding the atom. This energy is more than enough to disrupt the chemical bond between two carbon atoms. Ionizing radiation deposits a large amount of energy into a small area compared to other types of radiation.

2.0 Materials and Methods

2.1 Study Area

The levels of radiation were measured in Nairobi's CBD and the Industrial Area. The study was carried out along the highways, near tall buildings (e.g., Afya Centre, KICC, etc), mining areas or quarries as well as in and near industries (e.g., Kenya pipeline, Athi River Mining etc).

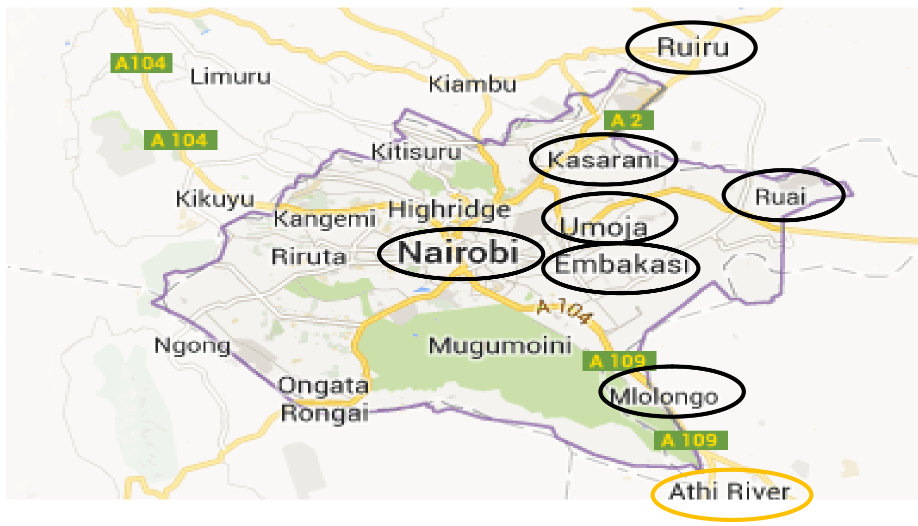

Figure 1: Map of Nairobi CBD and the industrial area

The level of radiations were determined in approximately one hundred spots with a spacing of about two hundred meters from one point to the other.

2.2 Sampling Strategy

Portable pocket radiometer comprising of an android pad and a radiation detector using GPS were used to measure the radiation levels in various places within the study area. The radiometer was connected to a laptop for recording and storage of the transmitted data. (The equipments were set up as shown in Figure 2 below). Mapping of the sampled area was achieved by using a GPS enabled Ideo Pad. Latitude, longitude and altitude of the various points were also recorded.

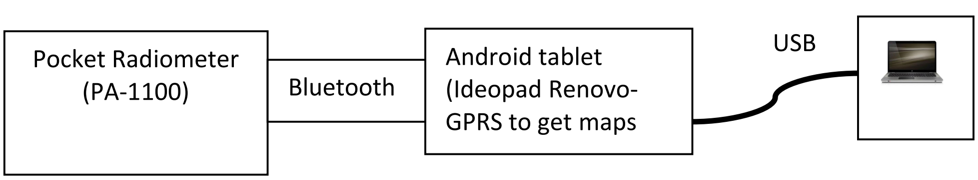

Figure 2: Layout of the instruments that will be used during the study.

2.3 Gamma Ray Spectrometric Analysis

Soil samples were collected and packed in polythene bags at places where high radiation readings were recorded. After collection, the soil samples were separately crushed into powder form and sieved through a 0.6 mm mesh sieve. The soil samples were dried in an oven at 80°C for 24 h, completely removing water from the samples. A mass of 200 g of each sample was packed in special gas tight polyethylene plastic containers then closed and tightly sealed using cello tape. The containers were labeled appropriately and then kept for 30 days so as to attain radioactive equilibrium. The samples were then analysed using gamma spectrometric method for the identification and quantification of the NORMS. Both the measured and calculated dose rates were recorded and compared with the recommended radiation levels internationally.

3.0 Results

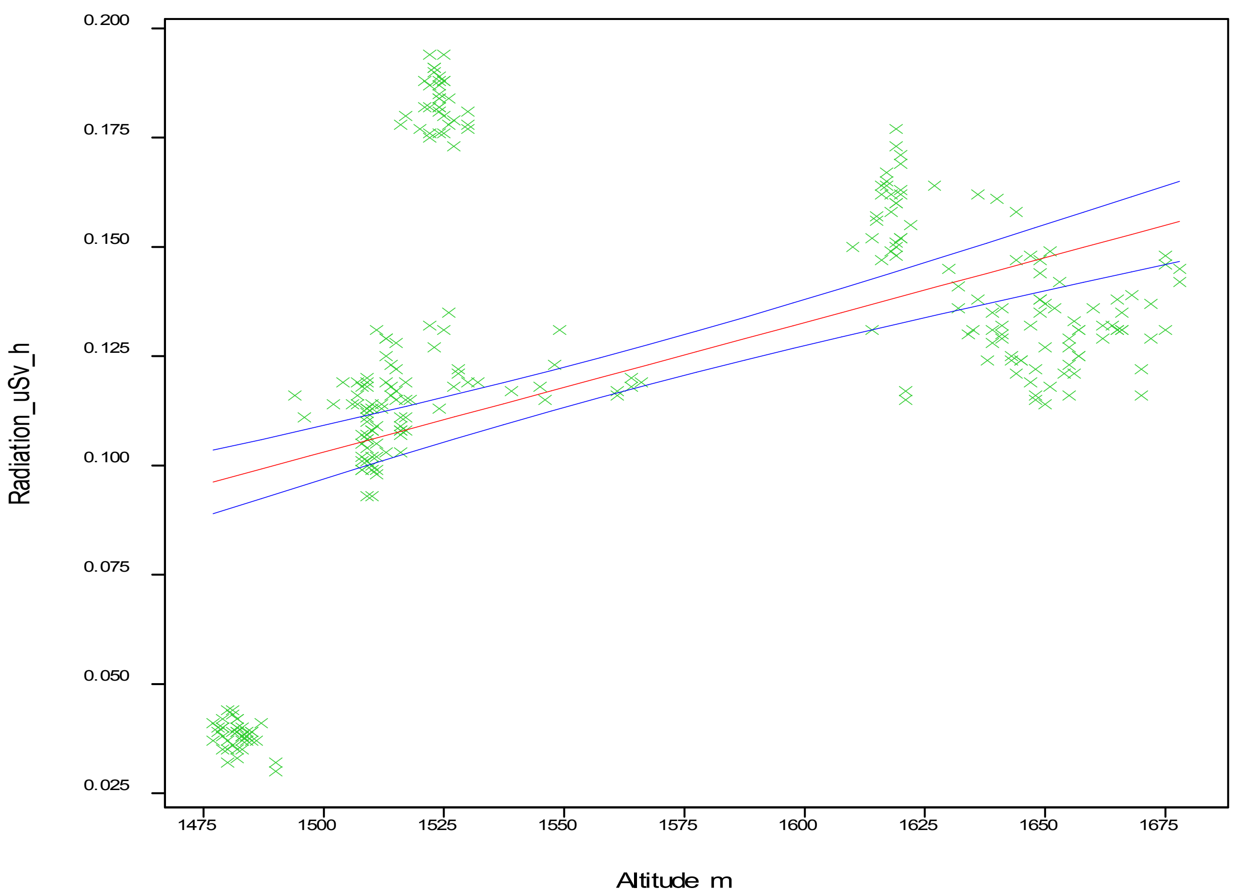

Figure 1: Radiation as a function of altitude

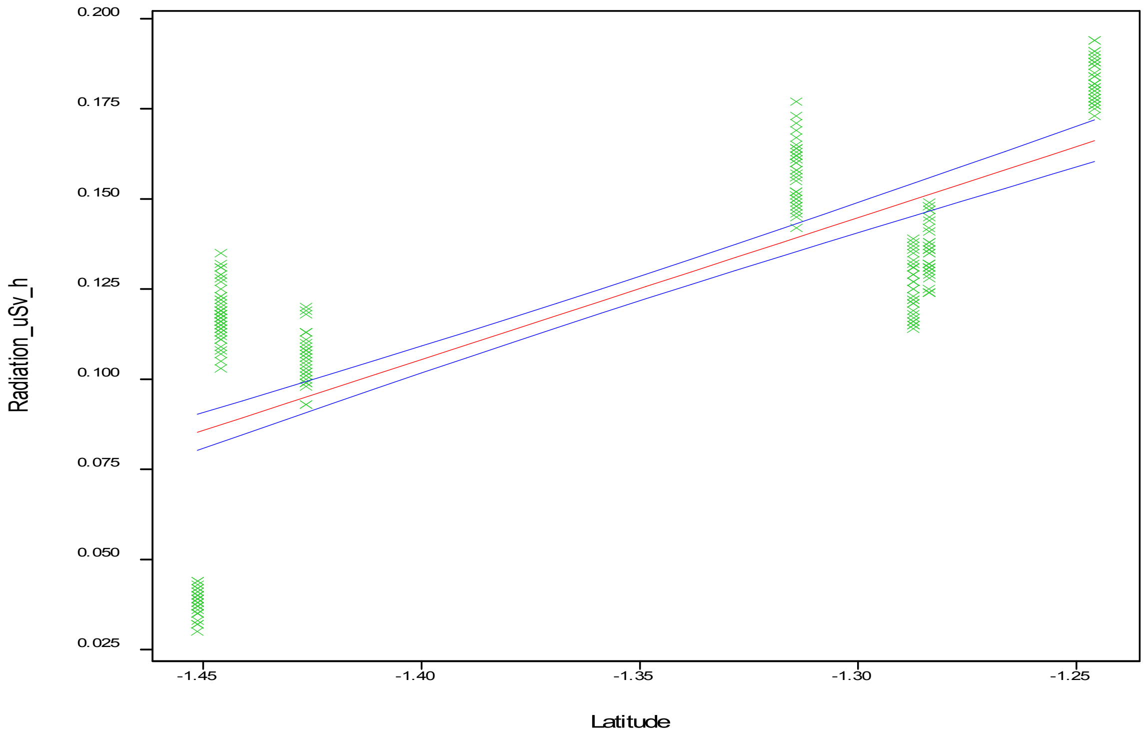

Figure 2: Radiation as a function of latitude

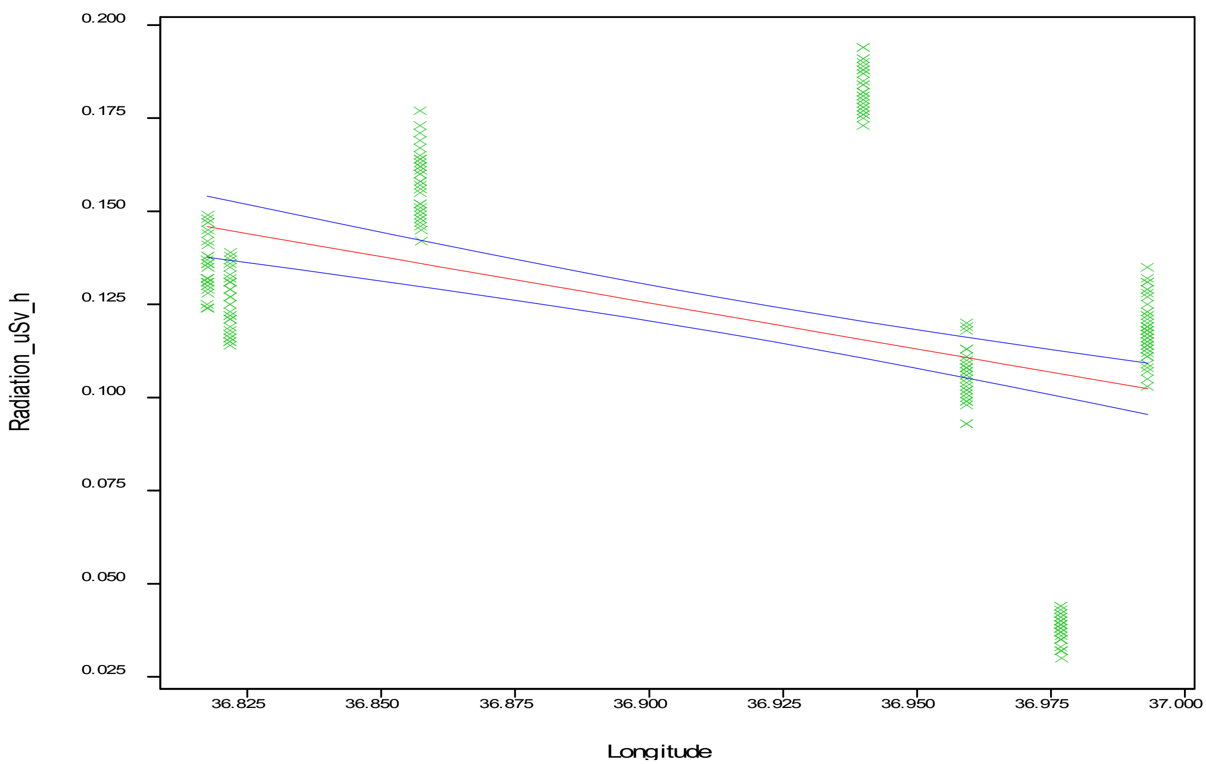

Figure 3: Radiation as a function of longitude

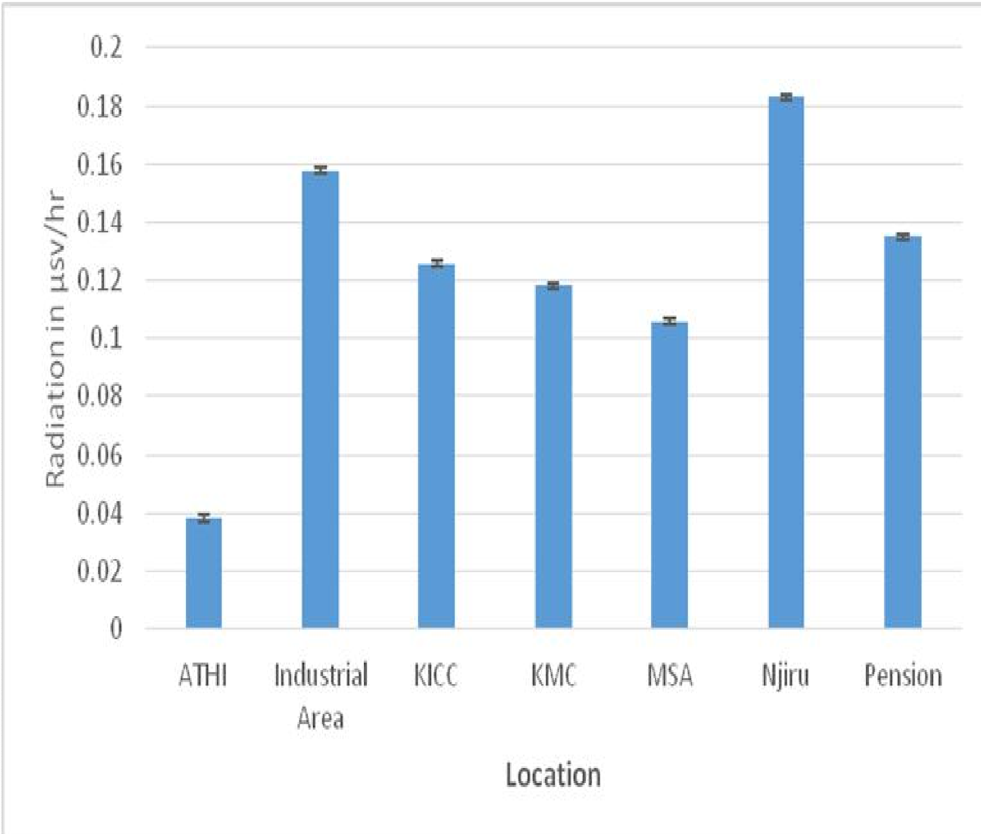

Figure 4: Comparison of the radiation levels at various places

4.0 Discussion of Results

The radiation levels were measured in one hundred points with a spacing of about 100 m from one point to the other using the handheld meter. At every point the radiation dose rates were recorded for atleast five minutes. The highest radiation dose rates were recorded at Njiru (0.999-1.603 mSv/yr). The high radiation levels recorded at Njiru could be associated with the mining activity that is ongoing in the area. Soil samples were analyzed in duplicates and the mean values of concentrations calculated. The internal and external hazards for njiru were 1.241 and 1.501 respectively. The dose rates indicated that the radiations from the ground originated from natural radioisotopes of Uranium and Thorium series in soils (NORMS). The radiation dose rates also increased with altitude due to cosmic rays. The location (longitude and latitude) also contributed to the increased dose rates.

5.0 Conclusion

The focus of this study was to evaluate the radiation levels in Nairobi's central business district and the industrial area i.e the space distribution of the dose rates. The profile of dose rates as a function of altitude. The radiation dose rates were found to be higher than the recommended values 1mSv/yr. The internal and external index values also exceeded the recommended value (≤1).

Recommendations

Further studies should be carried out on the radiation levels countrywide at the various workplaces. The Government should ensure that the regulations on the radiation levels at various workplaces are observed hence reducing the risk of exposure.

References

Busby, C., and Fucic, A. (2006). Ionizing radiation and children's health : Conclusions. Ionizing radiation and children's health, **95**(453 supp), PP 81–85.

Gilbert, E. S. (2009). Ionising radiation and cancer risks: what have we learned from epidemiology? *International journal of radiation biology*, **85**(6), 467–82.

Radiation Protection and NRC (2006). U .S. Nuclear Regulatory commission.

Takahashi, A., Suzuki, H., Omori, K., Seki, M., Hashizume, T., Shimazu, T., and Ohnishi, T. (2010). The expression of p53-regulated genes in human cultured lymphoblastoid TSCE5 and WTK1 cell lines during spaceflight. *International journal of radiation biology*, **86**(8), 669–81.

Wakeford, R., Kendall, G. M. and Little, M.P. (2009). The proportion of childhood leukaemia incidence in Great Britain that may be caused by natural background ionizing radiation, Macmillan Publishers Limited, **23**: PP 770–776.

Zamanian, B. A. and Hardiman, C. (2005b). And Human Health : A Review of Sources and Effects, (July).