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NATURAL GAMMA RADIOACTIVITY IN THE VILLAGES OF KANYAKUMARI DISTRICT, TAMIL NADU, INDIA

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In situ **radiometric survey carried out in 81 revenue villages of Kanyakumari District, Tamil Nadu, India, using a portable radiation dosemeter/detector, revealed the existence of radiation hotspots along the coastal belt. A close observation of the coastal villages specifically revealed high background radioactivity in 14 coastal villages. A very high intrinsic anomalous radioactivity of 41.03 μSv h^{-1} was observed, in a famous tourist spot in the coastal belt of Kanyakumari District. This is the highest level of radiation registered in South India, which is extremely higher than the permissible world average and is suggestive of causing severe clinical problems on continuous and prolonged exposure.**

INTRODUCTION

Studies on high background radiation areas in the world have been of prime importance for risk estimation due to the problems associated with long-term whole-body irradiation. As radionuclides are not uniformly distributed, the knowledge of their distribution in air, soil and rock plays an important role in radiation protection and measurement[1]. Human beings are exposed to the natural terrestrial radiation that originates predominantly from the upper 30 cm of the soil[2]. The concentration of these radionuclides in the soil is determined by the radioactivity of rock and the process of the formation of soils[3,4]. Therefore, radionuclides in soil generate a significant component of the background radiation exposure to the population[5]. Terrestrial gamma radiation dose rate is also an important contribution to the average dose rate received by the world's population[6,7]. The estimation of radiation dose distribution is important in assessing the health risk to a population and also serves as the reference in documenting changes to environmental radioactivity due to anthropogenic activities[8]. Radionuclides present in sand tailings near oceans are washed into the ocean and become a part of the marine ecosystem, including the flora and fauna[9]. The incorporation of such radioactive substances in the marine coastal environment also poses serious threat to the health and safety of biotic life, food chain and finally human beings. To solve these problems, measurement of radioactivity concentration in the environment and assessment of the radiological impacts of these radionuclides and gamma rays on human health is essential, particularly in areas where industrial activities take place near human settlements.

MATERIALS AND METHODS

Area under study

The area chosen for this radiometric survey was Kanyakumari District, with latitude 8°03′ and 8°35′E and longitude 77°15′ and 77° 36′N . This district which is the southern most region of the state of Tamil Nadu is the smallest district in the state, with a land spread of 1684 km^2. The district has 62 km of coast on the western side (Arabian Sea coast) and 6 km of coast on the eastern side (Gulf of Mannar/Bay of Bengal coast). The district is divided into two revenue divisions that consist of four taluks—Agasteeswaram, Kalkulam, Thovalai and Vilavancode, which are further divided into 81 revenue villages that include 2456 hamlets.

Methodology

Natural background radiation levels were measured in the 81 revenue villages of Kanyakumari District, Tamil Nadu, India, using a portable radiation dosemeter cum detector—GAMMA SCOUT, a device used by researchers all over the world[10–12]. Measurements were done by holding the instrument 1 m above the ground, and radiation levels were measured close to the soil by keeping the instrument adjacent to the ground. The primary radiometric survey was conducted in the four taluks of Kanyakumari District. The measurements were performed in micro sievert per hour (μSv h^{-1}).

Following this, an extended study was conducted along the coastal belt of Kanyakumari District. Radiation levels were marked in various pockets of the coastal regions showing high background

radiation. Geotagged photos focusing the dial of the radiation dosemeter/detector were clicked to substantiate the exact latitude and longitude of the hamlets under study. These photos, whenever needed, could be uploaded and tracked on Google Earth for substantiating the genuinity of the evidence and proving the existence of the mentioned level of gamma radiation in that particular region.

RESULTS

Natural background radiation in the 81 revenue villages of Kanyakumari District

In situ radiation survey conducted in Kanyakumari District showed natural background radiation varying from 0.12 to 3.78 μSv h^{-1}. In Agasteeswaram Taluk which consists of 17 revenue villages, natural background radiation was normal except in Kanyakumari revenue village, which was 1.8 μSv h^{-1}. In Kalkulam Taluk consisting of 25 revenue villages, the coastal villages namely Kadiapattinam, Manavalakurichi and Colachel showed high radiation levels. Kadiapattinam measured high radiation levels of 3.78 μSv h^{-1}, where human habitation was found to be high. Manavalakurichi revenue village exhibited high background radiation levels of $\sim$3.24 μSv h^{-1} even in the residential areas. Colachel measured a background radiation of 1.50 μSv h^{-1}. In Vilavancode Taluk which consists of 21 revenue villages, background radiation doses were found to be normal except in Midalam, Keezhmidalam and Painkulam, where it was found to be $>$1 μSv h^{-1}. In Thovalai Taluk which consists of 13 revenue villages, the highest background radiation level measured was 0.21 μSv h^{-1}. A summary of the radiometric measurements of the 81 revenue villages coming under the four taluks of Kanyakumari District is shown in Figure 1.

Natural background radiation in the coastal villages

In situ radiometric survey conducted in the coastal villages revealed that 14 of the 32 coastal villages studied showed high background radiation levels (Figures 2 and 3). Of these, Arockyapuram (3.24 μSv h^{-1}), Kovalam beach (3.55 μSv h^{-1}), Shanguthurai beach near Pallam (2.13 μSv h^{-1}), Muttom beach (1.50 μSv h^{-1}), Kadiapattinam beach (3.78 μSv h^{-1}), Manavalakurichi (3.24 μSv h^{-1}), Colachel (1.50 μSv h^{-1}), Kodimunai (1.50 μSv h^{-1}), Midalam (1.31 μSv h^{-1}) and Enayam (1. 20 μSv h^{-1}) were seen to emit high background radiations. Mandaikadu, Kottilpadu, Vaniyakudy and Kurumpanai also experienced radiation levels of $>$0.96 μSv h^{-1}.

Radiation pockets in the coastal beaches

In certain pockets in the coastal beaches of the district, radiation levels measured adjacent to the soil (within 15 cm from the ground) were found to be very high in Arockyapuram, Leepuram (a minor fishing harbor), Sunset Point in Kovalam (a famous tourist beach), Shanguthurai beach near Pallam, Muttom (a tourist beach), Chinnavilai (a village near Manavalakurichi) and Alanchi (a hamlet near Midalam).

Arockyapuram seashore measured 5.19 μSv h^{-1}, whereas certain pockets in Leepuram showed 3.51 μSv h^{-1}. The highest level was recorded near a sand pocket in Sunset Point, which measured 41.03 μSv h^{-1}. (The geotagged photo on Google Earth is shown in Figure 4.) Shanguthurai beach measured 2.89 μSv h^{-1} and Muttom beach 10.01 μSv h^{-1}. Chinnavilai, a coastal village of Manavalakurichi, showed 6.72 μSv h^{-1} near a few sand dunes, whereas Alanchi, a minor hamlet, found 1 km away from the seashore showed 6.10 μSv h^{-1}.

DISCUSSION

Ionising radiations have been a grave threat around the high background regions of the globe[13]. Selected pockets of Brazil, China and India are reportedly under the grip of high background radiation[14]. Former studies have also indicated the presence of monazite deposits throughout the coastal line between Kerala State and the State of Tamil Nadu, which could be one major reason for high background radiation[15]. The beach sectors of Kanyakumari District have revealed high radiation, which could be because of the highly radioactive black sand deposits spanning across the coastal belt. The level of radiation in the shores of many of the coastal villages is extremely high compared with the permissible limit to the general public, which is 1 mSv y^{-1} (the permissible limit for occupational exposure is 20 mSv y^{-1}) according to the regulations of ICRP 103. The high radiation levels experienced could be due to several natural and artificial factors. Weathering of mountains carried into the ocean by the estuaries could be one reason. The radioactive sand deposits were found as black sand slicks along the shores near Kanyakumari, Muttom and Kovalam beaches. Of the four Taluks studied, Thovalai Taluk was found to exhibit radiation levels that were only slightly higher. It is interesting to note that this Taluk, consisting of 13 revenue villages, is found in the hinterlands and is devoid of a coastal line. The heavy inflow of tourists who constantly visit the tourist spots like Sunset Point and Muttom Beach are being exposed to a chronic radiation dose which

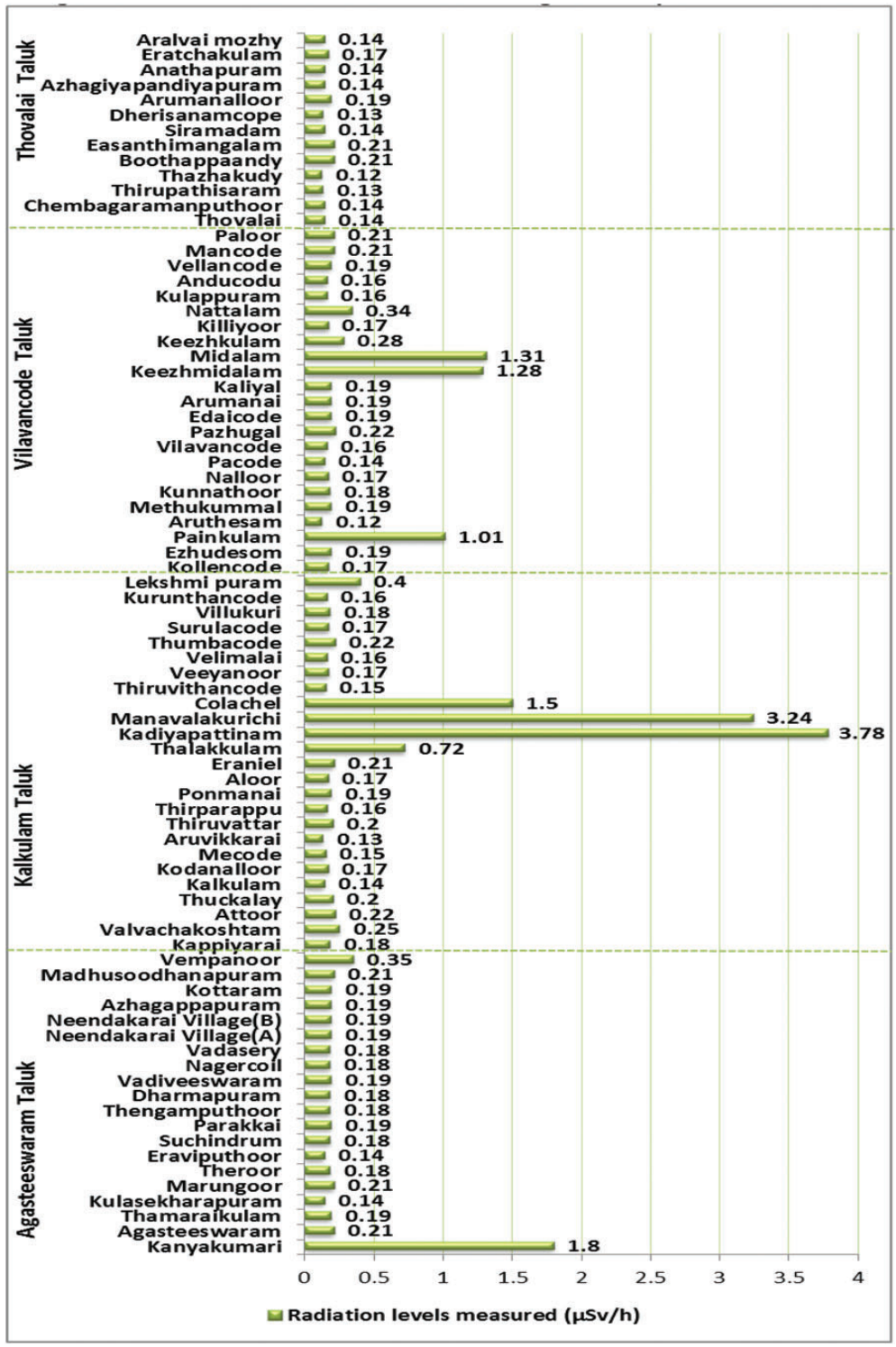
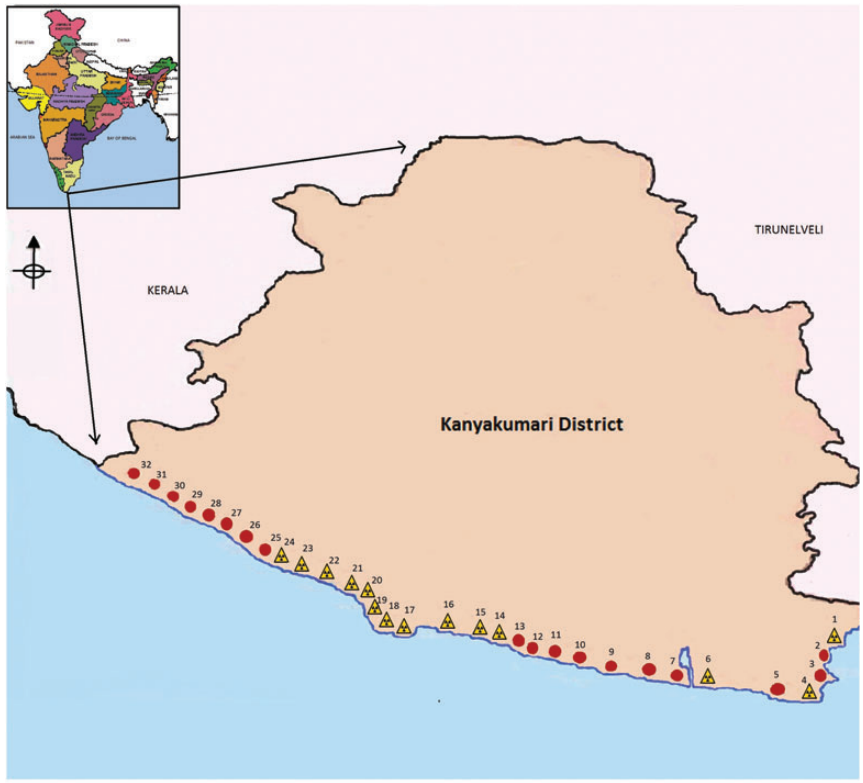


Figure 1. Radiation levels in the 81 revenue villages of Kanyakumari District.



1. Arockyapuram/Leepuram
2. Chinnamuttom
3. Vavuthurai
4. Kovalam
5. Manakudy
6. Pallam
7. Puthenthurai
8. Kesavan puthenthurai
9. Pozhikarai
10. Periakadu
11. Rajakkamangalamthurai
12. Azhikal
13. Pillaithoppu
14. Muttom
15. Kadiapattinam
16. Manavalakurichi
17. Mondaicadu
18. Kottilpadu
19. Colachel
20. Kodimunai
21. Vaniyakudy
22. Kurumpanai
23. Midalam
24. Enayam
25. Ramanthurai
26. Poothurai
27. Thoothoor
28. Chinnathurai
29. Eravyputhenthurai
30. Vallavilai
31. Marthandamthurai
32. Neerody

Figure 2. High radiation levels in the coastal villages of Kanyakumari District.

cannot be equalled to what they might receive in their whole life time. The radioactive elements in the environment, which eventually might enter the reproductive organs of living organisms, might induce biological ill effects. Moreover, the radioactive sand particles that enter their body through inhalation or ingestion through mouth and genital sources might remain inside their body and act as internal emitters, which might cause cancer after a latent period of 15–30 y. As radioactive sand deposits are often found near the coastal belt, a constant monitoring of radiation becomes essential in the coastal belt to ensure the safety of the general public from the hazardous impacts of radiation.

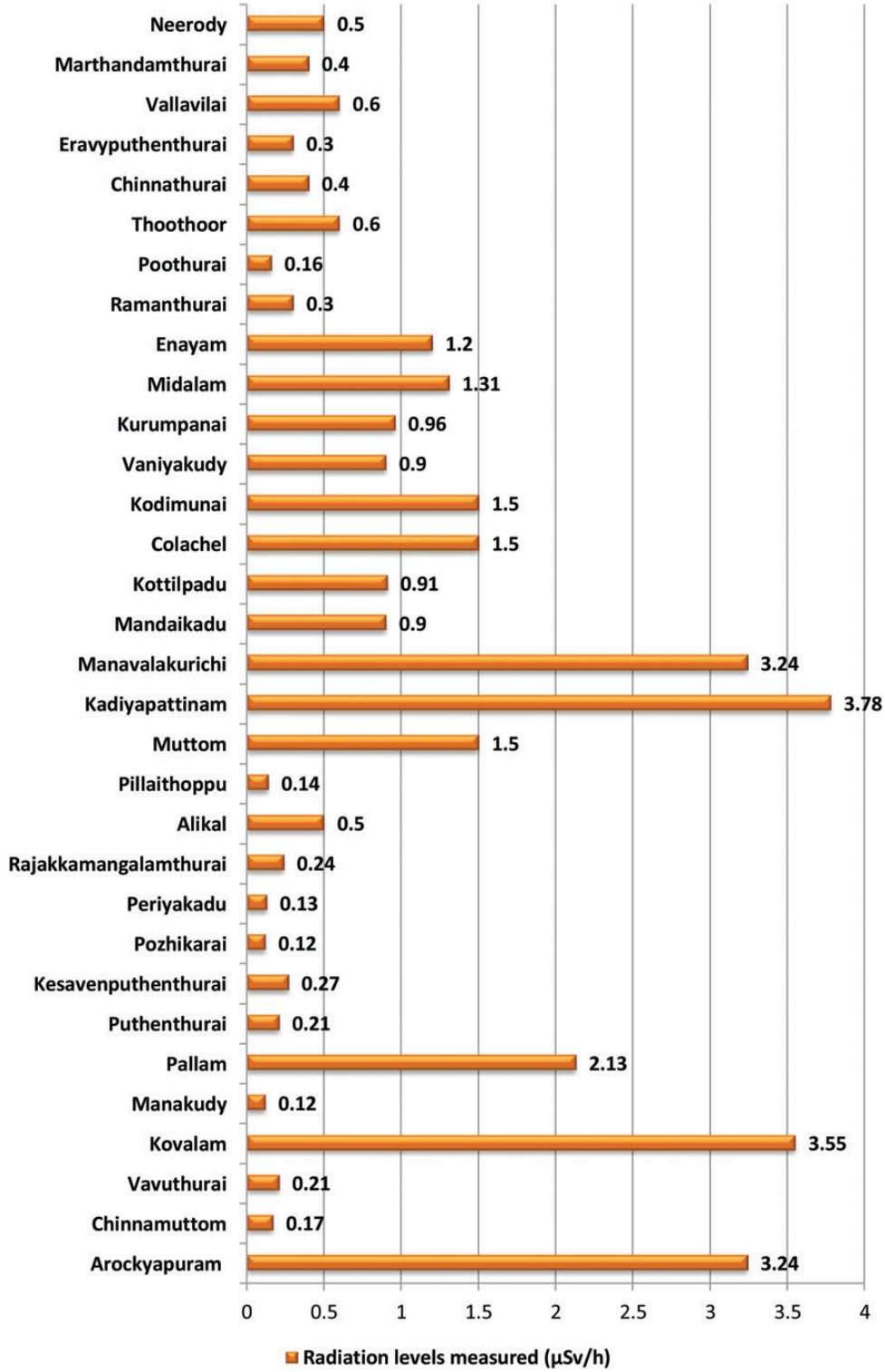


Figure 3. Radiation levels measured in the 32 coastal villages of Kanyakumari District.

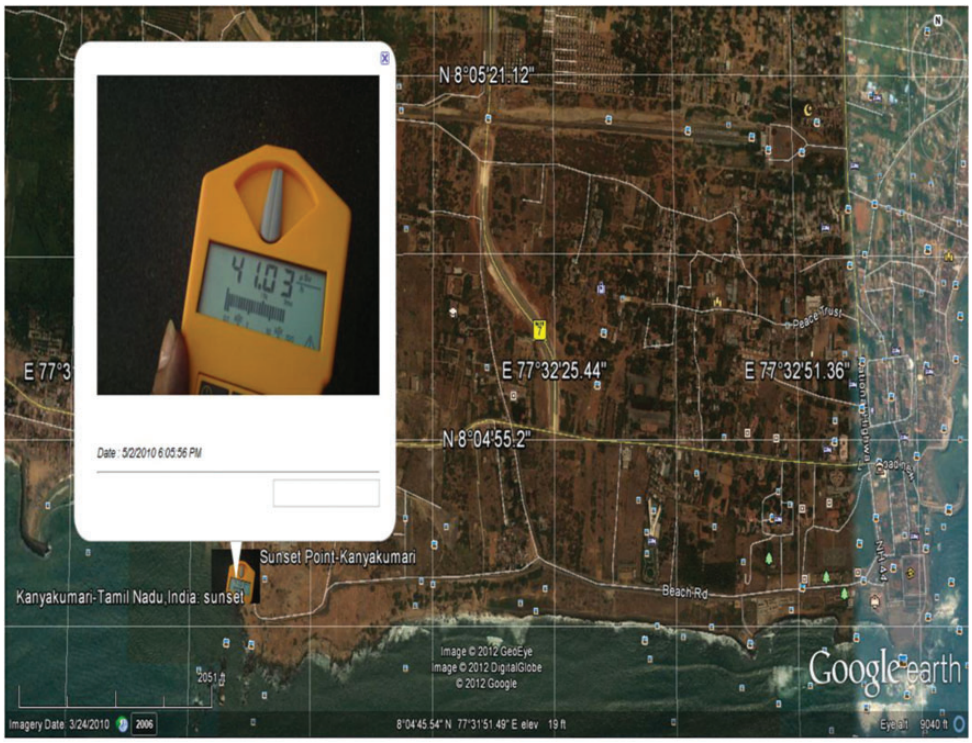


Figure 4. The geotagged photo of Sunset Point beach as seen on Google Earth. When viewed from the satellite mode of Google Earth, the photo can be seen tagged to the map in the location where it was clicked.

REFERENCES

1. Rani, A. and Singh, S. *Natural radioactivity levels in soil samples from some areas of Himachal Pradesh, India using γ-ray spectrometry.* Atmos. Environ. **39**, 6306–6314 (2005).
2. Chikasawa, K., Ishii, T. and Ugiyama, H. *Terrestrial gamma radiation in Kochi Prefecture, Japan*. J. Health Sci. **47**, 361–372 (2001).
3. Orabi, H., Al-Shareaif, A. and El Galefi, M. *Gamma-ray measurements of naturally occurring radioactive sample from Alkharje City.* J. Radioanal. Nucl. Chem. **269**, 99–102 (2006).
4. Al-Jundia, J., Al-Bataina, B. A., Abu-Rukah, Y. and Shehadeh, H. M. *Natural radioactivity concentrations in soil samples along the Amman Aqaba Highway, Jordan*. Radiat. Meas. **36**, 555–560 (2003).
5. Goddard, C. C. *Measurement of outdoor terrestrial gamma radiation in the Sultanate of Oman*. Health Phys. **82**, 869–874 (2002).
6. Tso, M. Y. and Leung, J. K. *Population dose due to natural radiations in Hong Kong*. Health Phys. **8**, 555–578 (2000).
7. UNSCEAR (United Nations Scientific Committee on the Effects of Atomic Radiation). *Sources and effects of ionizing radiation*. Report to the General Assembly. United Nations (2000).
8. Obed, R. I., Farai, I. P. and Jibiri, N. N. *Population dose distribution due to soil radioactivity concentration levels in 18 cities across Nigeria*. J. Radiol. Prot. **25**, 305–312 (2005).
9. Akram, M., Riffat, M., Qureshi, R. M., Ahmad, N. and Solaija, T. J. *Gamma-emitting radionuclides in the shallow marine sediments off the Sindh Coast, Arabian Sea*. Radiat. Prot. Dosim. **118**, 440–447 (2006).
10. Mesbahi, A. and Rouhani, A. *A study on the radiation dose of the orthopaedic surgeon and staff from a mini c- arm flouroscopy unit*. Radiat. Prot. Dosim. doi:10.1093/rpd/ncn227 (2008).
11. Abdullah, K. M. S. and Ramadhan, R. A. *Determination of gamma-emitting radionuclides in Duhok city, Iraq*. Nucleus **48**(4), 295–300 (2011).
12. Edah, A. O., Kolawole, J. A., Solomon, A. O., Shamle, N. and Awode, A. U. *Instrumental analysis of Arrinrasho clay for characterization*. J. Res. Environ.

Sci. Toxicol. **1**(2), 019–022 (2012). Available on http://www.interesjournals.org/JREST.
13. Mishra, U. C. In: Proceedings of the International Conference on High-level Natural Radiation Areas. IAEA Publication Series, IAEA, Ramsar, Iran, Vienna, 1993, p. 29 (1990).
14. Malathi, J., Selvasekarapandian, S., Brahmanandhan, G. M., Khanna, D., Meenakshisundaram, V. and Mathiyarsu, R. *Study of radionuclide distribution around Kudankulam nuclear power plant site (Agastheeswaram taluk of Kanyakumari district, India)*. Radiat. Prot. Dosim. **113**, 415–420 (2005).
15. Singh, H. N., Shanker, D., Neelakandan, V. N. and Singh, V. P. *Distribution patterns of natural radioactivity and delineation of anomalous radioactive zones using in situ radiation observations in Southern Tamil Nadu, India*. J. Hazard. Mater. **141**(1), 264–272 (2007).