Journal of Applied Sciences

ISSN 1812-5654

science alert

ANSInet
an open access publisher
http://ansinet.com

Journal of Applied Sciences 7 (20): 3091-3095, 2007
ISSN 1812-5654
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Naturally Occurring Radioactivity in the City and Across Near by Cities in Iran

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Abstract: Naturally Occurring Radioactive Material (NORM) could be contributed in radioactivity pollution of environment. The natural radioactivity concentration in soil, drinking water, certain food items samples of Zahedan city in Iran and absorbed dose across near by 5 Sistan and Blouchestan cities in Iran have been determined using gamma spectrometry and Multi Rad Low Level (MRLL) detector, respectively. Results show that the concentrations of ^{40}K, ^{238}U and ^{232}Th in the samples of the city varied from 396±38.4 to 576±57.4 Bq kg^{-1} with a mean of 473.3±40.7 Bq kg^{-1} for ^{40}K, whereas for ^{238}U and ^{232}Th values varied from 20.6±2.3 to 24.7±3.6 Bq kg^{-1} with a mean of 21.9±2.8 Bq kg^{-1} and from 28.9±3.3 to 36.5±3.6 Bq kg^{-1} with a mean of 33±3.7 Bq kg^{-1}, respectively. The absorbed dose rate in the air across Zahedan cities border ranged between 16±5 nGy h^{-1} and 300±44 nGy h^{-1} and the gross mean was 158.0±24.5 nGy h^{-1}. It can be concluded that no risk threat the residents around and center Zahedan city and in above mentioned border.

Key words: Radio nuclides, radioactivity, pollution, radioactive material, soil

INTRODUCTION

Naturally Occurring Radioactive Material (NORM) includes radionuclides with long half-lives, (^{238}U), (^{232}Th) and (^{40}K), as well as shorter lives, hydrogen-3, (^{40}K) carbon-14 and beryllium-7. Of these, ones emit gamma rays are often studied to determine the external gamma radiation dose to the public in a particular location The NORM under certain conditions can reach hazardous contamination levels (Shawki *et al*., 2001). Some of contamination levels may be sufficiently severe that precautions must be taken. There are few if any conditions where NORM reaches hazardous levels.

NORM has led to the performance of extentive surveys in many countries of the world. It occurs in many industrial situations, including petroleum recovery, energy production, mineral processing, water and sewage treatment and agricultural product fabrication and can contaminate the soils around these sites. There is a large literature from IAEA basis of publications, where there are also extensive data concerning NORM. Direct fall out from the atmosphere on the vegetation was primary source of contamination (IAEA, 1989). Efforts of Banzi *et al*. (2002) were being undertaken to create a natural radiation database to be used to assess the associated radiation risk to public and workers.

The disposed wastes to the environment may be generated from NORM. These have low radioactivity concentrations in comparison to radioactive ones associated with most research, industrial and medical applications. These are either relevant to one sample or occur at some sample locations. The quantities of naturally occurring radioactivity are extremely heterogeneous, because it is related to the characteristics of the soils in which retained the deposits more or less.

The radioactivity of radio nuclide in water (Sidle *et al*., 2001) and in soil (Dowdall *et al*., 2005; Obed *et al*., 2005; Black and Latham, 1994; Selvaskarapadian *et al*., 2000) and in air (Bergan, 2002) were measured. Pipka *et al*. (2004) showed that many factors contribute the absorption of radio nuclides in soil and water. Ng (1989) revealed that there are transfer factors for the dose from radionuclide in agricultural products. The radioactivity concentration for the waste is strongly influenced by the natural abundance of radionuclide, the geologic formation conditions where the materials produced and the characteristics of the production process (USEPA, 1993, 1994).

However, radio nuclides concentration in soil, drinking water and consumed food around and center Zahedan city as well as air adsorbed dose of radio nuclides radiation radioactivity rate of arid eastern border in Iran were unknown; so, these two items should be determined. Information about radionuclide in the border and around these cities are useful; because finding the amount of radiation reaching people is helpful to the health. Therefore, the results might be significant because there were few data for radio nuclides concentration in arid, semi natural ecosystem.

MATERIALS AND METHODS

It is supposed all the samples of soil, water and edible food that have been analyzed are not polluted by NORM but naturally contain NORM. Samples were taken twice from 5 places in round and central zone of Zahedan city. The samples were collected before any rain fall during summer and autumn. There were 25 samples of soil, 34 samples of drinking water and 20 samples of consumed cereal of food.

Soil samples were taken at each site in different dates in the morning by taking a 20×20 cm soil block as deep as 0 to 30 cm. This block was then mixed. After drying at room temperature, the soil was passed through a 2 mm sieve to remove stones and all subsequent analysis performed on the less than 2 mm fraction.

Four liters of drinking water from each source as water sample was provided. Then, 1 L was provided as a sub sample from them and was then carried to the analysis department for analysis.

The concentration of ^{137}CS and ^{131}I are lower than detector measurement (1 Bq L^{-1}). ^{40}K, ^{226}Ra, ^{238}U and ^{232}Th are measured, but from among only ^{40}K and ^{226}Ra can be determined directly from gamma spectrometry for drinking water and food and ^{40}K, ^{226}Ra and ^{232}Th are measured for soil. The permissible dose of ^{226}Ra in drinking water is 110 mBq L^{-1}.

One hundred grams of each cereal such as red bean, rice, pea, wheat and lentil as daily consumed food is chosen and put aside for 21 days as detention time for equilibrium; then, they are grounded; mixed and ready for spectroscopy set.

Radioactivity samples of soil, drinking water, edible cereal were detected by gamma spectrometer set. Counting errors vary with sample activity, but at 95% confidence level.

The spectrometry system consisted of HPGe detector having active volume 180 cm^3 with a relative efficiency 30% and operating voltage of 3000 v. For acquisation of data and analysis, a multichannel analyzer card of 8198 channels with inbuilt power supply, preamplifier was installed in a personnel computer. The resolution of the system was 2 kev at 1332.5 kev peaks of Co-60. The Lowest Limits of Detection (LLD) were determined. Spectrum analysis was done with the help of computer software Gene 2000 and activity concentration was determined.

Adsorbed dose of radiation in arid eastern air of Sistan and Blouchestan of Iran are determined by Multi Rad Low Levels Dosimeter (MRLL) set which is England producer in Press Saneco Company, ±0.1 sensitivity and 0.001 Gy as a range of energy detected. Firstly, the site was chosen among the various field due to being nearby villages, its population and distance to the main road. Then, the detector was carried to the height of 2 ft above the soil. The zigzag movement was carried on for 100 ft from a certain point with the detector. When a significant figure detected by the detector in every place during movement, the detector was paused for ten minutes and again we continued the measurements. This measurement was done twice in every site. The background activity of soil was also removed by using a nylone body to prevent its measurement.

Surveys of NORM background are often conducted to characterize a site before it is used for an activity that involves radiation. The population of city zone and the eastern arid border were required to generate a suitable sample size.

Limited information is available on the generation, inventories and projections of arid eastern border NORM wastes and location of a city. Like inventories, projections of NORM are limited and vary according to the region of the border. The given estimates also do not reflect possible opportunities for the reuse and recycling of NORM materials in commercial and industrial applications. The ubiquitous nature of NORM wastes accounts for the apparent enormous inventory of these materials.

The samples of soil and food that have been analyzed are not polluted by NORM, but naturally contain NORM

RESULTS AND DISCUSSIONS

The Naturally Occurring Radioactive Material (NORM) of five different areas, North, East, South, West and Center of the Zahedan in Iran are shown in Table 1. The highest amount of radioactivity of ^{40}K in western soil of the Zahedan city is 576±57.4 Be kg^{-1} and lowest one in eastern soil of the city is 396±38.4 Bq kg^{-1}. The maximum amount of ^{238}U in the soil of the south is 24.7±0.6 Bq kg^{-1} and minimum one is 20.6±2.2 Bq kg^{-1} in the north of the city. ^{232}Th in the soil ranges from 28.9±3.3 Bq kg^{-1} to 36.5±3.6 Bq kg^{-1} in the center and the north of the city, respectively.

Table 2 shows the cereal radioactivity as consumed daily food by people. Consumed food is maximum in red bean and minimum in rice, 427±8.3 and 69.2±11.8 Bq kg^{-1}, respectively.

Table 1: Concentration of radio nuclide radioactivity in soil sample

	(Bq kg^{-1})		
Site of a city	^{40}K	^{238}U	^{232}Th
North	446±34.9	20.6±2.2	36.5±3.6
East	396±38.4	23.1±2.8	33.5±3.5
South	512±37.2	24.7±3.6	34.4±4.0
West	576±57.4	21.1±3.0	31.7±4.1
Center	437±35.7	21.3±2.6	28.9±3.3

Table 2: Concentration of radio nuclide radioactivity in edible food

Sample	Lentil	Red bean	Pea	Wheat	Rice
^{40}K (Bq kg^{-1})	275±7.5	427±8.3	292±18.8	69.3±14.3	69.2±11.8

Table 3: Concentration of radio nuclide radioactivity in drinking water

Sample	South	East	Center	West	North
^{226}R (mBq L^{-1})	5±0.4	5.9±0.5	10.7±0.8	2±0.5	5.3±0.4

Table 4: Adsorbed dose radiation in eastern, arid border of Sistan and Blouchestan of Iran

		(nGy h^{-1})		
Provinces	Zone city border	Minimum	Maximum	Mean
Sistan	Zaboul	167	200.0	183.5
	Mir jave	117	150.0	123.5
	Pyshin	16	33.0	24.5
Blouchestan	Saravan	122	300.0	233.0
	Chahbahar	150	187.5	166.0

The radioactivity of drinking water is shown in Table 3. Drinking water has radioactivity 2±0.5 Bq L^{-1} in the north and 5.9±0.5 Bq L^{-1} in the east of the city.

The absorbed dose radiation in the air in the eastern arid border of Sistan and Blouchestan is measured (Table 4). It reveals that the amount of adsorb dose of radioactivity in the arid eastern border is different. It shows that the figures range from 16 to 300 nGy h^{-1} and mean value is 158 nGy h^{-1}.

A few measurements of radioactivity were carried out on the eastern arid border of Iran. by the Atomic Energy Agency set. The Zaboul, Mir jave, Pyshin, Saravan and Chahbahar sites situated in the eastern, arid border do not correspond to points in the center and around Zahedan city due to different distance between Zahedan and the other mentioned cities sites. Table 1 reveals ^{40}K in western site of Zahedan city is more than the other sites, 576±57.4 Bq kg^{-1} and minimum one relative to other sites in east of Zahedan city, 396±38.4 Bq kg^{-1}. These figures show radioactivity in soil of Zahedan city. The radioactivity of ^{40}K in the west of the city is higher than the east of the city. The distribution of ^{238}U and ^{232}Th in the soil is similar. The radioactivity in Zahedan city is the same. However, according to Table 1, there is no risk of radioactivity in Zahedan soil, especially ^{131}I, ^{137}Cs and ^{239}Pu- ^{240}Pu. The Ali *et al.* (2002) showed that the natural radioactivity in Peshwar Plain in Pakistan is more than this region. On the contrary, the resulting activity concentrations of natural radio nuclides in waste material of some laces could be several times higher than in the adjacent soil (Marovic *et al.*, 2006). It has also been estimated earlier that phosphates fertilizers applied to the fields in recommended amounts could raise radioactivity level in soil (Bhetti, 1994).

In food products radioactivity in red bean, 427±8.3 Bq kg^{-1} is more than rice, 69.2±11.8 Bq kg^{-1} and wheat, 69.3±14.3 Bq kg^{-1}. No absorbed dose of natural occurring radiation is also found in the food samples (Table 2). It shows that in seed product, red bean adsorb radioactivity is more, so pollution in red bean accumulated easier than other edible seed. In all the cases, the activities are lower than the ICRP standards (Anonymous, 1990). Ali *et al.* (2001) stated the naturally occurring radioactivity material is effective on health of human being. Black and Latham (1994) concluded that there is not significant radiological exposure to workers, the general public, or the environment.

Table 3 showed that there is no risk about using drinking water, from the point of view of radioactivity. The results of investigated study by Hutchinson and Toussaint (1998) showed that the state of Western Australia currently has the only low levels waste repository in Australia, located at Mt Walton East. To date this repository has been used predominantly to dispose of packaged radioactive waste containing artificial radioisotopes, but there is an increasing demand for the repository to accept bulk concentrated NORM wastes from mining and related industries.

Table 4 shows that the absorbed dose of natural occurring radioactivity in site Pyshin is less in comparison to other sites, 16 n Gy h^{-1}. It shows that NORM is not nearly released to the environment of region. On contrary, absorbed dose of natural occurring radiation in the site Saravan is more, 300 n Gy h^{-1}. The activities of man can concentrate naturally occurring radio nuclides in amounts large enough to be of concern as a radiation risk. The pollution in this area from different sources is high. The future for this region may be at risk from the view point radiation hazardous, but Copplestone *et al.* (2000) determined the dose rate to non-human species from environment. He stated that values are at least 3 orders of magnitude lower than 1 mGy per day level below. Betti *et al.* (2004) stated in recent years the additional dose to marine biota in this region due to the past NORM discharges is of the same order of magnitude as the natural background.

Investigations of natural radioactivity in the eastern arid border were carried out between 2004-2006 by the medical physics group. It has been foreseen that the origin of these contaminations in the border is not fix. The radio nuclides concentration could vary significantly from location to location because of the varying geologic characteristics of sources in different regions. (Nedveekite *et al.*, 2000; Schimmack *et al.*, 1994). NORM will be increased in the regions due to agricultural activity and mine and test explosion in which causes agglomeration activity. These investigations also revealed the contamination out of cities in the border and in the city. The study was conducted for the investigation of the

amount of radioactivity in barren and cultivated soil by Akhtar *et al*. (2003). This results that the adsorbed dose rate and ^{40}K, ^{238}U, ^{232}Th in that region is more than in the other regions of Iran. This indicates that this region lies in the area of higher radiation background; while comparing with average of each other. Giving fertilizer to soil cause value of dose to increase slightly.

The only available data is activities which were measured at the station of the city. No data is also available concerning the activities rejected into environment by the services of nuclear medicine in different points of the city. The regulations relating to the sources of radiological pollution are not available within the framework general legislative provision relating to radiological quality of drink or of surface waters. No systematic radiological monitoring of the aquatic environments is consequently put in this city and borders. Chen *et al*. (2005) said that current federal laws and regulations do not specify criteria for releasing these materials that may contain residual radioactivity of either man made or natural origin from regulatory controls.

However, people should be accustomed to use ICRP regulations and its recommendation in recognizing the source of radioactivity and doing make radiation protection to prevent all mechanisms, damage to all important molecules and the serious consequences of such damage for human health subsequent to all doses of radiation

REFERENCES

Akhtar, N.M., M. Ashraf Chaudhry, M.M.I. Tifai and S.D. Orfi, 2003. Radiometric and chemical analysis of saline soil sample of Pacca Anna Feisalabad. J. Res., 14: 49-59.

Ali, A., S.D. Orfi, H. Munzur and M. Aslam, 2001. Radiological impact on the workers, members of public and environment from partial decommissioning of Pakistanian Research Reactor-I and its associated radioactive residues. Health Phys., 80: 89-91.

Ali, A., S.D. Orfi and A.A. Qureshi, 2002. Assessment of the natural radioactivity and its radiological hazard in Shewa-Shahbaz Garhi Ignous complex, Peshawar PLAIN, NWF Pakistan. Health Phys., 82: 74-79.

Anonymous, 1990. Code of Federal Regulations CFR-10, Chapter 1. Washington DC. Nuclear Regulatory Commission (NRC).

Banzi, F.P., P. Msaki and I.N. Makundi, 2002. A survey of background radiation dose rates and radioactivity in Tanzania. Health Phys., 82: 80-86.

Bergan, T.D., 2002. Radioactive fall out in Norway from atmospheric nuclear weapon tests. J. Environ. Radioact., 60: 189-208.

Betti, M., L. Aldave de las Heras, A. Janssens, E. Henrich, G. Hunter, M. Gerchikov, M. Dutton, A.W. Van Weers, S. Nielsen, J. Simmonds, A. Bexon and T. Sazykina, 2004. European Commission Marina II study Results of the European Commission Marina II study: Part II--effects of discharges of naturally occurring radioactive material. J. Environ. Radioact., 74: 255-277.

Bhetti, T.M., 1994. Phosphate fertilizers a potential source for uranium recovery as by product. A technical report no paece/NIBGE-2/1994. National Institute for Biotechnology and Genetic Engineering (NIBGE), Faisalabad, Pakistan.

Black, S.C. and A.M. Latham, 1994. Radiological effect of a low level waste site on the environment. Health Phys., 67: 406-411.

Chen, S.Y., D.W. Moeller Dornsife, H.R.W.P. Meyer, A. Lamastra, J.O. Lubenau and D.J. Strom, 2005. Toward the framework and implementation for clearance of materials from regulated facilities. Health Phys., 89: 115-126.

Copplestone, D., M.E. Toal, M.S. Johnson, D. Jackson and S.R. Jones, 2000. Environmental effects of radionuclides-Observations on natural ecosystems. J. Radiol. Prot., 20: 29-40.

Dowdall, M., J.P. Gwynn, C. Moran, J.O. dea, C. Davids and B. Lind, 2005. Uptake of radionuclides by egetation at a High Arectic location. Environ. Pollut., 133: 327-332.

Hutchinson, D.E. and L.F. Toussaint, 1998. Near-surface disposal of concentrated NORM wastes. Applied Radiat Isot., 49: 265-271.

IAEA, 1989. Measurement of radionuclides in food and environment. Technical Reports Series, pp: 295.

Marovic, G., J. Sencar, M. Bronzovic and Z. Franic, 2006. Radioactive waste due to electric power and mineral fertiliser production. Arh. High Radia. Toksikol., 57: 333-338.

Nedveekite, T., S. Mutiejunas and V. Kucinskas, 2000. Environmental releases of radioactivity and the influence of thyroid disease at the Ignalia Nuclear Power Plant Health Phys., 79: 666-674.

Ng, Y.C., 1989. A review of transfer factors for assess the dose from radionuclides in agricultural products. Nucl. Saf., pp: 23-57.

Obed, R.I., I.P. Farai and N.N. Jibiri, 2005. Population dose distribution due to soil radioactivity concentration levels in 18 cities across Nigeria. J. Radiol. Prot., 25: 305-312.

Pipka, M., J. Lesn and J.M. Hornik, 2004. Plant uptake of radiocesium from contaminated soil. Nukleonika, 49: S9-S11.

Schimmack, W., K. Bunzl, F. Dietl and D. Klotz, 1994. Infiltration of radionuclides with mobility in to a forest soil. Effect of the irrigation intensity. Environ. Radioact., pp: 53-63.

Selvaskarapadian, S., R. Silvakumar and N.M. Manikandan, 2000. Natural radionuclide distribution in soils of Gudalore, India. Applied Radia Isot., 52: 299-306.

Sidle, W.C., D. Shanklin, P.V. Lee and D.L. Roose, 2001. ^{226}Ra and ^{228}Ra activities associated with agricultural drainage ponds and wetland ponds in Kankakee watershed, Illinois-Illiana, USA. J. Environ. Radioact., 55: 29-46.

Shawki, S., H. Amer, A.A. Nada, T.M. El-Macksoud and N.M. Ibrahim, 2001. Characteristics of NORM in the oil industry from eastern-western desert of Egypt. Applied Radia. ISO., 55: 135-139.

USEPA, 1993. Office of Radiation and Indoor Air. Diffuse NORM Wastes-Waste Characterization and Preliminary Risk Assessment, Draft, RAE-9232/1-2, SC and A, Inc. and Rogers and Associates Engineering Corporation, Salt Lake City, Utah.

USEPA, 1994. Science Advisory Board. Review of the Office of Radiation and Indoor Air Draft Document on Diffuse Naturally-Occurring Radioactive Material (NORM): Waste Characterization and Preliminary Risk Assessment, EPA-SAB-RAC-94-013, Washington, DC.