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Journal of Radiation Research and Applied Sciences

journal homepage: <http://www.elsevier.com/locate/jrras>

Evaluation of excessive lifetime cancer risk due to natural radioactivity in the rivers sediments of Northern Pakistan

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ARTICLE INFO

Article history:

Received 3 July 2014

Received in revised form

17 July 2014

Accepted 18 July 2014

Available online 6 August 2014

Keywords:

Activity concentration

²²⁶Ra, ²³²Th and ⁴⁰K

Hunza, Gilgit and Indus Rivers

Radiation indices

Annual effective dose

Excess lifetime cancer risk (ELCR)

ABSTRACT

Naturally occurring radionuclides ²²⁶Ra, ²³²Th and ⁴⁰K present in the rivers sediments of Northern Pakistan were measured using HPGe γ -ray spectrometer to evaluate the radiation health hazard indices and excess lifetime cancer risk (ELCR). Average concentrations of ²²⁶Ra, ²³²Th and ⁴⁰K in the sediments were found to be 50.66 ± 1.29 , 70.15 ± 1.45 and 531.70 ± 5.45 Bq kg⁻¹ respectively. Radium equivalent activity (190.89 Bq kg⁻¹), outdoor external dose (87.47 nGy h⁻¹), indoor external dose (165.39 nGy h⁻¹), and total average annual effective dose (0.92 mSv) were calculated. The hazard indices are higher than the world's average values. Total excess lifetime cancer risk (ELCR) was found to be 3.21×10^{-3} which is relatively higher. Numerous cancer deaths are annually reported from the Northern areas of Pakistan, which may be related to high radioactivity in the area.

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1. Introduction

Radiation in our environment comes from the cosmogenic, anthropogenic and primordial sources. Contribution of cosmogenic and anthropogenic sources to the total environmental radioactivity is negligible. Primordial radioactivity is widespread in the earth environment, mainly in various

geological formations and their disintegration products. As a result of rock weathering, the radionuclides are carried to the soils, streams and rivers by rain. Level of primordial radioactivity concentration depends on local geological conditions and geographical location of the area (UNSCEAR, 2000).

Long-term exposures to radioactivity and inhalation of radionuclides have serious health effects such as chronic lung diseases, acute leucopenia, anemia and necrosis of the

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Peer review under responsibility of The Egyptian Society of Radiation Sciences and Applications

<http://dx.doi.org/10.1016/j.jrras.2014.07.008>

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mouth. Exposure to radium may result in teeth fracture, anemia and cataract and may even cause cancer of various types. Thorium exposure can cause lung, pancreas, hepatic, bone and kidney cancers and leukemia (Taskin et al., 2009). These diseases are caused by γ -radiation, which is capable of traveling long distances through air to affect the human beings (www.lennotech.com/periodic/elements/radium.htm#ixzz2cg3HdHBk).

River sediments are a major source of radioactivity that contributes significantly to the background level of radiation. Knowledge of natural radioactivity in the river sediments is thus important. Therefore, concentrations of naturally occurring radionuclides (^{226}Ra , ^{232}Th and ^{40}K) in the sediments of Hunza, Gilgit and Indus River from Northern Pakistan were measured, to evaluate the radiation health hazard indices and excess lifetime cancer risk (ELCR) for the local population and visitors.

Gilgit city is the major town in the Northern Pakistan with estimated population approaching to 1,000,000. For that reason, the main focus of our study was around Gilgit. Gilgit has a broad small industrial base, producing manufactured goods for local and foreign markets. The discharge waste from such industries is negligible that does not contribute toward any radioactivity.

2. Material and methods

2.1. Study area

The study area is located in the Northern Pakistan which comprises of parts of the Hindukush, the Karakoram Range and the Himalayas, having more than fifty peaks exceeding 6500 m. Hunza, Gilgit and Indus are the three main rivers in



Fig. 1 – Map of Pakistan showing locations of major cities including Gilgit and surrounding areas. The study area extends from Gulmit near Baltit to Chilas. All rivers originating from higher ranges join the mighty Indus River that finally falls in the Arabian Sea near Karachi.

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