Radiation Doses Due to Natural Radioactivity in Selected Areas in Southern Part of Jordan

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Abstract:- The present study introduces some data regarding Radiation Doses Due to Natural Radioactivity measured the investigations we have already carried out in Selected Areas in Southern Part of Jordan. The investigated area, which is 270 Km long, includes three governorates in Jordan: Tafila, Ma'an, and Aqaba. These data emphasis on new findings of different radiation dose rates, to mainly identify the potential and known impacts of exposures in these areas of this part of the country on public health, and also to make recommendations for further studies. A significant part of the total dose contribution in the form of natural sources comes from terrestrial gamma radionuclides. The measured absorbed dose rates in air were in the range of 10 –200 nSv/ h. The lowest absorbed external dose rate was on the water body of Gulf of Aqaba, while the highest was on the highway of the industrial zone south of Aqaba.

Keywords: Jordan; Tafila; Ma'an; Aqaba; natural radioactivity; external gamma dose; NaI(Tl) detector; low radiation.

1 Introduction

A variety of systems and processes may transmit radioactivity into the environment. Human industrial activities involving those related to phosphate and potash (including mining, milling, reprocessing, and waste storage) leading to significant creation and release of radioactivity, which comes from pre-existing natural radionuclides, like potassium-40, uranium -238, and 235, radium-226 and radon-222, which would otherwise remain trapped in the earth's crust. Radionuclides released into atmosphere are subjected to a variety of physical processes that determine their fate. These processes are complicated and poorly understood, and affected by physical and chemical forms of the radionuclides [1].

The southern part of Jordan has a special situation where the most important mining industry, phosphate and potash, and huge expected mineral resources, uranium, copper, etc. are located, that make this area very promising for the Jordanian economy. The presence of mining industry makes it necessary to introduce proper tools to investigate newer places to check for mineral availabilities, and to have a clean environment. The most proper tool is the radiation detection of natural radioactive sources, which has a special characteristics making it preferable than any other techniques.

The above-mentioned objectives, surely contribute in the radiation dose received by people. A comprehensive assessment of radiation impact on people and environment of this part of Jordan is a must. The need to have clean environment, and to protect people from natural or industrial sources of radiation, if it is nationally generated or that comes across the boarders, pushes toward establishing a strong program for radiation protection.

This study matches with the other studies, which were conducted at different locations in Jordan, [2]; [3], [4], [5], [6], [7], [8], [9], 2011, [10], [11] and [12]. The aim of this work is to determine the gamma-ray-absorbed doses due to background radiation originating from naturally occurring radionuclides, along Tafila – Jurf – Ma'an – Aqaba – Saudi boarders Highway. This study represents a pre-project study to make a preliminary assessment

of the radiation doses in this part of the country. The results will be used to establish a radio-dose map for the named region. This map will be used as reference information to evaluate any changes in the radioactivity background level due to the change natural or man-made intervention in the environment.

2 Experimental

External gamma dose-rate levels were measured in different areas of the southern part of Jordan. These measurements conducted on The investigated area, which is 270 Km long, includes three governorates in Jordan: Tafila, Ma'an, and Aqaba. We may divide it into four regions: Tafila- Jurf highway region, Jurf-Aqaba desert highway region, Aqaba city region, and Aqaba-Saudi boarders region (Fig. 1).

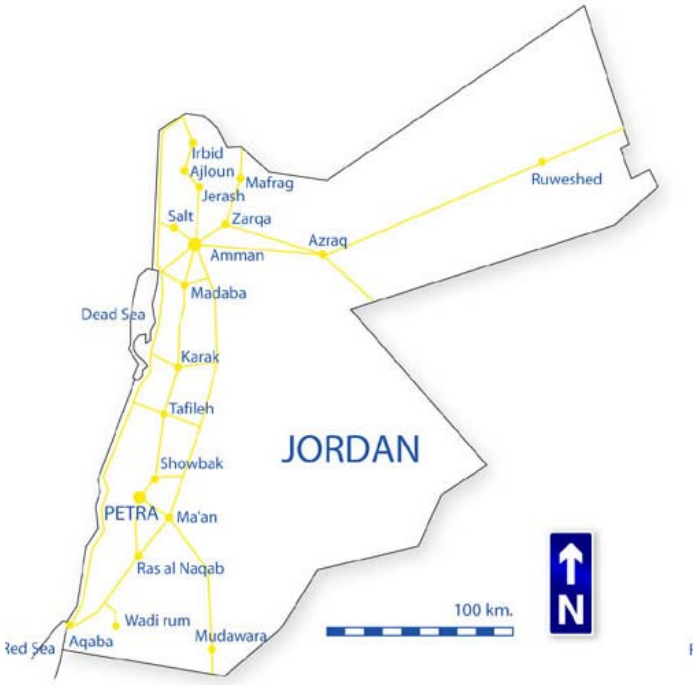

Fig. 1: Jordan map

The dose rates were doubly measured, first by using a portable radiation monitor (RADIAGEM 2000) which is a survey meter that includes an energy-compensated Geiger-Muller counter. It can measure gamma energy from 40 keV to 1.5MeV with 15% accuracy (Fig. 2). The second measurements is implemented by an external probe connected to *RADIAGEM 2000*. The new CSP (Canberra Smart Probes) *SG-1R* is designed for gamma radiation measurements. *SG-1R* which is a gamma probe with NaI(Tl) $1'' \times 1''$ detector, is not energy independent, but it measures dose-rate equivalent. It is used for medium sensitivity with a dose-rate range from 10 nSv/h to 200μSv/h (Fig. 3).

Fig. 2: (RADIAGEM 2000)

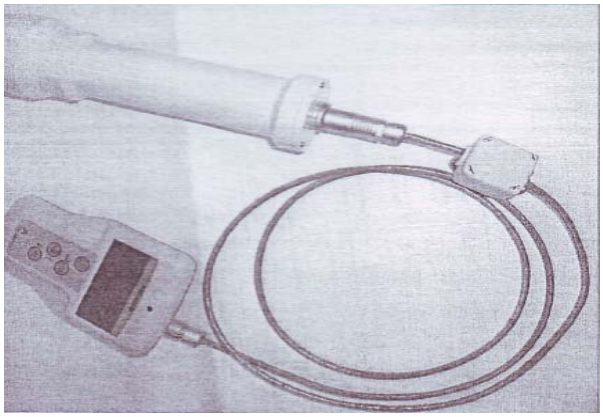

Fig. 3: Smart *SG-1R* Probe connected to RADIAGEM 2000

3 Results and discussion

The gamma dose rates at 1 m above ground in the investigated regions measured by survey meters were between 10 nSv/h and 200 nSv/h. External exposure is caused mostly by gamma radiation from radionuclides in the U-238 and Th-232 series.
Table (1) below presents the registered gamma absorbed dose rates in investigated area.

region	Characteristics of Location	Total Distance (Km)	Dose rate in air (nSv/ h)
1	Tafila- Jurf highway	35	30 - 60
2	Jurf-Aqaba desert highway	170	60 - 100
3	Aqaba city (streets)	20	90 - 150
4	Aqaba city (beach)	15	130 - 170
5	Aqaba city (water body)	10	10 - 20
7	Aqaba-Saudi boarders	30	115 - 200

Table (1): Registered Gamma Absorbed Dose Rates in investigated area

The important result which could be stated is that, the highest gamma dose rate registered, due to gamma radiation was measured to be 200 nSv/h. According to UNSCEAR reports [13], the dose rate in air outdoors from terrestrial gamma-rays in normal circumstances is about 57 nSv/h. The national average ranges from 24 to 160 nSv/h, while the world-wide average annual effective dose is approximately 70 μSv [14].

After comparing the measured absorbed dose measured in this work, with the registered, national or international, dose rates resulting from natural radiation areas, the gamma dose rates registered in southern Jordan represents a potential source of natural radioactivity, mainly Uranium.

4 Conclusions

The aim of this study is to present an assessment of radiation doses received by the public in a named region of southern part of Jordan, due to Background Radiation. This region included a 270 km length area, in three governorates in southern Jordan: Tafila, Ma'an, and Aqaba, divided into four regions: Tafila- Jurf highway region, Jurf-Aqaba desert highway region, Aqaba city region, and Aqaba-Saudi boarders region.

Using a portable Geiger–Muller counter, and NaI(Tl) detector, the area has been surveyed. The measured absorbed dose rates in air were in the range of 10 –200 nSv/ h. The lowest absorbed external dose rate was on the water body of Gulf of Aqaba, while the highest was on the highway of the industrial zone south of Aqaba. Concentration of natural radioactive materials, is suggested to be very high compared to their normal abundance in other areas. Further studies should be implemented to determine the concentrations of natural radioactive materials.

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