Levels of Radioactivity emitted from some Military Wastes and Urban Soils at Basra City, Southern Iraq

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الملخـص

تهدف هذه الدراسة،التي أجريت قياساتها في العام 2009، إلى الكشف عن مستويات النشاط الإشعاعي المنبعث من بعض المخلفات العسكرية والخردة الحديدية (السكراب) وكذلك من التربة في مواقع مختلفة من مدينة البصرة. وأجري القياس حقلياً على بعض الأهداف المستهدفة خلال حرب الخليج الثالثة العام 2003 بواسطة جهاز كاشف الطيف الإشعاعي نوع LB-1200، فيما تم الفحص مختبرياً على عينات التربة من مواقع مضروبة وأخرى غير مضروبة باستخدام كاشف إشعاعات ألفا وبيتا وكاما نوع Fluke victoreen. وأظهرت النتائج وجود انبعاثات إشعاعية عالية من الأهداف العسكرية المضروبة تراوحت مستوياتها من 0.11 ــ 0.13 ملي ريم/ساعة في أدناها إلى 13 ــ 14 ملي ريم/ساعة في أعلاها. أما بالنسبة لعينات التربة غير المضروبة، فقد تراوح معدل التركيز من 0.015 ملي ريم/ساعة في أدناها إلى 0.027 ملي ريم/ساعة في أعلاها. يستنتج من الدراسة الحالية أن التركيز في عينات التربة المضروبة يزداد عما عليه في العينات غير المضروبة ليصل إلى 0.6 ملي ريم/ساعة. وهذه المستويات مرتفعة قياساً إلى الخلفية الإشعاعية (0.008 ــ 0.011 ملي ريم/ساعة)، مما يدلل على ضعف التلوث الإشعاعي داخل مدينة البصرة، سوى في أماكن محدودة..

Abstract

This study was conducted and measurements have been carried out during 2009. It is aims to detect the levels of radioactivity emitted from some military wastes and scraps as well as soils from different sites at Basra city, Southern Iraq. Some destroyed targets, during the 2003 conflict, have been measured, in the field, by using a portable detector of LB-1200 type, while destroyed and undestroyed sites of soil samples have been measured, in the laboratory, by using detector Fluke victoreen type. The results have shown that radioactive emissions from destroyed military targets were high, which ranged from a minimum value of 0.11 – 0.13mr/h, to a maximum value of 13 – 14.5mr/h. While in undestroyed soil samples, the average concentration varied from a minimum value of 0.015mr/h, to a maximum value of 0.027mr/h. It was concluded that the average concentration of destroyed soil samples is higher than undestroyed samples which was reached to 0.6mr/h. By comparison with the background radiation level (0.008 – 0.011mr/h), the recorded values were higher. Despite there were some spots contaminated with radiation, but there are no acute radioactive contamination in Basra soil, except for limited spots.

Introduction

Pollution of the natural and human environment by radioactive substances is of concern because of the considerable potential that ionizing radiation has for damaging biological material and because of the very long half-lives of someradionuclides (Hewitt,2001). Determination of radioactivity levels, thus, in a given area and investigation on their health impacts is very important.

Radiation arises from a spontaneous rearrangement of the nucleus of an atom. Whilst some nuclei are stable many are not and these can undergo a change, losing mass or energy in the form of radiation. Some unstable nuclei are naturally occurring while others are produced synthetically. The most common forms of these radiations are alpha particles, beta particles, and gamma rays (Hewitt,2001). Radionuclide is radioactive particle, man-made or natural, with a distinct atomic weight number; can have a long life as soil or water pollutant (Lochbaum,2004). Some examples of radionuclides with a range of different half-lives include Sodium-26 (half-life of 1.07 seconds), Hydrogen-3 (half-life of 12.3 years), Carbon-14 (half-life of 5.730 years), and Uranium-238 (half-life of 4.47 billion years). The decay process of a radionuclide is the mechanism by which it spontaneously releases its excess energy (Kuperberg *et al.*,2004), to produce a radioactivity. Radioactivity is the amount of radiation emitted by a source per unit time is known as the activity of the source, expressed in terms of the number of disintegrations per second. The activity of a source is proportional to the number of radioactive atoms present and so diminishes with time according to first order kinetics (Hewitt,2001). Radioactive waste is a material deemed no longer useful that has been contaminated by or contains radionuclides (Kuperberg *et al.*,2004).

Alpha decay, for example, is a process that is usually associated with heavy atoms, such as Uranium-238 and Thorium-234, where excess energy is given off with the ejection of two neutrons and two protons from the nucleus.

Beta decay involves the ejection of a beta particle, which is the same as an electron, from the nucleus of an excited atom. A common example of a beta-emitter found in radioactive waste is Strontium-90. After an alpha or beta decay, the nucleus of an atom is often in an excited state and still has excess energy.

Radioactive waste can vary greatly in its physical and chemical form. It can be a solid, liquid, gas, or even something in between, such as sludge. Any given radioactive waste can be primarily water, soil, paper, plastic, metal, ash, glass, ceramic, or a mixture of many different physical forms. The chemical form of radioactive waste can vary as well. Radioactive waste is classified as high, intermediate, or low level. Depending on the radionuclides contained in it, a waste can remain radioactive from seconds to minutes, or even for billions of years (Kuperberg *et al.*,2004).

Radioactive pollution, however, could be defined as an any wastes deposited into environment, which contaminated by radioactive substances (radionuclides), leading to hazards on public health.

Biological effects of ionizing radiation may be grouped as somatic and genetic. Somatic effects are impacts on individuals who are directly exposed to the radiation. Radiation sickness (circulatory system breakdown, nausea, hair loss, and sometimes death) is an acute somatic effect occurring after very high exposure, as from a nuclear bomb, intense radiation therapy, or a catastrophic nuclear accident. Chronic effects resulting from long-term exposure to low doses of ionizing radiation can potentially include both somatic and genetic effects that occur because ionizing radiation damages the genetic material of the cell. As well, somatic effects include decrease in organ function and carcinogenesis. (Peirce *et al*.,1997).

Genetic effects result from radiation damage to chromosomes and have been demonstrated to be inheritable in animals but not in humans. The human genetic risk is estimated to be between I and 45 additional genetic abnormalities per 10 mSv (1 rem) per million liveborn offspring in the first generation affected, and between 10 and 200 per 10 mSv per million liveborn at equilibrium (Peirce *et al*.,1997).

According to a study published by United Nations Environment Programme (UNEP, 2003a), the 1991 Gulf War was the first conflict in which depleted uranium (DU) munitions were used extensively. A total of about 300 tones of DU were fired by the US and the UK during this war, with DU remaining in the environment as dust or small fragments. The US Department of Defense and the UK Ministry of Defense have admitted that the American and British coalition forces also used ammunition made from DU in the 2003 Iraq War. British Challenger tanks, for example, expended 1.9 tones of DU munitions, approximately twice as much as UK troops used in the 1991 Gulf War. DU was used in tank battles, also involving UK troops, to the west and southwest of Basra City.

The UK Ministry of Defense has provided UNEP with details of British DU target locations and has offered to provide advice on carrying out risk assessments on DU within urban areas, and on long-term monitoring of DU in the environment, including water resources. According to the UK Ministry of Defense, target areas are likely to be at a maximum distance of 3 km from firing positions. In June 2003, scientists from the UK Ministry of Defense completed a preliminary technical assessment of some Iraqi tanks thought to have been struck by DU rounds. So far, the UK Ministry of Defense findings indicate very low levels of DU in the vicinity of these tanks. Most of the heavy military equipment has been moved, mainly by troops, from the battlegrounds to scrap areas. While this made it difficult for the UK scientists to find remaining tanks or other heavy military equipment in the actual areas of battle, the scientists noted that most of the tanks found showed low levels of radioactivity, and were clearly marked with paint indicating that they had been hit by DU ammunition.

However, DU was reportedly used extensively in the vicinity of Basra during the 1991 Gulf War and March/April conflict 2003 (UNEP,2003b).

There were several studies which have been conducted to measure the levels of radioactivity in both Basra and other areas of Iraq, such as Al-Jubor (2003), Muhammad (2004), Hussain (2004), Vartanian and Adam (2005), Vartanian (2006), Ali and Al-Baahj (2007), Al-Imarah and Ali (2009), Vartanian and Rashed (2009).

Basra City (the study area) is located at the south of Iraq, on the point of 30º34N and 47º50E coordinate (see Fig.1). The total population is numbered about 1.337.000 person (according to 2002 UN estimates), and the total area is around 270 Km^2.

The present study, thus, aims to detect the levels of radioactive emissions from some military wastes and ground soils in urban area of Basra. These detections, then, may help to determine the magnitude of the health risk posing to local peoples.

Materials and Methods

Measurements of this study have been carried out during 2009. Radioactivity emissions from some military wastes (such as destroyed tanks, armored vehicles, and other equipments and scraps) which located within and in the vicinity of Basra city, as shown in Fig.1, were directly measured by using a portable detector of LB-1200 type, made in Bert Hold, Germany. This detector was used, in the field, to measure the background radiation and particles of Alpha and Beta.

Ground soil samples were collected from various sites in the urban area of Basra city as shown in Fig.1. These samples were selected from both destroyed and undestroyed sites across the rest of the study area. The samples have been taken by shave of the topsoil on the 0-10cm depth form each of sampling sites, and collect them in marked plastic bags of 1kg capacity. Then, the soil samples have been brought into the laboratory, in dried case (within chamber temp.) and spread each one of them in a vessel of 30cm radius. Each of soil samples was measured by using detector Fluke victoreen type, made in the USA. The detector is designed to check levels of Alpha, Beta, and Gamma radionuclides.

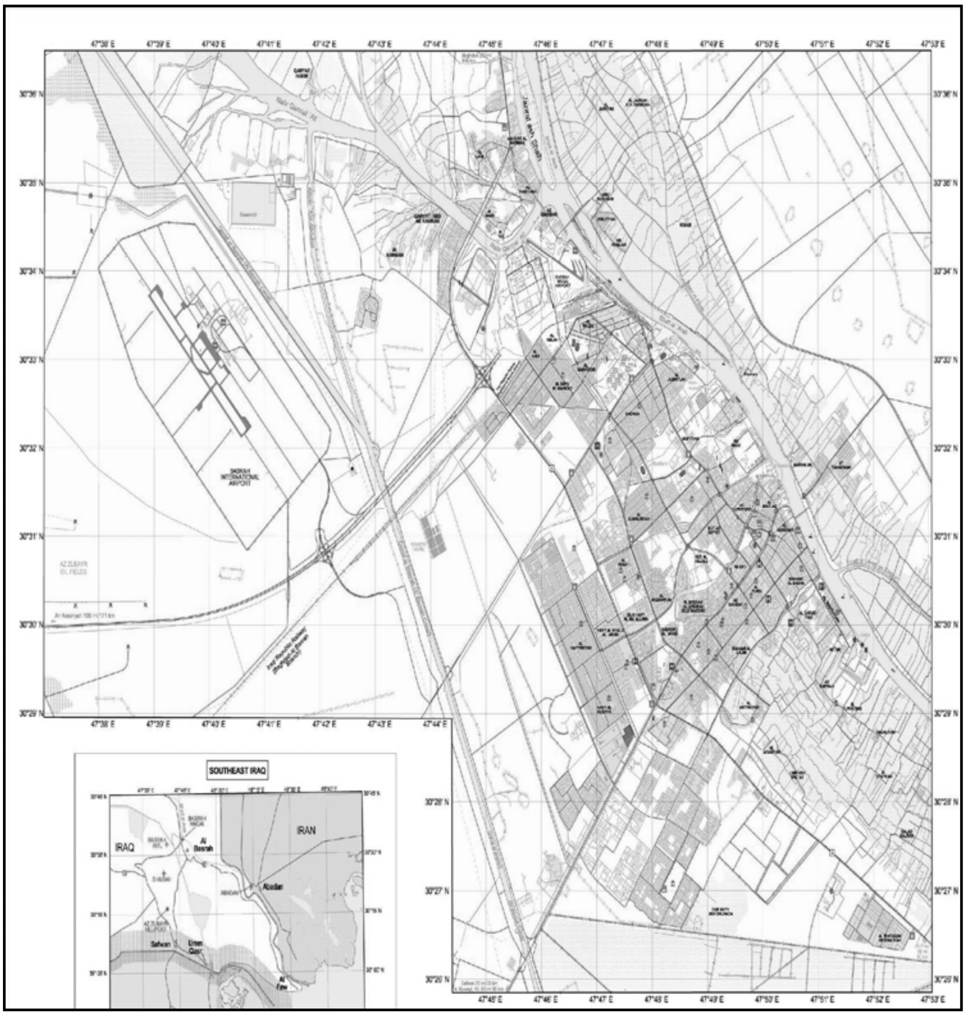


Figure 1: Map of the Study Area (Basra City) and Sampling Sites.

Table.1 shows the radioactivity levels emitted from some military wastes and scrap in the study area. As indicates from the detected values, the destroyed targets offers high concentrations of radionuclides due to their attack by DU ammunition used by the coalition forces during the recent conflict of 2003 (UNEP,2003b). Levels of these radioactive emissions are varied from site to another, it ranged from the minimum is 0.11 – 0.13mr/h as in the sample No.10, to maximum range of 13 – 14.5mr/h as in the sample No.6.

Table 1: Levels of Radioactivity emitted from some Military Waste and Scrap in the Study Area, 2009.

No.	Sampling site	Coordinate	Item	Concentration (mr/h)	Notes
1	Vicinity of Basra Airport	N 30'31'73 E 47'41'85	Destroyed Tank, T55	11.5	-
2	Airport Road	N 30'31'92 E 47'43'58	Destroyed Tank, T55	6.3 - 7	-
3	Airport Road	N 30'31'88 E 47'43'60	Destroyed Armored Vehicle, MTLB	3.2 - 4	-
4	Vicinity of Basra University Gate, Garmmat Ali	N 30'33'13 E 47'44'49	Destroyed Military Vehicle, Eva	0.7 – 0.9	New Finding
5	Vicinity of Police Academia, Maqal District	N 30'35'55 E 47'46'31	Destroyed Antiaircraft Ordnance of 57mm	0.13 – 0.20	-
6	Scrap Complex, Al-Asdaka District	N 30'30'54 E 47'46'49	Destroyed Ordnance of 155mm	13 – 14.5	New Finding

7	Scrap Complex, Al-Asdaka District	N 30'30'54 E 47'46'49	Destroyed Electric Transformer	0.78	New Finding
8	Scarp Complex, Vicinity of Hamdan Hotel, Ashar District	N 30'31'10 E 47'50'12	Military Scrap	3.5 - 5	New Finding
9	Qublah District	N 30'26'82 E 47'47'49	Destroyed Radio Tower	12	New Finding
10	Vicinity of AzZubyer Bridge	N 30'26'96 E 47'45'48	Destroyed Armored Vehicle, MTLB	0.11 – 0.13	-
11	Industrial District Road	N 30'26'51 E 47'52'82	Destroyed Tank, T55	6 – 7.1	-
12	Background Radiation			0.008 – 0.015	-

The spatial variability of these radioactivity levels emitted from destroyed targets could be explained on the basis of two reasons: firstly; noted that emissions from radioactive isotopes exist in the oil fields (Al-Imarah and Ali, 2009). Secondly; radioactivity reduced by the U238 decay series into isotopes have the ability to emit Alpha and Beta particles in the form of radionuclides (Al-Azzawi and Al-Naemi, 2002).

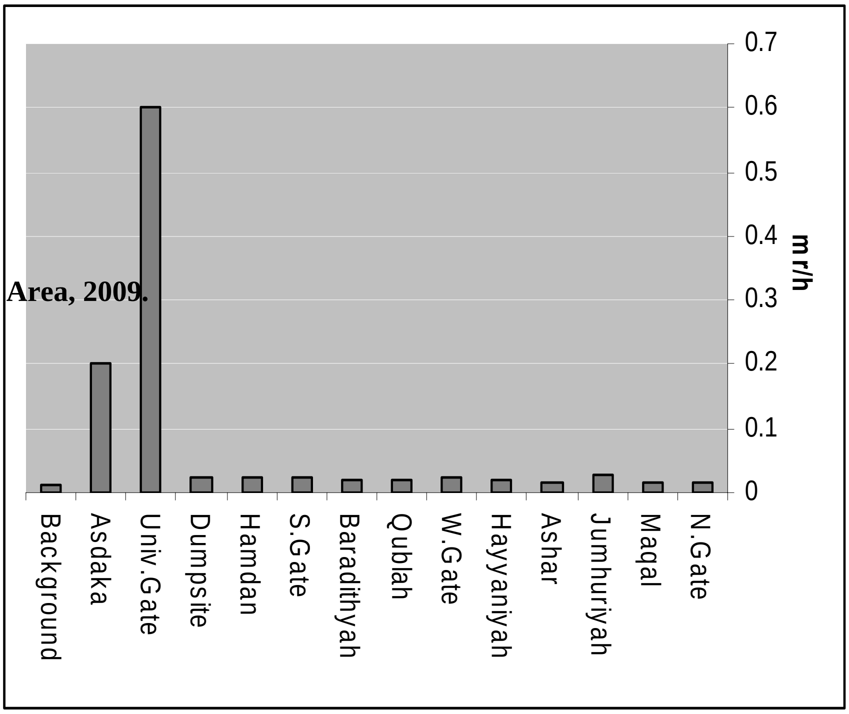
The highest levels of radioactive emissions to these targets could be realized by comparing with the level of background radiation in sample No.12 (as seen in Tab.1). By this comparison, there is a significant difference between the detected values and background radiation value. These destroyed targets, thus, may consider as radioactive "hot spots" and as a source of environmental contamination, as well as it represents a threat to public health, particularly when approaching them, because of the releasing radionuclides known to be carcinogens.

Table.2, graphically represented in Figure.2, shows the results of the radioactive survey for soils that have been carried out in the study area. It is clear that the levels of radioactivity emitted from soils for all of the sampling sites, except for the samples of Nos.12 and 13, were low. In the respect of undestroyed sampling sites, the radioactivity levels in soils ranged from the minimum of 0.015mr/h in the sample

Table 2: Levels of Radioactivity emitted from some Urban Soil Samples in the Study Area, 2009.

No.	Sampling site	Coordinate	Concentration Range (mr/h)	Concentration Average (mr/h)	Notes
1	Northern Gate on Basra City (Garmmat Gate)	N 30'33'29 E 47'44'23	0.014 – 0.016	0.015	undestroyed
2	Maqal District	N 30'33'16 E 47'46'36	0.013 – 0.020	0.016	undestroyed
3	Jumhuriyah District	N 30'31'17 E 47'47'55	0.025 – 0.030	0.027	undestroyed
4	Ashar District	N 30'31'10 E 47'50'12	0.015 – 0.017	0.016	undestroyed
5	Hayyaniyah District	N 30'30'23 E 47'49'39	0.018 – 0.020	0.019	undestroyed

6	Western Gate on Basra City (AzZubyer Bridge Gate)	N 30'23'01 E 47'42'14	0.025 – 0.026	0.025	undestroyed
7	Qublah District	N 30'27'40 E 47'48'34	0.017 – 0.020	0.018	undestroyed
8	Baradithyah District	N 30'29'59 E 47'51'09	0.019 – 0.020	0.019	undestroyed
9	Southern Gate on Basra City (Abo Al-Khaseb Gate)	N 30'30'01 E 47'50'42	0.019 – 0.032	0.025	undestroyed
10	Hamdan Industrial District	N 30'26'48 E 47'51'56	0.020 – 0.027	0.023	undestroyed
11	Main Dumpsite	N 30'28'53 E 47'43'44	0.017 – 0.027	0.022	undestroyed
12	Vicinity of Basra University Gate, Garmmat Ali	N 30'33'13 E 47'44'49	0.6 – 0.7	0.6	destroyed
13	Al-Asdaka District	N 30'30'54 E 47'46'49	0.2 -0.3	0.2	destroyed
14	Background Radiation		– 0.015 0.008	0.011	-



Samples in the Study Area, 2009.

Figure 2: A Graphic Representation of the Levels of Radioactivity emitted from Soil Samples in the Study Area, 2009.

maximum of 0.027mr/h in the sample No.3 (as seen in Tab.2 and Fig.2). Although these detected values which are, as mentioned above, for undestroyed sites, were relatively higher than background radiation average (0.011mr/h), it means that these samples may indirectly affect by the radioactive pollution due to the use of DU. Such case could be occurred through radioactive dust fallout on the ground soil surface. This impact is notable in the soil samples hereby two destroyed targets of Nos.12 and 13; the concentrations were reached to 0.6 and 0.2mr/h respectively.

The spatial variability in radioactivity levels for the destroyed sample sites of soils may be referred to target attacked by DU weapon, leading to generate intense energy as resulted, in turn, in very fine particles of airborne uranium oxides in the form of dust, smog, or aerosols. Resulting radioactive particles could be carried by wind for long distances, then ultimately deposited on the earth's surface, causing contaminate the soil and water (Hamilton,2004). Moreover, DU ammunition which stroke the targets in a wrong way may settle on the ground soil or buried inside it.

The low radioactive pollution in undestroyed sampling sites might be referred to the environmental and climatic factors, such as wind, rainfall, erosion agents, which plays a major role in the spread and carry the radionuclides from one site to another site. Another factor affecting the level of radioactive pollution is soil texture. As the soil texture is fine (i.e. clay-silt) and rich in organic matter, as in the study area, its capacity of radionuclides absorption will be higher (Vartanian,2006). Soil can be affected by radionuclides, it can penetrate the soil from surface deposits, and can transfer with irrigated water from the rotting zone by infiltration into deeper soil and by radioactive decay (Eral *et al*.,2003). In general, the distribution of radionuclides in soils depends on several factors including mineralogy, type of soils, as well as the microbiological processes taking place within the profile. So while most plutonium is largely associated with organic matter and colloidal soil oxides, it is well known that ^{137}Cs is preferentially associated with clay minerals in the interlayer exchange sites (Mirsal,2008).

The carrying of military waste and scrap from battlegrounds into the urban areas was one of the most important anthropogenic factors that has been contributed to the increase of the radioactive pollutants in the study area.

Consequently, radioactive pollution in the urban environment of Basra city is worrying. The releasing ionizing radiations may lead to many cancer incidences. A study on radiological dose in Basra (Al-Azzwai and Al-Naemi, 2002), for example, found that the studied group has received an annual whole body dose of 442-577 mSv (44.2-57.7rem) from inhaling DU oxides compared to 2.4 mSv (0.24rem) total annual dose the human body receives from all radioactive sources in the environment. This is perhaps explained the recent significant increase in incidence rates of cancer among many peoples.

Conclusion

The present study concluded that some spots at Basra city in which contained military wastes and scraps may consider as a radioactive emission source. However, there are little radioactive contamination in Basra soil, except for limited spots.

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