Radioactive Doses Contamination in Al-Tuwaitha Nuclear Site, Using GIS Techniques

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ABSTRACT

In this paper, the authors aim to introduce contamination in Al Tuwaitha nuclear site, Iraq using GIS techniques and visual interpretation. This contamination problem draws attention to the new result of high-radiation dose equivalents found in part of the country. The radiation levels in Al Tuwaitha nuclear site, compared with the international standards of UNSCEAR 2000 and world nuclear association (WNA 2011), the absorbed doses in the study area vary between (0.01-140) mrad/hr, in Al Tuwaitha nuclear research center. The maximum radiation dose was nearby the Russian 5 MW reactor. The absorbed dose in Russian 5 MW reactor was about (140) mrad/hr which is the highest hotspot in Al Tuwaitha nuclear research center. The obtained values of the average absorbed dose rate level are exceeding the permitted level by (9500) times higher than environmental levels given by UNSCEAR (2000).

Keywords: Al Tuwaitha Nuclear Site, Iraq, GIS Techniques and Visual Interpretation, Exposure and Dose Rate.

التلوث الاشعاعي لموقع التويثه النووي باستخدام تقنيات نظم المعلومات الجغرافيه

الخلاصة

في هذا البحث يهدف الباحثون الى تعريف التلوث لموقع التويثه النووي في العراق باستخدام نظم المعلومات الجغرافيه وطرق التحليل .مشكله التلوث هذه تبين نتائج جديدة لتركيز التلوث الاشعاعي الموجود في بعض مناطق البلاد .حيث ان مستوى الاشعاع في موقع التويثه النووي قورن مع المعايير العالميه للجنة الأمم المتحدة العلمية المعنية بآثار الإشعاع الذري UNSCEAR لسنه ٢٠٠٠ ومنظمه النوويه العالميه (WNA) لسنه ٢٠١١ . وقد وجد ان الاشعاع الممتص في منطقه الدراسة يتراوح بين (١٤٠-٠,٠١) mrad/hr . واعلى تركيز اشعاعي وجد قرب المفاعل الروسي 5MW . والتركيز الاشعاع الممتص فيه يقارب ١٤٠ mrad/hr والتي تعتبر اعلى نقطه ساخنة في موقع التويثه

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للأبحـــاث النوويـــه . وهـــذه القيمـــه تجـــاوزت (٩٥٠٠) مـــره اعلـــى مـــن الحـــدود المسموح بها لمعايير لجنة الأمم المتحدة العلمية المعنية بآثار الإشعاع الذري UNSCEAR لسنه ٢٠٠٠.

INTRODUCTION

There are number of sites in Iraq which have been used for nuclear activities and which contain potentially significant amounts of radioactive material. The principal nuclear site is Al Tuwaitha nuclear research center which contains about 18 facilities including Research reactors, hot cells, waste treatment and storage facilities. Al Tuwaitha site considered as unique case most of its facilities suffer substantial physical damage during the Gulf Wars and have been subjected to subsequent looting. Despite the long history of nuclear programs at Al Tuwaitha no significant radioactive contamination as a result of normal operations has been officially reported for the site or surrounding communities Radionuclide's are present in the environment and within the remaining structures. Location of these facilities are shown in Figure (1).

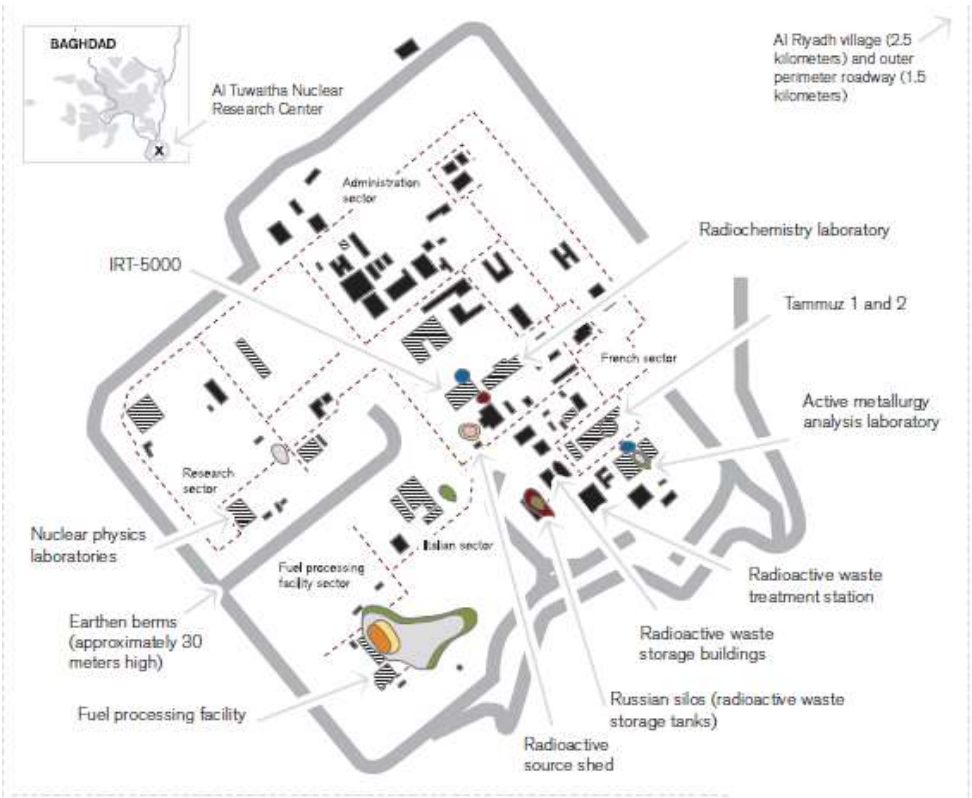

Figure (1) Map of Al Tuwaitha nuclear site Facilities (Chesser et al, 2009).

Radiation is known to cause cancer in humans and can also cause other adverse health effects, including genetic defects in the children of exposed parents or mental

retardation in the children of mothers exposed during pregnancy. The risk of these other effects is much less than the risk of developing cancer due to radiation exposure. The contaminated area was investigated and determined by using the integration of Geographic Information Systems (GIS) and statistical software.

This study introduces radioactive doses in Al Tuwaitha nuclear site and further complementary studies have been done to measure the dose and radiation rate in Iraq. Al Sharaa Hisham, 2012 [1] introduces more information about radioactivity dose in Al Tuwaitha site. This study goes, also, with the other studies which were done at different areas in Al Tuwaitha nuclear site ([2]; [3]; [4]; [5]).

AL TUWAITHA SITE DESCRIPTION

Al Tuwaitha Nuclear Research Center covers an area about 1.3 km^2 and is located approximately 1 km east of the Tigris River 18 km south of Baghdad. This site is fortified by large earthen be ams around the key facilities which cover over one km^2 which includes two research reactors (Osiraq and IRT-5000) a fuel fabrication facility, plutonium separation uranium enrichment, waste storage facilities and many other facilities, [4],[6]. The nuclear research facilities at Al Tuwaitha were built by various companies during the development of the Iraq's peaceful nuclear program. Therefore, the area inside the earthen beam is divided into many sectors. French, Italian, and Russian sectors are so named according to the nationality of the companies that designed and built the nuclear research facilities. Fig (1) illustrates the buildings layout within Al Tuwaitha region and the associated sector names. At gulf wars, the IRT 5000, Tammuz-2, radiochemistry and nuclear physics laboratories, fuel fabrication laboratories, the radioactive waste treatment station, and nuclear material stores were seriously destroyed. In late-April 2003, a documented radioactive dispersal occurred [6]. Iraqi civilians looted perimeter storage areas at Al Tuwaitha and dumped more than 200 barrels of uranium compounds in the form of yellowcake near the village of Ishtar. The barrels, still containing more than 10 kilograms of yellowcake residue, were transferred to nearby villages and used for household storage. Uranium residue from the looted barrels was likely dumped in residential areas prior to recovery of the containers. Coalition forces, IAEC hazmat teams, and others recovered most of the barrels and dumped yellowcake by June 2003. Also, they recovered numerous cesium and cobalt sources that possessed acute danger to surrounding communities. Subsequently, all high-level radioactive materials at the site were secured and transported out of Iraq. Remaining sources and unsecured radioactive materials were consolidated into on-site bunkers and storage buildings [6].

MATERIALS AND METHODS

In this paper, total of 201 soil samples were analyzed. The radioactivity data samples used in this paper were collected in 2009 were provided by Ministry of Science and Technology (MOST). They were collected locations with effective gamma and beta dose rates were measured (1-meter heigh) at same locations, they were collected from inner and outer perimeters of Al-Tuwaitha complex, storage location and the ditches along the outer perimeter highway Figure (2). While the background level is defined from samples collected within Baghdad city 18 km far from Al-Tuwaitha site, the output digital map layer includes contours for exposures dose radioactive maps were created by additive interpolation method of the

geographical information system using the integration between ArcGIS 9.3 and golden surfer. With ArcMap and Surfer spatial analysis extension and, DATA of subareas values can be imported to GIS through grid cells. These grid cells which have been classified in various ways and different colors are chosen for each class; the colors represent the progression of values for specified data. It is achieved after the raster themes are converted into a shape file, which includes radioactivity and information that represents sub grade characteristics. Data are interpolated by kriging method to introduce a continuous surface as visual display by using spatial interpolation which is the process of using points with known values to estimate values at other unknown points. In GIS, spatial interpolation of these points can be applied to create a raster surface with estimations made for all raster cells. [7]**,** [8]**,** [9] and [10]

RESULTS

The exposure doses in the study area vary between (0.01-110) mrad/hr, as shown in Figure (2and 3) as contour and 'mountain range' plots. Most of the outside perimeter areas of the nuclear center areas have value around (0.01) mrad/hr or less. However, these values increase to (5-40) mrad/hr in Al Tuwaitha site. The dose rates rise in the range between (50-110) mrad/hr in the IRT5000 (Russian) reactor, radiochemical laboratory, nuclear physical laboratory, Tammuz (1 and 2) reactors, Fuel fabrication facility and dose spots on location C as shown in Figure (3).

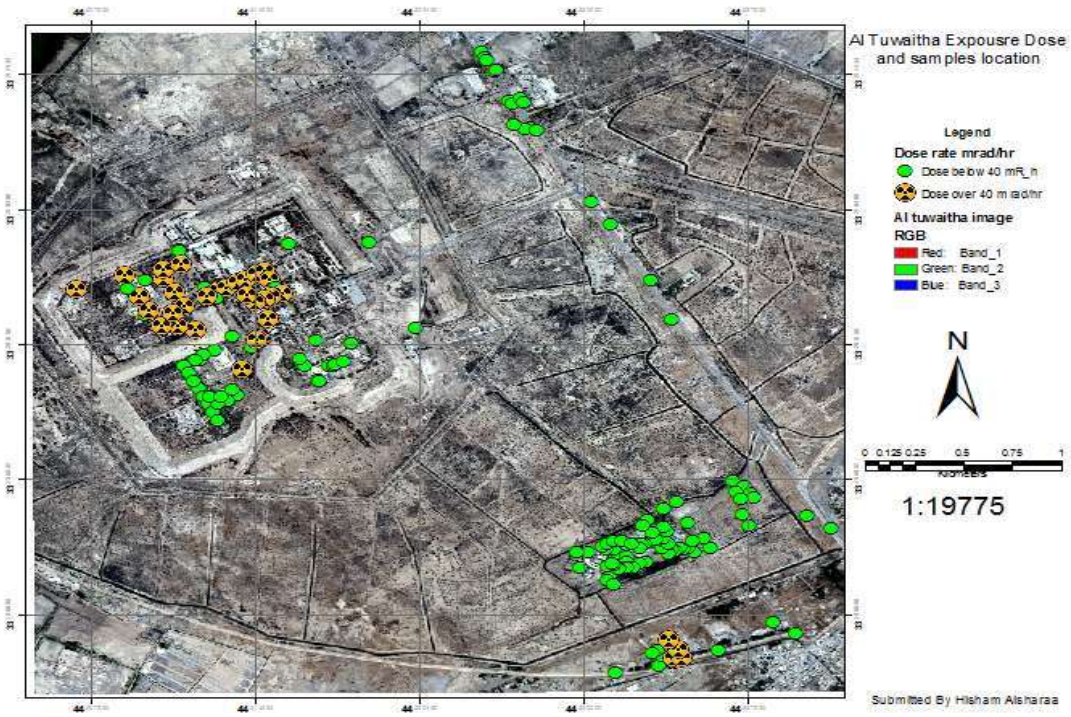

Figure (2) Photo map of samples locations.

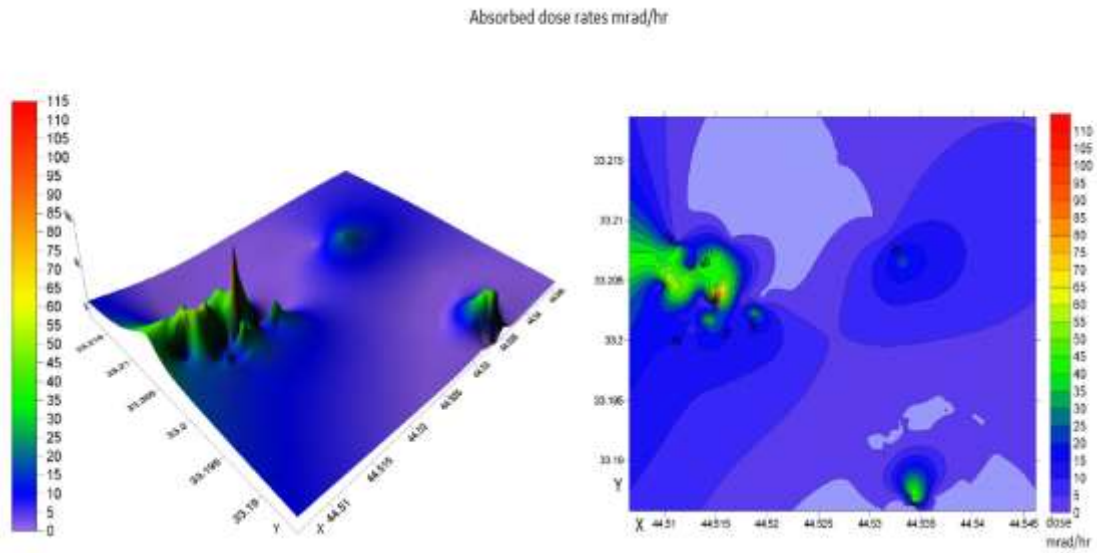

Figure (3) Dose rate contour and 'mountain range' plots.

The obtained values of dose rate level as average absorbed dose for locations mentioned above are exceed the permitted level by (9500) times acknowledged by UNSCEAR (2000).

For comparison with other international registered high radiation areas, represents the registered gamma absorbed dose rates in the world [11] including the results registered in this study can see high contamination on it Figure (2).

DISCUSSION

Dose rates at IRT 5000 (Russian reactor) and uranium storage (location C) are higher than those in other locations, because they represent the bombardment nuclear reactor in 1991 and radioactive material storage facility. The international average ranges from 0.02 mrad/hr as typical background limited to 0.2 mrad/hr. [12]. The external dose rate of the high radiation zone measured to be 140 mrad/hr on IRT 5000 and from 55-60 mrad/hr near location C. This was approximately more than 9600 times greater than the dose rates obtained outside the Al Tuwaitha site. The possible sources of these doses are the serious severely damaged during bombing in gulf wars and 2003 situation, the people near Al Tuwaitha has breached into the facility and carted off anything that looked useful or saleable or just interesting brightly colored 55-gallon barrels were especially prized looting , which are highly concentrated in areas. Further investigation should be done using gamma spectroscopy techniques based on NaI(Tl) and HPGe detectors. It is important to utilize these investigations to estimate the doses received by the visitors and workers in Al Tuwaitha nuclear research center.

At the same time, it is very important to investigate the proper health benefits gained by visitors and residents in the surrounding villages, and city according to potential areas of human health risks must be identified and consideration must be given to maintenance and inspection based on risk assessment.

CONCLUSIONS

It is concluded that radiation doses in Al Tuwaitha nuclear site region surveyed was found to range from 0.01 to140 mrad/hr as measured in IRT5000 (Russian) reactor, radiochemical laboratory, nuclear physical laboratory, Tammuz (1, 2) reactors, Fuel fabrication facility. The obtained values of absorbed dose rate exceed the permitted level by (9500) times UNSCEAR (2000). The gamma doses outside the site from 0.01 to 0.2 mrad/hr, which is very low. More research on the effect of this site should be done. Ongoing monitoring of health status of visitors and worker in this site should also be done.

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