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Using Reflection Anomalies to Detect Radioactive Contaminations in Nineveh Governorate Northern Iraq

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Abstract

Remote sensing techniques were used to detect changes in landuse and its relation with the environmental pollution, in the southern and northern limbs of Allan and Atshan structures respectively, within Nineveh Governorate northern Iraq.
Time sequential images had been used in order to determine and detect the changes that have taken place over the last two decades, which may have manifested through a combination of threats to the region. These changes could be checked by digital comparison between more than one satellite image data in different time intervals.
Landsat imagery taken in January (2004) shows local reflection anomalies throughout the study area. On the contrary, no such anomalies had been observed in previous acquired imagery. This information is used in conjuction with the analysis of geomorphological features, field measurment data, and digital image processing techniques to confirm the local radioactive contaminations. Such information is a prerequiste for any environmental pollution program in the study area.
Occupation forces must allow UNEP and WHO and other international agencies to conduct any exploration programs to assess the health risks to the people of Iraq of these radioactive contaminants since1991.

Keywords: Reflection Anomalies, Radioactive Contaminations, Nineveh,Iraq

1 Introduction

The studied area is located, physiographically within the Low Folded Zone, north west of Iraq. It is about 30 Km NW of Mosul city (Figure 1).

1Remote Sensing Center-Mosul University.

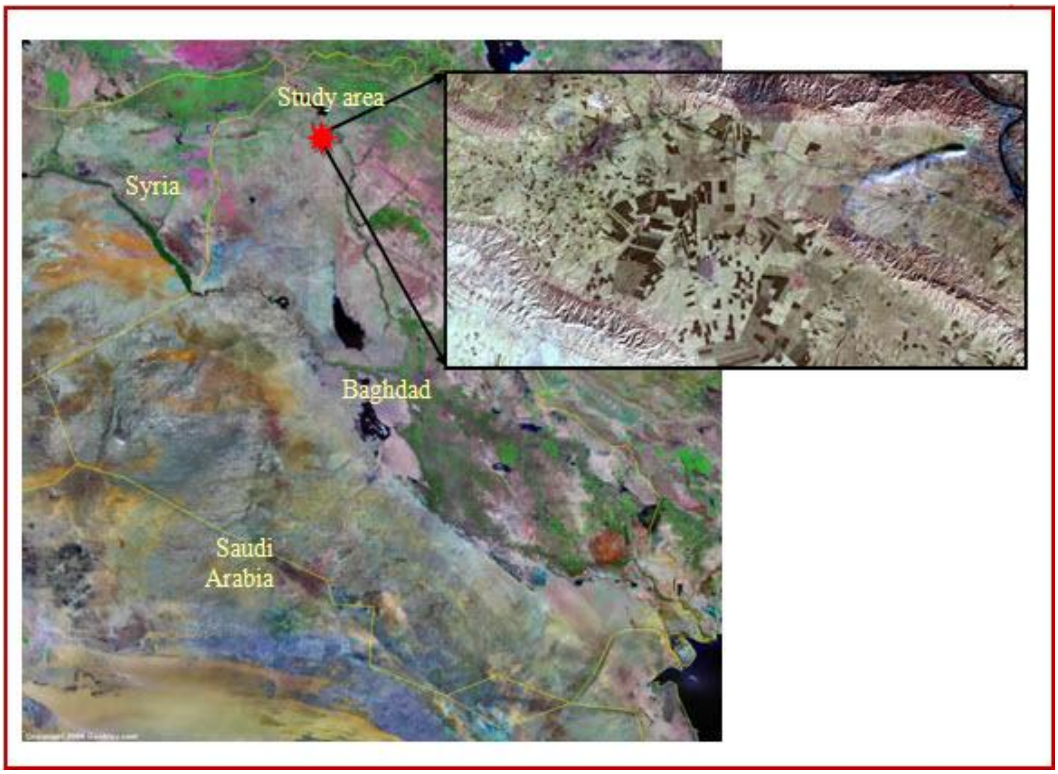


Figure 1: Location map of the study area

This study area is an approximately (380) Km2 and is located between 36° 18° 50° and 36° 28° 05° latitude north and between 42° 37' 5" and 42° 58' 40" longitude east of Greenwich. It included the area between Alan and Atshan anticlines and vicinity of the Badoosh Basin.

Complete coverage of Nineveh Governorate by landsat imagery has been analyzed for detecting suspected areas of radioactive contaminations, and for rationalizing the relationship between those deduced from reflection anomalies and field measurements.

The aim of this study is to detect radioactive contaminations in Nineveh Governorate using remote sensing techniques and GIS applications, beside all other types of available data, and to clarify the status of the sites that are located within the studied area.

2 Materials and Methodology

To achieve the aim of this study, the following available data in the archive of remote sensing center of Mosul University are used:

1-Geological reports and map at (1:250.000) scale

2-Topographical map at (1:50.000) scale

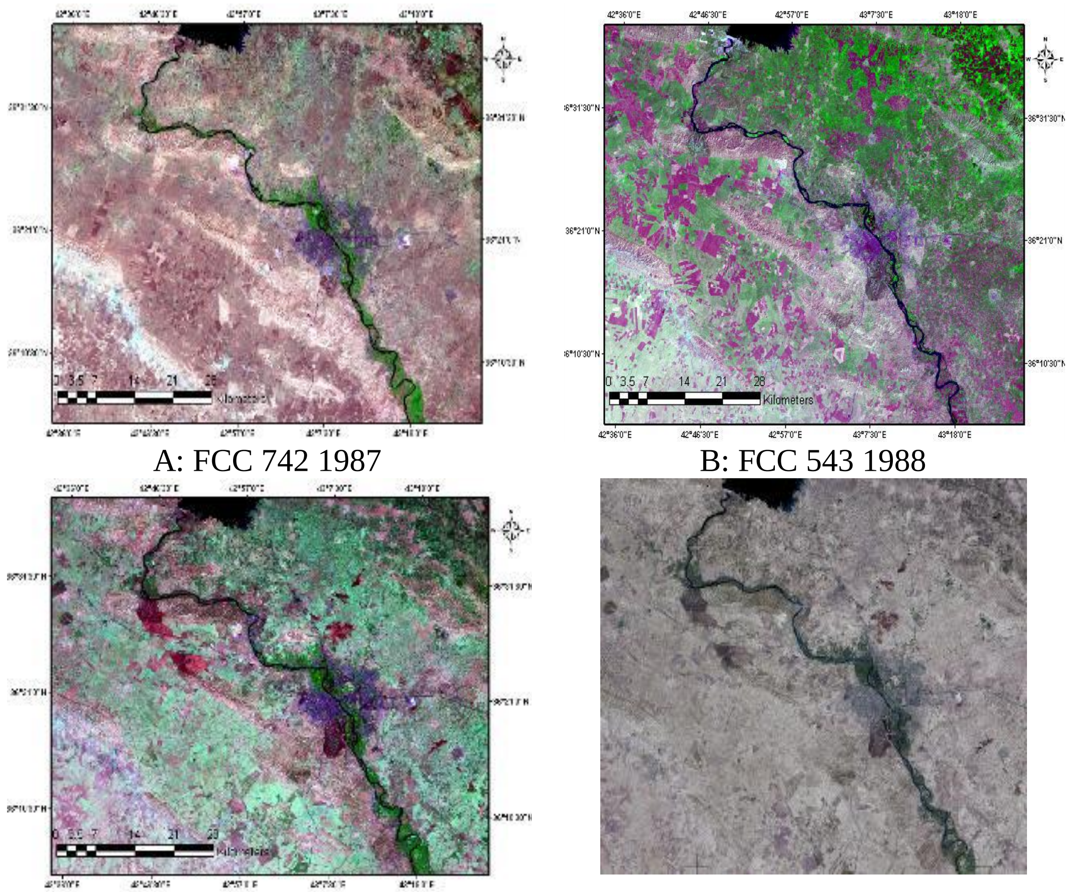
3-Multidate Landsat images with different combinations of many bands were used for visual and digital interpretation (Figure 2).

4-Topographical map and digital elevation data, which later on were used for DEM generation, slope angle map, drainage basin map.

5-ERDAS Imagine V. 9.1 software was used for image processing and change detection. Arc GIS V. 9.1 software was used for data analysis and map composition.

Table 1: Data from analysis of samples.

Landsat	Bands	Data
False color TM	7,4,2	6-4-1987
False color TM	5,4,3	3-2-1988
False color TM	5,4,3	10-1-2004
Normal color TM	1,2,3	20-5-2007



A: FCC 742 1987

B: FCC 543 1988

Figure 2: Multi date Landsat images used in this study

3 Geomorphic Landforms Analysis

Based on observation of individual geomorphic units and landforms from dynamic, tectonic and morphogenetic aspects, the study area was divided into two geomorphic zones. These are characterized and described below as they appear in the image (Figure 3) [1].

Figure 3: Geomorphic classification map as illustrated on Landsat TM 2, 3, 4 bands combination

A. Anticlinal Structural Ridge Zone**:**
Within the study area, there are three large discrete NW-SE and E-W oriented anticlinal structures severely dissected by many dry valleys. The folds include Alan, Atshan and Zambar-Ibrahim anticlinal structures from north to south.
The axial traces of these en ěchelon folds are discontinuous, when traced through the whole fold system. The synclines occupy a broad topographic low plains covered with thick Quaternary sediments.
The general elevation of the plains is ± 270 m (A.S.L.); Jebel Zamber-Ibrahim, at 593 m is the highest point on the structures.
B. Pediment Surfaces:
The most obvious area in this map is the zone of pediment surfaces that surround the anticlinal structures. These surfaces surround the flanks of above anticlinal structures, and can be divided into two subzones, according to the degree of geomorphologic processes and evolutions, these are:
-Accumulation footslope.
-Erosional footslope.
Accumulaton surfaces are plantation surfaces at a slope of (1-7)° developed by pedimentation. Erosion surfaces tend to occupy gently rolling terrain. However, the inclination of the erosional surfaces vary from (7-13)°

4 Classification and Change Detection

Change detection is the process of identifying differences in the state of an object or phenomenon by observing it at different times; it involves the ability to quantify temporal effects using multi-temporal data sets [2].

Many types of remote sensing techniques were used to analyze and output data related to the change in environment [3]. The main change detection techniques include popular methods, such as image differencing, image regression and image ratio. The basic premise behind these methods is to use basic algebra, such as subtraction or division to extract the change between two images of different dates. The change is then identified and quantified using different thresholds.

We applied ERDAS V. 9.1 software on a scene in Nineveh Governorate taken by the TM on the Satellite Landsat with resolution 30 m acquired 10/1/2004. Three bands were used of Landsat they are:

TM1 (0.45-0.52) µm, TM2 (0.52-0.60) µm and TM3 (0.63-0.69) µm.

ERDAS V. 9.1 software comprises many choices to be benefited in multi-spectral image classification as shown in (Figure 4 a,b,c) and one of these choices is level slicing image which is used in the test of training area to be used later in supervised classification (Figure 4c) [4].

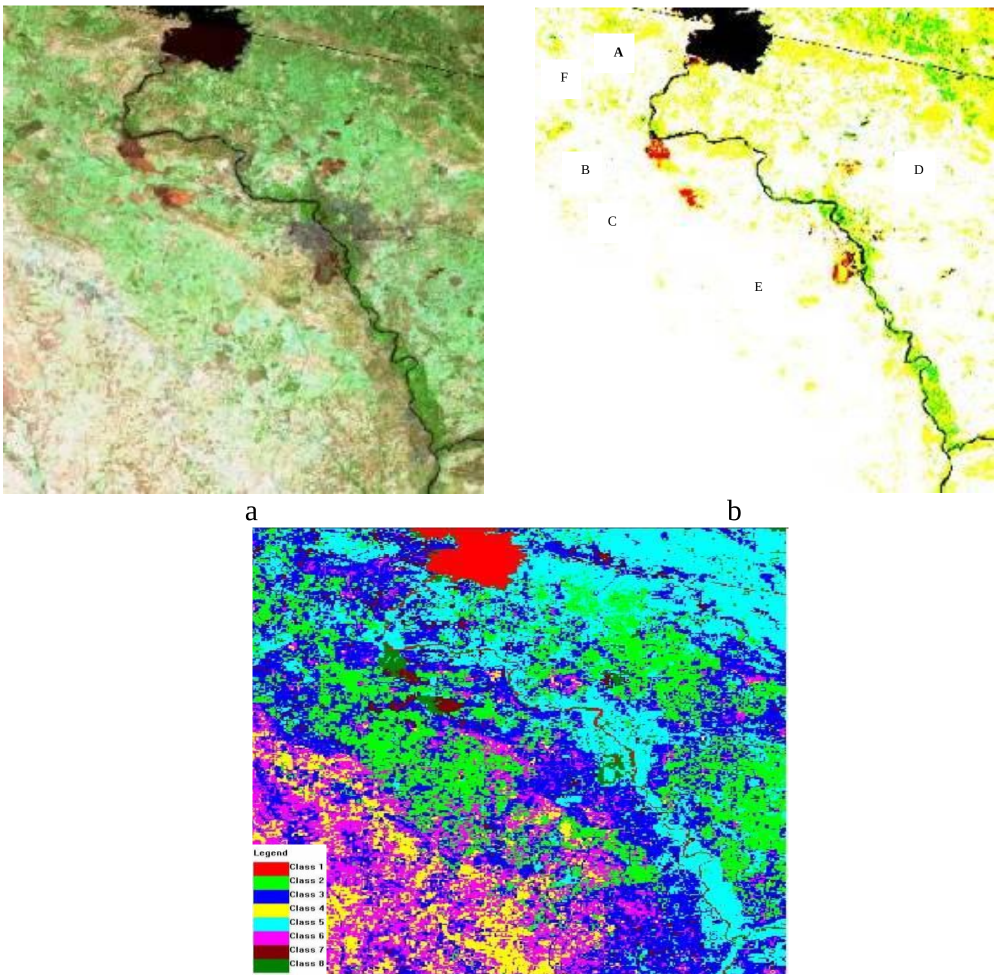


Figure 4.a: Landsat image of Nineveh Governorate acquired 2004.b: Enhanced image of the study area showing the contaminated areas. c: Supervised classification and its relationship with landuse of the study area

If a comparison was made between the available images, the result shows the significance of using supervised classification for multi-spectral images containing local reflection anomalies throughout the study area. Contrast stretching adjustment for three TM channels (TM123) were tested and proved the best technique to highlight and enhanced the reflection anomalies of the contaminated areas.
The result of visual interpretation of multi-temporal imagery for 1987, 1988 and 2004. It is clear that in 2004, the study showed the possibilities to detect the local reflection anomalies phenomena. The pixels having duller shade of orange are generally areas that have medium to high vulnerability of radioactive contaminations in Nineveh Governorate (Figure 4b) [4].

4.1 Down Loading Digital Elevation Model (DEM)

It is very useful for geomorphologic hazards map project to perform further analysis and to establish a set of supportive information in a form of geo-referenced database especially for project using GIS which provides valuable analysis tools that make the process simpler and gives very useful results for decision makers. For this purpose, a set of derivative maps were produced as follows:

4.2 A- Topographic (DEM) Map.

The basic datum for this map (Figure 5) was a digital terrain model compiled using software available at Remoteote Sensing Centre. For each generalized DEM a contour plot was made using the Arc GIS V.9.1 software. A close examination of the plot reveals that the DEM matches quite well with the topographic contours map that was available at scale of 1:50.000.

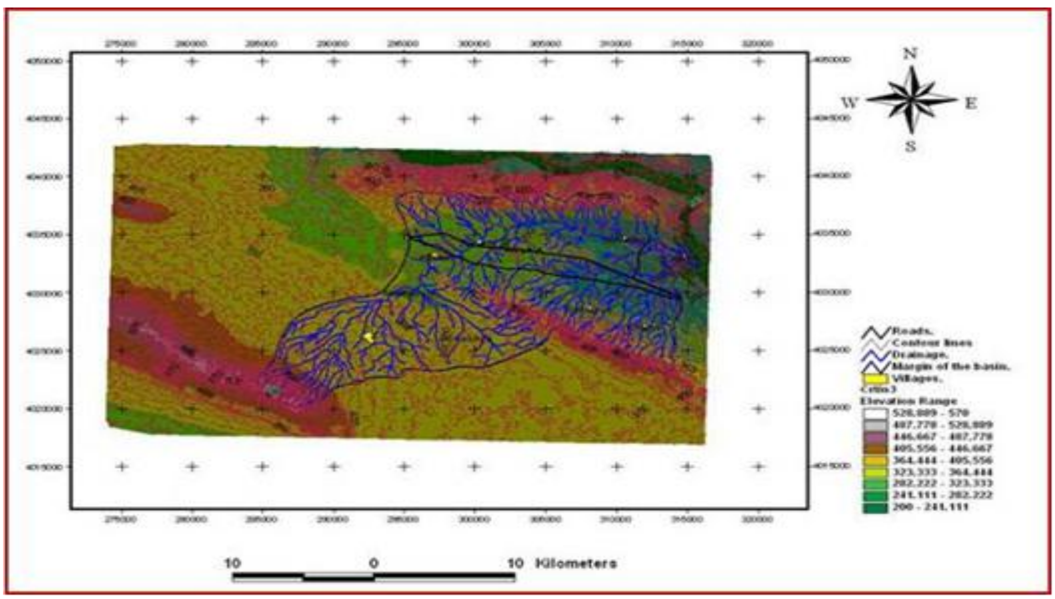


Figure 5: Topographic contour map as illustrated by digital elevation model
Relationships between erosion rates and gully area are significant for assessing the contribution from gullies in the contaminants sub-basin catchment to the sediment budget

of the Badoosh catchment. A combination of sleeper slopes, higher elevation range and the relatively moderate annual rainfall of the Badoosh Basin probably accounts for the larger gullies and,hence, higher erosion rates there, despite the bedrock materials being more resistant to erosion than those of the footslope site. Digital Elevation Models constructed from Imagery also have many advantages over traditional field measurements, and they are becoming a more accepted tool in geomorphological hazard research as the cost of hardware decline and the available technology improves over time.

4.3 B-Slope Angle Map

The slope function calculates the maximum rate of change between each cell and its neighbours, for example, the steepest downhill decent for the cell (the maximum change of elevation over the distance between the cell and its eight neighbours). Figure 6 shows the study area and the derived slope map, where every cell in the output raster has a slope value and the output slope dataset can be calculated as percent slope or degree of slope. We benefit from this analysis function in the determination of the location of the contaminated sites in the study area, besides calculating the slopes of the segments by drawing profiles and determine the potential regions(i. e., contaminants sub-basin catchment) [5].

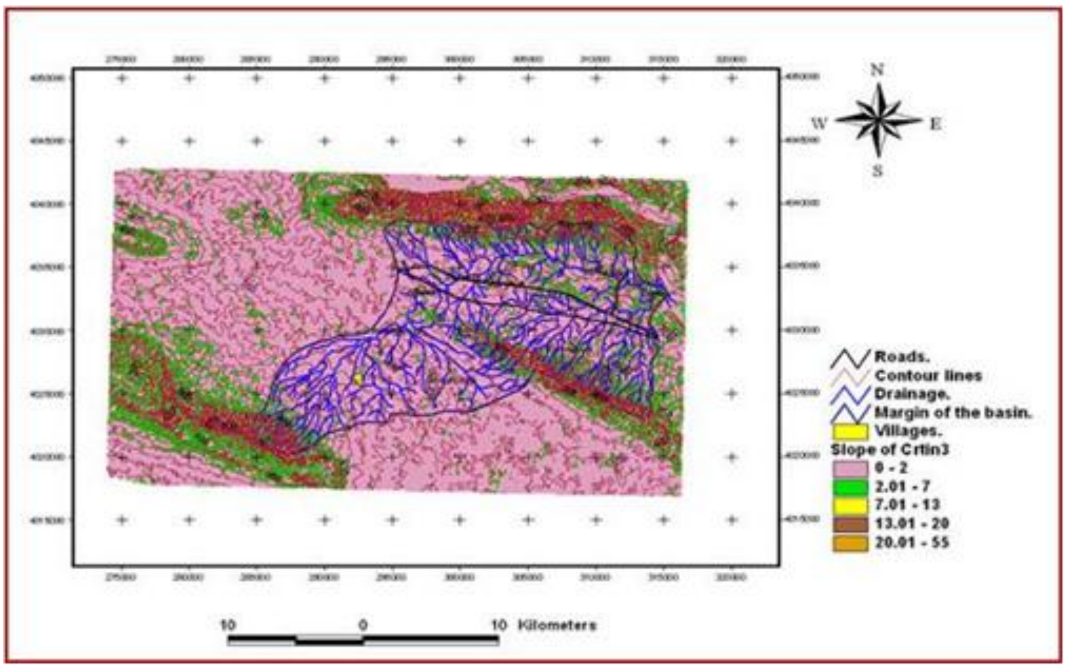


Figure 6: Slope angle classification map of the study area

4.4 Down Loading Drainage Base Map

In order to established drainage networks, we need to trace stream paths (Figure 7) [5]. The study area is characterized by parallel pattern of drainage which is common where slopes are steep and pronounced (i.e. consequent valley) which follows in general the trend of dip and zones of structural ridges.

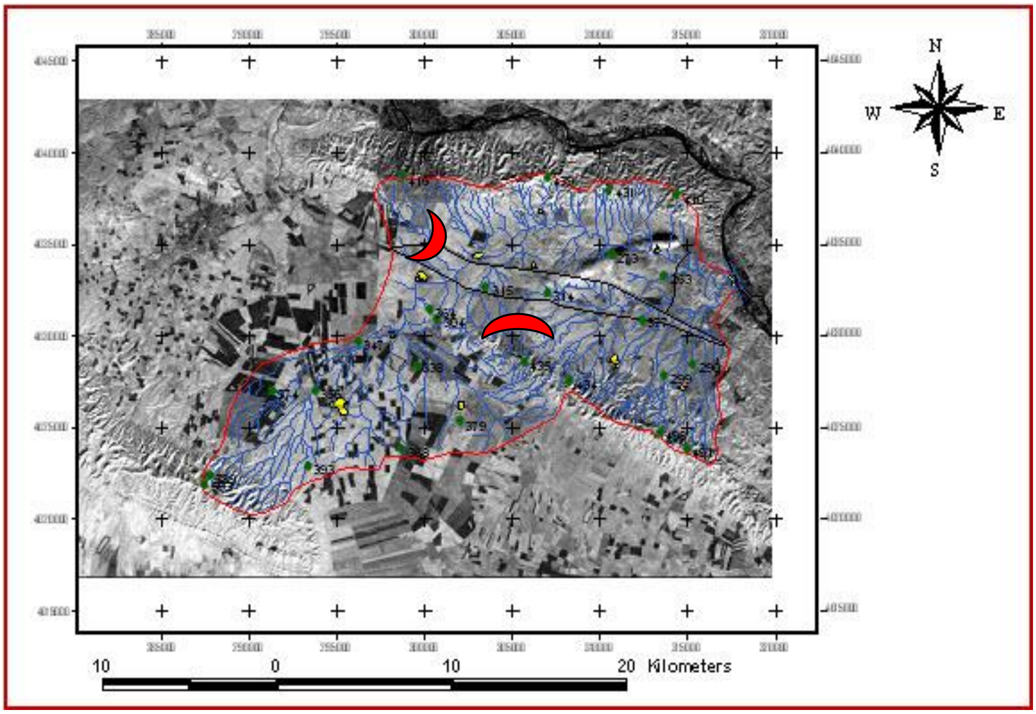


Figure 7: Drainage base map of Badoosh Basin

A second type of drainage is the dendritic pattern which follows in general, flat to gently sloping area of the Accumulation/ Erosion plains.
The Badoosh basin (seasonal flow) is drained into the Tigris River near Badoosh city. Main annual rainfall in the highland area is about 328.5 mm. There is a considerable seasonal variation with most of the precipitation falling during the winter months, much of its concentrated within a short period of days. It is believes that rainfall is play a role in responsible for migration of radioactive materials downstream.
The water in Badoosh basin is characterized by rapid high to moderate mobility because of rapid and abundant rain storms that fall on mountain outlets. For that, the majority of sub-basin coming from mountain heights (e.g. the two contaminated sub-basins) drain high flush floods in very short times. These flush floods erode soils and the contaminated substances downstream, which causes huge environmental risks in the landuse and the Tigris River later on.
A special purpose drainage map was prepared (Figure 7) showing the best location sites for small dams on the main flow of these two sub-basins. These barriers used to prevent migration of radioactive contaminations from reaching the Tigris River.

5 Impact of Radioactive Disaster

Natural and man-made disasters can be considered a big challenge to the operation of constructional development, causing big human and material losses and damage, and occasioning economic, health, and social problems especially in developing countries such as Iraq that lack advanced technologies and sound planning [6].

The problematic of the study has to do with haphazard bombardment and destruction of the military buildings and infrastructure especially in the Nineveh Governorate in the last two decades. However such disasters may stimulate scholars and specialists to benefit from them by studying these sites and to know how to deal with them to alleviate their destructive effect on people. The disasters that have befallen Iraq in the last two decades such as targeting the infrastructure of the country, continual destructive bombardment of industrial, civil and military buildings which was followed by years of difficult miserable years of siege, leading to human, environmental and health disasters [7, 8].

The colonization of Iraq followed under the American leadership of armies from all over the world, occasioning utter destruction, haphazard bombardment which cost a total ruination of the infrastructure of the country. The speed of the local reflection phenomenon, as a result of different degrees of contaminations, calls for joined efforts to know about the extent of impact of contaminations on the landuse of Badoosh drainage basin. A good understanding of how radioactive contaminations occur and the optimal measures that can be developed and implemented to mitigate the outcomes can only be gained by analyzing information from field measurements databases.

The disaster of haphazard bombardment and the local destruction by unauthorized people at the site of general company for AL-Jezira site which occurred on both limbs of Atshan and Allan, is considered the largest non-natural radioactive contaminators damaging to human and the environment in the region (AL-Azzawi, *et al*., 2006).

Owing to the situation prevailing in Iraq, no precise official documentation of the damage of this disaster was done except for the measurement by portable LB 1200 instrument belong to the Ministry of Ecology, at the site of AL-Jezira reach

(0.5-8) mr/h=(0.5 x10-2 – 8x10-2 msv/h)=1500-25000 imp/min.

This site was monitoring by IAEA since 1991, and shows no evidence of any radiation in previous images till the befallen Iraq in 9/4/2003.

Measurements by the team of Ministry of Science and Technology at 3/7/2004 show high levels of contaminations at AL-Jezira site as shown on (Table 2). This temporal phenomenon was detected on both field and landsat imagery and caused by haphazard destruction of the building by occupation forces.

Table2: Measurements by the team of Minestry of Science and Technology (max radiation allowed 0.1 mr/h=0.1 x 10-2 msv/h)

Location	Instrument		Note
	Seintrex c/sec	Wallac mr/h	
X=05090	50-75	< 0.05	The Entrance Gate. AL-Jezira
Y=29350			
X=05088	2000-3000	1-6	Site 400/UCL4 AL-Jezira
Y=29401			
	100-250	0.1-0.3	Concrete pools AL-Jezira

A primary and continuing objective of the IAEA inspections in Iraq is the verifications of the correctness and completeness of Iraqi nuclear material declarations. With the exception of small quantities of natural uranium still to be recovered from the waste at the AL-Jezira site, all declared bulk uranium stock and intermediate process materials have been verified and are maintained under seal at a single location, since 1991. Other activities at AL-Jezira location involve the salvage of building materials and the razing of some still standing structures on the UCL4 and UO2 building sites. Traditionally, we will throw this research and the importance of remote sensing technologies in the face of disaster, which is to provide details of locations, as we discussed the objectives of the new technology in discovering certain disaster and its criteria.

6 Conclusions

A number of research results as follows:
1-The existance of a close relationship between reflection anomalies shown on Landsat imagery and the sites of radioactive contaminations in Nineveh Governorate.
2-Field measurements confirm the existence of high ratio of the radioactive contaminators in these two sites.
3-Research has recommended the need to use the scientific method in the face of disaster and crisis prevention by conducted regular field surveys to understand and compare the perception of the radioactive contaminations in all sites.
4-The study has shown the importance of visual interpretation and the supervised classification in the selected training areas together with GIS applications.
5-Remote sensing techniques and GIS applications are found very useful in indicating radioactive contaminations areas.

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