Remote Sensing and GIS Techniques for Monitoring Industrial Wastes for Amman City

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Abstract

The city of Amman is located in the central Mesopotamian plain of the Mid Region of Jordan. Since Amman city is the capital of Jordan. It is surrounded by network of industrial areas for different purposes and this affects the environment. Solid wastes generated from domestic sources can significantly impair drinking, irrigation, recreational water, in addition to other water sources and soil in rural and urban areas. Therefore, the environment and wild life must be monitored and controlled very well. The techniques demonstrated in this research include procedures for developing regional spatial data into a coordinated GIS database, characterizing and identifying wildlife habitat, quantifying and assessing land use change, pollution due to changes in land use and demonstrating the application of these GIS and modeling methods for assessing cumulative environmental effects associated with land use change.

The main results of applying RS & GIS techniques for monitoring industrial wastes of Amman city were identifying Shab Industry Zone and Al Bayader Industry Zone as the most dangerous on land cover .The digital image classification coupled with GIS has demonstrated its ability to provide comprehensive information on the nature, rate and location of environment monitoring. Using GIS and RS techniques in the environmental assessment give a quick and low cost technique. Preliminary investigation can be considered as aiding tools to the traditional and detailed investigation procedures.

Key words: **GIS, Remote Sensing, Industrial Waste, Land use Monitoring**

1. Introduction

The city of Amman is located in the central Mesopotamian plain of the Mid Region of Jordan. According to the geological surveys, the whole area is covered by recent Limestone, dolomite, marl, shale. Limestone and dolomite layers are prolific aquifers in Eastern and Western Ceno- Mountain Basins (Figure 1a).

This research reveals several ways that GIS can be used as a tool for performing environmental assessment for Amman city. Over the past decade, environmental analysis professionals have increasingly embraced the idea that, in order to fully assess the impacts of a project on the environment a holistic approach is needed which can assess the additive and interactive responses to both single and multiple actions

across time and geography. [1] Data capture technologies include as well remote sensing by satellites and airborne platforms. Satellite imagery of the land is received in various wavelengths so that particular aspects of the land surface can be characterized through image processing procedures. The integration of remote sensing and geographic information systems (GIS) has been widely applied and been recognized as a powerful and effective tool in monitoring
environment. Geographic information system (GIS) technique provides a flexible analysis for entering, and displaying digital data from various sources necessary for environment feature identification, change detection and database development. The objectives in this research can be summarized as following Monitoring industrial wastes in Amman city Producing digital maps for Industrial
areas in Amman employing the capabilities of GIS and remote sensing techniques.

2. Classification

Unsupervised classification is carried out by using satellite image of Amman _ IKONOS satellite sensor to show land use (1M spatial resolution) [2]

2.1 Unsupervised Classification (The ISODATA Clustering)[3]

The ISODATA method in unsupervised classification that uses minimum spectral distance to assign a cluster for each candidate pixel.
The process begins with a specified number of arbitrary cluster means or the means of existing signatures, and then it processes repetitively, so that those means shift to the means of the clusters in the data. Because the ISODATA method is iterative. Figure (1b) shows the classification result of applying the ISODATA clustering algorithm.

3. **Industrial Areas in Amman City**

Solid waste streams should be characterized by their sources and by the types of wastes produced, as well as by generation rates and composition [4]. The range of industrial wastes generated as broad as the manufacturing industries that generate them, and as the waste management options used - which combine recycling, recovery and disposal techniques. In Jordan, large industries have mainly been in the petrochemical, fertilizers. Medium-sized industries are likely to include electroplating

facilities, tanneries, workshops and garages [5].Based on Amman mayoralty records, small and medium sized enterprises, as well as some large ones, do not always have the expertise or the resources to ensure that the management of their waste does not have environmental impacts. Manufacturing waste consists of food, wood, paper, chemical, non-metallic mineral, basic metal and other waste. The oil industries are major generators of a wide variety of industrial waste. Although industrial waste can include process waste, chemicals, ashes and other special and hazardous wastes, the industrial waste that could be accepted as part of the municipal solid waste stream should be limited to housekeeping wastes, packaging, food waste, construction and demolition materials and non-hazardous off-specifications products. All other hazardous industrial waste should be handled separately from the municipal solid waste stream [6]. Figure (2) shows the geographical distribution of industrial areas in Amman city with their descriptive data that will help in analyzing data later with accuracy depend on satellite image.

3.1 Production of Buffer for Industrial Areas Wastes around the land

The Geographic Information System (GIS) and the remote sensing techniques were used to monitor and detect the type of waste that is discharged. Amman city have suffered from rapid urban and random expansion over the last 40 years due to accelerated economic growth and other factors. The industrial areas are played a vital role in pollution of Amman city.

Satellite remote sensing collects multispectral data, and turns them into information valuable for understanding and monitoring industrial areas processes and for building urban land cover datasets. GIS technology provides a flexible environment for entering, analyzing and displaying digital data from various sources necessary for urban feature identification, change detection and database development. By using GIS techniques the industrial areas are classified according to the distance this helped in recognizing the pollution in the soil around the industrial areas. Figure (3). Shows the distances values to center of industrial areas computed using spatial technique method that depend on taking coordinate from corrected image of Amman then making interpolation between these values.

After the buffer of distance is built then this buffer is tied to the quantity of waste help in producing thematic map contain information about the most dangerous industrial areas on the soil as shown in figure (4), a and b that shows the most dangerous areas

4. Normalized Difference Vegetation Index (NDVI)

Normalized difference vegetation index (NDVI) has been found to be a good indicator for vegetation cover and surface radiant temperature. It was found that there is inverse relationship between NDVI and surface reflectance. NDVI image was computed from red and near-infrared (IR) of LANDSAT image using the following formula [7].

NDVI= IR RED/ IR + RED ……. 1

The original NDVI had the values between -1 to +1. Generally, residential and paved areas have low value of NDVI due to urban development which usually gives rise to a dramatic change of the Earth s surface, as natural vegetation is removed and replaced by non-evaporating and non-transpiring surfaces such as metal, asphalt and concert [7]. See figure (6) this figure help in producing values of NDVI (Their range is +1to -1) and it uses in the comparison between reflectance of Radiometer and IKONOS Image.

5. Comparison between reflectance of Radiometer and IKONOS Image

The Spectral Profile allows you to visualize the reflectance spectrum of a single pixel through many bands. This technique is particularly useful for hyper spectral data that can have hundreds of layers. It can be compared the profiles that you generate to those from laboratory (or field) spectrophotometers [8]. In the field the radiometer is used to measure spectral profile. A radiometer is a sensor that measures the intensity of electromagnetic radiation emanating from all objects within its field of view (FOV) and wavelength range. The radiometer is one of the non-imaging instruments that measure electromagnetic radiation using optical techniques. The instruments are non-imaging in the sense that they do not produce a picture but rather integrate over time, space, and wavelength to produce a spectral curve. See Figure (7) which represents the location of the sample that is measured using radiometer. Four filters were used in this research (as available), they have spectral band covering the range (0.42-0.780) micrometers, as shown in Table (1).

After the measurements of the radiometer are obtained then compared with the spectral reflectance of IKONOS image of Amman for the same location Figure (8) shows Comparison between digital number of Radiometer and IKONOS Image.

Table (1) Filters and bands used in radiometer

Band (m)	**Range of band(µm)**	**Peak (µm)**
Blue	0.420- 0.530	0.486
Green	0.490- 0.570	0.538
Yellow	0.470- 0.650	0.580
Red	0.580- 0.780	0.620

6. Conclusions

1. Shab industry Zone and Al Bayader industry Zone as shown in figure (2) are more dangerous on land cover as a result of GIS analysis.
2. The integration of remote sensing and GIS was found to be effective in monitoring and analyzing environment patterns and helped in producing maps that illustrates the danger of industrial areas.
3. The capability of GIS to produce overlaid information of more than one environmental property in the form of thematic map can help in representing the information and properties collected in a different prospective that take into account the combined affect of the properties used.
4. The digital image classification coupled with GIS has demonstrated its ability to provide comprehensive information on the nature, rate and location of environment monitoring.

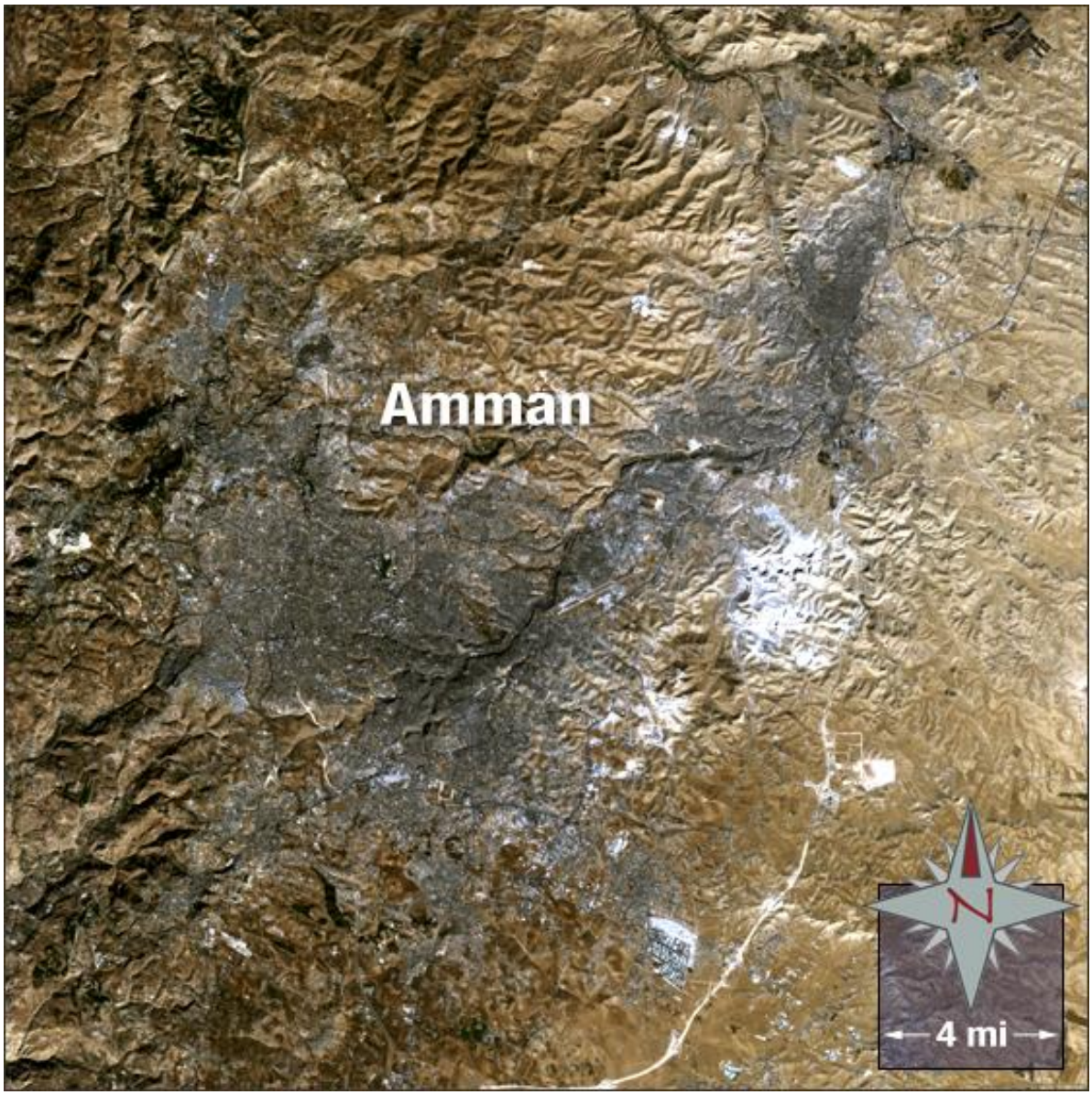

Fig.1a IKONOS image was acquired December 3, 2010. The image was created using TM bands 3, 2, and 1. Amman falls on Path 174 Row 38. **NASA GSFC Landsat/LDCM EPO Team**

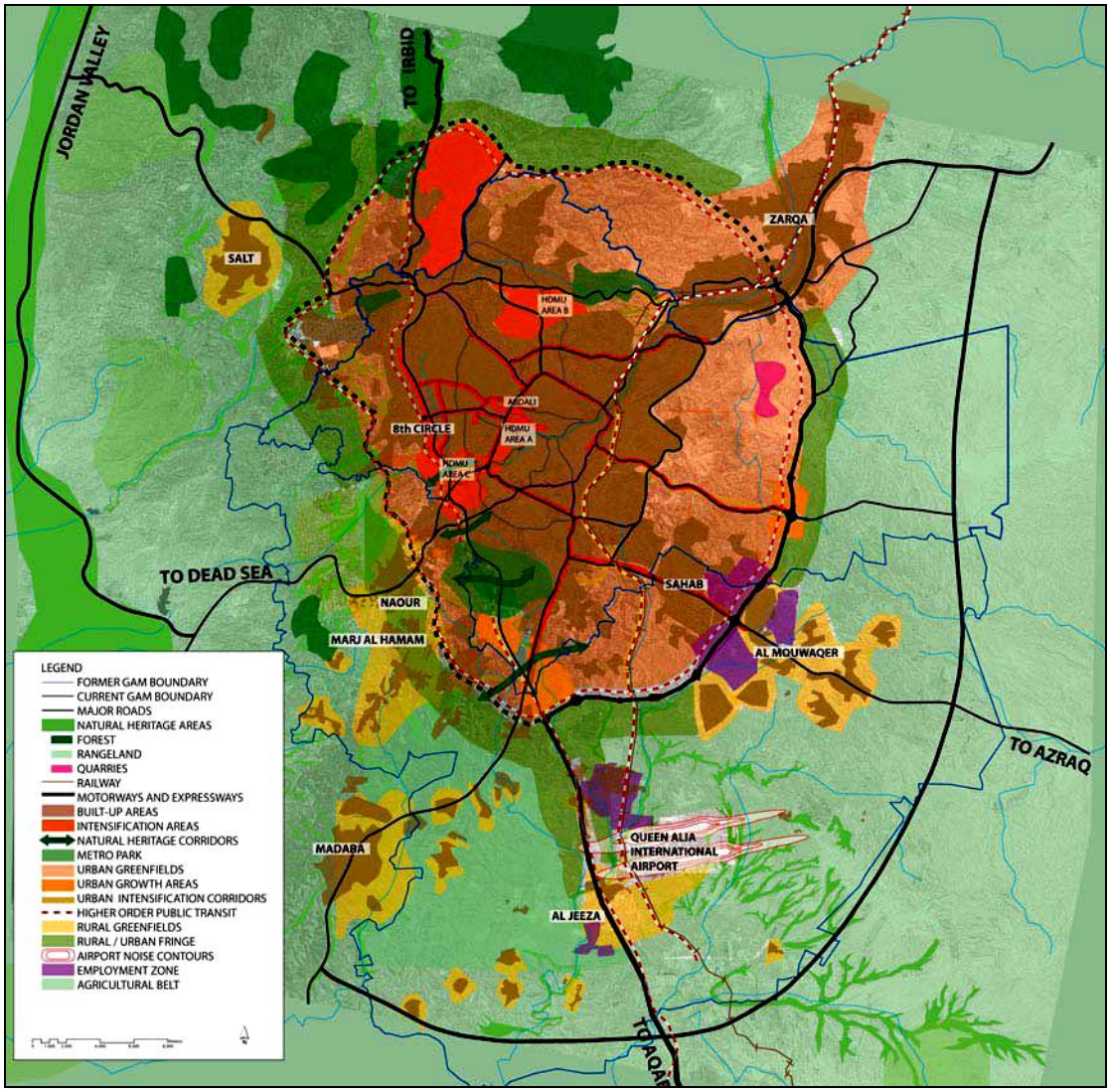

Fig.1b Map extracted from Unsupervised Classification (The ISODATA clustering for Amman)

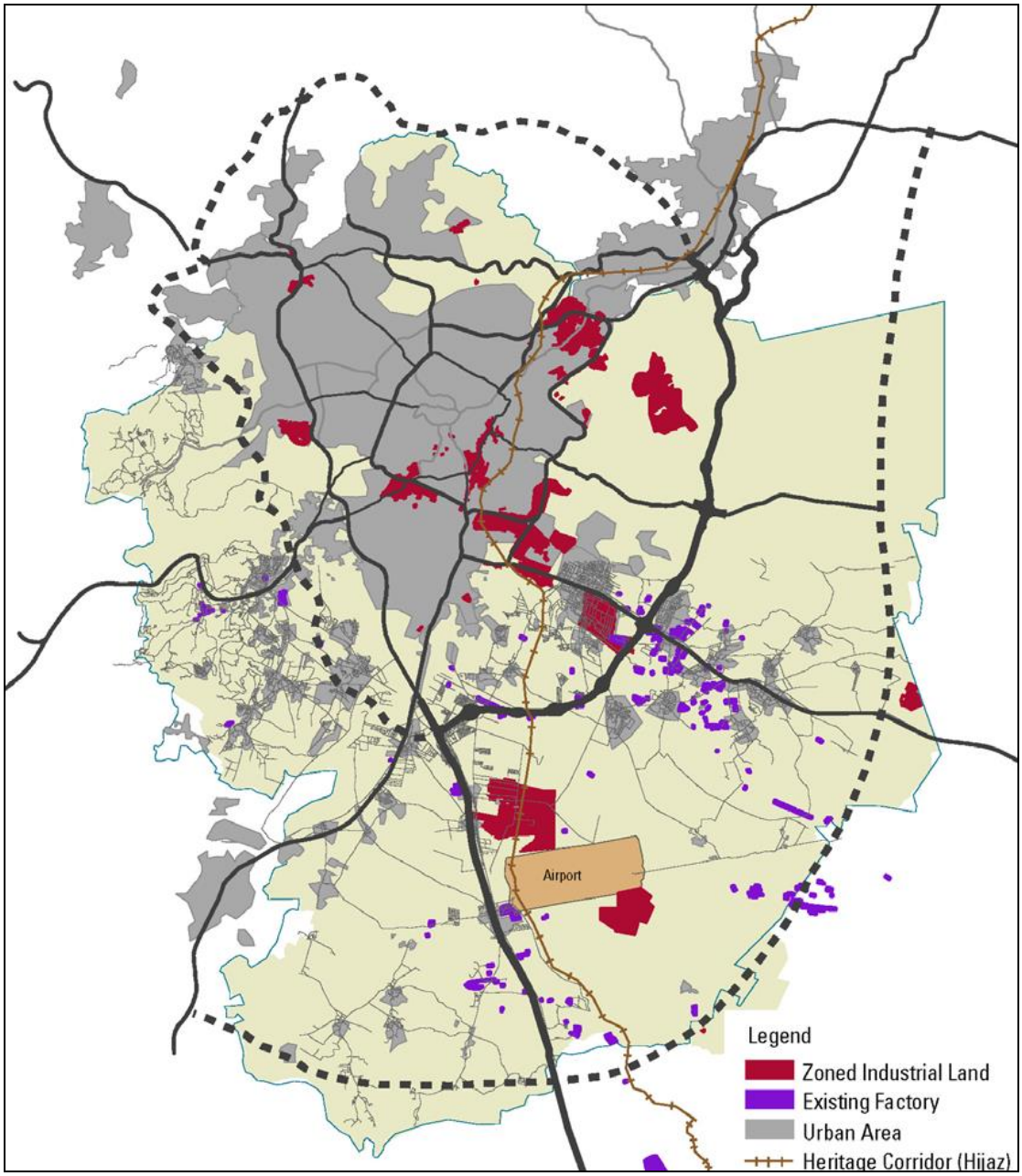

Figure (2) Industrial Areas in Amman City extracted from maps

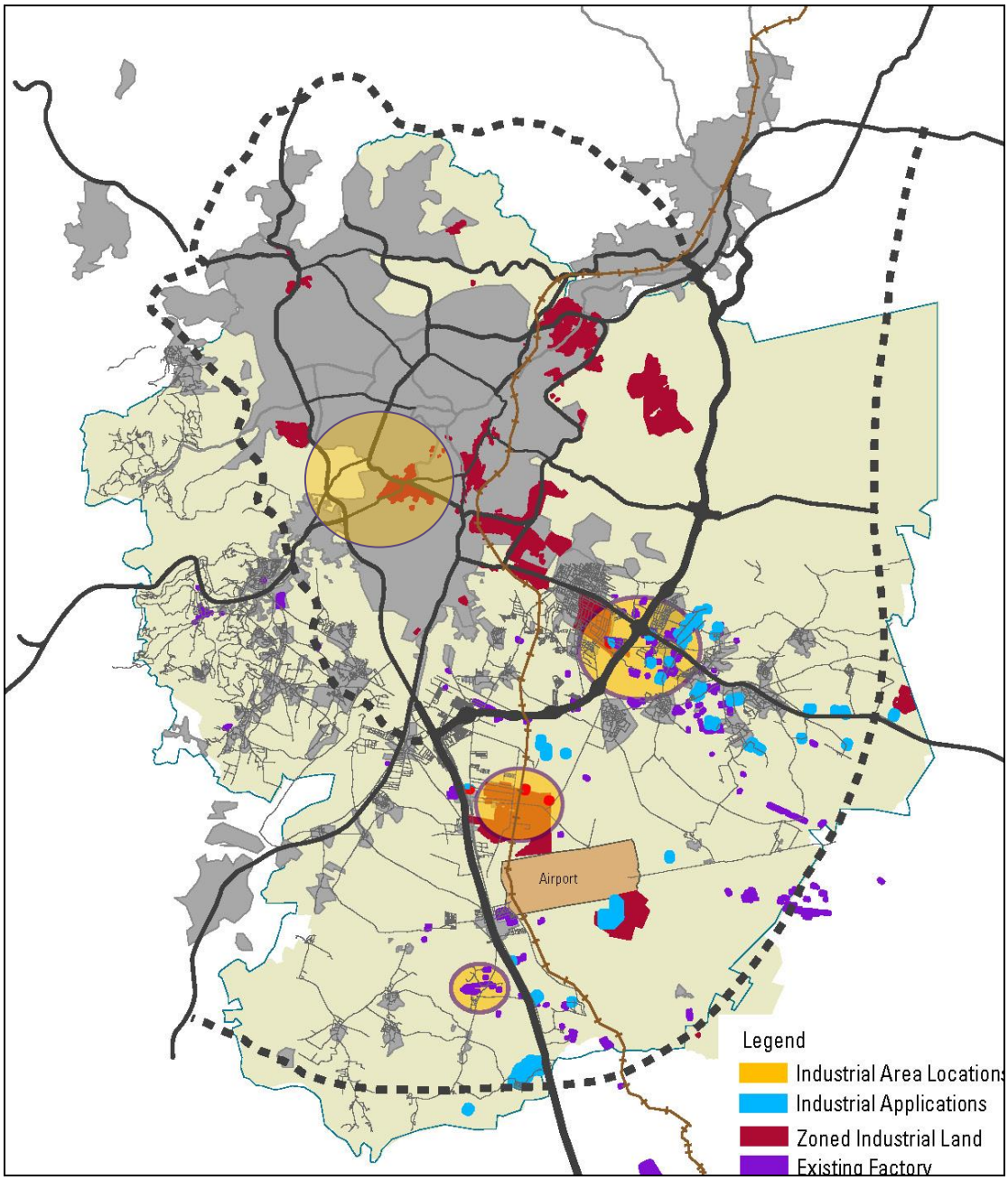

Figure (3) Buffer of Distance to industrial areas _the distances extracted from the satellite image using GIS

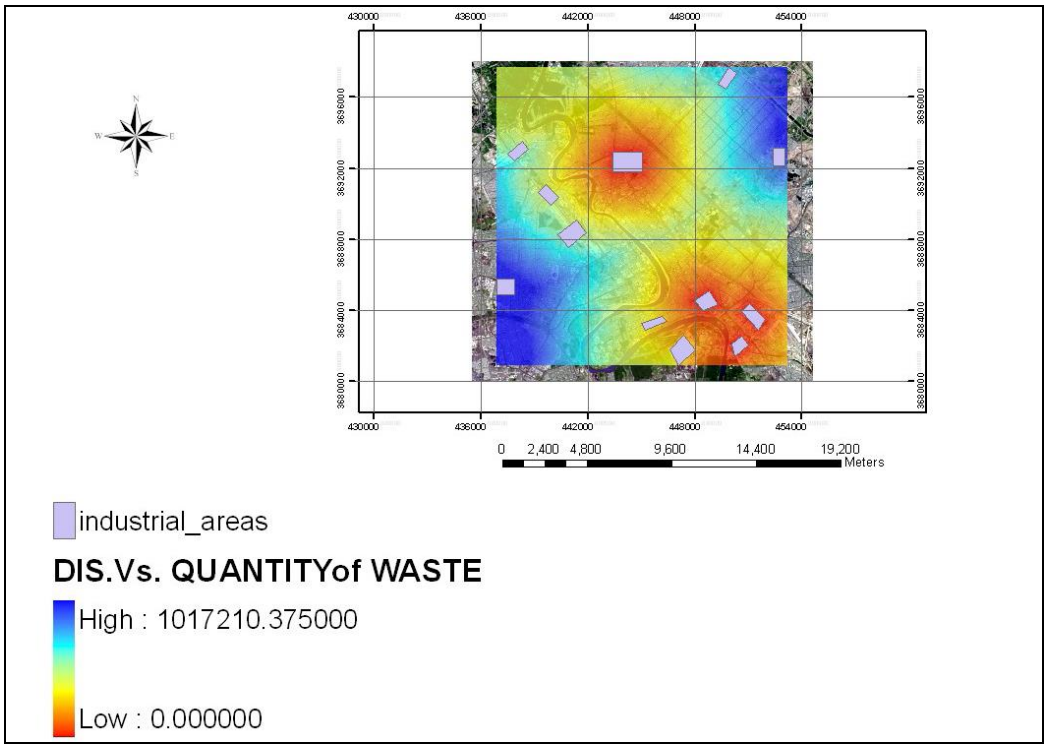

Figure (4) the dangerous industrial areas on soil _red color on map is represent more danger because it is very near to industrial areas that have huge pollution

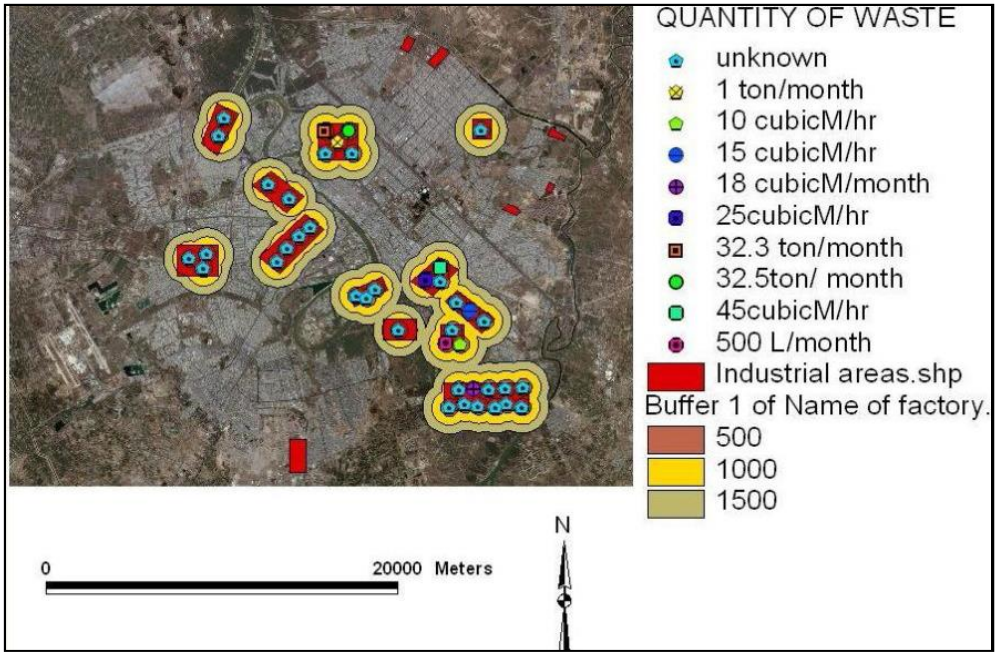

Figure (5) Quantity of Waste in Industrial Areas

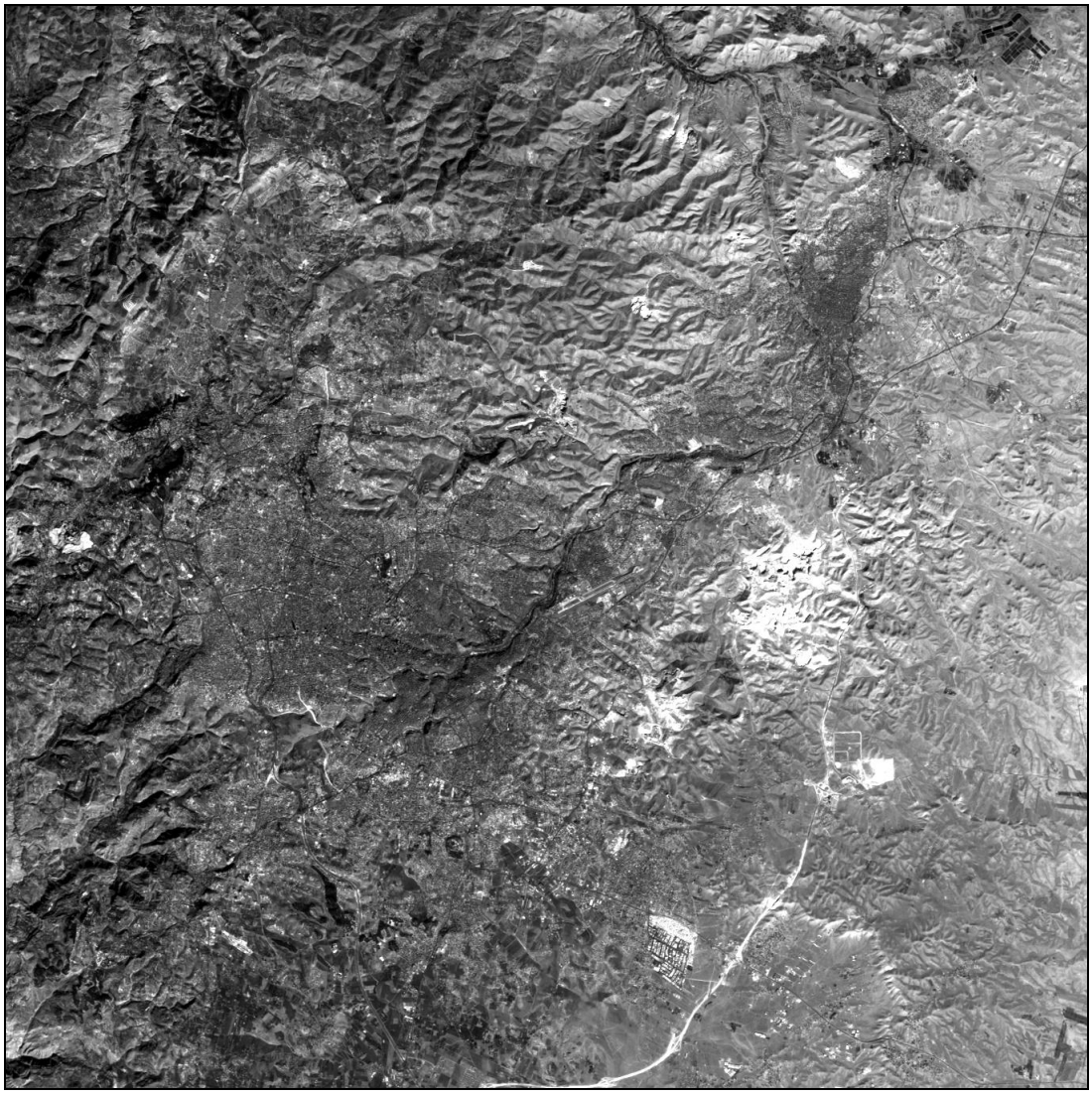

Figure (6) NDVI image

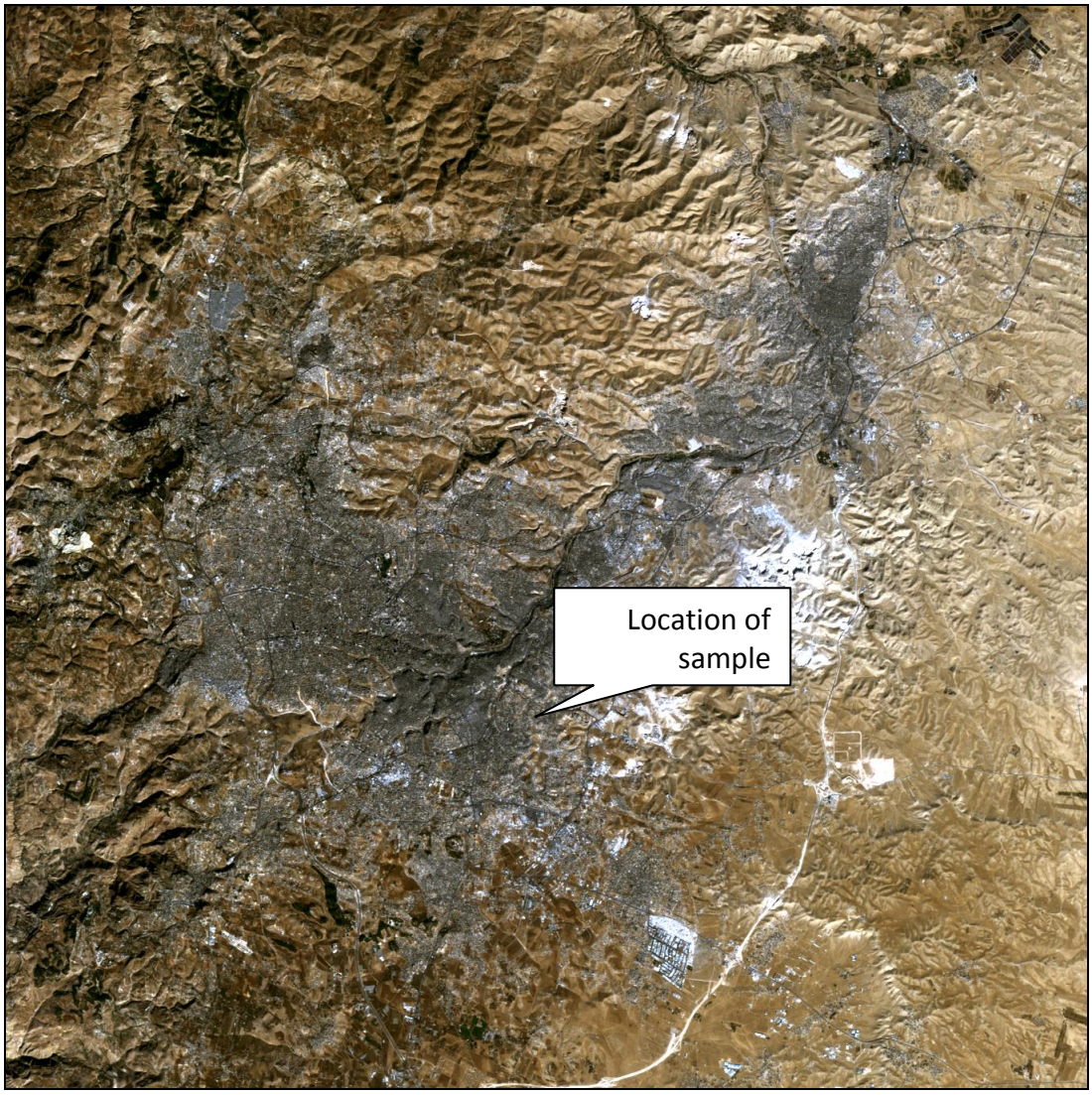

Figure (7) Location of the Sample

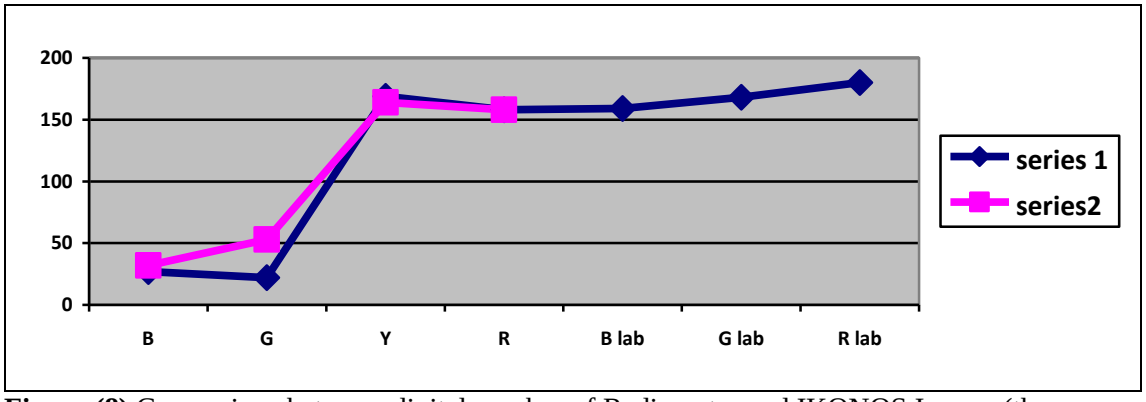

Figure (8) Comparison between digital number of Radiometer and IKONOS Image_(the B,G,Y,R are represent the bands of radiometre

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