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# USING INVERSE DISTANCE WEIGHTING INTERPOLATION METHOD TO PREPARE MAPS OF RADON CONCENTRATIONS DISTRIBUTION IN WASIT PROVINCE

Ebtesam F. Khanjer & Wassan Abdullha
University of Baghdad, College of sciences, Astronomy and space department

**ABSTRACT**
Radon is a natural radioactive gas without adour, color or taste. It cannot be detected without special equipment. Radon occurs as a product of uranium decay. Uranium is a natural radioactive material found in varying amounts in all rocks, soil, concrete and bricks. In this study, all the location we decided to take measurement in it's from GPS device and Map of Waist Governorate. The Radon gas concentrations were measured for pollutants environment within Wasit Governorate (Air dust, water and soil) using Rad-7device. The work consist of three parts, the first part of it includes the determination of Rn222 gas concentrations in air dust samples. The second part includes the same measurement for Rn222 gas concentrations in a water samples from the same selected regions in Wasit. The third part includes the determination of Rn222 gas concentrations in soil samples to the same regions in Wasit. All this measurements we was used to prepare maps for distribution of Radon concentration in air, water and soil in Wasit Governorate using Arc-GIS system and Landsat satellite image of Wasit city . then we was apply interpolation techniques use the available radon data in known locations to estimate the radon data for unmeasured area which will help to render an effective plan to mitigate the radon concentrations in Baghdad Governorate.

**KEYWORDS**: Radon concentration, Rad-7 device, Inverse Distance Weighting, spatial distribution, Wasit governorate.

## INTRODUCTION

Radon is a natural radioactive gas and is considered as chemically inert. It comes from the natural decay of uranium 238 series, with atomic number 86 and mass number 222. Radon is a colorless, odorless, tasteless gas with a density of 9.72 grams per liter, it is about seven times as dense as air[1]. Radon condenses to a clear colorless liquid at its boiling point and then freezes to form a yellow, then orange red color solid. It is also moderately soluble in water and, therefore, can be absorbed by water flowing through rock and sand containing radon. Its solubility depends on the water temperature, the colder the temperature of water the greater the radon's solubility[2, 3].

### Remote sensing

Remote sensing means collection information about any object at a distance without any physical contact with it, the physical role for recording the information in remote sensing about the target is achieved by the Electromagnetic Radiation (EMR) which is the only communication link between the sensor and the target and also the most important dynamic radiant energy made evident by its interaction in force fields[4]. Remotely sensed imagery can be made use in a number of applications, encompassing reconnaissance, creation of mapping products for military and civil applications, evaluation of environmental damage, monitoring of land use, radiation monitoring, urban planning, growth regulation, soil assessment, and crop yield appraisal[5].

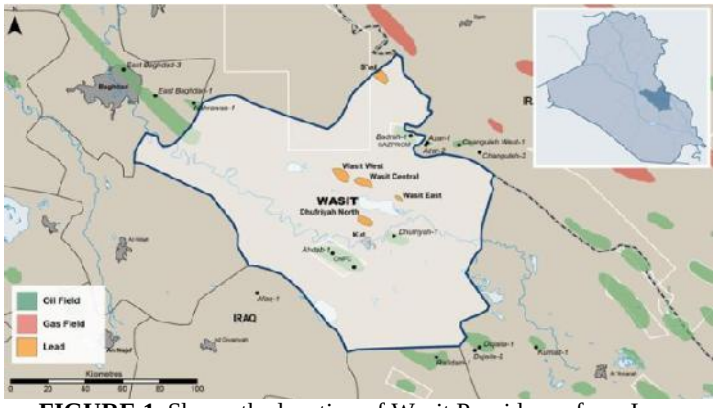


**FIGURE 1.** Shows the location of Wasit Providence from Iraq

**Study Area**

Wasit Governorate (Arabic: Wāsit) (or Wasit Province) is a province in eastern Iraq. Its name comes from the Arabic word meaning "middle," as it lies along the Tigris about midway between Baghdad and Basra. Its major cities include the capital Al Kut, Al-Hai, and the city Wasit. Prior to 1976 it was known as Kut Province and is situated on longitude of 32 degree and 40 minutes, latitude of 45degree and 45 minutes[6]. The following figures showing the location Wasite in Iraqm as shown in figure 1 above.

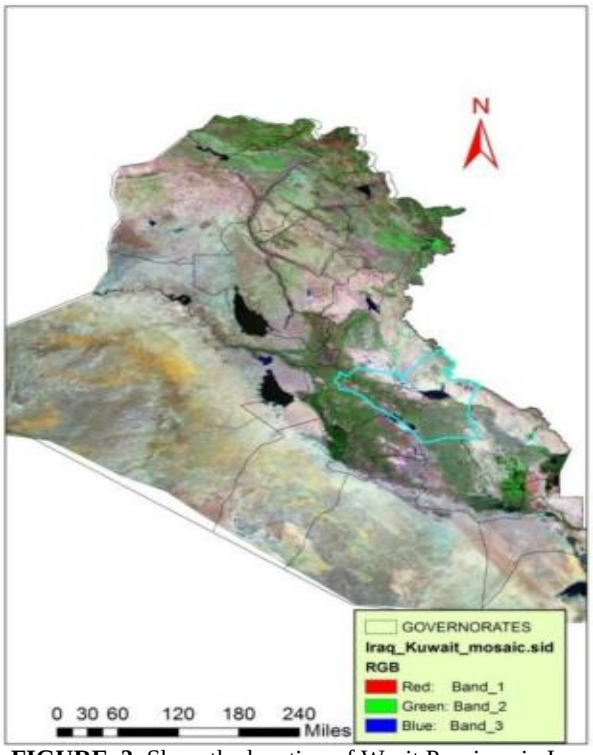


**FIGURE 2**: Show the location of Wasit Province in Iraq map

The following figure showing the location of the site 13 different regions of Wasite Province

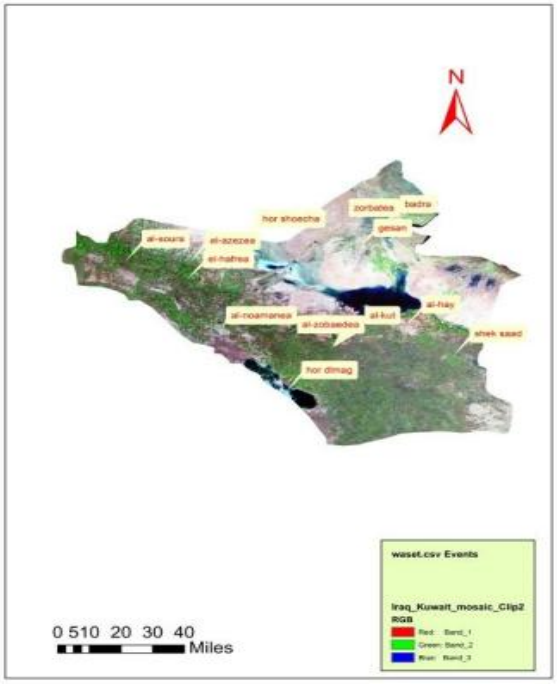


**FIGURE 3:** Showing the location of the site 13 different regions of Wasit Province

**EXPERIMENTAL RESULTS**

**Location of Cities**

**Data measurement and analyses**

**TABLE 1:** Show X,Y the location of each region in Wasit

| City | Longitude | Latitude |
|---|---|---|
| Zorbatea | 46.03 | 33.09 |
| Badra | 45.95 | 33.11 |
| Gesan | 45.83 | 32.98 |
| Al-hafrea | 45.05 | 32.82 |
| Al-azezea | 45.06 | 32.91 |
| Al-kut | 45.79 | 32.5 |
| Al-noamanea | 45.2 | 32.5 |
| Al-zobaedea | 45.72 | 32.45 |
| Al-soura | 44.77 | 32.92 |
| Hor dlmag | 45.5 | 32.2 |
| Hor shoecha | 45.3 | 33.03 |
| Al-hay | 46.05 | 32.56 |
| Shek saad | 46.27 | 32.4 |

**Measurement of radon and concentration in water samples**

The RAD H2o is an accessory to the RAD-7 detector that enables the measurement radon in water over a concentration range from less than 30 pCi/L to greater than 105pCi/L. The lower limit of detection is less than 10 pCi/L. The equipment is portable and battery operated, and the measurement is fast. An accurate reading of radon in water within an hour of taking the sample can be read.


**FIGURE 4:** Aerating a 250 ml water sample

**TABLE 2:** Radon concentrated in waist province in water

| City | Radon gas concentrated(Bq/L) |
|---|---|
| Zorbatea | 211.671 |
| Badra | 152.001 |
| Gesan | 67.230 |
| Al-hafrea | 52.771 |
| Al-azezea | 46.201 |
| Al-kut | 117.385 |
| Al-noamanea | 87.037 |
| Al-zobaedea | 77.923 |
| Al-soura | 97.245 |
| Hor dlmag | 33.251 |
| Hor shoecha | 25.511 |
| Al-hay | 82.357 |
| Shek saad | 18.993 |

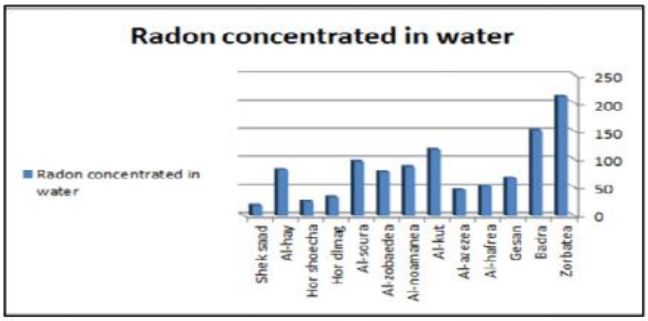


**FIGURE 5:** Radon concentrated in water

**TABLE 3:** Radon concentrated with increased with the depth of water of march ( hor shoecha)

| Depth | Radon gas concentrated (Bq/L) |
|---|---|
| 10 cm | 25.511 |
| 20 cm | 47.630 |
| 30 cm | 83.501 |
| 40 cm | 91.330 |
| 50 cm | 101.521 |
| 60 cm | 123.673 |

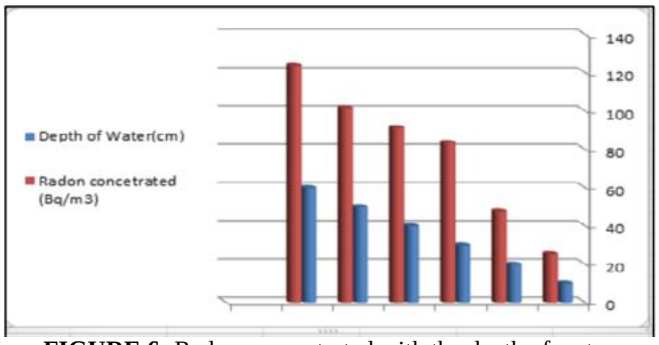


**FIGURE 6:** Radon concentrated with the depth of water

**Measurement of radon and concentration in soil-gas samples**

The RAD-7 can measure radon via 3 different modes. The mode used for the soil-gas measurements is called the Grab sample protocol. The RAD-7 pumps the soil-gas into the cell of the detector for 5 minutes, waits for 5 minutes and then counts for 5 minutes. 218Po has a half-life of 3.05 min and it takes about 3-5 half-lives for the 218Po activity to reach secular equilibrium, which is about 9-15 minutes. The decay of 218Po would then be counted after 10 minutes (5 minutes of pumping plus 5 minutes of waiting), in which time 95% of equilibrium would have been reached . In total, each set of readings includes four 5-minute cycles that in total takes 1 half hour. There are few types of soil-gas monitors that give real-time radon readings using the α-Probe model 711 to complete a radon soil depth profile, whereas the RAD-7 was used to measure the profile of the radon soil-gas in this study. Fig. (4.10) shows RAD-7 set up for soil measurements for one sample points of soil at wasit city with the probe and a steel probe.

**FIGURE 7:** The RAD-7 soil-gas setup, including the electronic radon monitor

**TABLE 4:** Radon concentrated in waist province in soil

| City | Radon gas concentrated (Bq/m$^3$) |
|---|---|
| Zorbatea | 947.6311 |
| Badra | 1020.217 |
| Gesan | 320.753 |
| Al-hafrea | 148.621 |
| Al-azezea | 211.142 |
| Al-kut | 1117.520 |
| Al-noamanea | 260.051 |
| Al-zobaedea | 200.230 |
| Al-soura | 497.223 |
| Hor dlmag | 133.502 |
| Hor shoecha | 129.624 |
| Shek saad | 100.021 |

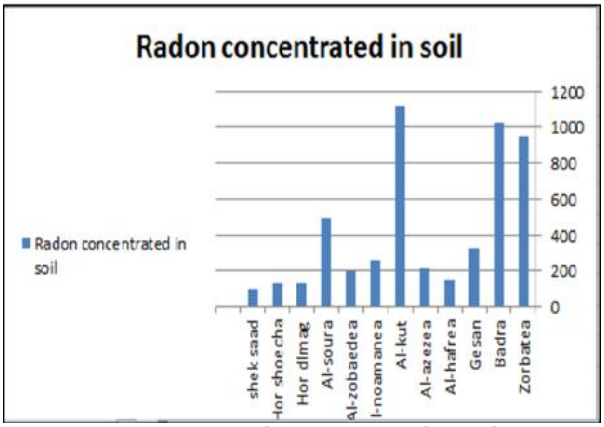


**FIGURE 8:** Radon concentrated in soil

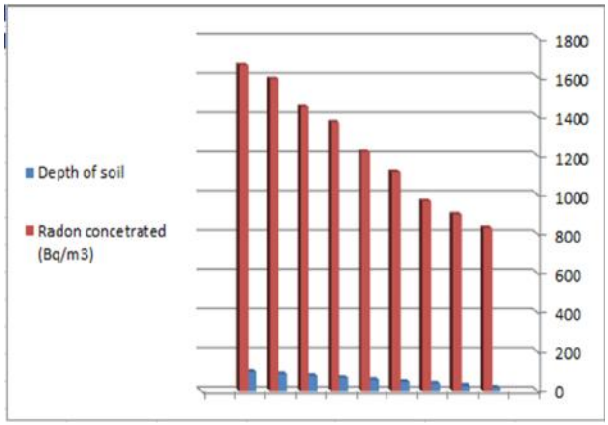


**FIGURE 9:** Radon concentration with the depth of soil

**TABLE 5:** Radon concentrated with increased with the depth of soil (Al-kut)

| Depth(cm) | Radon gas concentrated (Bq/m3) |
|---|---|
| 20 | 832.571 |
| 30 | 901.826 |
| 40 | 969.823 |
| 50 | 1117.520 |
| 60 | 1220.650 |
| 70 | 1370.880 |
| 80 | 1450.491 |
| 90 | 1590.331 |
| 100 | 1662.551 |

**Measurement of radon concentration in air samples**

Sniff mode and circle time was set to be 1 hour in accordance with running time of each path of the valve. In order to investigate radon and thoron released from the sample to air, the sample was enclosed into a column and airborne radon/thoron was measured with a continuous monitor of electrostatic type (RAD-7, Durridge Company, USA). The experimental setup shown in Fig. (4.14) shows the schematic diagram RAD-7-Air in building. The air flow rate was 0.7 L min-1. Room air was drawn from the inlet and radon generated in the air flow system was measured with the RAD-7. The measurement interval was 1 h. The sample weight was different from sample to sample.

**TABLE 6:** Radon concentrated in waist province in air

| City | Radon gas concentrated ($Bq/m^3$) |
|---|---|
| Zorbatea | 321.21 |
| Badra | 401.792 |
| Gesan | 142.239 |
| Al-hafrea | 89.49 |
| Al-azezea | 73.57 |
| Al-kut | 192.635 |
| Al-noamanea | 132.906 |
| Al-zobaedea | 104.433 |
| Al-soura | 223.721 |
| Hor dlmag | 8.682 |
| Hor shoecha | 12.167 |
| Shek saad | 11.822 |
| Al- hay | 187.213 |

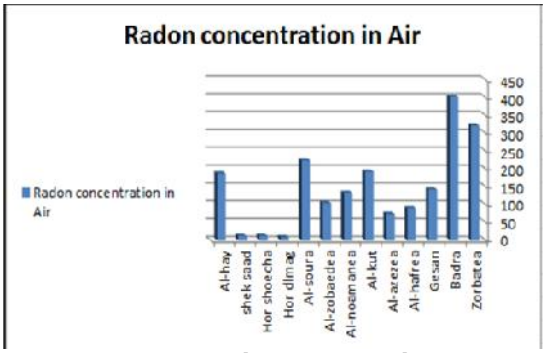


**FIGURE 10:** Radon concentrated in Air

**TABLE 7:** Radon concentrated with increased the altitude in air Atmosphere (Al-kut)

| Height (m) | Radon gas concentrated ($Bq/m^3$) |
|---|---|
| 1 | 192.635 |
| 1.5 | 176.253 |
| 2 | 155.761 |
| 2.5 | 149.270 |
| 3 | 132.007 |
| 3.5 | 110.631 |
| 4 | 70.908 |

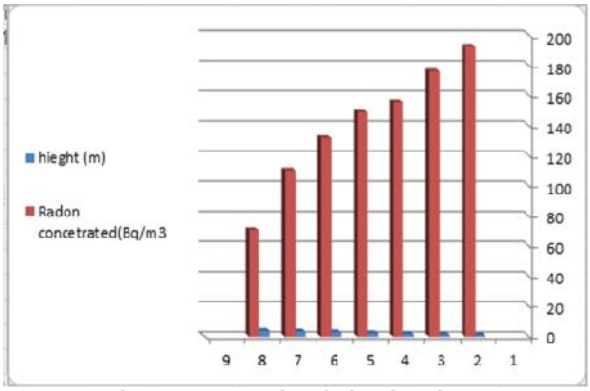


**FIGURE 11:** Radon concentrated with the altitude in air Atmosphere

**Analysis of data measurement using Arc-GIS techniques**

**Interpolation Methods**

Spatial interpolation is widely used for creating continuous data when data are collected at discrete locations. In this paper it has been used Inverse Distance Weighting (IDW).

**Inverse Distance Weighting (IDW**)

The inverse- distance weighted procedure is versatile, easy to program and understand, and fairly accurate under a wide range of conditions. Using this method, the property at each unknown location for which a solution is:-

$$P_i - \frac{\sum_{j=1}^{G} P_j/D_{ij}^{n}}{\sum_{j=1}^{G} 1/D_{ij}^{n}} \quad (1)$$

Where $P_i$ is the property at location i; Pj is the property at sampled location j; Dij is the distance from i to j; G is the number of sampled locations; and n is the inverse-distance weighting power. The value of n, in effect, controls the region of influence of each of the sampled locations. As n increase, the region of influence decreases until, in the limit, it becomes the area which is closer to point i than to any other (7,8 ).

This interpolation technique uses the available radon data in known locations to estimate the radon data for unmeasured area which will help to render an effective plan to mitigate the radon concentrations in Wasit.

IDW is a geostatistical technique, generally used to interpolate the value of a random field at an unobserved location from values at observed locations.

This method not only produces prediction surface, but also provides an error and uncertainty surfaces.

The analysis of radon data is helping in better understanding the radon problem in these areas. The analysis of radon data and results obtained from geostatistical method to provide information to the concerned authorities to take necessary steps in evaluating various steps to mitigate radon concentrations to acceptable levels.

The plots given in figures12,13 and14 show the measured versus predicted radon concentration values for these data set for IDW. Relatively high concentrations are producing in the north- west part of Wasit for air, while in the west of it for water, and It is also observed that these maps with high values distribution in several areas in middle Wasit.

The figures15, 16 and17 that are showing the probability (countor lines) maps. Contour lines which join the locations of equal value to each other. In the case of a contour line representing radon concentration values, which it is drawn a line on a map at connects points of equal value.

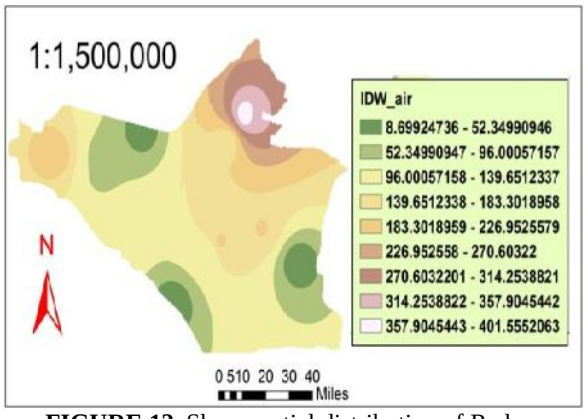


**FIGURE 12**. Show spatial distribution of Radon concentrated In air at Wasit Province Zone.

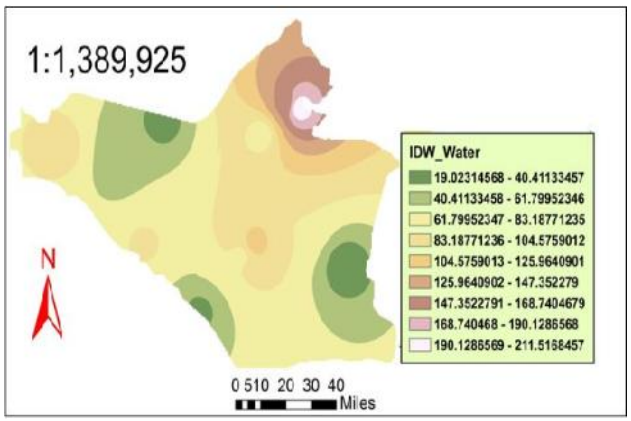


**FIGURE 13**. Show spatial distribution of Radon concentrated In Water at Wasit Province Zone.

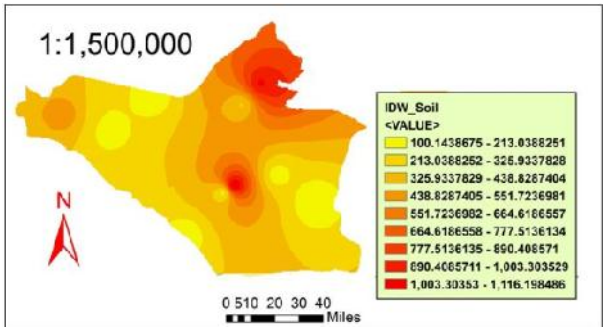


**FIGURE 14.** Show spatial distribution of Radon concentrated In Soil at Wasit Province

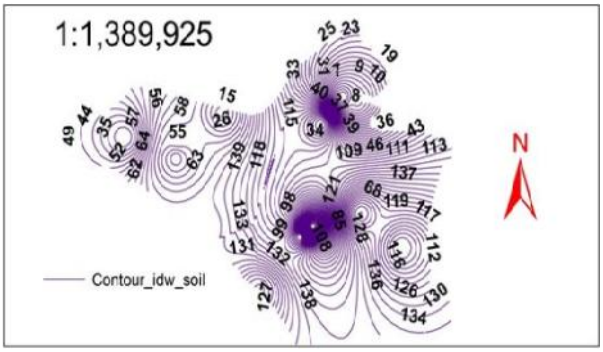


**FIGURE 15.** Show the contour lines of Radon concentrated in Soil at Wasit Province

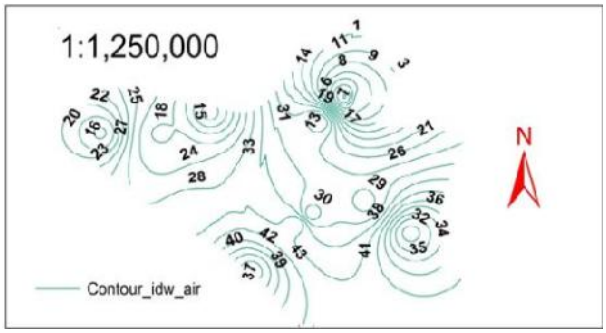


**FIGURE 16**. Show the contour lines of Radon concentrated in Air at Wasit Province

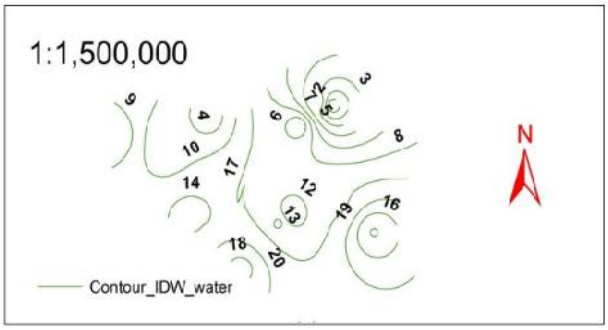


**FIGURE 17**. Show the contour lines of Radon concentrated in Water at Wasit Province

## RESULTS & DISCUSSION

These interpolation techniques use the available radon data in known locations to estimate the radon data for unmeasured area which will help to render an effective plan to mitigate the radon concentrations in Wasit. IDW is a geostatistical technique, generally used to interpolate the value of a random field at an unobserved location from values at observed locations. This method not only produces prediction surface, but also provides an error and uncertainty surfaces. The analysis of radon data is helping in better understanding the radon problem in these areas. The analysis of radon data and results obtained from geostatistical method to provide information to the concerned authorities to take necessary steps in evaluating various steps to mitigate radon concentrations to acceptable levels. The plots given in figures 18,9 ,10 show the measured versus predicted radon concentration values for these data set for IDW Technique Geo-statistical techniques are commonly used to map a range of environmental variables, particularly to generate probability maps that show where variables exceed a given threshold, see the figures (11,12 and 13), that are showing the probability (contour lines) maps . Contour lines which join the locations of equal value to each other. In the case of a contour line representing radon concentration values, which it is drawn a line on a map at connects points of equal value.

## CONCLUSION

From the result of Radon Concentrated in Wasit city clear that following-

**Data Measurements**

The first objective of the study was to measure the Radon concentration in the groundwater. In water, high radon concentration in wasit province in zorbatea region because the presence of military waste. High Radon concentration with increased with the depth of water, because the water depth and under the rocks because that of heavy gas.

High radon concentration in Al-Kut region because the presence of due to military camps and old waste buried in the soil of Kut . Increased Radon concentration with increased the of the soil, because it's heavy gas and in deep found the rocks.

High concentration in Badra region because found oil fields as well as the presence of military region that has seen many battles. Radon concentration decreased with the altitude of air atmosphere because the Radon is heavy gas.

**Interpolation method**

In soil, high radon concentration was found in wasit province in Al-kut region. Radon concentration increased with increased the depth of soil, because in air, high radon concentration in wasit province in Badra region. Radon concentration was decreased with increased the altitude of the air atmosphere. Because it's was heavy gas.

## REFERENCES

[1]. Price, P.N. (1997) Predictions and maps of county mean indoor radon concentrations in the mid-Atlantic states". *Health Physics*, 72, 893–906.

[2]. Shashikumar, T.S., Ragini, N., Chandrashekara, M.S. and Paramesh, L. (2008) Studies on radon in soil, its concentration in the atmosphere and gamma exposure rate around Mysore city, India", *Current Science*, Vol. 94, NO. 9.

[3]. Sannappa, J., Paramesh, L. and Venkataramaiah, P. (1999) Study of radon exhalation rate in soil and air concentrations", *Indian J. Phys. B.*, 73, 629–639.

[4]. B. Li. (2002) Spatial Interpolation of Weather Variables Using Artificial Neural Networks, the University of Wuhan, China.

[5]. Daily Claireh, J, and Neil, S.A. (2001) Comparison among Strategies for Interpolating Maximum and Minimum Air emperatures. Part II: The Interaction between Number of Guiding Variables and the Type of Interpolation method, Department of Geography, University of Edinburgh, Edinburgh, Scotland. 2001

[6]. Lubin, J.h.,Wang, Z.Y., Boice, J.D., J.R., Xu, Z.Y., Blot, De Wang, L.and Kleinerman, R.A. (2004) Risk of lung cancer and residential radon in china;Pooled results two studies", *Int. J. Cancer*, 109,132-137.

[7]. William, B.Ph., Model the effect of four artificial recharge dams on the quality of groundwater using geostatistical methods in GIS environment, Oman, *Journal of Spatial Hydrology***,** 2011 Fall Vol.5, No.2.

[8]. Al–Fifi Z., El-Araby E.H. and Elhaes H. (2012) Monitoring of Radon Concentrations in Jazan Beach Soil", *Journal of Applied Sciences Research*, 8, 2 (2012) 823-827.