Calculation of the Energy Density Levels of the Rays Emitted from Mobile Phone Towers inHand the Nile Center

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Abstract

This research ensures the measurement and discussion of the energy density levels emitted by mobile phone towers in hand the Nile center inBabylon Province and comparing it with the values allowed globally according to the organization ICNIRP In this research, a German-made HF59B analyzerdevice was used, which was manufactured by a company called (Giga Hertz Solution), and the device works within frequencies(700-2700) MHz and that the telephone devices operate within these frequencies. A map of the Nile area was taken from the Urban Development Directorate in Babylon.Also it divided into squares, the area of each square is $200m^2$,The energy density in the middle of the square was measured. The measured area was determined and installed on the map for thehand Nile. It was also noted that the lowest value for energy density was $18.15\frac{W}{m^2}$ and the higher value for energy density was$162\frac{w}{m^2}$. Also, the locations of the towers for mobile phones were known and installed on the map for the handNile. It was noted that the farther the measurement point is from the location of the tower lead to the values of energy density levels decrease, and that energy density levels depend on many factors, for example the type of tower, distance and height.

KeyWords: Power Density, Mobile Phone Tower, Radio Wave, Mobile Phone Device.
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Introduction

Electromagnetic(EM) spectrum are waves transmit energy by propagation in space,the electromagnetic (EM) spectrum include electric and magnetic fields, Electromagnetic (EM) waves transmitted in the speed of equal to the speed of light in the space,also contain electromagnetic waves over a wide of frequencies called electromagnetic spectrumdifferent parts of the electromagnetic spectrum have different names depending on its different properties in transmission absorption and the emission of the corresponding waves. In addition to it different applications,in electromagnetic spectrum,the frequency starts from smaller to the longer and the wavelength starts from longest to shortest.

Based applications of electromagnetic waves on frequency or on the wavelength [1].Use the electromagnetic waves in many applications for example in wireless communications [2].Remote sensing [3,2], radar[4,3)], wireless power transfer [5],the regions of electromagnetic spectrum shown in the table(1)[6].

Table 1. The regions of electromagnetic spectrum

Wavelength range (nm)	Frequency range (s^{-1})	Description
<0.1 nm	10^{20}–10^{23}	Gamma rays
0.1–10 nm	10^{17}–10^{20}	X-rays
10–400 nm	10^{15}–10^{17}	Ultraviolet
400–700 nm	10^{14}–10^{15}	Visible
700 nm to 1 mm	10^{11}–10^{14}	Infrared
1 mm to 1 cm	10^{10}–10^{11}	Microwaves
1 cm to 100 km	10^{3}–10^{10}	Radio waves
100–1,000 km	10^{2}–10^{3}	Audio frequency

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Three region of electromagnetic spectrum used in communication systems, the regionsare visible, radio waves and infrared,we can explain the radio waves which used in wireless communications,for example in antennas, where smart phone depend on electromagnetic radiations which emitted from antennas[7-8].

Table2. The electromagnetic spectrum used in electronic communication.[9]

Name	Frequency	Wavelength
Extremely low frequencies (ELFs)	30–300 Hz	10^7-10^6 m
Voice frequencies (VFs)	300–3000 Hz	10^6-10^5 m
Very low frequencies (VLFs)	3–30 kHz	10^5-10^4 m
Low frequencies (LFs)	30–300 kHz	10^4-10^3 m
Medium frequencies (MFs)	300 kHz–3 MHz	10^3-10^2 m
High frequencies (HFs)	3–30 MHz	10^2-10^1 m
Very high frequencies (VHFs)	30–300 MHz	10^1-1 m
Ultra high frequencies (UHFs)	300 MHz–3 GHz	$1-10^{-1}$ m
Super high frequencies (SHFs)	3–30 GHz	$10^{-1}-10^{-2}$ m
Extremely high frequencies (EHFs)	30–300 GHz	$10^{-2}-10^{-3}$ m
Infrared	—	0.7–10 μm
The visible spectrum (light)	—	0.4–0.8 μm

Units of Measure and Abbreviations:
kHz = 1000 Hz
MHz = 1000 kHz = 1×10^6 = 1,000,000 Hz
GHz = 1000 MHz = 1×10^6 = 1,000,000 kHz
= 1×10^9 = 1,000,000,000 Hz
m = meter
μm = micrometer = $\frac{1}{1{,}000{,}000}$ m = 1×10^{-6} m

Also the mobile phone device usedelectromagnetic radiation in it work, The mobile phones (MP) can be definedas low power radio tools where it works through the use of electromagnetic fields. Within the frequency rangefrom900MHz to 1800MHzand signal pulsed at pulse width equal to 577 with 217HZ[10-11].The flow rate which emitted from electromagnetic field energy for each unit area known the power density, where it is employ to calculate the amount of radiation from point of transmitting antenna,and can be measure by using the unit, The table(3) shows ICNIRP Safety Bounds forknownexposure[12].

Table3.ICNIRP Safety Bounds for knownexposure

Service Frequency	ICNIRP Safety limit E-field [V/m]	ICNIRP Safety Limit Power Density (W/m2)
GSM 900	41.9	4.66
GSM 1800	58.4	9.05
WCDMA	61	9.87

Experimental Work

1. The programs used in the search

a. Open Signal

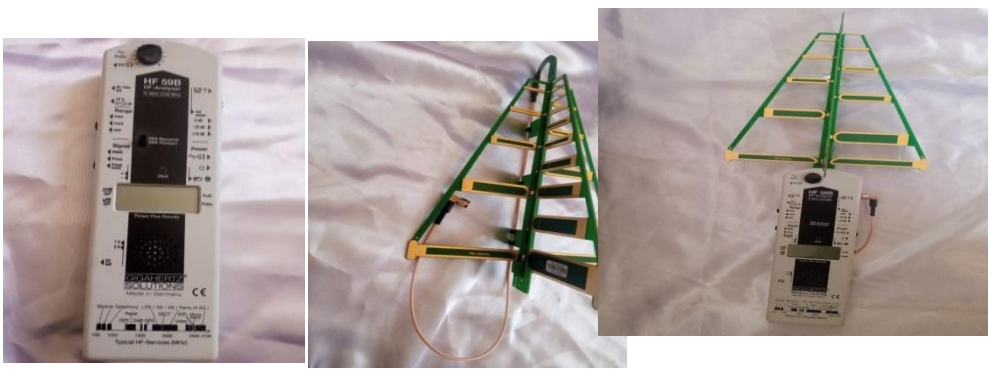
it is a program that enables the user to know the coverage and transmission in his area and is able to know thenearest towers to him.

b.Map System Coordinates

A program that shows maps of all countries of the world as well as showing the latitude and longitude of any city on the map.

2. The Device Used in the Search

A German-made device HF59B analyses was used in the research that uses this device to measure the density of electromagnetic energy emitted from mobile phone towers. The device is equipped with a non-folding antenna, its function is to make the device capable of receiving frequencies and this range of frequencies is (700-2700) MHz, soappropriate range for the work of cellular phones.Theenergy density of this device is measure in unit mW/m^2or$\mu W/m^2$and Figure (1) shows the image of the device.



(a)(b)(c)

Figure1.(1-a): One of the parts ofHF59B analyses the device

(1-b): One of the parts ofHF59B analyses the device

(c-1): device HF59B analyses

3. Prepare Maps

After obtaining the maps of the region from the Directorate of Urban Planning for the province of Babylon.

The maps was divided into squares, with the area of one square equal to$200m^2$.

Give each square a specific symbol that distinguishes it from the rest of the squares, as it consists of a letter and a number.

Due to the small area of the squares of $200m^2$ for each square, one measuring point was chosen, located in the center of the square, as shown in Figure (2).

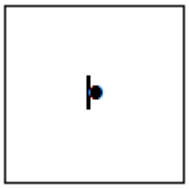


Fig. 2. Indicates that the measurement point is located in the center of the square

Determination Locations of the Towers

It is a program that helps to display maps and works on iPhone and Android devices. It was used in this research for the purpose of fixing the geographical locations of the points where the energy density was measured. As shown in figure(3).

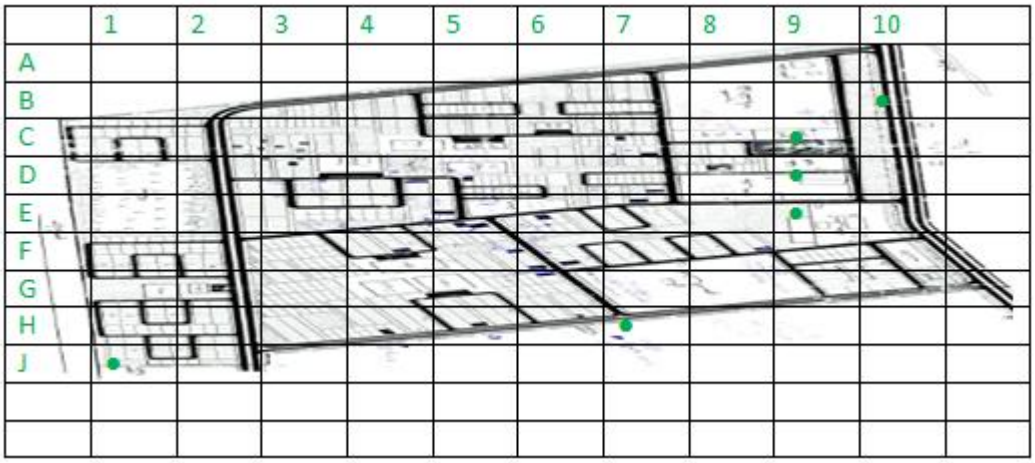


Fig. 3.A map of the Nile district center with mobile phone towers installed

Table4. Mobile phone towers in hand the Nilecenter

	The Company's name	Location by column	the coordinates of the location	Height
1	Asia Cell	in a columnB_{10}	N:32.542160 E:44.544579	40 on the roof of the house
2	Asia Cell	in a columnC_9	N:32.542160 E:44.544579	30 on the roof of the house
3	Zain	in a columnD_9	N:32.543261 E:44.553508	30 on the roof of the house
4	Asia Cell	**in a ColumnE_9**	N:32.543357 E:44.555888	60 meters above ground
5	Asia Cell	in a columnH_6	N:32.536435 E:44.578161	40 meters above ground
6	Zain	in a columnJ_1	N:32.530317 E:44.582568	40 meters above ground

Measuring Energy Density Levels

The method used to measure energy density levels is summarized as follows.

1. He center point for each of the squares was determined using the car meter in places where there are no industrial obstacles such

as buildings or natural obstacles such as rivers. As for the places where there are obstacles, the centers of the squares were determined using the scale bar

2. Put theHF59B device (used to measure the energy density levels of rays) at an angle of45° and record the readings for four geographical directions by rotating the body at the same point without moving from the measurement site so that the geographical coordinates do not change
3. To reduce the error rate, the total average of the four readings withinone square was extracted. As shown in figure(4).

Fig. 4. It shows a map of the center of the Nile side, with points on which the energy density was measured.

Results and Discussion

The energy density levels of the rays emitted from mobile phone towers were measured as shown in Table(5).

Table5. Practical readings of energy intensity levels in in hand the Nilecenter

Symbol	GPS	time	I	I	I	I	I	I
	N:32.537943 E:44.540579	5-7--2022 7:55AM	67.5	111.3	78.3	104.2	90.325	88.3025
	N:32.538087 E:44.540605	5-7-2022 8:20	104.6	132.6	120.4	112.6	117.55	
	N:32.538222 E:44.540572	5-7-2022 8:45AM	91.8	118.2	104.6	94.5	102.275	
	N:32.538391 E:44.540576	5-7-2022 9AM	105.2	101.6	139.9	113.2	114.975	
	N:32.538437 E:44.540579	5-7-2022 9:15AM	117.6	93.1	158.8	74.1	110.9	
	N:32.538476 E:44.540544	5-7-2022 9:35AM	89.4	139.1	66.1	104.8	99.85	
	N:32.539198 E:44.54057	5-7-2022 9:50AM	153.6	87.1	59.2	44.6	86.125	
	N:32.536165 E:44.541469	5-7-2022 10:10AM	138.6	90.1	159.6	77.3	116.4	
	N:32.542137 E:44.541169	5-7-2022 25AM	131.	90.2	156.3	75.6	113.2	
	N:32.544547 E:44.541038	5-7-2022 10:40AM	2.8	0.3	0.9	83	21.75	
	N:532837	5-7-2022	78.3	112.6	94.7	110.3	98.975	124.26

	E:44.543095	8:5AM						
	N:32.532306 E:44.54573	5-7-2022 8:11AM	127.2	158.9	144.1	159.6	147.45	
	N:32.532799 E:44.546038	5-7-02022 8:20	144.4	91.8	132.7	163.9	133.2	
	N:32.534324 E:44.545982	5-7-2022 8:36AM	141.3	115.1	141.6	71.9	117.475	
	N:32.536119 E:44.544823	5-7-2022 8:50AM	174.1	139.1	129.2	134.6	144.25	
	N:32.525869 E:44.544712	5-7-2022 9:00AM	134.7	120.7	78.4	105.2	109.75	
	N:32.538769 E:44.544762	5-7-2022 9:10AM	129.2	131.7	88.1	66.8	103.95	
	N:32.540606 E:44.544626	5-7-2022 9:17AM	111.6	110.6	166.3	143.4	132.975	
	N:32.542160 E:44.544579	5-7-2022 9:25	144.2	128.4	131.2	111.2	128.75	
	N:32.543564 E:44.544407	5-7-2022 9:33AM	134.6	132.6	108.4	127.7	125.825	
	N:32.531937 E:44.546881	6-7-2022 7:50AM	85.5	144.7	106.8	94.7	107.925	133.0125
	N:32.532610 E:44.546511	6-7-2022 8:00AM	101.5	136.6	92.7	168.7	124.875	
	N:32.533583 E:44.5460063	6-7-2022 8:7AM	113.3	129.1	130.9	135.2	127.125	
	N:32.534062 E:44.545822	6-7-2022 8:20AM	136.8	152.7	135.1	140.6	141.3	
	N:32.534062 E:44.545822	6-7-2022 8:31AM	124.2	154.6	145.2	158.7	162.7	
	N:32.537273 E:44.545278	6-7-2022 8:41AM	157.6	136.4	105.2	151.8	137.75	
	N:32.537273 E:44.545278	6-7-2022 8:53AM	105.9	111.5	150.3	105.5	118.3	
	N:32.541425 E:44.545141	6-7-2022 9:5AM	146.6	143.5	135.7	149.9	143.925	
	N:32.543544 E:44.545141	6-7-2022 9:17AM	108.5	143.5	143.2	146.2	135.35	
	N:32.544912 E:44.544801	6-7-2022 9:	106.4	118.8	170.5	127.8	130.875	
	N:32.529688 E:44.553855	6-7-2022 9:25AM	116.5	134.9	119.5	132.2	125.775	126.675
	N:32.530767 E:44.554327	6-7-2022 9:37AM	121.2	89.2	69.2	88.1	91.925	
	N:32.530894 E:44.554376	6-7-2022 9:50AM	123.2	112.2	134.2	105.8	118.85	
	N:32.533926 E:44.556305	6-7-2022 10:00AM	142.7	148.3	120.2	147.8	139.75	
	N:32.535484 E:44.556888	6-7-2022 10:10AM	111.4	149.8	98.6	104.1	115.975	
	N:32.537039 E:44.556406	6-7-2022 10:21AM	127.5	110.2	149.2	151.7	134.65	
	N:32.539488 E:44.556980	6-7-2022 10:30AM	136.3	144.6	106.3	160.3	136.875	
	N:32.541196 E:44.554313	6-7-2022 10:38AM	112.2	147.2	118.5	121.1	124.75	
	N:32.543261 E:44.553508	6-7-2022 10:50AM	112.6	130.2	137.3	130.8	127.725	

	N:32.545424 E:44.552922	6-7-2022 11:00AM	150.5	129.2	157.8	164.4	150.475	
	N:32.529508 E:44.556164	6-6-2022 7:45AM	25.2	31.2	22.1	27.3	26.45	54.6775
	N:32.531338 E:44.557914	6-6-2022 7:55AM	63.2	23.9	28.8	83.6	49.875	
	N:32.532319 E:44.557710	6-6-2022 8:10AM	124.2	138.8	20.4	96.3	94.925	
	N:32.534369 E:44.55791	6-6-2022 8:21AM	52.4	36.6	41.2	92.8	55.75	
	N:32.536726 E:44.557899	6-6-2022 8:30AM	88.4	90.0	45.2	126.9	87.625	
	N:32.537869 E:44.558423	6-6-2022 8:40AM	54.9	41.3	91.4	88.3	68.975	
	N:32.540242 E:44.557361	6-6-2022 8:51AM	85.3	90.1	38.7	118.6	83.175	
	N:32.541916 E:44.556651	6-6-2022 9:00AM	40.1	90.6	188.2	43.3	90.55	
	N:32.543357 E:44.555888	6-6-2022 9:15AM	40.4	67.0	69.2	88.1	66.175	
	N:32.545584 E:44.554925	6-6-2022 9:27AM	50.1	0.1	0.3	22.1	18.15	
	N:32.530100 E:44.566167	6-6-2022 9:38AM	31.1	20.4	124.7	53.2	57.35	40.7095
	N:32.531892 E:44.566206	6-6-2022 9:50AM	73.3	45.4	26.9	25.5	42.775	
	N:32.532872 E:44.566206	6-6-2022 10:00AM	25.9	41.3	25.7	20.2	28.275	
	N:32.534271 E:44.565531	6-6-2022 10:10AM	28.4	20.1	63.7	14.6	31.7	
	N:32.535222 E:44.56451	6-6-2022 10:20AM	14.9	25.3	38.8	23.1	25.525	
	N:32.538136 E:44.563219	6-6-2022 10:30AM	41.3	88.3	64.8	103.5	74.475	
	N:32.539743 E:44.562603	6-6-2022 10:40AM	36.7	24.5	25.7	19.7	26.65	
	N:32.542480 E:44.560468	6-6-2022 10:50AM	52.3	64.4	25.3	24.8	41.7	
	N:32.543240 E:44.559338	6-6-2022 11:00AM	93.9	21.6	19.1	17.2	37.95	
	N:32.545890 E:44.558163	6-6-2022 11:10AM	65.9	61.2	20.3	15.4	40.7	
	N:32.530521 E:44.574435	7-6-2022 7:50AM	35.1	20.6	18.8	24.3	24.7	58.7725
	N:32.531999 E:44.574050	7-6-2022 8:00AM	82.1	50.3	24.6	26.6	45.9	
	N:32.533855 E:44.574279	7-6-2022 8:10AM	27.1	40.1	25.7	19.7	28.15	
	N:32.534741 E:44.574188	7-6-2022 8:19AM	53.5	46.3	19.2	21.1	35.025	
	N:32.535709 E:44.573702	7-6-2022 8:30AM	105.2	128.2	111.4	67.2	103	
	N:32.5380036 E:44.572309	7-6-2022 8:40AM	88.5	115.2	88.1	98.6	97.6	
	N:32.540922 E:44.570650	7-6-2022 8:50AM	111.5	109.5	88.2	106.1	103.825	
	N:32.546082	7-6-2022	78.2	67.4	105.3	59.2	77.525	

	E:44.568382	9:00AM						
	N:32.547380 E:44.567799	7-6-2022 9:10AM	46.7	28.7	26.7	32.4	33.625	
	N:32.548873 E:44.566875	7-6-2022 9:23AM	25.6	35.6	41.7	50.6	38.375	
	N:32.530026 E:44.582723	7-6-2022 9:31AM	144.7	148.6	142.3	128.4	141	95.875
	N:32.529957 E:44.582968	7-6-2022 9:40AM	135.6	131.2	141.9	68.2	119.225	
	N:32.531628 E:44.581714	7-6-2022 9:50AM	111.3	113.4	67.2	157.1	112.25	
	N:32.531628 E:44.581714	7-6-2022 10:00AM	116.1	141.4	70.1	116.8	111.1	
	N:32.534157 E:44.579980	7-6-2022 10:10AM	105.1	107.2	139.2	138.2	122.4	
	N:32.536435 E:44.578161	7-6-2022 10:22AM	117.2	92.1	105.1	88.5	100.725	
	N:32.542283 E:44.575355	7-6-2022 10:30AM	123.5	111.3	94.1	109.5	109.6	
	N:32.544569 E:44.573946	7-6-2022 10:41AM	88.4	101.2	78.2	68.3	84.025	
	N:32.545791 E:44.572891	7-6-2022 10:53AM	27.5	32.6	41.3	28.8	32.55	
	N:32.54947 E:44.570963	7-6-2022 11:10AM	20.7	24.5	32.7	25.6	25.875	
	N:32.530317 E:44.582568	8-6-2022- 7:55AM	105.3	105.7	147.3	118.3	119.15	63.4075
	N:32532269 E:44.581401	8-6-2022 8:10AM	147.7	117.9	134.7	97.4	124.425	
	N:32.533728 E:44.580198	8-6-2022 8:20AM	65.5	142.7	126.6	163.8	124.65	
	N:32.53481 E:44.579340	8-6-2022 8:33	94.8	163.5	103.2	117.5	96.225	
	N:32.536072 E:44.578457	8-6-2022 8:45AM	40.6	39.6	21.2	25.6	31.75	
	N:32.538124 E:44.577951	8-6-2022 8:57AM	23.8	31.3	25.1	24.2	26.1	
	N:32.544848 E:44.5832321	8-6-2022 9:10AM	26.4	28.5	20.2	29.6	26.175	
	N:32.547333 E:44.579981	8-6-2022 9:22AM	41.3	26.3	19.0	26.2	28.2	
	N:32.532055 E:44.578668	8-6-2022 9:35AM	23.2	43.4	20.3	20.7	26.9	
	N:32.551242 E:44.574924	8-6-2022 9:50AM	20.9	31.2	43.4	26.5	30.5	

the safe zone depends on the amount of electromagnetic radiation emitted by the antennas of mobile phone towers.[13].

The intensity of electromagnetic radiation is affected by

1. Degree of temperature and humidity, as the temperature increases, the amount of electromagnetic radiation increases[15].
2. The distance where you move away from the tower, the lower the level of energy density of electromagnetic rays[14].
3. Direction to the emitting antenna where the energy density level is high if it is in the direction of the antenna[14].
4. The location where if there are obstacles between the tower and the inhabitants, the level of energy density decreases because it is affected by physical phenomena such as

reflection, refraction, interference and diffraction[14].

5. Frequency and wavelength to electromagnetic radiation emitted by the antenna.[15].
6. The stay time of the electromagnetic rays emitted by the tower in a specific space[14].
7. The number of people making calls at the same timewhere,

The higher the number of people, Leads to an increase in the level of energy density of electromagnetic radiation[14].

The locations of the mobile phone communication towers located in the Nile district center were also installed on the map of the Nile district center.

When observing the values of energy density levels for the Nile side, the levels were divided into:

Level one: areas of lowintensitydensityequal to(18.15-54.2)$\frac{\mu W}{m^2}$

Level Two: Areas of medium intensity density equal to(54.3-90.3)$\frac{\mu W}{m^2}$

Level three: Areas ofabove average intensity equal to(90.4-126.4)$\frac{\mu W}{m^2}$

Level four: areas of high intensity densityequal to(126.5-162.7)$\frac{\mu W}{m^2}$

As shown in figure(5).

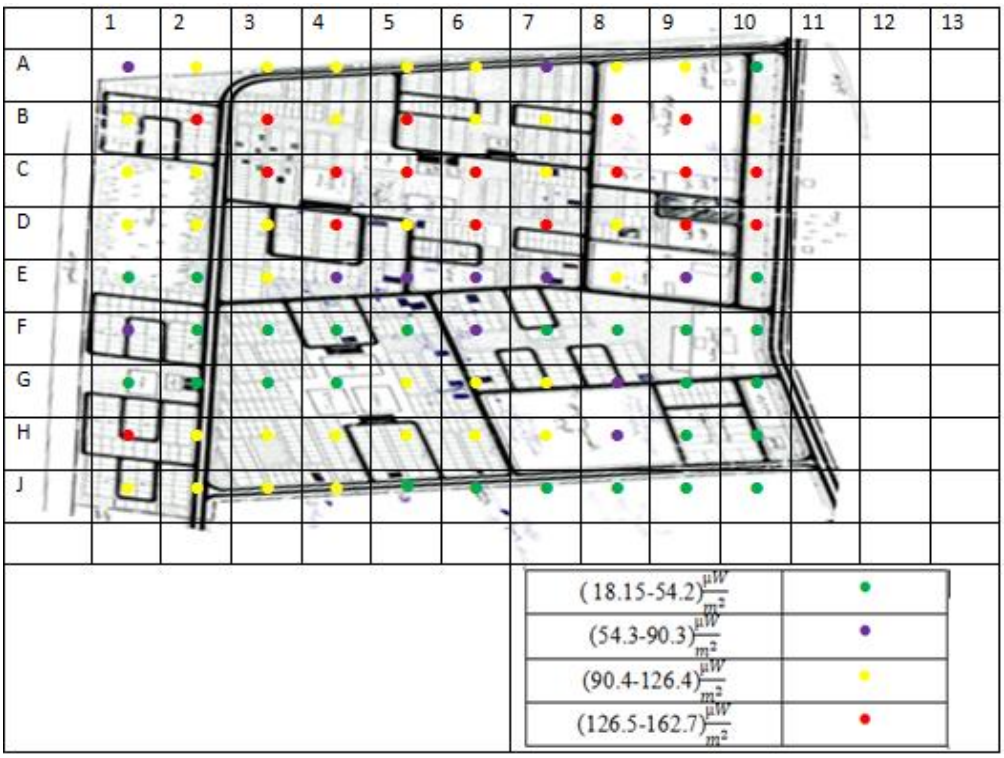


Figure5. Radio map of hand the Nilecenter the with ranges of energy density levels for the rays of mobile phone towers.

Conclusion

1. There are cell phone towers installed on the roofs of residential houses, which increases the health risks to the residents near the tower.
2. Energy density levels decrease the further away from the tower for mobile phones.
3. The values of energy density levels vary according to the properties of the tower, such as the type of tower, Asia, Zen or Cork, or according to the different physical characteristics of the same type.
4. Not knowing the health risks of communication towers for most people.

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