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Assessment of CO_2 with Weather Factors and its Percentage for Indoor and Outdoor

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ABSTRACT

In this paper, measurements of CO_2 rate and its relation to temperature, humidity and wind speed were carried out at 13 different locations in Erbil city during March [2017 to 2018], it was found that CO_2 rate is the same as global level (418ppm) for outdoor. Measurements of CO_2 rates for indoor environment showed that using kerosene heaters (during winter season) caused a rapid increase of CO_2 rate in a short time, which has harmful side effect on human health.

INTRODUCTION:

It is estimated that thousands ton of air pollutants are emitted every year in main cities over the world. Indeed, that leads to the climate changes that occur due to the global warming in which the increased of Carbon Dioxide (CO_2) emissions is responsible for. To gather the increasing air pollution and depletion of fossil fuels, they are noted as the major problems in the present Century [1, 2]. The Global warming is challenging the very existence of life on earth, which is caused by a phenomenon called as the Greenhouse effect. The primary cause of this phenomenon is the continuous emission of 'greenhouse gases' that mainly consists of carbon dioxide and methane. Greenhouse effect refers to the global increase of the atmospheric temperature contributed by greenhouses gasses and particulate matter present in the atmosphere. The radiation,

Carrying the heat, is trapped by these gases and unable to escape the atmosphere, thereby resulting in rising in main temperatures globally [3, 4].

Several laboratories and researchers make measurements of atmospheric carbon dioxide to better understand it is relation to global warming, Friedlingstein et al., 2014, developed Biosphere models to simulate surface fluxes of CO_2, [5] .

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Carslaw et al., 2018 and Lovenduski 2017 study the future evolution of the carbon cycle, and its effect for our climate and introduce the new method for minimize the rate of CO_2 [6,7]. Anne et.al, 2019 By using the designed mesoscale modeling framework, measured detailed surface exchanges of CO_2 and the relative contribution from the different surface types[8].

There are both natural and manmade sources of carbon dioxide emissions. Natural sources include decomposition, ocean release, and respiration. Human sources come from activities like cement production, deforestation as well as the burning of fossil fuels like coal, oil, and natural gas. 87% of all human-produced carbon dioxide emissions come from the burning of fossil fuels like coal, natural gas, and oil. The remainder results from the clearing of forests and other land that use changes (9%), as well as some industrial processes such as cement manufacturing (4%) [9].

Atmospheric CO_2 has been measured steadily ever since 1958, when American geochemist Charles David Keeling (1928–2005) made the first such measurements at Mauna Loa Observatory in Hawaii. Keeling found that month-by-month, atmospheric CO_2 tracks the growing season in the Northern Hemisphere, which contains most of the world's land area and most of its plants [21]. In spring and summer, as green plants grow, they remove CO_2 from the air; in winter, plant decay continues to release CO_2 while growth absorbs relatively little. The result is a series of peaks and

valleys in atmospheric CO_2 [NOAA gov. 2016]. From the top of each winter peak to the bottom of each summer valley, CO_2 concentration decreases by almost 5 ppm; from summer to winter, it increases by almost the same amount [10,11].

Carbon dioxide gas CO_2 has been emitted by its various sources and absorbed by its various sinks. Carbon dioxide sinks (absorbers) include the oceans, which become more acidic as they absorb CO_2 (Carbon dioxide) reacts with water to form bicarbonate and carbonic acid. And these species are involved in multiple biochemical reactions;
($CO_2 + H_2O \leftrightarrow H_2CO_3 \leftrightarrow H + HCO_3^-$) (1), and green plants. They include not only the familiar grasses, trees, and shrubs that grow on land but the trillions of single-celled phytoplankton that float in the top few meters of the world's oceans [12,17].

Rate of Outdoor CO_2

The atmosphere is not the only part of the Earth that has carbon. The oceans store large amounts of carbon, and so do plants, soil, and deposits of coal, oil, and natural gas deep underground. Carbon naturally moves from one part of the Earth to another through the carbon cycle. But right now, by burning fossil fuels, people are adding carbon to the atmosphere (in the form of carbon dioxide) faster than natural processes can remove it. That is why the amount of carbon dioxide in the atmosphere is increasing, which is causing global climate change [11].

The data collected at Mauna Loa indicates a continual rise in global CO_2 levels from less than (320 ppm, parts per million) when measurements were first recorded to approximately above (400ppm) today [10].

Table (1) shows that the average measurements of CO_2 concentration measurement during November 2008 were very high for CO_2 concentration and they are extremely exceeded.

Table 1: Averages of Nov- 2008 of primary pollutants concentrations measurements at Baghdad City with Iraqi and WHO standards [15].

Air pollutant	**CO_2 (ppm)**
Present study	**366.2**
Iraqi standards	**250**
WHO standards	**250**

Iraqi and WHO standards air pollutants. So, an air of Baghdad city is highly polluted due to the traffic, personal and private electrical generators, chemical transformation of some pollutants in industrial activities and poor vegetation cover and green areas in the city.

Health Effects

At low carbon dioxide concentrations, our breathing rate increases, capillaries dilate and the skin becomes flushed. High concentrations of carbon dioxide can cause asphyxiation quickly, without warning, regardless of the oxygen concentration. No one should enter an area with greater than 3 percent carbon dioxide without special breathing equipment to prevent adverse effects. However Carbon dioxide in its gas form is an asphyxia, which cuts off the oxygen supply for breathing, especially in 10 percent or more of carbon dioxide can cause death, unconsciousness, or convulsions [16]. Effect of Different Levels of CO_2 and it is harmful effect on human body shown in (table 2). [11,18].

Table 2: CO_2 level and its effect.

Level of CO_2	Concentration effect
350 - 450 ppm	typical atmospheric
600 - 800 ppm	Acceptable indoor air quality
1,000 ppm	Tolerable indoor air quality
5,000 ppm	Average exposure limit over 8-hour period
6,000 - 30,000 ppm	Concern, short exposure only

Experimental Methods.

Study Area:

Erbil is the capital of Iraqi Kurdistan region and the largest city in northern Iraq. It is located approximately 350 kilometers (220 miles) north of Baghdad and lies on latitude 36.2063° north and longitude 44.0089° east. Erbil is situated in a plain area of an elevation about 390 m above sea level, and its population reached 852,500 in the year 2015. Figure. 1 shows the study area and the location points where measurements are made.

Like many other major cities, the population and buildings of Erbil increased year after year, but its

distribution of buildings, vehicle and population are not standardized. In this study the CO_2 concentration were measured in Erbil city, by choosing (13) locations.

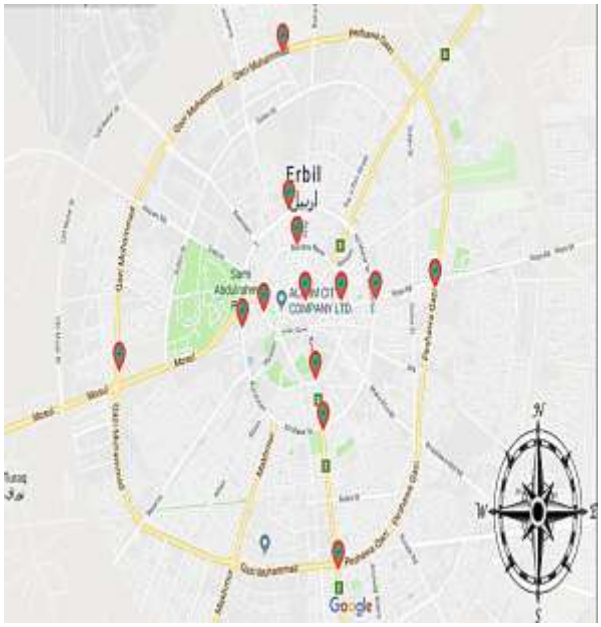

Fig. 1: Study area and points of CO_2 level Measurements in Erbil city.

The points were distributed around the Erbil citadel which is the central point in the city on the named (30, 60, and 100) meter streets, as shown in (fig.1).

Experimental Data of the Outdoor

The levels of CO_2 concentration are measured in the outdoor investigated during one year (1-3-2017) to (1-3-2018) covering the four seasons, as shown in (fig. 3)., for each day at (8AM) in the morning and (8PM) in the evening.

On the other hand, the relation of CO_2 concentration with (temperature, humidity, and wind speed) was also measured, (fig.4, 5, and 6).Relation of CO_2 concentration versus the number of automobile in the city was determined for the last (10) years, and the increasing trend in the graph was observed in (fig.8).

Apparatus

Measurements and collect datalogger with a PASPORT sensor were taken by using Explorer GLX shown in (Fig.2), and (CO_2 Gas sensor and Temperature/Humidity sensor) of PASCO company in which according to the CO_2 sensor datasheet, the sensor accuracy is 10%.

(a) **Xplorer GLX datalogger**

(b) (c)

Fig.2: Tools used in this researchers:-

(a) Xplorer GLX data logger, (b) Crbon dioxed

Gas sensor, and (c) humidity , and temperature sensor.

RESULTS AND DISCUSSION

The Rate of CO_2 in Erbil atmosphere is measured during one year at day and night as showed in (fig.3). The rate of CO_2 fluctuated between minimum range is (300 ppm) to the maximum value (450 ppm). The rate of CO_2 is about (1.5%) higher than the standard value for Erbil city.

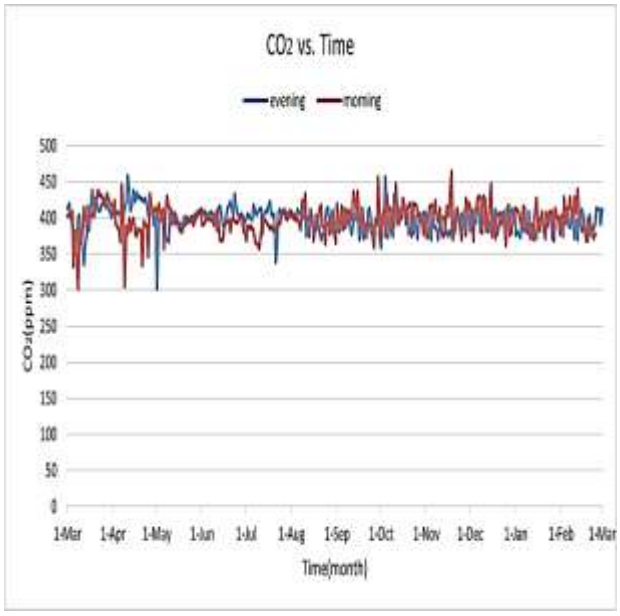

Fig. 3: Rate of CO_2 in Erbil atmosphere during one year at day (red line) and night (blue line). The rate of CO_2 fluctuated between minimum range is (300 ppm) to the maximum value (450 ppm).

Rate of CO_2 and temperature values along one year are shown in the (Fig. 4**)**, the main value of CO_2 is around 418 ppm, the CO_2 levels randomly scattered around the mean value.

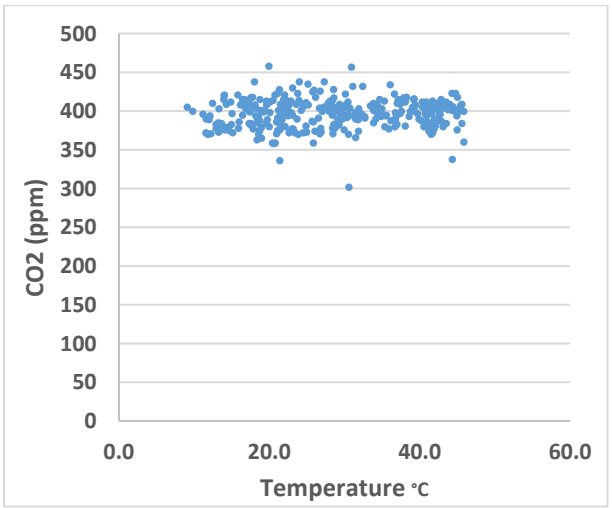

Fig. 4: CO_2 concentration versus Temperature.

The rate of CO_2 versus relative humidity along one year is shown in the (Fig. 5**)**, the figure shows that the (mean) value of CO_2 ranges between (300-450) ppm, again the CO_2 levels randomly scattered around the mean value.

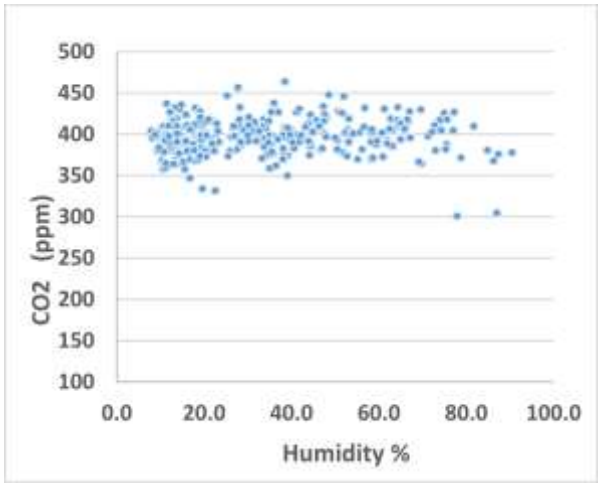

Fig. 5: CO_2 concentration versus relative humidity.

Therefore, the change of the CO_2 rate with change of temperature and humidity along one year has the same effect as shown in both (Fig. 4 and 5).

The relation between the wind speed in Erbil city and the rate of CO_2 is shown in (Fig. 6),

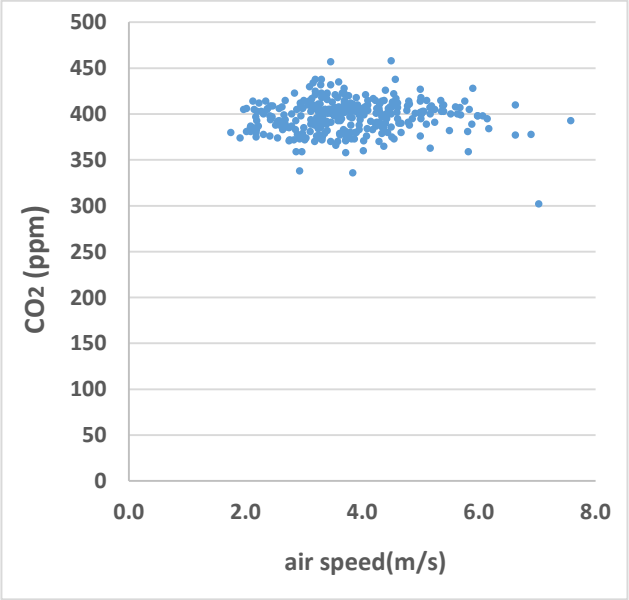

Fig. 6: CO_2 concentration versus wind speeds.

The rate of CO_2 change from 300ppm to 460 ppm along the time of taking data of; (2017 to 2018). The research shows that wind speed has no effect on the rate of CO_2.

Figure.7 shows the average distribution of CO_2concentration in Erbil city for one year (March 2017- March 2018), ranging from (353 ppm – 502 ppm). The higher concentrations of CO_2 in regions are related to where industrial activities are located and to high distribution of vehicles. The CO_2 level mean value is 418ppm with a standard deviation of 47ppm, and the medium is 417ppm. In an average there is small variation in the rate of CO_2 from point to point.

Erbil city witnessed a rapid increase in the number of automobiles that cause increasing in the rate of CO_2 level in the air as show in the [19]. These data are represented graphically as shown in (Fig. 8) below to clarify the multifold increase in the rates of pollution.

Jassim et al estimated the rate of emission of CO_2 for six years from vehicles as shown in (Table 3)

Table 3: yearly emission of CO_2 in Erbil [19].

Year	2006	2007	2008	2009	2010	2011
CO_2(ton)	255	527	890	1254	1800	2813

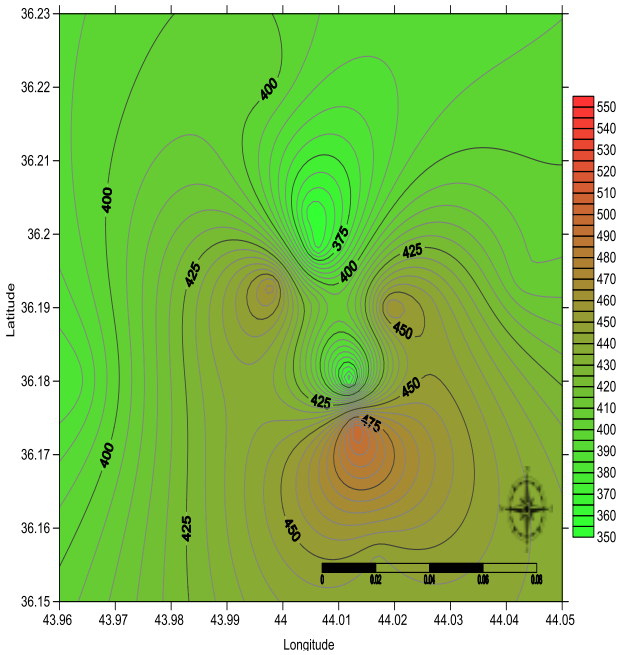

Fig 7.: Average distribution of CO_2 Concentration in Erbil city.

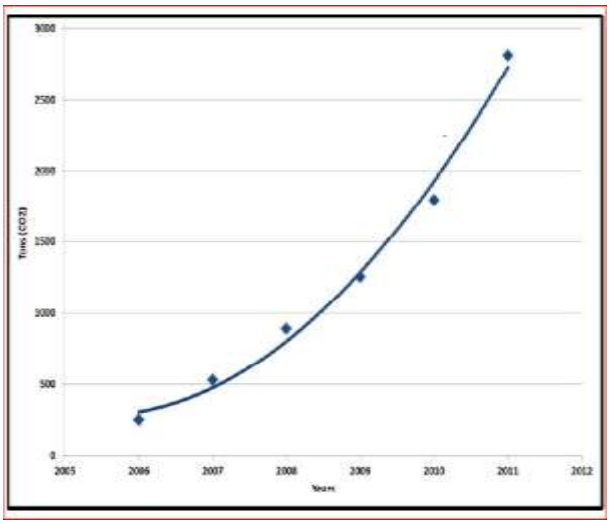

Fig 8.: Rate of increase of CO_2 gases emitted from different automobiles in Erbil [15].

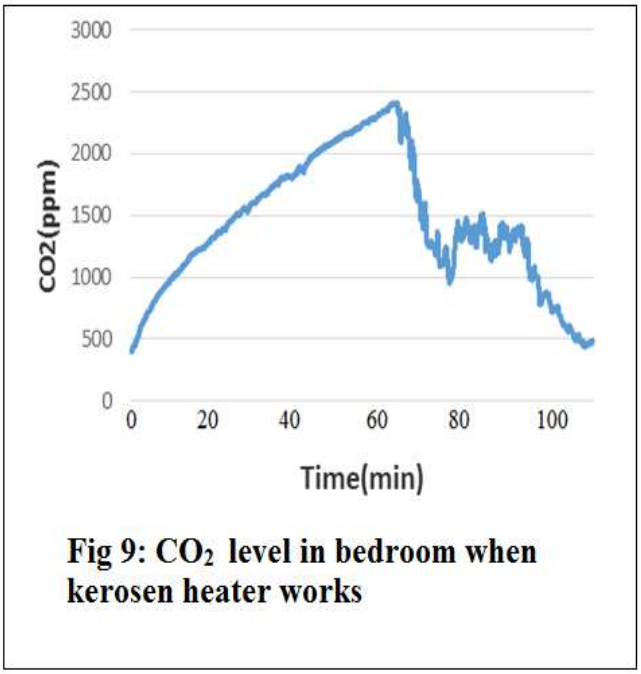

Fig 9: CO_2 level in bedroom when kerosen heater works

Experimental Data of the Indoor

Carbon dioxide gas is produced when people breathe. Each exhaled breath by an average adult contains 35,000 to 50,000 parts per million (ppm) of CO_2 100 times higher than what is typically found in the outside air (OSA) [20].

The CO_2 concentration in an occupied indoor space indicates if the building's air exchange balance is appropriate. That is if the optimal amount of OSA is

being mixed with air that has been circulated in the building. An elevated indoor CO_2 concentration directly related to the number of occupants in the building. The building's ventilation rate and the CO_2 level are in the outside air [13]. A kerosene heater draws in air and releases heat from the internal combustion of kerosene. This combustion process is very efficient, with only 7% to 8% of wasted energy tied up as a water-by-product. However, certain toxic fumes are released, including oxides of nitrogen, sulfur, as well as huge amount of carbon-dioxide [14].

Current ventilation guidelines, such as those from the American Society of Heating Refrigerating, and Air Conditioning Engineers [17], recommend that indoor CO_2levels should not exceed the local outdoor concentration by more than about 650 ppm. Good practice indicates that the ASHRAE 2007 [17].

There are different sources of CO_2 rather than from person inhalation in the indoor environment. For instance, CO_2 emissions from open gas appliance like Kerosene heater especially in bedroom and using it for a long period of time. (Fig. 9), shows graphical representation of increasing CO_2 level in bedroom when kerosene heater is working for an hour in a (6.5×4.2×3) m room with poor air exchange (closed door and window).

The result shows that CO_2 concentration is about 500-2400 ppm, whereas in the outdoor concentration is (350-450 ppm) which is higher by 8% than in the level of CO_2 concentration situation causing headaches, drowsiness, and stagnant poor concentration, increasing heart rate and slight nausea may also be present.

After good air exchange presence (open door and window) as observed CO_2 level decrease to around (1400 ppm) which is poor air, then the heater is shut down and CO_2 concentration back to its normal level of (418 ppm).The increase of CO_2 concentration is the fastest in the initial phase. It can be seen that the level of 1500 ppm is exceeded after just one an hour.

(Fig. 10), shows the rate of CO_2 in a bedroom (without heater) with one person in it for 8-hours, the CO_2 rate increases from 500 to 3300 ppm and this causes great risks to human health [22].

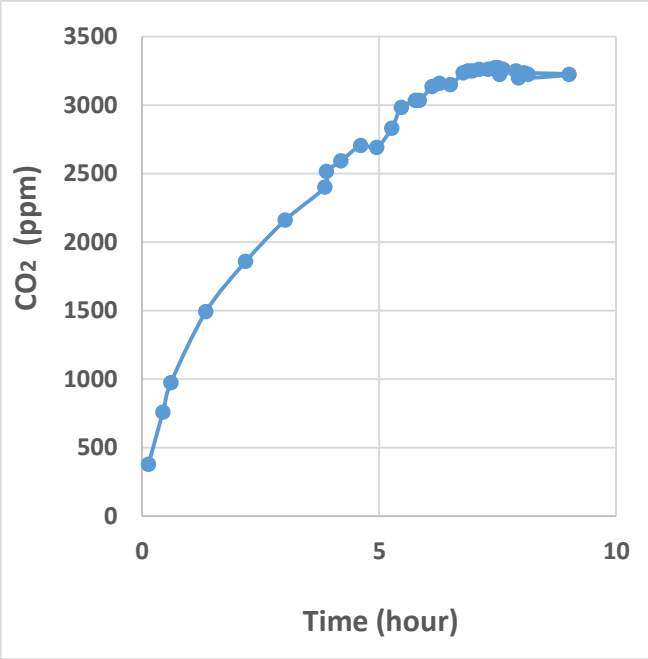

Fig 10.: rate of CO_2 in the center of bedroom as a function of time.

CONCLUSION

In this work, the level of CO_2 gas is measured in the atmosphere of Erbil and is found to be about 418ppm with small variation in the yearly average. It is found that CO_2 concentration is close to the global level of (400ppm), and it is rising (by several tens) each year, this is due to rapid increase of population and the number of vehicles on the roads. The relation of CO_2 levels with temperature and relative humidity does not reveal any consistent noticeable variation; this should be investigated with more detail. Also this study gives an important information about the hazard of kerosene heaters and its effect on CO_2 level when using it in a poor air ventilated living room. The research has revealed and recommend these results:

1-CO_2 gas has a key role on global warming, but due to low accuracy of our devices this relation was not appeared.

2-Rapid increasing of the number of vehicles and public generators cause extreme emission of CO_2 to the polluted atmosphere.

3-Kerosene heaters are quite harmful to be used by ignoring its rules that explained in suggestion section.

5- Erbil's CO_2 level is nearly the same as global level, which is relatively high comparing to several tens of years.

6-The rate of CO_2 can be kept away from the atmosphere by storing it underground.

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REFERENCES:

[1]Krawczyk, T. (1996). Biodiesel– alternative fuel makes inroads but hurdle remains. International News Fats Oils Related Matter (INFORM), 7: 801–815.

[2] Naveen, C. K. & Prasada, K. R. (2015). International Journal of Engineering Trends and Technology (IJETT) –26 (3).

[3] Solomon,N. Ramesh B. Seshu, N. & Anantha, K. N. (2016). In ternational Journal of Engineering Trends and Technology (IJETT) –36 (7).

[4] Batog, P. & Badura, M. (2013). Dynamic of changes in carbon dioxide concentration in bedrooms. Procedia Engineering, 57, pp.175-182.

[5] Friedlingstein, P. Meinshausen, M. Arora, V. K. Jones, C. D. Anav, A. Liddicoat, S.K., & Knutti, R.(2014). Uncertainties in CMIP5 Climate Projections due to Carbon Cycle Feedbacks, J. Climate, 27,511–526 JCLI-D-12.

[6] Lovenduski, N. S. & Bonan, G. B. (2017). Reducing uncertainty in projections of terrestrial carbon uptake, Environ. Res. Lett., 12.

[7] Carslaw, K. S. Lee, L. A. Regayre, L. A. & Johnson, J. S.(2018.). Climate models are uncertain, but we can do something about it, EOS, 99.

[8] Anne, L. Thomas, S. Jesper, C. Mathew, W. Kim,P. Lise-Lotto, S. & Casmills, G. (2019). Simulating the atmospheric CO2 concentration across the heterogeneous landscape of Denmark using a coupled atmosphere–biosphere mesoscale model system, Biogeosciences, 16, 1505–1524.

[9] Basim, I. & Wahab, T (2015). Effect of temperature and humidity on air pollution of Baghdad city, Diyala J for pure science, 12. 3, pp. 75-88.

[10] Raupach, R. M. et al (2007). Global and Regional Drivers of Accelerating CO2 Emissions. Proceedings of the National Academy of Sciences 104 10,288 –10,293.

[11] Abolhassani, M. Guais, A. Chaumet-Riffaud, P. Sasco A.J. S, & Schwartz, L. (2009). Carbon dioxide inhalation causes pulmonary inflammation. Am J Physiol Lung Cell Mol Physiol 296:L657–L665.

[12] Schwartz, L. Guais, A. Chaumet- Riffaud, P. Grévillot, G. Sasco, A.J. Molina, T. J. & Abolhassani, M. (2010). Carbon dioxide is largely responsible for the acute inflammatory effects of

tobaccosmoke. Inhalation toxicology, 22(7), pp.543-551,

[13] Gids, W. F. De & Wouters, P. (2010). CO2 as indicator for the indoor air quality-general principles. AIVC. VIP, (33).

[14] Stephen, A. (2016). Assessment of Mechanics' Knowledge on Vehicle Emissions and their Effects on the Environment and on Human Life, International Journal of Engineering Trends and Technology, 35. 8, 362-368.

[15] Saleh, S.A. (2011). Air quality over Baghdad City using earth observation and Landsat thermal data. Journal of Asian Scientific Research, 1(6), p.291.

[16] Fanger, P.O. (1988). Introduction of the OIF and decipol unites to quantify air pollution perceived by human indoors and outdoors, Energy and Building

[17] ASHRAE, (2007). Standard 62.1, Ventilation for acceptable indoor air quality, American Society of Heating, Refrigerating, and Air Conditioning Engineers, Atlanta, USA.

[18]http://www.energy.wsu.edu/PublicFacilities Support /Resource Conservation. aspx. (2013)

[19] Jassim, H. M. Kurdi,Y. A.& Al-nidai, F.H.I.(2013). Environmental issues in Erbil city. Internaltional Journal of Engineering Trends and Technology (IJETT), 4(8No5), pp.3509-3515.

[20] https://whatsyourimpact.org/greenhous e- gases /carbon-dioxide-emissions

[21] https://data.nodc.noaa.gov/cgibin/iso? id= gov.noaa.ncdc:C00672.

[22] Snow, S. Boyson, A. King, M. Malik, O. Coutts, L. Noakes, C. Gough, H. Barlow, J. & Schraefel. M. (2018.). Using EEG to characterise drowsiness during short duration exposure to elevated indoor Carbon Dioxide concentrations, https:// t.co/ HaJ0UZRADx # bioRxiv. doi: https://doi.org/10.1101/483750.

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تقييم نسبة ثاني أكسيد الكربون مع العوامل المناخية ونسبته المئوية في الداخل والخارج

عبدالرحمن خليل سليمان، خالد اكرم عباس، ادم طلعت حمد، كارزان نوري صالح

قسم الفيزياء، كلية العلوم، جامعة صلا ح الدين ،اربيل، كردستان العراق

الخلاصة:

في هذا البحث، تم إجراء قياسات لمعدل ثاني أكسيد الكربون في 13 موقعاً مختلفاً في مدينة أربيل خلال شهر مارس (2017 إلى 2018) مع قياس درجة الحرارة والرطوبة وسرعة الرياح، وتبين أن معدل ثاني أكسيد الكربون يعادل المستوى العالمي (418 جزءاً بالمليون). في الهواء الطلق. أظهرت القياسات ان معدلات ثاني أكسيد الكربون للبيئة الداخلية باستخدام سخانات الكيروسين (خلال فصل الشتاء) قد تسبب في زيادة سريعة في معدل ثاني اكسيد الكربون في فترة قصيرة، الأمر الذي يؤثر على صحة الإنسان.