Determination of Carbon Dioxide (CO_2) Concentration in Benghazi City and Compare it with Global Atmospheric Emission of (CO_2) during Spring Season

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Abstract

A major contributor to climate change and global warming, atmospheric carbon dioxide (CO_2) is the most significant human greenhouse gas. The main target of this work is to determine the dynamics of CO_2 concentration in Benghazi city and to compare it with global atmospheric emission of CO_2 during spring season 2023. The result revealed the main average concentration of CO_2 recorded in March 415 ppm, in April 416 ppm and recorded in May 424 ppm. The May period recorded the highest value of CO_2 in Benghazi, an increase of about 7 to 8 ppm degrees from April and March. May period is usually the period in which each year the highest CO_2 levels are recorded because the plants will close their stomata to prevent water evaporation and reduce photosynthesis efficiency. At this time, human activities become more and more frequent, which eventually leads to an increase in the concentration of CO_2 in the atmosphere. Globally the CO_2 concentration in May 2022 was recorded 421 ppm by the Mauna Loa Observatory in

Hawaii. In May 2023 was recorded 424 ppm, an increase of about 3 ppm degrees from last year, this increase caused the new rise in global warming caused by human activities.

Keywords: Carbon dioxide concentration, , Climate change, Benghazi city, Libya.

الملخص:

يعد ثاني أكسيد الكربون في الغلاف الجوي (CO_2) أحد أهم غازات الدفيئة البشرية، وهو مساهم رئيسي في تغير المناخ والاحتباس الحراري. الهدف الرئيسي من هذا العمل هو تحديد ديناميكيات تركيز ثاني أكسيد الكربون في مدينة بنغازي ومقارنتها مع انبعاثات ثاني أكسيد الكربون في الغلاف الجوي العالمي خلال فصل الربيع لعام 2023. وضحت النتيجة عن متوسط تركيز ثاني أكسيد الكربون الرئيسي المسجل في مارس 415 جزء في المليون، وفي أبريل 416 جزء في المليون والمسجل في مايو 424 جزء في المليون. سجلت فترة مايو أعلى قيمة لثاني أكسيد الكربون في بنغازي، بزيادة قدرها حوالي 7 إلى 8 أجزاء في المليون من أبريل ومارس. عادة ما تكون فترة مايو هي الفترة التي يتم فيها تسجيل أعلى مستويات ثاني أكسيد الكربون كل عام لأن النباتات ستغلق ثغورها لمنع تبخر الماء وتقليل كفاءة عملية التمثيل الضوئي. في هذا الوقت، أصبحت الأنشطة البشرية أكثر وأكثر تواترا، مما يؤدي في النهاية إلى زيادة تركيز ثاني أكسيد الكربون في الغلاف الجوي. على الصعيد العالمي، تم تسجيل تركيز ثاني أكسيد الكربون في مايو 2022 عند 421 جزءًا في المليون بواسطة مرصد مونا لوا في هاواي. وفي مايو 2023 تم تسجيل 424 جزء في المليون، أي بزيادة قدرها نحو 3 أجزاء في المليون عن العام الماضي، وتسببت هذه الزيادة في ارتفاع جديد في ظاهرة الاحتباس الحراري الناجمة عن الأنشطة البشرية.

الكلمات الدالة : تركيز ثاني أكسيد الكربون, تلوث الهواء, تغير المناخ, ليبيا.

1.Introduction

One of the most significant issues facing humanity today is climate change, which has an impact on both human society and natural ecosystems worldwide (Weiwei *et al*., 2023). The sixth report of the Intergovernmental Panel on Climate Change predicted that the global temperature will rise by 1.5 C over the next two decades due to the emissions of greenhouse gases, particularly carbon dioxide and methane (IPCC., 2014; Fang *et al*., 2015). One of the major human-caused reasons for CO_2 emissions is energy consumption, which results from various human activities like burning fossil fuels, industrial operations, and the destruction of forest vegetation (Shan, 2018). It should be noted that the extravagant use of fuel, cutting down forests or reducing green spaces contributed to the increase in the proportion of second gas carbon dioxide in the atmosphere, which may lead to a rise in the Earth's temperature, which is known as global warming (Houghton, 1995; Joos,1999).

Increasing it leads to difficulty in breathing and a feeling of congestion with irritation of the mucous membranes, inflammation of the bronchial tubes and irritation of the throat. Generally, the emission sources of CO_2 in Libya are mainly from oil, gas, flaring and cement but in Benghazi is mainly from car exhaust, combustion of garbage, power plants and industrial factories. Benghazi city is the second largest city after Tripoli; Benghazi is a center of business, work, culture and the center of development. The aim of this work is to determine the dynamics of CO_2 concentration in Benghazi city and to compare with global atmospheric emission of CO_2 (2023). Benghazi city is located northern east of Libya, and located on the Gulf of Sidra in the Mediterranean, Benghazi is a major seaport and the second-most populous city in the country, as well as the largest city in Cyrenaica (Fig.1).

The authors aware, there are few studies are published about emission CO_2 in restricted areas, such as Abogrean *et al*. (2015) and Yasser *et al*. (2017).

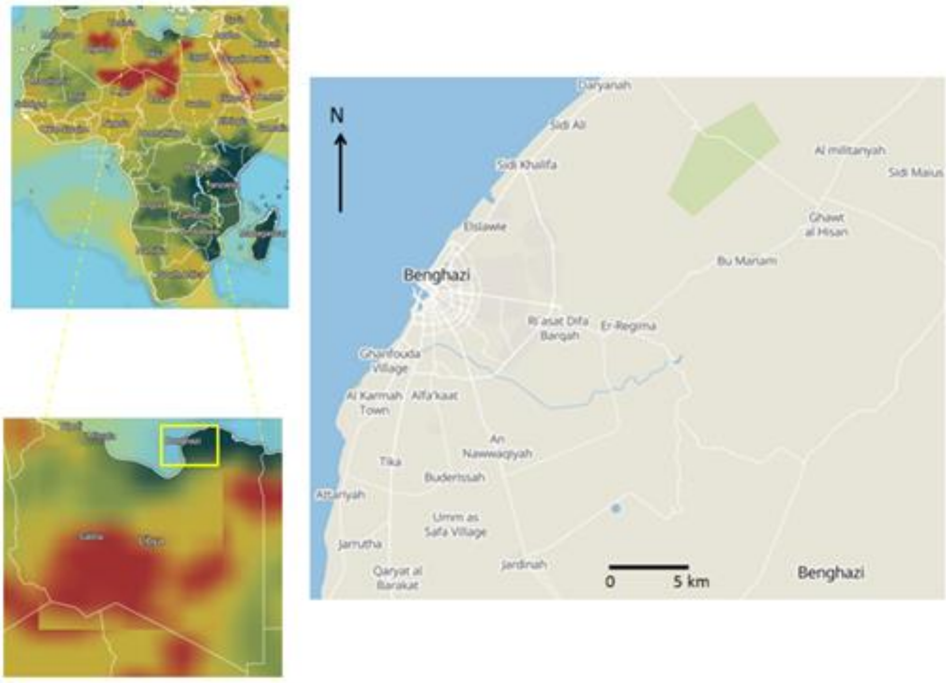

Fig. 1: Composite map showing the location of Libya and Benghazi city (modified after IQAir, 2023).

2. Methodology

The concentrations of air quality index (AQI), carbon dioxide (CO_2), relative humidity (RH)wind speed (WS)and temperature (T) were monitored at the center of Benghazi city using AirVisual Outdoors (AVO). The monitoring station measure every five minutes for each parameter. Authors collected daily reads from this station for three periods (March, April and May 2023). The AirVisual Outdoors monitor is characterized by high quality sensing elements to provide reliable and accurate readouts. Table (1) showed the specification monitoring station of AirVisual Outdoor while tables (2, 3 and 4) showed the daily average values of AQI, CO_2, T, WS and RH. Fares F. Fares and Farag M. El Oshebi has installed five monitor stations in Libya and they are defined on a global platform named AirVisual Platform for air quality and climate change (Fig. 2).

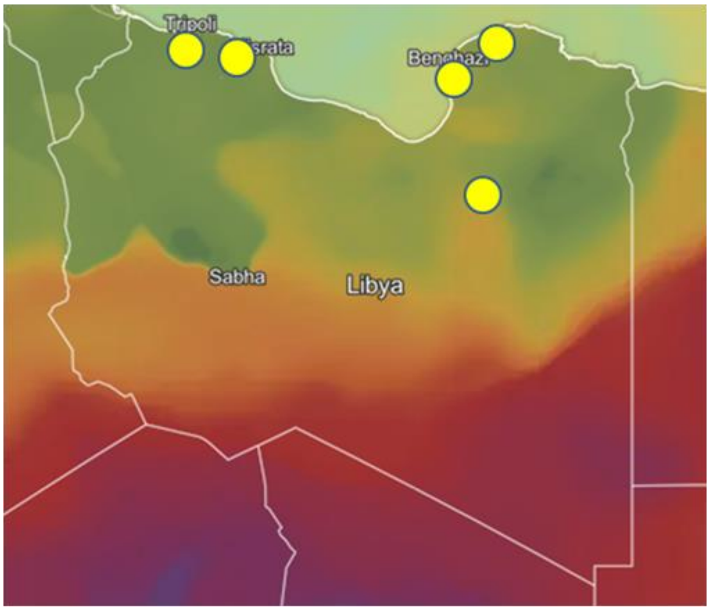

Fig. 2: Showing the location of AirVisual Outdoor stations in Libya.

Table 1: Description of AirVisual Outdoor (monitoring station).

Paramters	**Functions**
PM_1	0-1,000 µg/m^3 ±10 µg/m^3 / or ±10%
$PM_{2.5}$	0-1,000 µg/m^3 ±10 µg/m^3 / or ±10%
PM_{10}	0-1,000 µg/m^3
CO_2	requires optional module
T	-40 to 90 °C / -40 °F to 194 °F ±2 degrees C or F
Humidity	0 - 100% RH ±1%
Data Display	AirVisual app (iOS and Android)
Usage	Web dashboard

Table 2: The analysis data of AQI, CO_2 (ppm), WS (Km) and T(C°) for March period.

Date	AQI	CO_2	WS	T
17	62	414	23	13.9
18	77	415	35	15.1
19	80	415	36.7	15.2
20	139	419	61	15.1
21	126	412	29	19.6
22	152	408	44	19.9
23	64	411	46	16.4
24	62	414	45	15
25	74	418	57.8	16.5
26	83	416	46	16.4
27	77	424	46	16.8
28	98	414	47	19
29	87	419	24	15.1
30	93	421	27	14.4
31	70	420	21	15.7
Average	89	415	39.2	16.5

Table 3: The analysis data of AQI, CO_2 (ppm), WS (Km), RH (%) and T(C°) for April period.

Date	AQI	CO_2	T	RH	WS
1	93	420	19.3	36.3	50
2	102	410	32.8	24.6	50
3	89	401	17.8	61.2	40
4	72	407	16.7	66.5	47
5	64	419	14.1	75.4	18
6	98	412	16.7	59.4	40
7	75	416	14.8	60.5	61
8	71	417	15	72.6	28
9	59	417	16.4	76.4	30
10	47	415	15.9	65.5	15
11	49	412	13.8	71.3	7
12	69	418	15.8	69	40
13	79	429	19.3	50.9	22
14	91	414	21.8	44.2	43
15	89	413	17.5	70	36
16	85	420	18.9	60	32
17	73	412	17.5	69.3	36
18	56	414	17.6	64.3	38
19	60	417	17.5	68	38
20	112	420	21.3	43.2	40
21	160	410	24	28.3	47
22	158	408	25.1	30.5	48
23	89	410	21.8	61.9	43
24	89	415	20	72.1	25
25	84	419	19	70.3	36
26	69	419	21	54.7	36
27	70	414	18.5	67.4	43
28	58	414	17.6	53	43
29	67	416	18	60	35
30	64	417	19.9	48.5	25
Average	82	416	18.6	58.5	36.4

Table 4: The analysis data of AQI, CO_2 (ppm), WS (Km), RH(%) and T(C°) for May period.

Date	AQI	CO_2	T	RH	WS
1	102	413	24.5	28.2	20
2	118	408	22.4	52.8	15
3	85	415	18.8	76	20
4	68	416	18.6	75.7	23
5	61	413	17.9	97.5	29
6	70	417	19.2	74	21
7	78	419	19.8	72.8	21
8	86	418	21	56.5	25
9	149	411	24.8	33.7	18
10	209	407	23.9	42.5	23
11	106	413	21.5	71.1	22
12	83	421	21.4	60.9	24
13	85	423	25.5	38	22
14	137	419	29	26.3	30
15	140	418	27.8	35.4	35
16	67	423	20	70.3	15
17	64	430	20.5	66.8	17
18	88	435	23.5	41.2	18
19	89	429	28.3	26.1	19
20	181	438	24.8	46	14
21	170	449	20.9	75.3	26
22	68	453	20,2	76.7	23
23	69	435	20.7	74.2	23
24	106	439	23.9	54.8	26
25	116	432	26.4	42.8	26
26	117	429	23.7	66	24
27	78	430	19.5	80.5	21
28	77	433	20.9	78	22
29	79	424	22.4	70	23.0
30	92	414	22	38	21
31	156	406	27.3	50.5	43
Average	104	424	22.7	57.5	22.8

3. Results and discussion

The human body is very sensitive to the increase of the concentration of CO_2 in the air. In general, the CO_2 concentration in Mar ranged between 408 to 424 ppm (Fig. 3), the CO_2 concentration is positively correlated with wind speed (r=0.4) which indicated that the wind speed play a major importance in the distribution of CO_2 in the atmosphere (Milad, 2018) (Fig. 4), whereas there is no relationship with temperature and AQI(r = 0and 0).

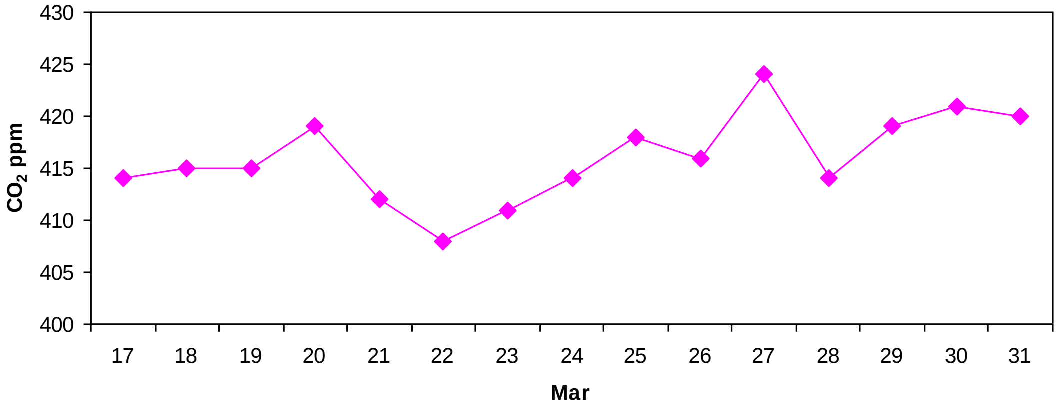

Fig. 3: The daily average distribution of CO_2 during the March.

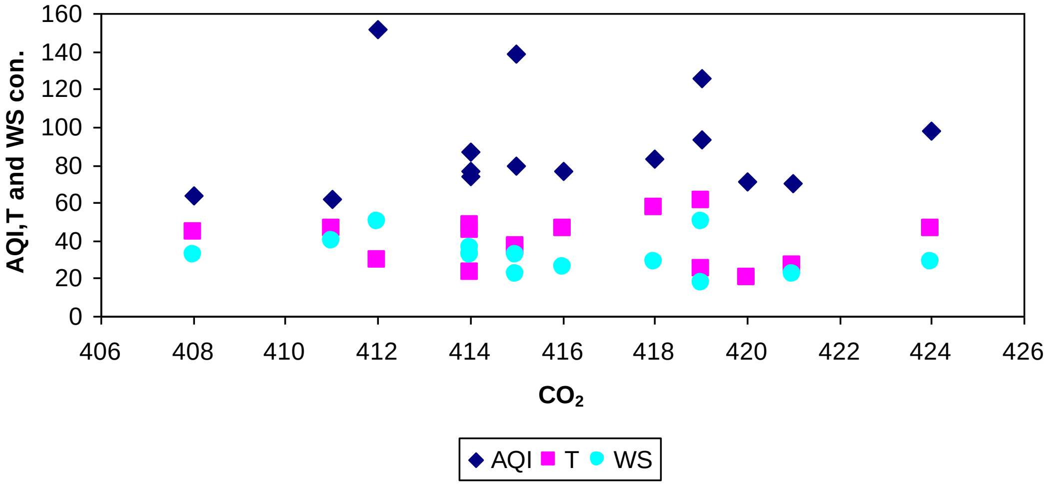

Fig. 4: Relationship between CO_2 with AQI, T and WS.

The CO_2 concentration in Apr, ranged in 407 to 420 ppm (Fig. 5) and negatively correlated with temperature, wind speed and AQI (r= -0.2,-0.1 and -0.3) and weak positively correlated with relative humidity (r= 0.2), which suggest that humidity has slightly affected on CO_2 (Fig. 6). The CO_2 concentration is similar distribution in March and April period. The CO_2 level some day's increases in the morning because of an increase in traffic congestion and some human activities resulting from factories.

On the other hand, the CO_2 level some day's increases at night due to plants respiring at night in a process opposite to the photosynthesis they do during the day, as plant cells take in oxygen from the air and release carbon dioxide and moisture (Nastiti and Muzayanah, 2022).

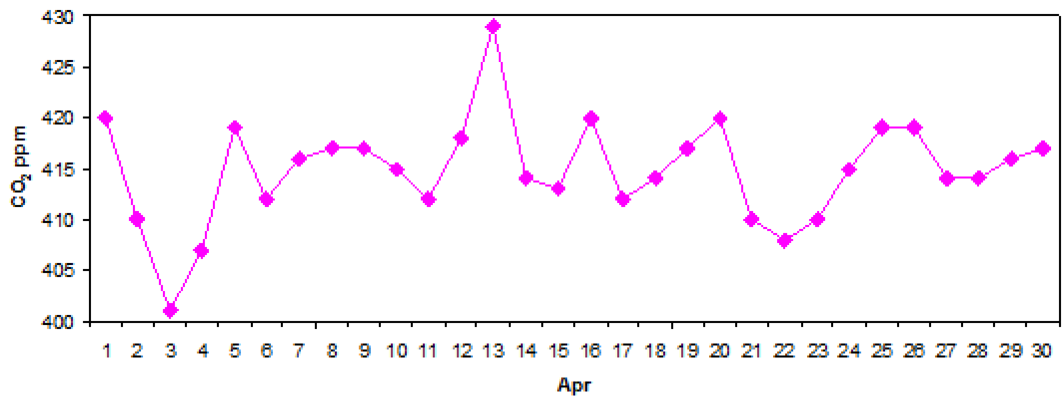

Fig. 5: The daily average distribution of CO_2 during the April period.

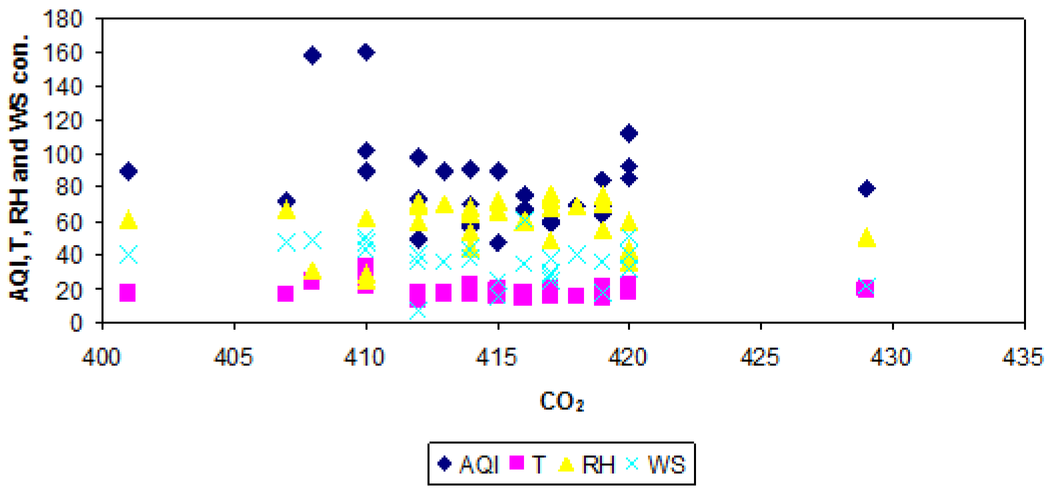

Fig. 6: Relationship between CO_2 with AQI,T, RH and WS.

The concentration of CO_2 was reported in the May period from 406 to 453 ppm (Fig. 7) and positivity correlated with AQI and H (r= 0.2 and

0.2) while negatively correlated with temperature and wind speed (r= -0.16 and -0.1), which suggests that, the increase in CO_2 , led to increase in AQI and RH trend (Fig. 8). The period of May recorded the highest value of CO_2 from March and April period, an increase of about 8 ppm (Fig. 9). This is because the period of May is a warm period and the temperature increases, which means that the plants will close their stomata to prevent water evaporation and reduce photosynthesis efficiency, this case in the north part of globe (Sharma, 2020).

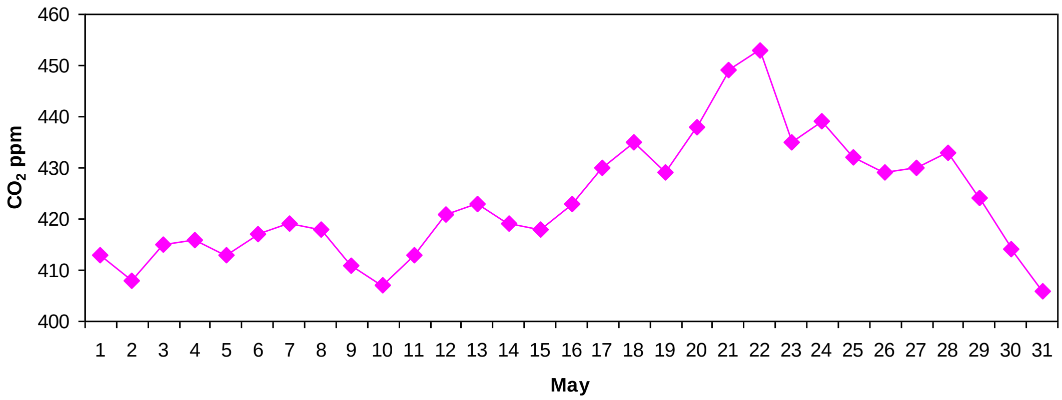

Fig. 7: The daily average distribution of CO_2 during the May period.

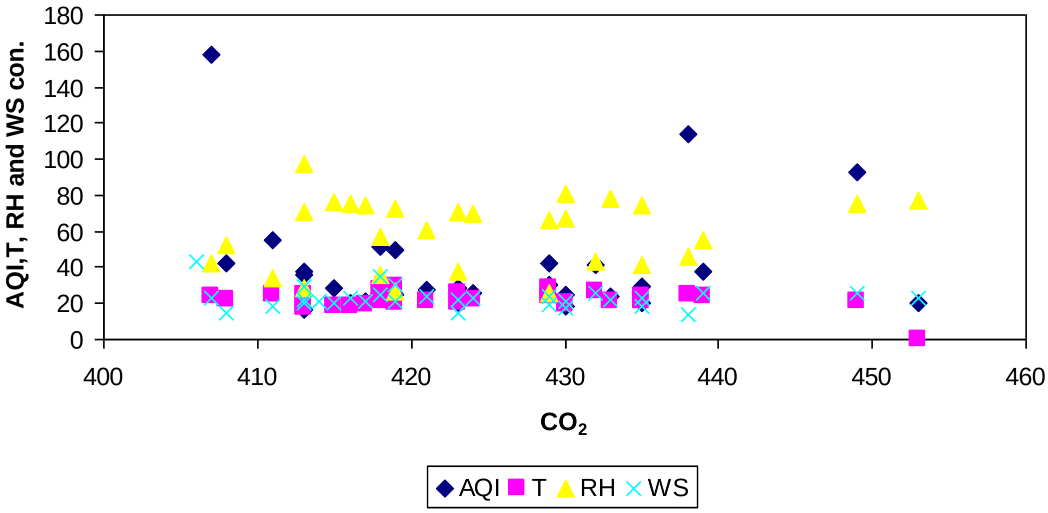

Fig. 7: Relationship between CO_2 with AQI,T, RH and WS.

In the same time at the southern part of the globe, it is the autumn season, meaning that most of leaves are falling off, and this leads to a decrease in the photosynthesis process, as human activities increase in frequency at this time, carbon dioxide reaches the highest concentration in the year (Fig. 10).

May period is usually the period in which each year the highest carbon dioxide levels are recorded. Globally, the concentration of CO_2 in May 2019 was recorded 414 ppm, in May 2020 was reported 417 ppm, in May 2021 was recorded 419 ppm and in May 2022 was reported 421 ppm.

According to AirVisual Outdoor monitor, the mean average of CO_2 in May 2023 is about 424 ppm (Fig. 11), the National Oceanic and Atmosphere Administration (NOAA) was recorded similar concentration of CO_2 (424 ppm) in the atmosphere.

The May 2023 is recorded the highest level of CO_2 in 4 million years, this increase caused the new rise in global climate temperature caused by human activities, the most important activities are transportation, cement productions, flaring, deforestation, and electricity production. According to NASA the total emission of CO_2 in Libya is about 75 million / tones from 2022 to now, the most emission CO_2 sources are from oil, gas, flaring and cement productions (Fig. 12), Libya emissions CO_2 is about 0.2 % from total emission that is about 36.5 billion/tons.

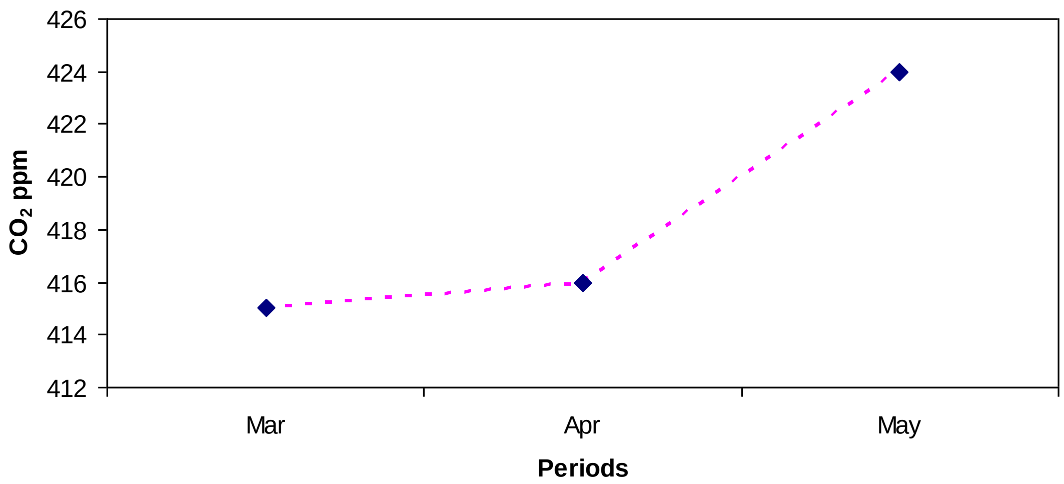

Fig. 9: The average monthly concentration of CO_2 during all periods.

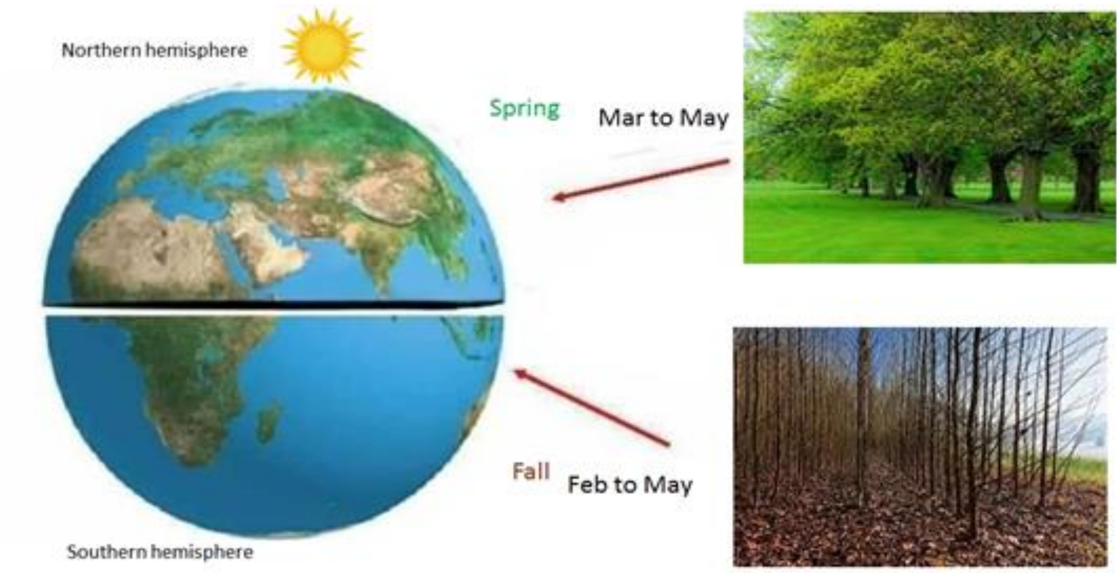

Fig. 10: Shows the northern and southern part of the hemisphere.

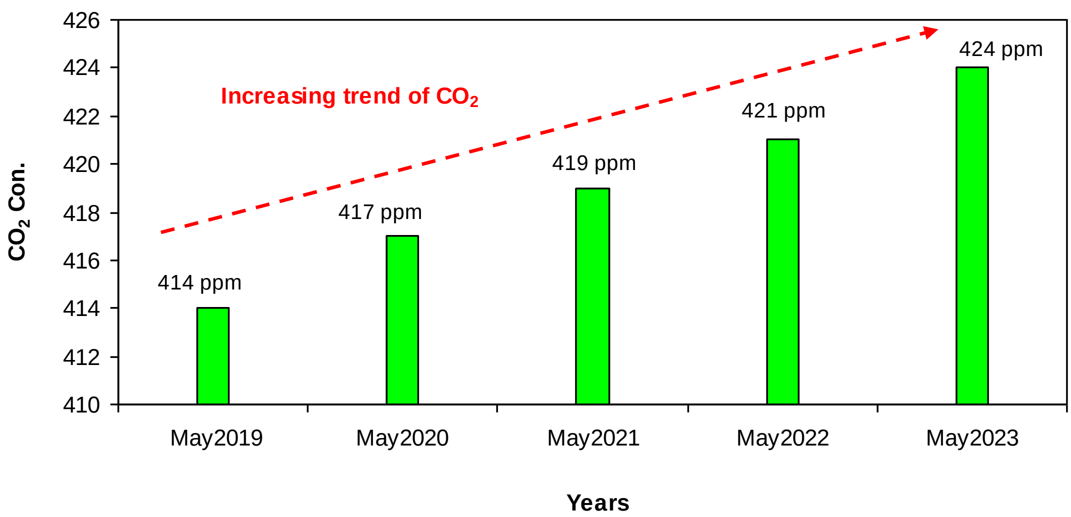

Fig. 11: The main globally average of CO_2 concentration during May 2019 to May 2023.

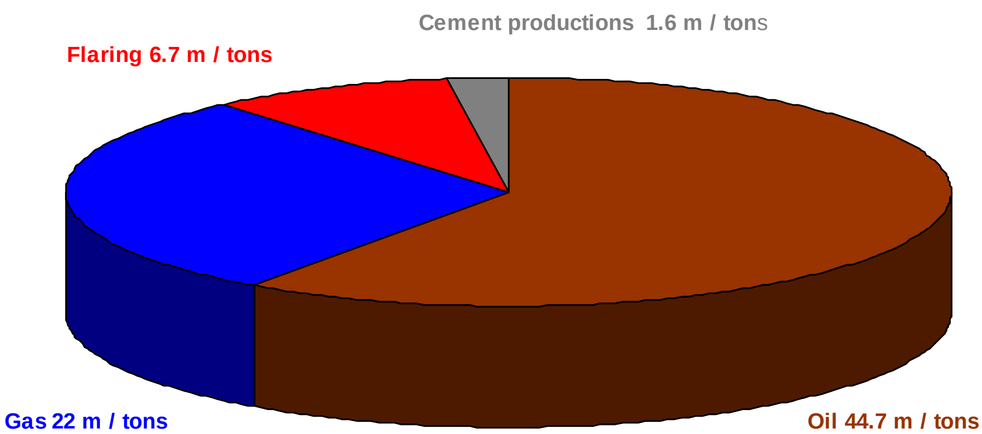

Fig. 12: Showing the main emission sources of CO_2 in Libya.

4. Conclusion

The main conclusion of this work are summarized as the following:

1) This work attempted to determine the level concentration of CO_2 in Benghazi city during March, April and May period and compare it with global atmospheric emission.
2) The station that used in this work named AirVisual Outdoor monitor designed in Switzerland and made in Germany.
3) The CO_2 concentration in March and April period is similar distribution in atmosphere while in May period recorded the highest values during spring season.
4) The concentration of CO_2 from May 2019 to May 2023 increases by about 2 to 3 degrees, and this is a very dangerous indicator that will have an impact after years on the planet, in which the temperature will increase, forest fires and sea level rise, as well as lead to a scarcity of drinking water and increase in desertification.
5) In this work, CO_2 concentration in Libya is the similar level of the global atmospheric emission of CO_2 specially during May period.

5. Recommendations

1) Afforestation should be expanded around and within the cities in Libya.
2) Reducing carbon emissions from oil fields, automobile exhaust, factories and power stations.
3) Increasing the efficiency of using renewable energy instead of fossil fuels.
4) CO_2 emissions in cement factories and power plants must be monitored.

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