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Towards a zero carbon Alexandria

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Abstract - Today, the world faces an unprecedented environmental crisis. Since the Industrial Revolution, the accelerated climate change is believed to be a result of human activities; that increase the concentration of greenhouse gases (GHG) in the atmosphere – to which carbon dioxide is the largest contributor. It made a must beginning to reverse the damage inflicted on the planet. Egypt is exerting great efforts to reduce the emissions of Green House Gases and mitigate the negative impacts of climate change and deal with the main challenges that affect sustainable development.

Based on an empirical analytical study, the paper examines all of the environmental factors and its effect on carbon dioxide concentration taking into consideration the characteristic of the urban fabric and conditions of Alexandria one of the biggest cities in Egypt as an applied case study of a big willing costal city. The paper simultaneously aims the management of the carbon dioxide emissions through several recommendations based on the stated study, while creating a vibrant urban environment.

Keywords - Environment; climate change; carbon dioxide; Sustainable Development; management.

I. INTRODUCTION

Human industrial activities and technological revolution have led to increased rates and concentrations of greenhouse gases GHG emissions in the atmosphere; causing climate change. (1) Atmosphere has some variable components including water vapor, dust particles, and ozone. Although these are found in small amounts, they can have significant effects on greenhouse gases and climate. (2) These are not considered sources of air pollution but it has been influential on the global warming phenomenon. Carbon dioxide is one of the main gases which has a large contribution of this phenomenon. (1)Therefore, the industrial applications of this type of converter are limited [1].

It is well known that GHG and climate change is a global phenomenon but its effects would vary from one place to another on earth. Egypt is expected to be largely vulnerable to number of risks and threats such as sea level rise, high temperatures, followed by shortages in water resources, impacts on agricultural productivity and difficulty on cultivating some types of crops; as well as impacts on touristic areas, public health and infrastructure that would affect energy, industry, food safety and national economy sectors. (1) Thus it became a significant matter analyzing the causes of carbon dioxide emissions and the mainly environmental factors that affect its concentration in atmosphere which differ from one place to another at the different time intervals.

Through studying two main axises of Alexandria city, different devices had been used to measure the values of carbon dioxide and several environmental factors in the atmosphere at different points. The collected data was analyzed comparing the effect of the environmental factors on the carbon dioxide concentration in the atmosphere for the same selected points. through this analysis a conclusion was made with some recommendations on how to control the carbon dioxide emissions, aiming to reduce greenhouse gases to make Alexandria a zero carbon city.

II. EGYPT'S STAT E OF CARBON DIOXIDE EMISSION

The table below shows the GHG emissions in Egypt in 2000 (co2.mt.eq) according to Egypt second national communication report, also shows the calculated emissions in 2009.

Table 1. GHG EMISSIONS IN EGYPT

Year	Egypt's amount of GHG emissions (co2eq Mt)	Egypt's share of the global GHG emissions (%)
2000	193,267	0,64
2009	305,1	0,71

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Egypt's CO2 emissions were fairly stable during the past decades as shown in the below figure 1. As compared to industrialized countries, Egypt's CO2 emissions are still considered low, and are marginal on a global level. Although the CO2 emissions level increased (from 116.6 Mt CO2 equivalent to reach 226.6Mt CO2 equivalent In 2007, i.e. about 93% increase), the greenhouse gases in Egypt still represents a very small percentage of the global yearly emissions (about 0.96%). (3)

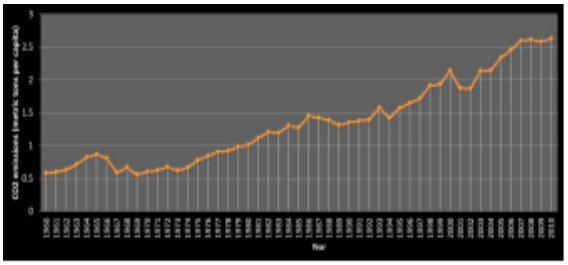

Fig .1. Egypt's CO2 emissions (metric tons per capita) from 1960 till 2010.

The below figure shows the different activities which contribute the carbon dioxide emission in Egypt. It is clearly noticed that fuel combustion in the energy sector has the major contribution in the carbon dioxide emission followed by the industrial activities

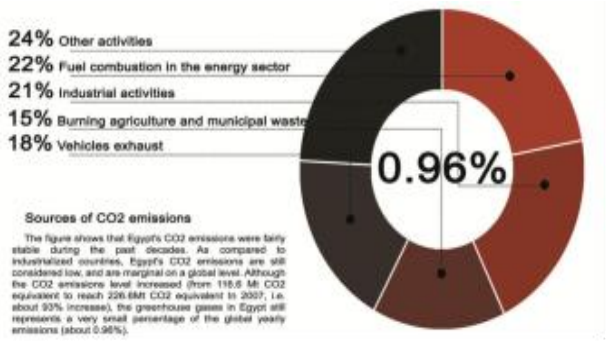

Fig .2. Sources of Co2 emissions in Egypt.

III. ALEXANDRIA AS A CASE STUDY

Alexandria, with a population approximately 3.9 million inhabitants, is Egypt's second largest city situated on the Mediterranean Sea. Its borders extend along a 70 km coastline north-west of the Nile delta. It is also the largest city lying directly on the Mediterranean coast. (4)

Fig .3. A recent map of Alexandria showing the linear form of the city.

A. Empirical Study

Six environmental factors had been investigated to observe their effect on the amount of carbon dioxide concentration in the atmosphere at different selected points. These environmental factors that had been investigated are air flow, air velocity, carbon monoxide, temperature, relative humidity and the urban fabric. The air velocity and airflow were measured using the Multifunctional AMI300 device. The carbon dioxide was measured using 2 devices; Air Quality data logger and Multifunctional AMI300. The carbon monoxide, temperature and relative humidity were measured using Air Quality data logger.

As shown in the below figure the first urban fabric is the suez canal street which is a main road axis perpendicular to the sea shore line and the second one is Abou Queer street which is a main road axis parallel to the sea shore line.

Fig .4. A map showing the two investigated road axis.

The table below sums up the different environmental factors measures versus the carbon dioxide emission in the form of charts in two different urban fabrics.

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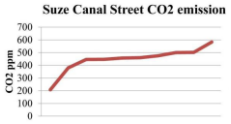
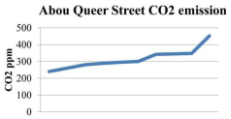
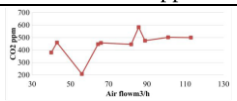
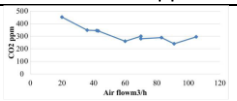
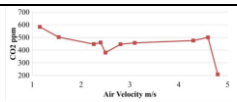
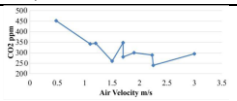
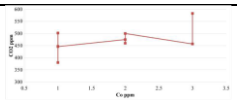
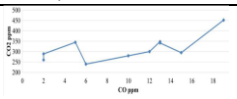
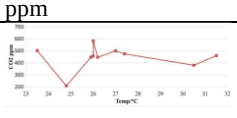
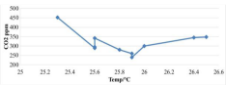
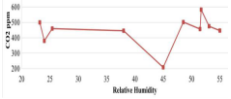
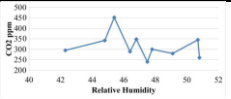
Table. 2. MATRIX OF CARBON DIOXIDE EMISSION VERSUS THE DIFFERENT ENVIRONMENTAL FACTORS

Points of comparison	Carbon dioxide emission	
	Suez Canal Street	Abou Queer Street
	 The average CO2 emission is 445 ppm	 The average CO2 emission is 315 ppm
Air Flow	 The average air flow 74 m3/h	 The average air flow 60 m3/h
Air Velocity	 The average air velocity is 2.9m/s	 The average air velocity is 1.7 m/s
Carbon monoxide	 The average carbon is 1.6 ppm	 The average carbon is 9.7 ppm
Temperature	 The average Temperature is 27 °C	 The average Temperature is 26 °C
Relative Humidity	 The average relative humidity is 41%	 The average relative humidity is 47%
Urban Fabric	 Figure I. Suez canal street Urban pattern. **Grid Pattern:** While the Suez canal road is perpendicular on the sea shore line; the sub-Streets have been aligned parallel to sea shore which had blocked the cooling breeze of the sea. It causes difficulty in getting out the produced carbon dioxide at once.	 Figure II. Abou queer street Urban pattern. **Grid Pattern:** While the Abou Queer road is parallel to the sea shore line; the sub-Streets have been aligned perpendicularly on sea shore line to take advantage of the cooling breeze of the sea. It also helps getting out the produced carbon dioxide at once.

B. Analytical Study

By studying and analyzing the above collected data it was found that the carbon dioxide emission is higher in the Suez Canal street with average 445 ppm than Abou Queer street with average 315 ppm but both are mostly still below the normal limit which is 450 ppm as shown in the below chart. This slight difference in CO2 emission showed a slight increase in the average temperature of in suez canal road with average 27°C than Abou Queer road with average 26°C.

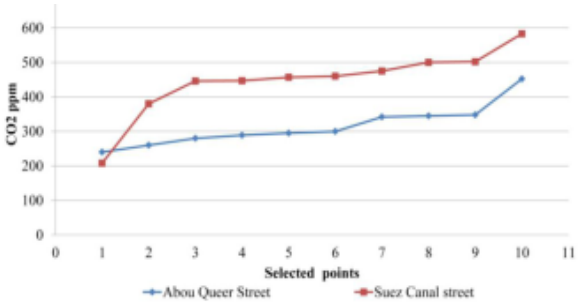


Fig.7. A chart showing the carbon dioxide readings of both road axises at 10 selected points.

As for the air velocity factor it was found that with the increase of the air velocity there is clear decrease in the CO2 concentration in the atmosphere that could be noticed in both road axises. The Air flow showed a steady concentration of CO2 as the air flow increases at the Suez canal Street, while it showed a slight decrease in CO2 concentration as the air flow increases at Abou Queer street.

The average relative humidity of both road axes were almost close; Abou queer street 47% and Suez Canal 41% were both showed a steady concentration of CO2 with the increase of relative humidity. The carbon monoxide showed an average higher reading in Abou Queer street 9.7 ppm than Suez Canal street 1.6 ppm without a noticeable effect on the CO2 concentration.

Finally the urban fabric which mainly could be noticed of having an effect on the air velocity and airflow which showed higher reading is the ax perpendicular to the sea shore (suez canal road) than in the ax parallel to the sea shore (Abou Queer road).

Table. 3. SWOT ANALYSIS OF STUDY AREA

Strengths	Weaknesses
• CDM Projects, which had been approved during 2008, reduce greenhouse gases emissions by up to about 0.9 million tons of carbon dioxide equivalent. • They have also an investment cost up to $ 66 million USD. • The good urban fabric around Abou Queer street allows the immediate disposal of produced carbon emissions from automobile exhausts which decrease the concentration of carbon dioxide. • Heritage buildings along Abou Queer Street feature strong opportunities for natural ventilation and daylight because of strong thermal mass for heat absorption.	• Many of heritage buildings in the city haven't benefited optimally from changes to building systems over the years which prevent these buildings from receiving the benefits of full sustainable upgrades. • limited energy code requirement for existing buildings • lack of corporate support and business community engagement • Mechanical systems sizes are driven by the internal loads on the building (heat from people, lights and equipment) as well as the external envelope loads. There for, the mechanical system efficiency is ultimately dependent on the architectural design of the building and its use.
Opportunities	**Threats**
• Ratification of the UN Framework Convention on Climate Change (UNFCCC) and Kyoto protocol and is committed to any obligation • Institutional formation of a National Committee of Climate Changes to manage all issues related to climate changes. • Make use of the three mechanisms of the Kyoto protocol for the reduction of GHG emissions: the Clean Development Mechanism (CDM), Joint Implementation and Emissions Trading.	• There are some factories along Suez canal street that emit massive amounts of greenhouse gases such as carbon dioxide and methane. • Retrofitting buildings is critical for the overall carbon emissions for the city

IV. CONCLUSION

According to the data collected and analysed it was found that the carbon dioxide concentration is inversely proportional with the air velocity, as when the air velocity increased, the carbon dioxide decreased in both road axis. This shows that the carbon dioxide concentration is affected with the air velocity which in turn is affected by the different urban fabric. Accordingly it can be concluded that urban fabric with perpendicular grid to the sea shore line has higher air velocity and airflow.

V. RECOMMENDATIONS

- Promoting Good environmental design solutions that benefit the community as a whole on both scales of buildings or urban planning.
- Using the open spaces along the Mahmoudya canal as an entertainment zones with landscape and green areas to create a strong Green corridor that can improve livability and reduce the heat island effect.
- Increasing the landscape elements and greenery in the residential zone and along the Suez Canal artery to help absorb the vehicle emissions.
- Creating a green axis as a spine that links a series of smaller green plazas to improve transportation, amenities and livability and also offer a way of respite for residents, commuters and visitors.
- Reducing key sources of carbon dioxide through policies and investments supporting cleaner transport, energy-efficient housing, power generation, industry and better municipal waste management.
- Updating to new, more efficient equipment, technologies and infrastructure for rail, bus and taxis, to realize significant carbon savings.
- Improving pedestrian and bicycle amenities will also decrease automobile use.
- Adding new transit options such as one-way car/scooter/bicycle programs will further reduce the need for private car ownership, reducing carbon emissions.
- Charging vehicles based on their emissions and the rush-hour congestion of certain roads
- Creating an energy code requirement for existing buildings.
- Increasing corporate support and business community engagement.
- Managing the vehicular use carefully adjacent to buildings and in vocational programs.

VI. ACKNOWLEDGMENT

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