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Exploration of Road Traffic Emissions and Their Impact on Air Quality in and around of Annaba City (North East Algeria)

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Abstract— *Global climate is warming, and the effects of climate change are associated with many causes; among them are the Greenhouse gas emissions from motor vehicles and factories. The study of exposure to air pollution related to road traffic in Annaba's region is based on the results of air analyses, which shows that air temperatures are frail, accompanied by a very high humidity due mainly to the presence of the sea and many bodies of water (Fetzara Lake). This can allow the accumulation of certain pollutants such as carbon monoxide and dust (contents of CO and dust exceed the WHO standards), while some pollutants are present in small to negligible quantities such as NO, NO_2, and SO. The air quality of Annaba and its surroundings (El Bouni, Sidi Ammar) can be generally described as good. Nevertheless, the existence of strong pollution due to the dust is noted close to the industrial complexes specially El Hadjar.*

Keywords*— *Air quality, Annaba, Climate change, Fetzara Lake, Road traffic

I. INTRODUCTION

Air quality is a matter of concern because of the health impacts of air pollution and its involvement in global warming through greenhouse gas emissions This effect has been widely studied [1], [2]

Climate change is defined as "any change in climate over time, whether due to natural variability or human activities (road traffic). Thus, climate change is reflected in several phenomena: modification of the Earth's surface temperatures, rise in sea level, melting of snow and ice, disruption of precipitation patterns, then multiplication and intensification of extreme events: floods, droughts [3]

Most urban pollution is due to road traffic, and its contribution is likely to increase further as more than 70% of the world's population will live in cities by 2050 [4]. The impact of traffic on the environment can be reflected in the chemical composition of water and air [5]. To better understand and control air pollution, it is necessary to understand, identify and quantify its sources. This way, actions can be taken to reduce emissions at source. Emissions inventories are also a necessary baseline for air quality assessments and for estimating the impacts of this pollution on health and ecosystems.

Road traffic emissions from tailpipes and exhaust sources have a significant impact on the concentration of particles in the urban atmosphere. This effect has been widely studied [6], [7]. In addition, very fine particles emitted by various processes related to road traffic (wear of brakes, for example) can penetrate human organs, many studies have been done on this impact: [8], [9], [10].

Knowing the physicochemical properties and sources of particles is essential to determine the effects of particles on the environment [11]. The exposure to diesel exhaust and other combustion products also increased the risk of lung cancer. The results of Nyberg *et al*., 2000 indicate that urban air pollution increases the risk of lung cancer and that vehicle emissions may be particularly important.

At the global level, the nightmare lies ahead. With currently more than a billion cars in circulation in the world and an annual production of around 70 million new cars every year, the propagation of automobile is becoming the main culprit of climate change (Figure.01). Taking an average of CO_2 emissions of around 1.8 T per year per car, we can estimate CO_2 emissions from the automobile on a planetary scale at around 2 billion T of CO_2/year [12].

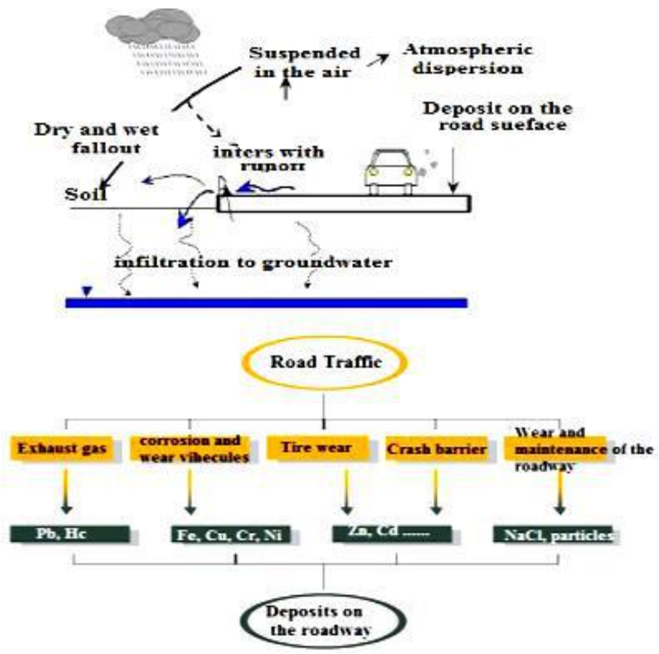

Fig.1 Method of pollutant transfer emissions to soils, air and groundwater [13].

Of course, the automobile is not the only cause of CO_2 emissions, but the continued growth of the automobile fleet and the global production of cars seems to have a definite impact on the growth of both CO_2 emissions and CO_2 concentration in the atmosphere (Figure.02). In 2006, the average carbon dioxide (CO_2) content of the Earth's atmosphere reached the highest levels ever recorded 381.2 ppm (WMO).

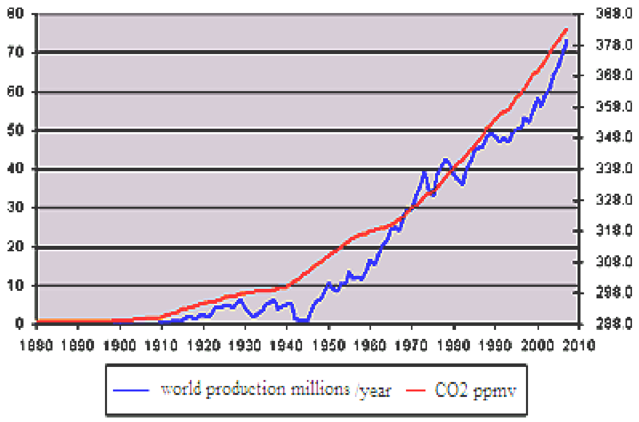

Fig.2 Comparative evolution of global car production and CO_2 concentration in the atmosphere

According to a recent study, the current concentration of carbon dioxide is 27% higher than the maximum reached during the last 650 thousand years. However, the correlation between the increase in the concentration of CO_2 in the atmosphere and the increase in the Earth's temperature has been proven since the four reports of the IPCC (Intergovernmental Panel on Climate Change). The last ten years (1998-2007) are the warmest years ever observed on a planetary scale [14].

II. MATERIALS AND METHODS

2.1 Context of the study site

Annaba city is located 600 km from the capital Algiers, in the extreme east of Algeria, open to the Mediterranean coast for 80 km. It covers 1 439 km_2 or 0.06% of the national territory between latitudes 36 °30' N and 37 °30' N, and longitudes 07 °20' E and 08 °40' E, with 12 municipalities. It is geographically limited by the Mediterranean Sea in the north, Guelma in the south, El-Taref in the east, and Skikda in the west (Figure.3).

Fig.3 Geographical location of Annaba city [15].

The assessment of air pollution in the region of Annaba is subject to permanent monitoring through the establishment of an air quality monitoring system called *SamaSafia*since June 2002.

The installation of the air quality-monitoring network was commissioned in March 2002. For a trial period of three months and began the actual operation in June 2002, but it was stopped in May 2007, this network consists of three stations: Annaba city, El Bouni, Sidi Ammar and Salines (Figure.4)

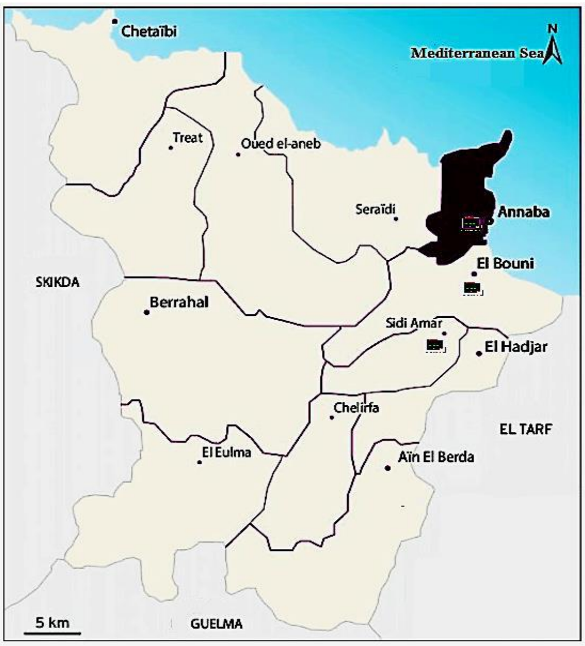

Fig.4 Location map of the air quality monitoring stations.

2.2 The climate of study area

The climate of the city of Annaba is temperate with an aridity index of DE.Martone located in the range 20<I<30, the study region is characterized by average annual rainfall is estimated at about 800 mm with irregular rainfall distribution. The average annual temperature is around 17.7°C. The Annaba plain is dominated by North to North-East, South-West to North winds [13].

The strongest winds occur in winter and the weakest in summer with a few episodes of SIROCCO, which increase the temperature (Figure.5) and (Figure.6).

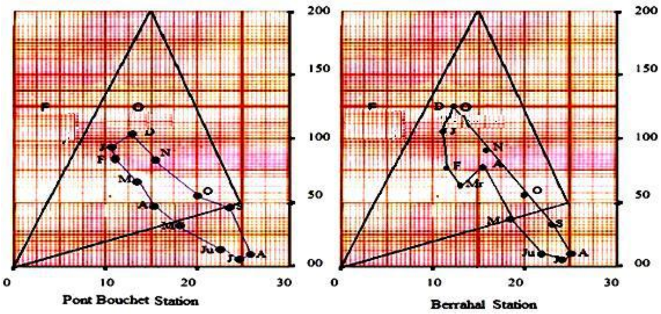

Figure.5 Climogram of PEGUY

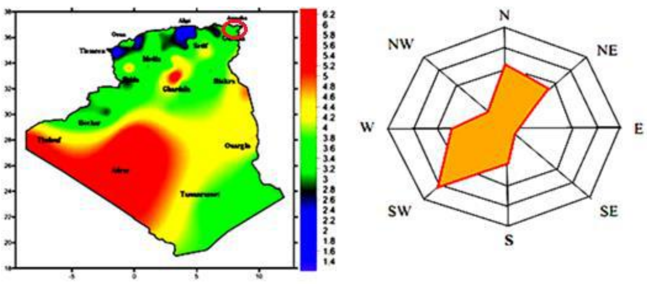

Fig.6 Speed and direction of the wind at Annaba

2.3 Evaluation of the impact of road traffic on air quality in the city of Annaba

2.3.1 Annual statistics of the vehicle fleet in the study area

The city of Annaba is considered one of the most polluted cities in Algeria. On the one hand, there is the existence of a steel complex and a very large fleet of vehicles compared to the distances traveled; on the other hand, certain topographical and climatic characteristics create a climate conducive to pollution [16].

According to the national service of statistics (2014), we could collect the different types of vehicles and their ages as well as the evolution of their number according to time during a period of 14 years (Figure.7a), (Figure.7b). At the level of the Wilaya of Annaba, the fleet has more than 170 thousand vehicles; tourist vehicles occupy 68% of the total number of vehicles in the wilaya. With its numerous traffic jams, arterial congestion, and challenging parking, the road traffic in Annaba city and its surrounding areas has grown to be quite complex. Long periods of time passed with no medium- or long-term plans for solving this problen **(**Figure.8).

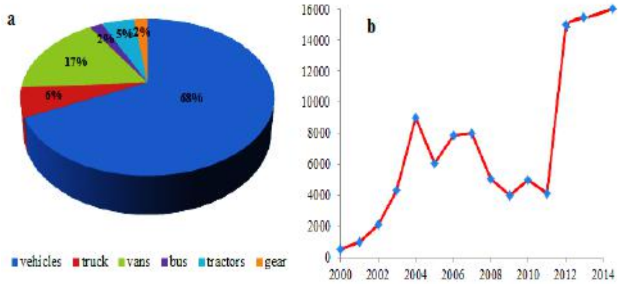

Fig.7 a. Number of vehicles by type. B. Annual evolution of the number of vehicles.

Fig.8 Traffic jams in Annaba city

2.3.2 Estimation of CO_2 release by vehicles according to their age and the type of fuel consumed

The amount of CO_2 generated by a vehicle is directly proportional to the amount of fuel consumed. The release of CO_2 is related to the distance (Figure.9), (Figure.10); the estimated release of CO_2 is increasing exponentially from a distance 10000 km to another 40000 km [17].

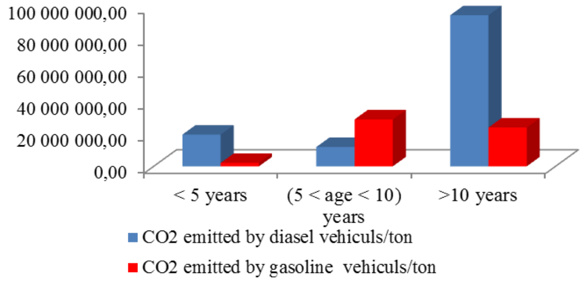

Fig.9 Quantity of CO_2 emitted by type and age of the vehicle

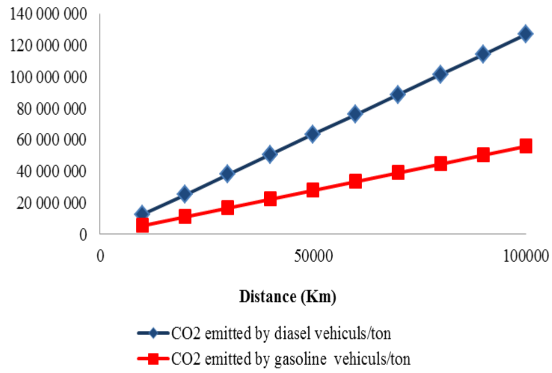

Fig.10 Quantity of CO_2 released by type of vehicle according to the distance traveled

2.3.3 Data analysis

The average values of the concentrations of gas emitted were estimated using MS-Excel, also calculated and represented in the form of graphs. The concentrations were compared to those of the WHO guideline values

III. RESULTS AND DISCUSSION

3.1 Nitrogen Monoxide Variation (NO)

The variation of NO is in function of time (Figure.11) shows that for the station of Sidi Ammar, the NO's concentrations recorded are higher compared to other stations. This pollution is generated by road traffic (motor vehicles), in some boilers and industrial engines, and during some processes of the chemical industry (Arcelor Mittal plant of the industrial complex El Hadjar).

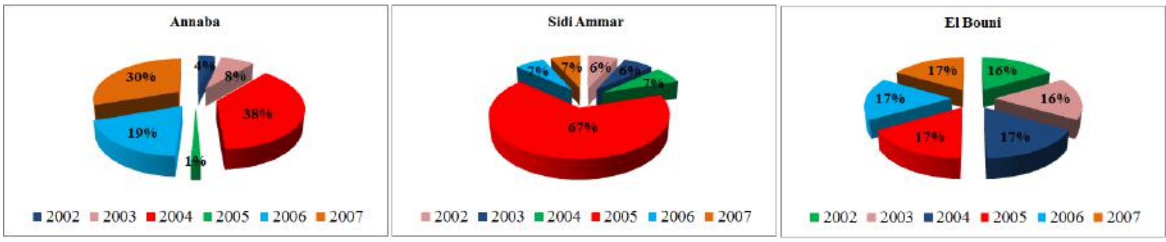

Figure.11 NO annual variation

3.2 Nitrogen Dioxide variation (NO_2)

Nitrogen dioxide (NO_2) associated with fuel combustion is partly emitted directly from the tailpipe and partly formed indirectly in the atmosphere from nitrogen monoxide. The NO and NO_2 concentrations generally increase in cities during peak hours (Figure.12).

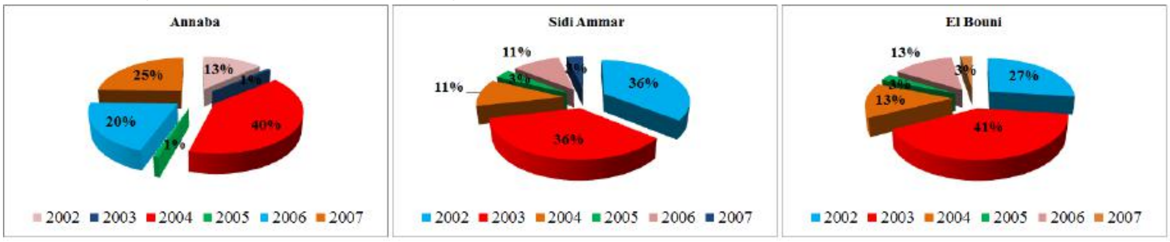

Fig.12 NO_2 annual variation

The station of Annaba city always records important values (Figure.12), but these values remain always weak compared to the standards of WHO (200 µg/m^3).

3.3 Dust Annual variation

The annual variation of dust at the three stations indicates a strong dust pollution (higher than the WHO standard: 50 µg/m^3) at the station of Annaba city, this value reaches 215 µg/m^3 in 2004 (Figure.13).

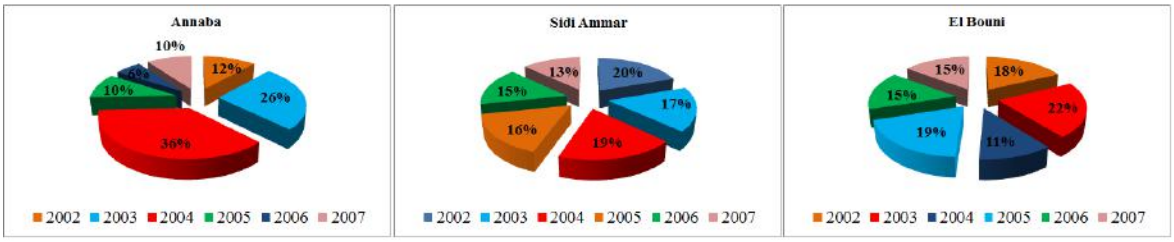

Fig13 Dust annual variation

3.4 SO_2 Annual variation

The annual variation of SO_2 (Figure.14) shows that for the three stations the concentrations remain below the WHO standards (125 µg/m^3).

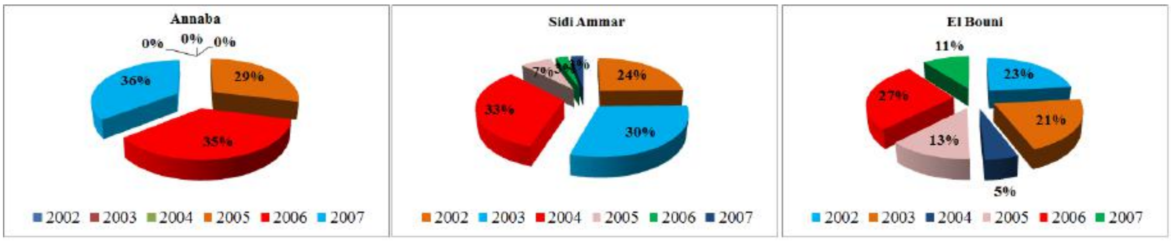

Fig.14 SO_2 annual variation

At the level of Annaba's station, the values vary from 0 µg/m3 (2002, 2003, and 2004), 21.75 µg/m3 (2005) to 22.1 µg/m^3 (2006, 2007), on the other hand in El Bouni, they range from 22.5 µg/m^3 (2002) to 16 µg/m^3 (2003), with a maximum recorded in 2004 (24.1 µg/m3), and dropped to 2 µg/m^3, while at the station of Sidi Ammar, they vary from a minimum of 4 µg/m^3 (2004) to a maximum of 28.4 µg/m^3 (2007).

The highest concentrations of SO_2 are recorded in the night phase. They are explained first by the production of primary pollutants at night since most of the factories in the industrial areas El Hadjar and Sidi Ammar operate 24/24h, at night, the thermal inversion, the low speed of the land breeze or mountain present favorable conditions for the accumulation of primary pollutants (SO_2).

The latter, whether emitted at night or during the day, are redirected by the night breeze towards the sea after having travelled through the agglomeration [18].

3.5 CO Annual variation

According to the graphical representation of the annual variation of CO recorded at three stations: Annaba city, El Bouni and Sidi Ammar (Figure.15), we notice that the CO is present in the air with strong contents, exceeding the standard of the WHO (0.125 µg/m^3).

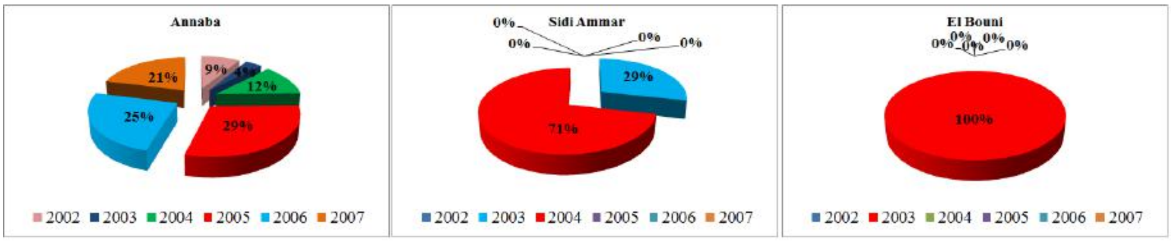

Fig.15 CO annual variation

The highest levels are recorded at Annaba's station with a value of 20 µg/m^3 and reach 2.0 µg/m^3 at the El Bouni station and 0.5 µg/m^3 at the Sidi Amar station. These high concentrations are probably generated by the action of vehicles, especially in Annaba city, the humidity that prevents the dilution of CO in the air as well as weak winds, which promote the accumulation of pollutants.

1.6 Air Quality Indices

How is the AQI Calculated? The index for a given pollutant is its concentration expressed as a percentage of its limit value.

AQI= (Pollutant $_{\text{Concentration}}$/Pollutant $_{\text{Standard}}$)*100

Pollutant emission limit values have been established by a specific monitoring station. To assess overall air quality, an index is calculated for each pollutant measured and the maximum is considered the air quality index for that monitoring station, as it represents the worst of the pollutants measured.

The frequencies of the air quality indices for Annaba's region and its agglomerations are presented in Figure 16. In total, the air quality in Annaba's region varies from excellent to fairly good with a rate of 81%. The poor quality is due in the majority of cases to dust levels and to a lesser extent to photochemical pollution during the summer season (Figure.16).

Fig.16 Air quality indices for the city of Annaba and its surroundings

IV. CONCLUSION

The study of air pollution exposure is based on the results of the air analysis conducted over the period (2002-2007). These results show that the air temperatures are very low accompanied by a very high humidity due mainly to the presence of the sea and many bodies of water (Lake Fetzara swamps ...).

This can allow the accumulation of some pollutants such as carbon monoxide and dust (CO and dust levels exceed WHO standards), while some pollutants are present in small to negligible quantities such as NO, NO_2, and SO_2.

Air quality in Annaba and surrounding areas (El Bouni, Sidi Ammar) can be described as good overall. However, in the vicinity of industrial complexes, such as El Hadjar, there is evidence of heavy dust pollution.

REFERENCES

[1] **Nober F.J, Graf H.F, Rosenfeld D. (2003)** Sensitivity of the global circulation to the suppression of precipitation by anthropogenic aerosols. *Global and PlanetaryChange*,37(1-2),57-80. https://doi.org/10.1016/S0921-8181(02)00191-1

[2] **Petkova E. P, Jack D. W, Volavka-Close N. H. & Kinney P.L (2013)** Particulate matter pollution in African cities. *Air Quality, Atmos. and Health*, 6, 603-614. https://doi.org/10.1007/s11869-013-0199-6

[3] **Thierry E (2019)** L'eau et le changement climatique https://www.oieau.fr/eaudoc/notice/Dossierp%C3%A9dagogique%E2%80%93-L%E2%80%99*eau-et-le changement-climatique*. OIE/3423.

[4] **Fallah-Shorshani M, M. André, C. Bonhomme, C. Seigneur (2015)**: Modelling chain for the effect of road traffic on air and water quality: Techniques, current status and future prospects, Environmental Modelling & Software.2015.22p. https://doi.org/10.1016/j.envsoft.2014.11.020

[5] **Maire-Liis H , Sürje P, & Rõuk H (2008)** Traffic as a source of pollution. *Estonian Journal of Engineering*, 2008, 14, 1, 65–82. https ://doi: 10.3176/eng.2008.1.05

[6] **Buckeridge, D.L, Glazier, R, Harvey B.J, Escobar, M, Amrhein, C and Frank, J (2002)** Effect of motor vehicle emissions on respiratory health in an urban area. *Environ Health Perspect*. 2002, 110, 293–300. DOI: 10.1289/ehp.02110293

[7] **Rogula–Kozłowska W., Rogula-Kopiec P, Klejnowski K and Blaszczyk J (2013)** Influence of vehicular traffic on concentration and mass size distribution of two fractions of carbon in an urban area atmospheric aerosol. Rocz. Ochr. Sr.2013, ISSN 1506-218X 1623–1644

[8] **Grigoratos T., Martini G. (2014).** Non-exhaust traffic related emissions – Brake and tyre wear PM. EUR 26648. Luxembourg (Luxembourg): Publications Office of the European Union; 2014. JRC89231. DOI 10.2790/22000 (print) , 10.2790/21481 (online)

[9] **Grigoratos T., Martini G. (2015)** Brake wear particle emissions: a review. *Environ Sci Pollut Res* 22, 2491–2504 https://doi.org/10.1007/s11356-014-3696-8

[10] **Kumar P., Pirjola L., Ketzel, M. and Harrison R.M.(2013)** Nano particle emissions from 11 non-vehicles exhaust sources-A review. *Atmos. Environ*.2013, 67,252–277. https://doi.org/10.1016/j.atmosenv.2012.11.011

[11] **Badyda A.J, Dąbrowiecki P, Czechowski P.O, Majewski G. & Doboszyńska A. (2014)** Traffic-Related Air Pollution and Respiratory Tract Efficiency. *Adv. Exp. Med. Biol*.2014, 834, 31–38. DOI: 10.1007/5584201413

[12] **Benoit L. (2013)** Contexte & Enjeux de l'atténuation des Gaz à Effet de Serre dans la lutte contre le changement climatique. *Programme des Nations Unies pour le Développement(PNUD) Dakar.*

[13] **Halimi S. (2020).** Evaluation of road traffic impact on the aquifers of the crossed areas. Application to annaba plain crossed by (NR21, NR16 and NR44). Northeastern algeria. *J Fundam Appl Sci. 2020, 12(3), 1404-1422.* doi: http://dx.doi.org/10.4314/jfas.v12i3.26.

[14] **Marcel R. (2008).** Automobile, CO_2, effet de serre et réchauffement climatique. Car Free France

[15] **Mellouk K. and Aroua N. (2015)** Le lac Fetzara, une zone humide fragile, menacée par l'extension urbaine de la ville d'Annaba (littoral est algérien). *La revue Méditerranée*. https ://doi.org/10.4000/mediterranee.8077, p. 133-140

[16] **Maizi N., Alioua A., Tahar A. (2012)** Jumelage des bio-indicateurs et d'un réseau de surveillance de la qualité de l'air pour la détection de la pollution par le SO_2 dans la région d'Annaba (Algérie). *Biotechnol. Agron. Soc. Environ*. 2012 16(2), 149-158.

[17] **Mourdi W. (2021).** Pollution urbaine et qualité des eaux dans une agglomération industrielle. Impact des particulesfines et leurs conséquences sur l'environnement. Cas de la région de Annaba et ses environs, Thes de doctorat, université Annaba. 190 pp.

[18] **Daheche S., Saihia A. (2020) :** Pollution atmosphérique et brise de mer à Annaba (Nord-Est de l'Algérie) : cas de l'ozone et du dioxyde de soufre. *Climatologie*,vol.16(2019)1-22 https://doi.org/10.4267/climatologie.1367