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Scattering of major air pollution of solid aerosols sources in an industrial area in the city of Khenchela

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ABSTRACT

Scattering of major air pollution of solid aerosols sources in an industrial area in the city of Khenchela.

Abstract

Air pollution is responsible for one in ten deaths in the world, six times more than malaria. The cause is Man and his activity, which led us to undertake this work on Scattering of major air pollution of solid aerosols sources in an industrial area in the city of Khenchela.

These sources in this region can be considered as the following: quarries, plastic shoe factories, petrol stations, waste incinerators,…..etc.

Quarries are the units from which the highest amount of particulate matter is emitted that contribute to the deterioration of air quality, and as the "E- Nsigha" quarry is the closest to the city, we chose it to study the atmospheric aerosols and dusts fallout around the unit for 5 days.

The results obtained at the end of the study may not be negligible, as a mass of 4.10 mg/cm^2/5 days can cause allergies and lung diseases, which the inhabitants of this area have confirmed, without forgetting the imbalance of meteorological phenomena that can be caused by the dust particles diffused by the wind in the atmosphere.

Key words : Scattering of air pollution in wilaya of Khenchela, Quarry of E-Nsigha , Aerosol, Dusts.

Distribution de la pollution atmosphérique majeure des sources d'aérosols solides dans une zone industrielle de la ville de Khenchela .

Résumé

La pollution de l'air est coupable d'un décès sur dix dans le monde, six fois plus que le paludisme. La cause est l'Homme et son activité, Ce qui nous a amené à entreprendre ce travail sur Distribution de la pollution atmosphérique majeure des sources d'aérosols solides dans une zone industrielle de la ville de Khenchela .

Ces source au niveau de cette région peuvent être considérer comme les suivantes: les carrières, les usines de fabrication des chausseurs en plastiques, les stations services, l'incinérateur des déchets ...etc.

Les carrières sont les unités depuis les quelle émettent la plus grade quantité de particules qui contribuent à la détérioration de la qualité de l'air, et comme la carrière de "E-Nsigha" est la plus proche de la ville, nous l'avons choisi pour étudier les retomber de les aérosols et de les poussières atmosphérique aux alentours de l'unité pendant 5 jours.

Les résultats obtenu à la fin de l'étude n'ont pas peut être négligeables, car une masse de 4,10 mg/ cm^2/5 jours peut engendrer des allergies et des maladies pulmonaire que les habitants ce cette zone ont confirmés sans oublier le déséquilibre des phénomènes météorologique que peuvent êtres causé par les particules de poussière diffusée par le vent dans l'atmosphère.

Mots clés : La Distribution de pollution atmosphérique de la wilaya de Khenchela. La carrière d'E-Nsigha Les aérosols, Les poussières.

توزيع تلوث الهواء من مصادر الهباء الصلبة في منطقة صناعية في مدينة خنشلة

ملخص

تلوث الهواء مسؤول عن وفاة واحدة من كل عشر حالات وفاة في جميع أنحاء العالم ، أي ست مرات أكثر من الملاريا. السبب هو نشاطات الانسان مما دفعنا إلى القيام بهذا العمل على دراسة توزيع تلوث الهواء من مصادر الهباء الصلبة في منطقة صناعية في مدينة خنشلة.

يمكن اعتبار هذه المصادر في هذه المنطقة على النحو التالي: المحاجر ، مصانع الأحذية البلاستيكية ، محطات الخدمة ، محارق النفايات ... إلخ.

المحاجر هي الوحدات التي تنبعث منها أكبر كمية من الجسيمات التي تساهم في تدهور جودة الهواء ، وبما أن مقلع "النسيغة" هو الأقرب إلى مدينة خنشلة ، فقد اخترناه لدراسة سقوط الغبار الجوي حوله لمدة 5 أيام.

النتائج التي تم الحصول عليها في نهاية الدراسة لا يمكن إهمالها، لأن كتلة قدرها 4.10 مغ / سم^2/5 أيام من الغبار يمكن أن تسبب الحساسية وأمراض الرئة للإنسان. حيث أكد ذلك سكان هذه المنطقة لظهور نفس الحالات المرضية عندهم دون نسيان إختلال الظواهر الجوية التي يمكن أن تسببه جزيئات الغبارو الهباء التي تنشرها الرياح في الغلاف الجوي.

الكلمات المفتاحية : توزع تلوث الهواء في مدينة خنشلة, مقلع نسيغة, الغبار, الهباء

List of abbreviations

%	Pursuant
(C_0)	Initial concentration
($Ca_{10}F_2(PO_4)_6$)	Fluorapatite
[R]	The concentrations of oxidizing radicals
<	Lower
µm	Micrometre
Ar	Argon
CaF	Fluorspar
CH4	Methane
CO^2	Carbon dioxide
Dp	Aerodynamic diameter
E	Logarithmic constant
F	Fluoride
H_2	Hydrogen
H_2SO_4	Acide sulfurique
Hb	Hemoglobin
HbCO	Carboxyhemoglobin
He	Helium
HNO_3	Nitric acid
K	Speed of photochemical reactions.
Kr	Krypton
N_2	Nitrogen
Na,AlF	Cryolite
Ne	Neon
NO_X	Nitrogen oxides
O_2	Oxygen

O_3	**Ozone**
PAHs	**Polycyclic aromatic hydrocarbons**
PBL	**The planetary boundary layer**
PM	**Particulate matter**
Rn	**Radon**
SO_2	**Sulfur oxides**
SO_3	**Sulfur trioxide**
T	**Time**
Wt	**Wight**
Xe	**Xenon**

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INTRODUCTION

Introduction

The atmosphere is, with the ocean, one of the most important components of the climate system ; and it is the component that is of particular interest in this book. The atmosphere is a relatively thin layer of gases that is held around the Earth by gravity. Dry air is composed of 78 % of molecular nitrogen (N_2), 21 % of molecular oxygen (O_2), argon, and other trace gases. Water vapor is also present in the atmosphere in very variable conditions both in space and time. The percentage by which water vapor can vary from close to zero in dry places, up to 4 % in wet and hot places. Pressure and air density in the atmosphere decreases with altitude, but Human activity has modified profoundly the chemical composition of the atmosphere, well beyond variations observed over the last thousands of years (Boucher, 2015).

The development of infrastructures in Algeria and more precisely the industries can increase the rate of polluants in the air and can affect the living beings and the human health is the first target.

In our work is to use a technique to measure or quantify the amount of dust in the region of the quarry with different distances during 5 days .we have shown that there was indeed a problem of air pollution in the vicinity of this region. Currently the air quality can only be more degraded with time.

After a **general introduction**, the dissertation is organized into three main parts:

- The first part is based on a **"bibliographical synthesis"** which aims to define air pollution in a general way by specifying the aspect relating to the aerosols of pollution with their impact and specified their sources and the influence of climate with the bio-monitoring.

- The second part, **"Material and Methods"** describes the study area, namely the region of Khenchela, by giving an overview of the geographical situation, the fauna and flora as well as the climatology. This description of the study area allows justifying the sampling plan, in particular the location of the sampling stations. It then explains then the method and technique used during this work, from sampling to analysis to achieve the objectives:

preparation of the sampling material, the (GPS), mode of sampling, and measured the quantity of dust by an analytical balance.

- The third part, **"Results and discussion"**, focuses on the results obtained and their treatment while comparing with the results obtained either on the national or international level international level, by previous works.
- Finally, a conclusion that summarizes all the parts treated and synthesized, as well as the perspectives concerning the importance of woody plants for the detection of air pollution.

CHAPTER I

ATMOSPHERICPOLLUTION, SOURCES AND IMPACTS

Introduction

An atmosphere is a mixture of gases and particles subject to the gravitational attraction of a planet and illuminated by the energy emitted by a nearby star. The defining characteristics of an atmosphere include its chemical composition, temperature and vertical structure as well as the pressure at the planet's surface (John, 2011).

I.1. Atmospheric Chemical Composition

As shown in the Table 1, nitrogen and oxygen are the two main constituents of the earth's atmosphere with their combined proportions approaching almost 99 % by mass as well as by volume. Their compositions vary little with time, so they are treated as permanent gases. Other gases exist in small amounts only (Saha, 2008).

Table 1 : Atmospheric Chemical Compositions (Saha, 2008).

Gas	Symbol	Mass by %	Volume by %	Molecular Wt
Nitrogen	N_2	**75.51**	**78.09**	**28.02**
Oxygen	O_2	**23.14**	**20.95**	**32.00**
Argon	**Ar**	**1.3**	**0.93**	**39.94**
Neon	**Ne**	$1.2*10^{-3}$	$1.8*10^{-3}$	**20.18**
Helium	**He**	$8.0*10^{-4}$	$5.2*10^{-4}$	**4.00**
Krypton	**Kr**	$2.9*10^{-4}$	$1.0*10^{-4}$	**83.7**
Xenon	**Xe**	$03.6*10^{-5}$	$0.8*10^{-5}$	**131.3**
Carbon dioxide	CO_2	**0.05**	**0.03**	**44.01**
Ozone	O_3	$0.17*10^{-5}$	$0.1*10^{-5}$	**48.0**
Radon	**Rn**		$6.0*10^{-18}$	**222.0**
Hydrogen	H_2	$0.35*10^{-5}$	**5.0*10-5**	**2.02**

The proportions of carbon dioxide and ozone are variable. Another constituent of the atmosphere which finds no place in the Table but is highly important for meteorology is water vapor which also occurs in small and variable proportion. But, as we shall see later, the three gases, viz., water vapor, carbon dioxide and ozone, though they occur in small proportions, play very important roles in atmospheric processes because of their radiative and thermodynamic properties (Saha, 2008).

I.2. Definition of air pollution

Defining “air pollution” is not simple. One could claim that air pollution started when humans began burning fuels. In other words, all man-made anthropogenic emissions into the air can be called air pollution, because they alter the chemical composition of the natural atmosphere. The increase in the global concentrations of greenhouse gases CO_2 , CH_4 , and N_2 (shown in Table 1), can be called air pollution using this approach, even though the concentrations have not found to be toxic for humans and the ecosystem. One can refine this approach and only consider anthropogenic emissions of harmful chemicals as air pollution (Daly, 2007).

I.3. Structure of Atmosphere

The atmosphere of the Earth is the gaseous envelope surrounding it and interdependent with the different movements of the Earth. The atmosphere may be regarded as a series of concentric layers delimiting different regions, the two main such regions being the homosphere, which extends from the surface of the Earth up to approximately 80 or 90 kilometers, and the heterosphere, extending beyond these altitudes. The two main components of the homosphere, nitrogen and oxygen, are present in this layer in constant proportions, whereas light gases, such as nitrogen, hydrogen and helium are prevailing in the heterosphere (Sizun, 2005).

I.4. Polluants, sources and impacts

Air pollution results from the input of gases and particles emitted by human activities. Those emissions are called anthropogenic. But atmospheric processes involve both natural and anthropogenic gases and aerosols.

Some polluting emissions are partially controlled, at least in highly industrialized countries. This is the case for many industrial emissions, such as SO_2, which are decreasing. Others, such as automobile emissions, are not. Indeed, almost everywhere in the world, car pollution is the major source of pollution. The effects of pollution are manifested on several scales. The effects of automobile pollution are fairly localized in large urban areas. Other types of pollution, such as acid rain, occur on a regional scale. Fortunately, these phenomena are probably not irreversible. On a global scale, the accumulation of carbon dioxide CO_2, which is not a polluant because it is not toxic, is a major cause of pollution (Masclet, 2005).

A). Particulate matter (PM)

All sources of pollution emit particles. Those particles vary greatly in size. Coarse particles (size > 2.5 µm) are not harmful to health because they are eliminated in the respiratory system so, are very fine particles. Particles between 0.2 and 2.5 µm in size are inhaled. They are called "respirable particles ", are dangerous because of their toxic contain or carcinogenic substances and settle in the bronchi, causing bronchitis and lung cancer. They are therefore a real health hazard, although the toxic portion of PM is only a small percentage of the total mass of particles (about 3%). These particles are mainly carbonaceous or metallic particles with organic compounds such as polycyclic aromatic hydrocarbons (PAHs) and heavy metals (Masclet, 2005).

I .5.1. Natural sources

Dust suspended in the atmosphere comes mainly from:

- Wind erosion of soils:
- Oceans : marine aerosol
- Volcanoes : volcanic aerosol
- Forest or savannah fires : biomass burning aerosol plant respiration, biogenic aerosol (Masclet, 2005).

I .6.2. Anthropogenic sources

- Oil and coal-fired power stations,
- Oil-fired power stations,
- Oil-fired power plants, coal-fired power plants,
- Diesel engines,
- And the fumes from many industries (Augier, 2008).

CHAPTER II

INFLUENCE OF CLIMAT, TRANSPORT OF POLLUANTS AND BIO-MONITORING

Introduction

Air pollutants are broadly categorized as either primary or secondary. Primary pollutants are directly emitted, such as inorganic carbon particulates. Secondary pollutants, such as tropospheric ozone and much of the fine particulate mass, are formed through chemical reactions in the atmosphere. Primary pollutants can be managed directly by reducing their emissions, although sources may be hard to identify or reduce. Management of secondary pollutants can be more complex because their relationships to emission sources may not be readily apparent and response to emission reductions may not be proportional.

II.1. Atmospheric dynamics and winds

The vertical movements of the air depend on the local state of thermal stability of the atmosphere. The horizontal movements constitute the essential part of the atmospheric dynamics. The winds which translate these movements are directly or indirectly the consequence of pressure differences sometimes induced by temperature differences. In a given point of the atmosphere, they are characterized by their direction and their intensity or speed, both measured in relation to the earth's surface. In addition, the rotation of the earth interferes in the perception that we have of these two characteristics because the atmospheric movements are precisely observed from the earth's surface (Delmas, 2007).

II.2. Polluant transport in the atmosphere

In a regional context, polluant transport occurs in the lower atmosphere, or troposphere, which is approximately 10 km thick. The troposphere includes the planetary boundary layer (PBL) and the free troposphere above it. The PBL is the most directly influenced by warming and cooling of the earth’s surface, and its thickness varies generally between a few hundred to a couple thousand meters during the day. Most regional air polluants are contained in this boundary layer. Within the PBL is the mixed layer, which is the region where the most rapid turbulent mixing occurs (Bergi, 2005).

Turbulence in the mixed layer is caused by ground-layer heating and mechanical forcing, which drives vertical transport. Vertical transport and mixing has a large effect on the ultimate distance pollution which is carried and on the dilution and chemical progression of the initial air parcel. Ground-layer heating warms air parcels next to the surface, causing them to rise, whereas colder air parcels from above fall, creating an unstable atmosphere with thermal eddies, which efficiently disperse pollutants throughout the mixed layer. This mixing can dilute ground-level emissions upward and fumigate elevated plumes from power plants (Bergi, 2005).

Horizontal transport is dominated by advection, generally following customary local and regionally seasonal wind currents. One estimate suggests that the climatologically averaged mean transport velocity is around 400 km per day, although this depends on episodic meteorology and can vary from a few tens of kilometers to about 1000 km. Strong winds can spread emissions and pollutants over a wide region, transporting persistent pollutants, increasing background concentrations, and causing occasional severe pollution episodes. However, many of the more severe pollution episodes occur when the air is more stagnant.
Transport and pollution patterns are influenced by physical changes on the earth's surface, such as land-ocean interfaces, mountain ranges, variations in surface land. Polluant distribution is affected strongly by the location of emission sources, including the dispersion of megacity emissions from highly in desterilized regions, and the geographical distribution of land-use changes that affect anthropogenic and natural emissions (Bergi, 2005).

II.3. The relationship between meteorology and pollution

The concentrations and spatiotemporal distribution of pollutants are not only determined by sources and physicochemical transformations. They are also determined by physical parameters related to atmospheric dynamics.

A pollution episode is observed when:

- ✓ The elements of pollutants are important.
- ✓ The weather is unfavorable.

There are four meteorological situations which favour pollution phenomena

- ✓ Absence of wind or weak wind.
- ✓ Heat and light.
- ✓ Absence of rain.
- ✓ Low inversion layer (Forbes, 2002).

II.3.1. Meteorological situations and air pollution

Meteorological conditions play an essential role in air pollution. They are not the origin of pollution, but can aggravate or reduce it.

If air quality depends on the emission of polluting substances by different sources (industries, transport, tertiary and domestic sources), it also depends on meteorological conditions. The topography of a site, the climatology (temperature, radiation, wind speed and direction, atmospheric pressure...) influence the transport, transformation and dispersion of pollutants.
Indeed, pollutants are emitted regardless of the meteorological situation. On the other hand, they can concentrate or disperse according to this situation. For the same emissions, the consequences will therefore vary greatly (Forbes, 2002).

Thus, bad weather can allow the dispersion of pollutants in the atmosphere thanks to strong winds and their solubilization or washing with precipitation. On the other hand, good weather favours their concentration and even the production of secondary polluants because of the sunshine, the heat, the absence of clouds and the low winds (Bertrand, 2002).

II.3.1.1. Influence of the wind on the transport of the polluant

The wind tends to disperse the pollution especially in the absence of relief. The stronger wind, the faster pollution is dispersed. This is particularly the case in Paris when the west wind blows, even if in this case, the pollution moves to the eastern suburbs. In mountainous areas, if the pollution meets a mountain barrier, the pollution can then return to the back and return to its site of origin. In this case of cities located there is no dispersion of polluants but accumulation (Masclet, 2005).

II.3.1.2. The light and the temperature

The light and the temperature increases :

- ✓ The probability and the speed **k** of photochemical reactions
- ✓ The concentrations of oxidizing radicals [R] such as OH

In both cases the life time of the species is shortened since t = 1/k.[R]
The primary species disappear more quickly but the secondary species, such as ozone, appear more quickly (Masclet, 2005).

II.3.1.3. The influence of precipitation

Precipitation is generally associated with an unstable atmosphere that also allows for good dispersion of air pollution. Moreover, it carries the heaviest polluants to the ground. It can sometimes accelerate the dissolution of certain pollutants. But, overall, pollutant concentrations in the atmosphere decrease significantly during rainy weather, especially for dust and soluble elements such as Sulphur dioxide (SO_2). In addition, topography and urbanization play a role in the movement of air masses (Denis, 2005).

II.3.1.4. The influence of humidity

Humidity influences the transformation of the primary pollutants emitted

-Sulfuric acid (H_2SO_4) is formed from sulfur dioxide (SO_2).

- Nitric acid ($HNO_{3)}$ is formed from nitrogen oxides (NO_X) (Denis, 2005).

II.3.1.5. The influence of atmospheric pressure

Low-pressure situations generally correspond to a fairly strong turbulence of the air and thus to good dispersion conditions. On the other hand, anticyclonic situations (high pressure), where the stability of the air does not allow the dispersion of polluants, lead to pollution episodes (Lesieur, 1998).

II.3.1.6. The influence of sunshine

Sunshine has less importance on photochemical polluants production than temperature if it occurs only in the morning. Low sunshine generally leads to an improvement in the air quality index unless the temperature is constant and high. High sunshine results in a deterioration, the magnitude of which is correlated with the temperature increase (Lesieur, 1998).

II.4. Biomonitoring of air quality

Due to the evolution and diversification of pollution sources has become complex, now constituting a veritable "cocktail" of pollutants whose effects are difficult to effects are difficult to characterize. At the same time the need to assess the risks (health and environmental) associated with environmental contamination has developed, making knowledge of the effects of air polluants. Faced with these challenges, plant and fungal biomonitoring of air quality can provide a lot of informations (Cuny, 2012).

II.4.1. Definition of Biomonitoring

Biomonitoring, in a general sense, may be defined as the use of bio-organisms/materials to obtain (quantitative) information on certain characteristics of the biosphere. The relevant information in biomonitoring (e.g. using plants or animals) is commonly deduced from either changes in the behavior of the monitor organism (impact : species composition and/or richness, physiological and/or ecological performance, morphology) or from the concentrations of specific substances in the monitor tissues (Wolterbeek, 2010).

Biomonitoring is defined as "the use of responses at all levels of biological organization (molecular, biochemical, cellular, physiological, tissue, morphological, ecological) of an organism or organisms to predict and/or reveal an alteration of the environment and to follow its evolution"; four concepts are four concepts are integrated into it : the use of biomarkers, bio-indication, bio-integration and bio-accumulation (Cuny, 2012).

In another context, the word “biomonitoring” refers to the observation of living organisms (plants or animals) for the purpose of monitoring the quality of environments. This observation can concern all levels of organization of these organisms of organization of these organisms: molecular biological, biochemical, cellular, physiological, tissue, morphological and even ecological if we consider a set of organisms) (Salines, 2012).

II.4.1.1. Plant and fungal biomonitoring

Plant and fungal biomonitoring of air pollution appeared at the end of the 19th century with the use of lichens, in particular by Nylander, who described them at the time as hygrometers. It was in the late 1950s that the idea of using higher plants for air quality biomonitoring was born, following the work done on the impacts of ozone, particularly on tobacco. The use of tobacco plants dates back to 1962 and is still relevant today. It was not only until the 1970s that large-scale scientific work on the mechanisms of the effects of pollutants on the models studied and biomonitoring techniques were developed (Cuny, 2012).

II.4.1.2. Human biomonitoring

Human biomonitoring is a particular modality of environmental public health surveillance, which is based on the monitoring of a certain category of indicators resulting from chemical and biological measurements biological measurements in individuals. It can be concentrations of molecules such as heavy metals, pesticides, carbon monoxide, proteins of inflammation proteins, etc.; or cell counts (leukocytes, red blood cells, macrophages, etc.). These measurements are carried out on biological matrices (blood, urine, hair, breast milk, exhaled air…). It can also be physical parameters of the individual (heart rate, blood pressure…) or even biological phenomena such as genomic characteristics. These indicators are called ‘biomarkers’ (Salines, 2012).

II.5. The different concepts of biomonitoring

II.5.1. Biomarkers

The use of biomarkers is the most recently explored "level" used in recently explored and used in biomonitoring. It concerns infra-individual, non-perceptible damage and is based on and is based on modifications of physiological, biochemical and molecular parameters. These markers are currently the subject of numerous developments benefiting from technological progress, particularly in molecular biology, with the aim of obtaining both early and specific responses (Cuny, 2012).

II.5.2. Bio-integration

Bio-integration is based on the observation of variations in communities, populations, groups of species. These variations concern for example the modifications of specific compositions, abundance, frequency, of species. Some authors prefer the term ecological indicator to that of ecological indicator to that of bio-integrator because, in addition to climatic parameters and pollution, mechanisms such as interspecific competition also acts as an ecological indicator (Cuny, 2012).

II.5.3. Bio-indication

Bio-indication is based on the observation of macroscopic damage to the organisms used. In plants, this translates into necrosis, chlorosis, floral and foliar malformations, and disturbances of the growth (Cuny, 2012).

Bio-indicators are defined as organisms, cells and subcellular compounds that can be used to assess environmental and ecosystem quality, as well as the impact of environmental stress on the composition and functioning of ecosystems. Therefore the term bio-indicator differs from the concept of environmental indicators. Bio-indicators can be used as environmental indicators, but environmental indicators cover more than the organism aspect (Kienzl, 2003).

II.5.4. Bio-accumulation

Chemicals can be accumulated in organisms via the direct uptake from surrounding medium (water, pure water) by gills, skin etc. or by ingestion of particle-bound chemicals (bio-concentration or bioaccumulation) as well as via food chain following various pathways along different trophic levels (biomagnification). These processes will not always manifest themselves in direct adverse effects (mortality), but complex phenomena can occur, reduced fertility, which constitute a risk potential for humans and environment (Franke, 1994).

II.6. Different global objectives of biomonitoring studies

It is possible to distinguish different global objectives of biomonitoring studies :

- Monitoring of spatial and temporal distributions of the effects of pollutants.
- Monitoring of point sources.
- Participation in health risk assessment studies.
- Information for the general public and decision support for public policies (Cuny, 2012).

II.7. Biomonitoring and air pollution

Regarding air quality, it has already been indicated that, by definition, biomonitoring integrates the different sources and pathways of exposure. It is therefore a tool for assessing the total exposure to chemicals in the in the environment. On the other hand, biomonitoring is not well suited as an indicator of the quality of a particular environment. Biomarkers are coming in. A notable exception is the measurement of carbon monoxide in exhaled air, which is a biomarker of exposure specific to airborne exposure and is commonly used in both, is routinely used in both clinical practice and in some biomonitoring studies (Salines, 2012).

CHAPTER III

AEROSOLS AND DUSTS

III.1. Aerosols

III.1.1. Definition

Many authors have worked and defined aerosols, among which we can mention: The atmosphere contains fine particles in suspension that are called aerosols (Ngô, 2004).

An aerosol is a set of particles, solid or liquid, suspended in a gaseous medium. A secondary organic aerosol is composed of secondary particles, of organic origin, whose precursors are secondary organic compounds. We also distinguish secondary inorganic species: sulphate, nitrate, ammonium..., elemental carbon (soot carbon) produced by combustion, organic carbon, formed by oxidation or incomplete combustion, mineral compounds and salt from abrasion and dust flight, metals from abrasion processes and biological compounds (pollen, spores, microorganisms) (Ineris, 2009).

III.1.2. Origin of the aerosol

There are two types of aerosols mixed in the atmosphere in all terrestrial atmospheres :

-Aerosol of natural origin

-Pollution aerosol

The share of each of the two types of aerosols depends on the distance from the centers of human and industrial activities on the one hand and the distance from the human and industrial activities and the distance from desert and marine areas on the other. In marine, polar or desert areas, aerosol is mostly natural. On the other hand, in urban areas, the pollution aerosol is always mixed with the natural aerosol, because the latter can be transported over long distances (M be transported over long distances (Masclet, 2005).

The dust in suspension in the atmosphere comes essentially from wind erosion of soils: terrigenous aerosol (size greater than 1µm), crustal aerosol (land crust), oceans (marine aerosol), volcanoes (volcanic aerosol), forest or savannah fires (biomass combustion aerosol), and biomass burning), and plant respiration (biogenic aerosol).

III.1.3. Aerosol size

The size of atmospheric aerosols ranges from a few nanometers to a few tens of micrometers for aerosols bound to plant debris. This last category is very specific; we generally limit the study of the spectrum to diameters of the order of ten micrometers micrometers : beyond that, the fall velocities (gravitational effect) are indeed important enough for that the aerosols are not to be considered (Sportisse, 2008).

All particles are considered as spherical or sphere-like. Their size is defined by the mean aerodynamic diameter called Dp. This approximation is correct for wet particles which are spherical. The size of the particles ranges over several orders of magnitude : from 0.001 μm to 100 μm. Three classes of particles are distinguished:

- Dp < 0.1 μm: the Aitken particles or nuclei. These particles are essentially due to the conversion of gases.
- 0.1 < Dp < 2.0 μm: the medium particles or accumulation mode, are considered to be the most important in atmospheric chemistry. As the name implies, the particles formed by conversion grow and accumulate.
- Dp>2.0 μm: large particles. These are detrital particles, sands or particles highly water-laden (Masclet, 2005).

III.1.4. Chemical composition of aerosols

A distinction is made between inorganic and organic aerosols, which contain carbon. In practice, aerosols appear as complex mixtures of organic species, inorganic species, soot and possibly liquid water. The average composition of the average composition of the atmospheric aerosol column is shown in Table 2. A significant part of the mass is not attributed by the current measurement methods. It is also necessary to take into account the measurement artefacts, e.g. due to surface processes on the filters, which lead to a change in the chemical composition change the chemical composition during sampling (Sportisse, 2008).

Table 2 : Chemical composition of the atmospheric aerosol column (1995) (Sportisse, 2008).

Species	Column mg.m^{-2}
Sea salt	07
Mineral	36.1
Sulphate	8.6
Nitrate	1.3
Biomass fires	3.9
Organic part	4.5

III.1.4.1. Aerosol data

In the following table, the concentrations of the different aerosols in the three compartments of the biosphere are mentioned.

Table 3: Aerosol concentrations (Boucher, 2012).

Type of aerosols	Mass concentration ($\mu g.m^{-3}$)	Concentration in number (cm^{-3})
Urban	100	10^5-10^6
Terrestrial	40	5000
Maritime	10	500
Polar	1	25

III.1.5. Source et flux des particules d'aérosols

At the global scale, many estimates of aerosol particle emissions have been made considering their anthropogenic or natural origin (Table 5). For each type of source, two different classes of aerosols are distinguished according to their mode of formation: primary aerosols and secondary aerosols.

Primary anthropogenic aerosols are largely dominated by industrial discharge aerosols, while secondary anthropogenic aerosols are 88 % sulfate aerosols. In addition, vegetation fires account for 18 % of primary anthropogenic aerosol sources. The table shows that the contribution of anthropogenic activities to the aerosol cycle is relatively small, about 6 % of the mass of aerosols emitted each year into the atmosphere. However, this view is misleading. Indeed, anthropogenic activities are responsible for 70 % to 90 % of the aerosol concentration in the atmosphere (Delmas et al., 2005).

III.1.5.1.Nature of the aerosol

There are two types of aerosols mixed with the atmosphere in all terrestrial atmospheres:
Naturally and pollution occurred aerosols (Boulaud and Renoux, 1998).

a. Terrigenous (earth) or crustal aerosol; is mainly of metal oxides and alum-inosilicates for the mineral compounds, and of plant debris or humus for the organic of plants or humus for the organic components.

b. The marine aerosol; produced by the oceanic "spray", and consists of chloride and sodium ions, but also large quantities of nitrates and sulfates. sodium ions, but also large quantities of nitrates and sulfates.

c. Volcanic aerosol consists of many metals and sulfur dioxide gas which is transformed into particulate sulfates (Boucher, 2012).

Table 4 : Emission flow of aerosols particules Mt.year^{-1}(IPCC, 2001)

Origin of the source		**Sources**	**Average flow (Mt.yr^{-1})**
Naturals (94 %)	Primary	Sea salts	3000
		Mineral dust	2000
		Biogenic sulfates	90
		Organic carbon	(> 1µm) 56
	Secondary	Volcanic ash	33
		Volcanic sulfates	21
		Organic carbon (Oxidation of biogenicVolatile Organic Compounds)	16
		Nitrates	4
	Total		**5220**
Anthropic (6%)	Primary	Organic carbon (0-2 µm)	
		Vegetation fires	54
		Comb. Fossil fuel	28
		Elemental carbon (0-2 µm)	
		Industrial dust	100
		Fossil fuel Fossil fuel	6.6
		Vegetation fires	5.7
	Secondary	Sulphates	120
		Nitrates	14
		Organic carbon (Oxidation of anthropogenicVolatile Organic Compounds)	1
	Total		**330**

III.1.6. Aerosol pollution

III.1.6.1. Primary aerosol or detrital aerosol: made up of 20 to 30% of tire debris, metal particles (lead, zinc, iron, copper, cadmium, etc.), coal dust, dust from waste incinerators, etc. tire debris, metallic particles (lead, zinc, iron, copper, cadmium, etc.), coal dust, dust emitted by waste incinerators, etc... Aerosols also carry water which, when the humidity level increases, condenses on the particles. These particles particles grow and form clouds or fogs. This aerosol is coarser and often larger than a micron in size (Masclet, 2005).

III.1.6.2. Secondary aerosol or conversion aerosol

Formed from 70 to 80 % of vapors condensation emitted by industrial, vehicular discharges and wood and fossil fuels combustions, vapor pressure of the compound exceeds the saturation point. It is formed by a process called "gas/particle conversion" (Masclet, 2005). This aerosol conversion is very fine, since its size is less than a micron (Figure 1).

Note that the most toxic particles are fine, so the pollution aerosol is often dangerous for human health. However, the contamination of the atmosphere by this type of aerosol becomes general (Boulaud and Renoux, 1998).

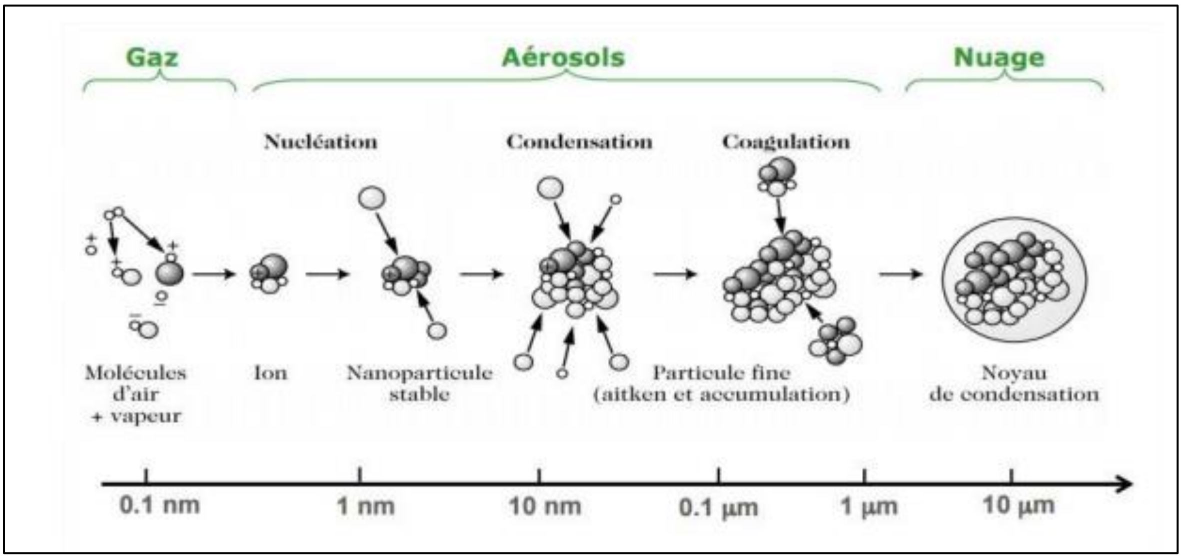

Figure 1: Evolution of an atmospheric aerosol (Marris, 2013).

III.1.7. Sources of aerosol emissions

They can be emitted by natural or anthropogenic sources (Stortini et al., 2009).

III.1.7.1. Natural sources

- ✓ Terrigenous particles (derived from dust blowing from soils, especially deserts),
- ✓ Particles from the oceans,
- ✓ Particles from vegetation or even particles linked to combustion such as forest fires,
- ✓ Volcanic eruptions (Almeida et al., 2005; Artinano et al., 2003; Paris et al., 2009).

III.1.7.2. The main anthropogenic sources

- ✓ Agriculture and forestry (pesticides, fertilizers),
- ✓ Manufacturing industry (chemicals, construction sites, metallurgy)
- ✓ Residential and tertiary sectors (wood and fuel combustion),

- ✓ Transport and energy transformation (electricity production, oil refining) (Almeida et al., 2005; Huang et al., 2009).

III.1.8. Climatic impact

In general, aerosols can have an impact on :

- Climate change (radiative forcing);
- Modification of precipitation regimes;
- The acidity of rainfall;
- Soil, water and vegetation pollution;
- Reduced visibility or building degradation (Vogel et al., 2009).

However, the effects of atmospheric particles on the chemistry or physics of the atmosphere and climate still raise many questions (Boucher, 2007). Atmospheric aerosols will also have an impact at a smaller scale : regional or local. Indeed, they can be the cause of a :

- Reduced visibility in urban and industrial areas. This is linked in particular to the influence of particles on the transfer of electromagnetic radiation in the visible range, by visible range, by scattering or absorption of light (Figure 2) (Horvath, 1995; Tsai et al., 2007).
- Responsible for the acidification phenomenon of rainfall. In some highly polluted areas, pH values of polluted areas, pH values of rainwater below 4 have been observed (Huang et al., 2008), linked in particular to the trapping of anthropogenic compounds.
- This oxidation is associated with the formation of condensation nuclei, which are responsible for the cloud formation when relative humidity is high, which allows the trapping of acid products that will be deposited by leaching (Aikawa et al., 2008).

Figure 2 : Aerosol effect on visibility (air quality); without pollution: visibility 250 km, with pollution : visibility 70 km (Marris, 2013).

III.2. Dusts

Most sedimentological definitions of dust include all particles below a maximum size in the range 60–70 µm and consequently include the both the silt(4–63µm) and clay (<4µm) classes of the Udden-Wentworth grain-size scale as well as occasionally part of the very fine sand class (63–125 µm) (Went-worth, 1922). In terms of Aeolian geomorphology, the important distinction between 'sand' and 'dust' is the way in which particles are transported. This difference in behavior (and hence the precise size boundary) is governed by the balance between the forces holding particles a lot of in the atmosphere and those pulling them towards the ground surface (Bullard, 2009).

III.3. Emissions, immissions and atmospheric deposition

The immissions depend mainly on the polluant considered and the conditions of dispersion and transformation in the air. The immissions do not depend (or depend very little) on the receptor and the ground cover. They can be measured immediately with appropriate technical equipment. The immission values quantitatively characterize an air pollution state in a given area and during a fixed time interval. It should be noted that the interactions that occur in the biosphere system are still very difficult to grasp. Difficulties are already apparent at the first stage, which is that of in situ observations and measurements (Martin and Mays, 1988).

CHAPTER IV

PRESENTATION OF STUDY AREA

IV. Geological and geomorphological framework

IV.1. Geographical location

The wilaya of Khenchela is located in the North-East of Algeria, in the South-East of Constantine, and in the foothills of the Aurès Mountain between 34° 06' 36" and 35° 41' 21" North latitudes; and between 06° 34' 12" and 07° 35' 56" East longitudes. Its surface area is 9715.6 km^2. It is administratively limited to:

- **North**: via the Wilaya of Oum El Bouaghi
- **South**: via the wilaya of El Oued
- **East**: via the wilaya of Tébessa
- **West**: via the wilaya of Batna
- **South-West:** via the wilaya of Biskra (DSA, 2011).

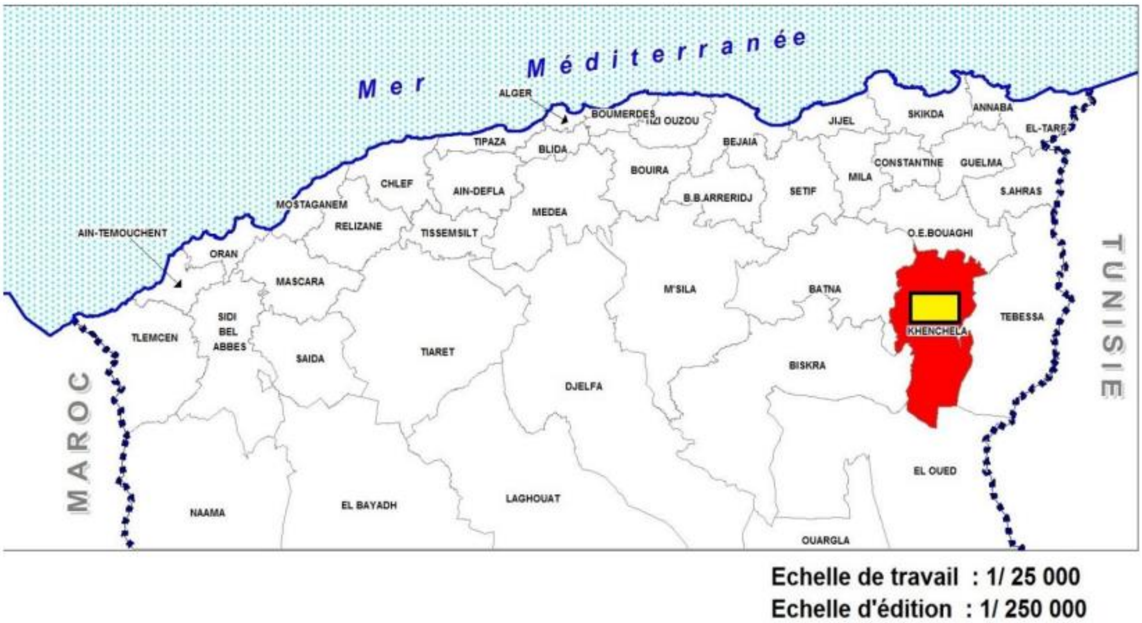

Figure 3 : Location of the wilaya of Khenchela in northern Algeria (DSA, 2011).

The wilaya of Khenchela is distinguished by its very diversified and multifaceted physical and natural environments, combining between:

- Tellian landscapes (high mountain areas, well watered and well wooded with green landscapes): The Aurès Mountains occupying the western part of the wilaya;

- High plains landscapes (high semi-arid cereal plains) for the northern part of the wilaya.

- Steppe and Saharan landscapes composed of: totally bare and eroded mountains (Némenchas mountains in the east), oases (Siar, Khirane and El Ouldja) and low plains (El Meita and Ouazerne) (PAW, 2009).

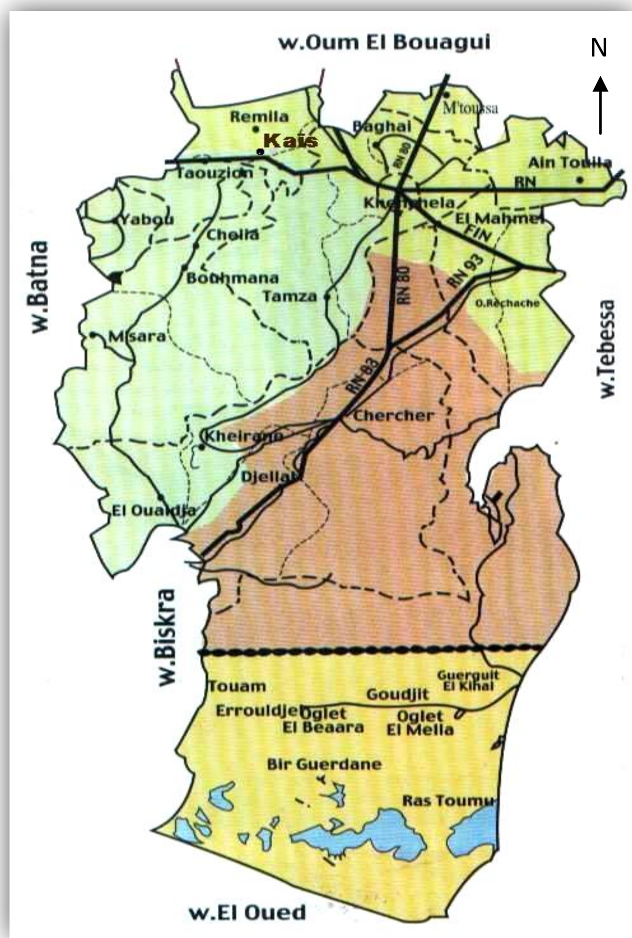

Figure 4: Administrative map of the wilaya of Khenchela (PAW; 2009).

IV.2. Geomorphological and structural overview

IV.2.1. Geomorphological framework

The territory of the Khenchela region is located in a transition zone between the Atlas domain, which is fairly folded in the North, and the Saharan plateau in the South. The contact between these two domains is very abrupt; it is marked by a large tectonic accident, called "South-Atlasic flexure". In the wilaya, there are two main sedimentary complexes:

- A flexible set affected by folds generally having a South-West/North-East direction;
- A rigid set affected by faults (Bougandoura, 2009).

IV.2.2. Relief

The relief of the wilaya of Khenchela presents, in a general way, three distinct compartments (Figure 5) :

- An area of high plains, to the north, which is characterized by an overall altitude varying between 825 and 900 meters and a generally low slope (less than 3 %). These high plains, a sort of belvedere, constitute a northern extension to the limestone outcrops of the natural site of Hammam El Salihine and occupied by the plain of Rémila.

- A mountainous area in the center of the wilaya, formed by the massif of the Aurès E-Némenchas, whose highest point reaches 2169 m on the Djebel Chélia, which makes it one of the highest peaks of the Algerian Atlas. This area, whose altitude varies between 1000 and 2169 meters, is intersected by narrow valleys, generally north-east, in one of which Hammam El Salihine is surrounded by medium altitude reliefs.

- An area of steppe and pre-Saharan plains in the south, part of which is below sea level (Oglat El Djerabaa: minus 26 m). With a relatively flat topography, it belongs to the large basin of the Chott Melghir basin where the Great Eastern Erg is located (PAW 2009).

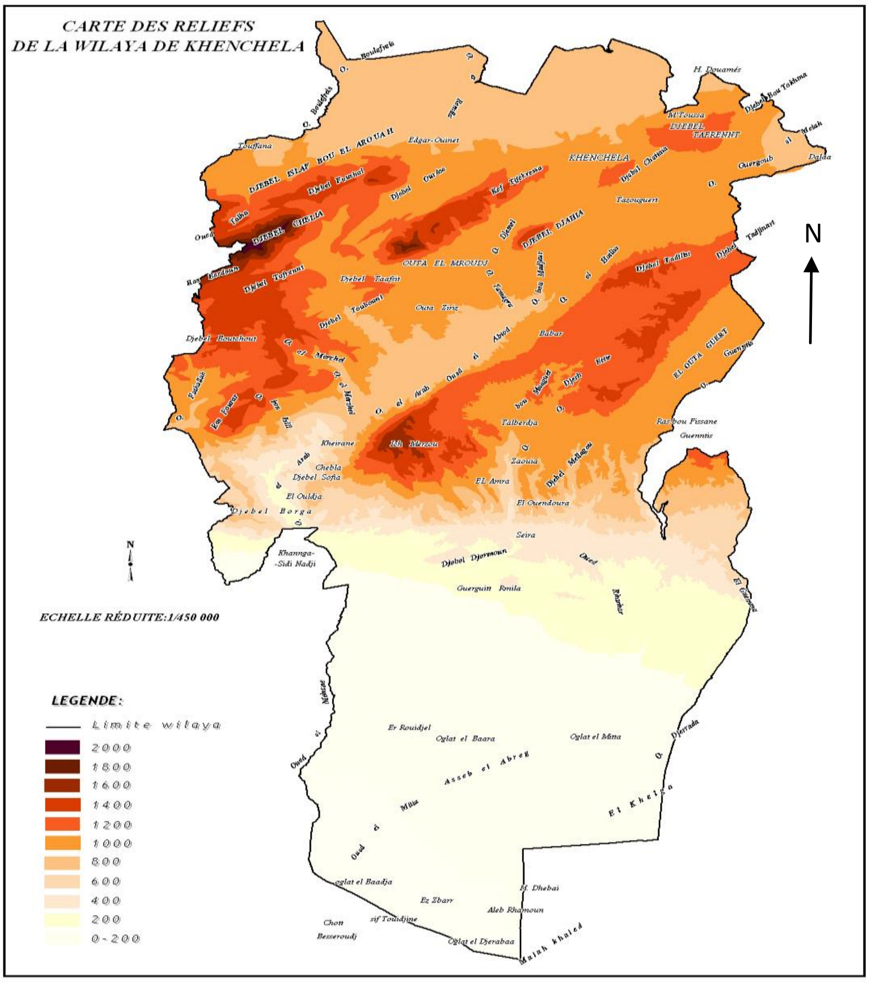

Figure 5: Map of the relief of the wilaya of Khenchela (PAW, 2009).

IV.2.2.1. Slope

As for the altitude classes, a map of the slope classes characterising the territory of the wilaya was drawn up, based on the grid used by MATET (Ministry of Land Management, Environment and Tourism) for the classification of mountain areas. This grid, which takes into account the desirable use of the land, recommends 04 classes (Figure 6) :

- **Class 1**: slope between **0** and **3.5 %:** relatively favourable to agricultural intensification (mechanisation and irrigation) and to the creation of technical infrastructures.
- **Class 2**: slope between **3** and **12.5 %:** favourable to the development of intensive to semi-intensive agriculture.
- **Class 3**: slope between **12.5** and **25 %**: favourable to fruit growing and other soil-fixing perennial crops to the detriment of annual crops, especially field crops.
- **Class 4**: slope greater than **25 %**: thus constituting a major constraint for the practice of agricultural activities and a handicap for the realisation of socio-economic infrastructures. As such, land use in this class should favour forestry (CENEAP; PAW 2009).

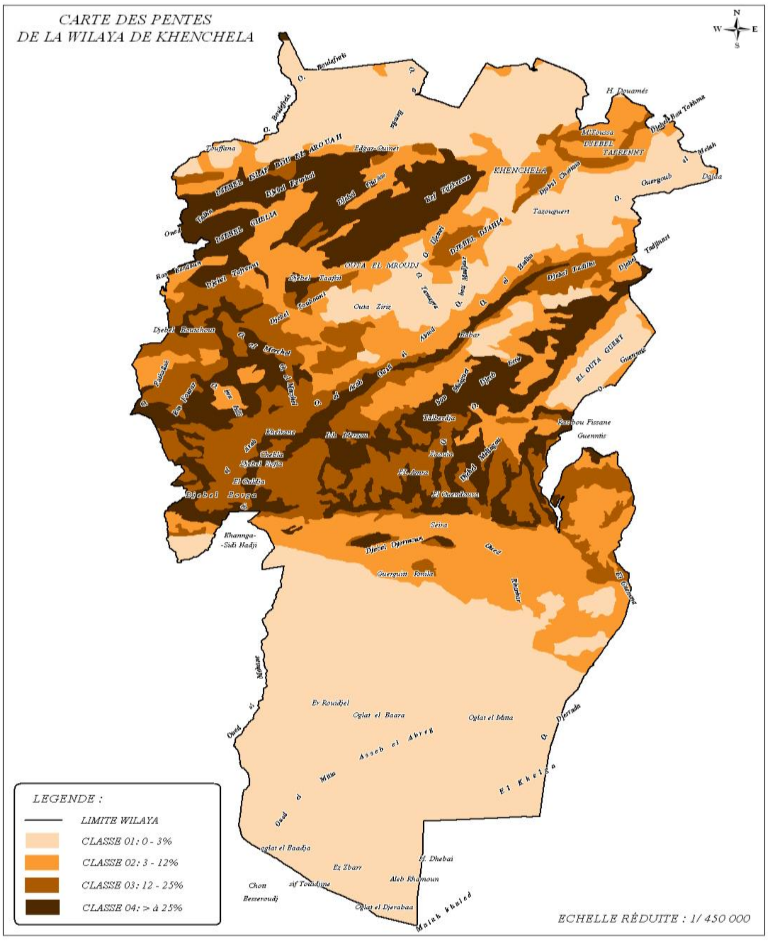

Figure 6: Map of slopes in the wilaya of Khenchela (Source PAW, 2009).

IV.3. Vegetation and the river system

IV.3.1 Vegetation

The forest areas occupy the mountainous reliefs of the communes in the area. The municipality of El Hamma has a fairly dense forest area in which there is the Tarbat forest, which is considered to be one of the largest forests in the area, as well as the Ras Serdoune forest located to the east and which extends into the municipality of Khenchela, thus limiting the town to the west (Bougandoura, 2009).

According to BNEF (1984), the study area contains, in order of importance, cedar, Aleppo pine, holm oak and juniper.

The Aleppo pine is located in the south of the area and in the centre of the massif on the Djebel Aourès syncline, around the Ain Mimoun ring. It is a young to medium-sized stand, with an average age of 84 years and an average diameter of 30.87 cm. The height is 10.81 metres.

The holm oak is located in the northern part of the area around Kaiset and on the eastern slopes of the Khenchela Antiviral. It occurs as a coppice with many small species, diameter less than 5cm and a height rarely exceeding 03 metres.

The Holm oak plays a very important role in the ecological context by protecting the soil; the leaves decompose slowly and contribute to the formation of humus.

The Juniper can be found in a mixture with the Holm oak forming a maquis, or as undergrowth in the Aleppo pine forests.

The Phoenician juniper is found mainly in degraded and very dry areas (Djebbar and Laiche, 2014).

IV.3.2. Hydrographic network

The hydrographic network of the area is of the endoreic type, it is quite dense over almost the entire territory (Figure 7).

The urban area of Khenchela is crossed from the North-East to the South-East by the oued Baghai. The commune of El Hamma is drained from north to south by the wadi El Hammam.

The municipality of Baghai is crossed by several wadis among which we quote oued Aimer in the North-East and oued Baghai in the North-West. The commune of Ensigha is drained by several wadis, the most important of which are Wadi Aimer in the North-East, Wadi Mahdi and Wadi Djemri in the centre and Wadi Bou Madjeur in the South. Finally, Oued Zoni to the north-east, Oued Oullal and Oued Fournis to the south cross the commune of El Mahmel. The water resources of the study area come mainly from groundwater, with the exception of the commune of Baghai, which also has surface water potential for irrigation.

The waters of Hammam El Salhine are drained by Oued El Kissen, which is 6 km long and originates on the heights of Dj Aourès and runs along the high plains of Rémila to end in Chott Ezzahar (Bougandoura, 2009).

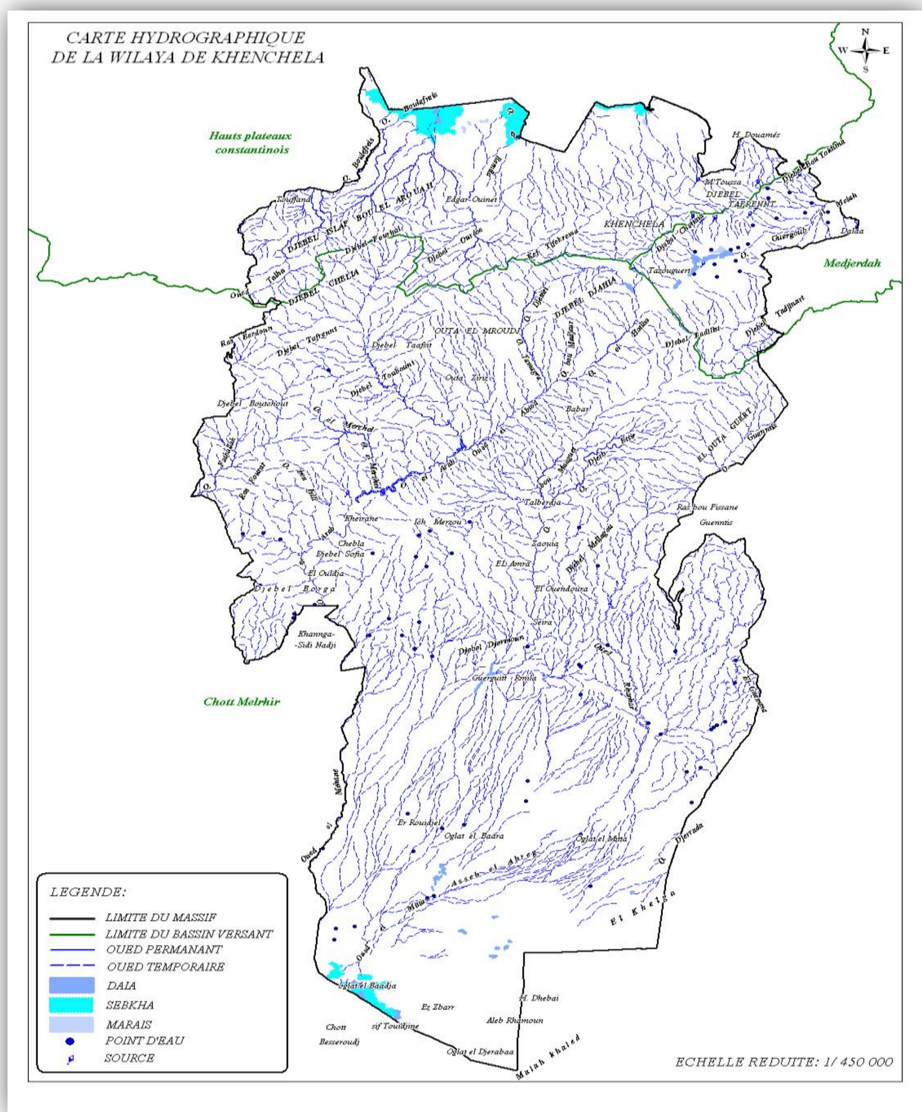

Figure 7 : Hydrological map of the wilaya of Khenchela (PAW, 2009).

CHAPTER V

CLIMATOLOGY OF STUDY AREA

Climatology is concerned with the longer-term quantitative analysis of the mean of the parameters required to characterise the states of the atmosphere, mainly air temperature, precipitation, sunshine duration, wind direction and speed, precipitation, sunshine duration, wind speed and direction. Climate thus represents the "average weather" at a given location (Emselem, 1989).

The Algerian climate is a transitional climate. It varies from the Mediterranean type in the north to the desert type in the Sahara. Due to its geographical and bio-climatological belonging to the arid and semi-arid zone.
Northern Algeria is subject to unfavorable hydro-climatic conditions, characterised by irregular rainfall with significant inter-annual variations and a strong seasonal and inter-annual irregularity of runoff.

From a climatic point of view, the wilaya of Khenchela is characterised by a continental climate, semi-arid climate with cold winters and hot, dry summers. The climatic characteristics of the study area are those of the Khenchela meteorological station (Bougandoura, 2013)

V.1 Climatic data

The temperature and precipitation data correspond to monthly rainfall and temperature and temperature that were collected at the station of the National Meteorological Office (OMN) of Khenchela (OMN) of Khenchela located at an altitude of 890 m following a measurement period from 2011 to 2021.

V.1.1. Precipitation

Precipitation is an ecological factor of fundamental importance in the alternation of the rainy season and the dry season, which plays a regulating role in biological activities (Ramade, 1984).
Precipitation is the water that reaches the ground in liquid (rain or dew) or solid (snow or hail) form, either directly or indirectly from the condensation of atmospheric water vapour. Precipitation (rain or snow) is measured at the earth's surface in millimetres. Annual precipitation is only indicative; the most important thing is its monthly and seasonal distribution. The average monthly precipitation heights observed in the experimental area over an 11^{-year} period (2011-2021) are plotted as in Figure 01

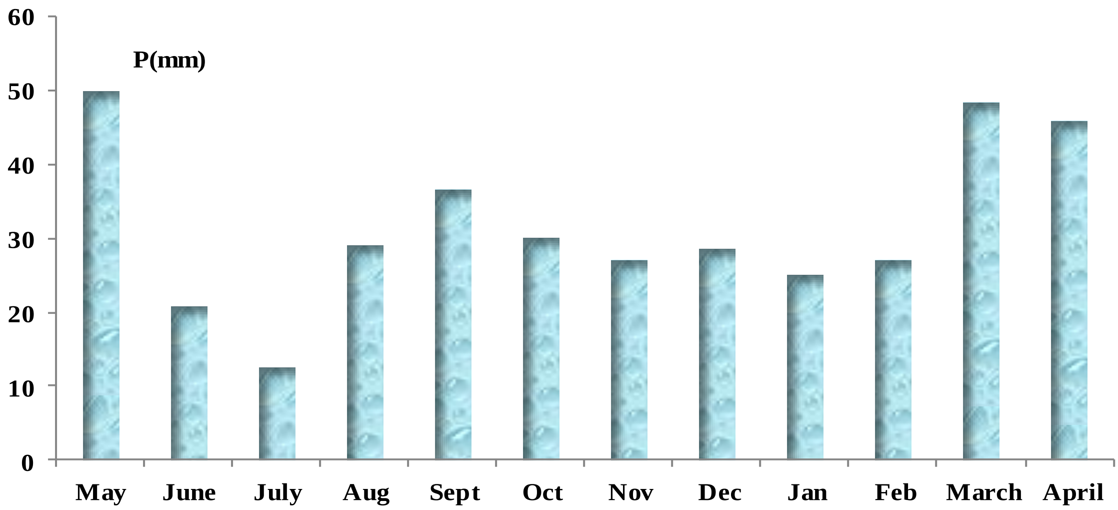

Figure 8: Average monthly precipitation for a period of 10 years (2011-2021).

May was the wettest month with an average of 49,93 mm. July was the driest month with an average of 12,6 mm.

V.1.2. Temperature

The temperature parameter is essential to climatology, as it accounts for its energy supply to vegetation, its evaporative power on wet surfaces, and finally, it is the cause of the proper functioning of the water cycle. Temperature is one of the important elements for characterising the climate (Ramade, 1984).

The temperature represents a limiting factor of any first, because it controls the whole of the metabolic phenomena condition of this fact the distribution of total spaces and communities of living being in the biosphere (Ramade 2003).

The wilaya of Khenchela is characterised by three different climatic zones :

- In the high plains, the climate is cold, harsh in winter and hot in summer.
- In the mountainous areas, the climate is very harsh in winter and temperate in summer.
- In the Saharan rangelands, the climate is mild in winter and hot and dry in summer.

The analysis of the data in graph shows that; the coldest month is January with an average temperature of 8,42°C, while the hottest month is July with an average temperature of 29,78 °C (Figure 9).

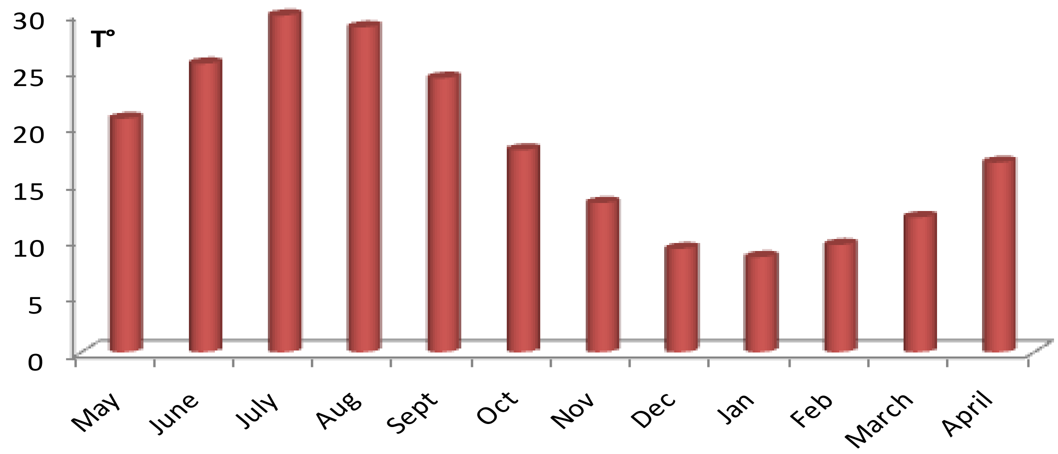

Figure 9: Histogram of monthly average temperatures for the period (2011-2021)

V.1.3. Gaussen Umbrothermal Diagram

This diagram is a graphic method through which we can define the dry period of the year in order to be able to make up for the water deficit. The months are plotted on the abscissa, the precipitation (P) on the right-hand side and the temperatures (T) on the left-hand side on a scale double that of the precipitation (P = 2T) [Gaussen index].

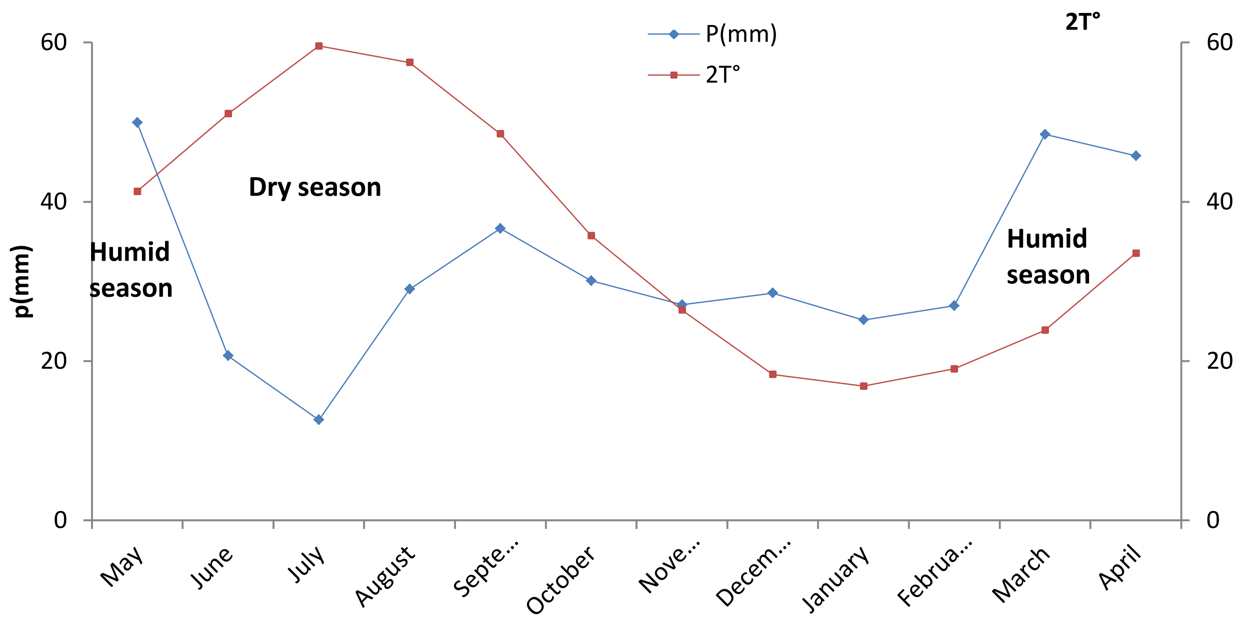

Figure 10: Umbrothermal diagram of Gaussen and Bagnouls in the wilaya of "Khenchela" (2011-2021).

The intersection of the two curves (P and T) defines the dry period (P' 2T) and the wet period (P' 2T). Figure 3 shows that the dry period starts from the end of May until the beginning of November, and the wet period from the beginning of November until the end of May.

V.1.4. Humidity

This is the mass of water vapour contained in a unit volume of area (Estienne and Godard, 1970). This humidity plays an important role in the comfort felt by the organism that is subjected to it (Delams, 2012).

Relative humidity is expressed as a percentage. 100 % corresponds to air saturated with water vapour (risk of clouds, rain, fog, dew or frost), 0 % corresponds to perfectly dry air (a relative humidity value never reached in nature, not even in deserts) 0 % means perfectly dry air (a relative humidity value never reached in nature, not even in deserts (Delams, 2012).

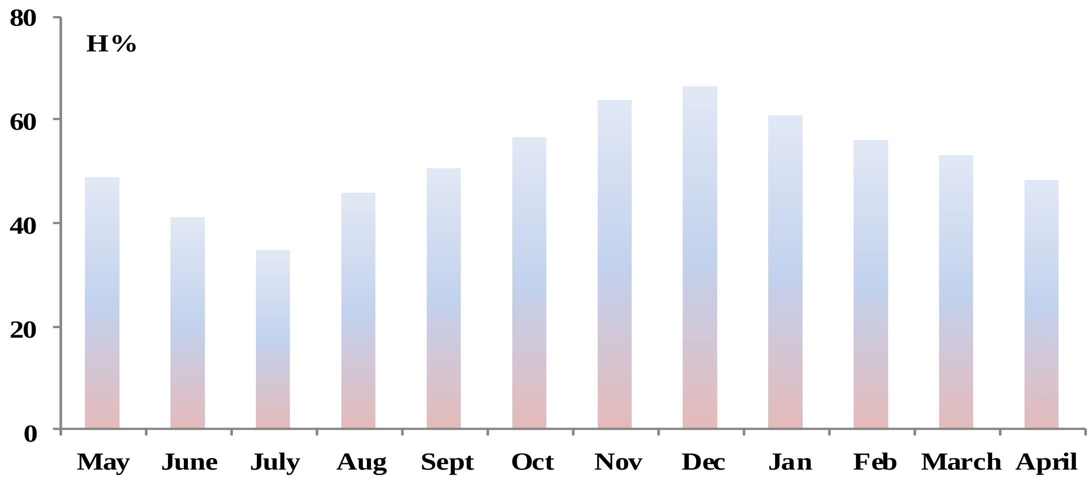

Figure 11 : Diagram of monthly average humidity for the period 2011-2021 (El Hamma meteorological station).

The hygrometrics show that the highest percentage is recorded during the month of December with an average of 66,36 %, which explains why it is the wettest month, while the lowest percentage is recorded during the month of July with an average of 34,5 %.

V.1.5. The wind

The wind exerts on any fixed surface in the atmosphere a pressure force, known as dynamic pressure, proportional to the square of its speed and dependent on its direction relative to that surface. For a wall perpendicular to the wind direction, the pressures exerted are grouped in the following table :

Table 5 : Wind speed and pressure (de Parcevaux and Huber, 2007).

Wind speed		**Dynamic pressure Kg.m^{-2}**	**Beaufort equivalent**
m.s^{-1}	**Km.h^{-1}**		
1	3,6	0,0	1: very light breeze
5	18	1,6	3 : light breeze
10	36	6,3	5 : good breeze
20	72	25,0	8 : gale
30	108	56,3	11 : violent storm
40	144	100,0	12 : hurricane

In the field of air pollution, winds are responsible for transporting air masses loaded with pollutants and particles from one point to another on the planet, both in the atmosphere and in the hydrosphere, over variable distances.

During this transport, aerosols act as vectors of chemical elements between the different compartments of the environment, notably via precipitation (Behra, 2013).

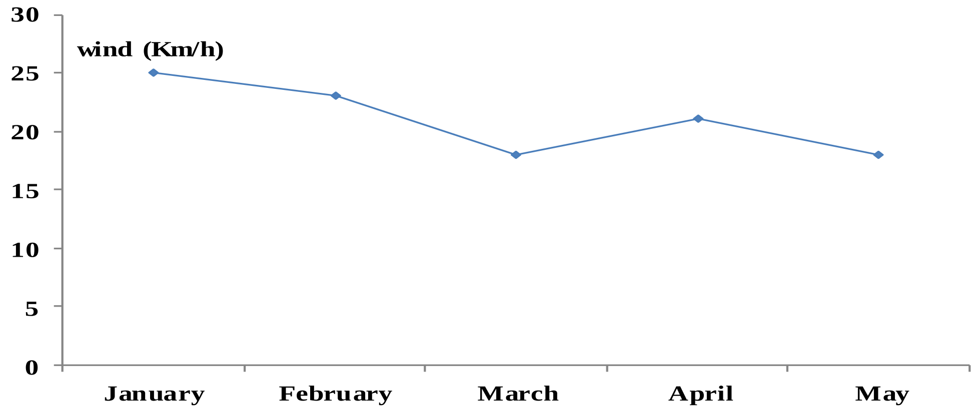

Figure 12: Wind speed graph for the year 2021 in the wilaya of Khenchela (El Hamma meteorological station)

For this year (2021) we notice that January is the month with the strongest wind with an average speed of 25 Km/h.

CHAPTER VI

MATERIALS AND METHODS

Characterization of study zone

VI.1. Presentation of the study zone

VI.1.1. Location

The limestone site for aggregates is located at Djebel Ghorfa town of Ensigha-Khenchela

-Nature of the substance: limestone for aggregates.

-Destination: building materials

- Surface of the deposit: 108ha.

- Legal nature of the land: State land (The environment directorate).

VI.1.2. Administrative location:

- Place : Djebel Ghorfa Municipality : Ensigha.

-Daira : ElHama.

- Wilaya : Khenchela (The environment directorate) .

Figure 13: Presentation of quarry zone.

VI.1.3. Location of the site

The site is located on the territory of the commune of ENSIGHA, 15 km south of the city of KHENCHELA. It is located at 01 km on the road RN N°88 connecting the city of KHENCHELA and AIN TOUILA (The environment directorate).

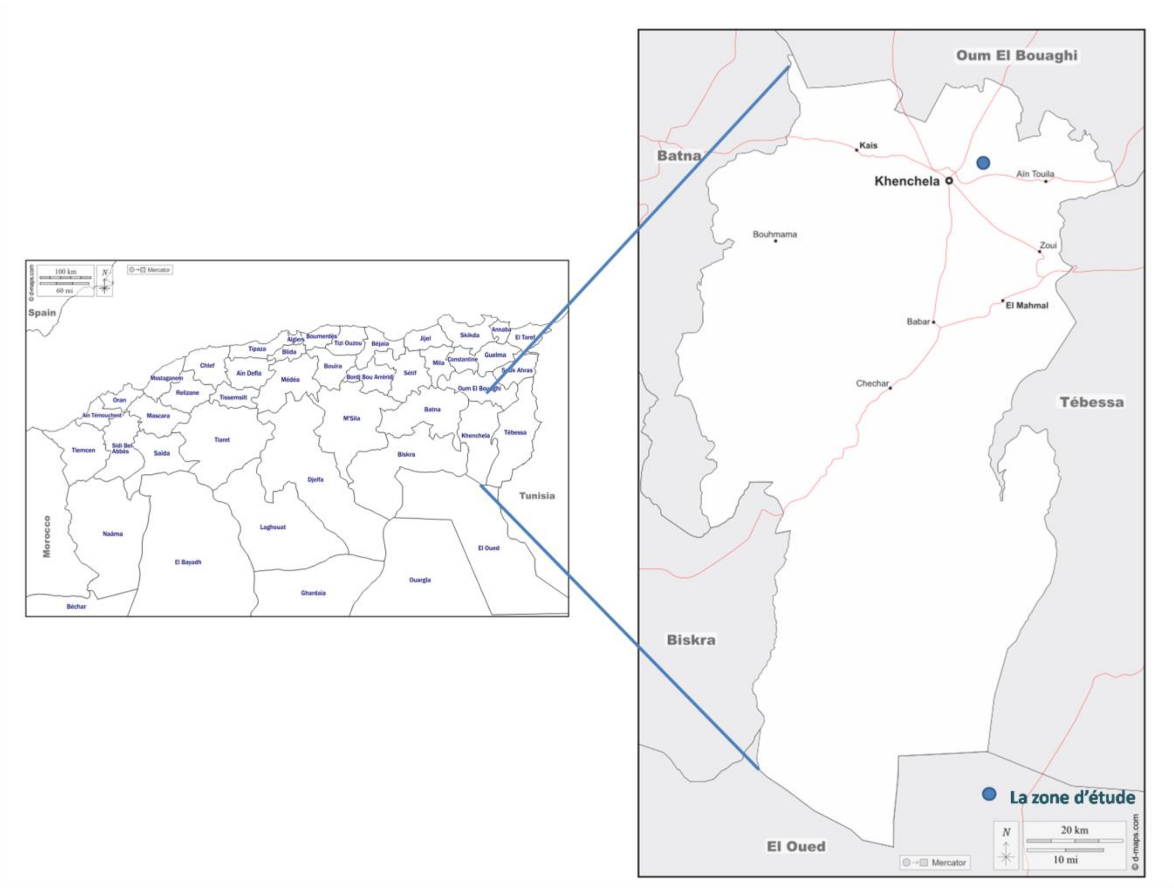

Figure 14: Location of the site quarry.

-Activity of the establishment: extraction of limestones by slaughter, of the quarry production and marketing of aggregates, by a station of crushing, grinding and screens. The production capacity is around 500000 tons and the service life of the operation is estimated at 10 years.

VI.1.4. Method of operation

The mine Ghorfa of production and marketing aggregates building materials and public works. Quarry is an exploitation to open sky projected in steps of 10 to 15 m of height in bats by levels, the extraction of limestone by blasting. The loading by hydraulic shovel on trucks 50 feeding chain of treatment (station of crushing, grinding and screen).

VI .1.5. Wind conditions in the study area

The study area is located in an area characterized by a total predominance of winds, dry and hot wind with drying effect, directed and channeled by the neighboring massifs, following the axis of the valley that is to say, from South-West and Northeast.

The winds of the region blow with speeds that vary between 28 and 29 m/s, in summer and in winter the average speed is 9 m/s.

VI.1.6. Air quality

The air in the vicinity of the deposit is not very polluted by dust emissions from quarries.

VI.1.7. Ecology

The study area where the quarry is located is not a protected area and is not protected.

VI.1.8. Socio-economic conditions

The activities of the municipality : The area is known mainly for its extractive and agricultural vocation.

- Urbanized areas : The site is located in a mining area. It is not urbanized.

- **Communication zones :** The communication network exists

-**Protected sites and monuments :** There are no protected sites or monuments in the area.

- Tourism : The activity of tourism is not practiced in the region.

-**Drinking water supply :** The site is not connected to any water supply (The environment directorate).

VI.1.9. The impact of the mining activity on the environment

The voids created by the exploitation in the ground, because of the existing constraints within the massif, can only be eliminated by backfill more or less for reclamation of the site (The environment directorate).

VI.1.10. Atmospheric pollution

The circulation of the machines generates atmospheric pollution by the release of exhaust gases such as carbon monoxide and dioxide and Sulphur oxides which are added to the dust in dry periods. The dilution of the pollutants in the atmosphere is quite fast since it is not a closed environment.

Concerning the raised dusts, this one can have an effect on the health of the exposed workers in the long term. Broncho-pneumopathies can be observed in individuals exposed to high levels of dust in a generally closed environment, which is the case of the considered farm.

Their effects on the green plants record deposits of dust on their tissues blocking the processes of photosynthesis from where the progressive death of the plant if there is no leaching of its fabrics (The environment directorate).

VI.1.11. Effects of operations on the environment

The degradation of the surrounding environment has become a major concern for all countries in the world. The impact study of various works, intervenes at this stage to make it possible to define beforehand the various nuisances which can be generated, and to prevent their effects.

Most environmental components can be affected by the activities related to a mining project. Indeed, even if the population is undoubtedly the first component affected, water, soil, air, vegetation, wildlife and landscape will be affected with more or less impact depending on the size of the site. It should be noted that the operation in question uses simple processes that do not use dangerous chemical products or additives or elements likely to generate emissions or releases that are very harmful to the environment or public health. Therefore, the impacts likely to be generated by the operation of this mine are as follows:

VI.1.11.1. Shooting nuisances

During a blasting operation, all the energy transmitted to the massif that is not used to fragment the rock is in the form of nuisance. It is important that the designer of a blasting plan should try to obtain the best possible efficiency in terms of both economy and environmental protection.

The main nuisances associated with blasting are

- ✓ Vibrations due to the elastic deformation of materials.
- ✓ Projections.
- ✓ Noise or acoustic energy.
- ✓ The projection of toxic residual gas.
- ✓ Dust.
- ✓ Physiological disturbances (The environment directorate).

VI.1.11.2. Dust emissions

Dust emission due to :

-The circulation of the machines for the loading of the ore and especially during discharge at the level of the station of crushing, in pus such as monoxide and dioxide.

-These machines release gases which generate atmospheric pollution.

-These gases react on the health of the workers by causing asphyxiation by the sites of fixation of the blood, one ignores by also the effect of these gases on the planes and vegetable Cover entraining the fall of the sheets, the blasting, and the mining installations and the circulation of the machines and the establishment of the sterile piles.

These dust emissions remain low (approximately 425 t/year) thanks to the fact that periodic monitoring (at least annually) of dust levels is necessary (The environment directorate).

VI.1.11.3. Effect of dust

The earth and its atmosphere constitute an almost perfectly closed system which is the common ecological niche for all living beings. Living beings are sensitive to all abnormal changes in the composition of the biosphere. A stronger increase leads to an increasing morbidity and mortality. Pollution by physical-chemical effluents leads to two categories of effects on the population.

Toxic effects which constitute, in the long term, a threat for the safety of the population (pulmonary diseases, bronchitis, asthma ....). The harmful effects which create in the individuals a feeling of discomfort, the effects of dust are multiple, namely (The environment directorate):

VI.1.11.4. Effect on health

Dust has a negative effect on the health of mine workers, the population in the vicinity of the mine, and even on the health of various animal species in the region.

- ✓ _Contaminated site: there is no contaminated site at the quarry level
- ✓ Occupational accidents: for the whole unit, there were notable occupational accidents in 2020
- ✓ Occupational illnesses: these are long-term occupational illnesses.

- ✓ Fire-fighting: the treatment plant is equipped with the necessary means of fire-fighting, in particular fire extinguishers and sand trays.
- ✓ Management of sanitary facilities: sanitary water is evacuated in the landfills, so there is no problem of There is no problem with the management of sanitary facilities (The environment directorate).

VI.1.12. Harmful gas for the underground

VI.1.12.1. Gas effect

The duration of the existence of harmful gases at the level of the fronts will depend on the quantity of explosives fired simultaneously and the speed of air circulation in the mining works.

The table below presents the average limit and exposure values of certain toxic gases by specialists :

Table 6: The average limit and exposure values of certain toxic gases (The environment directorate).

Gases	Ppm	Mg/m^3	Ppm	Mg/m^3
Carbon oxide (CO)	-	-	48	50
Carbon dioxide (CO_2)	4500	8500	-	-
Nitrogen monoxide (NO)	-	-	20	25
Nitrogen dioxide (NO_2)	3	6	-	-
Hydrogen sulfide (H_2S)	10	12	5	7
Sulphuric anhydride (SO_2)	5	10	2	5
Nitric acid (HNO_3)	4	10	2	5
Sulfuric acid (H_2SO_4)	-	3	-	1

The phenomenon of methemoglobinemia it is intoxication explains by incomplete combustion of carbon monoxide acts on the human body by causing asphyxiation through the sites of fixation of the blood.

The phenomenon of methaemoglobinaemia results in

- ➢ Drowsiness, which can lead to loss of consciousness.
- ➢ A general tiredness;
- ➢ -One for a long exposure can cause death.

The effect of hydrocarbon particles being partially similar to that of CO, a carcinogenic effect may be observed in individuals exposed to considerable doses over a long period of time. Sulfur oxides can cause serious damage to the tissues lining the respiratory tract, including damage to the bronchial tubes and alveoli, resulting in bloody sputum. In the long term, exposure to this type of pollutant can cause chronic respiratory diseases. The standards required for artificial ventilation in a mine are as follows Personnel : 20 L/sec per man :

- -Explosive pollution : 250 L/sec per square meter:
- -Pollution by diesel engine : 50 L/sec per HP,
- -The air speed must be between (0.25 to 0.50) m/s.

There are no flammable elements present and the unit is equipped with firefighting means. The exhaust gases released by the machines and vehicles in the tile of the unit are insignificant (The environment directorate).

VI.1.13. Assessment of the impact of the previous activity on the site environmental areas by atmospheric emissions

Environmental aspect	Situation in relation to the company	Result
Emission sources	During the operation of mechanical preparation the factor of dust emission is very present.	The emission source factor still persists, a watering project is in progress.
Treatment / disposal	The company does not have any dust collection station.	Treatment evacuation, still persists a project of watering is in progress.
Atmospheric discharges	There is no analysis of the discharge.	The factor rejections it is not controllable

VI.2. Assessment of dust quantities

VI.2.1. Principle

The emission of dust into the atmosphere is generally a discontinuous phenomenon in terms of flow. Depending on the size, granulometry and nature of the particles, as well as on the meteorological conditions (wind, temperature, humidity), the particles have a more or less long residence time and will be eliminated by two distinct atmospheric deposition processes:

- Dry deposition (by gravity, Brownian motion or by impaction and interception);
- Wet deposition (leaching during precipitation or trapping by cloud drops) (The environment directorate).

VI.2.2. Materials

VI.2.2.1. GPS

GPS stands for Global Positioning System and is a satellite-based positioning system. GPS was originally designed by the US Department of Defense and was later made available for civilian applications. The system is based on 24 satellites that revolve permanently around the earth in 6 different orbits.

It measures the propagation time of the waves and calculates the distance to the satellites, which enables it to determine its spatial positioning (longitude, latitude, altitude). Thus, thanks to the GPS system, you can know your position anywhere on the surface of the earth, at sea or in the air. GPS can also indicate the speed at which a person or object is moving at any given moment.

VI.2.2.2. Petri Dishes

Petri dishes are shallow cylindrical containers with fitted lids that are designed specifically for microbiology or cell culture use. Petri dishes are typically made of borosilicate glass or clear plastics (usually polystyrene or polycarbonate) and come in a variety of sizes. They can be disposable or reusable, with reusable types able to withstand repeated sterilization procedures (wet or dry).

VI.2.2.3. Adhesive tape: to fix the Petri dishes.

VI.2.2.4. Marker pen: To record the location of each sample on each Petri dish.

VI.2.2.5. Laboratory Scale

Analytical balances are highly sensitive instruments designed to measure mass accurately. Their reading has a range of 0,1 mg – 0,01 mg. Analytical balances have a draft shield or weighing chamber so that small samples are not affected by air currents.

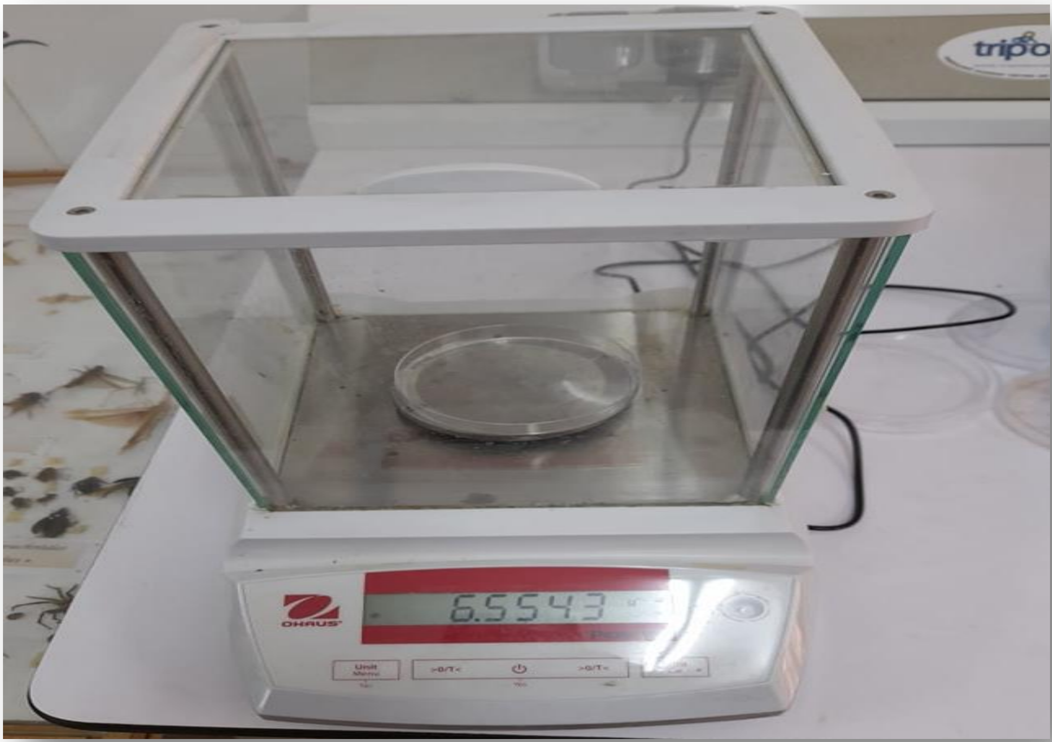

Figure 15: Analytical Scale.

VI.2.3. The choice of sampling stations

The sampling stations are chosen according to two factors: their distance from the quarry perimeter and the presence of dwellings:

- ✓ The station furthest from the quarry (100 m away) and next to the houses.
- ✓ The station that is moderately far from the quarry (50 m distance).
- ✓ The station closest to the quarry area (just near the quarry fence).

Figure 16: location of collection stations Dust collection.

Various techniques of passive dust collection have been developed: deposit gauges according to BERGERHOFF, OWEN gauges, DIEM plates, Liège Vaseline spheres... They allow a relative determination of the quantity of dust. By further processing of the samples, it is possible to determine their chemical composition. These passive techniques do not allow the separation of fine dust from sediment dust. Some of these techniques are still in use (e.g. various types of deposition gauges), while others (DIEM plates, Vaseline spheres) have been abandoned in favor of more specific measurements (Bullard, 2009).

In our case we used plastic Petri dishes which we fixed with adhesive tape to the branches of trees and rocks, as we avoided putting them directly on the ground so that the boxes would not be contaminated by the dust of the latter and then left them in the open air for 5 days.

Figure 17: Sample from station 2

Figure 18: Sample from station 1

Before collecting we weighed the empty Petri dishes and after 5 days we weighed them again and the difference is the amount of dust that fell out of the atmosphere.

Figure 19: Samples from station 3.

The emissions are the general term for the presence of pollutants in the ambient air. For gases and particles in suspension (aerosols), they are expressed in µg/m². For dust and sediment particles (diameter greater than 50-100 µm), the immissions are measured in mg/m² day, for example; we then speak more specifically of deposition (Martin and Mays, 1988).

CHAPTER VII

RESULS AND DISCUSSION

VII.1. Measuring the quantity of atmospheric dust that has fallen

The method of dust collection from the quarry unit calls for the collection of petri dishes 5 days after they are deposited, following the method of Bullard (2009).

Results are expressed as mg of dust per cm^2 for 5 days.

After collecting the Petri dishes from the quarry, we weighed them using an analytical balance. The weight of the empty dish was then reduced from the weight of the weighed dishes. The results obtained are presented in the following figure :

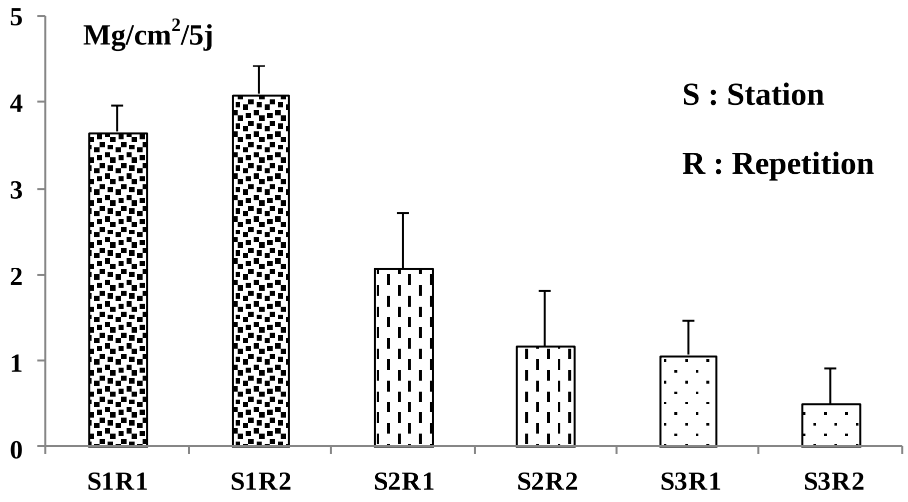

Figure 20 : Histogram of the amount (mg/cm^2) of atmospheric dust deposited in the vicinity of E-Nsigha quarry.

According to the graph, the area with the highest amount of dust is sampling station 01, which is the area closest to the quarry, with a mass of 4,10±0,31 mg/cm^2. The amount of dust decreases as you move away from the perimeter of the plant, where the displayed result is 2,07±0,63 mg/cm2 at Site 2 and 0,5±0,39 mg/cm2 at Site 3, considered the furthest from the quarry.

The areas surrounding this quarry may be contaminated by dust as these fine particles are easily blown by the wind and represent a serious problem for the inhabitants of these areas, not to mention the vegetation cover.

VII.2. The amount of dust per unit area (cm^2) for 5 days

In order to measure the amount of dust per unit of surface area, the surface area of the Petri dish used for collection must first be calculated.

- The surface area of the Petri dish:

  The diameter: d= 8.6 cm ⟶ $r = \frac{8.6}{2} = 4.3$ cm

  $S = \pi \cdot r^2 = 17.80\ cm^2$; which represents the average surface of the petri dish.

- Divide the mass of dust in each area over the surface of the box:
  - Station 01 : 69 / 17.80 = 3.87 mg/cm^2/5 days
  - Station02 : 35 / 17.80 = 1.96 mg/cm^2/5 days
  - Station 03 : 14/ 17.80 = 0.78 mg/cm^2/5 days

The mass of 3,89 mg/cm^2/5days is a quantity that can cause allergic reactions in the inhabitants of the region (Harry, 1978).

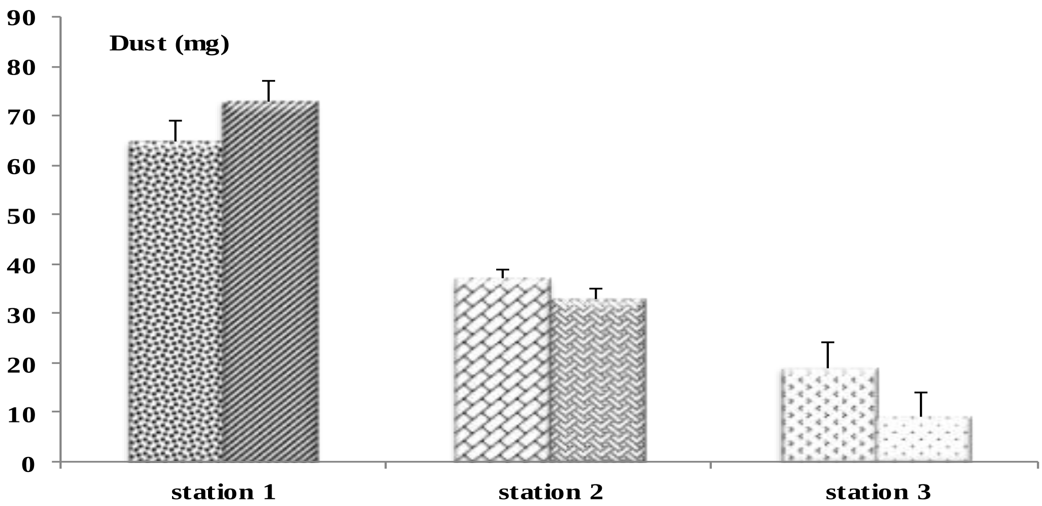

Figure 21 : Histogram of the amount (mg) of atmospheric dust deposited in the vicinity of E-Nsigha quarry.

The calculation of averages of each station in two repetitions gave results that agreed perfectly by making a simple comparison between the trends of the two graphs, whether the unit of quantification is in mg or in mg/cm^2 (Figure 20 and 21).

Note: after having questioned the inhabitants of the vicinity of the quarry, it was found that most of them have chest pains and testify that there are sometimes large quantities of dust emanating from the unit, which has pushed them to come forward to move the explosion zone away from their homes.

All this is confirmed by the "Air visual" application, as the day of the collection of the samples showed us that the air quality is poor figure 22 :

Figure 22: The quality of the area at the E-Nsigha quarry (Air visual application).

VII.3. The effect of dust on human health

The particles suspended in the inhaled air can in themselves be irritating, but frequently also, they fix many toxic products : sulfates, nitrates, hydrocarbons, heavy metals, etc. ; depending on their nature and the toxics they carry, they will be able to trigger a whole procession of pathogenic reactions affecting mainly the respiratory system of irritations, inflammations and allergic reactions.

Their site of action will depend on their size: if their diameter is greater than 10 µm (thousands of a millimeter), they are retained by the mucous membranes of the nasopharynx : when their size is between 5-10 µm, they generally remain in the large upper airways : trachea, bronchial tubes ; their pathogenicity increases when their diameter decreases and is less than 5 µm : in this case, they can penetrate into the pulmonary alveoli and disturb gases exchanges in the legs (Harry, 1978).

The maximum size of dust particles in the air of animal houses will be about 100 µm which have a settling velocity in still air of 30 cm/s, the mean particle size being about 10 µm with a still air settling velocity of 30 cm/min (Harry, 1978).

Recent epidemiological studies show a correlation between the air content of particles and the occurrence of bronchitis and asthma attacks. This mainly affects urban areas where there is more dust and where the dust load is more toxic (Martin and Mays, 1988)

VII.4. The effects of dust on meteorological phenomena

Aerosols are able to impact the climatic variability directly by scattering or absorbing solar radiation and indirectly by affecting droplet concentrations and therefore cloud formations. The presence of absorbing aerosol (e.g. dust, black carbon) can modify the atmospheric forcing from negative to positive, Knowing that our studies was carried out in summer.

However, Dust aerosols play a significant role to modify the Earth’s radiation budget and local meteorological conditions. The interaction between dust and short (long) wave radiation directly impact the radiation budget and can modify the microphysical and optical properties of clouds (Mukherjee et al., 2020).

Note: Originality of the work: The quantification of the atmospheric pollution is one of the most delicate fields to carry out, for that ; we would like to point out the difficulties met during the manipulations in natural environment. We would also like to point out that this work of estimation of the aerosols quantities in peri-urban zone was carried out for the first time in our faculty.

CONCLUSION

Conclusion

Today, air pollution is a very complex environmental problem on a local and global scale. Indeed, the quantification of the harms of air pollution is possible by woody species or by quantitative measurement of dust where air pollutants emitted from various sources, such as various industries as quarries ... etc. the monitoring of ambient air quality is therefore an extremely important field of study.

In our study, in terms of the amount of dust, we could see that the high levels of dust can be explained by an industrial activity carried out in the area and although they often use a sprinkler system but this does not prevent the dust from being transported by the wind, and this is what our study was able to show after samples were taken at several distances around the quarry for five days. In addition, dust can also be carried further by the wind.

The area with the highest amount of dust is sampling station 01, which is the area closest to the quarry, with a mass of 4,10±0,31 mg/cm^2. The amount of dust decreases as you move away from the perimeter of the plant. Note that khenchela has an arid climate in addition the average annual precipitation for 10 years is 31.73 mm.

Our study is only an initiative to evaluate the degree of pollution, other complementary studies on different levels and sectors are indispensable for the precise evaluation of the pollution but also to look for applicable, economic and permanent solutions.

Therefore, we propose some solutions that can minimize the air pollution in this quarry :

- Is to use the machines that have a sprinkler system linked to water just after the drilling (working in the same time).
- To save drinking water it is preferable to use wastewater treated.
- It is also important to cover the transport trucks that contain cement and that the speed is not fast during the transport, this can prevent the movement of particles by the wind.

The areas surrounding this quarry may be contaminated by dust as these fine particles are easily blown by the wind and represent a serious problem for the inhabitants of these areas, not to mention the vegetation cover.

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