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Research Article

Physicochemical Characterization of Gasoline and Analysis of the Vulnerability and Criticality of Atmospheric Pollutants in N'Djamena

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Abstract

In this work we made an analysis for the physicochemical characterization of gasoline sold on the roadsides of the city of N'Djamena. For our first experience on the storage of gasoline in cans exposed to the sun, we noticed the formation of lumps solid particles at the bottom of the cans. We then sampled a sample by district and subjected it to the analysis conditions. The analyses focused on Density at 15 ℃; ASTM distillation; Reid vapor pressure, Octane number; Determination of corrosion of copper blades as well as Determination of sulfur content. The results of the analyzed contraband gasolines are out of specifications under normal analysis conditions. Despite the many studies carried out on air pollution by particles, uncertainties remain. It is more or less complex to treat particulate pollution in urban areas, this is in fact due to the modifications resulting from different meteorological factors (wind, precipitation, etc.), topographical (slope, etc.) and urban morphological, which constitute limiting factors in the dispersion of these pollutants, thus, different maps have been studied according to the vulnerability and criticality of the accentuated situation relating to pollution throughout the city of N'Djamena. The results confirm the presence of particles that can affect human health. In addition to the presence of all the elements that we have been able to discover, there is on average the result of the presence of PM10 particles which is: 66.98016239 ug/m^3 well above the WHO guideline which recommends 50 $\mu g/m^3$/day as well as the daily average for PM2.5 which is: 56.83616723 ug/m^3 well above the WHO guideline which recommends 25 $\mu g/m^3$/day. The objective of this article is to clearly present the urgency of air pollution throughout the territory in order to take a binding decision on the current situation based on the proliferation and sale of petroleum products in the city of N'Djamena, particularly gasoline.

Keywords

Hydrocarbons, Refining, Smuggled Species, Analysis, Physico-chemical Characterization

1. Introduction

The city of N'Djamena is a Sahelian city par excellence with a semi-arid climate that suffers throughout the year from the torments of natural atmospheric conditions related to this type of climate. Wind, dust storms and heat waves follow one

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another, raising and suspending fine particles from the soil in the air throughout the year. With a nascent industry driven by the oil sector, seeing an increased proliferation of hydrocarbon service stations in the city of N'Djamena, The main anthropogenic sources of pollutants and emissions of atmospheric particles are breweries, cement plants, power plants, civil building construction sites driven by the city's economic growth, transport and many other small and medium-sized enterprises operating in the sector [1]. Among these pollutants are polycyclic aromatic hydrocarbons and fine particles of various sizes. Several scientific sources state that the level of pollution caused by fuel combustion is often higher in cities, thus, the main air pollutants associated with combustion or emissions are nitrogen oxides, sulfur oxides, particles, polycyclic aromatic hydrocarbons and volatile organic compounds that are released into the air. Once in the air, these components react to produce secondary pollutants such as ozone [2, 3]. It appears from the work of Haroun et al [2] that among the pollutants, there are polycyclic aromatic hydrocarbons and fine particles of various sizes. Air pollution due to fuel combustion is associated with an increase in human mortality, respiratory and cardiovascular diseases and cancer. The majority of these environmental toxicities are associated with the soluble aromatic fraction such as benzene, toluene, ethylbenzene, xylenes and naphthalenes, among the latter, there are elements that can have adverse effects on the nervous system. In addition to the impacts of spills, these substances pose a higher risk to humans because some of them are known or suspected carcinogens [2-5]. People who work in the development, distribution and transportation of petroleum products are the most exposed to volatile organic compounds that evaporate from oil and petroleum products in the case of our current study. [2-8]. Hydrocarbons are among the most widespread and environmentally hazardous pollutants [9-14].

As far as the presence of particulate matter is concerned, PM2.5 fine particles are mainly composed of carbonaceous species (elemental carbon and organic particles) emitted during incomplete combustion, as well as nitrates, ammonium and sulphates, which are produced by chemical reactions in the atmosphere. Most of them are the result of polluting activities (diesel engines, soot, chemical transformation of polluting gases, combustion waste). Indeed, carbon is a by-product of exhaust gases and factory fumes because any fireplace where combustion remains incomplete releases particulate carbon. Thus, PM2.5 is mainly made up of diesel particles. Diesel engines emit toxic nanoparticles with an average diameter of 0.1 µm, capable of reaching the pulmonary alveoli. Diesel gives off specific, visible pollution, black smoke and soot made up of carbon particles and impregnated with various substances, in particular hydrocarbons; other traffic-related particles, such as wear on the road, tyres, brake linings and clutches; sulphur particles. They are often secondary particles resulting from transformations of primary particles, such as sulphates, nitrates and sulphuric acid. The particles related to sulphur and nitrogen oxides are extremely hygroscopic, i.e. they have an affinity with water. They bind dangerous gaseous molecules and ensure the formation of haze [15-20].

Finally, it should be noted that one of the most dangerous components of PM2.5 for health is black carbon (BC). These carbon particles measure less than 1 micrometre, represent 30% of PM1 emissions and come from combustion engines (mainly diesel), residential wood combustion, power plants, the use of heavy fuel oil and coal. Unlike other particles, which have a wide variety of origins, black carbon is 100% primary and mainly linked to pollution from local road traffic. Microsoot is also defined, which measures from 0.05 to 0.1 micrometres and is emitted by the combustion of light fuel oil (diesel engines, domestic heating), petrol, kerosene and gas. They are essentially carbonaceous, but may contain sulphur if the fuel from which they are made contains it (light fuel oil, for example). They therefore penetrate very deep into the human body. Their lightness means that they contaminate the highest atmospheric layers and are therefore responsible for global pollution [21-23]. The impact of particulate matter can be seen on climate change (radiative forcing phenomenon) [24], changes in rainfall patterns, acidity of rainfall, pollution of soils, surface water or aquifers, reduced visibility and degradation of buildings [25]. Indeed, by influencing the radiation budget of the atmosphere (difference between incident and reflected solar radiation), particles play a role in global climate change [26].

2. Materials and Methods

The city of N'Djamena has 10 districts with a population of about 2,000,000 inhabitants. It stretches along the Chari River, 16 km long and 7 km wide. It is a hub, located on the border with Cameroon, at the tributary of the Logone and the Chari on its located in western Chad between longitudes 15˚02' and 15˚07' East and latitudes 12˚03' and 12˚10' North [27]. The map below gives us an overview of the different sample collection areas for our present work.

The Map shows the areas of sampling and/or sampling carried out for the evidence of this work.

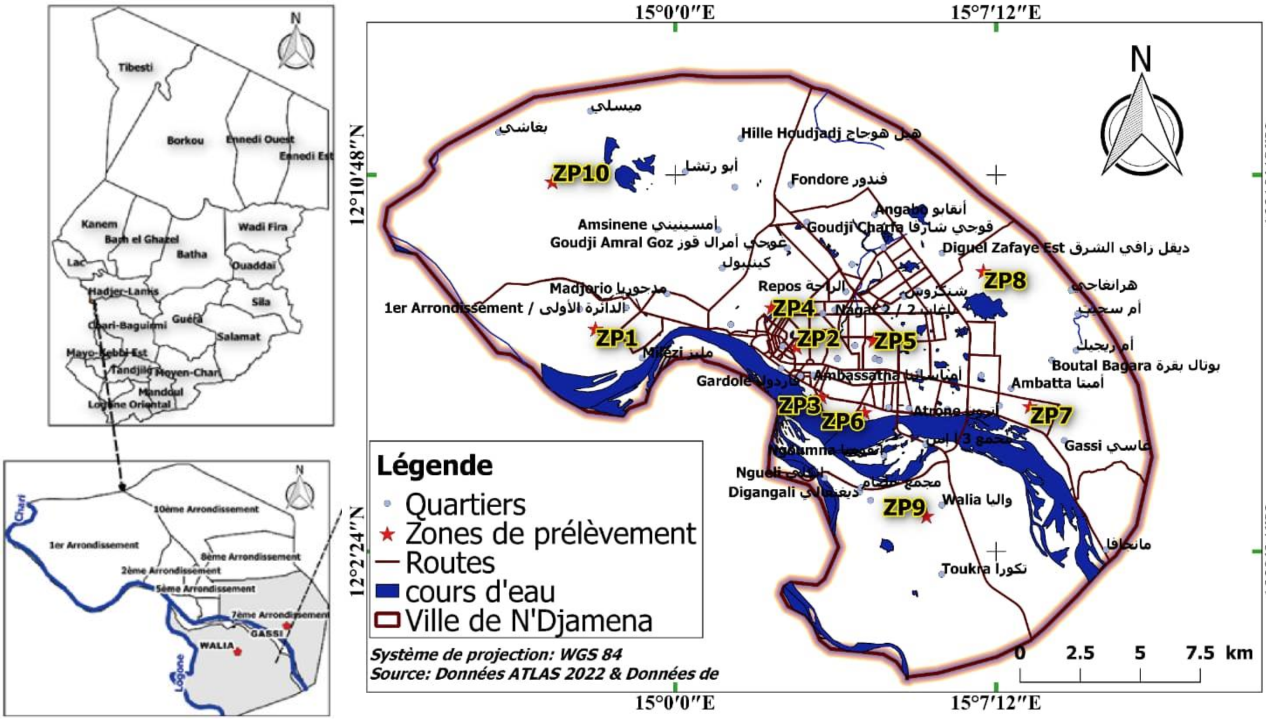

Figure 1. Location of study area. PAH quantification map by sampling site.

2.1. Physical Characterization Materials and Method

Equipment

The equipment used for physical analysis consists of reagents, solvents, glassware and analytical equipment used for characterization. The devices are, among others:

Density

DDM-2911 RUDOLPH RESEARCH ANALYTICAL brand automatic density meter, consisting of oscillating sample tube, electronic excitation system, frequency counting and display;

Bath running at a constant temperature within the desired range;

Outer capillary tube made of TFE-fluorocarbon with a tip adapted to the opening of the oscillating tube;

Flow or pressure adapter used as an alternative means of introducing the sample into the density meter by pump or vacuum;

Thermometer calibrated and graduated to 0.1 ℃ and a thermometer holder attached to the instrument to set and observe the test temperature;

Bottle to contain the sample to be analyzed.

Distillation

ASTM D86 distillation apparatus of JSR 1009BA brand incorporated with a condenser and a heating device;

a. Distillation flask;
b. Thermometer;
c. 100 mL graduated test tube.

Reid Vapour Pressure

TVR tester apparatus of brand JH0 103 13;

a. Fuel chamber with a volume of 140 cm^3;
b. Inner tube with a volume of approximately 550 cm^3;
c. Connection device for air and fuel chambers.

2.2. Physical Characterization Methods

The quality of the smuggled species was determined on the basis of the following physical parameters:

a. Density at 15 ℃ measured using a DDM-2911 RUDOLPH RESEARCH ANALYTICAL automatic density meter;
b. ASTM distillation determined by JSR 1009BA brand distiller;
c. Reid Vapour Pressure measured using a JH0 103 13 brand TVR tester;

2.2.1. Determination of Density at 15 ℃

According to ISO 12185, equivalent to the American ASTM D4052 document, a small volume (about 0.7 mL) of the liquid sample is introduced into an oscillating sample tube and the change in oscillation frequency caused by the change in tube mass is used in conjunction with the calibration data to determine the density of the sample [28].

Procedure:-Turn on and configure the automatic density meter according to the manufacturer's instructions;

a. Wait until the bath temperature is stable at 20 ℃;
b. Immerse the outer TFE-fluorocarbon capillary tube in the vial containing the sample. Sample aspiration is automatic;

c. Once the capillary tube is properly filled, introduce it into the oscillating sample tube;
d. The instrument displays a stable four-digit density reading in g/mL at 20 and 15 ℃;

Record the density value at 15 ℃ and convert it to kg/m^3

2.2.2. Determination of ASTM Distillation

a. According to NA 1445, equivalent to ASTM D86, a 100 mL test portion is distilled under prescribed conditions appropriate to the nature of the product [29].
b. Procedure: The distillation of the gasoline is carried out in the following steps:
c. Cool the gasoline sample to a temperature between 13 and 18 ℃;
d. Turn on the distiller and set the temperature of the condensation bath to 0 ℃;
e. Attach the flask (containing 100 mL of product to be analyzed) equipped with a thermometer mounted at the neck in the distiller;
f. Place a recovery specimen under the lower end of the condenser tube;
g. Start heating so that the first drop of the distillate falls in between 5 and 10 minutes;
h. Set the distillation speed between 4 and 5 mL/min;
i. Successively note the temperatures that correspond to the initial point (PI), 10%, 50% and 90% of the distilled volume as well as the final point (PF);

The sum of the total condensed volume plus the residue equals the total recovery. And the loss that is related to the volatility of the sampling is deducted from 100 mL and from the total recovery:

$$\% V (distillate) + \% V (residue) + \% V (losses) = 100\%$$

2.2.3. Determination of the Reid Vapour Pressure

According to ASTM D323, fill the fuel chamber of the equipment with the specimen previously cooled and connected to the inner tube. The device is immersed in a bath at a constant temperature of 37.8 + 0.1 ℃ and is shaken until a constant pressure is observed [30].

Procedure: Cool the sample and fuel chamber to 0 – 1 ℃;

a. Fill the fuel chamber with the sample until overflowing;
b. Couple with the inner tube as quickly as possible, then shake and turn upside down and place the chambers in the thermostatic bath (at 37.8 ℃) of the TVR test device;
c. After stabilization, note the value in KPa.

2.3. Materials and Method for the Chemical Characterization of Gasoline

Equipment

The equipment used for chemical analyses consists of reagents (2-2-4-trimethylpentane (isooctane), n-heptane), solvents, glassware and analytical equipment used for characterization. Among the devices, we have:

1) Koehler-K88620 portable octane analyzer
2) Apparatus of the Sindie XOS brand sulfur analyzer having:
   a. Sample Cup or Sample Cell
   b. X-ray transparent film
3) Copper plate corrosion measuring apparatus brand JSR2101; having:

Copper plate corrosion measuring apparatus brand JSR2101; having: -Copper blade; -Blade holder; -Bomb; -Test tube; -Water thermostat bath; Thermometer;

Polishing agent

Chemical Characterization Methods

The chemical parameters studied are:

a. Octane rating measured using a handheld device K88600XL Koehler Instrument Company, INC.;
b. The sulfur content determined by a Sindie XOS X-ray tester;
c. Copper plate corrosion determined using a JSR2101 brand copper plate corrosion meter [31].

2.3.1. Determination of the Octane Number

According to ASTM D2699, D2700: Two standard methods are used to measure the octane number of a fuel. These are the Research RON method (ASTM D 2699) and the Motor MON method (ASTM D2700) [32];

Procedure: - Turn on the Octane Rating device;

a. Calibrate the device according to the manufacturer's instructions;
b. Pour the sample into the appropriate test vial to the fill line marked on the vial;
c. Place the vial in the sample tube of the device;
d. Close the lid and press "play";
e. Read the value of RON and MON printed directly by the device.

2.3.2. Determination of the Sulphur Content

According to ASTM D4294, the sample is placed in beams emitted from an X-ray source, the excitation energy must be derived from a radioactive source or an X-ray tube. After scanning the X-ray beam, the sulfur content result will be displayed automatically on the device's display [33].

Procedure: Turn on the device, wait until the temperature is stabilized at 40 ℃;

a. Pour 6 mL of sample into the sample cup;
b. Place the transparent film on top of the sample cup;
c. Open the lid/drawer of the appliance, insert the sample cup into the appliance and close the lid/drawer;
d. Press the "Play" button;
e. After scanning the X-ray beam, the result of the sulfur content in ppm will be displayed automatically on the device's display;
f. Write down and convert the result to % mass and round it to three significant digits.

2.3.3. Determination of Copper Plate Corrosion

According to the NA 566 standard equivalent to ASTM D130, the principle is based on the immersion of a copper plate in a sample taken contained in a test tube; the tube is put in a bomb; the bomb in turn is immersed in a bath and heated to 50 °C for 3 hours. At the end of the test, the slide is removed, rinsed and the color is compared to the corrosion standards [34].

Procedure: Turn on the corrosion device and wait until the bath temperature is stable at 50 °C.

Place a 40 mL test portion of completely clear gasoline free of suspended water into a perfectly clean, dry test tube and slide a copper slide into it within one minute of final polishing using sandpaper.

Place the tube in the can and then in the bath; After 3 hours ± 5 minutes, remove the slide, rinse, dry and compare the color of the copper strip to the graduated color scale on the series of corrosion reference slides and note the number corresponding to the corrosiveness of the sample according to ASTM standards from 1a to 4c.

3. Results and Discussions

3.1. Results and Discussions of Physical Analyses

The average physical character test results for contraband species are given below.

3.1.1. Density at 15 °C

The d415 obtained for the average representative samples of contraband species are grouped in the following table:

Table 1. The d415 obtained by the different sampling tests.

Characterization	Density at 15 °C	Unit	Methods
Samples	Petrol Contraband		
E1	644.2		
E2	643.6	Kg/m^3	ASTM D4052
E3	646.3		
E4	644.4		
E5	638.9		
Specification	Min	715	
	Max	780	

From Table 1, it can be seen that the densities at 15 °C obtained by the various tests belong to the range [715; 780] set for the specification of super 90 petrol, so it can be inferred that the contraband species analysed do not conform from the point of view of density. However, too high a density of gasoline leads to low engine power and the opposite will lead to an increase in consumption and, in addition, poor vaporization which can reduce power and clog the engine.

3.1.2. ASTM Distillation of Pooled Samples

The boiling temperatures obtained as a function of the volumes of distillates collected are noted in the following table:

Table 2. Boiling Temperatures of Distilled Fractions from Different Sampling Tests.

Characterization	Les T_{eb} Petrol Contraband					Specification	Methods
	E1	E2	E3	E4	E5		
T10%	69.5	67	70	71	70.6	70 max	
T50%	118	119.9	122	121	123	120 max	
T90%	191	197	189	191	190	190 max	ASTM D86
PF	208	252	203	209	204	205 max	
Residue	1.9	2.9	2.7	2.6	2.2	2.0 max	
Unit	°C						

Nomenclature: T10%: Temperature 10% distilled T50%: Temperature 50% distilled
T90%: 90% Distilled Temperature PF: End Point

Good quality gasoline must evaporate regularly over its entire boiling curve, while remaining within the volatility limits so as not to disturb the proper functioning of the engine. Based on the results obtained, we can define some important points that are directly related to the operation of the engine, which are:

a. The TEB obtained by the 10% point are compliant within the required limit. They then reveal that they have a minimum content of light fractions with sufficient vaporization to ensure the cold start of the engine. However, if the TEB of the 10% point is too low, the engine will have difficulty starting and will take a long time to warm up. On the other hand, if they are too high, the gasoline will evaporate sufficiently, and the engine may stall or misfire in hot weather;
b. The TEB of the 50% point is slightly above the required standards. They ensure that the petrol is correctly volatile when the engine is restarted, which allows maximum power to be extracted;
c. The TEB of the 90% points and the PF are not compliant, since they are above the set limit (190 ℃ and 205 ℃). The Residue R of these species has reached the maximum limit (2% by volume), which confirms a significant presence of heavy fractions in these species.

3.1.3. Reid Vapour Pressure

The RVc obtained for the different samples of contraband species are grouped in the table below:

***Table 3**. The RVCs obtained by the different sampling tests.*

Characterization	TVR	Unit	Methods
Samples	Petrol contraband		
E1	74.18		
E2	74.53	KPa	ASTM D323
E3	75.75		
E4	73.08		
E5	74.2		
Specification	Min	-	
	Max	74	

The TVR directly determines losses during storage and handling. Its specifications impose a maximum of 74 Kpa not to be exceeded. It can be seen that the values of the TVR obtained are higher than the maximum limit set by the standard. This shows us that these species are not compliant from a TVR point of view. However, it is necessary to limit volatility during hot operation in order to avoid certain incidents such as loss of driving pleasure or stalling due to the formation of steam buffers in the fuel system and difficulty starting after a period of shutdown.

3.2. Results and Discussions of Gasoline Chemical Analysis

3.2.1. The RON

The averages of the RONs obtained for the different sampling tests are grouped in the table below:

***Table 4**. The RONs obtained by the different sampling tests.*

Characterization	Research Octane Number: RON	Unit	Methods
Samples	Petrol Contraband		
E1	87.4		
E2	87.8	-	ASTM D2699
E3	89.3		
E4	87.4		
E5	86.9		
Specification	Min	90	
	Max	-	

Table 4 shows that the octane ratings of contraband gasoline are non-compliant as they are below the minimum value required by the premium 90 gasoline standard. However, the use of gasoline with too low octane in an engine may spontaneously ignite due to compression in the cylinder.

3.2.2. Sulphur Content

The averages of the sulphur results obtained for the various sampling tests are grouped in the following table:

***Table 5**. Sulphur contents obtained by the various sampling tests.*

Characterization	Sulphur content	Unit	Methods
Samples	Petrol Contraband		
E1	0.049071		
E2	0.048665	% m/m	ASTM D4294
E3	0.049065		
E4	0.047446		
E5	0.048964		
Specification	Min	-	
	Max	0.05	

Table 5 shows that the total sulphur levels in contraband species are unsatisfactory as they have almost reached the maximum limit required by the super 90 standard. However, a high sulphur content has a significant impact on people, the environment and machinery. For men, respiratory and cardiovascular diseases. For the environment, formation of acid rain, destruction of the ozone layer, etc. For the engine, sulfur can cause wear and corrosion of the engine.

3.2.3. Copper Plate Corrosion

The averages of the corrosion results obtained for the various tests of contraband species are shown in the following table:

Table 6. *Copper plate corrosion results obtained by the various sampling tests.*

Characterization	Copper Plate Corrosion	Unit	Methods
Samples	Petrol Contraband		
E1	1b		
E2	1b	Cotation	ASTM D130
E3	1b		
E4	1b		
E5	1b		
Specification	Min	-	
	Max	1b	

From Table 6, it can be seen that the results obtained by the copper plate test limited by (< 1b) are not in accordance with the standards. They indicate that the presence of sulphur compounds in these species is corrosive. The presence of sulphur, which is organically combined, is transformed into sulphur dioxide, which, in the presence of water vapour, forms a particularly corrosive dilute sulphuric acid. [35].

Sulphur compounds in petroleum products are the main culprits of air pollution and corrosion problems caused by petroleum products, including street gasoline in this case [2].

The results obtained show that the combustion of sulphur contained in fuels leads to the formation of gaseous sulphur oxide SO_2. Studies show that the generation of SO_2 by this combustion process generates around 60 million tonnes of SO_2 per year worldwide. This SO_2 is a major contributor to urban pollution and acid rain. Nitrogen oxides in fuels contribute to sulphur oxide emissions and increase the production of particulate matter by engines, thus hindering the removal of nitrogen oxides from exhausts. The sulfur is then transformed during combustion into SO_2 and SO_3 to become a very corrosive acid that is sulfuric acid [2].

In our work, copper being particularly sensitive to the presence of corrosive compounds, we used a copper plate corrosion test. Depending on the quality of the sample, each result was different. We were therefore able to observe that species with a more volatile characteristic had a different colour from heavier species.

3.3. Analysis of the Degree of Particle Propagation in the City of N'Djamena

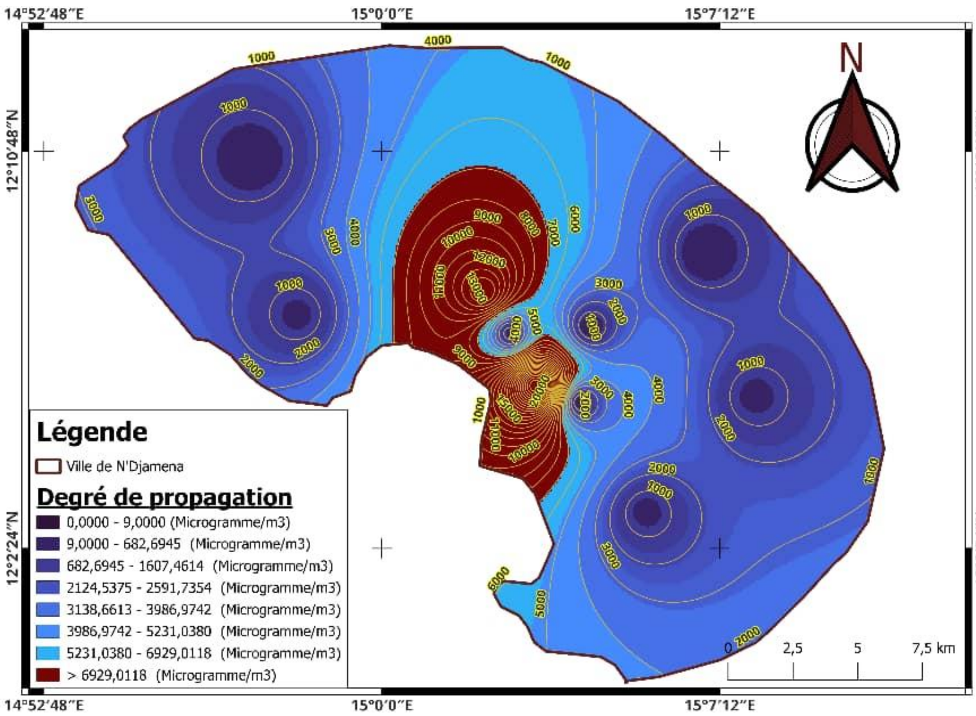

Figure 2. *Map of the analysis of the degree of particle propagation in the city of N'Djamena.*

The city of N'Djamena, as highlighted above, stretches along the Chari River, 16 km long and 7 km wide. Reading the map below allows us to see the degree of propagation of fine particles per microgram/m^3. As a result, we can see that pollution by fine particles concerns the entire city and it is in the order of 9.0000 to more than 6929, 0118. Recent studies by Haroun et al (2021) and Haroun et al (2020) [2, 36] confirm these results in the city of N'Djamena. Pollution is much more concentrated in one area, especially the administrative area that attracts the highest concentration of companies and companies in the city.

3.3.1. Analysis of the Presence of Hap and Fine Particulate Particles in the City of N'Djamena

The analysis of the presence of polycyclic aromatic hydrocarbons as well as the presence of fine particles is shown on the map below. Later results were found by the studies [2, 36] According to the physico-chemical analyses carried out on samples of smuggled species taken in various districts of the city of N'Djamena, the presence of particles that can be identified as a factor in the constituent elements of polycyclic aromatic hydrocarbons was identified in the results.

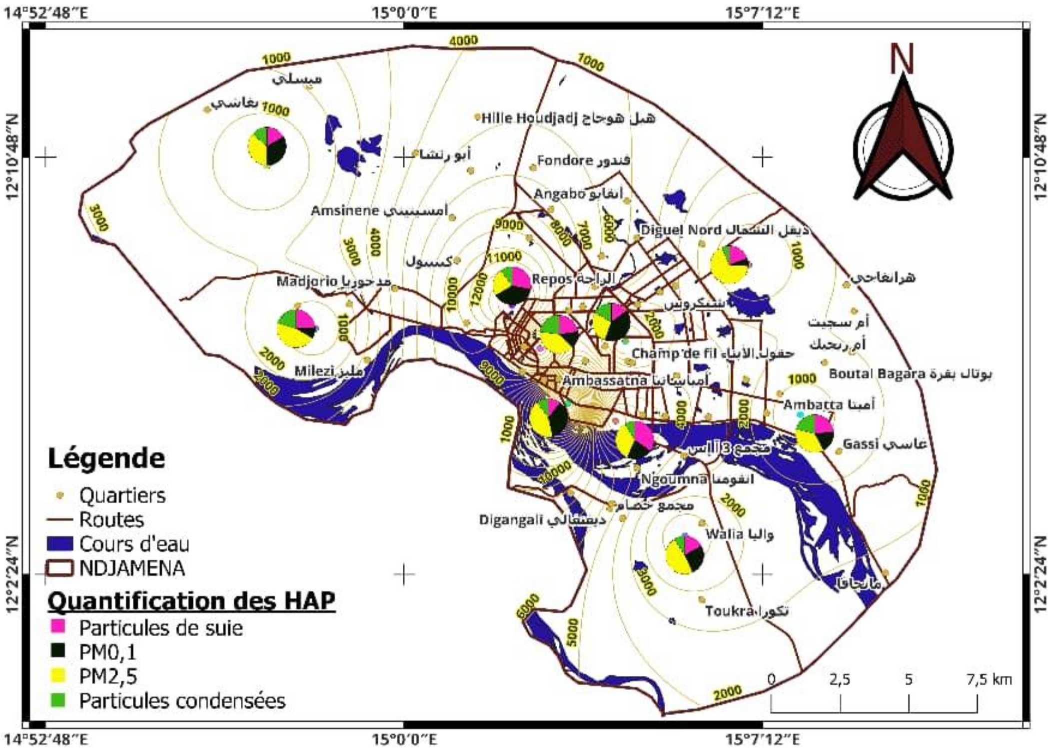

Figure 3. Map of the presence of fine particles and PAHs in the city of N'Djamena [2].

3.3.2. Analysis of the Results of Purple-air Sensors in the City of N'Djamena

Exposure to all these particles above a certain threshold is dangerous to human health. The sensor data gives us the following characteristics

a. 0-50: Air quality is considered satisfactory and air pollution poses little or no risk.
b. 51-100: air quality is acceptable; However, if they are exposed for 24 hours, there may be a moderate health problem for a very small number of people who are unusually sensitive to air pollution.
c. 101-150: Members of sensitive groups may experience health effects if exposed for 24 hours. The general public will probably not be affected.
d. 151-200: Anyone can start experiencing health effects if exposed for 24 hours; Members of sensitive groups may experience more severe health effects.
e. 201-300: Health alert: Anyone can experience more serious health effects if exposed for 24 hours.
f. 301-400: Health warnings of emergency conditions if exposed for 24 hours. The entire population is more likely to be affected.
g. 401: Health warnings of emergency conditions if exposed for 24 hours. The entire population is more likely to be affected.
h. The results obtained in relation to the presence of particles in the city of N'Djamena are represented by the figure below [2, 40].

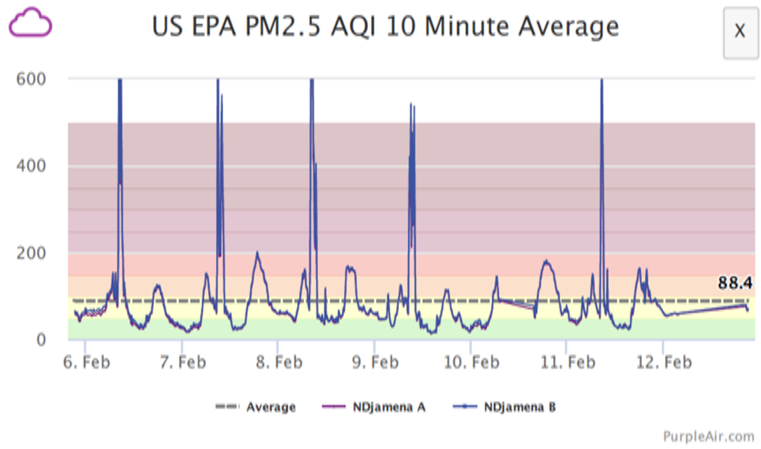

Figure 4. *Presence of particles PM2.5 observed every 10 minutes over a period of one week [2].*

The figures (Figure 4, and Figure 5) give us the averages of two chambers = 56.83616723 ug/m^3, so the daily average for PM2.5 is: 56.83616723 ug/m^3 well above the WHO guideline, the recommended one of 25 µg/m^3/day [37].

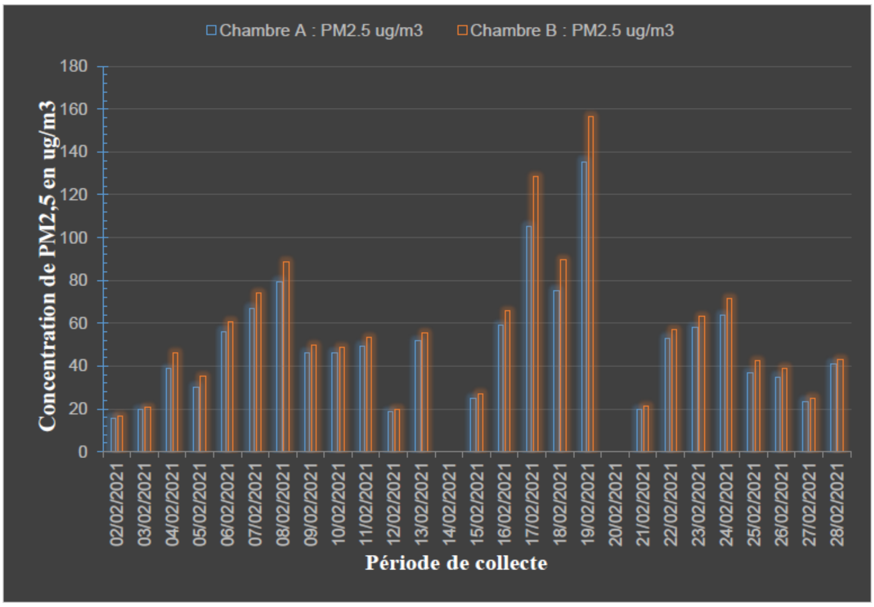

Figure 5. *Daily trend of PM2.5 particulate matter concentration.*

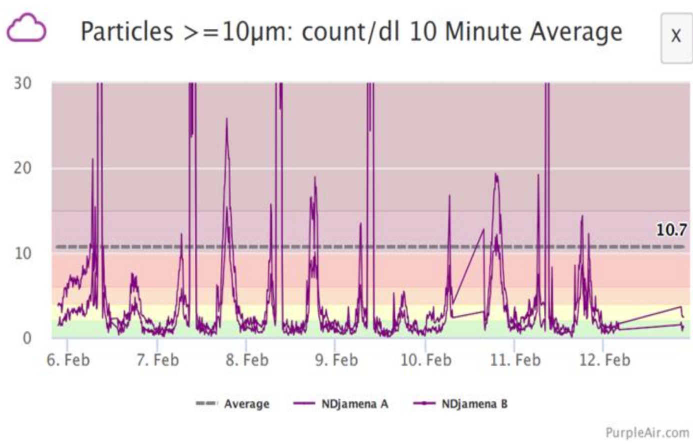

Figure 6. *Presence of particles > =10 µm observed every 10 minutes over a period of one week [2].*

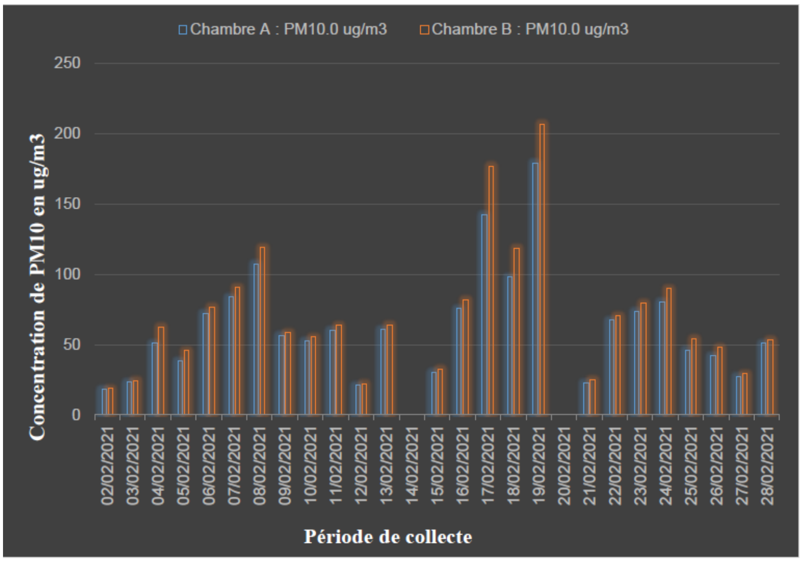

Figure 7. *Daily trend in PM10 particulate matter concentration.*

The figures (Figure 6, and Figure 7) give us the averages of two chambers = 66.98016239 ug/m^3, so the daily average for PM10 is: 66.98016239 ug/m^3 well above the WHO guideline of 50 µg/m^3/day. [38]

Table 7. *The daily average for measured PM2.5 and PM10 ug/m^3.*

Particulate Matter	City of N'Djamena	WHO recom-mendation
Daily average for measured PM2.5	56.84 µg /m^3	25 µg/m^3/jour.
Daily average for measured PM10	66.98 µg /m^3	50 µg/m^3/jour

3.3.3. Analysis of the Prospective Criticality in Terms of Pollution in the City of N'Djamena by 2030

According to our analyses, based on the results obtained and the trend of activities in the field [39, 40], if nothing is done to regulate the effect of pollution propagation in the city of N'Djamena, there is a risk that by 2030 there will be a trend of criticality in most of the city's districts, from an average situation to a very extreme situation. The map below shows us the extent of the critical pollution situation by 2030.

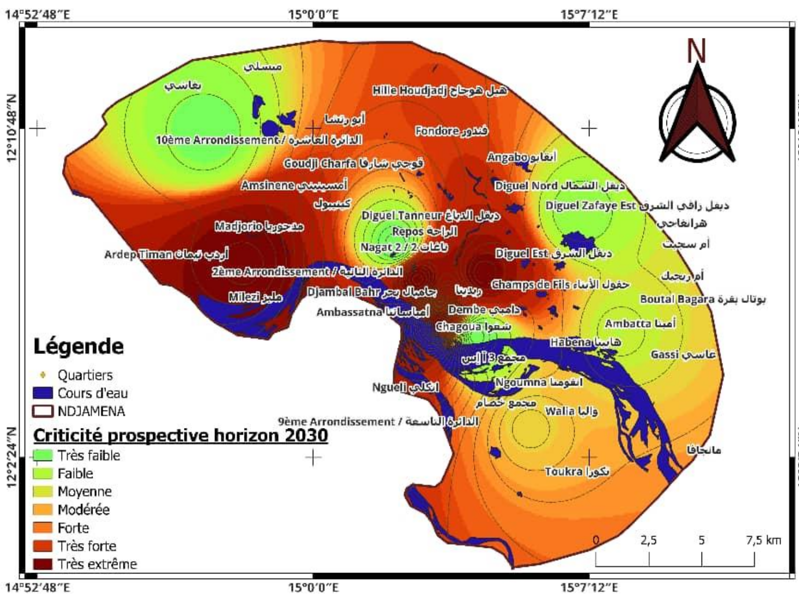

Figure 8. *Prospective criticality analysis map to 2030 in the city of N'Djamena.*

3.3.4. Analysis of the Prospective Vulnerability in Terms of Pollution in the City of N'Djamena by 2030

A projection has been made on vulnerability based on the low to hyper high trend, we also notice, as in the case of the criticality analysis, that there is an urgency throughout the territory if the restrictive responses of the current situation are not taken seriously. The map roughly describes the critical situation of an accentuated vulnerability throughout the city of N'Djamena [41].

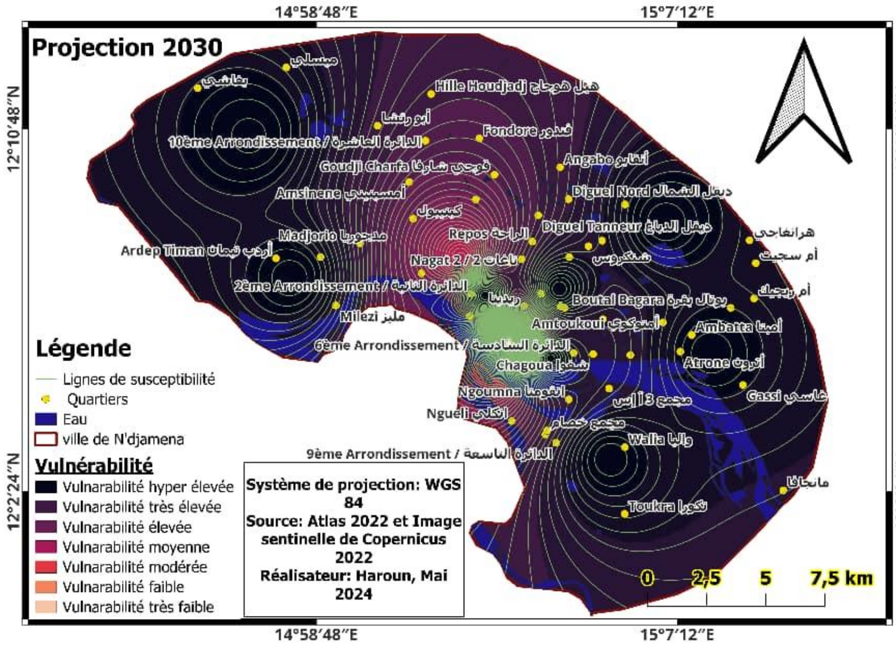

Figure 9. Vulnerability analysis map on a projection to 2030 in the city of N'Djamena.

4. Conclusions

The objective of this work is to evaluate and characterize the hydrocarbon street gasoline that does not comply with the standards. We first carried out two types of analysis: physical and chemical according to the parameters of on the density at 15 ℃; ASTM distillation; the Reid vapour pressure, the octane number; the determination of the copper plate corrosion as well as the determination of the sulphur content. The results of each analysis are out of the norm compared to good quality species. We note that the smuggled gasoline analyzed has negative results, unlike the other types of gasoline sold at the pump (some service stations) in terms of:

a. ASTM distillation, the T ɵb of the 90% points, FP and the residue are in excess of the control limits; this confirms the significant presence of heavy fractions in smuggled species; which does not meet any standard.
b. Octane, contraband gasoline has a low octane rating, below the minimum limit required by the standard for super 90 gasoline.
c. Total sulphur, smuggled species are sulphurous since they have almost reached or even exceeded the maximum limit required by the standard.
d. Corrosion, the smuggled species analysed have reached the maximum limit required by the standard in terms of corrosion [42]. We also found traces of water and unidentified solid debris at the bottom of most of our contraband samples.

However, we can say that the results of the smuggled gasoline analyzed are out of specification under normal analytical conditions and therefore do not comply with the standards in force used for standardized hydrocarbon testing in Chad [2].

The second step was to measure air quality with a Purple Air sensor taking into account the sampling areas in all (10) ten districts of the city of N'Djamena [2]. Several maps of the city have been studied for this purpose on the presence of particles, and polycyclic aromatic hydrocarbons. We then sought to make a long-term projection to 2030. The responses obtained were based on criticality and vulnerability as well as the presence of particles and haps. The results confirm the presence of particles that can affect human health. In addition to the presence of all the elements that we have been able to discover, there is on average the result of the presence of PM10 particles which is: 66.98016239 ug/m^3 well above the WHO guideline which recommends 50 µg/m^3/day as well as the daily average for

PM2.5 which is: 56.83616723 ug/m^3 well above the WHO guideline which recommends 25 µg/m^3/day [38-43]. The trend in terms of vulnerability and long-term criticality, if nothing is done, is extreme and therefore requires serious consideration by those responsible for the environmental issue in Chad.

Abbreviations

PAHs	Polycyclic Aromatic Hydrocarbons
POPs	Persistent Organic Pollutants
TVR	Reid Vapour Pressure
WHO	World Health Organization

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Author Contributions

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Ndiassé Fall: Visualization

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Conflicts of Interest

The authors declare no conflicts of interest.

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