

The Impact of Industrial Zones on the Environment: The Case of the “Naftal” Establishment Constantine

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Abstract

The establishment classified “Naftal” has experienced several industrial accidents in Algeria, therefore, we had to study it at the level of Constantine in order to locate the vulnerable areas, to develop a document to assist in the decision, and reduce the consequences of industrial risks to a level deemed tolerable.

Key words: Classified establishment, Constantine, vulnerability, industrial accident, risk.

INTRODUCTION

After Algeria’s independence in the period between 1967 and 1977, the state focused on economic growth and neglected the demand for housing resulting from rapid population growth; the housing sector was considered by the state as a capital consuming sector and it created 120 industrial zones in 1990. (Nedjai, 2013, p. 37)

The emphasis on economic growth as well as the diversification and rapid development of industry has only led to the neglect of the industrial risk on humans and the environment.

We mention a series of industrial accidents at the establishment of Naftal including the gas explosion of January 19, 2004, which caused 23 deaths and 74 injured, in addition to the explosion of the LPG pipeline in 2018 which also caused the death of two people and more than 40 injured, after the repeated accidents of Naftal on the one hand and its economic importance, on the other hand, it must study the establishment which is located at the level of Constantine and its impact on man and the environment:

- What are the sources of danger at the “Naftal” establishment?
- What is the impact of the products stored in the «Naftal» establishment on the environment?
- The impact of the Naftal establishment on the human and environmental level in case of a major accident?

As for the methodology used in this study, it is the descriptive analytical method; where we collected basic data, and they were analyzed and applied on the field with the help of ArcGIS; in order to obtain results of the field which allow us to use them in the decision-making by the institutions and organizations in charge of the management of industrial risks.

CLARIFICATION OF CONCEPTS RELATED TO INDUSTRIAL RISKS ON THE ENVIRONMENT

The risk is a possibility, and the consequences can be variable according to the environment associated with the sources of danger. This can be formulated as $r = a \cdot v$ where r is the risk, a (as a hazard) is the probability of occurrence of an event that can lead to certain damage (or effects) in a given area, and v is the potential consequences, taking into account the geographical characteristics of the area surrounding the hazardous installations. The probability/consequence pair appears central in the apprehension of risks and their spatial differentiation (Zimmermann, 2002, p. 17)

Although the classified establishment is the whole of the area of establishment comprising one or more classified installations and which falls under the responsibility of a natural person or legal entity, public or private, which holds, exploits or causes to be exploited the establishment and the classified installations which fall under it (Official Journal, 2006, p. 9)

Industrial risk is defined as an accidental event occurring on an industrial site involving dangerous products and/or processes and leading to immediate serious consequences for personnel, residents, property, and the environment.

To limit the occurrence and consequences of such an event, the most dangerous establishments are subject to special regulations (classification of facilities) and regular inspections. Nevertheless, just because a site is not classified does not mean that it does not present a hazard (INRS, 2014).

PRESENTATION OF THE WILAYA OF CONSTANTINE

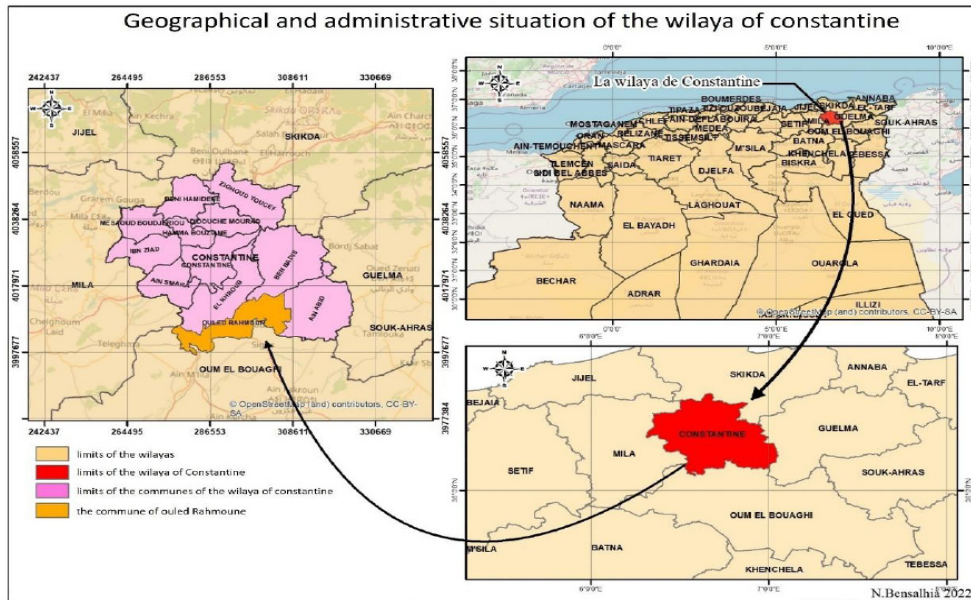
The Wilaya of Constantine is located in the northeast of Algeria, it is considered the capital of the East and it is 431km from Algiers, 235 km from Biskra, 89 km from Skikda, as well as 245km from the Algerian-Tunisian borders (Rahamniya, 2016); it occupies an area of 2,187 Kilometers (The Wilaya of Constantine, 2020)

The wilaya of Constantine is composed of twelve communes organized in 6 Daïras and it includes a multiform dispersion of the population, of which 6 communes are classified as urban and two others as rural, and the remaining three are mixed with an urban part, and another rural; The population estimated in 2020 at about 1.3 million inhabitants, its majority live in two communes (40% in Constantine and 30% in El Khroub), but the rest which represents 30% of the population is distributed on the territory of 10 communes.

Thus, the two majority communes in quality of population (Constantine, el khroub) are known a great popular density with 2247, 1565 hab/km² successively, also in this direction the commune of HammaBouzianeis known to a high density with 1556 hab/km². On the other hand, the average size of households is evaluated at 5 persons per family (La Wilaya de Constantine, 2020)

Our case study is located in the commune of OuledRahmoune, which is one of the communes of the Wilaya of Constantine with an area of 209.95 Km² (La Wilaya de Constantine, 2020) bounded by:

- In the North by the commune of El Kroub
- In the West by the commune of OuledHamlwilaya of Oum El Bouaghi
- In the South by the AinMlila and OuledGacemwilaya of Oum El Bouaghi
- In the East by the town of Ain Abid



Map1. geographical and administrative situation of the wilaya of Constantine. source: author’s conception 2022 through the administrative division of Algeria (INCT)

THE ECONOMIC DEVELOPMENT IN CONSTANTINE

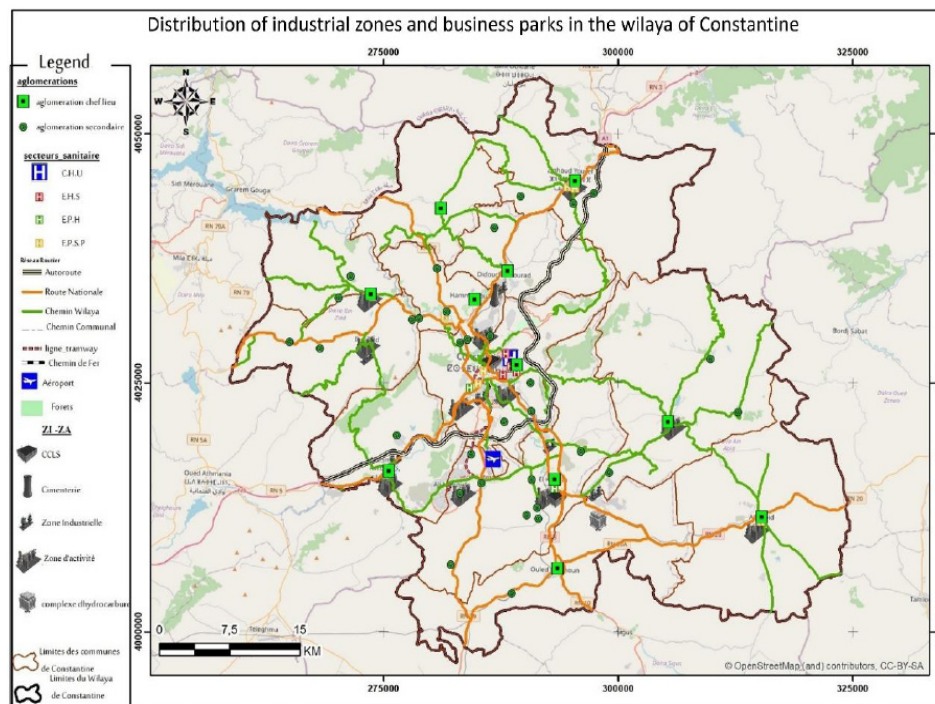
According to the information collected in the field, the first industrial zone (February 24, 1956) established in Constantine was in 1958 by colonialism, which laid the first features of economic growth and was limited to the craft, the latter is located south-west of the city of Constantine between OuedRhumel and RN05 and it occupies an area of 38, 76 ha.

After independence, the wilaya of Constantine has benefited from several industrial zones and business parks:

Table 1. Distribution of industrial zones and activity zones in the wilaya of Constantine.

Zone name	Municipality	Activity	Creation date	Area (ha)
24 février 1956	Constantine	ZI	1958	38,76
Tarf	OuledRahmoune	ZI	1976	447,6
Palma	Constantine	ZI	1975	73,39
Aissa Ben Hmida	Didouche Mourad	ZI	1984	95,55
Zighoud Youcef	Zighoud Youcef	ZA	1993	34,25
Ibn Ziad 1	Ibn Ziad	ZA	1983	
Ibn Ziad 2	Ibn Ziad	ZA	1989	
Ali Mendjli	El Khroub	ZA	1997	60,88
Ain Smara	Ain Smara	ZA	1981	21,40
Bekir	Hamma Bouziane	ZA	1988	10,01
Rhumel	Constantine	ZA	1981	79,49
Messaoud Boudjeriou	Messaoud Boudjeriou	ZA	1989	9,86
Ain Abid	Ain Abid	ZA	1982	8,86
Ibn Badis	Ibn Badis	ZA	1988	11,5
Khroub	El Khroub	ZA	1982	11,87

Source: UGZIA management, author treatment



Map2. Map of the distribution of industrial zones and activities in the wilaya of Constantine. Source: Directorate of Civil Protection

PRESENTATION OF THE ESTABLISHMENT OF NAFTAL (NAFTAL, 2014)

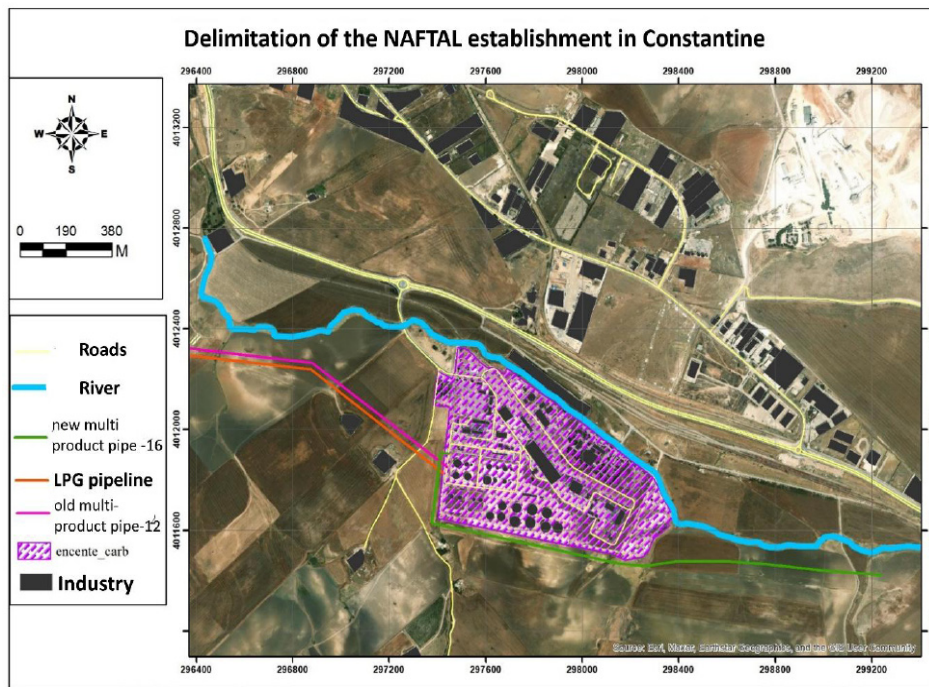
The multi-product center NAFTAL El Khroub is located in the industrial zone Tarf de Bounouara, commune of OuledRahmouneDaira of El Khroub, Wilaya of Constantine. The installations of CMP are erected on a total surface of 42 ha; the activity of the site consists in storing and distributing petroleum products.

The products present on the site are the following:

- Gasoline (normal gasoline, super gasoline, and unleaded gasoline)

- Gasoil
- Jet A1 (kerosene)
- Dyes for premium gasoline
- Lubricants belonging to Naftal Commercialisation
- Tires belonging to Naftal Commercialization
- LPG (butane, propane) belonging to the Naftal LPG branch.

The establishment is subject to a ministerial authorization AM



Map 3. Délimitation de l'établissement Naftal de Constantine. source: hazard study, author's treatment

The Impact of Products Stored at the Facility (Naftal, 2014)

Analysis of products present at the site (impact of exposure of workers and the environment):

Gasoline Hazard Analysis

- ***Fire/Explosion Hazard***

The product is stable at room temperature; It must be kept away from any source of ignition (heat, sparks, open flame) and avoid any accumulation of electrostatic charges.

In case of fire, a risk of explosion is to be noted under the effect of heat.

- ***Acute toxicity risk***

Probably irritating to the eye and skin.

Prolonged contact with skin may cause chemical burns (e.g., after a traffic accident).

Aspiration hazard: If swallowed, the product may enter the lungs and cause injury.

Harmful by inhalation.

May be irritating to the respiratory tract by inhalation of high concentrations of mists or vapors; high concentrations of vapors may cause nausea, dizziness, headache, or drowsiness.

Intentional inhalation (abuse) of solvents or intentional overexposure to vapors can cause severe central nervous system disorders, including unconsciousness and even death.

- **Chronic Toxicity**

Carcinogenic effects: Exposure to benzene may affect hematopoiesis resulting in blood disorders including anemia and leukemia.

Mutagenic effects Contain material which may cause heritable genetic effects. Benzene

Teratogenic and developmental effects Contain material which may cause birth defects based on animal data.

- **Ecotoxic hazard**

Persistence/degradability Biodegradability is inherent in its composition; Mobility/spills may be accompanied by soil penetration, resulting in groundwater pollution.

Bioaccumulation of this product in the environment through food chains is not expected.

Environmental hazards Toxic to aquatic organisms may cause long-term adverse effects in the aquatic environment.

Spills of this product may form a film on the surface of the water, causing physical damage to aquatic organisms and may disrupt oxygen transfer.

Analysis of Hazards Related to Diesel Fuel

- **Fire/explosion risk**

Diesel oil is stable and does not present any particular risk of ignition or explosion at ambient temperature; however, in the presence of hot spots, particular risks of ignition or explosion cannot be ruled out, for example during accidental releases of vapors or leaks of hot diesel oil under pressure.

- **Toxic risk / Acute toxicity**

For eyes, mucous membranes, and respiratory tract.

Vapors or aerosols irritating at high concentrations, In case of accidental ingestion.

Inhalation into the lungs (low viscosity); May give rise to inhalation pneumopathy developing within hours.

- **Ecotoxic risk:**

Gasoil is harmful to aquatic organisms and may cause long-term adverse effects on the aquatic environment; Based on its physicochemical characteristics and biological data, it may be hazardous to terrestrial or aquatic fauna and flora, but its bioaccumulation is very low; The product is inherently biodegradable, but its degradation is very slow.

Hazard Analysis of A1 Kerosene Jet

- **Fire/explosion hazard**

- The product is stable at room temperature; it must be kept away from any source of ignition (heat, sparks, open flame) and avoid any accumulation of electrostatic charges; in case of fire, a risk of explosion is to be noted under the effect of heat.

- Contact with strong oxidizers should be avoided; combustion of this product and other types of hydrocarbons will give off carbon monoxide and carbon dioxide.

- In moderate concentrations, carbon monoxide can cause headache, nausea, vomiting, increased heart rate, and mental confusion; exposure to higher concentrations of carbon monoxide can cause loss of consciousness, heart, and brain damage, and/or death.

- Exposure to high concentrations of carbon dioxide can cause simple asphyxiation by displacing oxygen in the air; combustion of this and similar products should only take place in well-ventilated areas.

- **Toxic and Ecotoxic Hazard:**

- The primary effects of exposure to this product are headache, drowsiness, and irritation of the eyes, nose, and lungs.

- Target organs include the respiratory system, nervous system, and mucous membranes; if ingested, the product may be aspirated into the lungs and cause very serious lung damage.
- This product contains benzene, which is classified as a carcinogen.
- The potential hazards associated with the storage tanks are the large volumes that may be involved in the event of loss of containment.
- The potential hazards associated with the products present on the site (flammable liquids) and with the truck and railcar loading activities are fire (tank fire and pan fire), UVCE, tank bursting, thin film boil-over, and tank pressurization.

The Study of the Major Risk of the Gas Spheres at the Level of the Establishment of Naftal

According to the training course carried out at the level of the establishment, we retained that the scenarios with thermal effects whose thresholds of significant lethal effects of the LPG spheres are the most major as follows:

Table 2. Effect extension of the hazardous feared events (GPL).

Identification of the Source of Danger	Dangerous Feared Event	Causes	Thermal Effect Extension
Propane sphere04 1600m 3	Fireball (BLEV)	Guillotine rupture	SELS :1088m SEL :1392,2m SEI :1789,2m
Butane sphere03 1600m3	(flash fire)	Guillotine rupture	SELS :138,9m SEL :158,8m SEI :185,6m
Propane sphere04 1600m3	cloudfire	Guillotine rupture	SELS :955m SEL :1050,5m SEI :1267,3m
Butane sphereSB01 2276m3	Slickfire	Guillotine rupture	SELS :969,6m SEL :1158,7m SEI :1416,3m
Cigare T02	Fireball BLEV	Guillotine rupture	SELS :446m SEL :576,1m SEI :746,4m
LPG truck of 30 m3	Fireball BLEV	Guillotine rupture	SELS :217,2m SEL :285,9m SEI :375,2m

Source: Hazard study, PII, author's processing

The table above shows that the extension of thermal effect (BLEV) of the sphere propane 04 (1600m 3) extends to 1789.2m for the threshold of irreversible effects, while the radii of extension of lethal effects and significant lethal effects extending over distances

(1392,2 / 1088m) successively; therefore it is imperative to locate the vulnerable stakes which exist around a site that has major risk (Naftal).

The Location of Vulnerable Issues

According to the consultation of the documents that define the feared events and their impacts on the human and environmental level of all the products that are located at the "Naftal" establishment, we tried to quantify the vulnerable stakes in the threshold radius of the significant lethal effects of the propane 04 sphere:

Table 3. Neighboring facilities affected by the major hazard

Establishment	Activity	Number of employees
SFDM		150
Household appliances company	Household appliances	100
Isopharme	Pharmaceutical industry	70
Military hangar	Military	2
Henhouse	Food industry	13
Empty shed		2

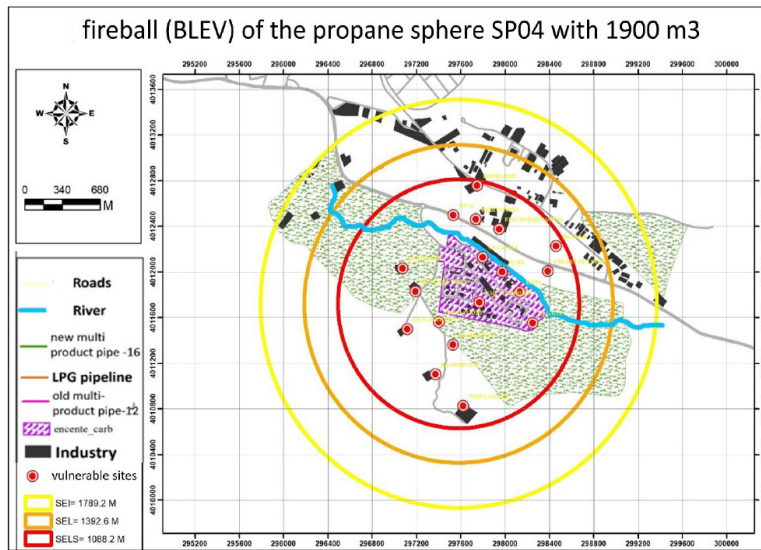
Source: Author processing

Table 4. Establishments receiving the public affected by the major risk

Establishment	Activity	Number of employees
A project life base GTP	life base	150
Fuel District	Administration	100
LPG District	Administration	95
Training Center NAFTAL	Training	52
Agglomeration and individual constructions	Dwellings	73
Farming operations	Agriculture	12

Source: Author processing

- Railways: To the North: a commercial railway that supplies and distributes the center’s fuel by rail and another railway that passes through Guelma at 120m.
- National road: RN°20 (double lane) along the North side at 160m as well as the entrance roads to the establishment, the Naftal training center, and the fuel and LPG districts.



Map 4. Fireball (BLEV) of the propane sphere SP04 with 1900 m3. source: danger study, PII, data processing by ARCGIS 10.8

CONCLUSION

- There are two types of extinguishing at the level of the establishment: water extinguishing and foam extinguishing; on the other hand, the implementation of a single water source causes a possibility of being damaged at the time of an industrial accident.

- According to the study of danger, the external risk is more probable, on the ground one finds direct access to the center Naftal contrary to Skikda; or it is necessary to enclose it and add a center of surveillance outside.
- The creation of industries and establishments receiving the public around a major risk site can contribute to an aggravation of the consequences after a major accident at the Naftal establishment.
- The consumption of agricultural land for the establishment of industrial zones and also the impact of products and substances used on the environment (farmland, nearby rivers, groundwater, soil, area)
- The city Zaaroura is expanding towards the establishment of Naftal, which gives an appeal to the authorities to control the expansion of urban and semi-urban areas, to reduce the consequences in case of a major accident
- The relocation of the administrative blocks and the training center outside the (1088m).
- Monitoring of classified establishments by the Directorate of Environment to reduce industrial pollution and its impact on the human and environmental levels.

List of abbreviations

- UGZIA: Unit of management of industrial zones and activities
- GPL: Liquefied Petroleum Gas
- PII: Internal intervention plan
- BLEV: Boiling Liquid Expanding Vapor
- SELS: threshold of significant lethal effects
- SEL: threshold for lethal effects
- SEI: threshold for irreversible effects

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