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Heavy metals leached from the waste from the landfill in the city of Meknes, and their impact on groundwater

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Abstract

The aim of this study is to evaluate the impact of leachate emerging from the public landfill in Meknès city, on the waters of the aquifer. In order to do this, a spatio-temporal monitoring of physico-chemical parameters (temperature, pH, conductivity, dissolved oxygen, TSS, B, Cd, Cu, Fe, Hg, Ni, Pb and Zn) was performed at eight sampling points during all four seasons of the year 2013, in order to make a comparison between the pollution load of the leachate and, the possibility that juice discharge contaminates groundwater. Physico-chemical analysis showed that the leachate is highly mineralized and less loaded with heavy metals. The results also show that Meknes city's landfill is not stable; it has not yet reached its maturation phase. However, other different sampling points are believed to be at the beginning of their infection. In order to test this, we analyzed eight samples (water wells and springs) surrounding the landfill site by using atomic absorption and physico-chemical analysis were performed according to standard protocols AFNOR [1]**.** The present study confirms that the marl is a temporary powerful obstacle, in front of permanent increasing pollution, generated by the decomposition of waste in the landfill of Meknes city.

1. Introduction

Waste production is increasing in Morocco, in quantity and quality, thus generating great risks on the environment and on human health [2]. Management of landfills and technical landfill centers in Morocco is one of the major challenges of our society. Landfills are the weakest element in the waste management process [3]**.** The landfill of the city of Meknes where are dumped all waste of the city is uncontrolled discharge area of 23 ha, it is part of the rural area of Dkhissa [3],located 5 km from the city center. It annually receives 185,000 tons of waste generated by 650,000 inhabitants since 2002 [5]. The waste spilled is rarely totally inert and many physico-chemical and biological reactions occur not only between the waste and the environment in which it is located (rocks, soil, groundwater, leachate), but also even within the waste of various origins [6].Leachate is formed of pollutants from landfills, in fact, production of leachate increases considerably in developing countries because of the nature of the population’s diet (very wet waste) but also, because of rainfall, moistened waste generates a significant quantity of leachate, taking with it all kinds physicochemical bacteriological pollution.However, the impact of metal pollution in the leachate (from the landfill in the city of Meknes) on the water table, is not yet known because of lack of previous work. Oued Boufekrane is exposed to damage caused by the landfill [4]. The geological environment consists of Miocene age marl, temporarily blocks the migration of pollutants into groundwater, but the continued production of leachate constitutes a persistent threat to surface and deep water [4]. The soils were composed of a thick layer of clay, the risk of water pollution is minimal [7].Therefore, it is necessary to study the environmental problems of the discharge through an assessment of the risk generated by the discharge of pollutants on the surrounding environment and particularly on water resources[2]. With the increasing use of landfill sites, leachates produced by uncontrolled waste disposal have become a serious threat for the aquatic environment [8]**.**

The objective of this study is to evaluate the impact of leachate emerging from the public landfill in Meknès city, on the waters of the aquifer.

2. Materials and methods

2.1. *The geographical situation*

Saiss basin is divided into two sub-basins by the flexure of Ain Taoujdate, it separates the plateau west of Meknes and Fez Sais (also called plain Saïss) to the east [9] . The study area is located at the northern end of the Meknes plateau (Figure 1).

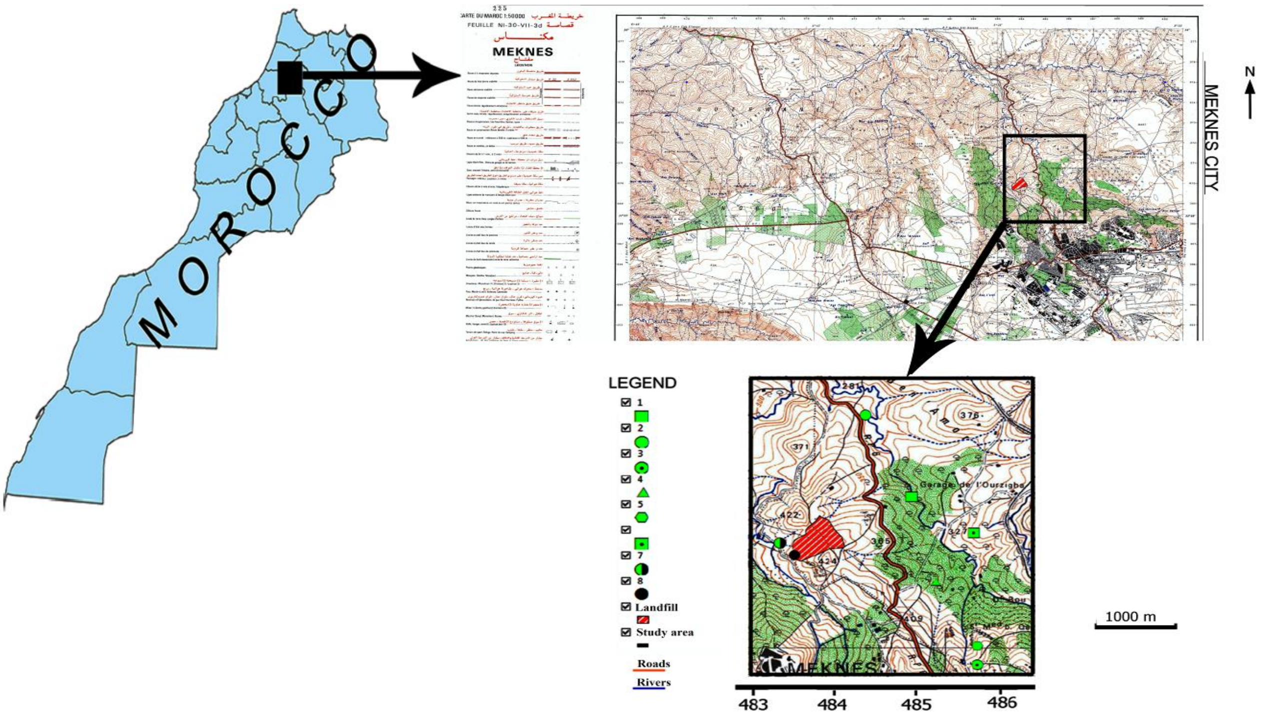

Figure 1: location of the study area.

2.2. *The geological and hydrogeological context*

The geographical locations of the study area, on maps and on field investigations have shown that the area comprising the landfill is located on floor marl. Miocene.

Indeed, the name of the plateau refers to that of the fill above the marls of Tortonian (Miocene) (Figure 2), which was made by detrital and lake sediments, determining a sensibly flat structural surface [10] .

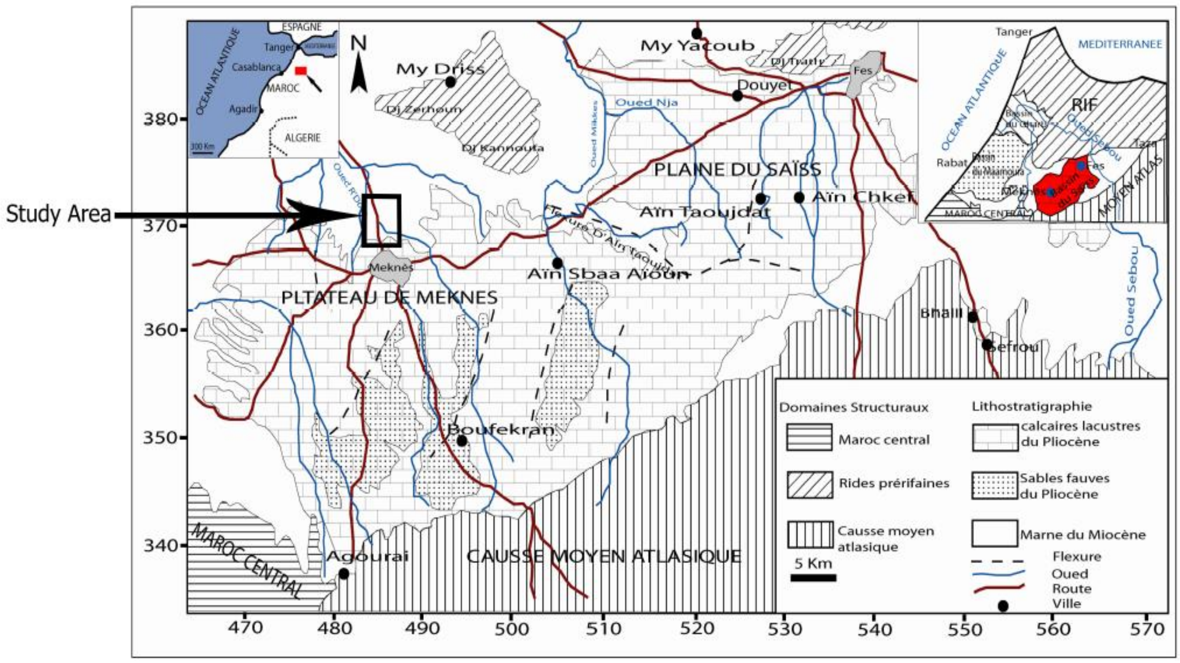

Figure 2: Map of geological situation of the study area [11]

The river system at the Meknes plateau has a direction SSE-NNW, the study area (landfill of Meknes) is located in the Rdom catchment area including rivers: Boufekrane, Ouisslane and Chajara.

The most important of these is the Boufekrane river, both because of its flow (310 L / s in low water) and that is deployed in the heart of Meknes city [10]. At the beginning of this study, it was found that the leachate is drained to the wastewater treatment plant by the competent authorities, whereas after approximately one year and after heavy rains, much leachate took a new path to the river Boufekrane. This river could be a drain, which could carry polluted water downstream, particularly from the landfill to Rdom valley downstream of the landfill [3].From a hydrogeological point of view, there are two major aquifers in the Meknes-Fes basin. The first one is represented by the lias limestone and forms the deep artesian aquifer in the center of the basin. The second one is situated in the Plio-Quaternary lacustrine limestone and forms the phreatic aquifer [12]. Our study site is located on an impermeable area of the groundwater table (Figure 3).

2.3. *Climatology*

The region of Meknes is an area that is characterized by a semi continental Mediterranean climate, the winters are cool, rainy and hot, the summers are dry. This climate is localized mainly in the prefecture of Meknes, and the province EL Hajeb [13].

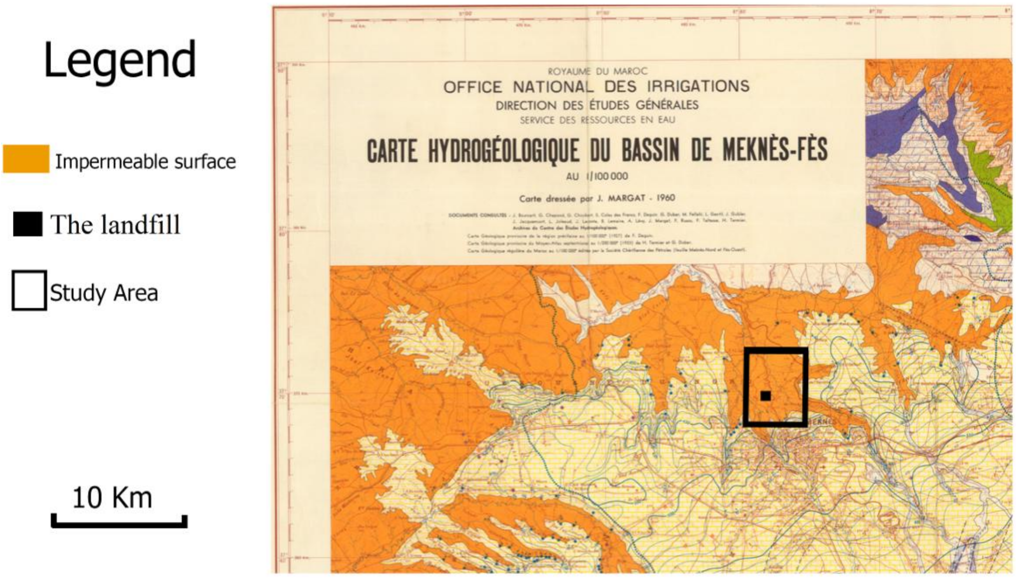

Figure 3: Part of the hydrogeological map of Meknes-Fes basin showing the study area, Margat J.[3].

Table1: annual rainfall in the province of Meknes (millimeters/ year).[13]

Province of Meknes	2004/2005	2005/2006	2006/2007	2007/2008	2008/2009	2009/2010
Rainfall (millimeters/ year)	290.9	561.4	342.8	304.8	715.9	782.5

For 2013, the estimated rainfall : 361 mm / year [14]

2.4. *Human population and activities*

According to the Census 2014, the prefecture of Meknes contains: 834,426 of Moroccans, 1,269 of foreigners, 835 695 of population and 192 654 of households. The prefecture of Meknes is distributed over several municipalities, those who discharge their household waste to the dump of the city of Meknes is the municipality of Meknes, the municipality of Al Machouar-Stinia, the municipality of Toulal, the municipality of Moulay Idriss Zerhoun and the municipality of Ouislane.

Table 2: The Census 2014.[15].

	The households	The population	The Foreigners	Moroccans
Municipality of Meknes.	126319	540428	1132	519296
Municipality of Al Machouar-stinia.	1264	4664	11	4653
Municipality of Toulal.	4434	19077	19	19058
Municipality of Moulay Driss Zerhoun.	3022	11615	12	11603
Municipality of Ouislane.	19562	87910	30	87880

In the study area, raising livestock is the main source of life for residents, however water from the majority of wells and springs used in sampling is used for livestock watering.

2.5. *Sampling strategy*

The choice of water sampling stations is primarily based on proximity to the landfill, these points are the only points the nearest water from the landfill in the city of Meknes.

Our study site is located on an impermeable area of the groundwater table (Figure 3).
For our study, we became interested in the study of the groundwater table of Plio-Quaternary age, because of a lack of wells in this area for the deep aquifer, most of the wells on the south side are to supply drinking water to the city of Meknes, while our study site is located north. For groundwater of Plio-Quaternary age is on the south side of the study area, East and Northeast. The piezometric maps show a general flow from south to north and specifically from SE to NW, the direction of general flow has changed only slightly and it has remained the same [3].
The well number 4 is distant 1236 m from the landfill, the well number 5 is distant 2144 m from the landfill, the spring number 1 is distant 900 m from the landfill, the spring number 2 is distant 1477m from the landfill, the sampling point number 7 is distant 100m from the landfill, the sampling point number 8 is distant 2m from the landfill, the sampling point number 3 is distant 2300m from the landfill, the sampling point number 6 is distant 1500m from the landfill of the city of Meknes.
The main vegetation that exists around the landfill are the cereal fields.
To assess the risk of contamination of groundwater by leachate from the landfill in the city of Meknes, we respected as much as possible the flow of water from the groundwater table. Water samples and leachate were collected quarterly from wells (No 4 and No 5), from water sources (No 1 and No 2) and directly from streams formed by water waste flow (No 7) and leachate (No 8) and river (upstream No 3 and downstream No 6), at midday of each half quarter of the year 2013, we conducted a total of 32 samples distributed over the four seasons of the year 2013 (Figure 4).

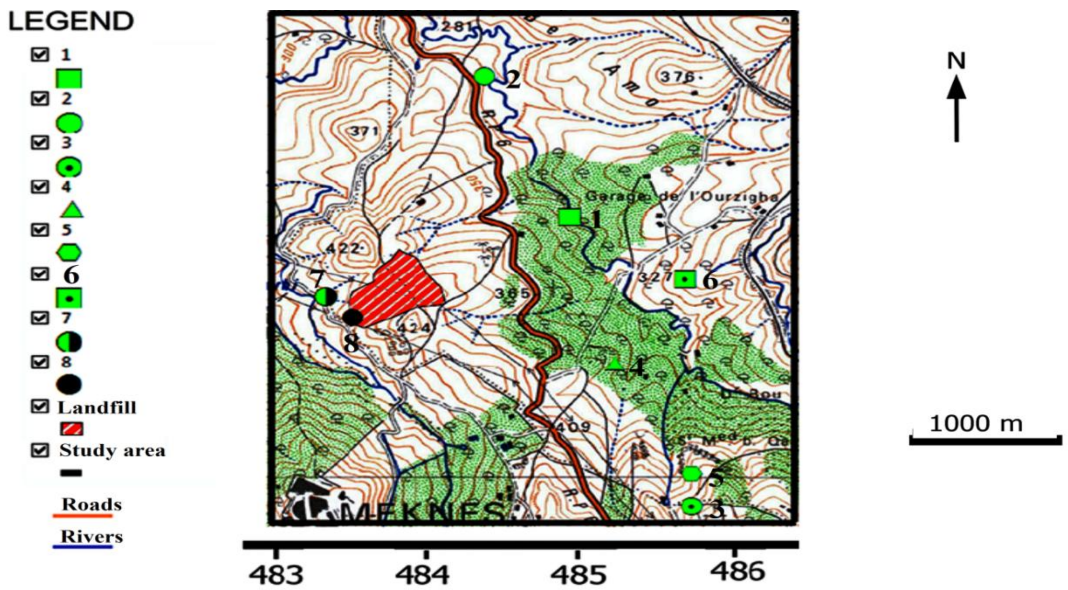

Figure 4: Location of sampling points.

2.6. *The physical and chemical parameters*

2.6.1. *The choice of parameters*

- pH: The pH, Hydrogen ion concentration (H^+), is a characteristic of the acidity of the water. The pH of a natural water may vary from 4 to 10 depending on the acidic or basic nature of the terrain to be traversed [16].
- Temperature:The temperature of the water plays an important role, for example the solubility of the salts and gases including oxygen which is necessary for the balance of aquatic life [16].
- Conductivity:The conductivity gives us an idea about the mineral load of water that is its salt pollution. The measurements of conductivity and concentrations of anions and cationsprovide informationabout the amount of leached salts in waste and can aid assessment of this mineral pollution in wastewater [17] .
- Dissolved oxygen:During respiration, organisms consume oxygen and give off carbon dioxide while absorbing food molecules to obtain energy for growth and maintenance.[18]
The concentration of dissolved oxygen is an important parameter for assessing the degree of pollution of this water.
- Heavy metals: The origin of these heavy metals in large part is due not only to the battery uses, food cans, but mainly to industrial waste [19].The results obtained by AINA shows that Cu, Ni and Pb attach easily unlike Zn which migrates to the bottom of the landfill [19].

The estimated proportion of the metal was oriented towards measuring the following heavy metals: Cd, Cu, Ni, Pb, Zn known by their strong character polluting overlooked the environment [20].

- ***cadmium***

Cadmium salts are used in photography, the manufacture of fireworks, rubber, porcelain, etc.
Cadmium oxides are used in the chemical industry, for the electroplating, in the electric batteries, as stabilizers for plastics, and pigments for enamels [21] .

- ***mercury***

It is used in the manufacture of thermometers, barometers, vacuum pumps, lamps and mercury vapor rectifier. It is used for tinning ice, manufacture of dyes, it is a component of cosmetic products (mascara), adhesives, and filters for air conditioning systems, etc [21].

- ***lead***

The manufacture of accumulators is the main use of lead (about 50% of the total consumption). The print, sheaths for electric cables and pipes for water and gas [21]. The main sources of heavy metals in urban waste, batteries (Hg, Zn, Pb, Cd), paintings (Cr, Cd, Pb), plastic (Cd, Ni, Zn), paper and cardboard (Pb), electronic components (Pb, Cd), ceramics, cosmetics [20]. The main metal transport vector is leachate [20]. We also observe differences in the organic load and lower metal content in methanogenesis phase [20].Legret followed the heavy metal content released by a column of household waste types during 2 years of degradation, and has demonstrated the exception of nickel and zinc. Other metals remain trapped in the heart of the garbage dump [20].

Table 3: The characteristics of the wavelengths for each element [22].

Element	B	Cd	Cu	Fe	Ni	Pb	Zn
Wavelength (nm)	249.678	214.438	324.754	238.204	221.647	220.353	202.551

2.6.2. *Measuring equipment.*

The temperature (T), dissolved oxygen (O_2) and electrical conductivity (EC), were measured in situ using a Multi-parameter brand 40 HQ D.
The pH is measured by a pH meter IP67. The samples were kept in polyethylene bottles and trasported to the laboratory at 4°C. Analyses of heavy metals (B, Cd, Cu, Fe, Hg, Ni, Pb and Zn) were performed in the laboratory of CNRST (National Centre for Scientific and Technical Research of Rabat). Samples (leachate, water from wells, springs and river) were purified by membrane filters of 0,45µm and then, acidified with nitric acid [1] and, measured by ICP method. A method of analysis by atomic emission spectrometry whose source is a plasma generated by inductive coupling, ICP = short for "ICP-AES" = "inductively-Coupled plasma-/ Atomic-emission-spectrometry" [23]. The device used is a spectrometer ICP AES type Jobin Yvon Ultima 2. The elemental analysis of solutions was under-taken by Inductively Coupled Plasma Atomic EmissionSpectrometry (ICP-AES). The sample is nebulized then transferred to an argon plasma. It is decomposed, atomized and ionized whereby the atoms and ions are excited. We measure the intensity of the light emitted when the atoms or ions return to lower levels of energy. Each element emits light at characteristics wavelengths and these lines can be used for quantitative analysis after a calibration [22]**.**
The geological study was completed with the use of geographic information system (GIS), through which it was possible to organize and present alphanumeric data on maps using ArcGIS software Version 9.3.1770.
The results of analysis were subjected to principal component analysis (PCA), via a statistical tool (15.2.03.514 XLSTAT 2013 version), which allowed us to explain the phenomena involved.

3. Results and discussion

The average values of various physical and chemical parameters of the leachate from the landfill in the city of Meknes (Table 4) show very high conductivity and a low concentration of heavy metals.

3.1. *pH*

The spatial variations of pH average values would be showed that the average values are between a minimum of P2 with an average value of 6,5 and a maximum of P8 (leachate) from an average value 7,65. The average values of pH in various points characterizing the groundwater (P1, P2, P4, P5) are very similar and very slightly acidic tending toward neutrality (Figure 5), which is in agreement with the work done by [1] and [24].

Table 4: Average values of physical and chemical parameters of the leachate from the landfill in Meknes city.

Parameters	Leachate
Conductivity (µS/cmat 20°C)	19115
Temperature (°C)	24.825
pH	7.65
Dissolved oxygen (mg/l)	1.065
TSM (g)	3.087
B (mg/l)	1.402
Cd (mg/l)	0.014
Cu (mg/l)	1.101
Fe (mg/l)	6.229
Hg (mg/l)	0.011
Ni (mg/l)	0.223
Pb (mg/l)	0.049
Zn (mg/l)	0.384
Cr (mg/l)	0.338

However, the points of the river (upstream (P 3) and downstream (P 6)) are slightly basic because they come from the wastewater discharged into this river, thus, the point (P7) which is a mixture of water and leachate waste rich in organic fecal matter, explains the decrease in the basicity of pH in comparison with that of the only leachates. In fact, the pH of the wastewater is usually slightly alkaline [25]. The average values of the pH of leachate (P8) 7,65 would be showed that leachate is slightly basic, indicating that our landfill is in the process of methanogenesis, signifying that it was just over the first two stages of the degradation of organic matter, namely the hydrolysis and acidogenesis. The latter corresponds to a pH drop by accumulation of the volatile fatty acid (VFA), and induced slowing the development of methanogenesis stage [17]. Methanogenesis stage leachate from biodegradation of waste that has a lower level of organic matter in comparison with leachate from waste acidogeneisis phase with a pH< 7[6]. Depending on the substrate used by bacteria and released products, there are four phases in anaerobic degradation: hydrolysis, acidogenesis, acetogenesis and methanogenesis (Bryant, 1979). Christensen et al. (2001) [24].

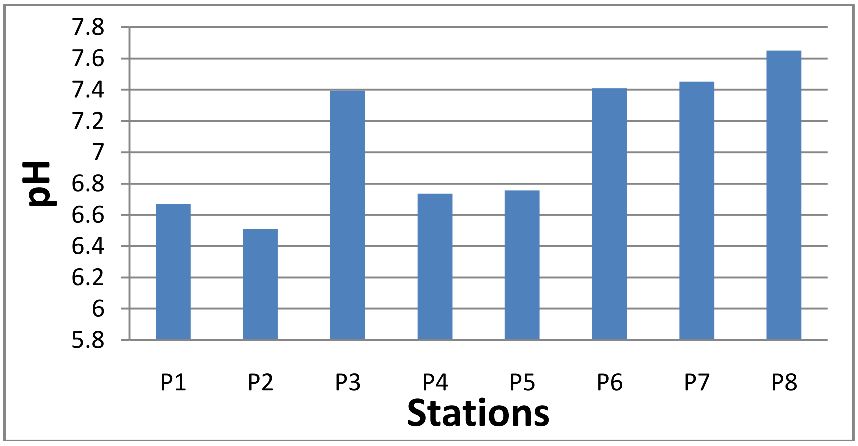

Figure 5: Spatial variations of the average values of pH.

Compared work done by Fadila Mezouari (2011) [20], the leachate from our landfill is relatively young.

3.2. *The temperature*

The average temperatures at various points characterizing groundwater (P1, P2, P4, P5), would be equal to an average of 20°C, the same value for the points (P3 and P6), then for P7 and P8 respectively 27,67°C and 24,82°C (Figure 6), the high temperature of the leachate is due to exothermic reactions happening in the landfill. However, H. Khattaabi [26] noted that the leachate pool has often a slightly higher temperature than the other pools, because of its warming by raw leachate. The landfill is a reactive environment which fosters various physical, chemical and biological processes. The change in temperature is one of the consequences of these processes [19]. Furthermore, the temperature increases the speed of chemical and biochemical reactions of a factor 2 to 3 for a temperature increase of 10 degrees Celsius (°C) [27].

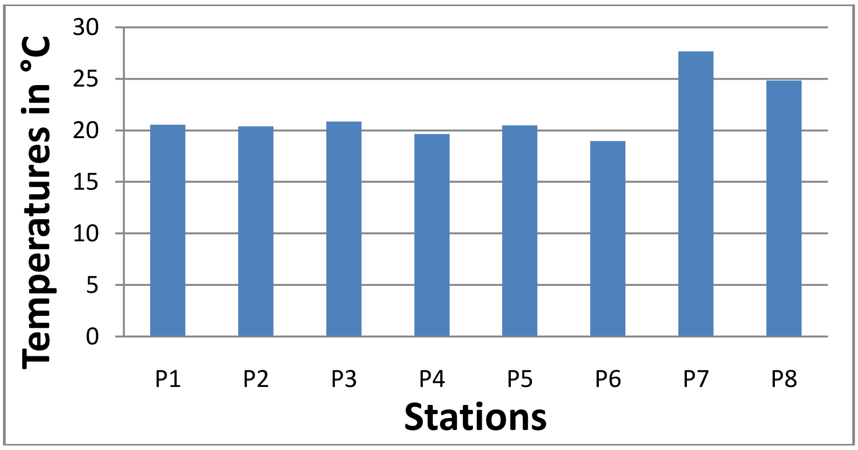

Figure 6: Spatial variations of the average values of the temperature.

3.3. *Electrical conductivity*

The spatial variations of the average values of electrical conductivity would be between a minimum 370,96 µS / cm and a maximum of 1040 µS / cm. For the points (P1, P2, P3, P4, P5, P6, P7), these values above the conductivity do not exceed the standards of drinking water, which is about 1300 µS / cm according to Moroccan law [28], while for leachate, the average is around 19115 µS / cm (Figure 7). This value is between 2500 to 25000 µS / cm conductivity characteristic of garbage leachate according to [17].

The leachate from the Meknes landfill would be highly mineralized, indeed it exceeds the standards of the conductivity of irrigation water, which is of 12 mS / cm at 25 °C [28], and requires the competent authorities to disallow the release of the highly mineralized leachate into the river Boufekrane.

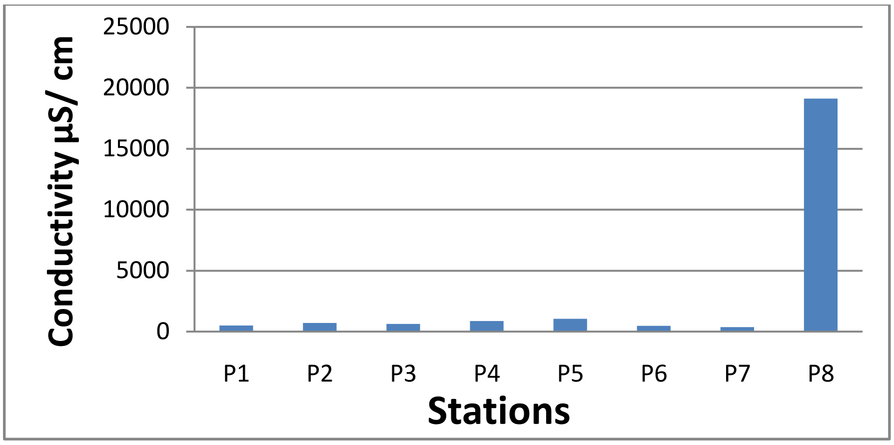

Figure 7: spatial variations of average values of the electrical conductivity.

3.4. *Dissolved oxygen*

The results obtained in this research would be showed a maximum average value in P6: 6,81 mg/l, while the minimum value obtained in P8 is 1,06 mg/l. Points (P1, P2, P4, P5) (Figure 8) have relatively high rates of dissolved oxygen in comparison with other points, this can be explained by the fact that the water of the groundwater does not have a high bacterial load which is proved by bacteriological analyzes during this search, in fact the oxygen content is used by the microorganism as a terminal electron acceptor during aerobic respiration and oxidation of organic substances. We note that upstream (P3), the river is highly loaded with bacteria and fecal matter from wastewater discharged into the river, In these circumstances there is a stimulation of degradation of organic matter by aerobic microorganisms with dissolved oxygen consumption, which is proved firstly by a small amount of oxygen at the upstream (P3) compared to downstream (P6) and secondly by a large amount of bacteria at the upstream as compared with the amount of bacteria at downstream of the river. In addition, the increased amount of dissolved oxygen can also be due to oxygenation of the waters of the river, by mechanical agitation caused by a simple drainage of water from upstream to downstream; as we can suggest that the amounts of oxygen may be due to a large phytoplankton development and therefore an important production of oxygen following photosynthesis. P8 point representing the leachate is the least oxygenated 1,06 mg / l of all the points this result can be explained by the abundance of bacteria, however, we are convinced that the lack of dissolved oxygen is mainly due to the elevated temperature of the liquid.

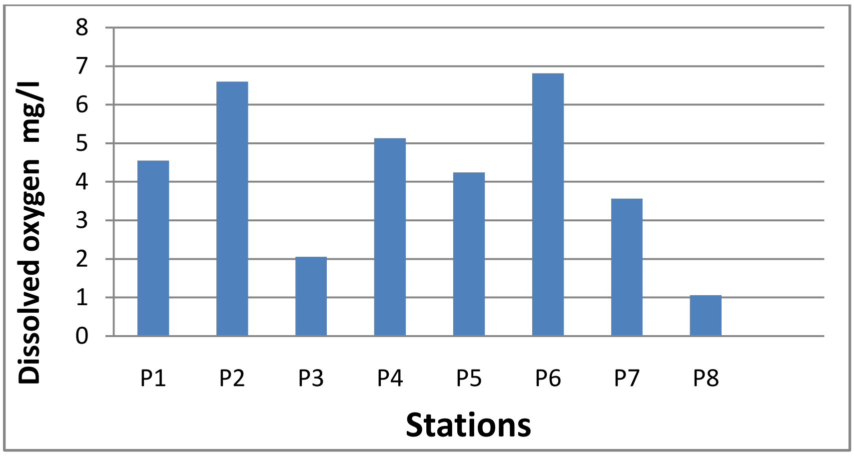

Figure 8: Spatial variations of the average values of dissolved oxygen.

However, when the temperature rises, the oxygen content decreases due to its lower solubility, but also because of increased consumption by living organisms and bacteria that multiply [1]. The point P7 which is a mixture of leachate and wastewater transported to the WWTP at this point we find that the oxygen level is the result of the consumption of oxygen by the bacterial mass, oxygen production by phytoplankton mass, temperature and mechanical oxygenation by routing the water.

Moroccan standard published in the Official Bulletin No. 5062- 30 Ramadan 1423 (5-12-2002) states that water containing 7 mg / l of dissolved oxygen requires a simple physical treatment and disinfection, a water containing 5mg / l dissolvedoxygen requires normal physical treatment, chemical treatment and disinfection, while for water 3mg / l dissolved oxygen requires physical treatment, advanced chemical treatment and disinfection. Using this standard, we can say that the water sampling points P2, P4 and P6 requires simple physical treatment and disinfection, the points P1, P5 and P7 requires normal physical treatment, chemical treatment and disinfection, however points P3 and P8 requires physical treatment, advanced chemical treatment and disinfection.

3.5. *Heavy Metals*

Landfills are loaded with heavy metals. Their quantification allows to evaluate the massive potential of the metal and take steps to anticipate the impacts on the environment. The treatment of liquid industrial effluents containing heavy metals is a major environmental problem affecting all industrialized countries [29]. To interpret the mechanisms that govern the behavior of these metals in the environment of garbage dump, the chemical parameters were subjected to a principal component analysis. The principal component analysis (PCA) applied to 32 samples in the vicinity of the landfill of the city of Meknes, has allowed us to understand the behavior of these metals in the environment and so see the mechanisms that govern the behavior of these metals. The observation of the table of the correlation matrix (Table 5) reveals strong correlations between TSS and conductivity parameters (0,96), TSS and Pb (0,86), TSS and Zn (0,99), Zn and conductivity (0,95), Zn and Pb (0,84), Pb and conductivity (0,8), Mercury and temperature (0,97), Cd and conductivity (0,65).

Table 5: Correlation Matrix CPA

pH	(D)	1								
Disolved oxygen mg/ l	(E)	-0.58	1							
Temperatures en °c	(F)	0.55	-0.58	1						
Conductivity micro S/ cm	(G)	0.50	-0.63	0.41	1					
Cadmium (mg/l)	(H)	0.54	-0.37	0.21	0.65	1				
Mercury (mg/l)	(I)	0.64	-0.54	0.97	0.53	0.31	1			
Lead (mg/l)	(j)	0.25	-0.55	0.43	0.88	0.43	0.54	1		
Zinc (mg/l)	(K)	0.67	-0.70	0.63	0.95	0.66	0.74	0.84	1	
TSS en g	(L)	0.61	-0.68	0.62	0.96	0.64	0.73	0.86	0.99	1
SYMBOLS OF VARIABLES		(D)	(E)	(F)	(G)	(H)	(I)	(j)	(K)	(L)

These strong correlations used to form groups of elements that are governed by the same mechanism during their development, and are shown to the community circle factorial F1-F2 (Figure 9).

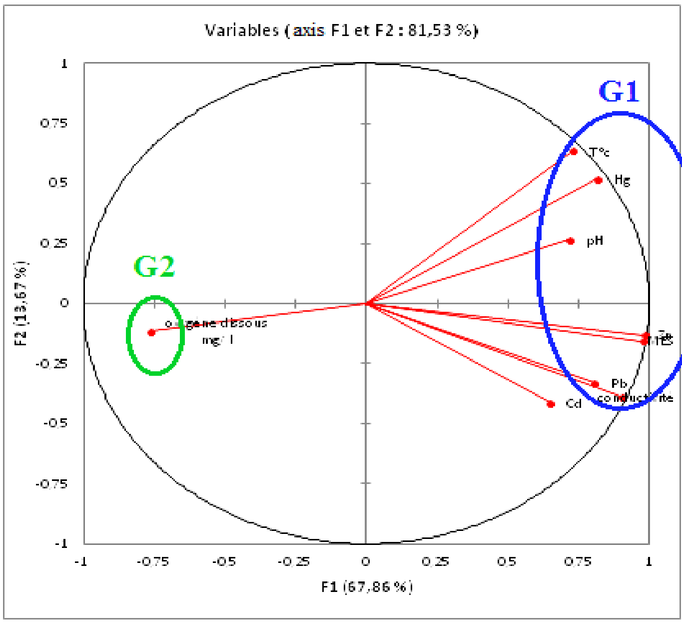

Figure 9: Community factorial F1-F2 plan Circle for different sampling points.

All parameters analyzed, except O_2, are positively correlated with the axis F1.
Many factors or parameters, whether biotic or abiotic, influence the levels of dissolved oxygen such as wind, temperature, salinity, but the most important are the biological activity (respiration of plants, animals, microorganisms, and oxidation senescent organisms and degradation by heterotrophic bacteria), and the balance of photosynthesis-respiration resulting. The interpretation of the evolution of this parameter is quite complexes [24] .According to [30], high values of 3 to 12 mg / l in the euphotic zone are primarily related to summer phytoplankton development in winter, lower values of 0 to 4 mg / l, related to the absence of primary production and degradation of organic matter by heterotrophic bacteria [30].
However, increasing the dissolved oxygen rate may be due to the different reasons listed above.
The factor F1 F2 plan explains about 81,53% of the variance (67,86% for F1 and 13.67% for F2).The F1 axis is positively formed by the parameters; Zn, TSS, EC, Hg, Pb, T, pH, showing respectively the following correlations with axis F1 0.98; 0.97; 0,90; 0.81; 0.80; 0.72; 0,71; These parameters form the group G1.
This axis is formed negatively by dissolved oxygen (group 2) with a negative correlation -0,766.
These results show that the F1 axis by its positive pole is the mostly axis of pollution, it is highly mineralized, in fact it is formed by the main studied pollutants. However, the negative pole is anti-correlated to the first pole of this axis is essentially constituted by the phenomenon of oxygenation.
The axis F2 is moderately correlated to the temperature (0.63), Hg (0.52). the Cd it's not belong for any axis and it's not belong to any of the above groups too.
It can be concluded from these tests that the more one moves around the axis of F1 positive side we shall have more heavily polluted water, so that movement of the negative side of the axis F1 water gives a less polluted mineral and this because of the increase of dissolved oxygen.
The positive correlation with the F1 axis of all parameters except the O_2 shows that this axis expresses the degree of pollution of the right to the left, due to the increase in the rate of O_2 dissolved.
Going from right to left the pollution increases from P2 to P8 station.
The sample points (P1, P2, P4, P5, P6) are very close together (Figure 10), and look to the waters of the groundwater quality, note that although the point P6 is a point downstream of the river receiving a quantity of wastewater is not highly mineralized, and as the P3 approaches himself all the above points, the P6 shows a natural and important reduction of mineral pollution, assuming that this allowance to do it organically.
Point P8 contributes 72,75% to the formation of the F1 axis is based on the above analysis of community circle factorial F1-F2, it is concluded that P8 (leachate) is the most heavily polluted developed and that pollution does not affect other points (P1, P2, P3, P4, P5, P6), except for the P7 point that is in addition to its strong mineralization is influenced by temperature and the mercury concentration.

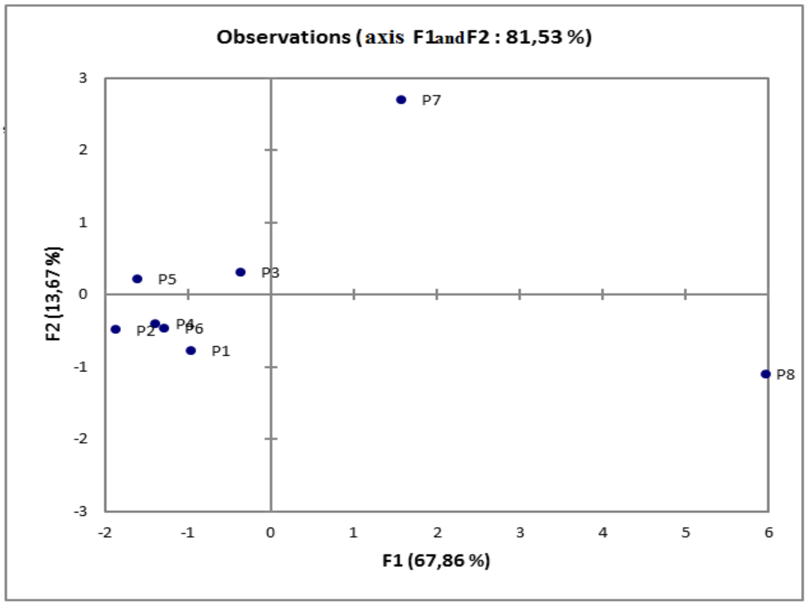

Figure 10: Projection of sampling points on the factorial plane.

Compared with the table range values of leachate generated during the degradation phase [19]. shows that the leachate from the landfill in the city of Meknes is strongly mineralized with a conductivity which is slightly higher than the conductivity of the second phase of degradation of landfills in developing countries, adding that the cadmium content and Crome confirms this phase, the pH and Pb parameters show the four phases namely, acidogenesis, acetogenesis methanogenesis and the maturation phase, Ni shows the phases, hydrolysis, acidogenesis, acetogenesis and methanogenesis phase, however, the iron content assumes that our landfill is at the maturing phase, then as zinc shows the hydrolysis phase and the copper shows the acidogenesis phase.
The results have nothings contradictions to the situation of our landfill phase, in fact since our landfill began receiving waste for 13 years and continues to receive household waste fees which affects the composition of the leachate the latter is formed by the breakdown of old waste and waste young which explains the degradation phases acidogenesis and methanogenesis.

Conclusion

We assume that the strong mineralization of leachate is mainly due to high levels of nitrates, while low values of heavy metals in the leachate because they remain trapped in the waste, these results corroborate those obtained by Baccini et al. (1987) who estimate that more than 99,9% of the heavy metals are still trapped in the landfill after 30 years[17].
The main point of this work is to detect the presence or absence of contamination of the groundwater. In this regard we will build on the first two approaches, the results of statistical analyzes that contrast categorically on the fact that groundwater is not contaminated by leachate from the landfill in the city of Meknes, however, there is a second approach that focuses on the concentration of a number of elements.
Indeed, it is the high concentration of cadmium that is especially the boundaries of the standard and Moroccan touches virtually most of the surveyed points.
The P7 and P8 far exceed the mercury concentration specified by the Moroccan standard is 0,001mg /l.
Zn this element was chosen for its strong leaching, but its low concentration in the leachate not allow us to decide for its origin in the different points studied, though its concentration is significantly lower than the values cited by Standard No. 1276- 01 of 10 Sha'ban 1423 (17 October 2002)[28].
Lead concentrations remain well below the Moroccan standards in different points studied, which is confirmed by research on groundwater.
The analysis of water from wells and springs in Meknes area, showed that their physicochemical and biological quality is largely influenced by the human activities [31].
We can conclude that the landfill is a time bomb, and that even this pollution is not clear, we urge the authorities to be vigilant, to undertake the rehabilitation of the landfill, to minimize and to control the production of leachates.
We can suggest a biological method to reduce the high rate of nitrates in the leachate, and therefore decrease the environmental contamination of the landfill in the city of Meknes, which will be published in future articles.

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