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The landfills in Algiers and the use of geosynthetics materials to protect the environment

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Abstract: The public health of our cities is in progressive degradation. The wastes resulting from different activities seem to be more overwhelming and come up with acute problems in the field of environment and public health. In the past, urban wastes composed, essentially, of organic and biodegradable materials was carried out of agglomerations to avoid unpleasant smell and visual pollution. The choice of the site occurred on a simple decision of the local authorities without any prior study. Nowadays, wastes have largely increased and nature has difficulty to resorb them. This paper is a flashback revealing that Algeria is facing a tricky situation in the field of urban solid waste management because of the lack of environmental rules. The studied case concerns the two official landfills of Algiers: the first one is the landfill of Oued Smar, which is a very representative raw landfill because of the pollution, which arise from it. The second one is a controlled landfill which still in progress in the Ouled Fayet site. A geomembrane is used at the bottom and the lateral inner-side to give a better waterproofing to the soil.

1 PUBLIC LANDFILLS, A SOURCE OF POLLUTION IN ALGERIA.

During the last decades, the evolution of Algerian lifestyle and consumption has given rise to repercussions on solid wastes production in quantity and quality. That is why the old practice which consists of establishing raw landfill on the city or the village outskirts, has become the principle cause of the pollution of vital resources such as: water, air, soil and the environmental plain. These indicators are too pessimistic: This situation may lead to economical and ecological disasters.
Nowadays, there are, at least, as many raw landfills as cities and villages. These are not a controlled landfills, except for two which are still on progress, a landfill in Algiers (Ouled Fayet), and another at 100 Km to the east of Algiers (Bouira). In the best case these existing landfills constitute a site for all types of waste dumping.
Generally, these are sites abnormally exploited without any environmental protection which gives rise to serious public health problems. Besides, the increasing quantity of toxic products arising from industrial, hospital and trade activities, despite the existence of a legislation regulating the management of wastes and landfills. This regulation exists since the beginning of the eighties.
In the near future, Algeria will be facing the problem of decontamination of polluted sites which is a very expensive and complex operation referring to industrialized countries experience.

1.1 Domestic wastes

Algeria is facing a deplorable and worrying situation, essentially in the great agglomerations which provide continually important quantities of wastes because of the population growth and the shortage of urban infrastructures: (sanitation improving and waste disposals).

The domestic waste quantity annually produced is estimated to 5.500.000 tons. One Algerian produces daily an average of 0,5 kg of solid wastes. In cities, one citizen produces daily an average of 0,75 kg of wastes. In the capital city, waste production is about 1Kg per day and per inhabitant.

The composition of domestic wastes is presented in (fig.1):

- 73.7% of organic materials,
- 1.9% of metal,
- 7.4% of paper,
- 2.5% of plastic,
- 0.96% of glass,
- 12.5% diverse.

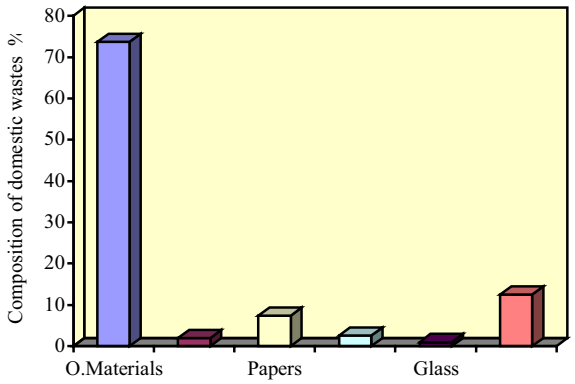

Fig.1: Composition of domestic wastes (M.A.T.E)

1.2 Industrial wastes

Algerian industry is experiencing a noticed evolution both in diversity and capacity aspects. This industrialization process was carried out without considering the environmental preoccupations. In fact, before the promulgation of the law dated 1983 and related to environmental protection, industrial projects were achieved without any environmental impact study. According to a study carried out in 1994 by a German Studies Office, the quantity of dangerous industrial wastes produced annually in Algeria is estimated to 185.000 tons. According to the nature of these wastes, this quantity is divided as below (fig. 2):

- Mineral wastes : 55.000 t/year
- Mineral mud : 18.000 t/year
- Petrochemical and liquefaction wastes : 58.000 t/year
- Polluted Zinc mud : 25.000 t/year
- Organic solvents, painting materials wastes : 4.000 t/year
- Manufacturing wastes : 2.500 t/year
- Metallic and electrolytic mud : 2.000 t/year

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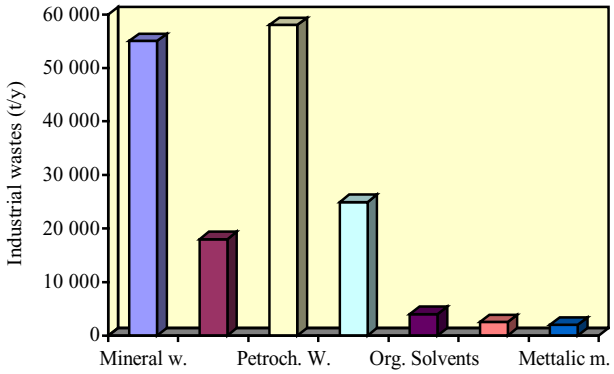


Fig.2: Industrial wastes production per nature and per year

1.3 Hospital wastes

The health sector generates wastes, which constitute an imminent danger for citizens and their environment. The quantity produced annually is estimated at 125.000 t and are divided as shown below, (fig. 3) :

– Ordinary wastes: 67.000 t/year
– Infectious wastes:22.000 t/year
– Toxic wastes : 29.000 t/year
– Special wastes: 7.000 t/year

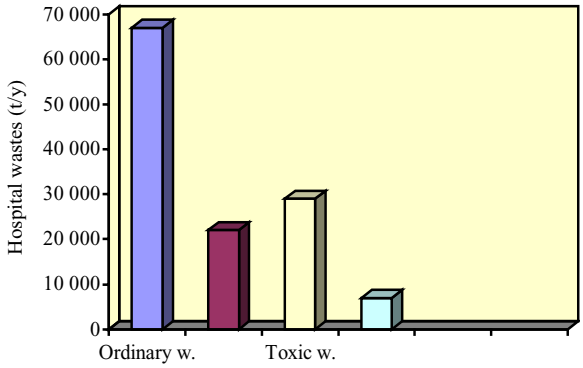


Fig.3: Mean production of hospital wastes

2 ALGERIAN ENVIRONMENTAL LEGISLATION

If in developed countries, solid waste management constitutes an important economical activity, in Algeria, however, the management of these wastes is not done in a global and coherent way.

This statement is essentially due to the lack of a global, coherent and accomplished waste legislation because the solid wastes management is legally governed only by the law N°83/03 dated 05/02/83, Chapter II, Title IV related to environmental protection, on one hand; and by the Decree N°84/378 dated 15/12/84 defining the clearing, the removing and the processing of solid wastes, on the other hand.

Nevertheless, some incoherence contained in the decree and its limited applications has not allowed a coherent management of urban solid wastes.

In order to fill this legal gap, the Territory Planning and Environment Ministry has initiated a bill (project of law) defining the global context of wastes management and the related activities, as collection, carriage, sorting, processing, improving and elimination.

This bill defines the national policy in waste management, which based on the following basic principles:

– The reduction of wastes production and their noxiousness.
– Organizing the management organization of wastes.
– The improving of wastes by reusing, recycling, and other actions which permit to obtain reusable materials or energy.
– Ecological and rational elimination of wastes.

3 WASTE MANAGEMENT IN ALGIERS

Algiers, the political and economical capital of Algeria, represents an area of 810 km², with 53 Districts and 3.000.000 inhabitants. Thus, Algiers agglomeration is facing a delicate situation in managing increasing urban wastes.

In this over urbanized territory, the elimination of wastes is done through the most classical way, that is to say by dumping. Excepted the official landfill of Oued Smar, Algiers has inherited from the neighboring cities about ten savage public landfills which do not obey to any rules related to health or environmental protection, (geographical map 1).

The agglomeration of Algiers has produced during the year 2000 more than 1.300.000 tons of solid urban wastes. In 1962, this production was about 200.000 t/year and in 1985 it was of 580.000 t/year, (Fig.4).

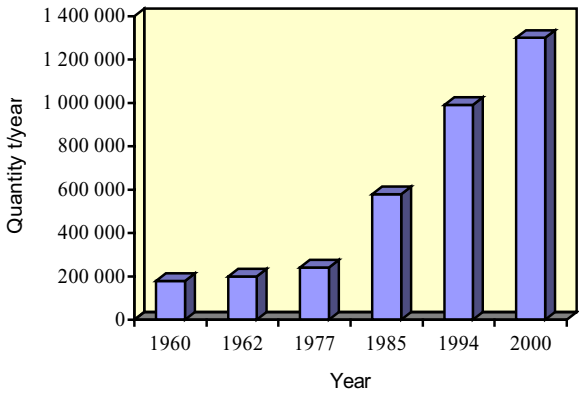
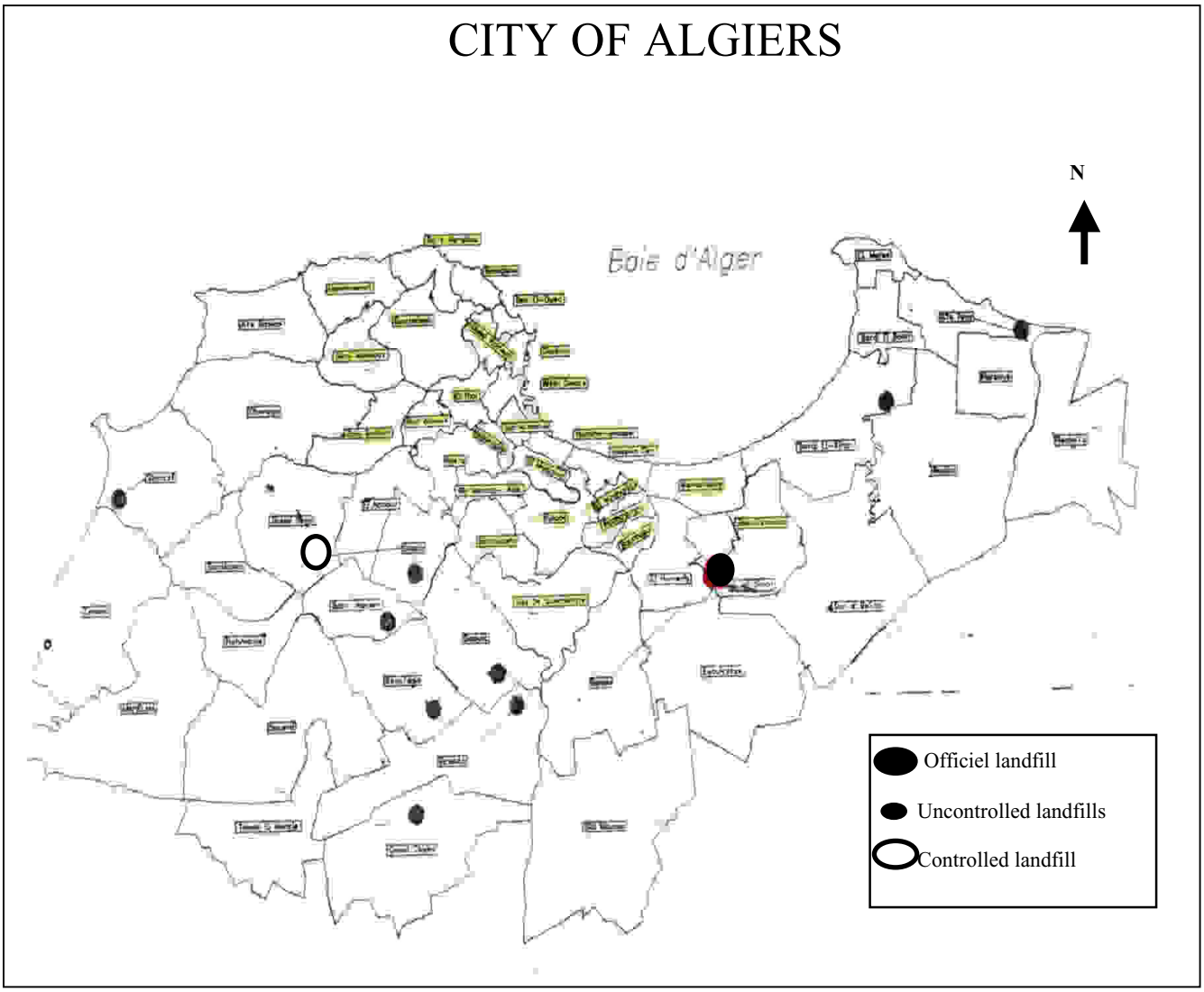


Fig.4: Evolution of production of urban solid wastes in Algiers. (Zebdji.2000)

3.1 The public landfill of Oued Smar

The only official landfill in Algiers is situated 20 km east of Algiers, Oued Smar. It is still exploited despite it's saturation since ten years. It receives all natures of wastes without any priority in sorting. The quantity dumped daily is about 4.000 tons for year 2000 only.

The sorting and the sale of improvable and recoverable materials is done inside the landfill itself by ragmen and rattlers. Their number is about 300 persons working in landfills of Algiers.



Geotechnical map 1: Landfils localization of in districts of Algiers

3.2 Physical characteristics of the site

Topography: The landfill site is located among Oued Smar plain which is situated under the basin of Oued El-Harrach and has a fairly plate morphology. All this region is drained by Oued Smar and its tributaries.

Geological context: This zone is a continuous subsidence where a slow movement of earth crust subsidence occurs under the weigh of sedimentary deposits and deformations action. This subsidence has given rise to an active sedimentation which elements come essentially from the Atlas of Blida relief. The permeability tests carried out on the landfill site have shown that the soil is predominantly clayey whit a high natural waterproofing (Belkacemi, 1993). The permeability coefficient is about 10^{-10} m/s, beyond a deepness of 1 meter. The soil is constituted of clay (45 %), silt (17%) and fine sand (16%).

Hydro geological characteristics: The region of Oued Smar is a marshy (boggy) region characterized by a weak deepness of the hydrostatic level of the aquifer water table. It is a part of the vast aquifer water table of Mitidja, which has deepness about 20 and 24 meters.

Climate characteristics: According to the National Agency of Hydrous Resources, the more important precipitation occurs between January and February, and the less important between July and August. The dominant winds are the Northern winds during the summer and Southwest wind during the winter.

3.2.1 Some data on the landfill

The Landfill opening occurred in 13 June 1978 on the clay exploiting site used for brick manufacturing. The exploiting time was fixed to ten (10) years.

Landfill area: initially planned to cover an area of 12 hectares. Nowadays, it represents more than 25 hectares.

No impact study was carried out before the opening of the landfill.

Actual landfill Height: > 15 meters.

3.2.2 Landfill impacts on environment

The image of a raw and non controlled landfill is characterized by wastes storing of all natures without any respect to a defined planning. Thus, biological and chemical reactions among wastes' constituents and the soil, in presence of air give rise to different aspects of pollution.

Concerning the landfill of Oued Smar, some aspects of these pollution are cited below:

- Unpleasant smell affecting more than 100.000 inhabitants
- Dust
- The fly of light elements: papers, plastics
- Insects proliferation: rodents and agents propagating illnesses.
- Fires
- Breathing illnesses and development of allergies.
- A slight contamination located at the table flowing axis, and down the landfill was detected (Belkacemi, 1993).

3.2.3 Recommended solutions

This landfill having largely exceeded its stocking capacity could not support any further wastes, at the risk of inducing an ecological disaster affecting the whole region of Mitidja. The authorities have become aware of this precarious balance and have taken the decision to close progressively this landfill by 2002 and replace it by a controlled landfill located in Ouled Fayet District.

The works consisting of setting up a compacted earth covering of 40 – 50 cm thickness are on progress. Nevertheless, the rehabilitation of this landfill is not yet in the agenda of the authorities of Algiers City.

3.3 The controlled public landfill of Ouled Fayet

The landfill site has been retained by the global sanitation plan of Algiers, adopted by the Presidential Decree N° 76/53-dated 25/03/76. It is located at 15 km from the Southwest of Algiers and 3 km from the Southern locality of Ouled Fayet.

The localization of this site has been facilitated because of its isolation, soil topography, the weak permeability of the soil and its easy access without crossing the agglomeration because of the existing ways: RN 36 (Algiers – Boufarik) and the Departmental way N°142.

The landfill site lies down on a large shelf lightly undulated at its Southern side where exist many valleys composed essentially of synclinal basins. The area is of 40 hectares, 20 are used to the wastes burying. The flowing direction of depressions is oriented, generally, to the slopes: the versant basin of the site is flowing in Oued El Kerma.

The studies carried out prove the lack of continuous flowing of waters on the landfill site where there is no source. Topography, morphology, and hydrographic of the site give good guarantees against surface waters pollution.

The dominating winds are oriented to South – West in autumn and winter and could reach more than 40 km/h. In sprint and summer, the winds have the same direction but sometimes oriented to North-North – East.

In order to verify the nature of substratum and better know the local geological conditions of the site landfill, detailed studies have been carried out between 1987 and 1998 by many laboratories and controls offices, notably, the National Office of Construction and Dwelling.

Seventy six drillings were implanted at the depth of ten (10) meters in order to investigate the characteristics of the site, and three (03) drillings were carried out in order to monitor the level of the underground water.

These drilling have shown the existence of compacted clay substratum. These materials are not permeable which can permit to deduce that there are no underground water resources.

3.3.1 Immediate environment

Except the two hamlets situated near the site of the landfill and a farm situated at about 100 meters the south, it can be said that the site is completely isolated from the urban area. Cultivated lands (especially cereal and vine) occupy the surroundings of the landfill.

3.3.2 Immediate environment

1. Working rooms

- A security control post situated at the entrance of the landfill.
- An administration building with ten working rooms.
- A maintenance workshop which is constituted of :
- A washing / lubricating room,
- Vulcanizing room,
- Electricity workshop.

2. Weighing bridge.

It is a weighing mechanism. The wastes are weighed at each arrival

3. Closing, portal and signals panels

- Closing up the whole area of the landfill by a wire fence of Two (02) meters height.
- Put in a portal at the entrance of the site.
- Panels for signals are put on near each exit of the landfill.

4. Waste dump, area of reception and unloading platform.

- Strengthening and bituming of the landfill road on a length of 385 meters.
- Interior path made up of fine gravels to allow easy access to all type of trucks and lorries.
- Temporary paths for tipping out wastes.
- Construction of a receiving area at the entrance of the landfill. This area is reserved to special waste such as rubble… etc.
- Construction of an unloading platform for dumping wastes classified as domestic in order to do not disturb work done by skippers especially at rush hours.

3.3.3 planning of the waste digging of the site

The landfill was designed to receive domestic waste of 521 000 inhabitants representing (20) districts of the Algiers ' urban area. The industrial and hospital wastes are not allowed in.

According to the technique of a controlled compacted dump, nine (09) digs of a total volume of 1 365 000 cubic meter will be planned and operated according to planned time of seven (07) years.

The compacting of the wastes allow to have a volume weight of 0.7 t / m^3 , which means a volume of 541 m^3 per day only the year 2000. This volume will reach 691 m^3 per day in the year 2007.

Table 1. Volume of waste stocked per dig.

Number of the dig	Area (m2)	Volume (m3)
Dig 1	7.300	58.400
Dig 2	10.950	87.600
Dig 3	33.030	264.240
Dig 3'	11.745	93.690
Dig 4	21.646	173.166
Dig 5	22.409	179.270
Dig 6	27.350	218.800
Dig 7	35.152	281.216
Dig 8	34.381	278.392
Total dumped	204.381	1.635.048

The works have started in September 2000 and consisted of:

The works have started in September 2000 and consisted of:

- Excavation work through a depth of eight (08) meters,
- Waterproofing of the bottom and the side of the dig using a compacted clay of (25) cm thickness,

The put down of a geomembrane in made of PEHD on the 1.5 mm layer clay. It is packed in the form of rolls of (130) meters of length and an area of 975 square meter. The main characteristics of these geomembrane are :

- Water proofing coefficient : 10^{-14} m / s,
- Failure resistance : 30 N /mm^2 ,
- Splitting resistance : 215 N

This geomembrane has a good behavior against water.

Another clay membrane with the same depth will recover the geomembrane,

Built up of a local draining system connected by sewers to the to the stocking tank. The draining system of the digs 1 and 2 are connected to the draining system of the dig 3. The others digs are working independently from each other.

Built up of (04) control posts of the quality of the water. Two (02) are situated upstream of the landfill, and one is situated at the stocking tank of the wastewater.

Built up of two (02) tanks to recover the wastewater. The first one of (12x24x04) dimensions will receive the affluent water of five (05) digs and has a stocking capacity of about 1 120 cubic meters. The second one will receive the affluent water from the others four (04) digs and has a stocking capacity of about 1 410 cubic meter. For these, two 02) destinations are considered :

Recycling by spraying in order to accelerate the decomposition of the organic materials,

By treatment done at the purification station situated at STAOUELI at twenty (20) Kms to the north of the landfill.

3.3.4 the using mode of the landfill

The wastes are controlled and weighed at the entrance of the landfill before being transported to the digs. Then they are tipped out before being spread in fine layers using caterpillar tracks. The filling up will be done through successive (40) cm compacted layers until reaching a height of 1.5 meter. Then they are recovered by an inert (10) cm compacted soil.

The life service of the Ouled Fayet landfill is estimated to (07) years. The last layer will be at a height of (02) meters and will be slightly rounded in order to make easier the flow of the rainwater.

4 CONCLUSION

Algeria is facing a considerable problem of environment degradation and loss of natural resources. The bad management of urban wastes and their elimination is one of the main causes.

The Oued Smar landfill constitutes a representative example of bad management of wastes and landfills. It shows the inexperience in the choice of waste stocking areas (centers).

However this has allowed having some advises for future studies which would be carried out in this field.

This, in spite of the limited financial resources and the absence of modern technological means, Algeria has undertaken a program which aims to improve the management of solid waste by eradicating none controlled landfills and the progressive fitting out of the controlled ones.

The Ouled Fayet landfill is an example of these new projects. A huge work is still to be done for this last one such as instrumentation and following up.

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