Forecast future production of municipal waste on the basis of a panel data model in Algeria

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Abstract:

This study analyses the factors that influenced the production of municipal waste in Algeria. It carries an estimate of future quantities of waste on the basis of data from 48 departments from 1997 to 2008. We use econometric projection of the waste to determine the factors that influence the production of waste. The analysis shows that the production of municipal waste in Algeria is related to several factors: population density, the retail trade. The projection of future municipal waste amount achieves the 28 million tons in 2025.

JEL : Q53, C33, C53, F18

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Introduction

In recent years, Algeria has experienced strong economic growth that exceeds 5%, the GDP per capita is increasing. Importation from the EU is progressing very remarkable. Following the various programs for economic recovery, several regions have recorded projects including in urbanization with the construction of over one million units over the all territory, the development of Small and medium firms in the context of devices assistance to micro projects, which still within the national agency to support youth employment ....

In parallel with this growth, the generation of municipal solid waste has also experienced significant developments. Evaluated in 2005 to about 8.5 million tons per year or 23 288 ton per day, and this production is growing significantly. According to the MATE, the threshold of 12 million tons of municipal solid waste is certainly reached in 2010. In the study of the MATE on the state of the environment in Algeria indicated that the production of waste per capita in urban areas increased from 0.76 kg / day in 1980 to 0.9 kg / day in 2002 (Metap 2004), to reach 1.2 kg / day on average in 2005 (MATE, 2005). On the other side, there is a gap of almost 30% between the rate of waste collection in smaller towns and cities.

It is emphasized that the coastal cities of Algeria, denser population generate amount of waste significantly higher than those of Highlands and Deep South. As for the capital, she has produced over 0.87 million tons in 2008. A dozen cities produce between 200 and 300 000 tones of MSW per year: this is the case of major cities such as Oran in the west, Constantine in the east and Tizi Ouzou in the center. Twenty medium towns produce between 100 and 190 000 tons per year. Finally, a some cities produce lower amounts of MSW to 50 000 tons per year, they are generally concentrated in the far south (Sahara) and are characterized by low population densities by RGHP 2008.(ONS, 2008)

Urban solid waste was resulting from the household consumption, the public institutions, the commercial premises and the firms. The amount of waste produced varies from one city to another in developing countries, according to several factors; the most important is population growth. To illustrate, during 2007, establishing Net-Com has collected of 763 382 tons of waste (household garbage) in the 28 municipalities in the Wilaya[2] of Algiers where he provides delivery.

The principal question of this paper is to estimate the future production of urban waste in Algeria if the same development programs recorded during the period 1994 to 2005 continuing into 2025? For this, we engaged an econometric analysis of factors that can explain the production of urban waste in Algeria? As a result we make a projection based on these factors.

We first present a summary of the economic literature devoted to questions of factors that may explain the waste flow. The objective of this literature review is to determine these factors, and developed econometric models to produce a projection of waste. Some of these studies are based on the assumption of a proportional change between waste generation and the level of economic activity, the other on the relationship between municipal waste generation and private consumption. Models devoted to developing countries use the income and population as the most important determinants of municipal waste generation.

Next, establish the second point by an empirical study devoted to develop an econometric model based on panel data, which includes the production of waste at the 48 Wilayas, and a set of data on the attractiveness of such territory, the establishment of retail trade, wholesale, firms and population density. And finally we will conclude this study with some remarks and suggestions.

1. Literature Review of Econometrics projection of waste

The article "*Future waste disposal in The Netherlands*" of D. Nagelhout et al published in 1990 is considered a reference in the literature review of the forecast waste. The authors have made an estimate of future amounts of waste in the Netherlands, and the impact of prevention

[2] Wilaya is a set of municipality (equivalent of department)

on the various methods of disposal and recovery. The study period extend from 1986, base year, from 2000, projection year. The object of the study is to present some results of research conducted by RIVM[3] has developed scenarios for waste disposal in the future. Ten of 17 categories of waste were identified by the study concerned with garbage, industrial waste, construction waste, used car's tires, car end of life ... etc.. To achieve the forecast amount of waste, the authors close the generation of each category of waste to factors including consumption and production. Forecasting scenarios of economic growth have been made by the Central Planning Board for the period 1985-2010. Strong growth with a rate of 4%, the average rate (3%) and low growth at 1.4%. The model of D. Nagelhout et al (1990) is based on a simple regression. The explained variable is indicated on the basis of 100, and each type of waste is explained by well-based scenarios of growth. For example, the garbage were explained by the consumption of food / drink, and total consumption. The households waste and assimilates are linked to the consumption of durable goods, commercial and industrial waste are explained by the different production sectors. The study results show that in the case of low and high growth scenario, increased amouts of waste from 1.2 to 2.2% per year, an increase of 15% in 2000 compared to 1986, and this in the absence of any improvement in prevention. However, applying to 13 prevention approaches established by the department, a small reduction in the volume of waste in 2000 compared to the situation in 1986 was recorded. However, a major change is registered in the amounts of waste recycled or reused in the event of a change in environmental policy.

The second study is the Beede and Bloom (1995). The authors studied the production and management of municipal solid waste (MSW) through economic objectives. The object was to make projections into the future by involving the current trends in the amount of MSW and to evaluate the elasticity of income and population with the production of MSW. They focused

[3] National Institute of Public Health and Environmental Protection

their analysis on developing countries, taking into account the example of the United States. The analysis is based on economic reasoning. The MSW studied were divided into two types, which can be reused waste (bottles, newspapers ...) and waste that cannot be reused (for waste health risk). The explanatory variables used by the authors are gross domestic product (GDP / capita) and population. The dependent variable is the total production of MSW is estimated at about 1.3 billion tons in 1990 to 149 countries with an average of 660 kg per capita per day. Several hypotheses have been assumed by the authors on different data sets. The growth of national GDP is assumed to be stable during the eighties, and population growth continues to increase as projected by the World Bank. The overall production of MSW is expected to double during 1990 to 2019 (that is to say an average annual growth rate of 2.4%), the proportion of MSW generation per capita will not double by 2049. The authors estimated the model by OLS, using the following regression:

$$\log(D) = \alpha + \beta_0 log(PIB_{hab}) + \beta_1 log(POP) + \varepsilon \qquad (1)$$

Where (D) is the total amount of MSW tons, $\beta_0$is the elasticity of income generation DSM $\beta_1$is the elasticity of population generation MSW.

Beede and Bloom have the example of Chinese cities and U.S. States, which they proceed to calculate the elasticity's with a model of cross-generation rate of MSW with the explanatory variables in 36 countries and in 45 Chinese cities and 33 U.S. states. The production was realized by three models, in the first model (M1) Chinese cities have been compared to U.S. states, the second (M2) ranks countries by their levels of wealth into four groups (poor: GDP less than 600 $., below average income: 630 $ to 2490 $, above average income: 2490 $ 7050$, and higher incomes: more than 9550 $) by calculating the proportion of each group in the overall production MSW (million tons and percentage), and the size of their populations in the world population and the share of their GDP in total GDP. The third model (M3) compares Taiwan and the United States. In each of these models, the same type of variables was used

(GDP and population). The results that emerge from their study show the existence of a significant discrepancy between the proportions of DSM industrial countries in the world and deposit their share of population in the world population. While in developing countries, the disparity is reflected in the share of the total MSW by MSW and the share of their income to worldwide income. The country analysis shows that MSW generation is positively correlated with the change in per capita income, and that output per capita does not vary with the size of the population in countries with comparable per capita incomes. The authors estimate that the production of MSW is increasing at an annual rate of 2.7% in developing countries until 2010. In the model (M1), a good relationship exists between the production of MSW to one side, and income and population on the other side.

The results show an increase of 1% of income per capita will generate an increase of 0.34% of total DSM, and an increase of 1% of the population will increase overall production from DSM of 1.04%. Model (M2) estimates the waste in countries with low income to 0.53 kg/inhab/day to 1.2 kg/inhab/day. On the basis of population, countries with high income are disproportionately represented in MSW (these countries account for less than a sixth of the world's population, but produce more than a quarter of total MSW). On the other side, on the basis of income, developing countries account for a disproportionate share of DSM (with less than half of global GDP, they produce three quarters of total MSW). Model (M3), presents the results for Taiwan and the United States. Regarding Taiwan, the output elasticity of DSM to changes in income is 0.59. However, it is 1.63 per population variation. Where MSW generation per capita does not vary with the population in countries with comparable incomes, the elasticity of DSM with income per capita rises, it goes to 0.72 (it is less than 1) but it decreases with the population, it is 1. For U.S elasticity of DSM with income are 0.86 and 0.63 for the population. On the assumption that MSW generation per capita does not vary with the population (taking the per capita income constant the elasticity of DSM overall income fell to 0.63. It is near that found in the model (M1). The overall conclusion of the model Beede and Bloom is that MSW generation is related to income as the population, but is more linked to the population to income, that is to say, is near a β_1 and $\beta_0$is less than 1.

Coopers and Lybrand (1996) conducted a study to make a projection of municipal waste by the year 1997 to 2000 in the Netherlands, based on two scenarios. The first scenario forecasts growth of municipal waste generation. The second scenario includes preventive measures that will reduce the waste stream. The starting point of the authors is to assume a trend scenario, where amount of waste are used as reference to evaluate preventive measures to reduce waste. The model is based on an approach developed by RIVM to forecast growth in production of household waste and bulky in the Netherlands. The RIVM model is based on the following assumptions, which are derived from a regression analysis of historical data:

- Increasing the amount of household waste is proportional to the increase in private consumption of food and luxury goods.
- The evolution of bulky waste is related to changes in consumption of durable goods.

The authors have taken a significant event, where the total production of municipal waste is related to the growth of total private consumption. Therefore, the function of municipal waste is a linear function of household consumption. The function is written:

$$Q_{mw} = f(CP) \quad (2)$$

The alternative scenario includes two additional scenarios about the effectiveness of preventive policies due to various uncertainties in the data. This uncertainty makes it difficult to predict the impact of these policies on waste production. Faced with this situation, Coopers and Lybrand suggested two situations, reduction of waste with high rates, 5% in 1997 and 10% in 2000 trend of the situation. The other situation, the reduction is low, 2.5% in 1997 and 5% in 2000 compared to the baseline. This study highlights that the production of municipal waste will increase, but that the evaluations are subject to significant margins of error due to variations in the quality and availability of data (the problem of heterogeneous data).

In 1997 and Bruvoll and Ibenholt (1997) develop a macroeconomic model of general equilibrium to estimate the future production of industrial waste in Norway. The authors' objective is to show the usefulness of an economic model based on the use of production inputs (raw materials ...) and technological progress to explain the future production of industrial waste industry. The authors used a general equilibrium economic model to address the multidimensional problems of waste and which takes into account technological change, relative prices of inputs and interaction of different sectors. The empirical data concern the production of industrial wastes in 1993 (3287.7 thousand tons), and includes paper, plastic, glass, textiles ... etc.. Bruvoll and Ibenholt and assume that the production of waste is proportional to the output and input (raw material ...) in each sector. These inputs may have two purposes, a commodity, or a residue (waste, pollution). So there is a relationship between the amount of goods and the amount of waste, increased production of the product involves an increase in waste. This relationship can be changed if a change in technology is integrated. This increases the number of units produced by keeping the waste production constant. In other words, it will reduce the proportion of waste and production of goods. In general, the model is based on the assumption that the actual amounts of waste are proportional to the explanatory factors, and that the proportionality coefficient is constant or exogenous in a given period. The model developed by the authors is as follows:

$D_{ij}\,(t)$ is the amount of waste type (*j*) produced in a sector (*i*) during the period (*t*)

$D_{ij}\,(t)$ is given by the following function :

$$D_{ij}\,(t) = U_{ij}(t) * D_{ij}(t_0) * d_{ij}(t) \tag{3}$$

Where $U_{ij}(t)$ represents the growth rate of the explanatory variables (value of output or input in the (*i*)), this variable depends on the type of waste (*j*). $d_{ij}(t)$ is the parameter of evolution exogenous explanatory level waste (e.g, the effects of policy measures that influence the production of waste). $D_{ij}(t_0)$ the amount of waste type (*j*) generated in the (*i*) during a reference year, in our case (t_0) is 1993, the amount supplied by the statistics. The total amount of waste type (*j*) is the amount of waste from all sectors, given by the function:

$$D_j(t) = \sum_i D_{ij}(t) \tag{4}$$

The reference year (t_0)=1988 ; the simulation period is from 1988 to 2030. The model contains 33 sectors and 48 products. The authors identified the share of each sector in the production of waste in the base year, and the growth of intensity of the materials. The results presented by Bruvoll and Ibenholt and show that the reference trajectory used to perform a projection of industrial waste takes an average of 1% of technological change in all sectors of production. This means that the input demand per unit of output fell by 1% per year, all things being equal. The effect of relative prices of inputs and technological change varies across sectors. The increase in industrial waste from 1994 to 2010 ranged from 45% to 110% depending on the type of waste, while the total increase is estimated at 64% and industrial hazardous waste to 58%. This increase exceeds the growth of commodity production, and is higher in the case of a domestic matter even with technological advances. In general, increasing waste stream would be included, depending on the type of waste between 35% to 60% by 2010. The projection shows an increase in waste intensity of 2.3% on average. For some waste types, this intensity reaches 18% over the simulation period, while it fell for hazardous waste. Increased inputs mainly explain the increase in waste and increase total production explains the increase of inputs to 52% over the simulation period. Substitution between production factors contributing to increased inputs. Technological change affects the price of inputs.

Contrary to the model and Bruvoll and Ibenholt, Anderson and his co-authors (1998) have developed a simple model that allows for future projections of production of household and industrial waste. This model links the production of various types of waste to various economic activities in Denmark. The authors defined the dependent variable (the amount of waste divided by type and source), and the explanatory variables which are the economic activities generating the waste. Historical data covering the period 1994 to 1996. In terms of household waste in 1996, ISAG has identified 1.964 million tons, accounting for much of the waste produced. These three types include household waste, household waste, green waste and similar waste biodegradable.

The basic assumption of this model is that waste generation is related to the level of economic activity. It assumes that the variation is proportional between the waste products and the level of economic activity. The screening was performed by Eq.(4) which shows the relationship between the amounts of waste and the explanatory variables. It reads as follows:

$$D_{f,s}^{t} = D_{f,s}^{t_0}\left[1 + \alpha_{f,s}\left(\frac{X_{f,s}^{t} - X_{f,s}^{t_0}}{X_{f,s}^{t_0}}\right)\right].\beta_{f,s}^{t} + \varphi_{f,s} Ds_{f,s}^{t} \quad (4)$$

where:

$D_{f,s}^{t}$, $D_{f,s}^{t_0}$ is the amount of waste of type f, the source s in year t, and the reference year t_0. $X_{f,s}^{t}$, $X_{f,s}^{t_0}$ is the explanatory variables for the type f, and the source s, year t, and the reference year t_0 $Ds_{f,s}^{t}$ is the amount of additional waste in addition to the category in year t, can be positive or negative. $\alpha_{f,s}$ is the coefficient of proportionality between changes in the amount of waste and the explanatory variable. $\beta_{f,s}^{t}$is the time-dependent factor to explain changes in relationships. For example, if $D_{f,s}^{t}$, $D_{f,s}^{t_0}$ are the amounts of waste paper / cardboard (f type) of households (source s), the explanatory variable $X_{f,s}^{t}$, $X_{f,s}^{t_0}$ is the private consumption of nondurable goods.

As $\alpha_{f,s}$equal to 1, changes in the amounts of waste are proportional to changes in the explanatory variable. By cons when $\alpha_{f,s}$ equal to 0.5, a 1% increase in the explanatory variable implies an increase of 0.5% of the amounts of waste.

$\beta^t_{f,s}$ is a series of time coefficients normalized to 1 in the reference year. If $\beta^t_{f,s}$ changed in some time, then the ratio of waste is also changing (the ratio between the amount of waste and the explanatory variable). The assumption is $\alpha_{f,s} = 1$, the coefficient of Waste period t, is the product $\beta^t_{f,s}$and the coefficient of the year t_0 is to say: $\left(\frac{D^t_{f,s}}{X^t_{f,s}} = \beta^t_{f,s}\frac{D^{t_0}_{f,s}}{D^{t_0}_{f,s}}\right)$. If $\beta^t_{f,s}$ varies from 5% of the reference year t_0 to year t, the waste coefficient also varies from 5%. This variation may be influenced by changes in policy on waste management, customs agents, packaging of goods. The amount $Ds^t_{f,s}$ may be positive or negative; often the waste is transferred from one category to another. The assumptions are: $\alpha_{f,s} = 1.0$; $\beta^t_{f,s} = 1$ and $\varphi_{f,s} = 0$, Eq.(4) will be reduced to:

$$D^t_{f,s} = c_{f,s}X^t_{f,s} \tag{5}$$

Where $c_{f,s}$ is a constant coefficient of waste on the base year. It is calculated as: $\left[\frac{D^{t_0}_{f,s}}{D^{t_0}_{f,s}}\right]$. This model can be used to analyze how the economy affects the future production of waste. Connect the waste generation in economic activities should be at a more detailed level. The assumption of a constant coefficient of waste implies that the amount of waste follows economic development. Changing the composition of production and consumption may change the proportionality at the aggregate level. In general, in the case of an increase of 10% of all economic activities, household waste are also increasing by 8% to 10% (that is, on the assumption that the index of 1996 is 1 it is 1064 in 2005). The amount of household waste increased from 2,741,200 tons in 1996 to 3,300,577 tons in 2005. At the same time, a total increase in waste generation by 6.6%, 1.5% is attributed to the household. In addition, if the private household consumption increases by 10%, the index of household waste increased from 1 in 1996 to 1,063 in 2005.

A methodology for projecting future waste has been developed by the EEA in 1999 following the report on Europe's environment published in 1999. In this report the issue of waste production in the EU Member States (15) was examined. It focuses on municipal waste (paper, glass, vehicle end of life). The starting point for developing a model projection of waste generation in Europe was to create an inventory of the situation regarding waste management (amount, composition, methods of treatment, type of waste, waste-producing industries ...). The statement was as follows:

- The lack of comprehensive and reliable data on waste,
- No common pattern has been developed for the screening of waste at the European level,
- The existence of a common feeling that the production of waste is related to the level of economic activity,
- The effects of national policies on waste are not appreciated,
- The assessments are subject to a margin of error due to very significant variations in the quality and availability of data.

The model developed by the EEA is dispute models Bruvall and Ibenholt (1997); and Anderson et al (1998), which is based on the relationship between the level of economic activity and the amount of waste produced. These models assume proportionality between two variables. That is, when economic activity increases by 10%, production of waste increases by 10%, which is proportionality constant. The EEA aims to link the production of waste at a level of economic activity in more detail. The starting point is that economic activity in some measures, may explain the production of waste. But linking this production to GDP is not a fair approach, given the origin of municipal waste, and the fact that fluctuations in national income do not necessarily affect consumption. It is based on the explanation of the production of municipal waste and household goods by the share of national income spent on private consumption. This creates a lot of mistakes, following the increase in other expenses of consumption (leisure, housing, energy), which will limit the share of consumer spending on products that generate waste.

The EEA model assumes that the amount of a type of waste depends on a specific economic activity and time. The function that defines this relationship is:

$$D_i^t = f(Y_i^t, T^t) \tag{6}$$

Which, (D_i^t) is the amount of a type of waste (*i*), the period (*t*), (Y_i^t) is the production of a specific economic activity (subject) expressed in monetary terms that produces the type of waste in the period (*t*), and (T^t) is time. The function f is assumed to be a log-linear function, and is written:

$$\log(D_i^t) = a_0 + a_1 \log(Y_i^t) + a_2 T^t \tag{7}$$

It assumes that the amount of municipal waste and household changes proportionally with the consumption of goods. Three categories of goods were determined by the agency, food and drink, clothing, furniture and household equipment. The amount of waste have been estimated by the following Eq.(8) based on Eq.(7) log-linear.

$$\log(D_{mm}^t) = a_0 + 1 \log\left(C_{alim}^t + C_{habi}^t + C_{equi}^t\right) + a_2 T^t \tag{8}$$

Where $D_{mm}^t$is the amount of municipal waste, household variables $C_{alim}^t, C_{habi}^t, C_{equi}^t$ represent the consumption of food / drink, clothing and equipment security. Given the lack of waste data, the estimate used the following Eq.(9) based on Eq.(11) with constant coefficient.

$$D_{mm}^t = \left[\frac{D_{mm}^{t_0}}{\left(C_{alim}^t + C_{habi}^t + C_{equi}^t\right)}\right]\left(C_{alim}^t + C_{habi}^t + C_{equi}^t\right) \tag{9}$$

Where the big hug is the coefficient of Waste in the base year t_0, and the sum of the categories of private consumption is the explanatory variable. Assumptions related to the development of model are as follows: $a_0$is a constant, a_1 is a coefficient of proportionality between the amount of waste generated and the value of economic activity, a_2 is a tendency to equal the annual% change in coefficient waste. The estimation of these coefficients, based on historical observations, is difficult because of insufficient data and multicollinearity. Therefore, the model was simplified by assuming $a_1 = 1$, meaning that the ratio between the amount of waste produced and the production of economic activity follows an exponential trend. The coefficient $a_2$was estimated from historical observations, which give the following equation:

$$\log(D_i^t) - \log(Y_i^t) = a_0 + a_2 T^t \quad \Rightarrow \quad \log\left[\frac{D_i^t}{Y_i^t}\right] = a_0 + a_2 T^t \tag{10}$$

In case of unavailability of data, it is assumed $a_2 = 0$in Eqs. (7) and (8), the model is constant coefficient, hence $e^{a_2 T^t} = 1$ and $a_0 = 0$, we obtain the following equation:

$$\left[\frac{D_i^t}{Y_i^t}\right] = a_0 . e^{a_2 T^t} \tag{11}$$

In practice the coefficient $a_0$is estimated by calculating the average excess amounts of waste over the period. In this study, only the last observed coefficients were estimated. It implies that other factors are constant over the forecast period. Two approaches have been developed to make projections: the first approach considers the data of waste production in recent years using the Eq.(8), and compare historical data with actual data for those years. If there is a good correlation between historical data and real data, the model estimated by this equation is reasonable and can be used to achieve the projection. A good correlation is achieved if a_2 is between (-0.02) and (0.02), t-student is significant and the R^2 greater than 0.6. The second approach is based on the constant coefficient model if the correlation is weak. This involves using the values of the most reliable historical data to produce future projections. Both the above approaches have been developed for the type of waste paper, cardboard and glass.

In raison to lack of data for Austria and the Netherlands the projection of waste was estimated by Eq.(8). The results show that equal 0.0196 and 0.0186 a_2 and that increased amounts of waste reaches a total of 55% and 74% respectively for the two countries during the simulation period from 1995 to 2010 (or 4110 thousand tons and 12,480 thousand tons), it should be noted that this rate was 11% during the period 1990 to 1995. For the remaining countries (except

Luxembourg) the constant coefficient model was used (Eq.9), the estimated results for the same period from 1995 to 2010 showed a total increase of 22% based on 11% from 1990 to 1995 (more than 191,454 thousand tons in 2010).

Other models, the model of V. Karavezyris (2000) which states that the estimated amount of waste produced is done at two levels, national / international or local / regional. The author analyzes the different forms of model associated with the estimation procedure. At the international level, the projection of waste is based on economic activities and time. The explanatory variables are complete consumption, inputs or outputs of production. The model applied can be described as follows:

$$\log D_i^t = \alpha + \beta log Y_i^t + \gamma t \tag{12}$$

where D_i^t is the amount of waste produced by the category (i) the period (t), Y_i^t is the amount of a specific economic activity expressed in monetary or physical, β is the constant coefficient ratio waste production and appropriate economic activity, and γ is the coefficient of a dynamic ratio of waste generation and production of appropriate economic activity. Following the lack of reliable data and significant margins of error in estimates, the model is reduced to simplest form:

$$Y_i^t = \varkappa Y_i^t \tag{13}$$

Where $\varkappa$ is the coefficient of waste from the base year. At the municipal / regional estimates of future amounts and composition of household waste are derived primarily as a function of demographics. The model can be represented as follows:

$$D_i^t = \lambda P_i^t \tag{14}$$

Where λ is a constant term and P is the population.

2. Empirical study

Algeria, an area of 2,381,741 km^2, consists of 48 wilayas (departments), with a 2008 population of about 34.8 million inhabitants spread over 1541 municipalities. Algeria has a population density of 14.59 inhabitants per km^2. About 40% of Algerians are concentrated along the northern coasts of 2% of the total area with an average density of 300 inhabitants per km^2. Thus, much of the country, particularly the Sahara is sparsely populated. The population density varies widely between coastal cities and towns in the South. According to the census of 2008, Algeria has 5.76 million households or 71% in urban towns, 15.7% in secondary towns and 13% in sparse areas. The average size of households is 5.9 persons against 6.6 people in 1998 and is 7.7 persons in nomadic households (ONS, 2008).

In this approach we estimate the total amount of waste in Algeria taking into account characteristics of attractiveness of the territories at the 48 wilaya of Algeria. The objective is to determine the factors that influence the production of waste in an area relative to another to make a projection for 2025. The data was presented below.

2.1. Data Presentation

Our endogenous variable is always the total amount of waste produced at each wilaya. Our data come from estimates by the national agency of the waste, they cover the period from 1997 to 2008. On exogenous variables, we incorporate into the model the following variables: **Density (DENS):** The explanatory variable used in most empirical studies is the population. Here we use population density instead of population to measure the attractiveness of the territories at 48 wilayas. The data on density were calculated using the population census published by the Office for National Statistics and they cover the period from 1997 to 2008. Five general censuses of population and housing (RGPH)[4] have been made since 1966, 1977, 1987, 1998 and 2008. Statistics between the two periods are estimates made by NSO on the

[4] http://rgph2008.ons.dz/

basis of the number of births and deaths each year in each wilaya. We expect that this variable has a positive influence in all regions.

Small and medium firms (SMFs) and crafts **(ART)**: The data relating to SMFs and crafts come from the Ministry of SMFs and crafts[5]. They include two types of SMEs; public and private. The census number of SMEs is based on businesses registered with the National Social Insurance Fund (**CNAS**). The scope of the activity of private SMEs is very wide, twenty-two sectors are concerned with the construction industry and trade are the most attractive. The number of SMFs per year takes into account births, reactivations and radiation thereof to recognize that the SMFs active in the same year. In contrast, public SMEs operate in 33 public sector (tourism, transport, ...). As for the artisans, their enumeration shall be made with the 31 Chambers of Crafts and Trades (CAM) and take into account the number of registrants and the number of delisted on 31 December each year. Three types of craft are concerned, craft goods production, craft production services and traditional crafts. These artisans are individual artisans, cooperatives or artisan enterprises.

In our study, we focus on SMFs and Artisans data distributed over the 48 wilayas countries. The inclusion of this variable in our model is justified by doing that they are concerned by the TEOM and by their production of MSW including packaging of the raw material needed to produce finished products. We expect that this variable positively influences the production of MSW in the big cities.

Trader: Other variables have been introduced into our model, they relate to data on numbers of registered traders within the Centre National du Registre du Commerce (NRC). We distinguish two categories of business: wholesale trade (COM_GT) and trade in detail (COM_D) or legal persons or natural persons. The number of traders per year per wilaya is

[5] http://www.pmeart-dz.org/fr/statistiques.php

composed of the number registered by deducting the radiation to obtain the active traders. These two categories of traders tend to influence the production of MSW.

2.2. Méthodologie et modèle économétrique

The model used here is unexpected by the model of Beede and Bloom (1995). We seek to estimate the impact of the economic attractiveness of Wilayat on the production of household solid waste (MSW). The general model is written as follows:

$$Log(waste_{wt}) = \alpha + \beta_1 \log(DENS_{wt}) + \beta_2 \log(PME_{wt}) + \beta_3 \log(COM\_D_{wt}) + \beta_1 \log(COM\_GT_{wt}) + \beta_1 \log(ART_{wt}) + \varepsilon_{wt}$$

Which, $(waste_{wt})$ represents the amount of waste produced by all residents, merchants, craftsmen and businesses in the wilaya (w) in year t, $(DENS_{wt})$ is the density of the population in each wilaya, (PME_{wt}) is the number of small and medium companies operating in the wilaya (w) in year t, (COM_D_{wt}) , (COM_GT_{wt}) , are the number trader for details, and large respectively, (ART_{wt}) is the number of artisans. ε_{wt} is the error term. The coefficients β_i represent the elasticity's of DENS, SMEs, COM_GT, COM_D, and ART production of solid waste.

Table 1 : The different estimation models

	LDENS	LPME	LCom_gt	LCom_d	LArt	ρ	σ_μ	σ_ν
OLS	0.128 (0.000)***	-0.017 (0.726)	0.241 (0.000)***	0.545 (0.000)***	-0.054 (0.000)***			
Within	2.729 (0.000)***	0.112 (0.020)**	0.011 (0.277)	0.346 (0.000)***	0.041 (0.006)***	0.99	5.7	0.08
Between	0.0824 (0.016)**	-0.090 (0.538)	0.752 (0.000)***	0.337 (0.002)***	-0.068 (0.009)***			
Wallace et Hussain	0.067 (0.002)***	0.364 (0.000)***	0.047 (0.012)**	0.621 (0.000)***	-0.030 (0.115)	0.74	0.26	0.15
Wansbeek et Kapteyn	2.496 (0.000)***	0.142 (0.003)***	0.013 (0.206)	0.371 (0.000)***	0.039 (0.009)***	0.99	5.70	0.08
Swamy and Arora	0.078 (0.000)***	0.419 (0.000)***	0.037 (0.000)***	0.624 (0.000)***	-0.008 (0.499)	0.89	0.24	0.08
MLE	0.089 (0.005)***	0.425 (0.000)***	0.036 (0.012)**	0.623 (0.000)***	-0.003 (0.837)	0.91	0.39	0.12

Table 1 summarizes the results of the coefficients and their p-value estimated by the OLS models, Within, Between. And three other evaluations of GLS. The estimator of Wallace and Hussain estimator Wansbeek and Kapteyn and Swamy and Arora estimator gives more of the coefficients of the variables values, σ_μ, σ_ν. Estimates made for the estimator under Eviews Swamy and Arora (1972), gives $\hat{\sigma}_\mu = 0{,}24$, $\hat{\sigma}_\nu$=0,08, $\hat{\rho} = \hat{\sigma}_\mu^2 / (\hat{\sigma}_\mu^2 + \hat{\sigma}_\nu^2) = 0{,}89$.

The results of various models show that the variable density (**DENS**) is a positive sign significant at a threshold of more than 99%. Variable (**SMFs**) is significant and positive in Model Within a threshold of 95% and in the three random effects models. However this variable is not significant in the OLS model and Between. The retail trade (**Com_d**) to a positive and significant in all models except for the model and the estimator Within Wansbeek and Kapteyn. Wholesale trade (**Com_gt**) is significant and positive in all models. Artisanal activity (**Art**) is significant and positive in models and in the Within estimator Wansbeek and Kapteyn, and a negative effect in the OLS and Between. However, this variable is not significant in the remaining models. We present in detail the estimate by OLS, then the two fixed effects models and random effects.

Table 2: The OLS estimate

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	6.184197	0.303375	20.38467	0.0000
LDENS	0.128066	0.010226	12.52367	0.0000
LPME	-0.017698	0.050652	-0.349413	0.7269
LCOM_GT	0.241226	0.030619	7.878213	0.0000
LCOM_D	0.545034	0.030701	17.75293	0.0000
LART	-0.054100	0.008939	-6.052198	0.0000
R-squared	0.900841	Adjusted R-squared0.899891		

Reading the results of the OLS model shows that the probability of Student's t matching variables are significant at 1% except for the variable that EPCA is not significant. Note that the variable density in a positive coefficient, supporting the hypothesis fairly obvious that population growth is positively correlated with increasing amounts of waste. The assumption of the commercial appeal is also supported by the positive coefficient. The results also show that the attractiveness scale impact negatively on the amount of waste. The industrial attractiveness is not significant with a negative sign. The R2ajustée of the estimate is equal to 0.89.

Regarding the fixed effects model, the most relevant is R2 R2 Within because it gives an idea on the part of intra-individual variability of the dependent variable explained by those variables. It is of 0.636. In this model the variable retail which is not significant and this contrary to our prediction.

Table 3 : The estimated fixed effect model (Within)

	Coefficient	Std. Error	t-Statistic	Prob.
C	-2.088370	0.346528	-6.026546	0.0000
LDENS	2.729435	0.121880	22.39440	0.0000
LPME	0.112677	0.048154	2.339943	0.0197
LCOM_D	0.346896	0.029923	11.59296	0.0000
LCOM_GT	0.011191	0.010293	1.087288	0.2775
LART	0.041141	0.014976	2.747114	0.0062

The random effects model gives the variable craft insignificant.

Table4 : Estimating a random effects model

	Coefficient	Std. Error	t-Statistic	Prob.
C	3.941870	0.224893	17.52777	0.0000
LDENS	0.078791	0.018275	4.311460	0.0000
LPME	0.419506	0.043475	9.649401	0.0000
LCOM_D	0.624151	0.025743	24.24543	0.0000
LCOM_GT	0.037683	0.010217	3.688206	0.0002
LART	-0.008572	0.012696	-0.675189	0.4999

The econometrics of panel data requires two tests, the first test used to verify the existence of significant specific effects through the Fisher test. The second is used to make the choice of estimator between the fixed effects model and random effects model across the Hausman test. We test the first hypothesis of the existence of specific effects:

$$Y_{it} = \alpha + f_i + \beta X_{it} + \mu_{it}$$

H0 : $\alpha_1 = \alpha_2 = \cdots \ldots \ldots \ldots \ldots\ \alpha_n = \alpha$

H1 : $\alpha_1 \neq \alpha_2$

The Fischer test rejects H0.

In the fixed effects model, the probability of the Fisher test is 0.000, so it validates the presence of specific effects in the model. The Hausman[6] test is to test the hypothesis that α_i is correlated with X_{it}:

H0: α_i is uncorrelated with X_{it} and therefore the GLS estimator is consistent and effective;

H1: α_i are correlated with X_{it} and therefore Within estimator is preferable.

Table 5 : Hausman Test

Test Summary		Chi-Sq. tatistic	Chi-Sq. d.f.	Prob.
Cross-section random		561.477615	5	0.0000
Cross-section random effects test comparisons:				
Variable	Fixed	Random	Var(Diff.)	Prob.
LDENS	2.729435	0.078791	0.014521	0.0000
LPME	0.112677	0.419506	0.000429	0.0000
LCOM_D	0.346896	0.624151	0.000233	0.0000
LCOM_GT	0.011191	0.037683	0.000002	0.0000
LART	0.041141	-0.008572	0.000063	0.0000

Table 5 informs us that the probability of the Hausman test is less than 10%, so we reject the null hypothesis. It indicates that the specific effects are correlated with the explanatory variables, so the fixed effects model is preferable to random effects model.

Table 6 : Test of fixed effects

Effects Test	Statistic	d.f.	Prob.
Cross-section F	623.469368	(47,465)	0.0000
Cross-section Chi-square	2196.033254	47	0.0000
Period F	205.974509	(10,465)	0.0000
Period Chi-square	893.301011	10	0.0000
Cross-Section/Period F	593.266102	(57,465)	0.0000
Cross-Section/Period Chi-square	2270.565809	57	0.0000

We evaluate the effects of specifying fixed effects model. Eviews estimated three specifications: the effect period is fixed, the individual effect is then fixed with a common constant. The results show three test sections. Each section contains two tests to test the significance of effects. The first two tests measure the significance of individual effects (F

[6] To execute the Hausman test in Eviews, we must first estimate a random model, then View / Fixed / Random Effects Testing / Correlated Random Effects - Hausman Test.

Fisher and Chi-square). The two statistical values are 623.46 and 2196.03 and p-values respectively. We reject the null hypothesis that the effects are redundant. The other four values assess the significance of common period effects and global effects, respectively. All results suggest that the effects are statistically significant.

Table 7 : Correlation test errors

	Coefficient	Std. Error	t-Statistic	Prob.
RESID01(-1)	0.388724	0.039623	9.810647	0.0000

R-squared	0.152190	Mean dependent var	0.010065
Adjusted R-squared	0.152190	S.D. dependent var	0.074755
S.E. of regression	0.068832	Akaike info criterion	-2.512221
Sum squared resid	2.269414	Schwarz criterion	-2.503525
Log likelihood	603.9330	Hannan-Quinn criter.	-2.508803
Durbin-Watson stat	2.083536		

Under the null hypothesis that errors specific (idiosyncratic) are uncorrelated, the residues of the function must have an autocorrelation coefficient of -0.5. Here, we obtain a ρ -1 = 0388 appears to be far from zero. The Wald test rejects the null hypothesis of no correlation of residuals.

Table 8 : Wald Test

Test Statistic	Value	df	Probability
F-statistic	503.0910	(1, 479)	0.0000
Chi-square	503.0910	1	0.0000

Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
0.5 + C(1)	0.888724	0.039623

Restrictions are linear in coefficients.

If we reject this hypothesis, i.e the errors are auto correlated individuals. So we must adjust our model to account for autocorrelation errors. We run the fixed effects model a second time by including the method of White diagonal standard errors & covariance under Eviews to consider the robustness of our model. The results are presented in the following table:

Tableau 9 : White correction procedure model

	Coefficient	Std. Error	t-Statistic	Prob.
C	-2.088370	1.256169	-1.662491	0.0971
LDENS	2.729435	0.607810	4.490606	0.0000
LPME	0.112677	0.085509	1.317723	0.1882
LCOM_D	0.346896	0.078525	4.417667	0.0000
LCOM_GT	0.011191	0.015215	0.735537	0.4624
LART	0.041141	0.017746	2.318278	0.0209
	Effects Specification			
Cross-section fixed (dummy variables)				
R-squared	0.992697	Adjusted R-squared		0.991898

2.2. Result

After the estimation of fixed effects model, the results led to the following conclusions: firstly that it has variable density (**DENS**) is significant. The elasticity of the density of waste production, however, is 2.72. The amounts of waste produced are highly correlated with density. The densely populated cities tend to produce more waste than cities with low density. This confirms the finding by the department in which the ratio per capita per day in cities was 1.5 kg in medium cities and 0.9 kg and less than 0.7 kg in Saharan cities (MATE, 2005). It appears from the study that the activity of retail trade (**Com_d**) is significant at 100% with a positive effect on waste production and an elasticity of 0.346. The sale of products in retail requires removing packages containing these products (including packaging waste such as cardboard). These packages that facilitate the transport of such goods or merchandise from the wholesaler or retailer are collected directly in the retail merchants. In contrast, the packaging of the product itself (boxes, canned, ...) are generated at the household level is that can be explained by the variable population density.

We also note that the craft (**Art**) is significant at 95% with a small positive elasticity of 0.041. This low yield is caused largely by the craft service production that does not require the raw material that may be likely to generate waste. The only category of waste is produced handicrafts production and that of many traditional handicrafts with very small amounts for the number of craftsmen in each wilaya, which remains very low.

Unlike what we expected, the variable (**SMFs**) and (**Com_Gt**) are not significant. The explanation we can give to the relationship between SME activity and production of waste at each wilaya is that this activity is characterized by the type of activity performed by these SMFs is generally not generate waste treated as household waste so it has a system of collection or disposal rather special (industrial waste for industrial, inert waste for construction activity, green waste from agricultural activities). On the wholesale (**Com_gt**) has no relation with the amounts of solid waste produced. Among the explanations that can be given for this is that the main role of the merchant and provide a link between producers or importers and traders in detail, the products are sold in their original condition without any amendment, and retail merchants and consumers bear the waste.

3. Projections of waste amount for 2025

Our projections of the amount of waste at each wilaya are based on assumptions that the growth of all explanatory variables follows the same trend recorded during the period 1997 to 2007 to the year 2025.

Projected amounts of waste were performed using the command in Eviews Forecast 6. In a general model, Eviews calculated for each case the fitted value of Y using the parameters evaluated and the corresponding values of X and Y:

$$\hat{y}_t = \hat{c}(1) + \hat{c}(2)x_t + \hat{c}(3)z_t$$

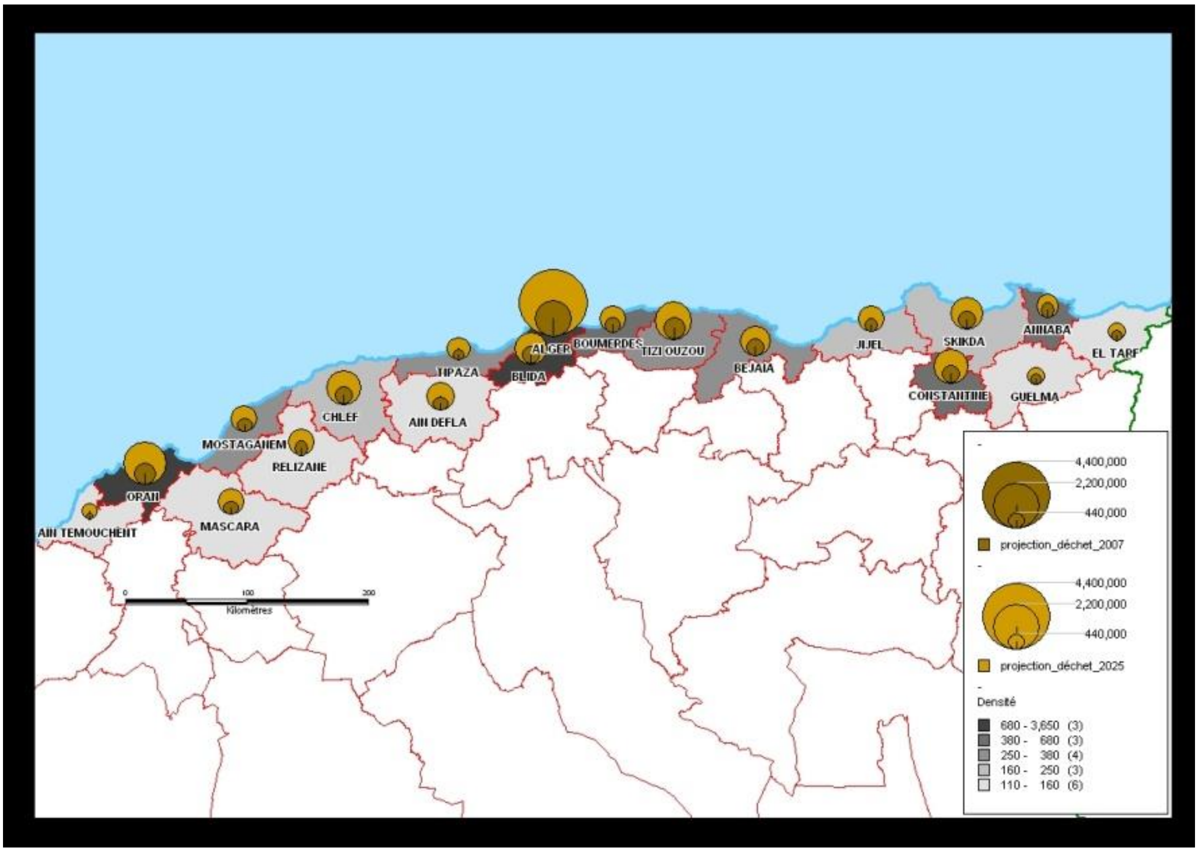
So the forecast made by the static method, calculates the result of a sequence step forward, using actual rather than predicted values for the dependent variables (delayed). Here we ignore the uncertainty coefficient of error types (standar error). The model is written:

$$\hat{y}_{S+k} = \hat{c}(1) + \hat{c}(2)x_{s+k} + \hat{c}(3)z_{s+k}$$

The table shows the average annual predicted amounts of waste each year during the period 1997 to 2007 and 2025. The estimated total amount of waste in 2007 was 9.752 million tonne, it will increase to 28.664 million tons in 2025.

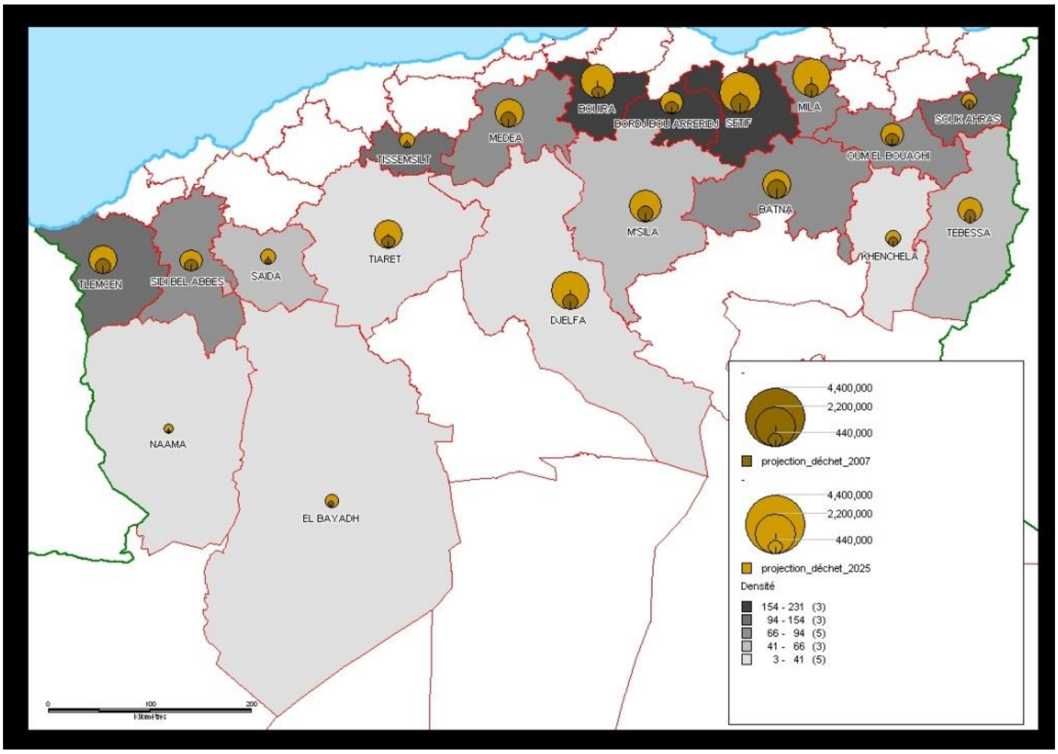
To get a better reading of our results, the predicted amounts were reorganized into three groups, each representing a region (North Highlands, and South).

Fig 1 : Projected amounts of waste from northern Wilayas



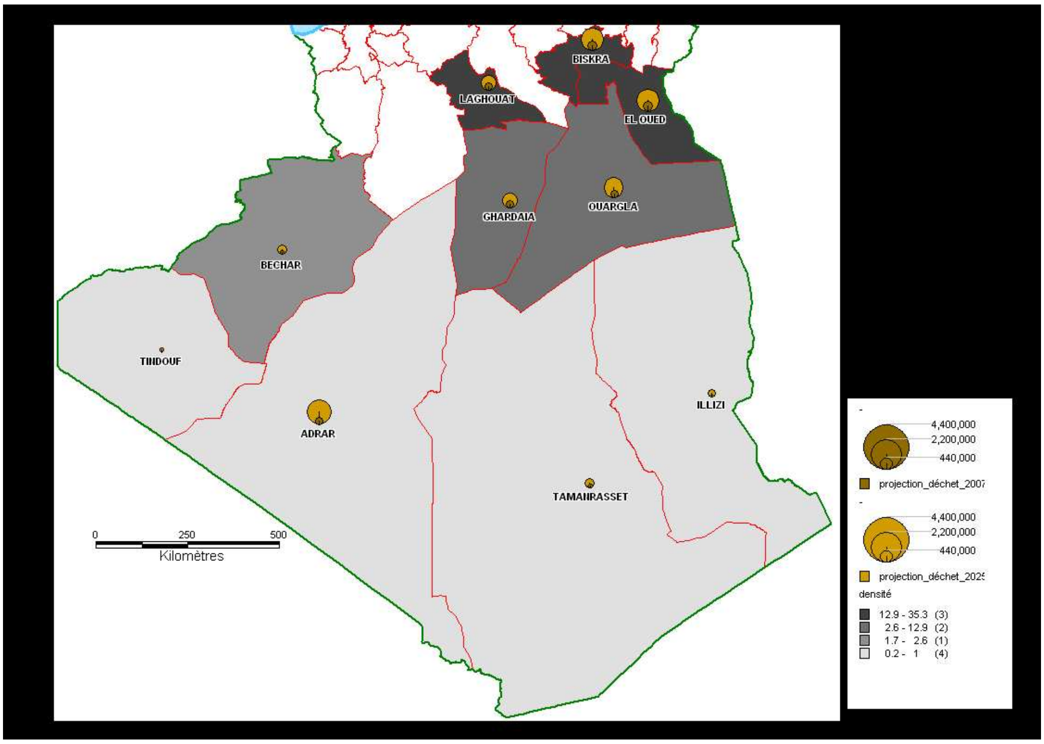
The projected amounts of waste in the northern region to the year 2025 shows that the wilaya of Algiers is the first city in Algeria in the production of solid waste with a doubling compared to the amounts of 2007 or 3 , 39 million tons in 2025. The second is after Algiers Oran Wilaya with nearly 2M tons. The northern region will produce more than 45% of total amount that can be domestically produced, is 13.11 million tons. The high concentration of population and commercial attractiveness are the two most productive areas of waste in these cities. The increase in population causes a sharp increase in food consumption. The development of new technology has pushed households to change their old electronic equipment (TV, ...). These products are products that require packaging including cardboard.

Figure 2: Projected amounts of waste in the wilaya of Highlands



The Highlands region by 2025 will produce more than 41% of the total amount of waste. The wilaya of Setif is the largest producer of waste with 2.36 million ton.

Figure 3: Projected amounts of waste in the South and large South



Wilayas located in the South or the deep south of Algeria are the cities generating less solid waste. The share of this region is 13.36% compared to the total amounts. The wilaya of Adrar on by itself produce more than 1.4 million tons in 2025.

Conclusion

Urban development is a very important element in economic development. This development requires two essential steps: first, the development of land through urban development projects (residential, government, business, trade), secondly, provide the infrastructure necessary to remove solid waste from the all actors in everyday life.

We can expect a growing awareness of waste amounts at the level of attractiveness. Wilayas will certainly pay more attention in the years to come to their environmental policy to address the increased amounts of waste. This increase will create another problem is that the capacity of landfills that an average life of between 7 and 15 years with a tonnage of 100,000 tons per year.

Among the policies adopted to address this phenomenon, it is the policy of source reduction through sorting, eco-design of packaging, reuse, etc .... Another policy is the recycling of waste including plastic, paper, glass. In the absence of a policy of recycling waste from a household Algerian consist of all of these materials in addition to organic waste. Introduce the principle of extended producer responsibility is also needed in environmental policy.

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