KASDI MERBAH UNIVERSITY OUARGLA

FACULTY OF APPLIED SCIENCES

MECHANICAL ENGINEERING DEPARTMENT

Dissertation

Presented to obtain a diploma of

MASTER

Specialty: Mechanical Engineering
Option: Energetic Engeneering
Presented by

BERRIM Imen

Theme

Biomass and bioenergy by-products valorization: modelling of olive waste in Algeria

Publicly supported on: 31/05/2017

In front of the jury:

RAHMOUNI Soumia	MAA	Université Kasdi Merbah Ouargla	Présidente
BENCHIKH Kamel	MAA	Université Kasdi Merbah Ouargla	Examinateur
NEGROU Belkhir	MCA	Université Kasdi Merbah Ouargla	Promoteur

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Dédicace

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À ma mère

À mon idole, mon héros et mon mentor :

À mon père

À l'âme de mon cher oncle Taher

À mon frère et mes sœurs

À tous ceux qui, par un mot, m’ont donné la force de continuer …

Abstract

The valorization of the agricultural oil waste into renewable energy constitutes new trends. We will focus on the agricultural and energy recovery. we chose the olive wastes which is consists from olive pomace and olive mill wastewater For energy recovery, the important quality standards (e.g., physicochemical characteristics, calorific value) will take into consideration. The work will concern the determination of the storage of the biomass as biofuels (biodiesel and biogas). This evaluation will be based on the GIS system to geographically locate the accumulated biomass. Specific software will be used to determine the potential energy generated by biomass. This work should be performed in the main production area which should be a platform development of green energy from biomass and an innovative tool for policy makers, for the sustainable development of the Algerian biomass-growing areas and improving the competitiveness of this sector.

Resumé

La valorisation des déchets d'huiles agricoles dans les énergies renouvelables constitue de nouvelles tendances. Nous concentrerons sur la récupération agricole et énergétique. Nous choisissons les déchets d'olive qui se composent les grignons d'olive et les margines d'olives, pour la récupération d'énergie, les normes de qualité importantes (par exemple, les caractéristiques physico-chimiques, le pouvoir calorifique) prendront en considération. Le travail concernera la détermination du stockage de la biomasse comme biocarburant (biodiesel et biogaz). Cette évaluation sera basée sur le système G pour localiser géographiquement la biomasse accumulée. Un logiciel spécifique sera utilisé pour déterminer l'énergie potentielle générée par la biomasse. Ce travail est réalisé dans la zone de production principale qui devrait être une plate-forme de développement de l'énergie verte à partir de la biomasse et un outil novateur pour les décideurs, pour le développement durable des zones algériennes de croissance de la biomasse et l'amélioration de la compétitivité de ce secteur.

ملخص

تقييم زيوت المخلفات الزراعية في مجال الطاقة المتجددة يمثل أهداف جديدة. ركزنا على استعادة الطاقة الزراعية. كان اختيارنا هو نفايات الزيتون التي تتكون من نواة الزيتون ومياه النباتية للزيتون لاستعادة الطاقة، ونأخذ كمعايير والخصائص الفيزيائية والكيميائية، القيمة الحرارية. العمل يخص تحديد تخزين الكتلة الحيوية كوقود حيوي (وقود الديزل الحيوي والغاز). ويستند برنامج نظم المعلومات الجغرافية على تحديد جغرافيا الكتلة الحيوية المتراكمة. وسيتم استخدام برامج معينة لتحديد الطاقة الكامنة الناتجة عن الكتلة الحيوية. يجب أن يتم تنفيذ هذا العمل في منطقة الإنتاج الرئيسية التي يجب أن تكون منبرا لتطوير الطاقة الخضراء، لتحقيق التنمية المستدامة في مجالات النمو والطاقة الجزائرية من الكتلة الحيوية وتحسين القدرة التنافسية لهذا القطاع

Summary

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Introduction

General Introduction

The Non-renewable energy sources are fossil energies as petroleum, the coal and gas whose limited reserves may be depleted. The Renewable sources are energy solar, hydraulic and biomass that is the source with the greatest potential to help meet the energy needs of modern society, and good for developed economies than for developing economies around the world (From Parliamentary Assembly - Union for Mediterranean). This biomass makes many services to the environment and man: food production, CO2 capture, soil fixation ...

The development of bioenergy can be considered as a concrete solution to the deployment of renewable energies in Algeria. The potential of bioenergy is developed exclusively from the volume of crop residues and from agricultural waste, and the valorisation of agricultural wastes that are rich in organic matter can make a significant contribution to the ever-increasing demand for fossil fuels.

Almost all olives are produced by the Mediterranean countries, of which Algeria produces about 1% of world production [1], The extraction of oil from oil mills generates large quantities of by-products. These are mainly mill wastewater (liquid) and pomace (pasty). Indeed, 100 kg of olive produce on average 35 kg of pomace and 100 L of wastewater [2]. Olive pomace and olive mill wastewater can be used as a good fuel after heat treatment according to some references .

In this work our main objective is the valorisation of the by-products of the olive industry, this evaluation will be based on the GIS system to geographically locate the accumulated biomass. Specific software will be used to determine the potential energy generated by biomass. The present work has two main parts:

- A bibliographic overview: the potential of biomass and bioenergy and its uses, olive production in Algeria, oil extraction methods, olive chemical composition and waste characteristics.

- Estimated bioenergy potential (biofuels: biodiesel, biogas) of olive waste from Algeria's total production in 2015.

Chapter.I: literature review

1. Introduction

Renewable energy is an energy source that is naturally restocked, it consists by some types: Photovoltaic or thermal solar energy, Hydro power (Ocean currents), wind energy, Soil energy geothermal energy and Biomass energy from organic matter which includes wood, biofuels or biogas this energy is produced by burning or metabolizing organic matter that's we will see in this chapter.

The sustainable use of vegetable resources is definitely a global goal to be transmitted to the generation to come. However, sustainability is also associated to the local productions, therefore responding to the specific needs of the population. Production of food is unavoidably linked to the production of waste that later needs to be disposed of in some way. The valorisation of wastes could represent a joint solution with great advantages for economy and environment. Several solutions have been proposed, among them the processing of wastes producing new materials to be employed in fields also far away from the food world and final residues, which can be valorized by a variety of energetic application.

2. Biomass & bioenergy

2.1 Definitions

2.1.1 Biomass

Biomass is the most widely used renewable energy source in the world today. It is used mostly in solid form and, to a lesser extent, in the form of liquid fuels and gas. The utilization of biomass for energy production has increased at only a modest rate in modern times. Biomass is used to meet a variety of energy needs, including generating electricity, heating homes, fueling vehicles and providing process heat for industrial facilities. Biomass potential includes wood, animal and plant wastes [3]. Biomass is the biodegradable fraction of products, wastes and residues from agriculture in forestry and related industries and the organic degradable fraction of industrial and municipal waste [4]. It is the primary source of renewable energy, combustion is the most widely used process for this whether they are individuals, industrialists or communities [5].

2.1.2 Bioenergy

Bioenergy is the global term for heat and energy from organic matter [6]. Bioenergy is energy produced from biomass and all major organizations and countries worldwide define it in a similar way; The UN’s Food and Agriculture Organisation (FAO) defines bioenergy as all energy derived from biofuels where biofuels are fuels produced directly or indirectly from biomass [7]. International Energy Agency (IEA) consider bioenergy as the energy produced from material which is directly or indirectly produced by photosynthesis and which is utilised as a feedstock in the manufacture of fuels and substitutes for petrochemical and other energy intensive products [8].

The different ways of using bioenergy:

- Electricity production and heat using electric power stations exploiting biomass (mainly using wood as raw material), central heating system for biomass (wood, peat, and may also be decentralized), central of biogas (the biogas being produced by fermentation).
- Fuels in the form of :
  - Bioethanol (fermentation of sugar), vegetable oils (rapeseed, soybean), biodiesel (transesterification of vegetable oils), biomethane (from biogas) that is the first generation.
  - The fuels of the sector BTL (biomass to liquid - from biomass to liquids) and bioethanol derived from cellulose, and that is the second generation.
  - The fuels obtained from algae, the third generation [9].

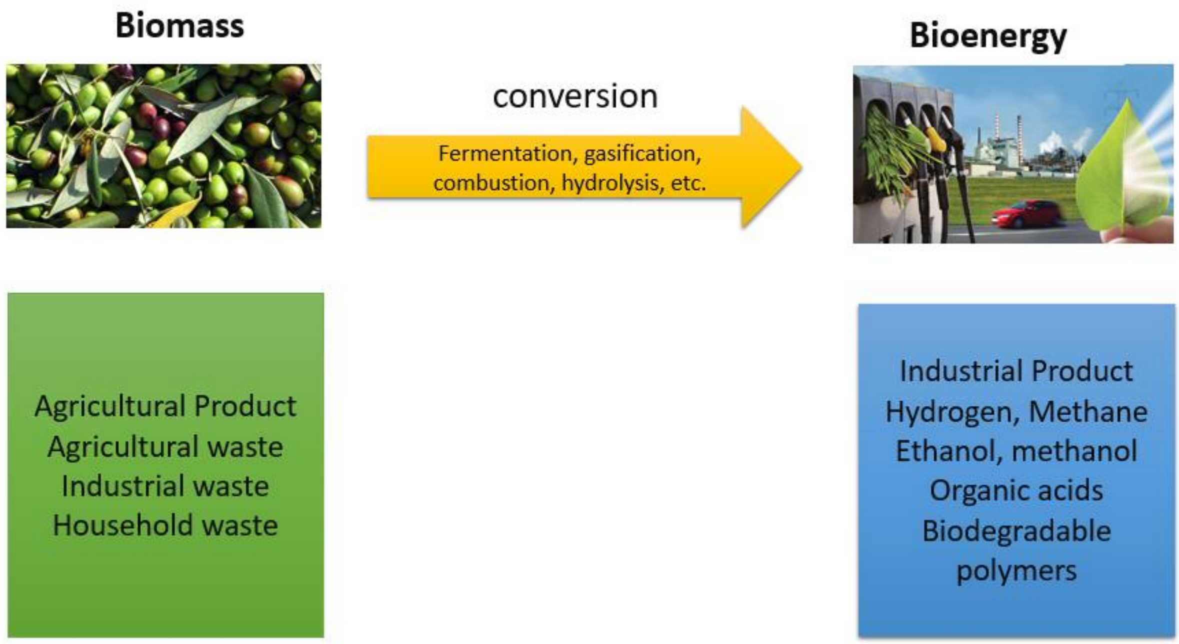


Figure.1: the transformation of the biomass to energy.

2.2 Technology applications of biomass

The release of energy from the combustion of biomass imitates natural processes. Therefore, the energy obtained from biomass is a form of renewable energy and, in principle, utilizing this energy does not add carbon dioxide to the environment, in contrast to fossil fuels. Of all renewable sources of energy, biomass is unique in that it is effectively stored solar energy. Furthermore, it is the only renewable source of carbon and is able to be converted solid, liquid and gaseous fuels [10]. Biomass can be used directly (e.g. burning wood for heating and cooking) or indirectly by converting it into a liquid or gaseous fuel (e.g. alcohol from sugar crops or biogas from animal waste) using converting technologies [11]. The net energy available from biomass when it is combusted ranges from about 8 MJ/kg for green wood, to 20 MJ/kg for dry plant matter, to 55 MJ/kg for methane, as compared with about 27 MJ/kg for coal, Many biomass fired electricity generators use wood and waste materials of forestry and agricultural processes [12].

2.2.1 Biofuels

Currently biofuels are combined with oil-based fuels so that typical United Kingdom (UK) petrol is composed of 3-4% biofuel. At present much of this biofuel comes from sources that directly or indirectly compete with land and resources that would otherwise be used to grow food [13].

It can be defined as liquid fuels produced from biomass for either transport or burning purposes. They can be produced from agricultural and forest products, and the biodegradable portion of industrial and municipal waste [5]. There are two types of transport biofuel: bioethanol and biodiesel which account for more than 90 per cent of global biofuel usage [14]. The olive oil industry produces large amounts of wastes; Two types of these wastes - fallen olives left on the ground in orchards, and olive pomace from olive mills - may contain large amounts of residual oil which is not suitable for marketing as edible olive oil, and thus may be utilized for production of biodiesel. In addition, the dry matter from these wastes may contain large amounts of cellulose and hemicellulose, which may be utilized for production of bioethanol [15]. Bioethanol is a distilled liquid produced by fermenting sugars from sugar plants and cereal crops Bioethanol can be used in pure form in specially adapted vehicles or blended with gasoline. Bioethanol can be blended with gasoline in any proportion up to 10 per cent without the need for engine modification [16]. Biodiesel or vegetable oil methyl ester is produced from the reaction of vegetable oil with ethanol or bioethanol, Oil is produced from oily crops or trees such as rapeseed, sunflower, soya, palm or coconut, but it can also be produced from animal fats, tallow and waste cooking oil, Similar to bioethanol, biodiesel can be used in pure form in specially adapted vehicles or blended with automotive diesel [16].

2.2.2 Bio-power

Bio-power, or biomass power, is the use of biomass to generate electricity. There are six major types of bio-power systems: direct-fired, cofiring, gasification, anaerobic digestion, pyrolysis, and small, modular. Most of the bio-power plants in the world use direct-fired systems. They burn bioenergy feedstocks directly to produce steam. This steam is usually captured by a turbine, and a generator then converts it into electricity. In some industries, the steam from the power plant is also used for manufacturing processes or to heat buildings. These are known as combined heat and power facilities. For instance, wood waste is often used to produce both electricity and steam at paper mills. [14] In 2008, the United States generated more than 11,000 megawatts of bio power from landfill gas, sorted municipal waste, wood residues, and other sources—primarily for use by the forest products industry, utilities, and large institutions [17], additional demand for bio power is met entirely from corn stover and wheat straw. Simulated demand of 88 billion kWh of electricity is generated through the use of 58.8 million dry tons of crop residues in 2005 (Figure 2).

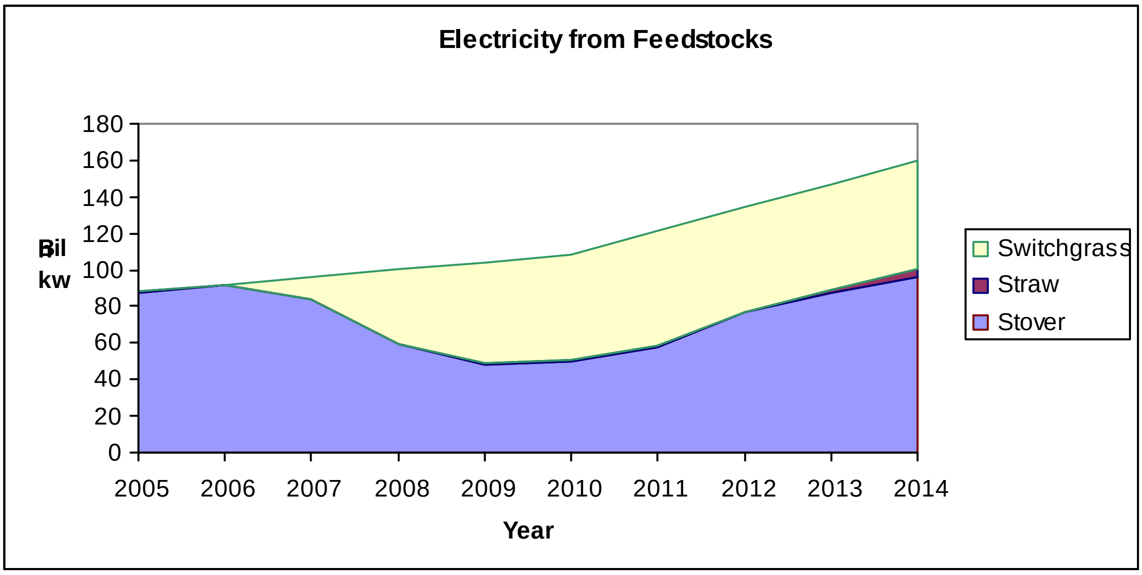


Figure 2. Feedstock quantities used in the production of electricity by type [18].

2.2.3 Bio-products

Biomass can be used to produce a variety of biodegradable plastic products, whatever products we can make from fossil fuels, we can make using biomass. These bio-products, or bio-based products, are not only made from renewable sources, they also often require less energy to produce than petroleum-based products. Researchers have discovered that the process for making biofuels - releasing the sugars that make up starch and cellulose in plants, also can be used to make antifreeze, plastics, glues, artificial sweeteners, and gel for toothpaste [14]. Bio-products make up a very small portion of total feedstock demand. Levulinic acid, which is the only bio-product using biomass, only accounts for 0.02 percent of total biomass feedstock demand [18].

2.3 Biomass potential:

Today, there are 1.4 billion people around the world that lack access to electricity, some 85% of them in rural areas. Without additional dedicated policies, by 2030 the number of people drops, but only to 1.2 billion. Some 15% of the world's population still lack Son the traditional use of biomass is projected to rise from 2.7 billion today to 2.8 billion in 2030 [19, 20].

Table.1: Number of people relying on the traditional biomass use as their primary cooking fuel in 2009 (million people) [20].

	Rural	Urban	Total
Africa	481	176	657
Sub-saharan Africa	477	176	653
Developing Asia	1694	243	1937
China	377	47	432
India	765	90	855
Other Asia	533	106	659
Latin America	60	24	85
Developing countries	2335	444	2679
Wolrd	2335	444	2679

Bioenergy technologies have applications in centralized and decentralized settings, with the traditional use of biomass in developing countries being the most widespread current application. Bioenergy typically offers constant or controllable output. Figure.3 shows the share of bioenergy in the world energy mix.

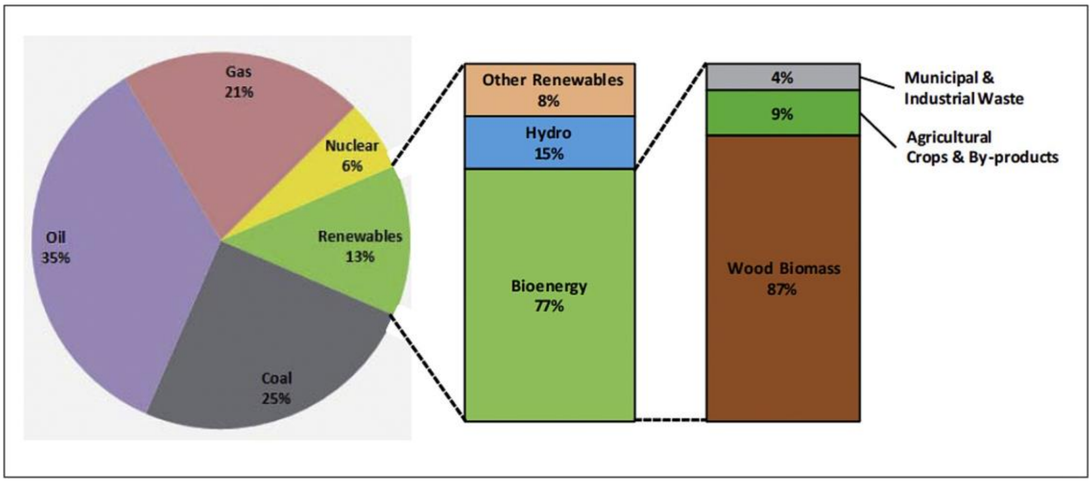


Figure.3: share of bioenergy in the world primary energy mix [21].

Biomass, mainly, now represents only 5% of primary energy consumption in industrialized countries [20]. However, much of the rural population in developing countries, which represents about 50% of the world's population, is reliant on biomass, mainly in the form of wood, for fuel, Biomass accounts for 35% of primary energy consumption in developing countries, raising the world total to 14% of primary energy consumption [20,21].

2.3.1 Potential in the world

In 2009 the biomass exploited in the world represents a primary energy of 27.5 EJ / year (7,639 TWh / year). In 2011, the potential of forest, agro-food and urban biomass is estimated at 19.5 million tones of dry matter. This equates to gross thermal energy of 334 PJ / year (93 TWh / year) [22].

The literature review comes to the conclusion that the global potential of biomass for different categories in the studies ranges from less than 50 EJ/year to more than 1 000 EJ/year by 2050 [23].

2.3.2 Potential in Algeria

Algeria has an area of (238174100ha), of which (42889305ha) cultivable or (8461775ha) used so a very great agricultural potential [24]. The energy potential of biomass residues would be about 2.1 Gtep that of energy crops 6.2 Gtep [25].

2.4 Biomass uses

Biomass is the fourth largest source of primary energy in the world (meaning 12% of the total energy consumption) and rising to nearly 40% of it in some developing countries [26]. European Union objective to reach about 20% total energy use coming from renewable sources by 2020 directly focuses on biomass, as its consumption is expected to have grown by 260% by that date [27].

Biomass provided 1.2 billion TEP in the world in 2011, while global energy consumption was 12 billion TEP and contributed 80% of renewable energies [5].

The use of biomass is mainly practiced in developed countries [28]:

- 84.3 TWh in Western Europe
- 67.6 TWh in North America
- 27.3 TWh in Southeast Asia
- 20.7 TWh in South America

Many studies have demonstrated that just minor technology improvements could increase the efficiency of biomass energy production and use significantly, maintain high productivity of biomass plantations on a sustainable basis and mitigate environmental and health problems associated with biomass production and use. The main technology options are summarized in Table 2, and are described below. Each technology has its own advantages according to the biomass source and form of energy requirement [29,30].

Table.2: Main characteristics of biomass conversion technologies [29,30].

Conversion technology	Biomass Type	Example of Fuel used	Main product	End-use	Technology status
Combustion	Dry biomass	Wood logs, chips and pellets, other Solid biomass	Heat	Heat and electricity (steam turbine)	Commercial
Co-firing	Dry biomass	Agro-forestry Residues (straw)	Heat/electricity	Electricity and heat (steam turbine)	Commercial
Gasification	Dry biomass	Wood chips, pellets and solid waste	Syngas	Heat (boiler) and electricity (engine, gas turbine)	Commercial
Pyrolysis	Dry biomass, and biogas	Wood chips, pellets and solid waste	Pyrolysis oil	Heat (boiler) and electricity (engine)	Commercial
CHP	Dry biomass	Straw, forest residues, wastes and biogas	Heat and electricity	Combined use of heat and electric power (combustion and gasification)	Commercial
Etherification/ Pressing	Oleaginous Crops	Oilseed rape	Biodiesel	Heat (boiler), electricity (engine) and transport fuels	Commercial
Fermentation/ hydrolysis	Sugar, starches, and cellulosic material	Sugarcane, corn, and woody biomass	Ethanol	Liquid fuels and chemical feedstock	Commercial
Anaerobic Digestion	Wet biomass	Manure, sewage sludge, and vegetable waste	Biogas and by-products	Heat (boiler) and electricity (engine, gas turbine)	Commercial

Combustion technologies produce about 90% of their energy from biomass, converting biomass fuels into several forms of useful energy, e.g. hot air, hot water, steam and electricity. Commercial and industrial combustion plants can burn many types of biomass ranging from woody biomass to municipal solid wastes [31]. The simplest combustion technology is a furnace that burns the biomass in a combustion chamber. Biomass combustion facilities that generate electricity from steam-driven turbine generators have conversion efficiency between 17 and 25%. Cogeneration can increase this efficiency to almost 85%. Large-scale combustion systems use mostly low-quality fuels, while high-quality fuels are more frequently used in small application systems. The selection and design of any biomass combustion system is primarily determined by the characteristics of the fuel, the environmental constraints, and the cost of equipment and the size of the plant. The reduction of emissions and efficiency are the main goals. There is an increasing interest in wood-burning appliances for heating and cooking [32].

3. Olive products as Biomass/Biofuels

The cultivation of olive trees, with a high cultural and heritage value in the Mediterranean region, and olive oil production, account for about 97% of world production. This production is accompanied by the emergence of by-products [33].

In the context of the possible implementation of a plan for the development of waste treatment and energy recovery for the production of biofuels in Algeria, an inventory of waste and biomass is required. Indeed, a multitude of local raw materials convertible into biofuels is available such as: agricultural waste, waste from the agri-food industry and releases from the paper industry. Energy crops not intended for food and already being tested in the Mediterranean Basin. The use of waste for biofuel production is very interesting, however, with regard to energy crops, it will be necessary to take into account the fact that they must not require large quantities of water and must occupy land that will not be used for food crops [34].

3.1 Chemical composition of the olive

In order to understand more easily the variations in the chemical composition of the different types of olive waste it may be useful to recall (Table 3) the chemical composition of the various components of the olive [35].

Table.3: Chemical Composition of Mature Olive Components

Part	Material AZ total	Marterial grasses	Crude fiber	Mineral materials	Non-nitrogenous extract
Epicarpe	9 ,8	3,4	2,4	1,6	82,8
Mesocarp	9,6	51,8	12	2, 3	24,2
Endocarp (Kernel and almond)	1,2	0,8	74,1	1,2	22,7

The part richest in oil is the mesocarp (or pulp), and that which is richer in crude cellulose the endocarp (or nucleus) [35].

3.2 Waste characteristics from olive oil production

The oil production process can be subdivided in two main phases:

3.2.1 Oil extraction and purification

Oil is extracted by a press or a decanter, water and solids are thus separated from the oil and further centrifuged in order to recover residual oil. Oil is purified through clarification by sedimentation or filtration by vibrating screens. Wastewater streams are also clarified before disposal. Residual solids from the purification step are mixed with those coming from the extraction process [36].

3.2.1 Preparation of an homogeneous olive pulp

By means of grinding and mixing pulp and olive-stone, followed by a beating process to further break down olive cells and to create large oil droplets [36].

Table.4: Oil yield and waste amount as a function of extraction technology.

Production process	Input	Amount of input	Output	Amount of output
Pressing	Olives	1 t	Oil	200 kg
	Washing water	0,1–0,12 m^3	OH	400 kg
			OMW	400–600 l
Three-phase decanter	Olives	1 t	Oil	200 kgl
	Washing water	0.1–0.12 m^3	OH	500–600 kg
	Fresh water for decanter	0.5–1 m^3	OMW	1000–1200 l
Two-phase decanter	Olives	1 t	Oil	200 kg
	Washing water	0.1–0.12 m^3	OH	400 kg
			OMW	85–110 l

OMW olive mill wastewater, OH olive husk

The main chemical characteristics of olive mill wastewater (OMWW) and the solid residue from olive oil extraction processes are summarized in (Table 5). In this review, the term “solid residue” or “olive pomace” refers to the pomace obtained from the different olive oil extraction processes. The term “olive cake” is used specifically for pomace obtained from pressing processes and three-phase systems, whereas two-phase olive mill waste (TPOWM) is a term specific to pomace from two-phase systems [37].

Table.5: Properties of olive residue [38].

Proximate analysi (wt.%)	s	Component ana (wt.%)	lysis	Elemental analy (daf [a])	sis
Moisture	10.6	Cellulose	56.0	Carbon	44.82
Volatiles	70.4	Oil	4.7	Hydrogen	5.08
Ash	3.7	Protein	4.25	Nitrogen	0.92
Fixed carbon	15.3	–	–	Oxygen[b]	49.18

[a] Dry, ash-free basis. [b] By difference.

4. Conclusion

The use of renewable raw materials can help to preserve raw material resources as the petroleum and the bioenergy from forestry and agriculture plays a key role in the fight against climate change and increases the security procurement of energy, biomass is used to meet a variety of energy needs, with a good potential in the world, especially in industrialized countries, with increase over time, its application in bio-power, bio-products and biofuels it occurs from agricultural waste.

18%, of the surface of Algeria cultivable what gives us a large amount of agricultural wastes and in the following chapter we will value the olive waste to have the bioenergy.

Chapter.II: Valorisation and estimation of potential production

1. Introduction

The valorisation of wastes has economic advantages (Contributes to sustainable development and economic autonomy for biogas producers) and environmental advantages (Avoiding pollution with a significant reduction in CO2 and CH4 emissions). It makes it possible, through the sale of energy, to reduce by at least 20% the price of treatment of urban waste. It reduces the volume by 90% and the waste mass by 70% [39].

Among the several types of waste; Organic wastes, and in the olive oil industry which produces the oil as a main product, we obtain large quantities of by-products, which are two residues; one liquid (olive mill wastewater) and the other solid (the pomace, Leaves and twigs) in this chapter we will valorise this two type of wastes.

2. Olive production:

The world's olive-growing area is estimated at 8.6 million ha for a production of about 17.3 million tons of olives, on which more than 800 million olive trees are planted. The first four producing countries (Spain, Italy, Greece and Turkey) account for 80% of world olive production and the top ten, all located in the Mediterranean area [40].

Almost all olives are produced by the Mediterranean countries, including Algeria, which produces about 1% of world production [1].

Algeria has 59,724,085 olive trees in an area of 419,544 ha in 2015 is distributed in several region, the table 1 clarify the olive distribution in the 48 region and its yield.

Table 1: Number of trees in Algeria 2015 [41].

Region	Area occupied (ha)	Number of trees	Productivity (kg/trees)
1 ADRAR	0	0	0
2 CHELF	4 310	601 090	14,7
3 LAGHOUAT	2 082	468 205	20,0
4 O.E.BOUAGHI	1 557	212 865	8,6
5 BATNA	10 477	2 066 964	30
6 BEJAIA	52 798	4 557 164	21,1
7 BISKRA	4 245	962 349	20,8
8 BECHAR	1 334	371 076	4,2
9 BLIDA	2 237	339 741	24,7
10 BOUIRA	35 098	4 502 950	29,2
11 TAMANRASSET	174	17 400	0
12 TEBESSA	8 097	1 488 971	6,6
13 TELMCEN	13 698	1 848 667	56,8
14 TIART	7 683	1 298 869	11
15 TIZI OUZOU	35 608	4 009 604	13,3
16 ALGER	94	43 151	14,7
17 DJELFA	10 898	2 179 600	12,2
18 JIJEL	14 975	1 632 750	12
19 SETIF	20 706	2 417 925	14,9
20 SAIDA	4 194	460 649	29
21 SKIKDA	10 758	1 503 059	17,8
22 S.B.ABBES	7 645	902 292	45,5
23 ANNABA	748	109 621	19,3
24 GUELMA	9 035	900 381	7,1
25 COTANTINE	895	173 120	8,4
26 MEDEA	8 165	967 830	27,5
27 MOSTAGHNEM	7 467	1 599 300	16,8
28M’SILA	10 244	1 966 850	8,6
29 MASCARA	13 165	1 696 390	43,6
30 OUARGLA	642	106 364	21
31 ORAN	6 733	1 307 000	14,1
32 EL-BAYADH	757	631 700	10
33 ILIZI	122	17 019	1,7
34 B.B.ARRERIDJ	25 001	2 280 813	11,8
35 BOUMERDES	7 926	861 135	11,1
36 EL-TAREF	4 955	555 075	21,7
37 TINDOUF	124	25 235	0
38 TISSEMSILT	6 580	847 245	12,7
39 EL-OUED	3 000	1 133 360	3,2
40 KHENCHELA	6 500	1 158 690	13,3
41 SOUK-AHRAS	8 057	1 446 760	13,9
42 TIPAZA	1 790	596 368	35,7
43 MILA	10 583	1 259 700	14,4
44 AIN-DEFLA	7 150	1 342 500	27,8
45 NAAMA	2 528	630 100	6,8
46 A.TEMOCHENT	4 564	976 880	17,3
47 GHARDAIA	1 250	308 300	11,4
48 GHELIZANE	9 926	1 531 700	29,6
TOTALE ALGERIE	**419 544**	**59 724 085**	**19,2**

We note that the following six regions represent the biggest number of trees compared to the others:

-BEJAIA: 85 trees/ha

-BOUIRA: 128 trees/ha

- TIZI-OUZOU: 112 trees/ha

-B.B.ARRERIDJ: 91 trees/ha

-SETIF: 116 trees/ha

- BATNA: 179 trees/ha

The figure 1 represent the distribution of olive trees in the six top region

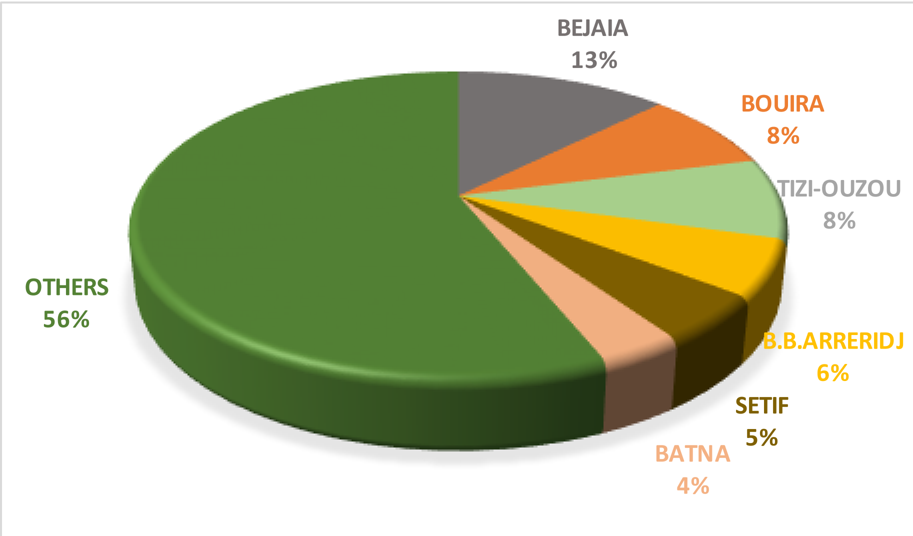


Figure 1: Distribution of olive trees by region.

We represent the distribution of the number of olive trees in the 48 regions in the map of Algeria (figure.2).

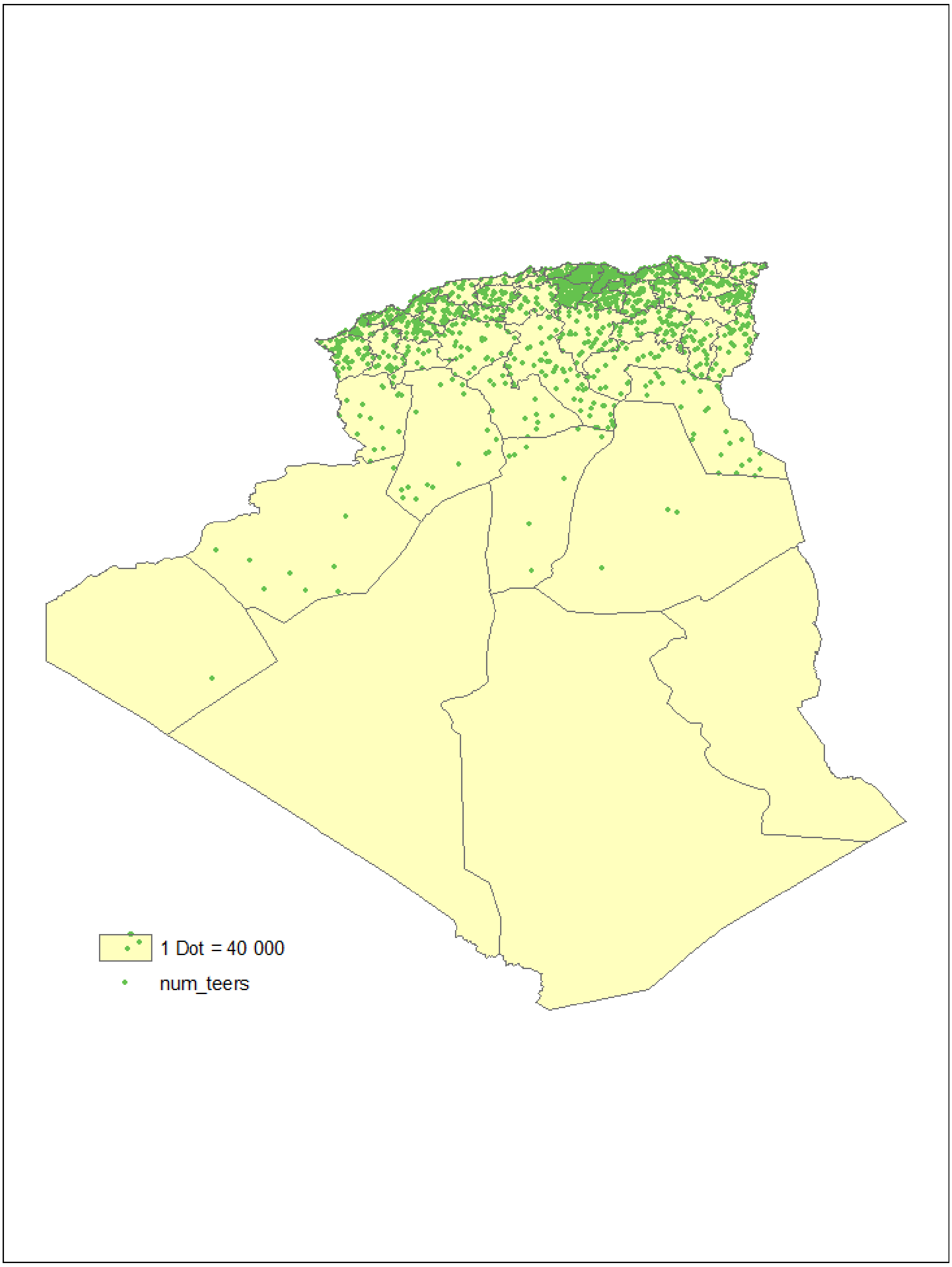


Figure2: The distribution of the number of olive trees in Algeria 2015.

3. Olive by-Product

3.1 Leaves and twigs

They are leaves collected after washing and cleaning the olives at the entrance of the oil mill, estimated at about 5 to 6 kg of dry matter per tree per year [2].

Fgure.3: Photography leaves and twigs of olive trees.

3.2 Olive pomace

Olive pomace are composed of the nucleus, the pulp, the skin and in some cases, the vegetation waters of the olives [42].

Figure.4: Photography of live pomace.

3.3 Olive mill wastewater

Wastewater pomace come from the liquid fraction of olives and water possibly added during the process of crushing [42].

Figure.5: Photography of olive mill wastewater.

4. Valorisation of olive by-product

4.1 Estimate of by-product

Addition to oil as a main product, olive oil industry generates large amounts of By-products, basically, 100 kg of olive produces approximately from 27% to 48% kg of olive pomace (or olive husk) and 100 l of vegetation water (olive mill wastewater), on average 25 kg of leaves and twigs [2].

To estimate the quantity of wastes from olive production in Algeria we have:

By adopting the average value of 35% for the percentage of pomace olives compared to the treated olives, each 100 kg of olive gives us 35 kg of pomace.

1kg/olive gives us 0,35kg/pomace … (1)

1kg/olive gives us 1l/mill wastewater … (2)

To have the quantity of olive:

$$M = N \times P \ ... \ (3)$$

With: M: Quantity of olive kg/region/year

N: Number of trees/region/year

P: Productivity kg/trees

From (1), (2) and (3) we get:

$$F_P = M \times \left(\frac{3}{100}\right) \dots (4)$$

$$F_{ww} = M \times 1 \dots (5)$$

With: F_P: quantity of pomace kg/region/year

F_{WW}: quantity of mill wastewater l/region/year

The total productivity in Algeria (2015) is 19,2kg/trees with the number of trees 59724085

So M=1146702432 kg

F_P = 401345851,2 kg

And F_{WW}=1146702432 l

We compare the quantity of pomace and mill wastewater in Algeria from the production of 2015 (figure.6).

Figure 6: Olive wastes in Algeria 2015.

We calculate the quantity of olive and olive wastes in all the regions of Algeria from the production of 2015 (table 2).

Table 2: Olive wastes in Algeria 2015.

Region	**Olive (kg) 10^6**	**Pomace (kg) 10^6**	**Olive Mill Wastewater(l) 10^6**
1 ADRAR	0	0	0
2 CHELF	8,836023	3,09260805	8,836023
3 LAGHOUAT	9,364100	3,27743500	9,364100
4 O.E.BOUAGHI	1,830639	0,64072365	1,830639
5 BATNA	62,008920	21,7031220	62,008920
6 BEJAIA	96,1561604	33,65465614	96,1561604
7 BISKRA	20,0168592	7,00590072	20,0168592
8 BECHAR	1,5585192	0,54548172	1,5585192
9 BLIDA	8,3916027	2,937060945	8,3916027
10 BOUIRA	131,486140	46,020149	131,486140
11 TAMANRASET	0	0	0
12 TEBESSA	9,8272086	3,43952301	9,8272086
13 TELMCEN	105,004286	36,75149996	105,004286
14 TIART	14,287559	5,00064565	14,287559
15 TIZI OUZOU	53,3277332	18,66470662	53,3277332
16 ALGER	0,6343197	0,222011895	0,6343197
17 DJELFA	26,591120	9,306892	26,591120
18 JIJEL	19,593000	6,857550	19,593000
19 SETIF	36,0270825	12,60947888	36,0270825
20 SAIDA	13,358821	4,67558735	13,358821
21 SKIKDA	26,7544502	9,36405757	26,7544502
22 S.B.ABBES	41,054286	1,43690001	41,054286
23 ANNABA	2,1156853	0,740489855	2,1156853
24 GUELMA	6,3927051	0,2237446785	6,3927051

25 COTANTINE	1,454208	0,5089728	1,454208
26 MEDEA	26,615325	9,31536375	26,615325
27 MOSTAGHNEM	26,868240	9,403884	26,868240
28M'SILA	16,324855	5,71369925	16,324855
29 MASCARA	73,962604	25,8869114	73,962604
30 OUARGLA	2,233644	0,7817754	2,233644
31 ORAN	18,428700	0,6450045	18,428700
32 EL-BAYADH	6,317000	2,210950	6,317000
33 ILIZI	0,0289323	0,010126305	0,0289323
34 B.B.ARRERIDJ	26,9135934	9,41975769	26,9135934
35 BOUMERDES	9,5585985	3,345509475	9,5585985
36 EL-TAREF	12,0451275	4,215794625	12,0451275
37 TINDOUF	0	0	0
38 TISSEMSILT	10,7600115	3,766004025	10,7600115
39 EL-OUED	3,626752	1,2693632	3,626752
40 KHENCHELA	15,410577	5,39370195	15,410577
41 SOUK-AHRAS	20,109964	7,0384874	20,109964
42 TIPAZA	21,2903376	7,45161816	21,2903376
43 MILA	18,139680	6,348888	18,139680
44 AIN-DEFLA	37,321500	13,062525	37,321500
45 NAAMA	4,284680	1,499638	4,284680
46 A.TEMOCHENT	16,900024	5,9150084	16,900024
47 GHARDAIA	3,514620	1,230117	3,514620
48 GHELIZANE	45,338320	15,868412	45,338320
TOTALE ALGERIE	**1146,702432**	**401,3458512**	**1146,702432**

Because the yield changes from one region to another, it can be seen from the table preceding that the great quantities of olive production are not in the same regions, which have the biggest number of olive trees, and this means that the amount of wastes will be large in the regions that have large amounts of olive. The distribution of olive production is shown in figure 7.

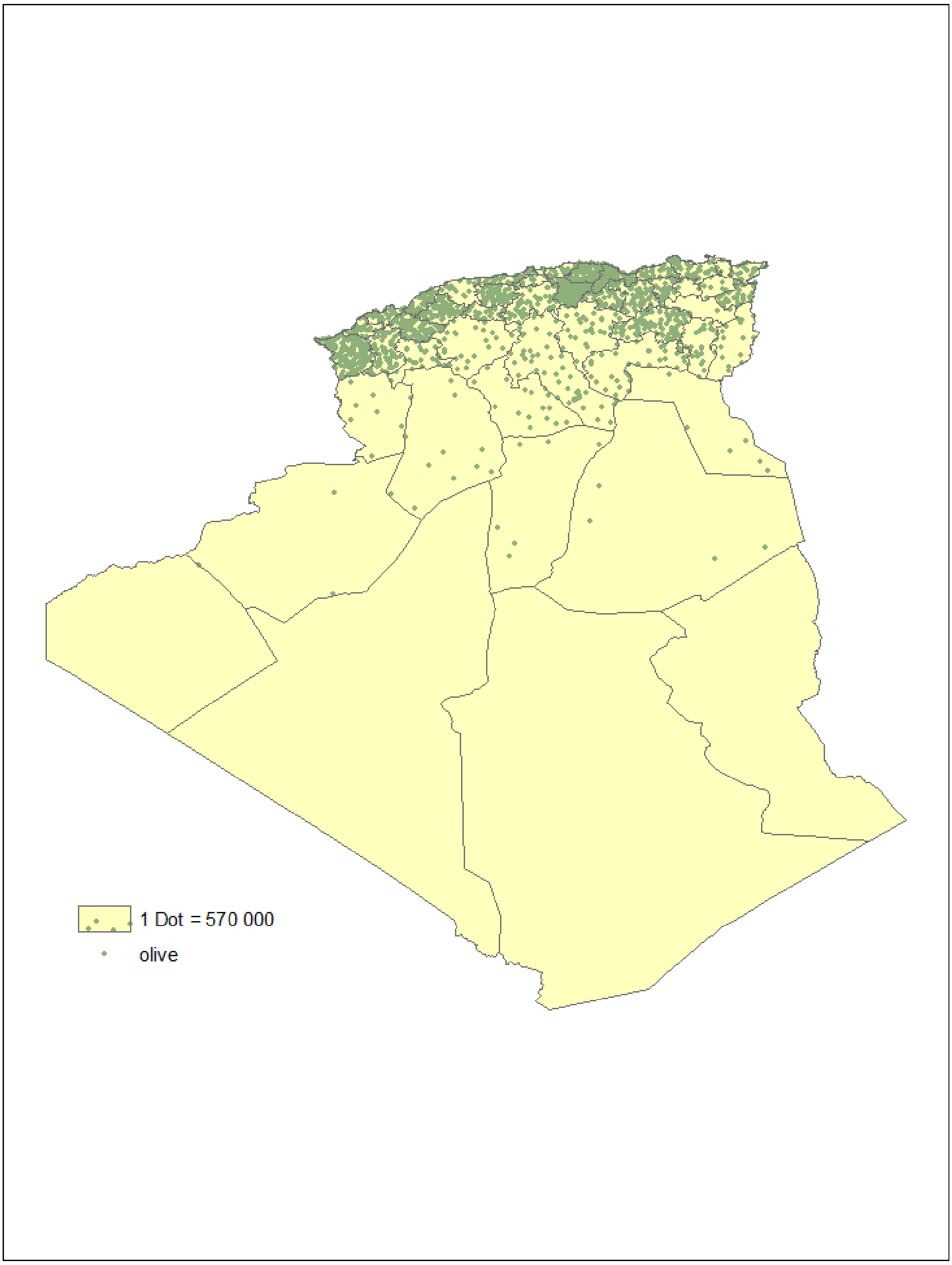


Figure.7: Olive production in Algeria 2015.

We compare the olive pomace and olive mill wastewater obtained in the regions that presenting 44% of the total production (figure8).

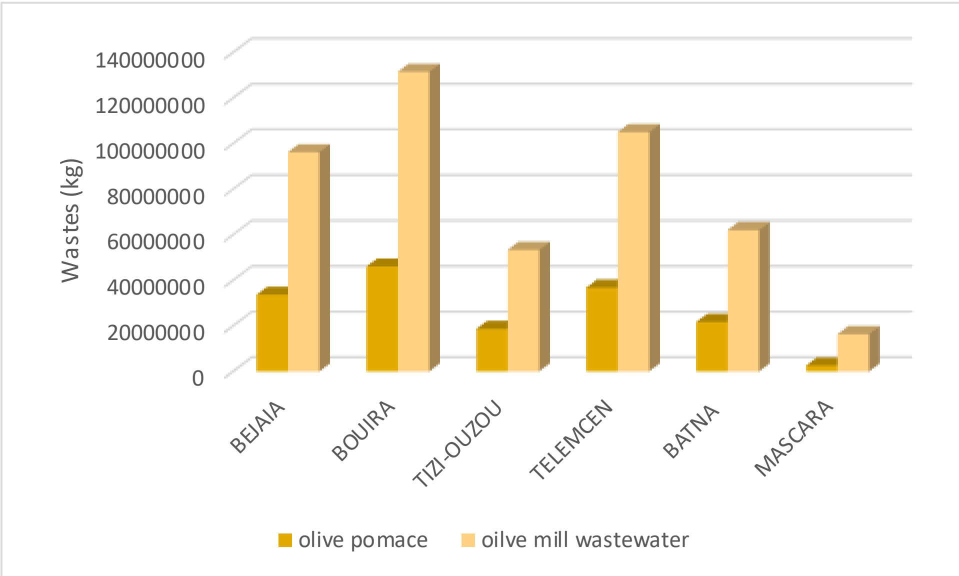


Figure.8: Olive pomace and olive mill wastewater in Algeria regions.

We represent the quantity of waste and its distribution in the 48 regions in the map of Algeria in the figure 9.

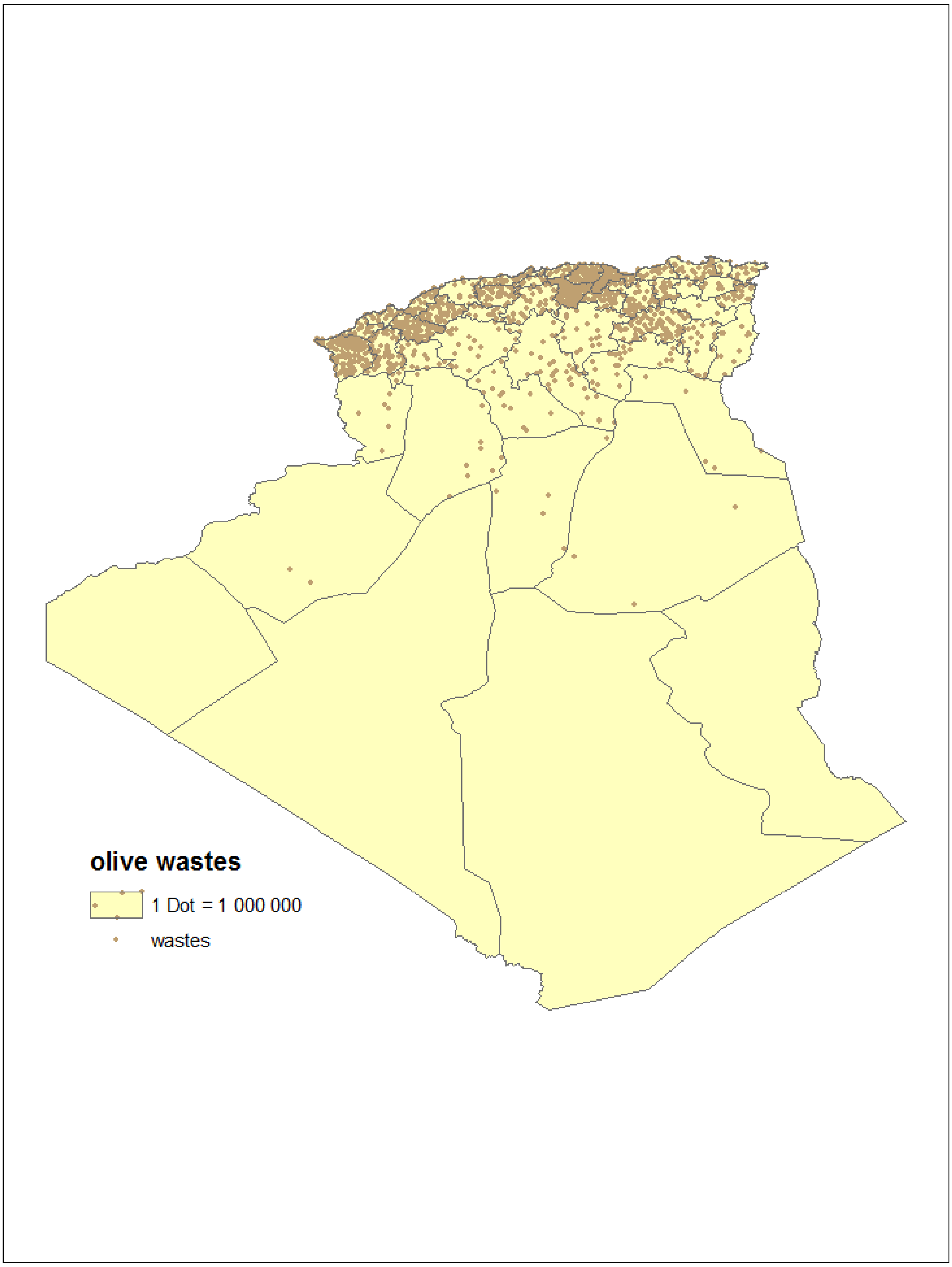


Figure.9: Olive wastes in Algeria 2015.

4.1.1 Estimate of olive pomace oil

To obtain the conversion yields there is an experimental study was done in [1], we adapted its values.

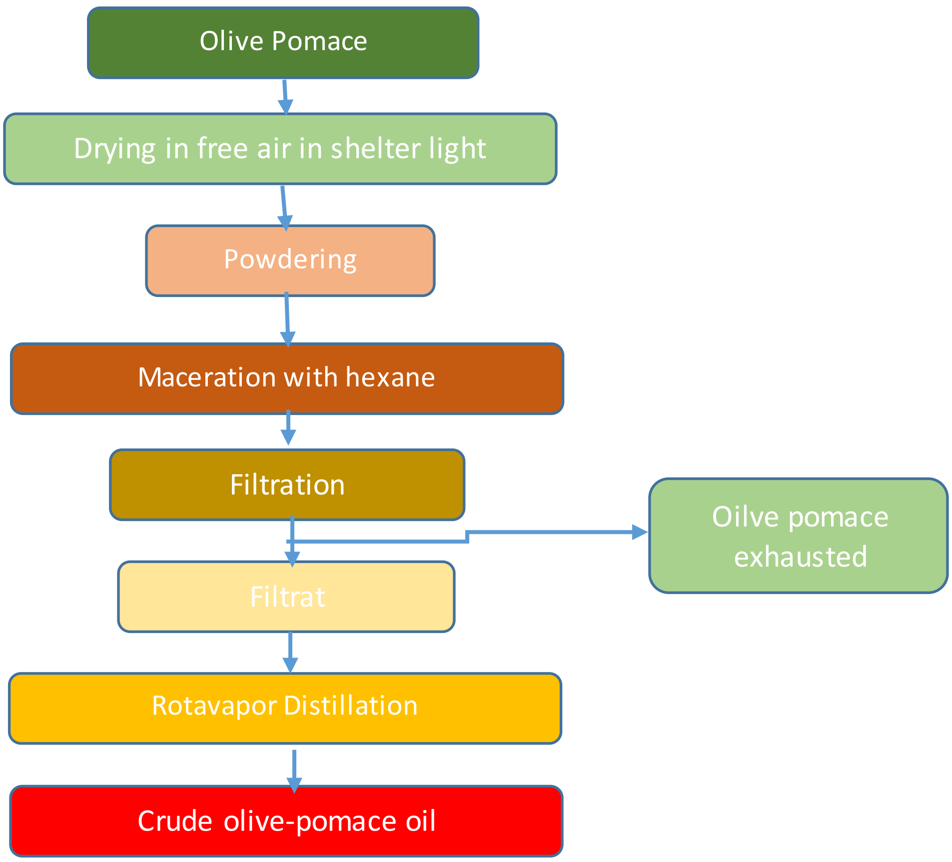
The olive-pomace contains most of the dry matter of the olive (skin, pulp, small pieces of core) and a certain proportion of vegetation, which contains the water-soluble components of the olive, a proportion that depends on the extraction system used. The olives are dried, ground and degreased by solvent [43].

In Algeria, the percentage of residual oil in olive residues can reach very high levels; This is due to the non-adaptation of technological processes to the quality of triturated olives [1]. Oil from pomace mills working in the press or in a three-phases continuous system have a residual oil content of 4-8% [44].

4.1.1.1 The process of obtaining oil

The oil of the olive-pomace extracted cold, by maceration in hexane, the next figure (figure.10) summarizes the main steps in this process.

Figure.10: Steps for extracting olive-pomace oil [1].



After extraction and removal of the solvent, by distillation with a rotary evaporator, the olive-pomace oil obtained is stored in a refrigerator [1].

We take the average value 6% oil pomace from the precedent process.

And from equation (4)

$$\text{Fop} = \text{Fp} \times \left(\frac{6}{100}\right) \; ... (6)$$

With: Fop: quantity of oil pomace kg/region/year

F_P: quantity of pomace kg/region/year

The total productivity of pomace in Algeria in (2015) is 401345851,2 kg, which gives us 24080751,072kg of oil pomace.

4.1.1.2 The process of obtaining biodiesel from olive-pomace oil

The use of unrefined oils in biodiesel production, by inter-esterification is varied by several constraints, such as, the saponification parasite of free fatty acids by the catalytic converter, NaOH. Without refining, inter-esterification of the oil of pomace olive in the case where its acidity is high, generates large quantities of soap which constitutes a loss. This we have therefore led to opt for a process adapted to the acid oils [1].

The main steps of this process are illustrated in the following flowchart (figure.11)

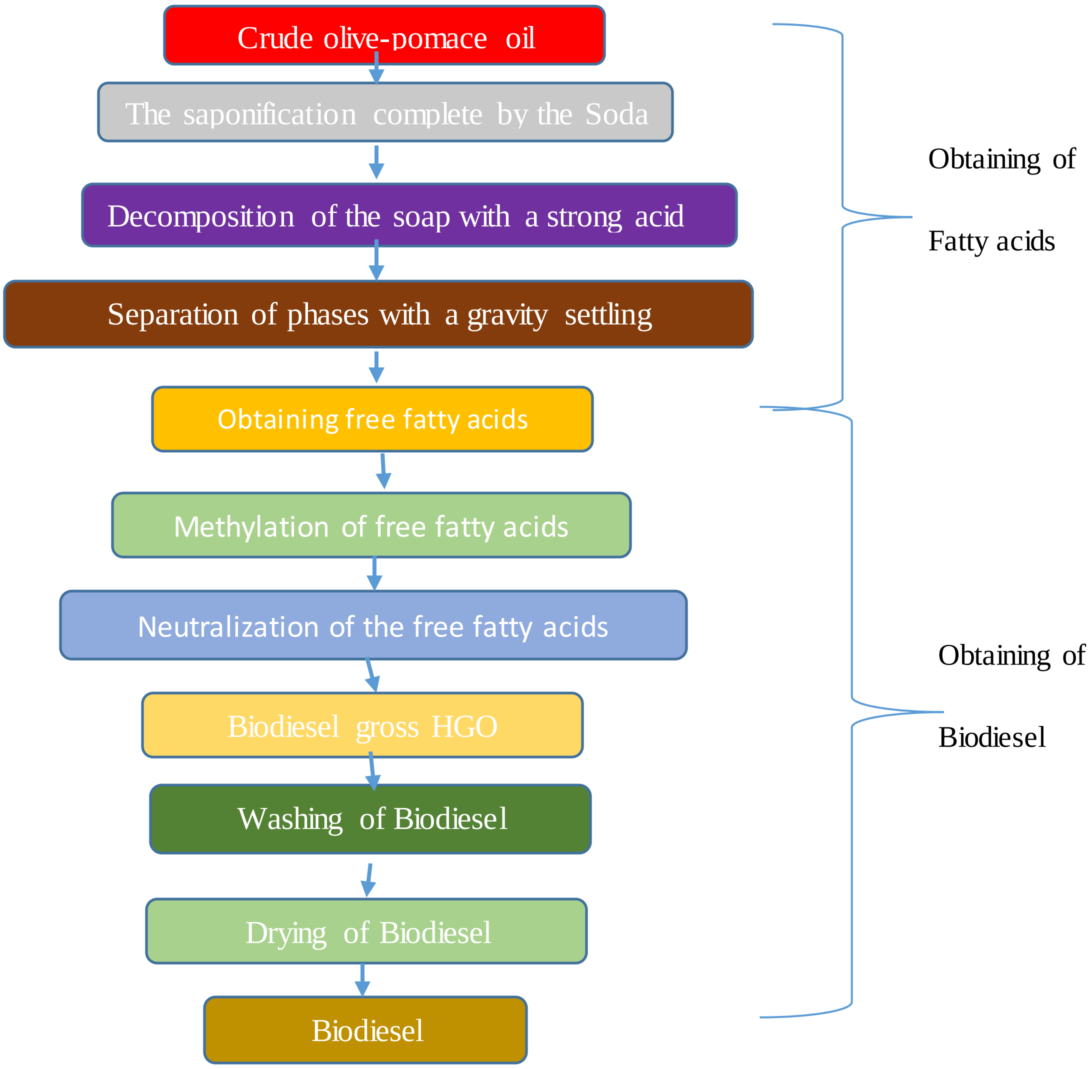


Figure.11: The protocol for obtaining of biodiesel in the laboratory [1].

The yield of the esterification of the Biodiesel obtained is 81.3% [1], The density of biodiesel developed, 874 g/l, is less than that of olive pomace oil 912, but it is consistent with European standards in force, 860-900 g/l [45].

We have the total productivity of oil pomace in Algeria (2015) is 24080751,072 kg, which is 2640433,231 l

From the equation (6) we get:

$$F_{biodiesel} = Fop \times \eta \times (\frac{1}{d}) \dots (7)$$

With F_{bio} is the quantity of biodiesel obtains from pomace oil (l).

F_{op} is the quantity of oil pomace (g).

η is the yield of the esterification of the Biodiesel obtained.

d is the density of olive oil pomace.

η= 81,3%

d= 912 g/l

We calculate the quantity of pomace oil and the biodiesel obtains for all the region from the productivity of 2015, the table 3 represent the result.

Table.3: quantity of pomace oil and biodiesel in Algeria in 2015.

Region	Pomace oil (l)	Biodiesel (l)
1 ADRAR	0	0
2 CHELF	20346,1056	16541,3838
3 LAGHOUAT	21562,0724	17529,9648
4 O.E.BOUAGHI	4215,28717	3427,02847
5 BATNA	142783,697	116083,146
6 BEJAIA	221412,211	180008,128
7 BISKRA	46091,4521	37472,3506
8 BECHAR	3588,69553	2917,60946
9 BLIDA	19322,7694	15709,4115
10 BOUIRA	302764,138	246147,244
11 TAMANRASSET	0	0
12 TEBESSA	22628,4409	18396,9224
13 TELMCEN	241786,184	196572,168
14 TIART	32898,9845	26746,8744
15 TIZI OUZOU	122794,123	99831,6216
16 ALGER	1460,60457	1187,47152
17 DJELFA	61229,5526	49779,6263
18 JIJEL	45115,4605	36678,8694
19 SETIF	82957,0979	67444,1206
20 SAIDA	30760,4431	25008,2402
21 SKIKDA	61605,6419	50085,3869
22 S.B.ABBES	94532,8954	76855,244
23 ANNABA	4871,64378	3960,6464
24 GUELMA	14720,0446	11967,3963
25 COTANTINE	3348,50526	2722,33478
26 MEDEA	61285,2878	49824,939
27 MOSTAGHNEM	61867,6579	50298,4059
28M'SILA	37590,1266	30560,773
29 MASCARA	170308,628	138460,914
30 OUARGLA	5143,25921	4181,46974
31 ORAN	42434,5066	34499,2538
32 EL-BAYADH	14545,7237	11825,6734
33 ILIZI	66,6204276	54,1624077
34 B.B.ARRERIDJ	61972,0901	50383,3092

35 BOUMERDES 36 EL-TAREF	22009,9308 27735,491	17894,0737 22548,9541
37 TINDOUF 38 TISSEMSILT 39 EL-OUED 40 KHENCHELA	0 24776,3423 8351,07368 35484,8813	0 20143,1663 6789,42291 28849,2085
41 SOUK-AHRAS 42 TIPAZA 43 MILA 44 AIN-DEFLA	46305,8382 49023,8037 41769 85937,6645	37646,6464 39856,3524 33958,197 69867,3212
45 NAAMA 46 A.TEMOCHENT 47 GHARDAIA 48 GHELIZANE	9866,03947 38914,5289 8092,875 104397,447	8021,09009 31637,512 6579,50738 84875,1247
TOTALE ALGERIE	**2640433,231**	**2146672,2899**

The following figure shows the production of biodiesel from olive pomace oil in regions with high production, the highest value is BOUIRA with 246,147244 m^3.

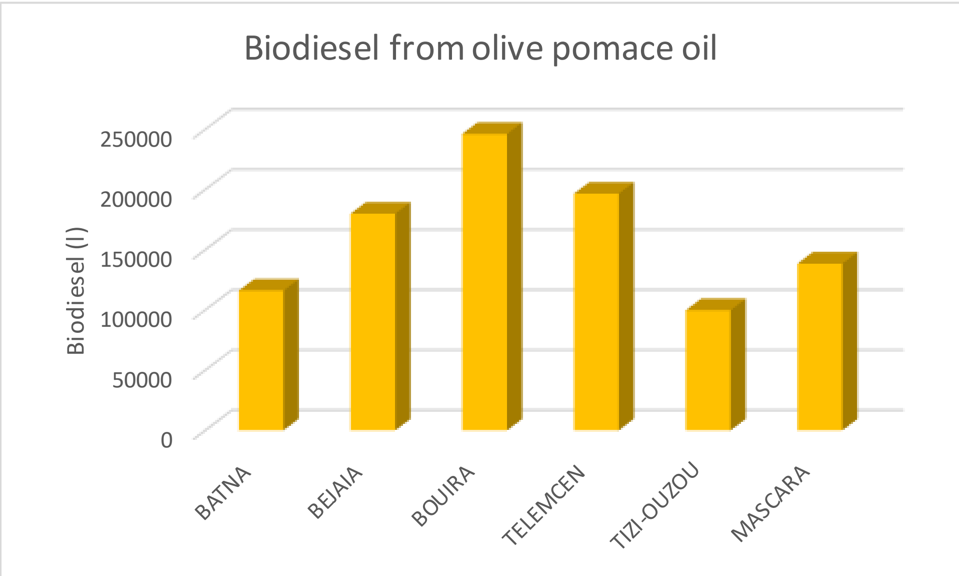


Figure.12: Biodiesel obtained from olive pomace oil in Algeria regions.

4.1.2 Estimate of mill wastewater

The wastewater is valorised in the same manner as olive pomace that is by drying it and performing a second extraction of oil with solvents [46].

The chemical composition of olive mill wastewater contains a residual oil content of 1% and 15% organic matter [1].

We calculate the quantity of residual oil and biodiesel obtained from this oil as follows:

$$F_{oww} = F_{ww} \times (1/100) \ldots (8)$$

With F_{oww}: quantity of oil obtained from mill wastewater.

F_{ww}: quantity of mill wastewater l/region/year.

The total quantity of mill wastewater in Algeria for 2015 is 1146702432 l that give us 11467024,32 l of oil residual, we use the next equation to estimate it to biodiesel.

$$F_{biodiesel} = F_{oww} \times (81{,}3/100) \ldots (9)$$

With: $F_{biodiesel}$: quantity of biodiesel from mill wastewater l/region/year.

We calculate the quantity of oil mill wastewater and biodiesel obtained in all the region of Algeria and we present it in the table 4.

The application of the process of anaerobic digestion to mill wastewater makes it possible to transform about 80% of the organic substances into biogas [42]. This process of anaerobic digestion degrades the organic substance through biochemical reactions that transform large molecules into small molecules until they are converted into biogas [47], there are typically 4 successive steps: hydrolysis of polymers, fermentation of monomers or acidogenesis, acetogenesis with forced production of hydrogen and methanogenesis [48].

$$F_{omww} = F_{ww} \times (15/100) \ldots (10)$$

With: F_{omww}: quantity of organic matter from mill wastewater l/ragion/year

We use the equation (10) and the next equation to calculate the quantity of biogas

$$F_{biogas} = F_{omww} \times (80/100) \ldots (11)$$

The total production of mill wastewater in Algeria for 2015 is 1146702432 l that gives us 172005364,8 l of organic matter and 137604291,84 l of biogas.

We calculate the quantity of biogas obtained from mill wastewater in all the region of Algeria and we present it in the table 5.

Table.4: quantity of oil mill wastewater and biodiesel obtained from it in Algeria (2015).

Region	Oil mill wastewater (l)	Biodiesel (l)
1 ADRAR	0	0
2 CHELF	88360,23	71836,867
3 LAGHOUAT	93641	76130,133
4 O.E.BOUAGHI	18306,39	14883,0951
5 BATNA	620089,2	504132,52
6 BEJAIA	961561,604	781749,584
7 BISKRA	200168,592	162737,065
8 BECHAR	15585,192	12670,7611
9 BLIDA	83916,027	68223,73
10 BOUIRA	1314861,4	1068982,32
11 TAMANRASSET	0	0
12 TEBESSA	98272,086	79895,2059
13 TELMCEN	1050042,86	853684,842
14 TIART	142875,59	116157,855
15 TIZI OUZOU	533277,332	433554,471
16 ALGER	6343,197	5157,01916
17 DJELFA	265911,2	216185,806
18 JIJEL	195930	159291,09
19 SETIF	360270,825	292900,181
20 SAIDA	133588,21	108607,215
21 SKIKDA	267544,502	217513,68
22 S.B.ABBES	410542,86	333771,345
23 ANNABA	21156,853	17200,5215
24 GUELMA	63927,051	51972,6925
25 COTANTINE	14542,08	11822,711
26 MEDEA	266153,25	216382,592
27 MOSTAGHNEM	268682,4	218438,791
28M'SILA	163248,55	132721,071
29 MASCARA	739626,04	601315,971
30 OUARGLA	22336,44	18159,5257
31 ORAN	184287	149825,331
32 EL-BAYADH	63170	51357,21
33 ILIZI	289,323	235,219599
34 B.B.ARRERIDJ	269135,934	218807,514
35 BOUMERDES	95585,985	77711,4058
36 EL-TAREF	120451,275	97926,8866
37 TINDOUF	0	0
38 TISSEMSILT	107600,115	87478,8935
39 EL-OUED	36267,52	29485,4938
40 KHENCHELA	154105,77	125287,991
41 SOUK-AHRAS	201099,64	163494,007
42 TIPAZA	212903,376	173090,445
43 MILA	181396,8	147475,598
44 AIN-DEFLA	373215	303423,795
45 NAAMA	42846,8	34834,4484
46 A.TEMOCHENT	169000,24	137397,195
47 GHARDAIA	35146,2	28573,8606
48 GHELIZANE	453383,2	368600,542
TOTALE ALGERIE	**11467024,32**	**9322690,77216**

Table.5: Quantity of organic matter in mill wastewater and biogas obtained from it in Algeria (2015).

Region	Organic matter (l)	Biogas (l)
1 ADRAR	0	0
2 CHELF	1325403,45	1060322,76
3 LAGHOUAT	1404615	1123692
4 O.E.BOUAGHI	274595,85	219676,68
5 BATNA	9301338	7441070,4
6 BEJAIA	14423424,1	11538739,2
7 BISKRA	3002528,88	2402023,1
8 BECHAR	233777,88	187022,304
9 BLIDA	1258740,41	1006992,32
10 BOUIRA	19722921	15778336,8
11 TAMANRASSET	0	0
12 TEBESSA	1474081,29	1179265,03
13 TELMCEN	15750642,8	12600514,3
14 TIART	2143133,85	1714507,08
15 TIZI OUZOU	7999159,98	6399327,98
16 ALGER	95147,955	76118,364
17 DJELFA	3988668	3190934,4
18 JIJEL	2938950	2351160
19 SETIF	5404062,38	4323249,9
20 SAIDA	2003823,15	1603058,52
21 SKIKDA	4013167,53	3210534,02
22 S.B.ABBES	6158142,9	4926514,32
23 ANNABA	317352,795	253882,236
24 GUELMA	958905,765	767124,612
25 COTANTINE	218131,2	174504,96
26 MEDEA	3992298,75	3193839
27 MOSTAGHNEM	4030236	3224188,8
28M'SILA	2448728,25	1958982,6
29 MASCARA	11094390,6	8875512,48
30 OUARGLA	335046,6	268037,28
31 ORAN	2764305	2211444
32 EL-BAYADH	947550	758040
33 ILIZI	4339,845	3471,876
34 B.B.ARRERIDJ	4037039,01	3229631,21
35 BOUMERDES	1433789,78	1147031,82
36 EL-TAREF	1806769,13	1445415,3
37 TINDOUF	0	0
38 TISSEMSILT	1614001,73	1291201,38
39 EL-OUED	544012,8	435210,24
40 KHENCHELA	2311586,55	1849269,24
41 SOUK-AHRAS	3016494,6	2413195,68
42 TIPAZA	3193550,64	2554840,51
43 MILA	2720952	2176761,6
44 AIN-DEFLA	5598225	4478580
45 NAAMA	642702	514161,6
46 A.TEMOCHENT	2535003,6	2028002,88
47 GHARDAIA	527193	421754,4
48 GHELIZANE	6800748	5440598,4
TOTALE ALGERIE	**172005364,8**	**137604291,84**

The following figure shows the production of biodiesel from oil mill wastewater in regions with high production, the highest value is BOUIRA with 1068,98232 m^3 .

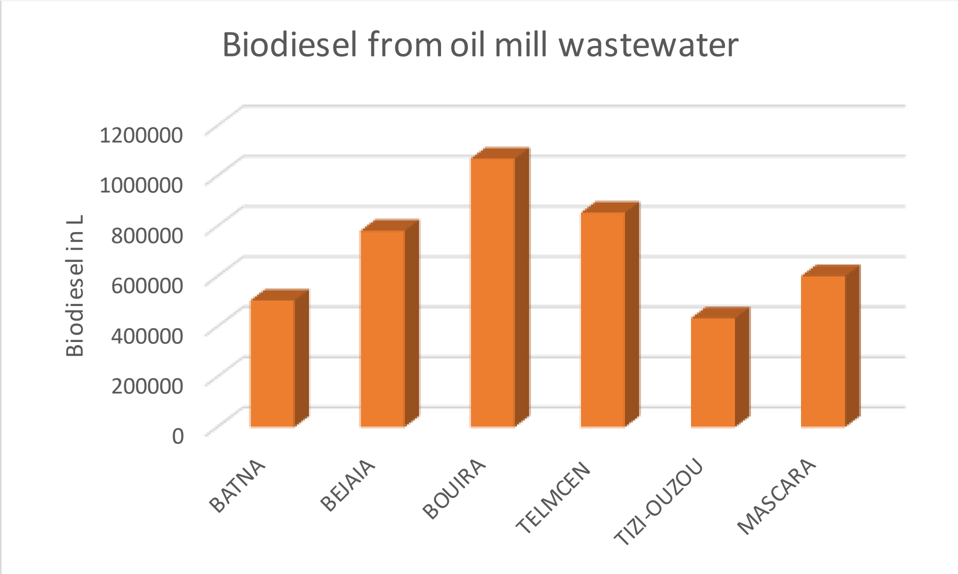


Figure.13: Biodiesel obtained from oil mill wastewater in Algeria regions.

We compare the biodiesel gets from the two wastes, we notice that the one who is getting from mill wastewater is doubled. Figure 14 shows the comparison in Algeria regions and figure 15 shows in the comparison in all of Algeria.

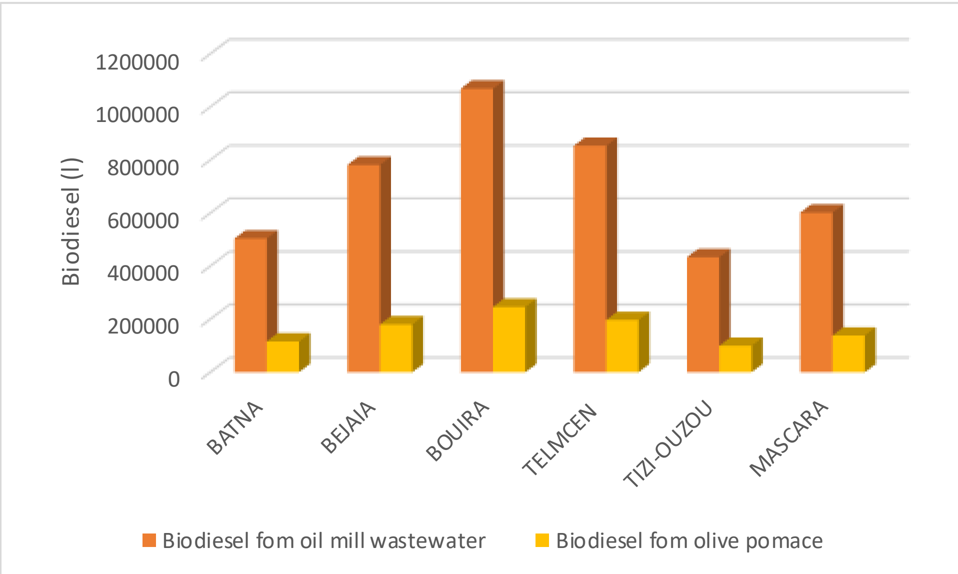


Figure.14: Biodiesel obtained from the two types of wastes in Algeria regions.

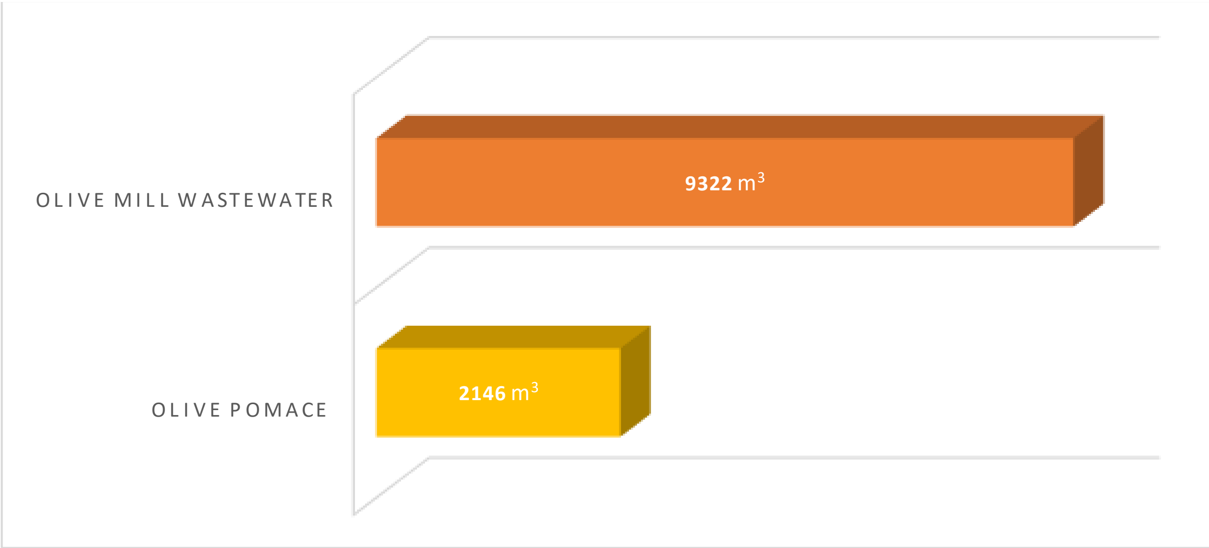


Figure.15: Biodiesel obtained from the two types of wastes in Algeria.

The total Biodiesel obtained from Algeria wastes in 2015 is 11469,363 m^3, its distribution in the 48 regions is presented in the map of Algeria (figure.16).

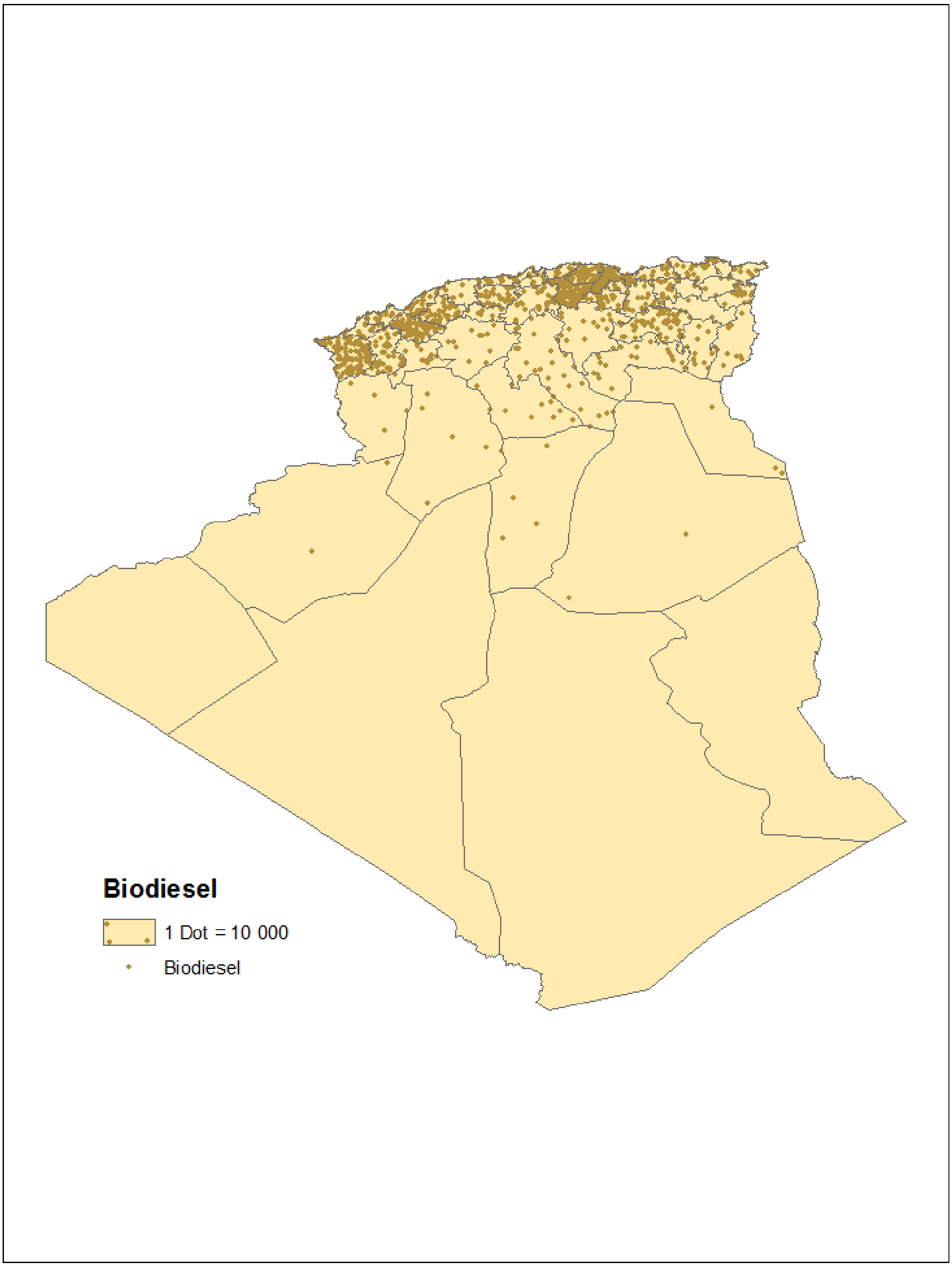


Figure.16: Biodiesel obtained from the wastes of olive in Algeria for 2015.

The following figure shows the six regions with high production of biogas, the highest value is 15778,3368 m^3 (figure.17).

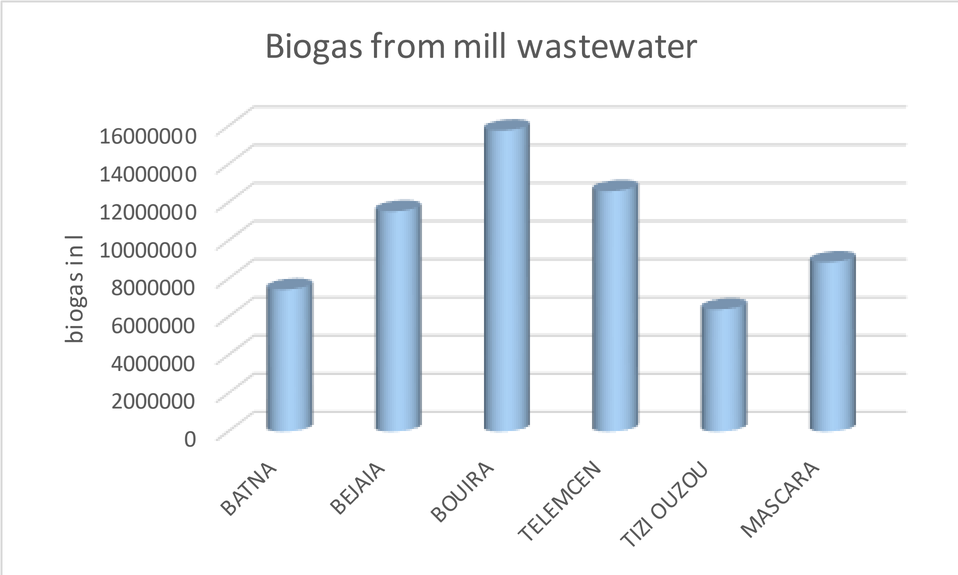


Figure.17: Biogas obtained from mill wastewater in Algeria (2015).

The total quantity obtained of biogas in Algeria is 137604,29184 m^3 , And it is distributed in 48 regions, the following map of Algeria shows this distribution (figure.18).

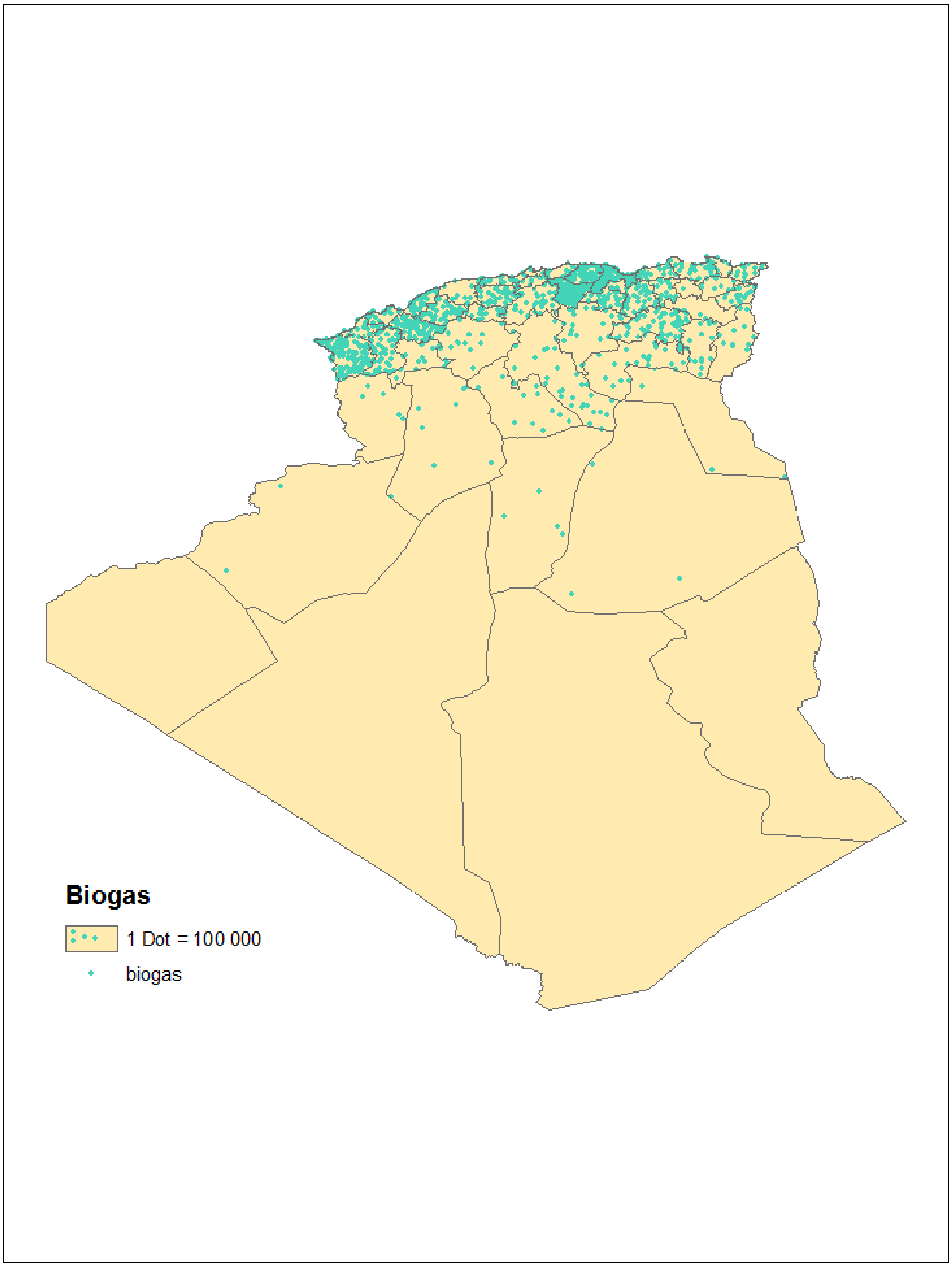


Figure.18: Biogas obtained from mill wastewater in Algeria for 2015.

We compare the total biodiesel and biogas obtained from olive wastes in Algeria for 2015 in the next figure (figure.19).

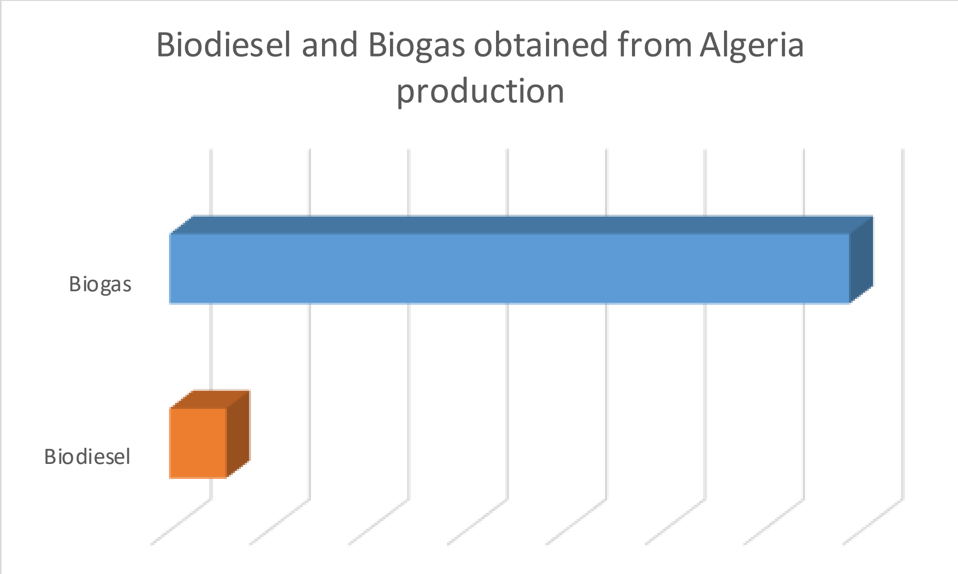


Figure.19: Comparison of biodiesel and biogas

5. Conclusion

The olive waste of the Algerian production of the year 2015 gives us 401,345,8512 tons of pomace and 1146,702432 tons of wastewater with a yield of 35kg / kg and 1l / kg in order, with an area of 419,544 ha And 1146702432 kg of olive. The valorisation of this waste to have a biofuels happens by two processes, starting with obtaining oil of the pomace 6% of its quantity and the wastewater 1% to the obtaining of biodiesel with a yield of 81,3 from the oil obtained gives us 11469,363 m^3 biodiesel.

The olive mill wastewater could valorised also to an biogas from its organic matter which is present 15% from the mill wastewater that is 172005,3648 m^3, and it self gives us 80% from its quantity biogas 137604,29184 m^3.

Conclusion

General Conclusion

In our work, we have valorised the olive waste and we estimated the potential of biofuels from olive pomace, and the biogas from olive mill wastewater, large quantities have been obtained which can be applied in several energy-consuming sectors, in the year 2015 the transport sector (road) was the most consumable sector of energy with 9284 thousand tons of biofuels, (according to Ministry of energy), our obtained quantity can't satisfy the needs but it can take into consideration.

After the estimation of the biofuels, we get from the olive pomace 2146,6722 m^3 of biodiesel and 9322,6907 m^3 from mill olive wastewater, and 137604,2918 m^3 biogas from the waste of olive in Algeria production for 2015.

Waste treatment is today an effective means of fighting pollution. There are several methods of treatment adopted in many countries, which offer an advantageous alternative to landfill, landfill, incineration and composting. The Ministry of Agriculture forecasts a net increase in production of the olive oil sector by 2019 to reach 8.1 million quintals. But this will be achieved first by modernizing the olive-growing industry. This will increase production and thus increase the amount of bioenergy obtained.

The increase in production presents an increase in waste these results will be used and applied in the several energy-consuming sectors.

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Annex (1)

ArcGIS

ArcGIS is a set of GIS software developed by ESRI. The current version is ArcGIS 9.2, There are different levels within the ArcGIS suite, including:

ArcView: basic version.

ArcEditor: Basic Version + Topological and Editing Feature.

ArcInfo: ArcEditor + extra powerful modules.

Modules

ArcCatalog, for the management and the navigation in the databases.

ArcMap, to analyze data, produce cartographic products.

ArcScene, to visualize the data in three dimensions.

ArcGlobe, to view data on the globe.

ArcReader, to view documents created by ArcGIS.

Extensions

ArcGIS 3D Analyst.

ArcGIS Spatial Analyst.

ArcGIS Geostatistical Analyst.

ArcGIS Network Analyst.

ArcGIS Publisher.

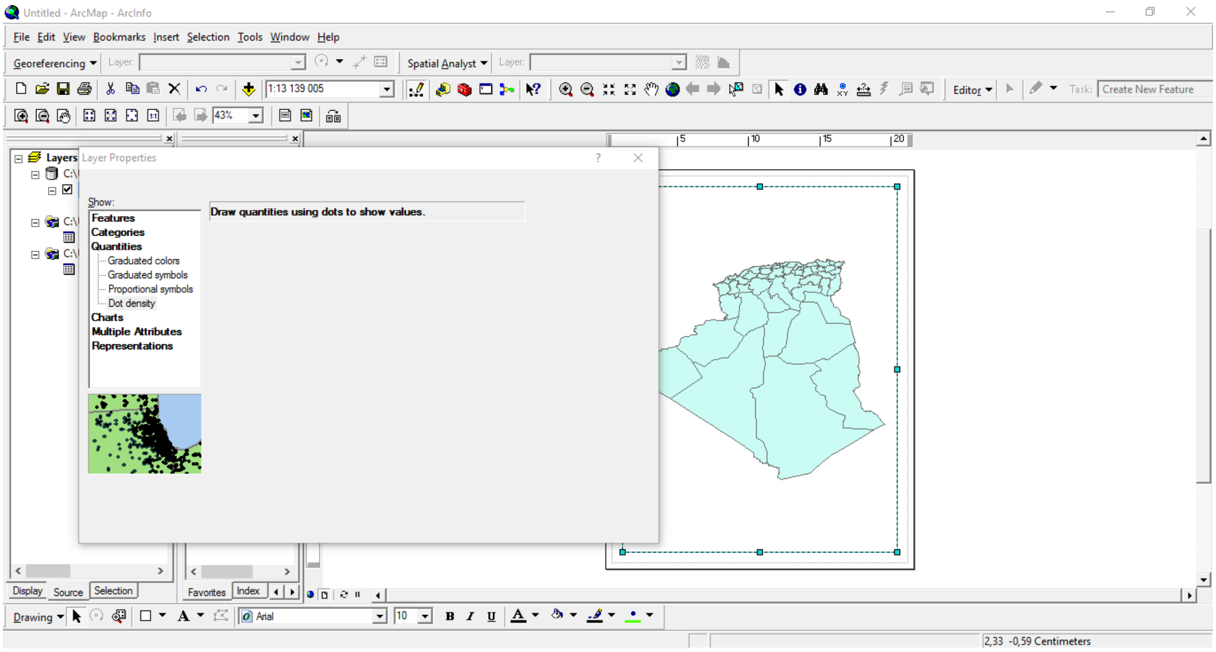
ArcGIS Schematics.

ArcScan.

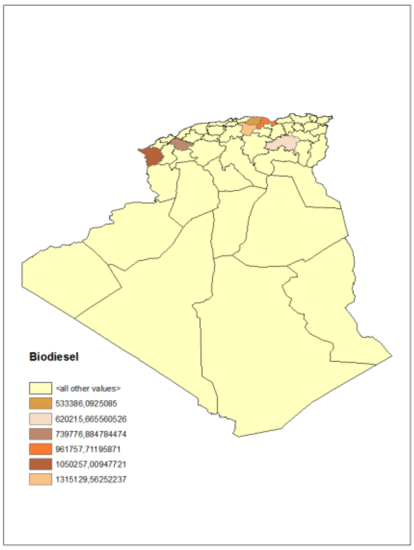
Maplex.

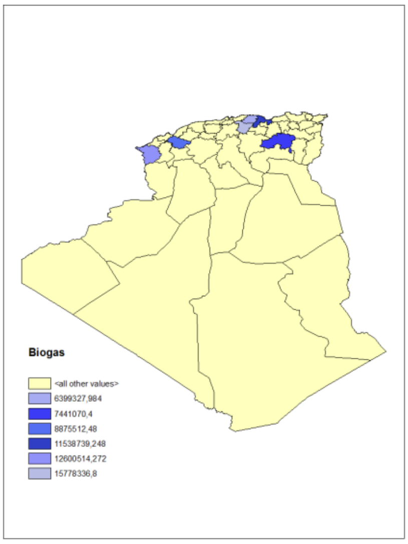
ArcGIS Tracking Analyst.

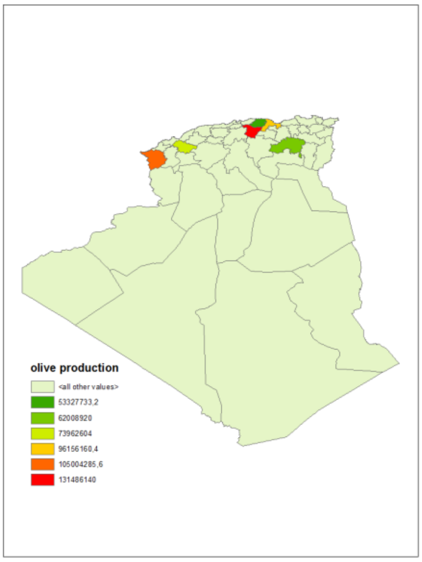
ArcGIS Data Interoperability.

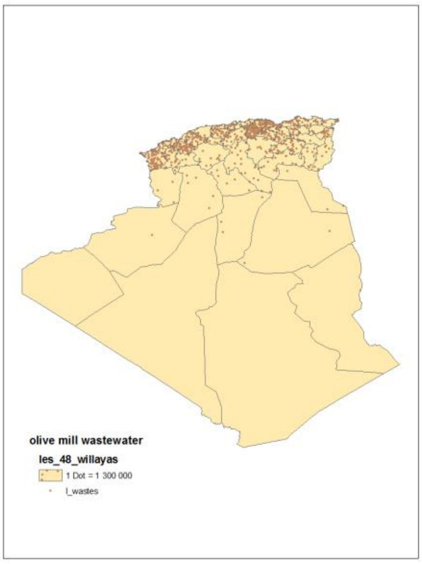

Untitled - ArcMap - ArcInfo
File Edit View Bookmarks Insert Selection Tools Window Help
Layer Properties
Show:
Features
Categories
Quantities
Graduated colors
Graduated symbols
Proportional symbols
Dot density
Charts
Multiple Attributes
Representations
Draw quantities using dots to show values.
2,33 -0,59 Centimeters

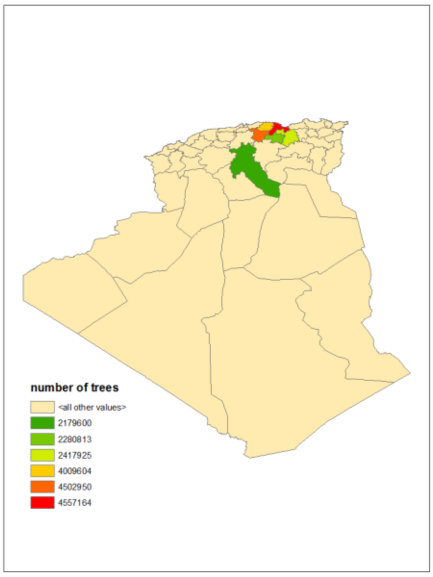
The six top regions produce biodiesel and biogas and has the bigest quantity of wastes, and the regions who has the big number of trees.







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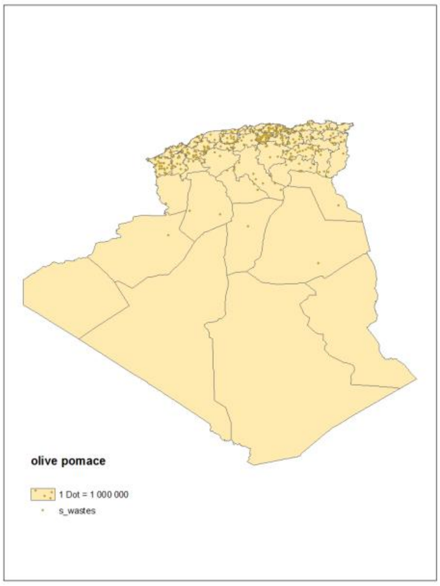
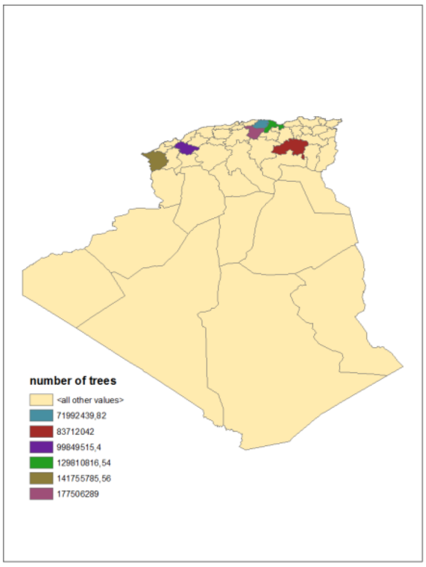
2417925
4009604
4502950
4557164


olive pomace
1 Dot = 1 000 000
s_wastes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Annex (2)

Production data for 2015 in Algeria

Colonne1	Superficie occupée	Oliviers en masse	Oliviers isolés	Total olivier complanté	Oliviers en rapport
WILAYA	(ha)	(Nbre d'arbre	(Nbre d'arbre	(Nbre d'arbre	(Nbre) arbres
1 ADRAR	0	0	0	0	0
2 CHLEF	4 310	555 150	45 940	601 090	322 400
3 LAGHOUAT	2 082	442 510	25 695	468 205	216 400
4 O.E.BOUAGHI	1 557	212 295	570	212 865	29 898
5 BATNA	10 477	1 982 433	84 531	2 066 964	1 187 562
6 BEJAIA	52 798	4 121 070	436 094	4 557 164	4 233 475
7 BISKRA	4 245	868 667	93 682	962 349	627 180
8 BECHAR	1 334	289 300	81 776	371 076	56 882
9 BLIDA	2 237	196 365	143 376	339 741	276 117
10 BOUIRA	35 098	4 144 916	358 034	4 502 950	2 315 950
11 TAMANRASSET	174	0	17 400	17 400	0
12 TEBESSA	8 097	1 471 971	17 000	1 488 971	548 505
13 TLEMCEN	13 698	1 573 893	274 774	1 848 667	965 000
14 TIARET	7 683	1 251 523	47 346	1 298 869	342 500
15 TIZI-OUZOU	35 608	3 691 659	317 945	4 009 604	2 885 328
16 ALGER	94	24 995	18 156	43 151	26 229

17 DJELFA	10 898	2 179 600	0	2 179 600	1 307 400
18 JIJEL	14 975	1 296 888	335 862	1 632 750	1 221 304
19 SETIF	20 706	2 066 265	351 660	2 417 925	1 548 739
20 SAIDA	4 194	437 899	22 750	460 649	335 287
21 SKIKDA	10 758	1 118 352	384 707	1 503 059	1 106 850
22 S.B.ABBES	7 645	729 750	172 542	902 292	599 646
23 ANNABA	748	76 805	32 816	109 621	62 343
24 GUELMA	9 035	680 230	220 151	900 381	440 281
25 CONSTANTINE	895	121 495	51 625	173 120	88 750
26 MEDEA	8 165	916 068	51 762	967 830	221 454
27 MOSTAGANEM	7 467	1 473 975	125 325	1 599 300	737 275
28 M'SILA	10 244	1 891 850	75 000	1 966 850	1 169 700
29 MASCARA	13 165	1 557 110	139 280	1 696 390	1 252 235
30 OUARGLA	642	64 376	41 988	106 364	20 003
31 ORAN	6 733	1 202 705	104 295	1 307 000	918 133
32 EL-BAYADH	757	227 100	404 600	631 700	96 410
33 ILLIZI	122	16 719	300	17 019	312
34 B.B.ARRERIDJ	25 001	2 196 108	84 705	2 280 813	1 282 314
35 BOUMERDES	7 926	760 870	100 265	861 135	668 485
36 EL-TARF	4 955	497 975	57 100	555 075	191 930
37 TINDOUF	124	20 188	5 047	25 235	1 980
38 TISSEMSILT	6 580	845 245	2 000	847 245	267 700

39 EL-OUED	3 000	1 063 360	70 000	1 133 360	562 500
40 KHENCHELA	6 500	1 062 423	96 267	1 158 690	424 550
41 SOUK-AHRAS	8 057	1 386 040	60 720	1 446 760	516 600
42 TIPAZA	1 790	287 308	309 060	596 368	130 139
43 MILA	10 583	1 058 543	201 157	1 259 700	625 000
44 AIN-DEFLA	7 150	1 187 500	155 000	1 342 500	622 105
45 NAAMA	2 528	628 800	1 300	630 100	48 353
46 A.TEMOUCHENT	4 564	494 622	482 258	976 880	687 939
47 GHARDAIA	1 250	155 858	152 442	308 300	188 362
48 RELIZANE	9 926	1 474 130	57 570	1 531 700	936 570
	12 973	2 920 978	488 330	3 409 308	1 673 619
TOTAL ALGERIE	419 544	52 923 882	6 800 203	59 724 085	33 987 694

Colonne1	Production d'olive	Colonne2	Colonne3	Rendement d'olive	Production d'huile	Rendement d'huile
	pour		Total			
WILAYA	la conserve	pour l'huile	Prod. Olives			
	Qx	Qx	Qx	Kg/arbre	Hl	Litres/quintal
1 ADRAR	0	0	0	0	0	0
2 CHLEF	11 990	35 470	47 460	14,7	4 967	14,0
3 LAGHOUAT	25 980	17 340	43 320	20,0	2 601	15,0
4 O.E.BOUAGHI	1 383	1 184	2 567	8,6	177	14,9

5 BATNA	177 386	178 809	356 195	30,0	28 141	15,7
6 BEJAIA	1 581	893 428	895 009	21,1	193 312	21,6
7 BISKRA	78 410	52 240	130 650	20,8	6 791	13,0
8 BECHAR	1 186	1 185	2 371	4,2	71	6,0
9 BLIDA	15 301	52 964	68 265	24,7	3 471	6,6
10 BOUIRA	4 265	671 257	675 522	29,2	118 710	17,7
11 TAMANRASSET	0	0	0	0	0	0
12 TEBESSA	6 000	30 000	36 000	6,6	5 600	18,7
13 TLEMCEN	298 440	250 000	548 440	56,8	29 775	11,9
14 TIARET	32 700	5 000	37 700	11,0	700	14,0
15 TIZI-OUZOU	0	382 457	382 457	13,3	75 862	19,8
16 ALGER	1 322	2 529	3 851	14,7	333	13,2
17 DJELFA	37 220	122 640	159 860	12,2	18 686	15,2
18 JIJEL	255	146 673	146 928	12,0	28 798	19,6
19 SETIF	179	230 416	230 595	14,9	51 903	22,5
20 SAIDA	70 180	26 910	97 090	29,0	1 794	6,7
21 SKIKDA	0	196 680	196 680	17,8	45 236	23,0
22 S.B.ABBES	215 525	57 301	272 826	45,5	8 023	14,0
23 ANNABA	1 688	10 370	12 058	19,3	1 787	17,2
24 GUELMA	0	31 120	31 120	7,1	1 272	4,1
25 CONSTANTINE	4 433	3 003	7 436	8,4	475	15,8
26 MEDEA	9 515	51 468	60 983	27,5	7 707	15,0
27 MOSTAGANEM	123 980	0	123 980	16,8	0	0
28 M'SILA	24 500	76 600	101 100	8,6	11 426	14,9
29 MASCARA	534 400	11 550	545 950	43,6	1 400	12,1
30 OUARGLA	2 624	1 585	4 209	21,0	166	10,5
31 ORAN	117 431	12 089	129 521	14,1	1 603	13,3

32 EL-BAYADH	1 769	7 841	9 610	10,0	1 180	15,0
33 ILLIZI	5	0	5	1,7	0	0
34 B.B.ARRERIDJ	7 441	143 715	151 156	11,8	23 347	16,2
35 BOUMERDES	528	73 348	73 876	11,1	15 403	21,0
36 EL-TARF	11 000	30 650	41 650	21,7	5 211	17,0
37 TINDOUF	0	0	0	0,0	0	0
38 TISSEMSILT	10 000	24 000	34 000	12,7	3 600	15,0
39 EL-OUED	13 200	4 800	18 000	3,2	530	11,0
40 KHENCHELA	5 400	51 000	56 400	13,3	8 900	17,5
41 SOUK-AHRAS	17 000	55 000	72 000	13,9	11 000	20,0
42 TIPAZA	8 328	38 172	46 500	35,7	4 961	13,0
43 MILA	13 181	76 961	90 142	14,4	12 229	15,9
44 AIN-DEFLA	91 940	81 060	173 000	27,8	13 438	16,6
45 NAAMA	360	2 928	3 288	6,8	387	13,2
46 A.TEMOUCHENT	71 861	46 968	118 829	17,3	6 237	13,3
47 GHARDAIA	18 000	3 500	21 500	11,4	350	10,0
48 RELIZANE	266 039	11 108	277 147	29,6	1 332	12,0