Development of knowledge-based web services to promote and advance Industrial Symbiosis in Europe (eSYMBIOSIS)

LIFE09/ENV/GR/000300

ACTION 1: Service and user requirements

D1.2 Recording, analysis and assessment of industrial clusters in target country

(Viotia Prefecture - Greece)

Summary

July 2012

Background

This report was produced under co-finance of the European financial instrument for the Environment (LIFE+) as the second Deliverable 1.2 of the first Action (Action 1) of Project "eSYMBIOSIS" (LIFE 09 ENV/GR/000300) during the implementation of its first Activity (Activity 1.1) on the "Review regional profile for the target region by evaluating clusters of companies involved and types of data available. Selection of sample cases for validation".

Acknowledgements

eSYMBIOSIS team would like to acknowledge the European financial instrument for the Environment (LIFE+) financial support.

Disclaimer

The information included herein is legal and true to the best possible knowledge of the authors, as it is the product of the utilization and synthesis of the referenced sources, for which the authors cannot be held accountable.

INTRODUCTION

Viotia is one of the fifty-one prefectures of Greece and a heavily industrialized region northern to Attica. It hosts numerous industries opting to expand and in essence decentralise the industrial activity to wider neighbouring geographical regions. It is within the Central Greece periphery, expanding on an area of 3.211 square kilometers with a population of approximately 135.000 residents according to the general census of 1991. Its capital, both in commercial and financial terms, is Livadeia, the second largest city being Thebes, and Oinofita as well as Sximatari represent urban commercial trading and industrial centers.

In light of the fact that the industrial region of Viotia lacks up to now any thorough planning and monitoring system for the control of area's industries with regard to waste management and environmental supervision, the vigorously emerging environmental issues are of vital importance and should be treated as such.

A viable and efficient practice to control and mitigate the faults that the current situation gives birth to, is to incorporate industrial waste materials through Industrial Symbiosis (IS) practices into a coherent management mechanism encompassing the considerable utilization of environment friendly processes such as recycling, reusing and re-processing.

The preliminary step to gather all necessary information for the industrial activity of the target area being selected as the pilot region to develop the IS service, is to review thoroughly its regional industrial profile and ascertain in detail all its features so to render eSYMBIOSIS team in a position to reach a pragmatic and accurate research outcome.

The Deliverable 1.2 represents a review and recording analysis of the industrial activity profile for the target region, and specifically for the Municipalities of Sximatari and Oinofita which are considered the most industrialized areas of Viotia Prefecture.

The full report of Activity 1.1 is structured upon (4) different units, namely:

- ✓ Review of the regional profile of Viotia
- ✓ Recording, analysis and presentation of industries being involved in the survey
- ✓ Presentation of selected industries as case studies for the validation of the performance of eSYMBIOSIS web platform
- ✓ Classification of solid wastes.

1. Review of the regional profile of Viotia

The target region is reviewed with respect to: (a) its geographic and geomorphologic features, (b) the population trends, (c) the economic sectors, (d) applicable legal framework on national level, (e) the survey methodology for the recording and selection of existing and updated data.

The undertaken survey methodology for the recording and analysis of industrial sectors and industries of the studied region includes the following individual procedural steps:

- Data were mainly selected from previous studies conducted by National Technical University of Athens and entitled: 1. "Integrated management of liquid industrial waste and sewage of the wider region of Oinofita and Sximatari, 2010", 2. "Preliminary investigation for the Project: Establishment and operation of a central processing unit for the treatment of industrial wastes generated from Asopos region and municipal wastes from Avlona town".
- The environmental registries of industries operating at the regional unit of Viotia, was the basic database providing all necessary information throughout the conduction of the aforementioned studies.
- Mapping of the region involved a number of on-site visits in order to record the existing industrial units under operation.
- Information with regard to qualitative and quantitative data of industrial processes was collected through questionnaires being distributed during visits.
- The existing data were updated through internet and personal contacts (emails, telephones).

Economic Sectors

Primary Sector

The main pillar of economic development of the prefecture of Viotia is the primary production sector. The extensive flat area of the county is rich in agricultural production. The total cultivated area covers about 78% of the total area of Oinofita and Sximatary cities.

In region's fertile lands are cultivated agricultural products such as cotton, tobacco, olives, cereals, legumes, vegetables, fruits and nuts.

Secondary Sector

The economic activity both of the city of Livadia and Sximatari and Oinofita, focuses mainly on the secondary (ginning houses, craft industrial units, etc.) and the tertiary sector (commerce-services), while, nowadays, agricultural production contributes to an ever diminishing extent to the overall income.

The Viotia shows a marked dependence on the secondary sector of production whereas a significant proportion of employment of county manufacturing companies is located in processing industry. Viotia is featured by high potentiality of productivity and vigorous presence in modernized industrial activity.

The geographical position of Viotia is indeed very advantageous and thus has up to date attracted more than 3.000 small and large industries mainly in the areas Sximatari and Inofita, transforming these areas into significant regional industrial centers. In the prefecture of Viotia, large factory production units operate such as cotton ginning, textiles, building materials etc.

2. Recording, analysis and presentation of industries being involved in the survey

The second section of Deliverable 1.2 constitutes a thorough survey being undertaken for the selection of already existing data that have been recently updated. In the context of the survey, the industrial sectors of Viotia have been recorded and classified as well as a number of individual industries per sector in terms of their production process, qualitative and quantitative data with regard to their capacity, types and quantities of raw/ancillary materials, final products and waste types (liquid, solid, sludge).

More specifically, the industrial clusters – sectors come up to twenty five (25) divisions which in turn are combined into eleven (11) general sectors, namely: 1. Food and Beverage Industries, 2. Leather processing and textiles industries, 3. Wood industries, 4. Production of pulp, paper and paper products, 5. Chemical industries, 6. Manufacture of other non-metallic mineral products, 7. Basic metal production, 8. Retail trade units, 9. Warehouses, 10. Livestock farming, 11. Various industrial units. The classification of clusters is based on Statistical Industrial Classification of Economic Activities (Greek acronym STAKOD 2008) as defined by the National Statistical service of Greece in two-digit analysis that is equivalent to the Nace, the European industrial activity classification.

The sectors being involved in the survey and the total number of industries/ industrial units corresponding to each sector are presented in the following table.

Table 2-1: Total industrial activity in the study area

Industrial sectors	**STAKOD 2008**	**Number of industries**
Livestock farming	01	11
Food and beverage industries	10, 11	41
Leather processing & textiles industries	13, 15	20
Wood industries	16, 31	15
Production of pulp, publications and printings	17, 18	17
Chemical industries	20, 21, 22	77
Manufacture of other non-metallic mineral products	23	20
Basic metal production	24, 25, 27, 28	96
Retail trade units	46, 47	9
Warehouses	52	26
Various	32, 38, 45, 49, 96	46
Total:		**378**

The distribution of recorded industrial units by sector is illustrated in Figure 2-1.

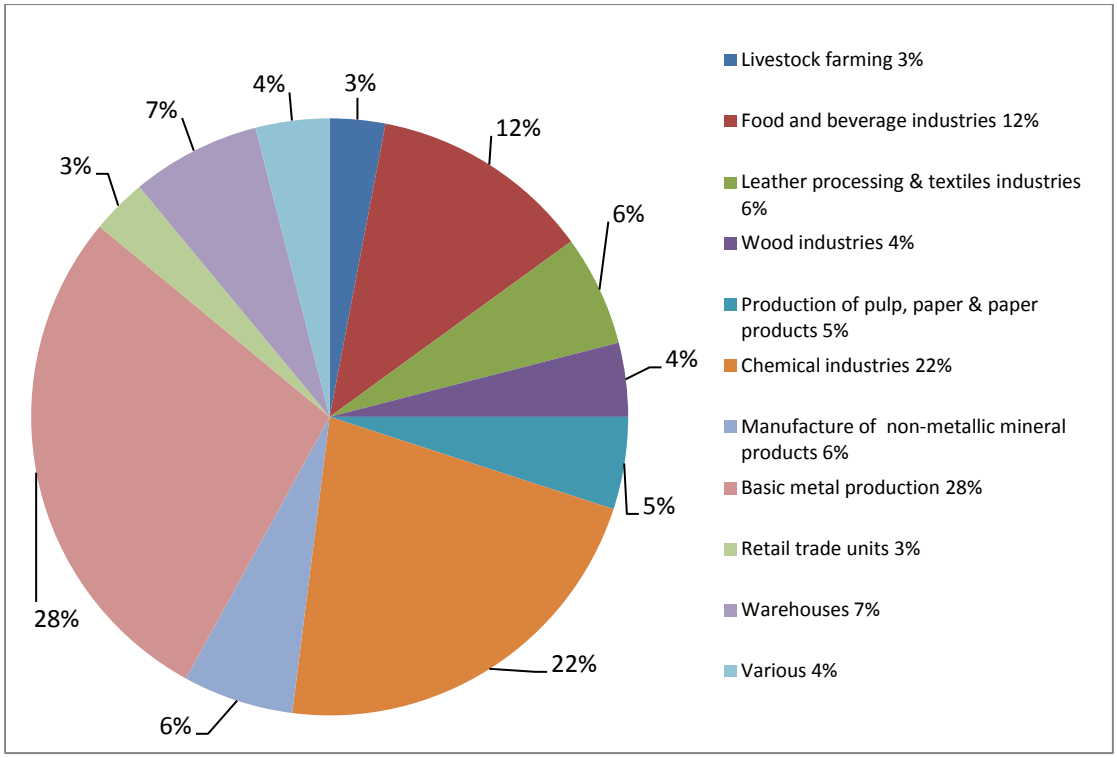

Figure 2-1: Chart of Industrial Units' distribution by sector in the studied area

Among the reported industrial units included in the survey, a number of 139 units generate high volumes of wastewater. The total amount of produced wastes comes up to 9.044 m^3/day while the percentage of 84% corresponds to industrial wastes being produced during industrial process. As shown in the Figure 2-2, the main volume is generated from the leather processing and textiles, food and beverage industries and basic metal production sectors at percentages of 25%, 21% and 30% respectively.

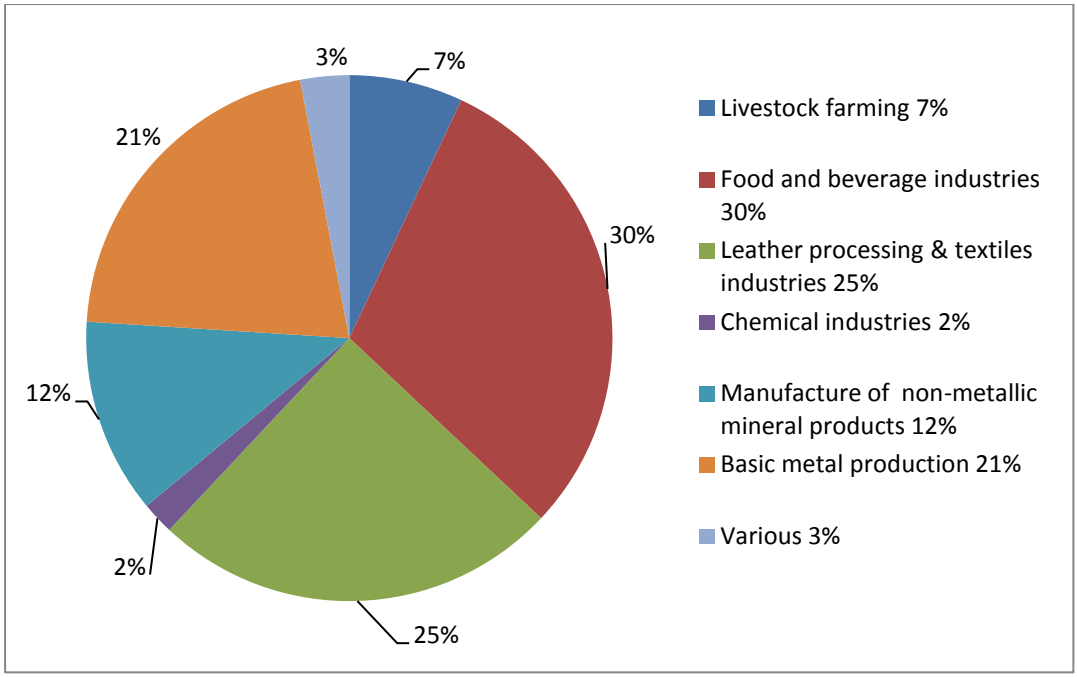

Figure 2-2: Percentage distribution of liquid waste by industrial sector

The example table below demonstrates the available set of data for a typical food industry. Taking into consideration the confidentiality of selected data, in the Deliverable the industrial units are presented with their ID number.

Table 2-2: Presentation of available data for a food industry

Industrial Unit ID: 9 **STAKOD:** 10.4 Manufacture of vegetable and animal oils and fats			
Products (tn/year)			
Olive oils	15.000	Cooking fat	3.000
Seed oils	10.000	Margarines	4
Raw/Ancillary materials (tn/year)			
Olive oils	15.000		
Seed Oils	10.000	Vegetable fats	7.000
Production process (Individual steps)			
- Production of crude olive oil			
- Filtration, ultrafiltration			

- Packaging	
- Refining of olive oil	
- Production of margarines and cooking fats	
- Homogenization / Pasteurization	Pasteurization at T= 72^{o}C
- Packaging	
Water consumption (m^3/year)	150.000
Maximum industrial wastewater (m^3/day)	180
Municipal wastewater (m^3/day)	10,5
Amount of sludge produced (tn/day)	150

3. Presentation of selected industries as case studies for validation of the performance of eSYMBIOSIS web platform

In the third section of Deliverable 1.2, thirty eight (38) representative industries are selected as potential users for the verification of the efficiency of the web platform (Activity 3.2). A significant number of selected industries expressed their interest and willingness in the Launching event to get involved and participate in the project as platform users.

Each industry falls under one particular subsector –division for every general sector and its selection is based on the following parameters:

- The trend of dynamic growth and the respective productivity of the industrial units themselves.
- Types of raw and/or ancillary materials that can be efficiently utilized in the context of eSYMBIOSIS.
- Quantitative and qualitative characteristics of the various types of wastes produced (solid, liquid, sludge).
- Matching with similar success stories of Industrial Symbiosis in other countries worldwide.
- Potential cooperation of industries with eSYMBIOSIS project's team.

The criteria used for the selection of industries are mainly qualitative based on typical characteristics that industries as potential users of the IS practice should have. In particular, the aforementioned criteria constitute the characteristics of potential platform users ensuring the successful matching between them and

therefore the formation of industrial symbiosis network. The criteria were defined and evaluated in terms of their significance for Industrial Symbiosis Methodology and National Industrial Symbiosis Programme approach (successful stories) without utilizing a software tool or a specific approach based on assessment models.

Additionally in this section, the different types of solid wastes generated by a number of industries included in the four most robust industrial clusters of the region (Sximatari – Oinofita) are set out. These clusters are: (1) Basic metal production, (2) Food and beverage industries, (3) Production of chemicals & chemical products including the sector of Plastic and rubber products manufacturing industry and (4) Manufacturing of other non-metallic mineral products. These clusters comprise approximately 62% of the total number of industries operating in the studied area. Specifically, the estimated amount of metallurgical industries is 97 (28%), food and beverage industries come up to 41 (11%) and chemical industries to 77 (22%) including the sector of manufacturing industries of plastic and rubber products. The available primary quantitative and qualitative data, for the selected industrial cases include waste types such as solid and liquid (sludge) and the raw and ancillary materials.

A brief review of the aforementioned sectors in terms of the industrial activities and waste types generated are presented below.

(1) Basic metal production

The main activities of metallurgical industries are summarized as follows:

- Production of basic iron, steel and iron alloys.
- Primary cold treatments of iron and steel, (i.e. rolled narrow strips, forming or folding, and production of ferroalloys).
- Production of non-ferrous metals like aluminum, lead, zinc and tin, copper and gold.
- Rolling of aluminum, manufacturing a number of different products, (i.e. aluminum foil and special alloys used in the automotive industry, for heat exchange applications, aluminum coils and sheets used for soft drink and food cans).
- Casting of metals such as iron and steel.
- Annealing (change of mechanical properties).
- Mechanical treatments (such as cutting, turning, welding).
- Chemical treatments deoxidation, metal cleaning, metallic coating, coloring, phosphating, electrostatic paint spraying.

The diverse types of waste (solid and liquid) that are produced by metal industries involved in the survey are presented in Table 3-1.

Table 3-1: Waste types of metal industries

Waste Types	**Main characteristics**
Scrap	Steel, iron (Fe) ,aluminum (Al), copper (Cu)
Skimming	Aluminum (Al)
Used Tows	Polluted with lubricants, solvents, minerals
Batteries	Vehicle batteries
Rollers	Iron (Fe), aluminum (Al), plastic, steel
Package Materials	Plastic, wood, paper, metallic, tinfoil, mixed
Fire resistant materials	Inert materials
Sludge	Source: waste treatment facilities /systems
Filters	Dust with oils from rolling, papers with lubricants, papers from bag filters, filter plate
Oils and lubricants	Engine oils, sheet oil
Plastic Tanks	
Paint vessels	
Coated Tubes	PET coated, PVC coated
Iron Barrels and bungs	
Metal off cuts	Copper (Cu), aluminum (Al)
Cables	
Construction and demolition waste	
Emulsion	

Assessing the current situation in the studied region, recycling represents the most common practice for solid waste management of residues such as scrap, cables and batteries, as well as the produced skinning aluminum.

Sludge from waste treatment could be used as an alternative fuel to cement industry, also probably to road construction sector. Advanced sorting technologies (for various types of scrap) could be a potential to add economic value to secondary processing of scrap leading to raw materials savings.

(2) Production of chemicals & chemical products

The chemical industries being included in the survey engage in the below areas:

- Production of basic chemicals (including gases, dyes, inorganic and organic basic chemicals), fertilizers, and nitrogen compounds, plastic and synthetic materials (i.e. synthetic rubber) in primary forms.
- Production of pesticides and other agrochemicals.
- Production of paints, varnishes, printing inks and similar coatings.
- Manufacture of soaps, detergents, perfumes and essential oils.
- Manufacture of explosives and pyrotechnic products, glues and gelatins.
- Production of artificial and synthetic fibers.

The following table summarizes the major waste types (solid and liquid) arising from chemical industries.

Table 3-2: Waste types of chemical industries

Waste Types	**Main characteristics**
Scrap	Steel
Polyurethane	
Package materials	Plastic, wood, paper
Filters	Activated carbon, Calcium carbonated $CaCO_3$ from water trap for dust
Lubricants, grease, oils	
Barrels	
Sludge	Sludge water soluble-inert, organic sludge
Powder Paint Bags	

Currently, the sludge produced by treatment plants in the studied region is used in composting facilities, the polyurethane is disposed to landfills, lubricants and filters are treated and disposed by waste management companies.

(4) Food and beverage industries

The industrial activities of this sector are briefly stated in the below areas:

- Production, processing and preservation of meat products
- Processing and preservation of edible fish and its products
- Production, processing and preservation of fruits and vegetables
- Production of vegetable and animal oils and fats
- Production of milk products
- Production of flour-mill products, starches and starch products
- Production of bakery and floury products
- Production of other food including: sugar, cacao, chocolate, sweets, processing tea and coffee, ready meals and dietetic foods.
- Production of prepared animal feeds.

The major waste types of the particular sector consist of: package materials (plastic, wood, paper, and metallic, tinfoil, mixed materials), sewage sludge produced from waste water treatment, cooking oils, oil filters and coffee pellets. Sludge is currently treated and is used as a fertilizer or compost while it could be utilized as an alternative fuel to cement industry. In addition, cooking oils are used as alternative raw materials for the production of biodiesel.

4. Classification of solid wastes

The fourth section includes a thorough description of solid waste types being generated from different industrial sectors. Solid wastes derive from various waste streams which are characterized by different origins, qualitative criteria and alternative end uses. In general, wastes originate either from production processes (e.g. scrap waste materials, by products, etc.) or waste treatment facilities (such as sludge from physicochemical or biological wastewater treatment etc.) and other sources (unused raw materials, cleaning and maintenance equipment).

The recorded types of solid wastes fall into two basic categories: a. common types resulting from different industrial sectors (such as package materials, batteries) and b. solid waste which vary according to the industrial activity.

The common solid waste categories are the following:

- Package materials
- Waste from filters
- Inert materials

- Batteries
- Special wastes such as used tires, electrical and electronic equipment

Solid waste materials by industrial sector

Additionally, the last section of Deliverable includes a description of solid wastes produced from different sectors during several stages of the production process. The categorization of solid wastes by sector is based on the European Waste Catalog (EWC) and hazardous waste list commonly used for the classification of wastes and the formation of a consistent waste classification system across the EU.

Solid wastes generated from the following industrial units were recorded and presented in the full Deliverable 1.2: 1 Food industries, 2 Production and packaging of pesticides, 3 Production of beverages, 4. Cement production, 5 Surface treatment and coating of metals, 6 Formatting, physical-mechanical surface treatment of metals, 7 Secondary metal production, 8 Production of mineral fertilizers, 9. Treatment of starchy crops, 10 Processing and canning of fruits and vegetables, 11 Glass production, 12 Production of inorganic chemicals, 13 Production of organic chemicals, 14 Medicines' production, 15 Manufacturing of soaps and detergents, 16 Preparation, processing and preservation of fish, 17 Preparation, processing and preservation of meat, 18 Preparation and processing of poultry, 19 Oil mills, 20 Regeneration of used mineral oils, 21 Production of paints and varnishes, 22 Pulp and paper production, 23 Plastics manufacturing, 24 Production of printed material, 25 Tanneries, 26 Dyeing and finishing Textile mills, 27 Production of wood products.

The table above summarizes the main solid waste types produced by a number of industrial sectors being involved in the survey of the project.

Table 4-1: Presentation of solid wastes by sector

Industrial Sector	Main characteristics and alternative uses of solid wastes
Food industry	➢ High concentrations of nitrogen and phosphorus ➢ Can be reprocessed and turned into valuable products for fertilizers and animal feed production ➢ Include spent agricultural products, residues ➢ Recoverable materials that are available for animal feed, also can be reused by other industries as raw/ancillary materials
Production – packaging of pesticides	➢ Include: unsuitable raw materials or final products for reusability, spent filters dust, damaged containers, paper packaging products polluted with pesticides,

Industrial Sector	Main characteristics and alternative uses of solid wastes
	Solid waste from production processes, product packaging ➢ Dust being produced from cleaning of floors and packaging machines ➢ Plastic or iron barrels of raw materials or toxic labeled products ➢ Toxic materials
Production of beverages	➢ Byproducts (residues) of raw materials' fermentation, byproducts from different stages of alcohol distillation ➢ High total organic matter, potential end uses: feed, soil conditioners for remediation of soils
Cement production	➢ Waste preparation mixture before thermal processing - waste from calcination and hydration processes of lime ➢ Powder that is removed from the gas oven ➢ Solid waste (hazardous or not), sludges and filter cakes from the treatment of produced water and gaseous wastes ➢ Waste concrete and concrete sludge ➢ Depleted and damaged fire resistant materials being used for oven coating
Formatting, physical-mechanical surface treatment of metals	➢ Products from liming and turning of metal chips throughout mechanical treatment of metals ➢ Dust and metal particles ➢ Wastes from welding processes ➢ Sludge from membrane systems ➢ Wastes from degreasing ➢ Saturated or spent resins from ion-exchange process ➢ Sludge from effluent treatment systems where metal precipitation takes place

The fourth section also includes a brief presentation of the four industrial sectors which are characterized by the production of significant sludge amounts on an annual basis.

References

Achilleos A. (1999), *"Production and processing of wastewater generated from dairy factories",* Athens.

Grigoropoulou E. (2005), "*Industrial Waste Management",* Academic notes, National Technical University of Athens, Greece.

Loizidou M. (1996), *"Preliminary Research for the Project: Recording of industrial wastes in Greece"*, National Technical University of Athens.

Loizidou M. (2002-2005), *"Development and Implementation of integrated system for monitoring and control of municipal wastewater treatment plants in Cyprus – COMWATER Project"*, National Technical University of Athens.

Loizidou M. (2006), "*National Solid Waste Management Strategy Implementation"*, National Technical University of Athens.

Loizidou M. (2006), *"Solid wastes"*, Academic notes, National Technical University of Athens, Greece.

Markantonatos G. (1990), *"Treatment and disposal techniques of wastewater: Municipal wastes, industrial and animal wastes"*, 2nd Edition, Athens.

School of Chemical Engineering, National Technical University of Athens (1997), "*Preliminary investigation for the Project: Establishment and operation of a central processing unit for the treatment of industrial wastes generated from Asopos region and municipal wastes from Avlona town",* Greece.