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The environmental balance of the Alta Val d'Agri: a contribution to the evaluation of the industrial risk and strategic sustainable development

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Abstract

This study presents the preliminary environmental balance of the Alta Val d'Agri (Basilicata Region, Southern Italy), an area of great naturalistic interest characterized by the presence of huge oil and gas fields. The DPSIR methodology has been used to outline the background in terms of environmental impacts mainly caused by the oil extraction activities, as well as existing potential responses. The study aims at providing stakeholders with an exhaustive framework to identify the existing data, the main sources of pollution, their potential impacts, the associated industrial risks and the existing policy strategies. Moreover, the DPSIR approach allows identifying the vulnerable areas and defining targeted actions for a sustainable development of the area.

1 Introduction

The environmental balance is a voluntary tool that describes qualitatively and quantitatively the relationships between the anthropogenic activities and the environment supporting either strategic planning and policy assessment (Nilsson, 2008). In particular, it allows evaluating the environmental performances of industrial settlements and assessing their pressure on vulnerable areas, highlighting the most important impact factors and the associated potential industrial risks (Piemonte Region and Regional Agency for the Protection of the Environment of Piemonte, 2013). The environmental balance provides a static representation of the analysed system in a given time period, evaluating its eco-efficiency and highlighting the bottlenecks as well as the existing response strategies to the environmental problems. In this process it is also possible to evaluate the variations of the state of the environment by comparing the environmental balances of different time periods, according to data availability and to identify the best available technologies that allow obtaining a significant improvement of system's performances.

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In this paper, a preliminary environmental balance of the Alta Val d'Agri industrial area is presented with the aim to provide stakeholders with an exhaustive framework for the characterization of anthropogenic pressures of the industrial settlement as whole as well as to outline a possible path towards a sustainable development of this area.

The Alta Val d'Agri is a peculiar area in which there are the hugest oil field in Italy and a protected naturalistic area (the "Appennino Lucano, Val d'Agri, Lagonegrese" National Park). The presence of an oil treatment centre, the "Centro Olio Val d'Agri – COVA", where the extracted fluid is collected, separated into crude oil, gas and water and further processed, represents undoubtedly a significant source of environmental impact with an important associated industrial risks. Therefore, an in depth characterization of the whole anthropogenic impacts, is fundamental to outline the state of art on which interventions and recovery plans are developed.

2 The methodological approach

In this study, an ad-hoc survey methodology has been implemented for a detailed characterization of the industrial area as well as to outline and monitor the relationships between the anthropogenic activities and the environment.

This methodology, mainly based on the DPSIR model implemented by the European Environment Agency (EEA, 1995) combined a qualitative and quantitative assessment to evaluate the integrated effect of the most dominant factors that determine the environmental impacts and their main effects. This preliminary analysis is essential to identify the strengths and weaknesses of the study area, the potential risks as well as to define strategies and measures to promote a sustainable development of the energy system.

To this issue a detailed survey of existing activities with a focus on industrial activities was carried out utilizing selected indicators. The indicators checklists were also complemented by customized questionnaires submitted to all the industries located in the study area (respondents were 74,5 % corresponding to 88,4 % of total employers and about 60 % of total energy consumption), aimed at providing additional qualitative information for a thorough description of the industrial activities including the existing energy-environmental management systems.

In the following a summary description of the DPSIR methodology and the selection of indicators are reported.

The DPSIR (Driving-Pressure-State-Impact-Responses) methodology represents an upgrade of the former PSR (Pressure-State-Response) model adopted by the Organisation for Economic Cooperation and Development (OECD, 1994). Its basic concept is the causality relationship among the pressures put forth by human activities on the environment and its changes in terms of quality and quantity of natural resources.

In this framework, specific indicators are used to provide concise information about each stage of the DPSIR process and constitute a sound database for evaluation and legislation. These indicators are essential to quantify the anthropogenic pressures and impacts and consequently to assess the state of environment supporting qualitatively and quantitatively policy evaluation studies and end-users information. In particular, the environmental indicators typically illustrate all the elements of the causal chain between the anthropogenic activities and their environmental effects as well as the community responses (Niemeijer et al., 2012).

The survey of the Alta Val d'Agri industries was aimed at characterising the industrial area by collecting specific data on resource use and environmental performances.

Therefore, appropriate socio-economic and environmental indicators were selected from the European Environment Agency (EEA, 2012) and the Institute for the Protection and Environmental Research (ISPRA, 2012) catalogues. These indicators, following the European Environmental Agency guidelines (EEA, 2005), were used to report the information related to Environment (air, soil, water), Resources (energy, raw and secondary materials, waste), Socio- Economic (policy, business, society, end-use sectors) as well as to highlight the main criticalities in terms of industrial risks.

The selected indicators are reported in Table 1 together with the DPSIR drivers and the reference components (input–output matrices).

All the information were reported in Excel tables including the following data: company factsheet (business, name, ISTAT code, number of employees, etc.), raw materials (processed, manufactured and used), water use, energy use, environmental authorizations and compliance with ISO standards.

Some of the collected data will also be included in a thematic database implemented by the Department of Productive Activities of the Basilicata Region to manage and monitor the industrial areas of the region.

3 The Alta Val d'Agri industrial district

The Alta Val d'Agri industrial district is located in the Basilicata region (Southern Italy) in the towns of Viggiano and Grumento Nova (Fig. 1a and b). The most important activities in the study area include a water treatment plant, a 4.5 MW PV plant, a 5.2 MW CHP plant, a 7 MW CC plant and the oil treatment centre COVA.

The industrial area is very close to the "Appennino Lucano, Val d'Agri, Lagonegrese" National Park and to built-up areas. It is also located in the Agri River Basin, in the neighbourhoods of the Casale stream, a tributary of the Agri River.

As a first step a survey of the infrastructures and services was carried out (Table 2).

Moreover, the industrial area hasn't yet a toponymy and there aren't schools, hospitals, sport and leisure centres in the surroundings.

The industry activities related to the oil/gas treatment centre, the COVA, owned by ENI, represent the most significant sources of environmental impact. In fact, besides being the major integrated energy company of Italy, ENI is also the major operator of the Val d'Agri (60.77 % of exploitation concessions). ENI started its activity in the Basilicata region in 1996, with the "Monte Alpi" production line, whereas the COVA started its production in 2001. Currently there are five production lines from 26 wells, with a maximum capacity of about 16.500 $m^3\,day^{-1}$ (about 104.000 barrels day^{-1}) and 3.1 million $Sm^3\,day^{-1}$ of natural gas.

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The extracted fluid is processed through a three-phase system that separates the oil extracted into crude oil, gas, and water. Crude oil is transported through an underground pipeline of about 136 km length to the ENI refinery in Taranto, located in the neighbour Apulia Region. Natural gas pre-treated at COVA is then delivered to the SNAM national grid (ENI, 2013) whereas the process water is re-injected into the subsoil through the Costa Molina Sud injection well.

The oil industry causes a high impact on all environmental matrices (air, water, soil), on vegetation and wildlife, and ultimately on human health, during all of the processing phases, from drilling to transportation (Sviluppo Basilicata, 2011).

In fact, the oil treatment centre COVA is a major hazardous plant (one of 10 hazardous plants located in the Basilicata Region) and should comply with the Seveso 3EU Directive (EU/2012/18) that addresses the consequences to the regulation of major accident hazard sites in order to limit their consequences for human health and the environment. The COVA has accordingly prepared an emergency plan and requested an Integrated Environmental Authorization (IEA, 2011), according to IPCC directives (Directive 2008/1/EC).

It should be also noticed that the oil fields are located in a high seismic risk area characterized by a series of important active trans-current tectonic faults that make particularly unstable the territory on the whole. In fact, according to the (Basilicata Law n. 9/2011), the Val d'Agri belongs to the vulnerability class 1b characterized by a Peak Ground Acceleration (PGA) of 0.275 g and a maximum magnitude of 5.8 and these geographic conditions contribute heavily to increase the vulnerability of the territory.

3.1 Preliminary results and discussion

3.1.1 Driving forces

As regards the driving forces, a systematic collection of data on energy, environmental and socio-economic aspects has been performed in order to identify those activities causing the major impacts. Starting from the data provided by ASI Potenza about the industry activities and taking into account the European industrial activity classification (Eurostat, 2008), a detailed socio-economic characterization of business activities was carried out. The summary results are reported in Table 3.

The characterisation of the industry sector points out that, apart from the economic activities induced by the oil extraction plant, there is a prevalence of micro-manufacturing firms. The petrochemical sector is characterized by medium and large enterprises with a high level of technological innovation based on the achievement of high economy of scale (Sviluppo Basilicata, 2011).

Among the small and medium enterprises, the most relevant sectors in terms of employees are manufacturing (small businesses), construction and related industries (stone processing, production of lime and concrete, metal and wood carpentry), and professional, scientific and technical activities.

Transporting materials and finished goods in and out of the industrial area represents one of the critical aspects with a significant impact on environment. In fact, due to the lack of rail, road transport is carried by truck along the SS 598 Fondo Valle dell'Agri which connects the industrial area to the highway. The traffic associated with goods transport is the main source of impact as urban traffic is negligible due the lack of service centres.

3.1.2 Pressures

Any pressure on the natural environment and human health requires the handling and the processing of raw materials (Eurostat, 2011).

The use of material resources plays indeed a crucial role in the generation of environmental pressures directly caused by primary activities and indirectly through their feedback to the natural environment in terms of air pollutants, water discharges, waste production and land use.

In fact, resource productivity is the main indicator selected by the European Commission to monitor sustainable consumption and production (Council of the European Union, 2006).

The Alta Val D'Agri industrial district covers an area of about 190 ha of which about 168 built-up, 34 public green and about 6 ha not suitable for building (Cooperative of ASI, 2012).

The use of raw materials (typology and quantities) was estimated taking into account the Legislative Decree n. 152/99 tables (Legislative Decree n. 152/99). The data provided by the Cooperative of ASI referred to a sample of 13 companies, were integrated and extrapolated to 2013 through a survey conducted in the early months of 2013, whose summary results are reported in Table 4.

As regards water use very detailed data were provided by the Aziende Riunite Gestione Aree Industriali Potentine (ARGAIP, 2012), a consortium of companies responsible for the operating and maintenance of industrial plants. Figures 2 and 3 show water consumption for industrial and civil uses by sector. The drinking water is provided by the local aqueduct, industrial water is supplied from the treatment plant whereas a sewer collect wastewater. These infrastructures are managed by the Cooperative of ASI.

As shown in Fig. 2, mining and quarrying (both for civil and industrial use) and manufacturing (civil use) have the highest consumption (respectively about 82.6 % for civil use and 94.6 % for industrial use and for manufacturing about 15.0 % for civil use and 4.3 % for industrial use). Among the other sectors (Fig. 3) as concerns the civil use, professional activities (0.77 %) and water supply (0.70 %) show the most significant water consumption whilst for industrial use construction (0.47 %) and wholesale and retail trade (0.28 %) are the most relevant consumers.

In addition, also waste flows were investigated using the so called "Model for Environmental Declaration-MUD" the annual declaration on the total amounts and characteristics of waste produced, that industries are obliged to fill in according to the Italian legislation (Legislative Decree 152/06 and its subsequent modification and Ministerial Decree n. 52/2011).

Taking into account the information provided by the MUD declarations filled in by the companies located in Val D'Agri for the years 2010–2011 (Chamber of Commerce and Industry of Potenza, 2013) and additional data provided by the Regional Agency for the Environment of the Basilicata Region (ARPAB, 2013), the waste flows (Hazardous Waste-HW and Non-Hazardous Waste–NHW) were obtained.

In particular, Fig. 4 reports the amounts of hazardous waste and non-hazardous waste by sector estimated by the Regional Agency for the Environment of the Basilicata Region ARPAB.

Figure 5 reports an insight of hazardous waste (CNR-IMAA elaborations on ARPAB data). It can be seen the significant contribution of oil extraction activities (i.e. "mining and quarrying" sector) especially with oily wastewater (e.g. water used to wash equipment and tanks, drain water, oil sludge, etc.).

Figure 6 reports an insight of non hazardous waste (CNR-IMAA elaborations on ARPAB data). Manufacturing activities and, more specifically, machineries and equipment manufacturer (NEC) contribute significantly to the production of non hazardous waste, whereas mechanical activities produce a large amount of hazardous waste (emulsions and solutions for machinery, without halogen and packaging containing residues of dangerous or contaminated substances).

According to the MUD declarations and the European Waste Catalogue (EWC) categories a further disaggregation of industrial waste flows was estimated (Table 5).

The evaluation of the waste flows didn't take into account the sludge from urban waste water treatment as well as Municipal Solid Wastes (MSW) because it was not possible to distinguish the amounts produced by the industrial district by the whole amount of MSW produced by Viggiano and Grumento Nova municipalities.

Energy consumption is an important indicator to assess the impact of the end-use sectors, with particular attention to energy-intensive activities (e.g. power generation, refineries, steel and aluminium industries, etc.) characterized by high specific electrical and thermal energy consumption. The Alta Val d'Agri industrial district includes two power plants: (a) the CHP Azimut, a 5.2 MW natural gas co-generative plant connected to district heating network of about 2 km, and (b) the CC power plant named Nuova Azimut, a 7 MW plant natural gas fuelled. Since 2013 the Azimut plant has not been operative and it will be dismantled in a near future therefore also the district heating will not fulfil the thermal energy demand.

The total consumption of the industry sector (about 7300 toe) were estimated from the average unitary energy consumption for the whole Basilicata Region industry sector (e.g. the total energy consumption by sector by working unit) (ENEA, 2012), considering the number of employees by sector of the Alta Val d'Agri industries in 2012 and the percentage of use of energy carriers estimated by the direct survey (Fig. 7).

Figure 7 highlights that electricity is the most used fuel (71 %) followed by natural gas (18 %), LPG (10 %) and thermal energy from the district heating (1 %). This fuel mix represents an environmental bottleneck because natural gas network is not yet finished and cannot fulfil the whole industrial energy demand.

In this evaluation, COVA consumption are not included as well as the ones of the two power plants. The COVA consumption estimated by the ENI company are reported in Table 6.

Energy consumption constitute the basis to estimate the pollutant emissions due to combustion processes and to identify the most pollutant activities. The atmospheric emissions were thus estimated from the energy consumption according to the CORINAIR methodology (EMEP/EEA, 2009), considering emission factors by the SINA Net (SINA Net, 2012) and the ANPA CTN-ACE guidebook (ANPA CTN-ACE, 2002) and utilising suited proxy variables by sector (e.g. socio-economic and demographic indicators). Figures 8 and 9 show the pollutant emissions from energy processes for the main end-use sectors emphasising the high contribution of manufacturing.

The COVA emissions for the period 2009–2011 provided by the ENI company, are reported in Table 7.

In addition to the emissions from combustion, the emissions from non-energy process were estimated by using the solvent consumption as activity indicator. This amount increases 24.5 % the total yearly emissions on average (data not shown).

Besides the evaluation of yearly pollutant emissions the analysis concerned also the localization of pollution sources (in particular point sources).

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A census of the emissions permits (Legislative Decree N. 152/2006) and the Integrated Environmental Authorization granted by the Basilicata Region survey was therefore carried out to integrate the information obtained by the direct industry. This investigation is also aimed at a physical-chemical characterization of pollution sources in a near future.

3.1.3 State

The state of the environment and the impacts of the anthropogenic activities in the study area were assessed by investigating air and water quality and by assessing the firms with environmental certifications (ISO standards, EMS and HSM).

The bulk of data were provided by the Environmental Observatory of the Val d'Agri (OAVDA, 2013) and from monitoring campaigns carried out by local authorities and scientific institutions. In particular, the official data were provided by the Environmental Monitoring Plan (whose implementation, in compliance with the DD.GG.RR. 313/2011 and 627/2011, have been established by an operating protocol between the Basilicata Regional Agency for Environmental Protection ARPAB and the ENI company signed in 2011). This operating protocol defines an integrated environmental monitoring process implemented in the framework of the "Project of modernization and improvement of production performance of Oil Centre Val d'Agri" of the Integrated Environmental Authorisation – IEA. It aims at characterizing the impacts caused by the oil extraction activities on air, soil and subsoil matrices in an area of 13 km × 8 km surrounding the COVA as well as to assess their temporal trends. Table 8 summarises the analysed parameters and the monitoring equipments with reference to the investigated matrices.

Some preliminary consideration concerning air quality and surface and reinjection water quality can be made from the analysis of current available data.

In particular, in the framework of the activities of the Environmental Observatory (OAVDA, 2013), a preliminary analysis of air quality data referred to the period from 28 February to 13 June has been performed. This analysis showed that the monitoring station close to the Oil Centre Val d'Agri-COVA is characterized by high concentrations

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of all pollutants and in particular of volatile organic compounds (C_6H_6, NO_x, toluene, ethyl-benzene) probably originated by the oil treatment activities and also H_2S shows high concentrations compared with the WHO guidelines (WHO, 2000). As concerns the pollutants with threshold values, O_3 threshold value is exceeded the highest number of times.

As concerns the quality of groundwater, there aren't significant problems according to the ARPAB data for the town of Montemurro (ARPAB, 2013a).

A monitoring project to assess the quality of water reinjection of Costa Molina 2 had been carried out in 2010, 2011, 2012 and the first six months of 2013. The results of these monitoring campaigns, partly reported in (ARPAB, 2013b) point out that some analytes, like iron and total hydrocarbons exceeded the regulatory limits.

Another interesting analysis concerns a census of the companies that adopted quality management systems to certify their performances as:

- ISO 9001 Quality Management Systems (QMS),
- ISO 14001 the Environmental Management Systems (EMS),
- BS OHSAS 18001 Health and Safety Management Systems (HSM).

The results of this investigation, based on the official data (ACCREDIA, 2013) point out that only 14 companies certify their performances as reported in Fig. 10.

Moreover, no company has still adopted the EU EMAS regulation (EMAS, 2013) that has additional requirements respect to other environmental management systems. In fact, the implementation of the EMAS scheme need several compulsory steps: the definition of the company environmental policy, an environmental management system, an environmental audit for the periodic evaluation of the company environmental performances, an environmental statement, that through periodic public report reports the performances, programme and objectives of the company as well as the compliance with environmental laws, and finally verification and registration to validate the environmental statements by the EMAS National Body that authorise the use the EMAS logo.

The analysis of the currently available data points out the necessity to have longer time series of validated data for all the considered environmental matrices to perform a thorough assessment of the state of environment in the case study area, with the aim of monitoring the evolution of pollutant phenomena. To this issue, it should be noticed that a potential criticality is a lack of the knowledge about the period prior to the start of mining activities that hamper a full evaluation of the changes occurred in the time and the cause-effects.

3.1.4 Responses

To compensate the environmental impact of the mining activities as well as to guarantee satisfactory life conditions and adequate information to the population, a set of measures have been implemented. Among these policy strategies aimed to control/improve the environmental conditions, policy and incentives to foster technological innovation, business creation and development and to improve information to community have been considered. In particular, as concerns the impact of mining activities and oil treatment processes, several measures were undertaken by the companies to limit the damage and to check their environmental performances, extensively reported in the previous paragraphs. The main considered strategies with a synthesis of the pursued aim and the planned measures are reported in Table 9. Among the policy strategies, it is worth noting the establishment of "Environmental Observatory of Val d'Agri" that provides for the implementation of the above mentioned monitoring project, ensuring also a proper and well-documented dissemination of environmental information, realized by means of archiving and managing many environmental data in dynamic databases. The Environmental Observatory is also involved in several research projects on the Val d'Agri environmental and health issues.

Of considerable interest is also the "Action plan for air protection of quality in the towns of Viggiano and Grumento Nova", established with the Regional Decree (DGR 1640/2012).This plan is aimed to the improvement of air quality providing for a 20 %

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reduction of the threshold values of SO_2 and H_2S and the definition of four attention reference levels related to the overtaking of threshold values.

Specific measures for promoting the development and competitiveness of the regional production system were also provided by the ERDF Operational Programme of Basilicata Region, in particular by the ERDF Innovative Actions 2000–2006 ("Regional Programme of Innovative Actions in Basilicata – Italy"; ERDF, 2007), the Regional Law n. 1/2009 (Basilicata law n. 1/2009) and the 2007/2013 ERDF Programme (Operative Programme Val d'Agri-Melandro-Sauro-Camastra; ERDF, 2013), that provides for specific actions to promote the territorial development, the environmental certification and to facilitate the settlement of the productive and tourist activities in the case study.

As concerns energy issues, financial incentives were addressed at boosting energy production from Renewable Energy Sources (RES) to valorise endogenous resources as well as to limit the use of fossil fuels. These mainly resulted in a noticeable diffusion of PV systems as reported in Table 10.

The "Regional Environmental Energy Plan" (PIEAR, 2010) provides for a reduction of energy consumption and bills, the increase of the production of electric and thermal energy from RES and the creation of a Val d'Agri energy district. Specific objectives are to support research and technological innovation and to promote sustainable mobility.

Despite the existence of several planning strategies, other measures could be deployed by the Institutions in order to improve the management and the environmental performances of this area. To this aim an improvement of the infrastructure and common facilities is necessary (i.e. the completion of natural gas distribution network) and, more generally, a support of a strategic environmental action for the sustainable development of this site, which could also lead to the application of audit scheme (EMAS) certification to the Alta Val d'Agri industrial area. In this perspective, a "territorial" approach based on EMAS can be considered as a new opportunity to pursue in a synergetic and mutually reinforcing way the public, private, social and industrial targets and interests emerging in the local context. In particular, this approach gains a great importance for those territorial contexts that are known as industrial districts (Daddi et al., 2012).

4 Conclusions

Mining activities are at the same time a resource for the territory and an important source of impacts causing severe damages to the environment as soil erosion, loss of biodiversity, pollution phenomena interesting air, soil and groundwater that may affect severely local population.

The DPSIR methodology allows describing exhaustively the cause-effect relationships among the different components as well as taking into account the recovery plans and strategies. In fact, the DPSIR framework highlights both weak and strength points in order to monitor the state of environment, manage the critical phenomena and valorise the endogenous resources to check environmental quality and improve life standards.

This study presents a preliminary environmental impact study and assessment of the industrial activities of Alta Val d'Agri district. The investigation was also addressed at identifying the critical factors for a development of business activities, currently hampered by a significant lack of infrastructures.

The work performed so far provides a sound reference framework for further investigations and is helpful to evaluate the potential risks represented by the mining activities in a study area with peculiar environmental and geographical features.

An in-depth characterization of the study area and the impacts of industrial activities will be performed utilising additional monitoring data on the different environmental matrices in order to carry out a complete environmental balance. Moreover, different methodologies will be integrated to characterize the strengths and weaknesses of the system and to define tailored guidelines for local sustainable development.

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Table 1. Indicators of the Val d'Agri study area.

DPSIR Drivers	Indicators	Component (Input–Output matrices)
Driving forces (D)	Population, Number of enterprises, Number of employees by sector GDP	Socio-Economic/ Society, Business
	Barrel of oil extracted Sm^3 day^{-1} of natural gas	Environmnent Socio-Economic/Industry
	Number and typology of freight transport (fuels, raw materials, goods)	Socio-Economic/Transport
Pressures (P)	Land use	Environment/Soil
	Natural resources use	Resources/Raw material
	Water extraction, consumption and waste	Environment/Water
	Energy production and consumption	Resources/Energy
	Atmospheric emissions by sector (CO_2, SO_2, NO_x, VOC, CO, TSP, PM_{10}, $PM_{2.5}$, NO_2, O_3, SO_2)	Environment/Air
	Waste produced by industry sector (Special hazardous waste, Special Non-Hazardous Waste)	Resources/Waste
	Integrated Environmental Authorization-AIA	Socio-Economic/Industry
State (S)	Atmospheric pollutant concentrations (SO_2, NO_x,VOC, CO, TSP, PM_{10}, NO_2, O_3)	Environment/Air
	Chemical-Microbiological parameters (BOD_5, COD, PH, organic substances, fecal contamination indices) Ecological parameters (SECA, LIM, IBE)	Environment/Water
Impacts (I)	All indicators reported in the above categories to assess the variations and changes on the environment	Environment/Air, Water, Soil
	Other indicators to assess the damages on eco-system, human health, economic	Socio-economic/Society, Business
Responses (R)	Environmental evaluation and certification Number of RES plants installations	Environment/Air, Water, Soil
	Policies and strategies at national, regional, provincial and municipal level (e.g. SEAP, mitigation and adaptation plans, other thematic plans) Financial measures and incentives to promote RES and EE deployment Other actions promoted by Local Authorities and Associations categories for environmental protection and sustainable development	Socio-economic/Policy, Business, Society

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Table 2. Alta Val d'Agri industrial district: state of infrastructures.

Infrastructures	Availability	Situation
Electricity grid	X	Completed
Natural Gas grids	X	Società Nazionale Metanodotti-SNAM grid in the area identified as "ex-219" An ASI grid connecting all the industries under construction
Oil pipeline	X	A 136 km pipeline connects the oil centre COVA in Viggiano with the Taranto refinery
High voltage grid (≥ 15 kW)	X	about 1.5 km North
Drinking and industrial water	X	Completed
Public lighting	X	Completed
Sewerage	X	A water drainage system and a sewage treatment plant
Roads	X	The state road S.S. 598 Fondo Valle d'Agri has exits on the highway at Athena Scalo (province of Salerno) and on the SS 106 Jonica between the towns of Policoro and Scanzano Ionico
Highways and Freeways		
Other Roads		Internal roads are not properly maintained, with no road markings and insufficient traffic signs
Railway		The nearest town with a railway station is Potenza, the chief town
Telephone line	X	Completed
Internet line (ADSL, optical fiber, etc)	X (partially available)	An optic fiber ring is under construction to serve the ENI offices

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Table 3. Characterization of the industry sector of Alta Val d'Agri.

Indicators	Reference period: 2012–2013	
Total number of employees	1095	
Distribution of enterprises and employees by sector		
Sectors of activity	N. of enterprises	N. of employers
Mining and quarrying	7	218
Manufacturing	**18**	**440**
Electricity, gas, steam and air conditioning supply	3	6
Water supply, sewerage, waste management and remediation activities	5	54
Construction	**5**	**210**
Wholesale and retail trade	6	28
Transport and storage	3	44
Information and communication	1	2
Real estate activities	1	1
Professional, scientific and technical activities	**10**	**116**
Administrative and support service activities	1	1
Education	1	3
Other service activities	1	3

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Table 4. Raw materials and finished product per sector of activity.

Indicator Raw Materials Input/Output		
Sectors Of Activities	Raw Materials (Tons)	Finished Product (Tons)
B Mining And Quarrying	34 763 (ktoe)	
C Manufacturing	83 016.6	55 094
F Constructions	–	–
G Wholesale And Retail Trade; Repair Of Motor Vehicles And Motorcycles	–	2000

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Table 5. Waste flows according to EWC classification (source: ARPAB internal communication).

EWC	Description of wastes	Quantity of waste generated [tons]	Quantity of waste received [tons]	Quantity of waste delivered [tons]
01	Wastes resulting from exploration, mining, quarry, as well as by physical or chemical treatment of minerals	26 371.28	4.58	26 359.30
03	Wastes from wood processing and the production of panels and furniture, pulp, paper and paperboard	45.70	0.00	46.60
05	Wastes from petroleum refining, natural gas purification and pyrolytic treatment of coal	190.68	0.00	190.68
06	Wastes from inorganic chemical processes	0.38	0.00	0.38
07	Wastes from organic chemical processes	700.41	0.00	700.41
08	Wastes from the manufacture, formulation, supply and use of coatings (paints, varnishes and vitreous enamels), adhesives, sealants and printing inks	0.39	0.00	0.40
10	Wastes from thermal processes	41.26	0.00	41.26
12	Wastes from shaping and physical and mechanical surface treatment of metals and plastics	636.65	0.00	633.78
13	Oil wastes and wastes of liquid fuels (except edible oils, and those in chapters 05, 12 and 19)	9.69	0.00	10.38
14	Organic solvents, refrigerants and propellants (except 7 and 8)	0.02	0.00	0.02
15	Waste packaging, absorbents, wiping cloths, filter materials and protective clothing (not otherwise specified)	1533.99	0.00	1530.82
16	Wastes not otherwise specified in the list	59 622.78	0.00	59 619.63
17	Wastes from construction and demolition wastes (including excavated soil from contaminated sites)	210.32	13 403.63	212.06
19	Wastes from waste treatment plants, wastewater treatment plants off-site, as well as clean water and its preparation for industrial use	154.64	0.00	154.64
20	Municipal wastes (household waste and similar products to commercial and industrial activities and the institutions) wastes including waste collection	1340.11	0.00	1340.01

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Table 6. Energy consumption of COVA (Source: ENI, 2013).

Energy flows	2009	2010	2011
Gross energy consumption [internal production plus purchased energy] [MWh]	148 843	155 212	158 151
Net energy consumption [produced plus purchased/sold energy] [MWh]	131 933	144 281	153 949
– of which produced electricity [MWh]	148 329	153 196	144 467
– of which energy purchased by other companies [MWh]	514	2016	13 683
– of which energy sold to other companies [MWh]	16 910	10 931	4202
Net electricity consumption [MWh] per thousand of produced barrels	4621	4497	4429

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Table 7. Total yearly emissions from COVA (Source: ENI, 2013).

Reference year	2009	2010	2011
	thousands of tons		
GHGs direct emissions	497.66	469.78	394.5
of which CO_2 from combustion and process	307.57	273.8	205.1
of which CO_2 equivalent from flaring	72.82	67.28	49.77
of which CO_2 equivalent from CH_4	117.26	128.71	139.64
SO_2 emissions	0.032	0.028	0.039
NO_x emissions	0.536	0.5	0.333

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Table 8. Framework of synthesis parameters, and monitored environmental components (Source: OADVA).

Environmental matrix	Analyzed parameters (in situ and/or laboratory measurements)	Sampling frequenzy	Monitoring equipments
Air	SO_2, O_3, CO, NO, NO_2, NO_x, $PM_{2.5}$, H_2S, CH_4, NMHC, THC, VOCs, C_6H_6, toluene, ethylbenzene and m, p, o-xylenes (BTEX); odorous compounds-sulfurmercaptans; measure the concentration of radon gas	continuous	4 fixed monitoring stations
	PAHs and Al, As, Cd, Cr, Mn, Ni, Pb, Fe, Cu, Zn, Tl, Sb and V	–	
	temperature, pressure, relative humidity, precipitation, global radiation and net speed and wind direction, UVW sonic velocity components and sonic temperature	continuous	
Groundwater	– pH, temperature, turbidity, water table depth, dissolved oxygen, conductivity, salinity, redox potential – IPA, sulfates, metals, hydrocarbons with C < 12 hydrocarbons with C < 12, aromatic organic compounds	monthly	4 piezometers
Surface Water and Sediment	physico-chemical parameters processing of indexes: I.B.E, Trophic and functional indices, indices of diversity, LIM, SECA, S.A.C.A.	monthly	7 sampling stations
Noise	Sound levels for day and night	continuous	4 stations
Odor emissions	"The monitoring of odor emissions will be made on the basis of an adequate scientific study with direct applications in the surrounding territory on the Oil Centre Val d'Agri in collaboration with scientific institutions and research organizations" (Protocol implementation in development)		

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Table 9. Main responses and pursued scopes.

Strategy	Measure	Objectives/scope
Basilicata Region Environmental Observatory Val d'Agri	1. Monitoring Project 2. Implementation of dynamic databases 3. Development of training projects 4. Environmental Assessment 5. Implementation of several research projects on the environmental and health issues	1. Environmental monitoring 2. Archiving and managingof environmental data 3. Promotion of information campaigns aimed at ensuring to the citizenship a correct and well-documented information on environmental issues 4. Study and verification of compatibility among existing activities and the principles of biodiversity conservation 5. Population and Health assessment and surveillance
Action Plan for the protection of air quality in the municipalities of Viggiano and Grumento Nova	20 % reduction of SO_2 and H_2S emissions and definition of four attention levels	Improvement of air quality
ERDF Operational Programme of Basilicata Region	1. Supporting the entrepreneurship 2. Improving the sustainable use of environmental resources, the efficiency and the management of decion-making process	Territorial development, environmental certification to facilitate the settlement of the productive and tourist activities
Regional Environmental Plan	1. Reduction of energy consumption and energy bills 2. Increase of the production of electric and thermic energy from RES 3. Creation of a district energy in the Val d'Agri	1. Energy savings and improved energy efficiency of public and private buildings 2. Larger energy distributed generation from RES 3. To support research and technological innovation 4. Sustainable mobility

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Table 10. Type and capacity of RES systems installed in the Alta Val d'Agri industrial area (data from direct survey).

RES	Installed capacity [kWp]	Type of system
PV	200	Totally integrated on roof
PV	20	Partially integrated on roof
PV	200	Not integrated
PV	4500	On land

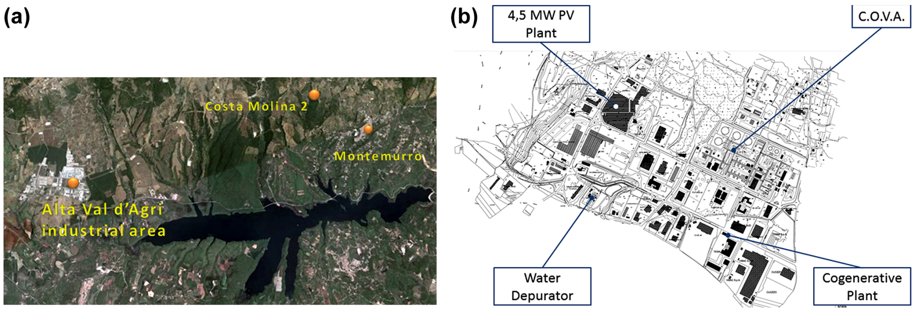

Figure 1. (a) The Alta Val d'Agri industrial area (Source: Google Earth, 2013), and **(b)** the site plan of relevant industrial activities (Source: IMAA-CNR elaboration on Bonaduce's image).

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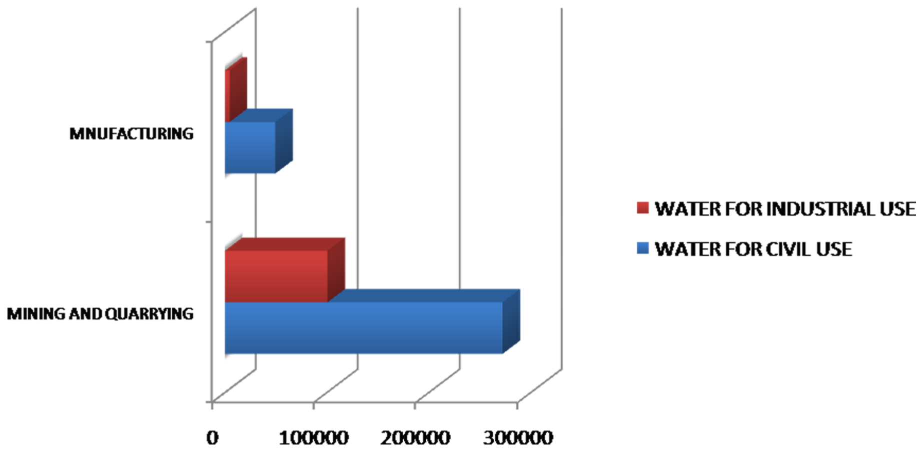

Figure 2. Water Consumption for industrial and civil use: mining and quarrying and manufacturing [10^6 m^3] (Source: ARGAIP Potenza).

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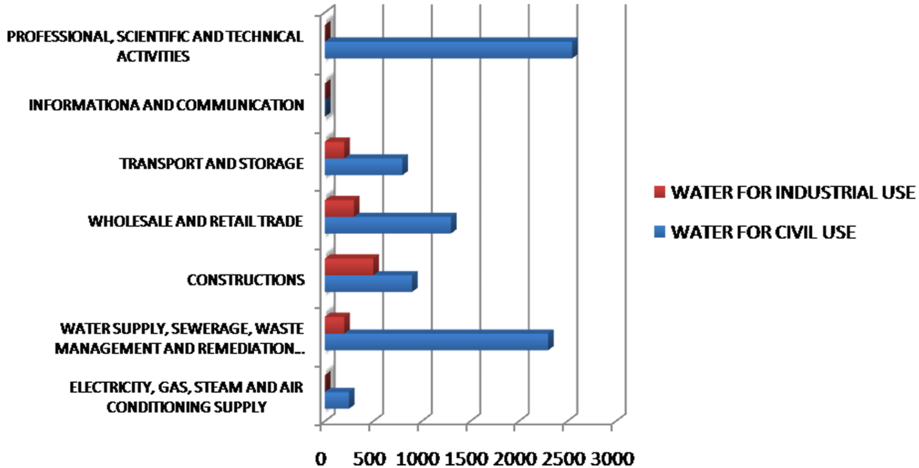

Figure 3. Water consumption for industrial and civil use by sector [m^3] (Source: ARGAIP Potenza).

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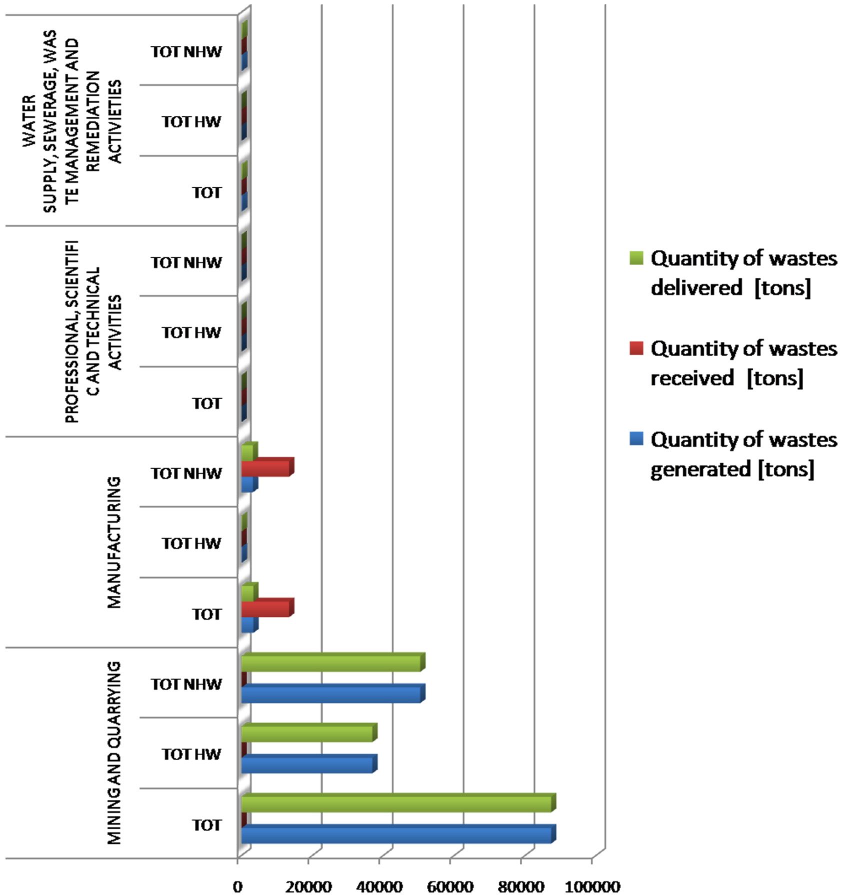

Figure 4. Waste flows by sector: Hazardous (HW) and Non Hazardous Waste (NHW) (source: ARPAB).

Figure 5. Hazardous Waste (HW) by sector [tons] (CNR-IMAA elaborations).

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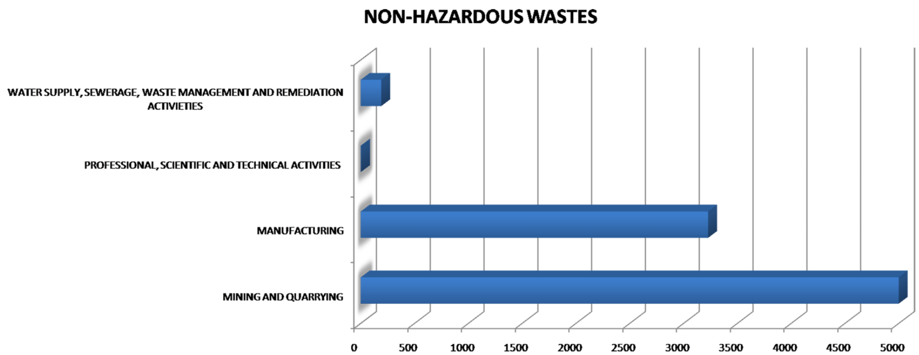

Figure 6. Non Hazardous Waste (NHW) by sector [tons] (source: IMAA-CNR elaboration on data from ARPA Basilicata).

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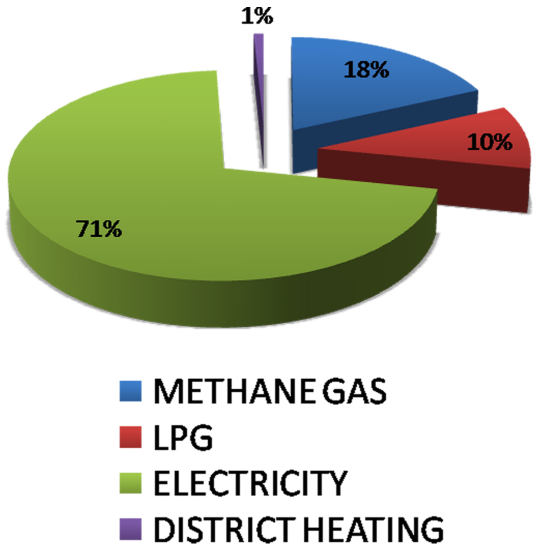

Figure 7. Energy consumption by energy carrier – industry (year 2012).

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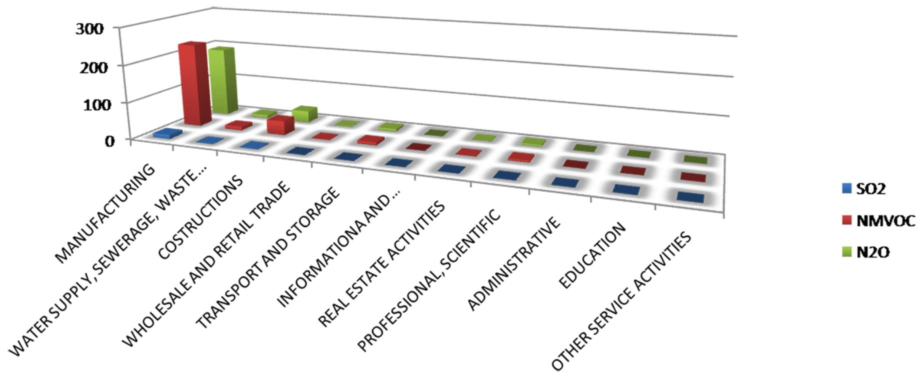

Figure 8. Local Air Pollutant emissions from energy processes by sector [kg year^{-1}].

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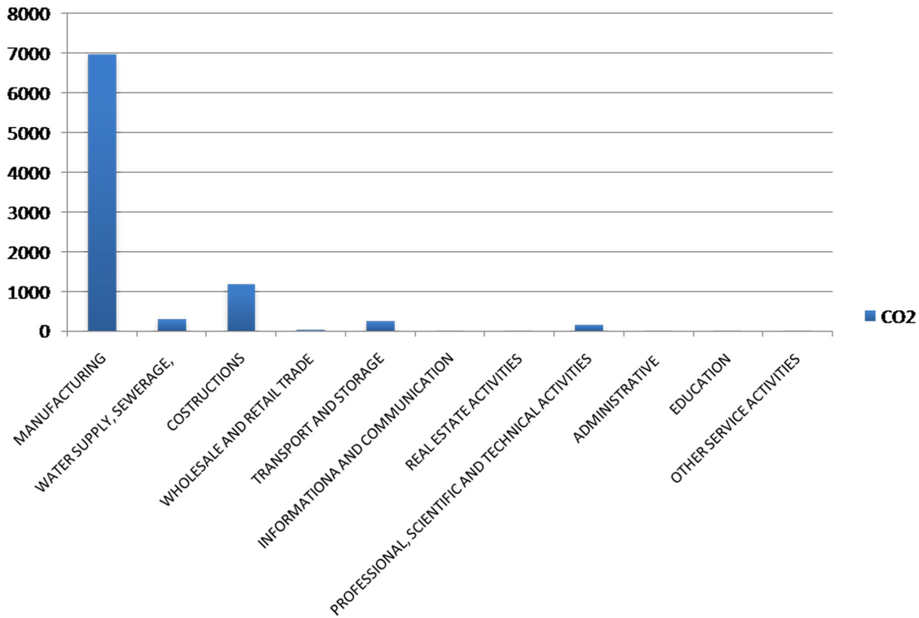

Figure 9. CO_2 from energy processes by sector [tons].

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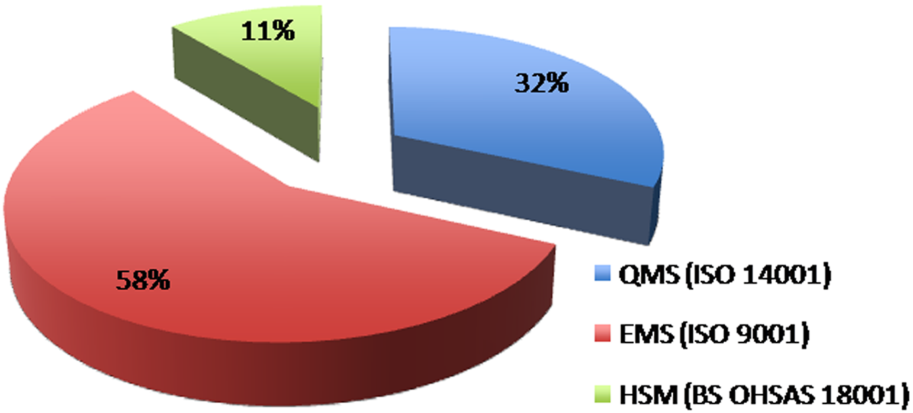

Figure 10. Percentage distribution of the different accreditation schemes of industrial processes (Source: CNR-IMAA elaboration on ACCREDIA data) (Source: ACCREDIA).