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 Driving Forces-Pressure-State-Impact-Responses (DPSIR) methodology was used to outline the background in terms of environmental impacts mainly caused by oil extraction activities, as well as potential existing 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 the identification of the vulnerable areas and the definition of targeted actions for a sustainable development of the area.

1 Introduction

The environmental balance is a voluntary tool that describes relationships both qualitatively and quantitatively between anthropogenic activities and the environment (Karageorgis et al., 2006) supporting either strategic planning or policy assessment (Nilsson M., 2008). The DPSIR framework describes environmental problems through appropriate indicators and assesses the critical environmental issues that need to be addressed in local environmental plans (Naviglio et al., 2009). In particular, it allows the evaluation of environmental performances of industrial settlements and assesses 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 bottlenecks as well as the existing response strategies to 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 to improve system's performances. This logical framework allows local authorities to move towards improving environmental quality through targeted actions and to evaluate the effectiveness of the policies in place. Anyway, as any conceptual scheme, a main drawback is the simplified representation of the environmental and social dynamics of a territory that are actually very complex. In particular, it would be useful to exploit the relationships among the indicators as well as to assign a priority to the different environmental issues in order to determine the most effective actions (Naviglio et al., 2009)

This paper presents a preliminary environmental balance of the Alta Val d'Agri industrial area providing stakeholders with an exhaustive framework in order to identify the anthropogenic impacts of the industrial settlement as a whole as well as to outline a possible path towards its sustainable development. This study shows an innovative application of the DPSIR, a well-established reference methodology to collect and process environmental data, in which different aspects not fully addressed in previous studies were integrated. A preliminary application of this methodology to an industrial area is reported in (Cosmi et. al. 2006).

The Alta Val d'Agri is a peculiar area in which there are the hugest oil field in Italy and a naturalistic area (the Appennino Lucano, Val d'Agri, Lagonegrese National Park). The presence of an oil/gas treatment centre, Val d'Agri Oil Centre (COVA), where the extracted fluid is collected, separated into crude oil, gas and water and further processed, undoubtedly represents a significant source of environmental impact and important associated industrial risks. Therefore, an in depth characterization of all anthropogenic impacts as a whole is fundamental in outlining the framework on which interventions and recovery plans should be developed.

2 The methodological approach

This study used an ad-hoc survey methodology to obtain 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, based on the DPSIR model implemented by the European Environment Agency (EEA, 1995) combines a qualitative and quantitative assessment to evaluate the integrated effect of the dominant factors causing the main environmental impacts and to assess their effects. This preliminary analysis was essential to identify the strengths and weaknesses of the study area, the potential risks as well as to define strategies and measures to promote its sustainable development.

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

The following provides a summary description of the DPSIR methodology and the selected indicators are reported.

The DPSIR 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 deals with the causality relationship among the pressures put forth by human activities on the environment and its changes in terms of natural resources depletion and degradation.

Specific indicators in this framework are used to monitor each stage of the DPSIR process, constituting a sound database for policy making and assessment. These indicators are essential in quantifying anthropogenic pressures and impacts and, consequently, in assessing the state of environment in order to support policy evaluation studies and to provide key information to end-users. In particular, the environmental indicators illustrate all the elements of the causal chain between anthropogenic activities and their environmental effects as well as community responses (Niemeijer et al., 2012).

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 to characterise the Alta Val d'Agri industrial area. These indicators, following the European Environmental Agency guidelines (EEA, 2005), reported 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 list of indicators together with the DPSIR drivers and the reference components (input–output matrices) are reported in Table 1.

All the collected information was filled in Excel tables including: company factsheet, raw materials processed, manufactured and used, water use, energy use, environmental authorizations and compliance with International Organization Standardisation (ISO) standards.

The collected data was also utilised to populate a thematic database on the industrial areas of the Basilicata implemented by the Department of Productive Activities of the Basilicata 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 1 a) 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 COVA.

The industrial area is very close to the Appennino Lucano, Val d'Agri, Lagonegrese National Park and to many 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 has still not got a toponymy and there are no schools, hospitals, sport or leisure centres in the surrounding areas.

The industry activities related to COVA, owned by Ente Nazionale Idrocarburi (ENI), represent the most significant sources of environmental impact. In fact, besides being the major integrated energy company in Italy, ENI is also the biggest operator in the Val d'Agri (60,77% of exploitation concessions). ENI started its activity in Basilicata in 1996, with the Monte Alpi production line, whereas 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.

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 neighbouring Apulia region. Natural gas, pre-treated at COVA, is delivered to the Società Nazionale Metanodotti (SNAM) national grid (ENI, 2013) and the process wastewater 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, COVA is classified as a major hazardous plant (one of 10 hazardous plants located in Basilicata) and should comply with the Seveso 3EU Directive (EU/2012/18) for the regulation of major accident hazard sites in order to limit their consequences for human health and the environment. In compliance with the Seveso 3EU Directive, COVA defined an emergency plan and according to Intergovernmental Panel on Climate Change (IPCC) directives (Directive 2008/1/EC), requested an Integrated Environmental Authorization (IEA, 2011).

It should also be 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 the territory particularly unstable. In fact, according to (Basilicata Law n.9/2011), the Val d'Agri belongs to the 1b vulnerability class 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 increasing the vulnerability of the territory.

3.1 Preliminary Results and discussion

3.1.1 Driving Forces

A systematic collection of data on energy, environmental and socio-economic aspects was performed to identify those activities that cause major impacts. Starting from the data provided by the Consortium for Industrial Development (ASI) of Potenza 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 pointed out the coexistence of medium and large enterprises with a high level of technological innovation in the petrochemical sector and a prevalence of micro-manufacturing firms. (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), as well as professional, scientific and technical activities.

The transport of materials and finished goods inside and outside the industrial area represents one of the critical aspects with a significant impact on environment. In fact, due to the absence of a railway, road transport is carried by truck along the SS 598 Fondo Valle dell'Agri which connects the industrial area to the motorway. The truck traffic associated with goods transport represents therefore a main source of environmental pollution being urban traffic negligible.

3.1.2 Pressures

The use of material resources plays 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 (Eurostat, 2011).

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 ha is built-up, 34 ha is public green and about 6 ha is not suitable for building (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 ASI, referred to a sample of 13 companies, was integrated and extrapolated to 2013 utilising the results of a survey conducted in the early months of 2013 (Table 4).

Very detailed data concerning water use was provided by the Aziende Riunite Gestione Aree Industriali Potentine (ARGAIP, 2012), a consortium of companies responsible for the operating and maintenance of industrial plants. Water consumption for industrial and civil uses by sector are shown in Fig 2 and Fig 3. The drinking water is provided by the local aqueduct whereas industrial water is supplied from the wastewater treatment plant. These infrastructures are managed by the 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 in mining and quarrying and about 15,0% for civil use and 4,3% for industrial use in manufacturing). As shown in Fig 3, professional activities (0,77%) and water supply (0,70%) are the most significant water consumers in civil sector ,whereas construction (0,47%) and wholesale and retail trade (0,28%) are the most relevant consumers in the industrial one.

Waste flows were also investigated by a survey of the Model for Environmental Declaration-MUD, i.e. the annual declaration on the total amounts and characteristics of waste produced released by industries in compliance with 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 MUDs declarations of the Alta Val d’Agri industries for the years 2010–2011 (Chamber of Commerce and Industry of Potenza, 2013) and other additional data provided by the Regional Agency for the Environment of the Basilicata Region (ARPAB, 2013), waste flows (Hazardous Waste-HW and Non-Hazardous Waste–NHW) were estimated.

In particular, the amounts of hazardous waste and non-hazardous waste by sector estimated by the ARPAB are reported in Fig 4.

An estimation of hazardous waste amount is reported in Fig 5 (CNR-IMAA elaborations on ARPAB data) showing a significant contribution of oil extraction activities (i.e. mining and quarrying sector) especially oily wastewater (e.g. water used to wash equipment and tanks, drain water, oil sludge, etc.).

An estimation of non hazardous waste amount is reported in Fig 6 (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) classification 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 has 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 Nuova Azimut, a 7 MW natural gas fuelled plant. The Azimut plant was closed in 2013 and will be dismantled in the near future therefore it cannot be used to supply the district heating thermal energy demand.

The total consumption of the industry sector (about 7300 toe) was estimated from the average unitary energy consumption for the whole Basilicata industry sector (e.g. the total energy consumption by sector by working unit) (ENEA, 2012), considering as a proxy variable 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 a direct survey (Fig 7).

Fig 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 a major environmental bottleneck due to the unfinished natural gas network that cannot fulfil the whole industrial energy demand.

In this evaluation, COVA consumption as well as the consumption of the two other power plants are not included. In particular, COVA consumption was provided by the ENI company (Table 6).

Energy consumption constitutes the basis to estimate the pollutant emissions due to combustion processes and to identify the most dangerous activities. The atmospheric emissions were estimated according to the CORINAIR methodology (EMEP/EEA, 2009), considering the emission factors of the SINA Net (SINA Net, 2012) and the Agenzia Nazionale Protezione Ambiente Centro Tematico Nazionale- Atmosfera Clima Emissioni guidebook (ANPA CTN-ACE, 2002) and utilising suited sectoral proxy variables (e.g. socio-economic and demographic indicators). Fig 8 and Fig 9 show the pollutant emissions from energy processes from the main end-use sectors, emphasising the high contribution from manufacturing.

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

The emissions from non-energy process were estimated by using the solvent use as an activity indicator. Their amount constitutes an additional 24,5% of the total yearly emissions on average (data not shown).

Besides the evaluation of yearly pollutant emissions the analysis also concerned the localization of pollution sources with a main reference to point sources.

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 directly by the industries. This investigation was also aimed at improving the physical-chemical characterization of the pollution sources for further studies.

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 considering the companies owning recognised environmental certifications.

Most of the data was provided by the Environmental Observatory of the Val d'Agri (OAVDA, 2013) and from monitoring campaigns. In particular, the official data was provided by the Environmental Monitoring Plan (whose implementation was established by an operating protocol between the ARPAB and the ENI company in 2011 in compliance with the DD.GG.RR. 313/2011 and 627/2011). This operating protocol defines an integrated environmental monitoring process implemented in the framework of the Project of modernization and improvement of production performance of the Val d'Agri Oil Centre 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 x 8 km surrounding 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 wastewater reinjection 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 was performed. This analysis highlighted that high concentrations of all pollutants and in particular of volatile organic compounds (C_6H_6, NO_X, toluene, ethyl-benzene) probably originated by the oil/gas treatment activities were recorded by the monitoring station close to COVA. Also H_2S concentrations were higher than the values reported by the World Health Organization (WHO) guidelines (WHO, 2000) and O_3 threshold value was exceeded the allowed highest number of times.

As concerns the groundwater quality, the ARPAB data didn't point out significant problems for the Montemurro municipality (ARPAB, 2013a).

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

Other interesting results can be inferred from a census of the companies that adopted quality certifications of their performances as:

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

Based on the ACCREDIA official data (ACCREDIA, 2013) only 14 companies have adopted quality management systems to improve their performances (Fig 10).

In addition to that, no company has adopted till now the more restrictive European Eco-Management and Audit Scheme regulation (EMAS, 2013) that requires as compulsory steps the definition of the company environmental policy, the adoption of an environmental management system, an environmental audit for the periodic evaluation of environmental performances of the company and an environmental statement.

The analysis of the currently available data points out the lack of validated data time series for all the considered environmental matrices to perform a thorough assessment of the state of environment in the case study area, as well as to monitor the evolution of the most important pollutant phenomena. In particular, there is a lack of knowledge about the period before the starting of mining activities and this hampers a full evaluation of the changes occurred in the time and the cause-effects relationships.

3.1.4 Responses

To compensate the environmental impact of the mining activities as well as to guarantee adequate life conditions and information to the population, a set of measures have been implemented. The main considered strategies with a synthesis of the pursued aim and the planned measures are reported in Table 9. These include 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 the community. As concerns the impact of mining activities and oil treatment processes, several measures were undertaken by the companies to limit the damage and to verify their environmental performances, extensively reported in the previous paragraphs. Among the policy strategies, it is worth noting the institution of the Environmental Observatory of Val d'Agri that participated in several research projects on environmental and health issues, organised monitoring campaigns, managed and analysed environmental data ensuring a proper and well-documented information to population, promoted scientific conferences and dissemination events.

Among the response measures a noticeable interest arouses also the Action plan for air protection of quality in the town of Viggiano and Grumento Nova, established with the Regional Decree (DGR 1640/2012). This plan is aimed to improve air quality, providing for a 20% reduction of the threshold values of SO_2 and H_2S and the definition of four attention reference levels for exceeding the threshold values. According to this action plan, specific measures should be implemented in order to prevent and limit the causes of environmental/air quality degradation.

Specific measures to promote the development and competitiveness of the regional production system were also provided by the European Regional Development Fund (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.

With regard to energy issues, financial incentives were granted to boost energy production from Renewable Energy Sources (RES) (large energy distributed generation) in order to valorise endogenous resources and to limit the use of fossil fuels. These incentives fostered a noticeable diffusion of PV systems as reported in Table 10.

The Regional Environmental Energy Plan (PIEAR, 2010) foresees a reduction of energy consumption and bills, by increasing energy savings and energy efficiency in public and private buildings, the production of electric and thermal energy from RES and by creating an energy district in of the Val d'Agri with the aim of supporting research and innovation and to promote sustainable mobility.

Despite the existence of several planning strategies, further measures would be necessary to improve the management and the environmental performances of this area. A main need is the improvement of infrastructure and common facilities (i.e. the completion of natural gas distribution network). In addition a wide application of audit scheme (EMAS) certification to the Alta Val d'Agri industries should be supported to foster a sustainable development of the area. A "territorial" approach based on EMAS scheme diffusion can be considered a great opportunity to pursue synergically public, private, social and industrial targets as well as to reconcile different interests emerging in the local context, resulting an approach of increasing importance for a sustainable development of industrial districts (Daddy 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, air, soil and groundwater pollution phenomena that may significantly affect local population.

The DPSIR methodology describes comprehensively the cause-effect relationships among the different components including the recovery plans and strategies. In particular, the DPSIR framework highlights weak and strength points facilitating the monitoring of the state of environment, managing the critical phenomena and valorising the endogenous resources to improve environmental quality and standard of living.

This paper presents a preliminary environmental impact study and assessment of the Alta Val d'Agri industrial district. The investigation was mainly aimed at identifying the critical factors for the sustainable development of business activities, currently hindered by a insufficient infrastructures.

The work performed so far provides a basic reference framework for further investigations and to evaluate the potential risks caused by the mining activities in a vulnerable area with peculiar environmental and geographical features.

Additional data (not currently available) is necessary to perform an in-depth characterization of the study area and of the impacts of industrial activities in order to characterize the different environmental matrices and to carry out a complete environmental balance. Further studies will be therefore performed in the future also integrating different methodologies to improve the description of the study area and to define tailored guidelines for its sustainable development.

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References

Agenzia Nazionale per la Protezione dell'Ambiente (ANPA), Centro Tematico Nazionale (CTN) Atmosfera, Clima, Emissioni (ACE): Manuale dei fattori di emissione nazionali, 2002

Agenzia Nazionale per le nuove Tecnologie, l'Energia e lo Sviluppo Economico Sostenibile (ENEA): Statistiche Energetiche Regionali 1988-2008 available at http://www.efficienzaenergetica.enea.it/doc/2011/sier/17_Basilicata.pdf, 2012

Agenzia Regionale per la Protezione dell'Ambiente Basilicata (ARPAB), internal communication, 2012

Agenzia Regionale per la Protezione dell'Ambiente Basilicata (ARPAB): Report Campionamento acque superficiali del 19/09/2013 Comune di Montemurro – C/da La Rossa, Fonte dati: Ufficio Risorse Idriche Dipartimento di Potenza, 2013a

Agenzia Regionale per la Protezione dell'Ambiente Basilicata (ARPAB): Risultati dell'attività di controllo delle acque sotterranee relativa a 8 piezometri e 2 sorgenti nel territorio interessato dal passaggio della condotta di reiniezione delle acque derivanti dall'estrazione e separazione degli idrocarburi del Centro Olio Val d'Agri, Fonte dati: Ufficio Suolo e Rifiuti Dipartimento di Potenza, 2013b

Aziende Riunite Gestione Aree Industriali Potentine (ARGAIP), internal communication, 2012

Basilicata Region Law n. 1/2009: Legge regionale per lo Sviluppo e la Competitività del Sistema Produttivo Lucano, B.U.R. Basilicata 9, available at http://www.consiglio.basilicata.it/consiglionew/site/Consiglio/detail.jsp?sec=107173&otype=1150&id=100261&anno=2009, 2009

Basilicata Region Law n.9/2011: Disposizioni urgenti in materia di microzonazione sismica – BUR 17, 2011

Basilicata Region and European Union: (ERDF) Innovative Actions 2000-06, Regional Final Report, Regional Programme of Innovative Actions in Basilicata – Italy, available at http://www.pofesr.basilicata.it/eng/ , 2007

Basilicata Region (DGR 1640/2012): Piano di Azione per la protezione della qualità dell'aria nei comuni di Viggiano e Grumento Nova, available at http://www.regioni.it/download.php?id=280553&field=allegato&module=news , 2013

Basilicata Region and European Union (ERDF): Operative Programme Val d'Agri-Melandro-Sauro-Camastra, available at http://www.povaldagri.basilicata.it/povaldagri/Webby.do?service=reload, 2013

Chamber of Commerce and Industry of Potenza, internal communication, January 2013

Consiglio Regionale di Basilicata: Piano di Indirizzo Energetico Ambientale Regionale (PIEAR), Regional Official Bulletin (BUR) 2, 2010

Consorzio per lo sviluppo industriale della provincia di Potenza (ASI): direct survey, 2012

Cosmi C., Loperte S., Macchiato M., Marmo G., Pietrapertosa F., Proto M., Salvia M., The environmental balance: an application to an industrial district of Southern Italy for supporting strategic sustainable planning, Fresenius Environmental Bulletin, ISSN 1018-4619, Volume 15-No.8a, 2006

Council of the European Union, Review of the EU Sustainable Development Strategy (EU SDS) – Renewed Strategy, 10117/06 Brussels, June 9 2006

Daddi T., De Giacomo M.R., Testa F. and Tessitore S., Cluster approach and innovation in four industrial clusters of Tuscany region (Italy) – Environmental Economics Vol 3, Issue 2, 2012 Directive 2008/1/EC of the European Parliament and of the Council of 15 January 2008 concerning integrated pollution prevention and control, available at http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32008L0001, 2008

Eco-Management and Audit Scheme (EMAS), available at http://www.isprambiente.gov.it/it/certificazioni/emas , 2013

Ente Italiano di Accreditamento (ACCREDIA), available at http://www.accredia.it/, 2013

EMEP/EEA air pollutant emission inventory guidebook, available at http://www.eea.europa.eu/publications/emep-eea-emission-inventory-guidebook, 2009

ENI (Ente Nazionale Idrocarburi) ENI in Basilicata, Local Report, available at: http://www.eni.com/files/documenti/eni-in-basilicata.pdf , 2013 (in Italian)

European Environment Agency (EEA): Europe's Environment: the Dobris Assessment. In: Stanners & P. Bourdeau (Eds.), Copenhagen, available at: http://www.eea.europa.eu/publications/92-826-5409-5, 1995

European Environment Agency (EEA): Technical report No 1/2005 EEA core set of indicators Guide, ISSN 1725-2237, 2005

European Environment Agency (EEA) website http://www.eea.europa.eu/data-and-maps/indicators#c7=all&c5=&c0=10&b_start=0, 2012

Eurostat Methodologies and Working papers: NACE Rev.2 – Statistical classification of economic activities in the European Community, ISSN 1977-0375, 2008

Eurostat Statistical Books, Sustainable development in the European Union, 2011 monitoring report of the EU sustainable development strategy, Luxembourg 2011 Istituto Superiore per la Protezione e la Ambientale (ISPRA): Annuario dei dati ambientali (Environmental Data Yearbook), 2012, available at http://annuario.isprambiente.it/content/indice/, 2012

Karageorgis AP, Kapsimalis V., Kontogianni A., Skourtos M., Turner R.K. and Salomons W. Impact of 100-year human interventetions on the deltaic coastal zone of the Inner Thermaikos Gulf (Greece): A DPSIR framework analysis. Environmental Management 2006, 38 (2): 304-15

Legislative Decree n.152/1999: Disposizioni sulla tutela delle acque dall'inquinamento e recepimento della direttiva 91/271/CEE concernente il trattamento delle acque reflue urbane e della direttiva 91/676/CEE relativa alla protezione delle acque dall'inquinamento provocato dai nitrati provenienti da fonti agricole, available at http://www.camera.it/parlam/leggi/deleghe/testi/99152dl.htm, 1999

Legislative Decree n.152/2006: Norme in materia ambientale, available at http://www.camera.it/parlam/leggi/deleghe/06152dl.htm 2006

Ministerial Decree n. 52/2011: Regolamento recante istituzione del sistema di controllo della tracciabilità dei rifiuti, ai sensi dell’articolo 189 del decreto legislativo 3 aprile 2006, n. 152 e dell’articolo 14-bis del decreto-legge 1° luglio 2009, n. 78, convertito, con modificazioni, dalla legge 3 agosto 2009, n. 102, 2011

Naviglio L., Castorina M., Barbato F., Paci S., Sbrana M., Signorini A., DPSIR: An Environmental Analysis Tool Useful for management Purposes, ENERGIA, AMBIENTE E INNOVAZIONE, ENEA 5/2009

Niemeijer, D., De Groot, R.S.: A conceptual framework for selecting environmental indicator sets, available at journal homepage: www.elsevier.com/locate/ecolind, 2012

Osservatorio Ambientale della Val d'Agri (OAVDA) http://www.osservatoriovaldagri.it/getpage.aspx?id=1, 2013

OECD: Environmental indicators – In: OECD (Eds.) OECD Core Set. Paris, 1-157, 1994

Piemonte Region and Regional Agency for the Protection of the Environment of Piemonte: Pressioni Ambientali Rischio Industriale in Lo Stato dell’Ambiente in Piemonte, ISBN 978-8874-791-255, 2013

Resolution of the Regional Council of Region of Basilicata n ° 313 11/03/2011- quarter par. 29 of Legislative Decree 152/2006 and subsequent amendments – Integrated Environmental Authorization (I.E.A.), 2011

SINA Net Rete del Sistema Informativo Nazionale Ambientale: Fattori di emissione per le sorgenti di combustione stazionarie in Italia, available at http://www.sinanet.isprambiente.it/it/sia-ispra/serie-storiche-emissioni/fattori-di-emissione-per-le-sorgenti-di-combustione-stazionarie-in-italia/view, 2012

Sviluppo Basilicata: SEPA Project: Viggiano industrial area as a sustainable and equipped productive area. Feasibility study, 2011

The Seveso 3 - EU Directive of July 4, 2012 (EU/2012/18), available at http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32012L0018, 2012

World Health Organisation (WHO): Regional Publications: Air quality guidelines for Europe - Second Edition, European Series, No.91,available at http://www.euro.who.int/en/health-topics/environment-and-health/air-quality/publications/pre2009/who-air-quality-guidelines-for-europe,-2nd-edition,-2000-cd-rom-version,2000

Table 1: Main indicators for the DPSIR of Alta Val d'Agri industrial 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^3day^{-1} of natural gas	Environment 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	Environment/Air, Water,

	assess the variations and changes on the environment	Soil
	Other indicators to assess the damages on eco-system, human health, economic	Socio-economic/Society, Business
Responses (R)	Environmental evaluation and certification	Environment/Air, Water, Soil
	Number of RES plants installations	
	Policies and strategies at national, regional, provincial and municipal level (e.g. SEAP, mitigation and adaptation plans, other thematic plans)	Socio-economic/Policy, Business, Society
	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	

Table 2: State of infrastructures of Alta Val d'Agri industrial area.

Infrastructures	Availability	Situation
Electricity grid	X	Completed
Natural Gas grids	X	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 COVA in Viggiano with the ENI's refinery located in Taranto
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 Highways and Freeways Other Roads	X	The state road S.S. 598 Fondo Valle d 'Agri from Athena Scalo to Policoro connects the A3 highway to the the SS 106 Jonica. 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: Distribution of enterprises and employees by industrial sector for Alta Val d'Agri industrial area (in bold the most significant sectors)

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

Table 4: Flows of raw materials and finished product per sector of activity

Indicator		
Raw Materials Input/Output		
Sectors of activities	Raw Materials	Finished Product
	(Tons)	(Tons)
B Mining and quarrying	34763 (ktoe)	
C Manufacturing	83016.6	55094
F Constructions	-	-
G Wholesale And Retail Trade; Repair of motor vehicles and motorcycles	-	2000

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	26371.28	4.58	26359.30
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	59622.78	0.00	59619.63
17	Wastes from construction and demolition wastes (including excavated soil from contaminated sites)	210.32	13403.63	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

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

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

Energy flows	2009	2010	2011
Gross energy consumption [internal production plus purchased energy] [MWh]	148843	155212	158151
Net energy consumption [produced plus purchased/sold energy] [MWh]	131933	144281	153949
- of which produced electricity [MWh]	148329	153196	144467
- of which energy purchased by other companies [MWh]	514	2016	13683
- of which energy sold to other companies [MWh]	16910	10931	4202
Net electricity consumption [MWh] per thousand of produced barrels	4621	4497	4429

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

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

Environmental matrix	Analyzed parameters (in situ and/or laboratory measurements)	Sampling frequency	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 Val d'Agri Oil Centre in collaboration with scientific institutions and research organizations" (Protocol implementation in development)	

Table 9: Main response indicators selected for the case study

Strategic/political instrument	Measure	Objective/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 managing of 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 decision-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

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

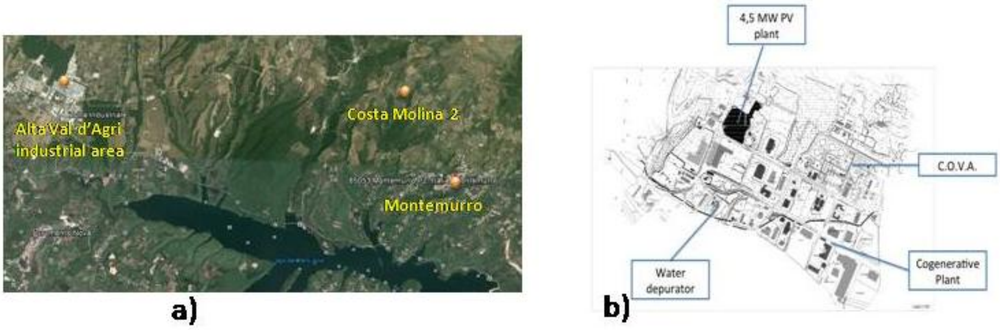

Figure 1. (a) Map of the analyzed area in which are highlighted the Alta Val d'Agri industrial area, the location of wastewater reinjection well (Costa Molina 2) and Montemurro (Source: Google Earth, 2013), and **(b)** Site plan of Alta Val d'Agri industrial district with highlighted by the boxes the most relevant industrial activities (Source: CNR-IMAA elaboration on Bonaduce's image)

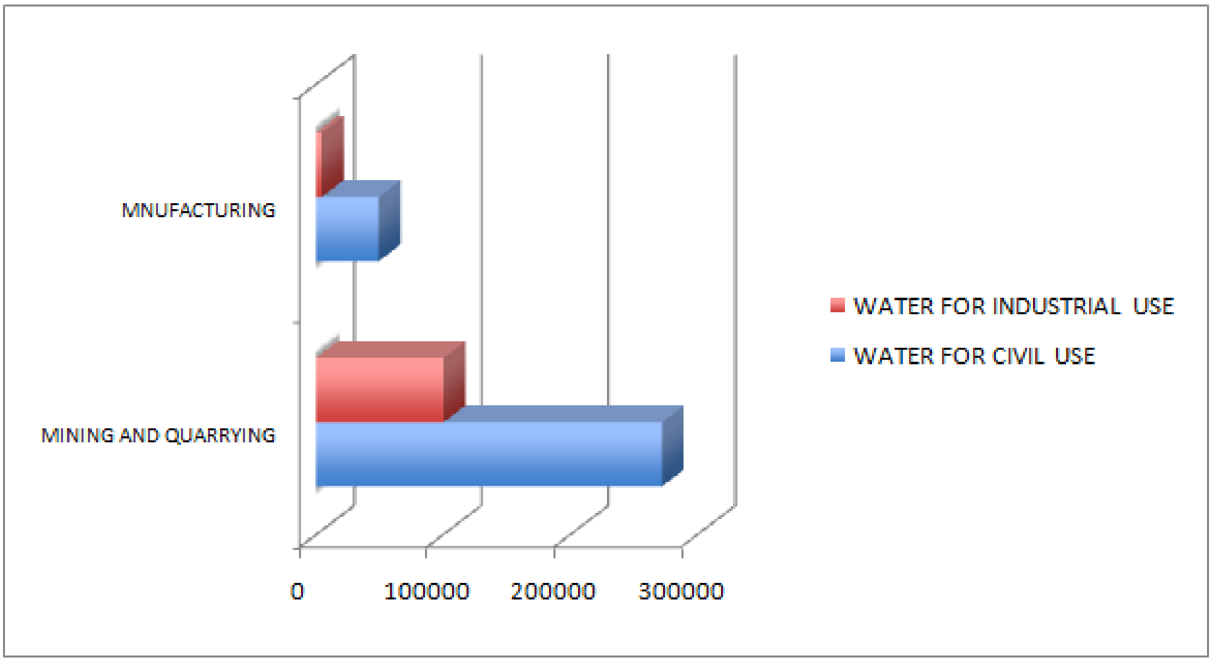

Figure 2. Water consumption for industrial and civil use for mining and quarrying and manufacturing sectors [10^6 m^3] (Source: ARGAIP Potenza)

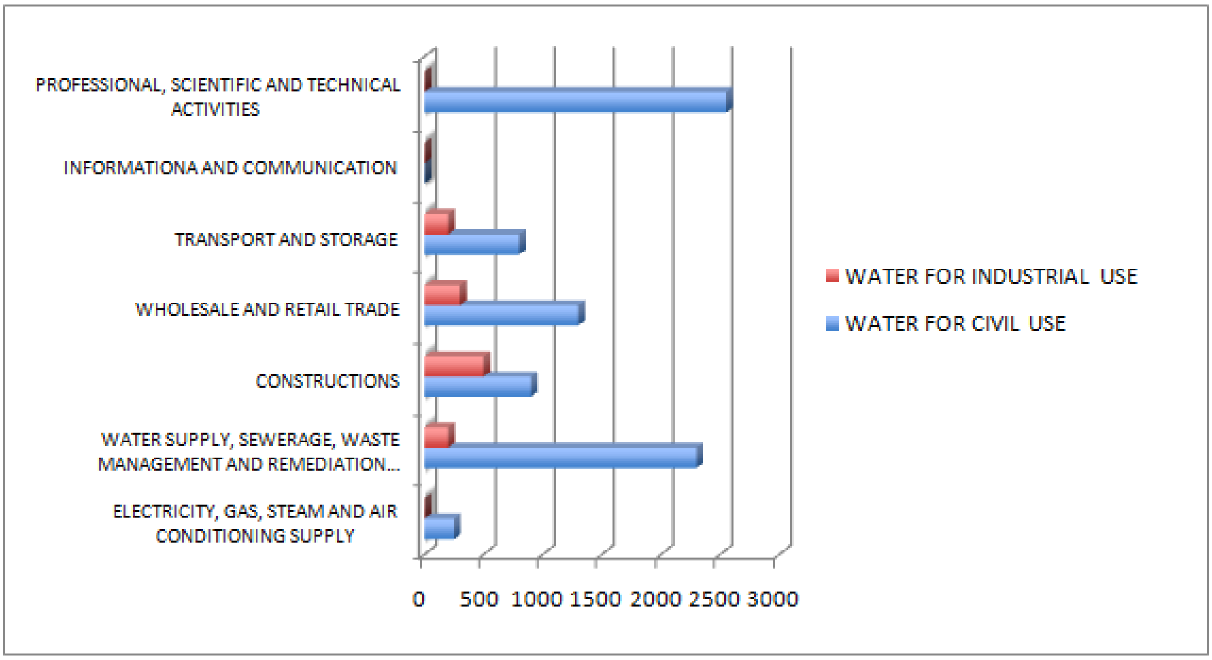

Figure 3. Water consumption for industrial and civil use by industrial sector [m^3] (Source: ARGAIP Potenza)

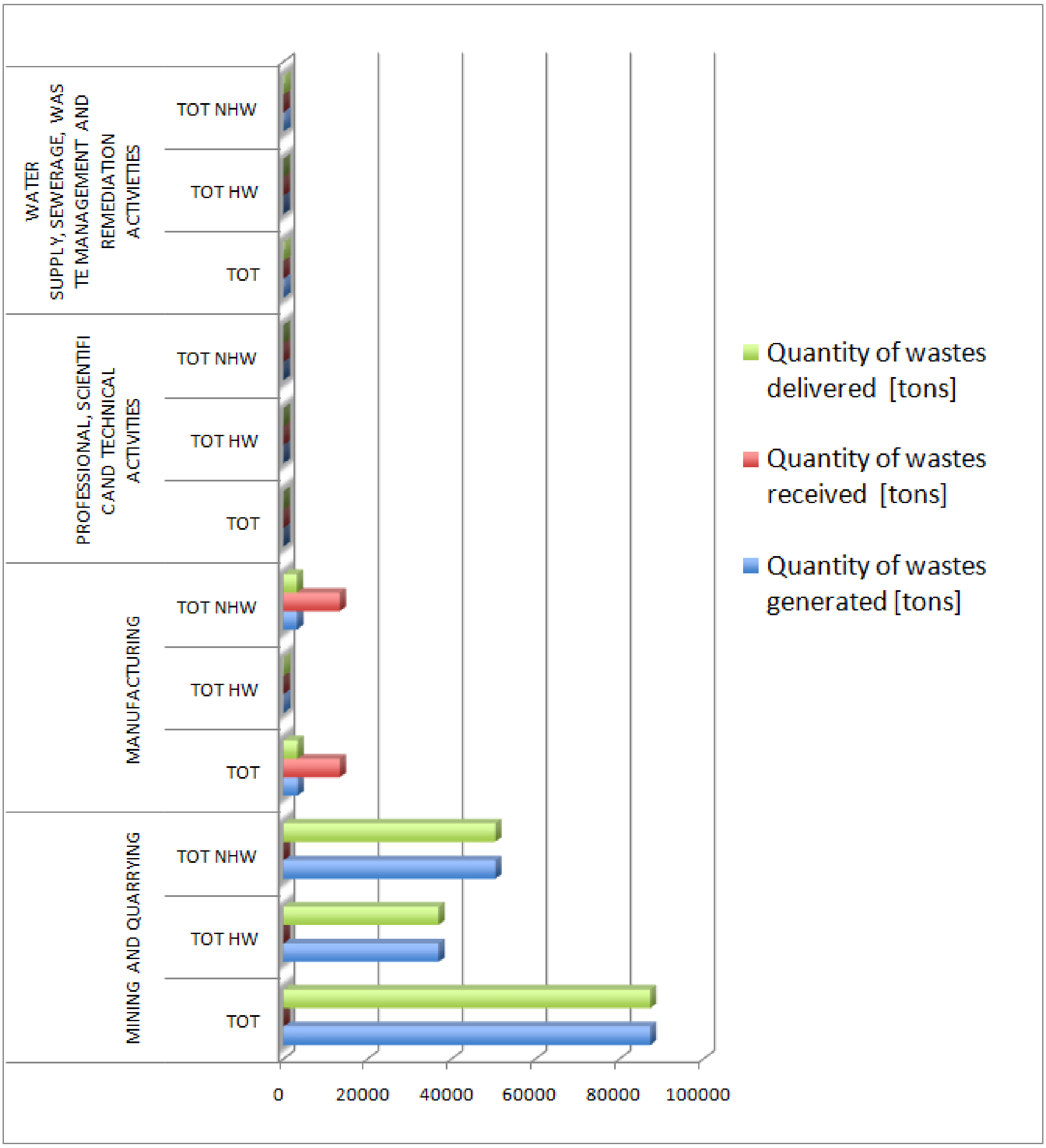

Figure 4. Hazardous (HW) and non hazardous (NHW) waste flows by sector (source: ARPAB)

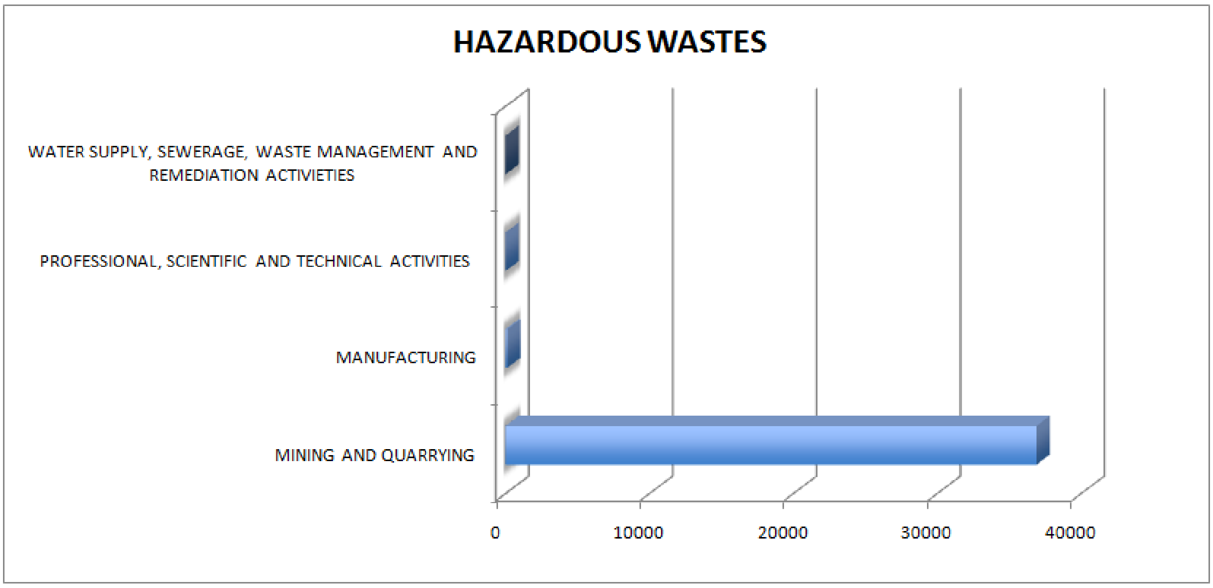

Figure 5. Hazardous waste (HW) flows by sector [tons] (CNR- IMAA elaborations)

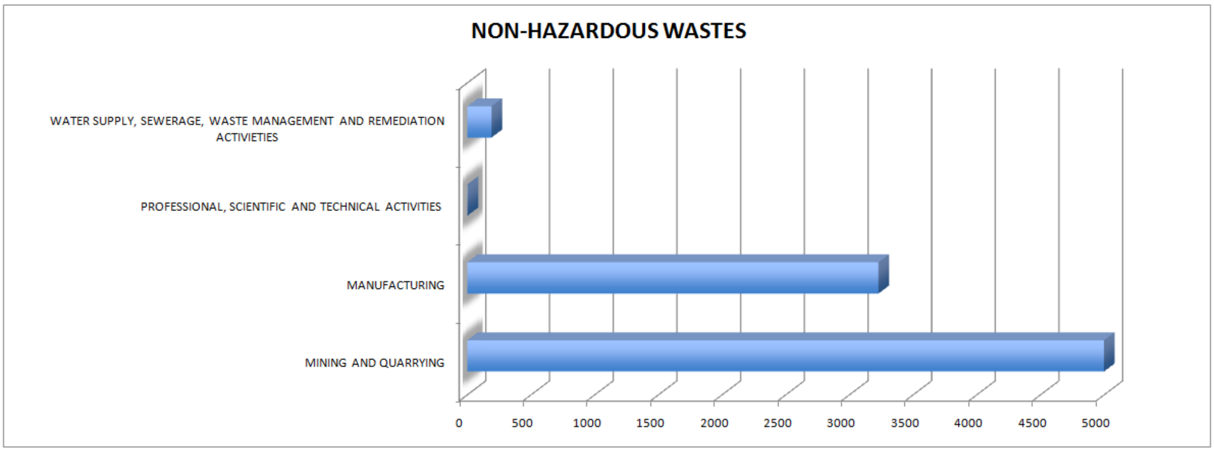

Figure 6. Non hazardous waste (NHW) flows by sector [tons] (source: CNR-IMAA elaboration on data from ARPA Basilicata)

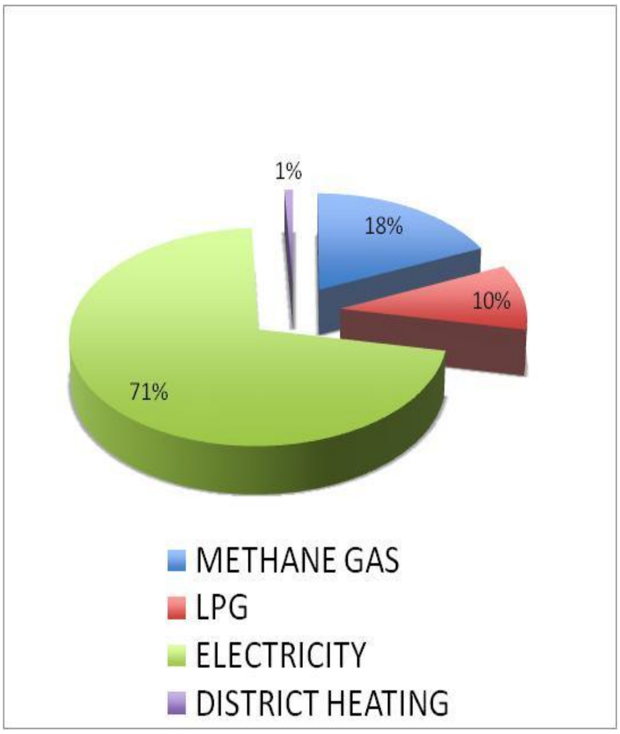

Figure 7. Energy consumption by energy carrier - Industry (year 2012)

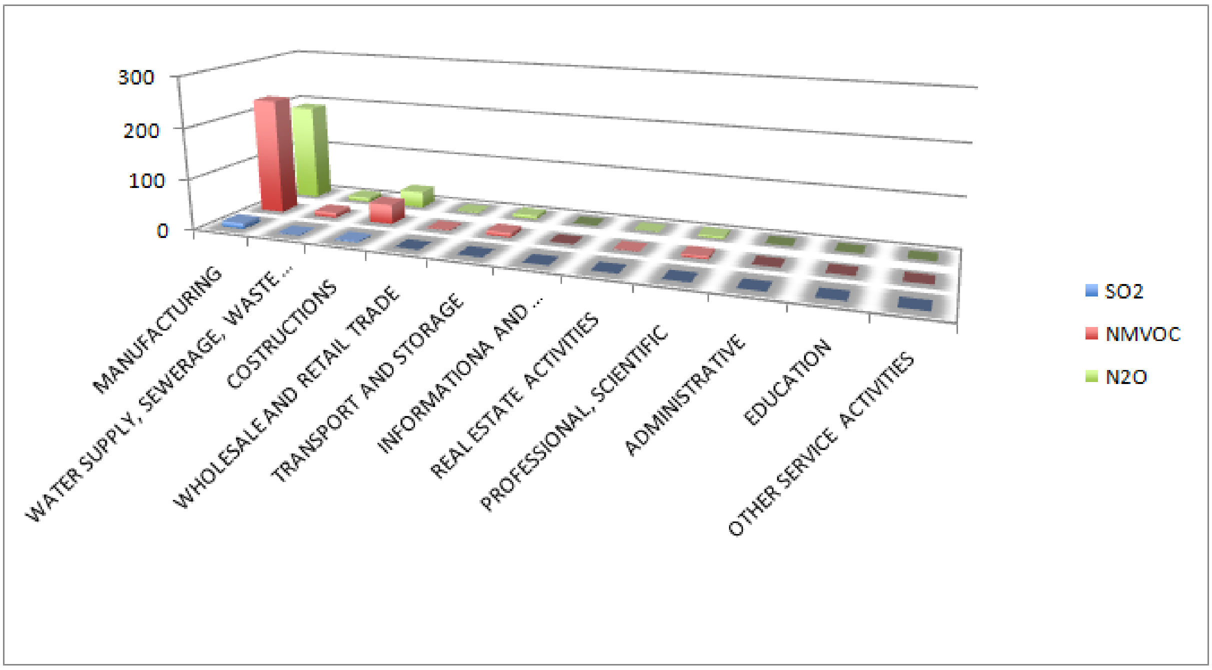

Figure 8. Local air pollutant emissions from energy processes by sector [kg/year]

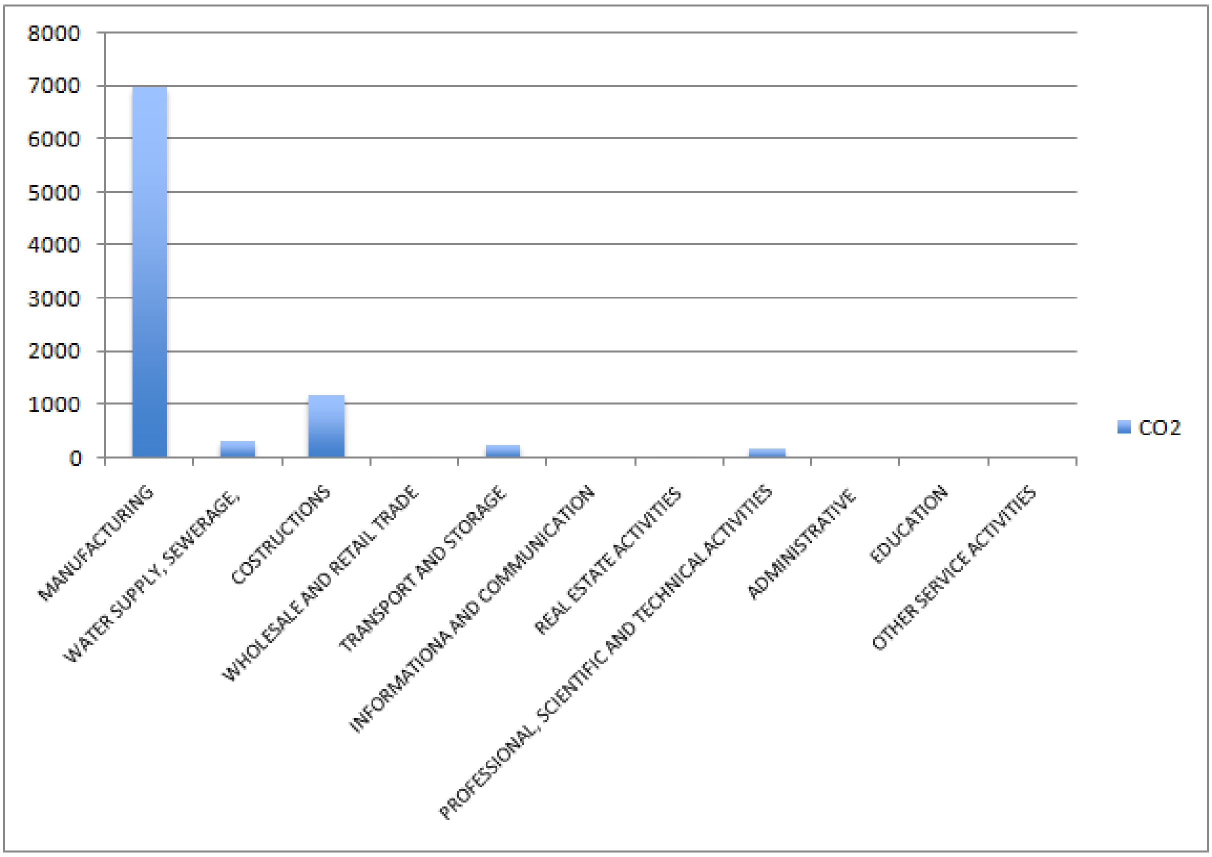

Figure 9. CO_2 emissions from energy processes by sector [tons]

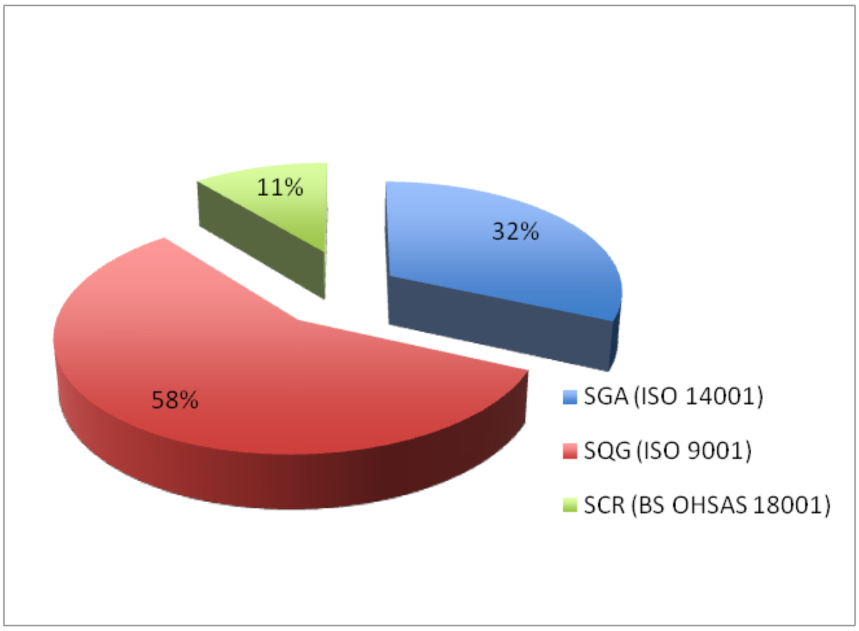

Figure 10. Percentage distribution of the different accreditation schemes of industrial processes (Source: CNR-IMAA elaboration on ACCREDIA data)