Production data and Sustainable Development Indicators (SDIs) for the Greek Mining/Metallurgical Industry in the period 2007-2011.

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ABSTRACT

Greece is one of the EU countries that possess substantial mineral wealth, consisting of a variety of minerals and ores with a large industrial and economic interest. For the first time after a long period of positive economic growth which stimulated increased output, the minerals industry experiences a significant decline in both production and sales from the second half of 2008 and afterwards. This decline followed the sharp fall in demand of raw materials in the fields of steel, construction and infrastructure. However, in the years of economic recession, the challenges for sustainable management, safety and environmental protection not only remain but also constitute the most pressing needs of this era – deeply influencing the development of the mining industry, its traditional character for many centuries and finally its very existence.

This paper presents production data for various mineral commodities produced in Greece in the period 2007-2011 fully illustrating the crisis trends and giving hints for lessons learned. Also, data from twelve groups of Sustainable Development Indicators (SDIs) provided by the Greek Mining Enterprises Association (GMEA) over this period are discussed giving information necessary for decision making, identifying weaknesses, stimulating problem solving, evaluating the whole system of monitoring and improving indicators. Results as well as options for sectoral actions, best practices and policies are also discussed, providing a holistic comparative analysis for sustainability assessment and validation of the overall performance of the sector.

1. INTRODUCTION

Since the "Earth Summit" in Rio de Janeiro, Brazil, in 1992, and its resulting action plan Agenda 21, sustainability issues have moved from the fringe to the mainstream. Sustainable development rapidly became the key principle underpinning official environmental policy at both national and international levels.

The mining and minerals industry faces some of the most difficult sustainability challenges of any industrial sector. Some scholars have suggested that mining is an inherently unsustainable activity, since it is based on the extraction of non-renewable resources. Moreover, despite the industry's undoubted importance in meeting the need for minerals and its significant contribution to economic and social development, concerns about aspects of its performance prevail, thus it has come under pressure to improve its social, developmental and environmental performance.

To this end, a number of initiatives emerged with the aim to respond to some of SD challenges, as it was first actively demonstrated by the Global Mining Initiative (GMI), perhaps the earliest large scale -industry based- effort to establish sustainability practices in the sector. Also, the mining and minerals industry started to develop a framework for sustainability indicators (SDIs) as a tool for performance assessment and to demonstrate continuous long term improvements as proposed by the Mining, Minerals and Sustainable Development project (MMSD 2002 a,b) and later by others (Azapagic 2004, Komnitsas and Agioutantis 2003, GMEA 2006, Valta et. al. 2007).

Following the GMI and MMSD reports on sustainability for the mining and metals sector, various initiatives were launched such as the US-based Sustainable Minerals Roundtable (US SMR), the Canadian Minerals and Metals Indicators (MMI) Initiative, the International Council on Mining and Metals (ICMM), the Global Reporting Initiative (GRI), and in EU level, the European Union initiative-Sustainable Development Indicators for the EU Non-Energy Extractive Industry.

In November 2008, the EU launched the Raw Materials Initiative (RMI) with a view to secure reliable and undistorted access to raw materials for Europe. In the EU 2020 agenda several flagship initiatives are presented that will contribute to the same goal: smart, sustainable and inclusive growth in Europe. In 2012, EU launched the European Innovation Partnerships (EIP) initiative in order to stay competitive in the global world while minimizing the environmental impacts. If well planned and managed such initiative will create a platform for innovations in technology, sustainable mining and materials management-models as well as the social innovations necessary to meet future challenges.

However, despite examples of good practice, the complexity of situations at the mine site denotes that its implementation across the sector is highly variable. Questions remain as to whether current verification and reporting regimes are sufficient to meet the needs of key stakeholders–from investors to communities. In a large number of cases, there is little idea of how exactly these should be translated into progress on the ground. Meanwhile, new pressures on the sector, such as competition from emerging economies, climate change and a reemergence of the 'resource nationalism' debate, are putting the challenges and solutions for sustainable development in mining in a new light (Buxton 2012).

The Greek Mining/Metallurgical Industry (GMMI) constitutes an important sector of the economic activity of our country as it supplies essential raw materials for primary industries and various downstream users. Although the sector's significance to Greek economy has been declined during the past 20 years, GMMI still contributes 3-5% of the Gross Domestic Product (GDP), with the inclusion of interrelated enterprises such as quarrying, cement, concrete, processing and production of intermediate and final products. Moreover, approximately 20 thousand people are employed in the sector (in mines, quarries, and the two basic extractive metallurgies of the country) and more than 80 thousand are employed in jobs dependent upon or associated with it (Tzeferis 2009-2012).

Greece's mining and mineral industry is engaged in the debate of SD and should respond to the challenges for enhancing sustainability. GMEA adopted in 2006 the 'Code of principles for SD' and agreed to work actively towards continuous improvement in economic, environmental and social performance of the Greek mining sector. This paper draws on this research and the results of its application, providing approaches to both sustainability performance management and reporting.

2. PRODUCTION DATA FOR VARIOUS MINERAL COMMODITIES IN THE

PERIOD 2007-2011.

Production data for various mineral commodities produced in Greece in the period 2007-2011 are listed in Table 1. Reported figures are combined data from (a) statistics provided by the Mineral Resources Division of the Ministry of Environment, Energy and Climate Change (YPEKA) and (b) annual statistics provided by GMEA. Exports data for the Greek marble industry have come from the Greek Statistical Authority (ELSTAT) and was analysed by marmaronet.com.

In the second half of 2008, the sector experienced a significant decline in mineral production and sales, following the fall in demand and subsequently the prices of raw materials in the steel, construction, cement, and concrete industries. The recession continued and worsened in 2009-2010 by the severe economic problems and the lack of investment initiatives that could reverse the trend and lead to domestic growth. Production levels of mineral commodities in Greece have been declined by 20 to 30% and sometimes more than 50%, below the 2008 figures. For example, the sector of construction aggregate materials fell gradually to 50 million tons in 2010 (from 90-100 million tons before crisis) and to 35 million tons in 2011, marking an unprecedented downturn due to the shrinkage of domestic building and construction activity.

However, in contrast to the shrinking domestic market, especially in construction, the tendency was to strengthen the export sector with regards to products placed on the international market (industrial minerals, aluminum, nickel, mixed sulphide Pb-Zn ores, magnesium compounds etc.), where the demand and prices soon rallied largely to pre-crisis levels. For 2010-2011, prospects for recovery appeared in the industry internationally because of the escalating rise in demand for raw materials. In 2010, a total sales volume of mining/metallurgical products of 1.1 billion € was achieved, of which 790 million was comprised of exports (72%). In 2011, the same trend continued with the export sector producing satisfactory results, while the downturn in the domestic sector deepened widely.

Despite the EU "20-20-20" targets involving gradual decrease in the lignite-fueled electricity production and consequently in the exploitation of coal domestic deposits, brown coal ("lignite") production remained at before crisis levels (around 60 million tons). Based on the above data, in 2011, the contribution of lignite in the energy mix on the interconnected system of the country exceeded 55%, while the corresponding participation in the whole country (including non-interconnected islands) was 49.5%, demonstrating the dominance of lignite reserves in the country's energy scene.

The industry of marble products and ornamental stone, despite the severe impact of the economic crisis on domestic consumption, managed to maintain the upward trend that began in 2008 mainly thanks to strong demand from the Chinese marble market (Fig.1). For 2011, the total production of marble products exceeded 1 million tons, while exports according to data of the Greek Statistical Authority, increased by more than 10% in quantity and 30% in value compared with 2010 corresponding data.

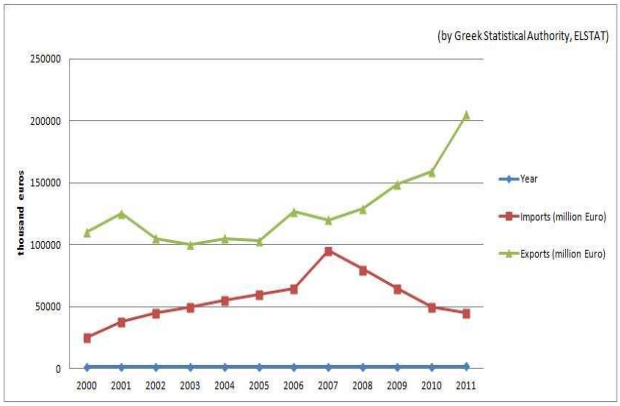

Figure 1: Imports and Exports of marble and other natural stones [2000-2011]

Greece has the potential to become a near-term gold producer with a number of exploration companies active in the country. Hellas Gold SA (owned by Eldorado Gold Corp. Canada) is developing a project including

mining and processing at the Skouries gold-copper project, and the initiation of mining at the Olympias polymetallic project. Eldorado Gold Corp. is also developing the Perama Hill gold project through its subsidiary Thracean Gold Mining SA. Both projects are in the process of licensing from the Greek State. A third gold project in Sappes, Thrace, by the mining Thrace SA, is currently being evaluated by YPEKA.

In 2011, the State completed the new reformed Regulation on Mining and Quarrying Activities (KMLE, MD 2223/11) satisfying a long-standing demand of the industry with regard to health and safety (H&S) in extractive areas. Another important initiative was the adoption in 2012 of the National Policy for the Strategic Planning and Exploitation of Mineral Resources, which was developed in collaboration with all stakeholders in order to respond to modern needs incorporating at the same time the context of European integration initiative on raw materials (RMI).

3. SD INDICATORS FOR THE GREEK MINING / METALLURGICAL INDUSTRY IN THE PERIOD 2007-2011.

Using company-supplied information, we examined twelve groups of sustainability performance indicators including employment matters, environmental management and land stewardship, waste management, energy and water management, H&S issues and local community development. The results, which have not been fully verified yet, were compiled primarily from the annual sustainability reports of GMEA companies in the period 2007-2011. These results are presented in Table 2.

This report does not claim to provide a complete assessment of the country's sustainability in the sector. Such a report would address a broader range of stakeholders and would include small local companies which are not members of the GMEA. In addition, a more complete report would verify this public information both with the companies themselves and independently.

As shown in Table 2, energy and resource consumption, as well as waste generation and disposal do not vary considerably in the years of interest. Even the most innovative Greek mining firms continue to depend upon increased amounts of energy and water, while they are challenged by the disposal of tailings or other waste (including overburden and waste rock) produced during mining.

In the period 2007-2011, efforts have been made to promote responsible stewardship of natural resources and the environment including remediation of past damage, minimize waste and environmental impacts and protect critical natural capital. Also, the mining companies have been encouraged to use eco-efficient and sustainable products, improve recycling and avoid the use of dangerous chemicals (REACh, 2006).

However, significant progressive differentiation on the performance of the whole production system of the sector and the corresponding indicators, can only be achieved by major technological innovations which cannot be easily implemented for the time being. Also, a wide range of available regulatory, fiscal, and educational instruments, need to be effective, administratively feasible, cost efficient, reliable and reproducible across different groups and regions so that they are credible and acceptable to all stakeholders.

In the social era, the H&S of workers is a major challenge to Greek mining companies. Leading companies have implemented or are currently implementing standards for employee safety, including occupational safety training, protective gear, and health care. All companies showed a strong commitment to workplace safety including contractors and indirectly employed personnel. Despite this improvement in H&S performance during the past decade, results show that the fatality rate remains relatively high, not higher though than the EU average.

With respect to labor practices, Greek mining companies face a number of challenges. In

addition to hiring and retaining qualified employees GMEA companies are required to create opportunities for the education and advancement of their workers no matter if they are directly or indirectly employed. As shown in Table 2, the development of skills for both categories of the staff (direct and indirect) remains in good standard, one of the highest in the Greek Industry (6-8,5 training hours per employee).

Despite the increasing financial crisis since 2008, some activities still show high intensity as evidenced by the relative numbers of indicators. More specifically:

- The exploration and R&D costs with an average score of 8.7 million € per year.
- The total funding and generally the resources offered to the local communities. GMEA companies are challenged to contribute to the sustainable growth of the communities in which they operate by leaving behind institutions and supporting infrastructure. Although for some of these companies the support of local communities was a common practice long before the adoption of SD principles, knowledge about effective strategies for promoting community development is still evolving. This is, in part, because many mining companies in Greece have only recently become involved in structured community development activities and it is still too early to evaluate some of the long-term impacts of these initiatives.
- The increase of the percentage of the activities that have been certified according to the standards of ISO and OHSAS.

4. CONCLUSION

Despite economic recession followed by the lack of investment initiatives and the collapse in the domestic materials market, the perspectives or the Greek mineral industry appear to be positive, relying mainly to its export orientation. However, the industry has to identify and exploit the trends and opportunities of the international business environment in order to overcome crisis, remain competitive and further improve its position and perspectives.

Results from the list of key performance sustainability indicators demonstrate the significant strides the industry has made in regards to sustainability. It is also clear that there is still a need for improvement in environmental performance and good practice has far to go before it spreads to all parts of the mining industry, especially for the small-scale mining. Also, questions remain as to whether current assessment and reporting can be translated into valuable knowledge on the ground, providing sufficient tools for companies and for communities.

Finally, we need a new agenda focused on good practice guidance that is built around society's demands and the realistic aspirations of a much more capable industry sector.

REFERENCES

Azapagic, A., 2004. Developing a framework for sustainable development indicators for the mining and minerals industry, Journal of Cleaner Production 12, 639-662.

Buxton, A., 2012. MMSD+10: Reflecting on a decade of mining and sustainable development, International Institute for Environment and Development, pp.34.

GMEA, 2006. Proceedings of GMEA meeting: Importance of the implementation of the Code of Principles of Sustainable Development in the Greek mining industry, November 10, Volos, Greece.

GMEA, 2007-2011. Activity Reports.

Komnitsas, K., and Agioutantis, Z. 2003. Risk assessment and sustainable development framework in the mining industry, SDIMI 2003, Conference Proceedings, Milos, 53-58.

MMSD Project , 2002. (a). Mining for the Future, Main Report, D. Van Zyl, M. Sassoon, C. Digby, A.-M. Fleury & S. Kyeyune. IIED, WBCSD, April 2002, No 68, pp.31 (b). Sustainability Indicators and Sustainability Performance Management. Report by A. Warhust, IIED, WBCSD, March 2002, No 43, pp.129.

REACh, 2006. Regulation (EC) No 1907/2006

Tzeferis, P., 2009-2012. The mining/metallurgical industry in Greece–statistical review (review 2007-2008 Mineral Wealth 153/2009:1–16, review 2008–09 Mineral Wealth 156/2010: pp. 51–54, review 2009-10 Mineral Wealth 162/2012: pp. 43–50, review 2010-11 Mineral Wealth 165/2012: pp. 45–56).

Valta, K., Komnitsas, K., Grossou-Valta, M 2007. Sustainable development indicators for the Greek industrial minerals sector, Proceedings, SDIMI 2007, Milos, 189-196.

TABLE 1: Production of Mineral Commodities in Greece (metals, industrial minerals, minerals fuels and related materials) [quantities in metric tons unless otherwise specified]

	2007	2008	2009	2010	2011
Bauxite	2.093.433	2.174.000	1.935.000	1.993.826	2.300.000
Aluminium, primary (Foundry Line)	167.937	162.339	134.7371	139.824	167.490
Alumina, calcined (Al_2O_3)	761.746	771.769	718.797	661.882	683.030
Alumina, hydrated (Al_2O_3)	789.000	807.500	795.500	785.100	809.700
Mixed sulphide ore	208.724	264.299	225.054	230.134	214.943
Galena, PbS (conc.)	22.407	23.314	17.027	17.674	16.592
Zinc blend , ZnS (conc.)	39.729	46.532	34.255	40.592	39.127
Nickeliferrous ores (laterites)	2.367.000	2.261.637	1.400.000	1.902.976	2.235.966
Ferronickel:	NA	87.664	42.423	69.596	93.905
Ni content of ferronickel	18.668	16.640	8.269	13.956	18.527
Slag by-product (coarse)	NA	85.345	62.022	57.156	69.674
Slag by-product (fine, -5mm)	NA	90.180	52.696	59.500	79.011
Magnesite, crude	399.475	455.069	250.234	513.487	541.813
Dead-burned magnesia	41.961	48.719	22.370	31.594	38.343
Caustic-calcined magnesia	71.032	70.545	55.545	61.628	59.838
Basic monolithic refractories	31.042	35.617	31.634	36.031	45.202
Bentonite, crude	1.382.800	1.500.000	844.8045	1.384.118	1.188.442
Attapulgite clay	7.000	28.584	81.382	39.012	17.748
Huntite, crude	16.370	19.600	10.652	16.350	23.800
Pozzolan, Santorin earth	1.520.000	1.059.000	830.000	550.000	350.000*
Pozzolan, specific use (not cement industry)	NA	NA	21532	79.600	49.733
Kaolin, crude	30.000	4.360	0	1.045	NA
Perlite, crude	1.100.000	1.000.000	862.9358	790.100	842.870
Perlite, treated	650.000	600.000	398.4519	440.000	507.235
Pumice	838.000	828.000	381.000	412.700	468.960
Silica (SiO_2)	125.000	64.521	37.905	5.742	1.671
Gypsum and anhydrite, crude	836.967	1.000.000	730.000	574.768	590.000
Olivine	40.000	37.150	48.050	35.300	55.325
Amphibolite	57.367	57.500	25.902	23.453	23.263
Calcium Carbonate ($CaCO_3$), [processed all sources]	500.000	600.000	580.000	450.000	400.000
Feldspar	95.000	62.000	28.617	17.380	10.563
Quartz	15.000	16.201	10.909	30.794	11.241
CO_2 [liquid]	12.500	12.200	8.000	9.980	10.200
Lignite	66.100.000	64.521.000	61.800.000	56.366.202	58.400.000
Crude oil, in barrels	575.413	477.679	628.278	894.002	675.504
Natural gas , in Nm^3	21.221.053	14.058.056	11.123.714	6.124.844	5.927.401
Salt, sea salt	212.000	220.000	189.000	164.765	174.500
Mineral Aggregates (sand, gravel, crushed stones etc.) *	90.000.000	85.000.000	65.000.000	50.000.000	38.000.000
Marble, rough blocks plus	350.000*	347.526	255.516	268.033	285.000

slate stones (m^3)					
Marble, rough shapeless blocks	420.000*	451.505	254.491	358.963	390.000
Marble chips	NA	1.218.056	761.933	598.111	650.000
Emery	NA	NA	8.000	7.000	5.900

NA: not available, *estimated

TABLE 2 : SDIs for the Greek Mining/Metallurgical Industry in the period 2007-2011

SD Indicators for the Greek Mining/Metallurgical Industry	**2007**	**2008**	**2009**	**2010**	**2011**
1. Employment					
a. Average number of people directly employed	10.392	10.920	10.305	10.166	9.729
b. Average number of people indirectly employed (including contractors)	4.193	5.203	5.151	4.769	5.446
c. Total number of hours worked (including a and b) *[hours]x10^3*	26,569	32,106	29,915	28,906	30,493
d. Number of hours worked per ton of marketable product	0,27	0,31	0,31	0,34	0,38
2. Development of Skills					
a. Total number of training hours, *[hours]x10^3*	118,743	106,967	89,117	124,154	129,906
b. Training hours per employee	8,32	6,69	5,78	8,31	8,56
3. Health and Safety					
a. Number of working hours lost due to accidents	34.504	29.495	32.643	23.050	24.585
b. Total number of hours in Health & Safety training	43.810	47.004	41.779	54.625	66.481
c. Number of hours in Health & Safety training per employee	3,07	2,93	2,71	3,66	4,38
d. Number of fatalities	3	5	7	0	3
e. Number of fatalities per 10000 employees	2	3	4,5	0	2
f. Accident frequency indicator for all the employees (direct and indirect) *(x10^6)*	5,8	4,05	5,01	5	4,39
g. Accident seriousness indicator for all the employees *(x10^6)*	165,67	114,83	136,38	99,52	100,78
h. Employees that are periodically under medical supervision *[% of total employees]*	40	74	68	85	80
4. Total turnover & production					
a. Total turnover *[million €]*	2.109,97	2.031,74	1.786,78	1.973,58	2.123,11
b. Production of marketable products *[million tons]*	96,766	104,507	96,994	85,903	80,183
5. Exploration – R&D costs					
a. Total exploration costs *[million €]*	7,759	8,998	8,390	12,338	6,611
b. R&D costs per ton of marketable product (5a/4b) *[€/t product]*	0,08	0,087	0,086	0,14	0,082
6. Communication with the community					
a. Number of public events - “open days”	82	58	40	36	56

b. Number of visits (schools, universities)	236	231	178	161	153
c. Number of trained students	332	330	505	454	223
d. Resources available to the local community (infrastructure, unions, support, awards etc) *[million €]*	25,552	27,734	27,258	25,994	10,919
e. Resources available to the wider community (same as d) *[€]*	1.449.100	1.670.975	764.419	706.076	497.430
7. Energy Demand					
a. Total energy consumption *[MJ]x10^6*	28.520	27.987	20.155	24.330	30.965
b. Energy consumption per ton of final product (7a/4b) *[MJ/t product]*	294,7	267,8	207,8	283,23	386,18
8.Water Demand					
a. Total net water consumption *[m^3]*	11.896.545	17.435.018	16.980.791	17.809.519	16.936.337
b. Total consumption of recycled water *[m^3]*	5.843.221	6.948.150	5.118.120	8.667.330	9.494.971
c. Water consumption during production *[m^3]*	12.890.396	18.013.768	15.894.993	10.745.469	18.119.550
d. Total net water consumption per ton of final product *[m3/t product]*	0,12	0,17	0,17	0,21	0,23
e. Water consumption in rehabilitation / restoration activities *[m3]*	325.774	982.331	907.765	582.814	311.054
9. Land Demand – Environmental Rehabilitation					
a. Total land in use for deposit exploitation at the end of the calendar year (rehabilitated surface is excluded) *[acres]*	154.742	154.868	157.675	154.779	164.001
b. Total land surface under rehabilitation *[acres]*	3.540	3.556	3.729	1.682	3.688
c. Total land surface returned to beneficial use or rehabilitated by planting trees *[acres]*	55.350	55.938	59.996	63.520	63.550
d. Number of planted trees at the end of the calendar year	156.048	622.367	588.468	506.193	169.024
e. Cost for rehabilitation of mines and protection of the environment *[€]*	11.280.096	11.675.475	9.376.164	16.151.915	8.732.448
f. Cost for rehabilitation per ton of final product (9e/4b) *[€/t product]*	0,11	0,11	0,11	0,19	0,11
10. Waste Management					
a. Wastes from mining activities the current year *[thousand tons]*	562.660	555.889	543.087	532.206	600.478
b. Wastes from mining activities per ton of final product (10a/4b) *[tons/t product]*	5,81	5,32	5,6	6,19	7,4
c. Wastes from mining activities used for backfilling *[thousand tons]*	450.475	405.576	462.059	439.480	440.882
d. Wastes recycled or/and used for the production of secondary materials *[thousand tons]*	1.120	1.328	1.153	797	508
e. Other not mining wastes recycled *[thousand kg]*	4.150	4.908	9.923	13.678	14.641
11. Use of dangerous substances					
a. Quantity of classified dangerous substances used during production (lubricants are excluded) according to the Directive 67/548/EEC *[tons]*	6.600	6.286	2.287	3.966	38.432
12. Company Certification					
a. ISO 9001/2 *(GMEA members [%])*	48	50	59	66	65
b. ISO 14001 (*GMEA members [%])*	30	32	32	33	36
c. OHSAS 18001 *(GMEA members [%])*	10	14	20	24	27