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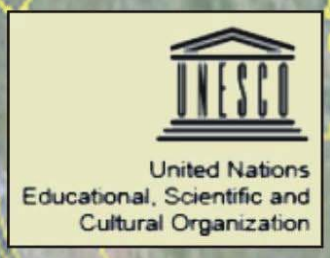

1st INTERNATIONAL WORKSHOP
ON THE PROJECT

ANTHROPOGENIC EFFECTS ON THE HUMAN ENVIRONMENT IN THE NEOGENE BASINS IN THE SE EUROPE

PROCEEDINGS

Edited by:
Serafimovski & Boev
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National UNESCO-IGCP Committee in the Republic of Macedonia has long tradition and active work in area of correlation in geology. More than five decades this Committee brings together scientific researchers in the area of geology within the Republic of Macedonia and creates basis for animation of geological problems in the country and abroad. Numerous active memebers of the Macedonian IGCP-Committee took participation in numerous scientific projects that were financially supported by UNESCO, but there are few teams in the Republic of Macedonia that have managed to be leaders of important projects in the area of geology and human environment, also.

During the last decade the Macedonian Nationa UNESCO-IGCP Committee successfully was involved in studies of anthropogenic effects on the human environment in a wider region that occupies area of former Yugoslavia, Mediterranean and presently Southeastern Europe. As main partners of the Macedonian UNESCO-IGCP Committee in these important activities participate national UNESCO-IGCP Committees of the Republic of Slovenia and Republic of Croatia, regularly supported by National UNESCO-IGCP Committees, groups and individual researchers from the UK, France, Switzerland, Bulgaria, Russia, Greece, Romania, Slovakia, Czech Republic, Germany etc.

The ongoing UNESCO-IGCP Project "Anthropogenic effects on the human environment in the Neogene basins in the SE Europe", which financially have been supported by the Participation Programme 2010-2011, represents just confirmation of the continuity of scientific activities of the National UNESCO-IGCP Committee and opens an opportunity for new studies and enclosure of more younger scientific workers in the country and from abroad. In that context speaks already organized 1st International Workshop on this project at 3-4 June 2011 in Stip, Republic of Macedonia where active participation took more than 40 participants from few European countries. These project activities have resulted with preparation of a Proceeding Book containing 14 selected scientific papers, which have been presented at the aforementioned Workshop.

Aknowledgement:

This Workshop was organized with a financial support from the UNESCO-IGCP Participation Programme 2010-2011through the National Commission for UNESCO in Skopje, Republic of Macedonia

C O N T E N T S

AIR POLLUTANTS EMISSION ESTIMATION FROM MINING INDUSTRY IN MACEDONIA

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Abstract

This paper presents air pollutants (particles and gaseous) emissions estimation from extraction and concentration processes of raw mineral materials (commonly referred as mining industry). Emissions estimations are based on extensive analysis of each specific site including production rates, equipment and processes used as much as type of material processed. Data for national mining industry are based on 2010 unofficial reports (obtained through authors direct research), and are compiled as per CORINAIR (CLRTAP) reporting requirements. Methodologies and results are discussed below.

Introduction

Emission estimations and creation of polluters inventory is first step for proper planning of protection measures, as much as requirements from international agreements signed by our government. Having this in mind and as a part of wider National reporting activities taken by MOEPP and different subcontractors of the specific project, an extensive efforts for inventory of mining operations and estimation of associated emissions were taken during the 2010.

Due to each mine/quarry unique characteristics and based on intensity and type of activities/processes involved, a different methodologies for emission estimations are applied, including:

- ✓ Guidelines for CLRTAP Emission Inventories 2001 - ETC ACC (Group 05).
- ✓ US EPA (1998), Compilation of Air Pollutant Emission Factors, AP-42, Fourth Edition, United States Environmental Protection Agency.
- ✓ NATIONAL POLLUTANT INVENTORY GUIDE, 2004 Version 3.1, Australian Government, Department of Environment and Heritage.

Based on methodologies requirements, the emission inventory compiled includes all operations (active in 2010) at the national level, involved in some form of extraction and primary processing of raw mineral materials. Based on type of minerals involved, and according to industry standards all operation are classified in four major groups, as follow:

- Extraction and processing of energy minerals
- Extraction and processing of hard rock metallic minerals
- Extraction and processing of aggregates
- Extraction and processing industrial minerals

The inventory does not include sand and gravel operations as much as dimensioned stone quarries, where due to specific technologies and usual low intensity of activities, air pollutants emission are quite limited and of now importance at local or national level. Due to similar reasons underground mining operations are also omitted.

Emission sources and air pollutants of interest

Using the same approach, common emission sources could be divided in two distinctive groups, emissions from raw mineral extraction processes and emissions from primary processing activities.

During the extraction processes common air pollutants include particulate matters (TSP and PM 10) and following gaseous substances CO, NO_x, SO_x and VOC_s, usually associated with following activities;

- blasting,
- material transportation and handling,
- vehicle exhaust emissions.

Pollutants of interest from primary processing activities are dominated by particulate matters (TSP and PM 10) and in many smaller rates gaseous substances including CO, NO_x, SO_x and VOC_s, associated with following activities;

- crushing
- grinding
- classification
- material transportation and handling

Processes of material destruction and natural disintegration, especially for energy minerals (oxidation, self-burning…) could result with greenhouse gasses emissions including methane, ethane and propane.

Largest part of this emissions could are fugitive emissions (>90%) and cannot be associated with specific location or process, while small part (<10%) comes from point or line sources.

Emission factors

As basis for estimation in the inventory creating processes, default emission factors recommended by US and Australian (USEPA, SPCC and NERDDC) reports were used. The emission factors used were drafted as a compilation of systematic measurements in real operating conditions in Australian and US mines.

Based on certainty expected, for each emission factor an appropriate rating (EFR) is defined. The EFR system is as follows:

A - Excellent
B - Above Average
C - Average
D - Below Average
E - Poor
U - Unrated

It must be noted that those ratings does not imply emission factors absolute precession. The main criterion affecting the uncertainty of an emission factor remains the degree of similarity between the equipment/process selected in applying the factor, and the target equipment/process from which the factor was derived. This means that if properly selected and applied factors could provide satisfactory precession and could be used with great certainty.

Emission factors for specific operations and associated activities are given bellow.

Table1. Default emission factors - coal extraction and processing

Activity	**TSP**	**PM_{10}**	**Units**	**EFR**
Draglines	0.06	0.026	kg/m^3	B
Excavators/Loaders	0.029	0.014	kg/t	C
Buldozers	102	32.5	kg/h	B
Bucket wheel	minimal	minimal		
Screpers	1.64	0.53	kg/VKT	A
Stockpiling	0.004	0.0017	kg/t	U
Reclaiming	0.03	0.013	kg/t	U
Transfer points	0.00032	0.00015	kg/t	U
Conveyor (runoff mine)	0.005	0.002	kg/t	C
Conveyor (dry material)	0.06	0.5	kg/t	C

Table 2. Default emission factors - extraction d processing of aggregates, construction materials and industrial minerals

Activity	**TSP**	**PM_{10}**	**Units**	**EFR**
Excavators/ loaders	0.025	0.012	kg/t	C
Bulldozers	17	4	kg/h	B
Mine roads, fugitive dusts	3.88	0.96	kg/VKT	U
Trucks	0.012	0.0043	kg/t	
Draglines	0.06	0.026	kg/m^3	B
Scrapers	1.64	0.53	kg/VKT	A

Table 3. Default emission factors - extraction of metallic ores

Activity	**TSP**	**PM_{10}**	**Units**	**EFR**
Excavators/ loaders	0.025	0.012	kg/t	C
Bulldozers	17	4	kg/h	B
Mine roads, fugitive dusts	3.88	0.96	kg/VKT	U
Trucks	0.012	0.0043	kg/t	
Draglines	0.06	0.026	kg/m^3	B
Scrapers	1.64	0.53	kg/VKT	A

Table 4. Common emission factors for gaseous substances

Activity	Emission factors (kg/1000 l diesel)					
	PM_{10}	**CO**	**NO_x**	**SO_x**	**VOC_s**	**EFR**
Buldozer	3.03	9.4	34.16	1.7	3.31	C
Excavator	17.7	14.73	34.29	1.7	1.58	C
Screper	3.27	10.16	30.99	1.7	2.28	C
Trucks	17.7	14.73	34.29	1.7	1.58	C
Loader	3.51	11.79	38.5	1.7	5.17	C

Table 5. Common emission factors - processing activities

Activity	TSP	PM_{10}	Units	EFR
Primary crushing	0.2	0.02	kg/t	C
Secondary crushing	0.6	ND	kg/t	D
Tertiary crushing	1.4	0.08	kg/t	E
Material transport and handling	0.06	0.03	kg/t	C

Results obtained

Data collected for each site are used for construction of specific flow charts, in order to identify material flow and processes involved. Based on those flow charts, emissions are estimated and results are compiled in a format as per CLRTAP emission inventories requirements. Emission data compiled in tables for each of the major groups of national mining industry are presented below.

Table 6. Fugitive emissions - industrial minerals

Sites	(kg/year)					
	TSP	**PM 10**	**CO**	**NOx**	**SOx**	**VOCs**
Govrlevo	205.950	60.408	2.304	5.944	284	452
Usje	365.140	82.645	3.599	8.960	433	591
Mikrogranulati-Gostivar	140.165	19.646	1.735	4.616	218	390
Hamzali	128.278	16.720	247	615	30	40
Memisli	291.516	33.031	502	1.264	61	88
Opalit	365.305	58.336	848	2.060	100	121
Strmos	154.648	39.161	970	2.427	117	164
Silika Mineral	235.696	31.606	1.723	4.603	217	394
Group Total	1.886.699	341.554	11.929	30.489	1.460	2.240

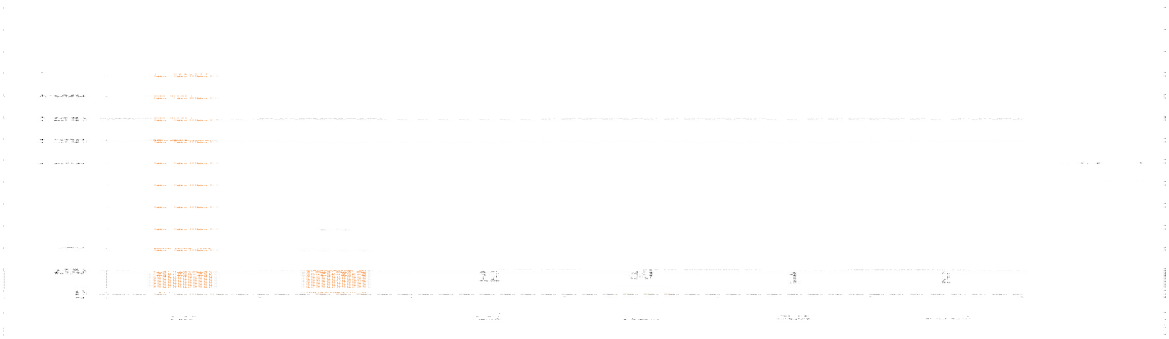

Fig. 1. Total emission - industrial minerals group

Table 7. Fugitive emissions - energy minerals group

Sites	(kg/year)		m^3/year			
	TSP	PM 10	Mhetane	Ethane	Propane	CO
REK Bitola	1.814.021	1.222.461	14.146.000	1.028.800	514.400	771.600
REK Oslomej	671.277	417.677	1.903.000	138.400	69.200	103.800
BRIK Berovo	7.965	3.840	26.250	2.100	1.050	1.575
Piskupstina-Struga	9.215	4.443	27.000	2.160	1.080	1.620
Group Total	2.502.479	1.648.420	16.102.250	1.171.460	585.730	878.595

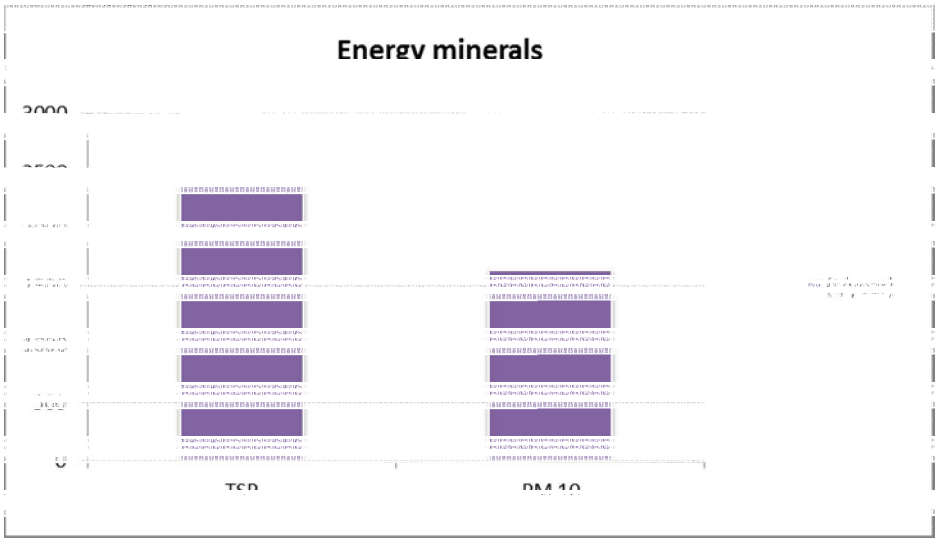

Fig. 2. Total particulate emission - energy minerals group

Fig. 3. Total gaseous emission - energy minerals group

Table 8. Fugitive emissions – construction materials/aggregates group

Sites	(kg/year)					
	TSP	**PM 10**	**CO**	**NOx**	**SOx**	**VOCs**
Banjani	232.776	39.628	921	2.315	112	159
Cajle	573.493	77.049	1.069	2.649	128	171
FHL Sivec	1.231.208	176.954	13.449	36.914	1.724	3.424
Brazda	133.050	34.827	2.516	6.477	309	489
Zebrenjak	202.055	24.904	1.362	3.516	168	268
Grupcin	16.772	5.514	1.835	4.947	232	435
Prevalec	389.835	43.430	818	2.022	98	129
Krasta	200.788	24.679	1.872	5.050	237	445
Gopceli	138.040	19.298	2.021	5.399	255	462
Tatarli-Cuka	108.271	14.501	1.925	5.157	243	445
Trojaci	184.184	22.400	1.704	4.659	218	428
Pelagonija-Gostivar	202.905	24.357	901	2.437	114	216
Pelagonija Kavadarci	151.822	18.504	790	2.026	97	151
Progres Gostivar	192.512	24.503	707	1.757	85	115
Sopotnica	299.923	42.078	853	2.184	105	161
Tajmiste	235.560	32.480	633	1.641	78	127
Urban Invest	97.381	11.317	448	1.131	54	79
Vratnica	187.344	23.929	781	2.024	96	156
Zelenikovec	136.121	16.752	309	803	38	62
Group Total	4.914.040	677.103	34.914	93.106	4.393	7.925

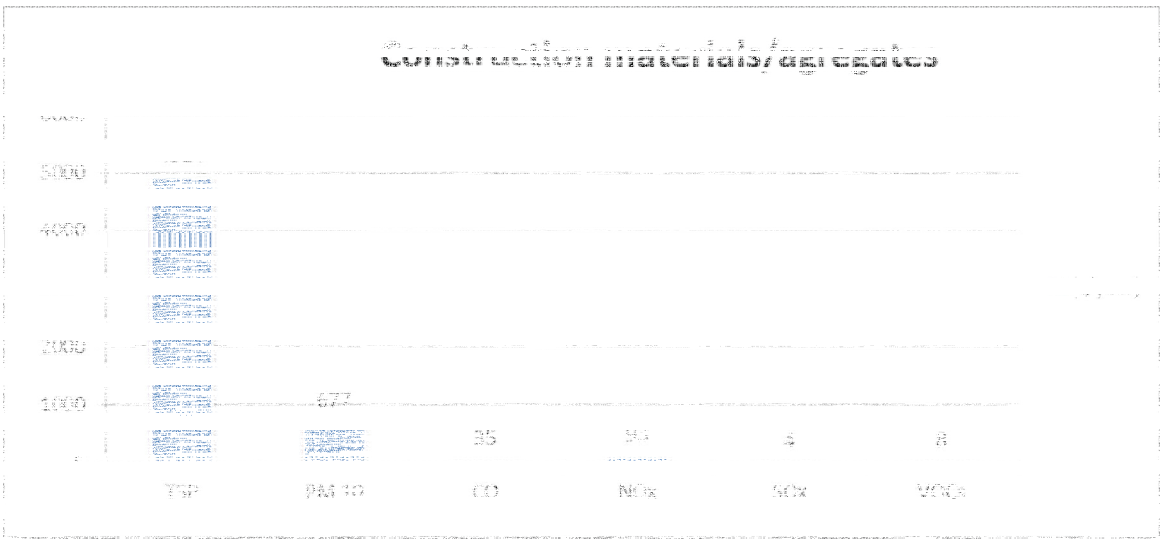

Fig. 4. Total fugitive emissions - construction materials/aggregates group

Table 9. Fugitive emissions – metallic minerals group

	(kg/year)					
	TSP	**PM 10**	**CO**	**NOx**	**SOx**	**VOCs**
Feni	1.531.230	183.643	2.926	7.674	364	619
Buchim	9.884.902	1.167.752	15.505	40.275	1.918	3.140
Group Total	11.416.132	1.351.395	18.431	47.948	2.282	3.759

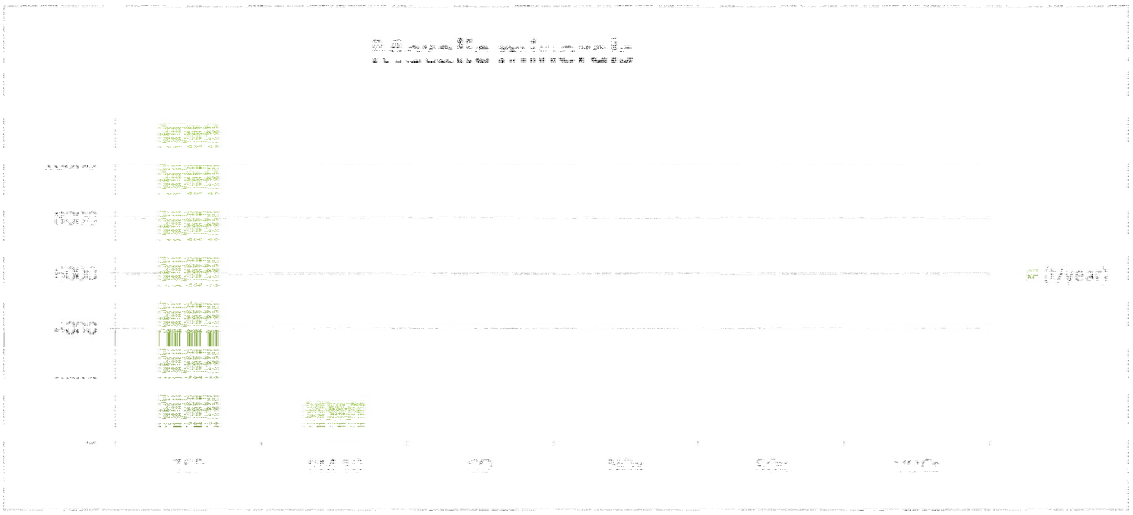

Fig. 5. Total fugitive emissions – metallic minerals group

Instead of conclusion

It must be noted that the results presented are indicative and for reporting/planning purposes only, and total values does not have any significance as an air pollution indicators for national level.

Of course parameters obtained for each specific sites or agglomeration operation located in close proximity could be a solid base for planning and licensing purposes.

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