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"Multicriteria risk analysis for the classification of closed extractive waste facilities"

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- Risk Analysis
- Conclusions-Proposals for further study

1. INTRODUCTION

Framework for the Management of waste from the extractive industries:

- ✓ Directive 2006/21/EU (MWD)
- ✓ JMD No.39624/2209/E103/ 2009 GG B΄2076)

Article 20 of the MWD:"Member States shall ensure that an inventory of closed waste facilities, including abandoned waste facilities, located on their territory which cause serious negative environmental impacts or have the potential of becoming in the medium or short term a serious threat to human health or the environment is drawn up and periodically updated. Such an inventory….shall be carried out by 1 May 2012, taking into account the methodologies as referred to in Article 21, if available."

2. STUDY FRAMEWORK

Methodology developed by the School of Mining and Metallurgical Engineering, NTUA in cooperation with IGME, (2009), for the classification of closed and abandoned metallic mine waste facilities based on their potential environmental risk

Waste facilities data from EU program aiming to register closed mining and metallurgical waste facilities and develop novel techniques for their beneficial reuse, (IGME, 2009).

Detailed record of the main metal mining centers in Greece, covering 9 Regions and 24 Prefectures was compiled. 107 metal mining centers& mine waste facilities recorded. Quarries, bauxite mines and lignite mines were not included in this study.

2. STUDY FRAMEWORK

Methodology Developed prior to the publication of the Guidance Document for a Risk Based Pre-Selection Protocol for the Inventory of closed Waste facilities, prepared by the TAC of the MWD in 2011. However, this Risk Analysis technique is also based on similar selection criteria, including data regarding the wider environment where the waste facility is located, the facility itself and the contained wastes.

This methodology was then employed by the Greek YPEKA for the preparation of the first Inventory of closed waste facilities Article 20 of the MWD as harmonized in the Greek legislation, (YPEKA, 2012).

→ GUIDANCE DOCUMENT FOR A RISK-BASED PRE-SELECTION PROTOCOL FOR THE INVENTORY OF CLOSED WASTE FACILITIES AS REQUIRED BY ARTICLE 20 OF DIRECTIVE 2006/21/EC

3. RISK ANALYSIS

MULTICRITERIA RISK ANALYSIS, based on

pollution source-pathway-receptor methodology

ASSESSMENT OF THE

- ✓ CLOSED WASTE FACILITY AND WASTES IT CONTAINS (Potential pollution sources)
- ✓ CHARACTERISTICS OF THE WIDER AREA WHERE THE FACILITY IS LOCATED (Pathway-receptor)

For sites where no analytical data were available, the site classification was based on available qualitative data and the expertise of the study team

3. RISK ANALYSIS

MULTICRITERIA RISK ANALYSIS, based on

pollution source-pathway-receptor methodology

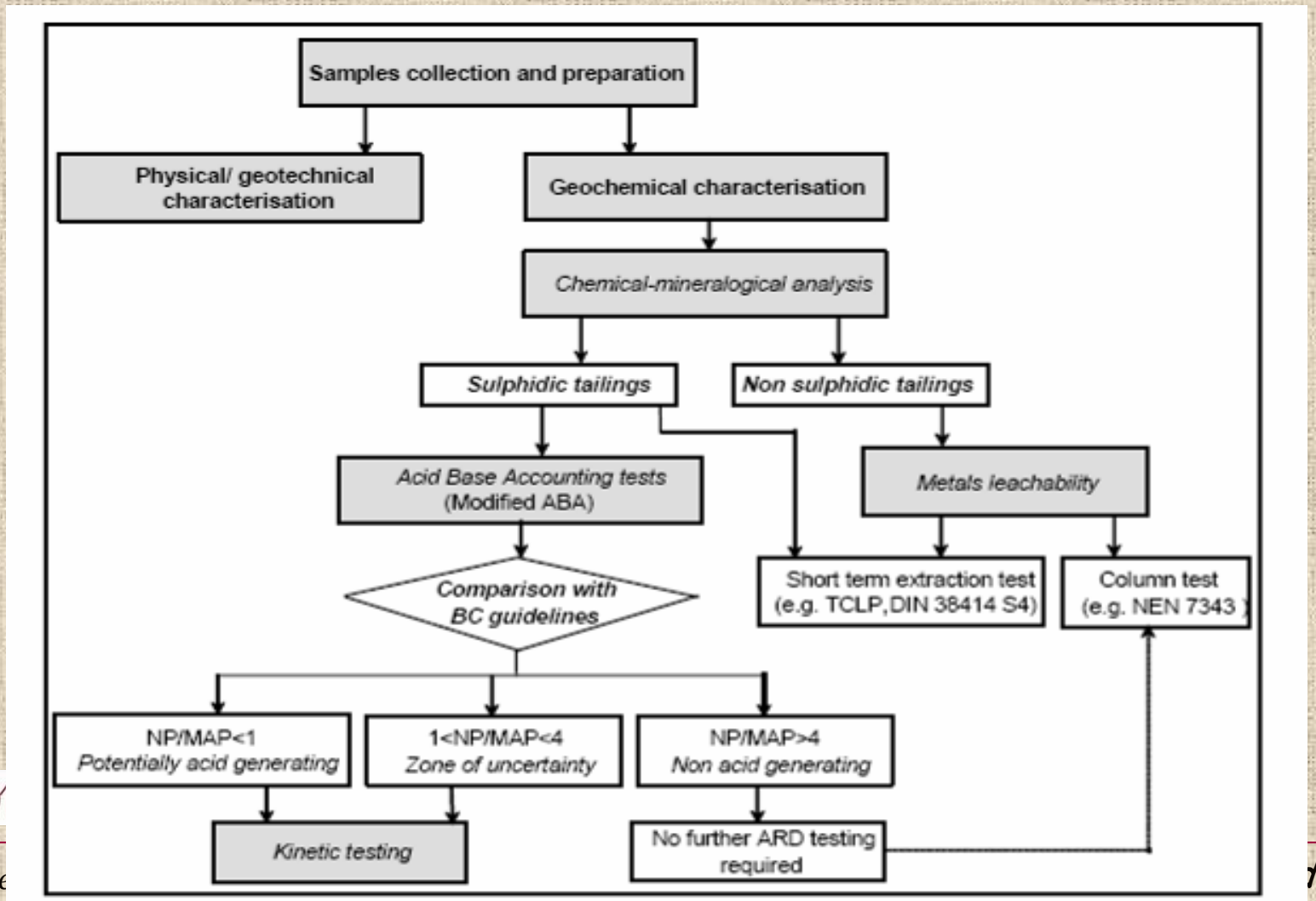
1. Deposition Characteristics-(Pollution source) Parameters examined

- ✓ Waste Characterisation-Type (Overburden-Waste Rock-Temp. Ore Depositions-Tailings-slags)
- ✓ Composition-Leachability of Contaminants
- ✓ Volume of disposed wastes

3. RISK ANALYSIS

Methodology for Waste Characterisation,

BREF 2009, http://eippcb.jrc.es



3. RISK ANALYSIS

Waste characteristics that may cause serious, negative environmental impact:

- ✓ Potential for AMD, indicator NP/MAP(NPR)
- ✓ Leachability of contained contaminants

a) Category E1, leachability of the contained pollutants < test limits or/and the drinking water limits.

b) Category E2, leachability < limits for the discharge of liquid effluents into natural receivers and > drinking water limits.

c) Category E3, lechability of pollutants > limits for discharge into natural receivers.

d) Category E4. Wastes in this category present an increased leachability measured at least ten times greater than the limits for discharge into natural receivers.

3. RISK ANALYSIS

✓ Leachability of contained contaminants-Test Used

No specific leachability test is yet developed for the mining wastes, - the standard test EN 12457 of Landfill Directive 1999/31/EC (JMD 29407/3508/02) is often used for mine waste characterisation.

Despite the fact that the management of mining waste is presently covered by the MWD, standard leachability test results are occasionally compared with the limits of the Decision 2003/33/EC establishing criteria for the acceptance of waste at landfills. This comparison is occasionally deemed necessary due to the lack of specific regulations regarding the mobility of contaminants contained in mining wastes.

3. RISK ANALYSIS

MULTICRITERIA RISK ANALYSIS, based on pollution source-pathway-receptor methodology

1, Deposition characteristics

B,C. Pathway-Receptor Characteristics Parameters examined

2. Aquifer characteristics
3. Distance from water resources
4. Distance from human activities
5. Distance from sites with environmental protection-archaeological areas
6. Specific local characteristics, (rainfalls, wind, seismicity)

One or more criteria correspond to each one of the above groups

Each criterion receives a value ranging from 0 (negligible risk) to 5 (very high risk).

3. Risk Analysis- Forms

Evaluation Criterion	SCORE 5 (Very high risk)	4 (High risk)	3 (Moderate risk)	2 (Low risk)	1 (Very low risk)	0 (negligible risk)	Weight factor	Value for lack of data
1. Deposition Characteristics								
Acid Mine Drainage	**D6**	**D5**		**D3**	**D2**	**D1**	5	2
Criteria	NPR < 1	NPR <1		NPR 1-2	NPR 2-4	NPR >4		
	acidic pH	Neutral pH						
Leachability	**E4**		**E3**		**E2**	**E1**	5	1
Criteria	>10 times greater than effluents discharge limits		> effluent discharge limits to natural receivers		> Effluent limits and < drinking water limits	< Drinking water standards		
Volume		**O4**	**O3**	**O2**	**O1**		2.5	2
Criteria		> 500 kt	<500 and > 100 kt	<100 and > 50 kt	< 50 kt			

4. Risk Analysis-Forms

Evaluation Criterion	SCORE 5 (Very high risk)	4 (High risk)	3 (Moderate risk)	2 (Low risk)	1 (Very low risk)	0 (negligible risk)	Weight factor	Value for lack of data
2. Aquifer Characteristics								
Low permeability	**YX4**			**YX3**	**YX2**	**YX1**	1.8	2
Criteria	Within the area			distance <2 m	distance 2-10 m	distance > 10 m		
Moderate permeability	**YM4**		**YM3**	**YM2**	**YM1**		2.4	2
Criteria	Within the area		distance <2 m	distance 2-10 m	distance > 10 m			
High permeability	**YY4**	**YY3**	**YY2**	**YY1**			3	3
Criteria	Within the area	distance <2 m	distance 2-10 m	distance > 10 m				

3. RISK ANALYSIS

Facilities classification

1. Deposition characteristics
2. Aquifer characteristics
3. Distance from water resources
4. Distance from human activities
5. Distance from sites with environmental protection- archaeological areas
6. Specific local characteristics

Each criterion receives a value ranging from 0 (negligible risk) to 5 (very high risk).

The score for each group can be either the sum of the values for each individual criterion (the case of 1st and 6th group) or the maximum value of the individual criteria examined (2nd – 5th group).

The final classification of wastes based on the final score presenting their potential environmental risk.

3. Risk Analysis- Results: Lavrion (Bodossakis sulphidic tailings)

Evaluation criterion	Selection	Score	Weighting Factor	Weighted score	Score of the group
1.Depositions Character.					
AMD potential	D6	5	5	25	
Leachability	E4	5	5	25	57.5
Volume	O3	3	2.5	7.5	
2.Aquifer Characteristics					
Moderate permeability		2	2.4	4.8	4.8
3. Distance from Water Res.					
Existing drinking water wells	PY1	0	5	0	
Future drinking water wells	MY1	0	2	0	0
Other drinking water wells	AY1	0	5	0	
4. Distance Human Activities					
Playgrounds	PX2	2	5	10	
Recreation areas	XA3	4	4	16	16
Industrial areas	BM2	1	4	4	
Road network	OD3	4	2	8	
5. Distance protected areas					
Estuaries, debouchments	EP1	0	1	0	
Surface waters (rivers, lakes)	EY2	2	1	2	2
Proteccted areas	PP1	0	1	0	
Archaeological sites	AP1	0	2	0	
6. Special Local Characteristics					
Precipitation	B2	1	2	2	
Winds	A4	3	2	6	11
Seismicity	S2	3	1	3	

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3. Risk Analysis Results: Kirki (waste rock)

Evaluation criterion	Selection	Score	Weighting Factor	Weighted score	Score of the group
1.Depositions Character.					
AMD potential	D6	5	5	25	
Leachability	E4	5	5	25	57.5
Volume	O3	3	2.5	7.5	
2.Aquifer Characteristics					
Moderate permeability		2	2.4	4.8	4.8
3. Distance from Water Res.					
Existing drinking water wells	PY1	0	5	0	
Future drinking water wells	MY1	0	2	0	0
Other drinking water wells	AY1	0	5	0	
4. Distance Human Activities					
Playgrounds	PX1	0	5	0	
Recreation areas	XA1	0	4	0	0
Industrial areas	BM1	0	4	0	
Road network	OD1	0	2	0	
Estuaries, debouchments	EP1	0	1	0	
Surface waters (rivers, lakes)	EY3	5	1	5	5
Protected areas	PP1	0	1	0	
Archaeological sites	AP1	0	2	0	
6. Special local characteristics					
Precipitation	B3	2	2	4	
Winds	A3	2	2	4	11
Seismicity	S2	3	1	3	

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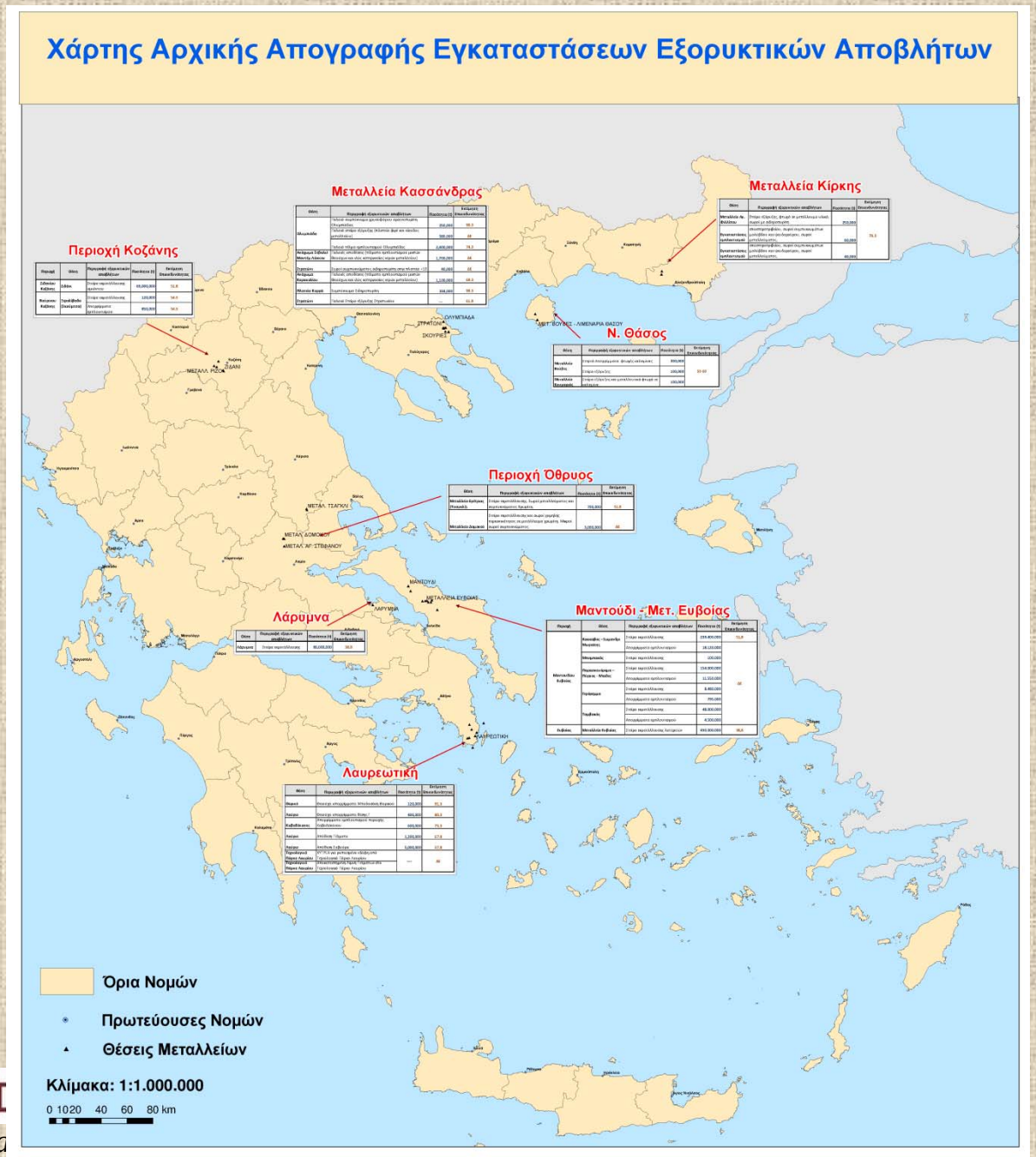
3. Risk Analysis Results: Selected Closed Metallic Mine Waste facilities presenting increased environmental risk

Code	Location	Type of Waste	Waste (t)	Score
1	Lavrion, Attica	Sulphide tailings, Bodosakis area	120 000	91.3
2	Lavrion, Attica	Sulphidic tailings, location C	400 000	80.3
3	Kirki, Thrace	Sulphidic Wastes/ and Tailings	250 000/ 120 000	78.3
4	Olympias, N. Greece	Flotation Tailings*	2 000 000	69.3

*currently under reprocessing for the recovery of the contained pyrites.



Inventory of Examined closed Metallic Mine Waste Facilities

4. CONCLUSIONS-FURTHER RESEARCH

✓Methodology developed to assess and classify potential environmental risks from closed mine waste facilities in Greece based on the Source-Pathway-Receptor Risk Analysis

✓The first inventory compiled included closed waste facilities from metallic mines, IGME records, 2009

✓Methodology developed –Reliable Tool, used by YPEKA for the first inventory of closed Waste facilities, Art. 20 MWD

✓Further employed for updating the initial list from other energy and industrial minerals produced in Greece-Classification-Prioritisation of reclamation schemes

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Thank you for your attention

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