UNECE

Subregional Workshop on strengthening mine tailings safety for Central Asian countries

Almaty, Kazakhstan
20-21 November 2019

UNECE Convention on the Transboundary Effects of Industrial Accidents

Assistance Programme

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Ranking TMFs by their hazard

Prof. Dmitry Rudakov
TU Dnipro University of Technology
Dnirpo, Ukraine

DATA COLLECTED

Country	Country code	Number of TMFs	Comments
Kazakhstan	KZ	121	Sites classified as TMFs according to national legislation
Tajikistan	TJ	11 ?	Data will be refined
	Total	132	

EVALUATION FEATURES

- National toxicity scales similar to those used in the former USSR was applied.
- In addition to the THI, the potential transboundary effect was evaluated for TMFs.

GENERAL EVALUATIONS. KAZAKHSTAN

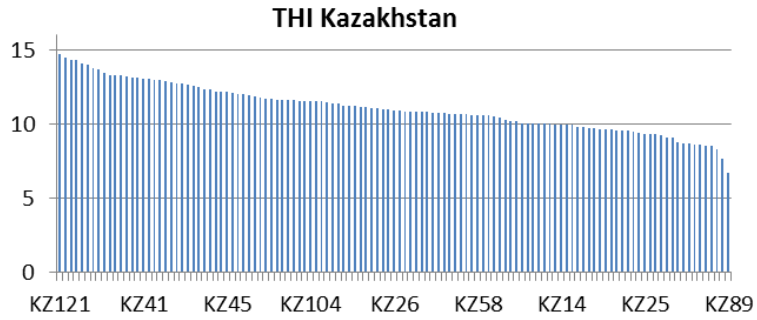
Overall evaluation

TMF number			TMF capacity, mln m^3			Prevailing tailings materials
Active	Inactive	Total	Min	Max	Total	
94	27	121	0.002	595.4	2868.5	Slurry of non-ferrous ore extraction, waste of phosphorus production

Two regions with TMFs of highest hazard

Region	TMF number	Amount, mln m^3	THI_{av}
Turkestan	9	514.36	12.57
Akmola	8	123.55	11.59

IDENTIFICATION OF POTENTIALLY DANGEROUS SITES. KAZAKHSTAN



Two most hazardous TMFs

THI rank	TMF code	TMF name	Region	TMF capacity, mln m^3	Toxic substances	THI
1	KZ117	Sludge storage nr. 6 of LLP «Tioline»	Turkestan	286.624	P	15.46
2	KZ116	Sludge storage nr. 5 of LLP «Tioline»	Turkestan	95.5	P	14.98

TMFs with potential transboundary effect

THI rank	TMF code	TMF name	Region	TMF capacity, mln m^3	Toxic substances	THI
63	KZ16	TMF nr.1 of LLC "Akt. Copper Company"	Aktobe	14.83	Fe, Zn, Cu	10.17
18	KZ41	TMF of Orlovsky dr.pl. LLC"Vostoktsvetmet"	East kazakhstan	10.6	Cu, Zn, Pb, Au, Ag	12.03

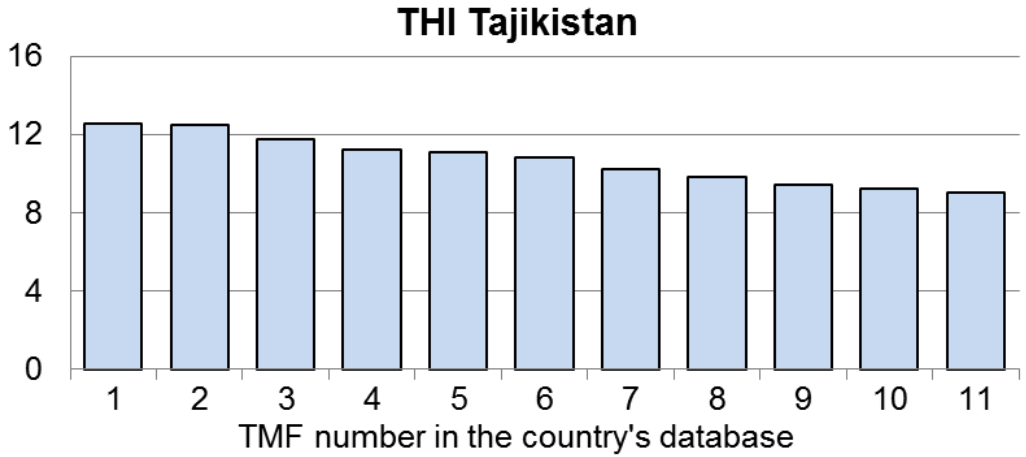
GENERAL EVALUATIONS. TAJIKISTAN

TMF number			TMF capacity, mln m^3			Prevailing tailings materials
Active	Inactive	Total	Min	Max	Total	
8	3	11	0.178	33.1	49.043	Cyanides, Au, Pb, Zn

Region with TMFs of highest hazard

Region	TMF number	Amount, mln m^3	THI_{av}
Sughd region	9	43.032	10.62

IDENTIFICATION OF POTENTIALLY DANGEROUS SITES. TAJIKISTAN



Two most hazardous TMFs

THI rank	TMF code	TMF name	Region	TMF capacity, mln m^3	Toxic substances	THI
1	TJ01	Old TMF of JV "Zeravshan" LLC	Sughd region	33.1	Cyanides, Au	12.52
2	TJ07	TMF of JV “Aznob”	Sughd region	2.9	Sb, Pb	12.46

IDENTIFICATION OF POTENTIALLY DANGEROUS SITES. TAJIKISTAN

TMFs with potential transboundary effect

Rank	Code	TMF name	Region	TMF capacity, million m^3	Toxic substances	THI
1	TJ01	Old TMF of JV "Zeravshan" LLC	Sughd region	33.1	Cyanides, Au	12.52
4	TJ02	TMF of JV "Zeravshan" LLC, Dam nr. 1	Sughd region	1.62	Cyanides, Au	11.21
5	TJ03	TMF of JV "Zeravshan" LLC, Dam nr. 2	Sughd region	1.23	Cyanides, Au	11.09
8	TJ10	TMF nr. 1 “Zarnisor"	Sughd region	0.7	Pb, Zn	9.85
6	TJ11	TMF nr. 2 “Zarnisor"	Sughd region	0.67	Pb, Zn	10.83

IDENTIFICATION OF POTENTIALLY DANGEROUS TMFS

5% TMFs with maximum values of THI

Rank	Code	TMF name	Region	TMF capacity, million m^3	Toxic substances	THI
1	KZ117	Sludge storage nr. 6 of LLP «Tioline»	Turkestan	286.624	P	15.46
2	KZ116	Sludge storage nr. 5 of LLP «Tioline»	Turkestan	95.5	P	14.98
3	KZ114	Sludge storage nr. 3 of LLP «Tioline»	Turkestan	44.5	P	14.65
4	KZ115	Sludge storage nr. 4 of LLP «Tioline»	Turkestan	16.875	P	14.23
5	KZ82	Conserved TMF of Zhezkazgan dressing plants nr. 1,2.	Karaganda	595.394	Cu, Pb, Zn, SiO2, Fe, Al2O3, CaO, S	13.77
6	KZ121	TMF"Koshkar-Ata"	Mangystau	51.79	Radionuclides	13.71
7	KZ84	TMF of Zhezkazgan dressing plant nr. 3.	Karaganda	43.84	Cu, Pb, Zn, SiO2, Fe, Al2O3, CaO, S	13.64

CONCLUSIONS TO TMF EVALUATION (preliminary)

- The share of active TMFs in Kazakhstan (77.7%) and Tajikistan (72.7%) is quite large, which indicates the active development of mining and the urgent need of implementing modern approaches to the TMF safety, especially in these countries.
- The average TMF capacity in Kazakhstan 23.7 million m^3 is higher compared to 4.46 million m^3 in Tajikistan. The average toxicity assessment of substances in TMFs of Tajikistan THI_{tox} 1.09 is lower than the similar indicator for Kazakhstan 1.68, but the average THI for Tajikistan 10.69 is higher than for Kazakhstan (10.32) due to higher natural hazards.

RECOMMENDATIONS ON GROUPING TMFs BASED ON THE THI

- The THI is a dimensionless index, its absolute value depends on the accepted scales to evaluate individual parameters, for example, toxicity. For this reason it is inappropriate to use absolute THI values to identify TMF groups by hazard and priority of inspections.
- Recommendation. Instead of absolute figures use relative THI values and break all tailings into 3 groups
  1) Most dangerous: 10-15% of TMFs with the highest THI,
  2) Heightened danger: 35-40% of TMFs with the THI values above the average THI for the country (region),
  3) Moderate danger: about 50% of TMFs with the THI value below the average THI for the country (region).

Thank you for attention!

THI Calculation.
Evaluation of TMF Capacity

The TMF capacity hazard is assumed to increase with the growing volume of stored materials by logarithmic relation with the base of 10.

The risk induced by the amount of tailing materials is calculated by the formula

$$THI_{Cap} = Log_{10}\,[V_t]$$

where V_t is the volume of tailings materials in the TMF (or TMF capacity), m^3.

For a big TMF with V_t = 10 Mio m^3 → $THI_{Cap} = 7$.

For a small TMF with V_t = 0,01 Mio m^3 → $THI_{Cap} = 4$.

THI Calculation.
Toxicity contribution evaluation

The equivalency of various classifications is shown in Table. the notations “WGK 3” or “CH 1” relates to maximum toxicity of substances, the notations “WGK 0” or “CH 4” relates to minimum toxicity of substances.

	Classification		Value of THI_{Tox}
	WGK (WHC)[1]	Class of Hazard[2]	
Minimum hazard →	“0”	“4”	0
	“1”	“3”	1
	“2”	“2”	2
Maximum hazard →	“3”	“1”	3

[1] WGK = Wassergefährdungsklasse (WHC = Water Hazard Class), German classification,

[2] CH = Class of Hazard, Ukrainian classification

THI Calculation.
Evaluation of TMF Status

The hazard caused by TMF status is higher for active and abandoned TMFs and lower for closed (non-active) or rehabilitated TMFs as follows .

TMF status	Value of THI_{Manag}
Closed or rehabilitated	0
Active or abandoned	1

THI Calculation. Evaluation of Site Location Impact. Seismicity

The site-specific hazard of the TMF includes the contributions of seismic hazard, flood hazard

$$THI_{Site} = THI_{Seismicity} + THI_{Flood}$$

The value of $THI_{Seismicity}$ is defined by the reference peak ground acceleration (Reference PGA) a_{gR} with the returning period T_{Ret}, years.

Seismic risk at the TMF location area	Reference PGA a_{gR} with the returning period T_{Ret}	Value of $THI_{Seismicity}$
Low	<0.1	0
Moderate or high	>0.1	1

THI Calculation. Evaluation of Site Location Impact. Floods

$$THI_{Site} = THI_{Seismicity} + THI_{Flood}$$

THI_{Flood} for each TMF is determined based on the parameter HQ_{500}, (flood event frequency with a five-hundred-year return period).

TMF location	Value of THI_{Flood}
In the area of HQ-500	1
Out of the area of HQ-500	0

THI Calculation. Dam Failure Evaluation

If Factor of Safety (FoS) is available in TMF databases for all facilities THI_{Dam} is calculated using the criteria based on slope stability (FoS) and TMF age

$$THI_{Dam} = THI_{FoS} + THI_{Age}$$

FoS range	Value of THI_{Fos}
FoS > 1,35	0
FoS < 1,35 or FoS is unavailable	1

TMF age	Value of THI_{Age}
≤30 years	0
>30 years	1