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A METHODOLOGY TO IMPROVE THE SAFETY OF TAILINGS MANAGEMENT FACILITIES

Національний технічний університет ДНІПРОВСЬКА ПОЛІТЕХНІКА 1899

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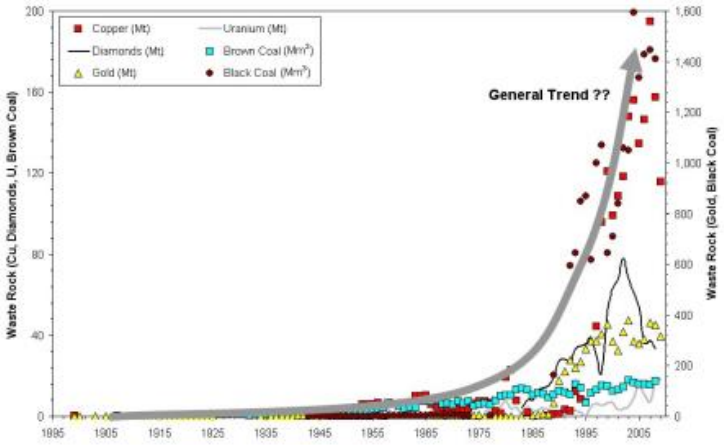
Introduction

- Dramatic growth of wining waste amount in the world last decades.
- Accidents and failures at TMFs in Rumania (2000), Hungary (2010), Ukraine (2008, 2011), Finland (2012), Brazil (2015, 2019), Kazakhstan (2016), Mexico (2018).



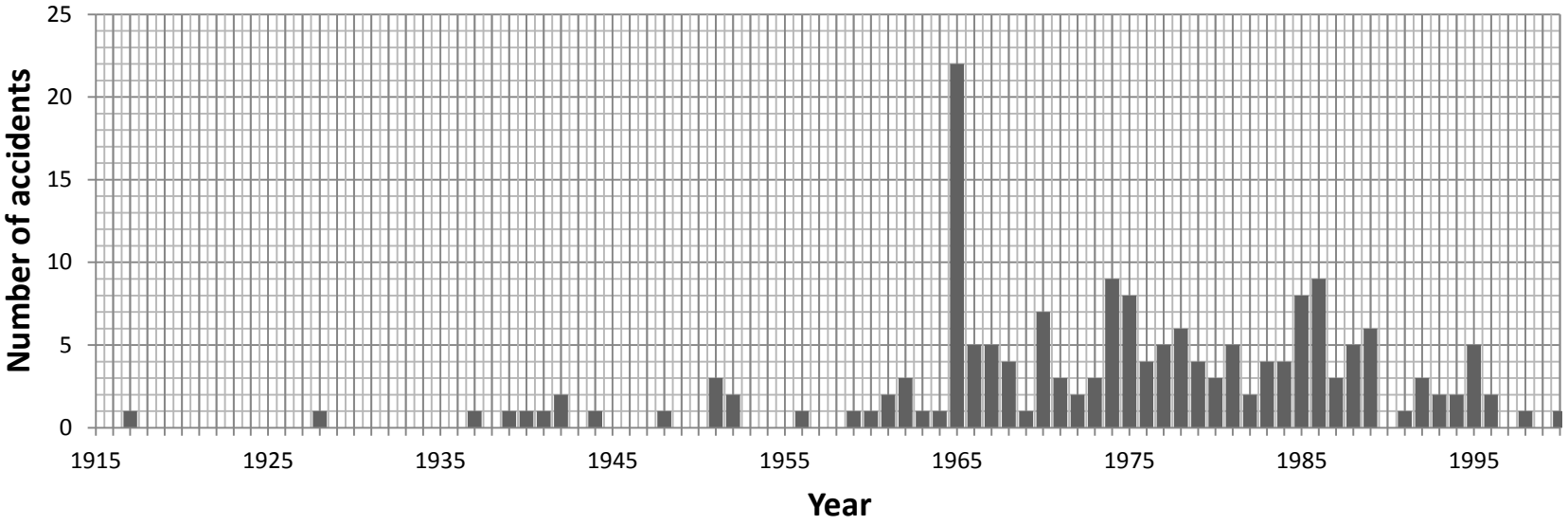
http://users.monash.edu.au/~gmudd/files/2007-WasteMment-Sustainability-v-MineWastes.pdf

The TMF at Ajkai (Hungary) after the dam failure (2010)

The river after dam failure at the TMF of Ridder in East Kazakhstan (2016)

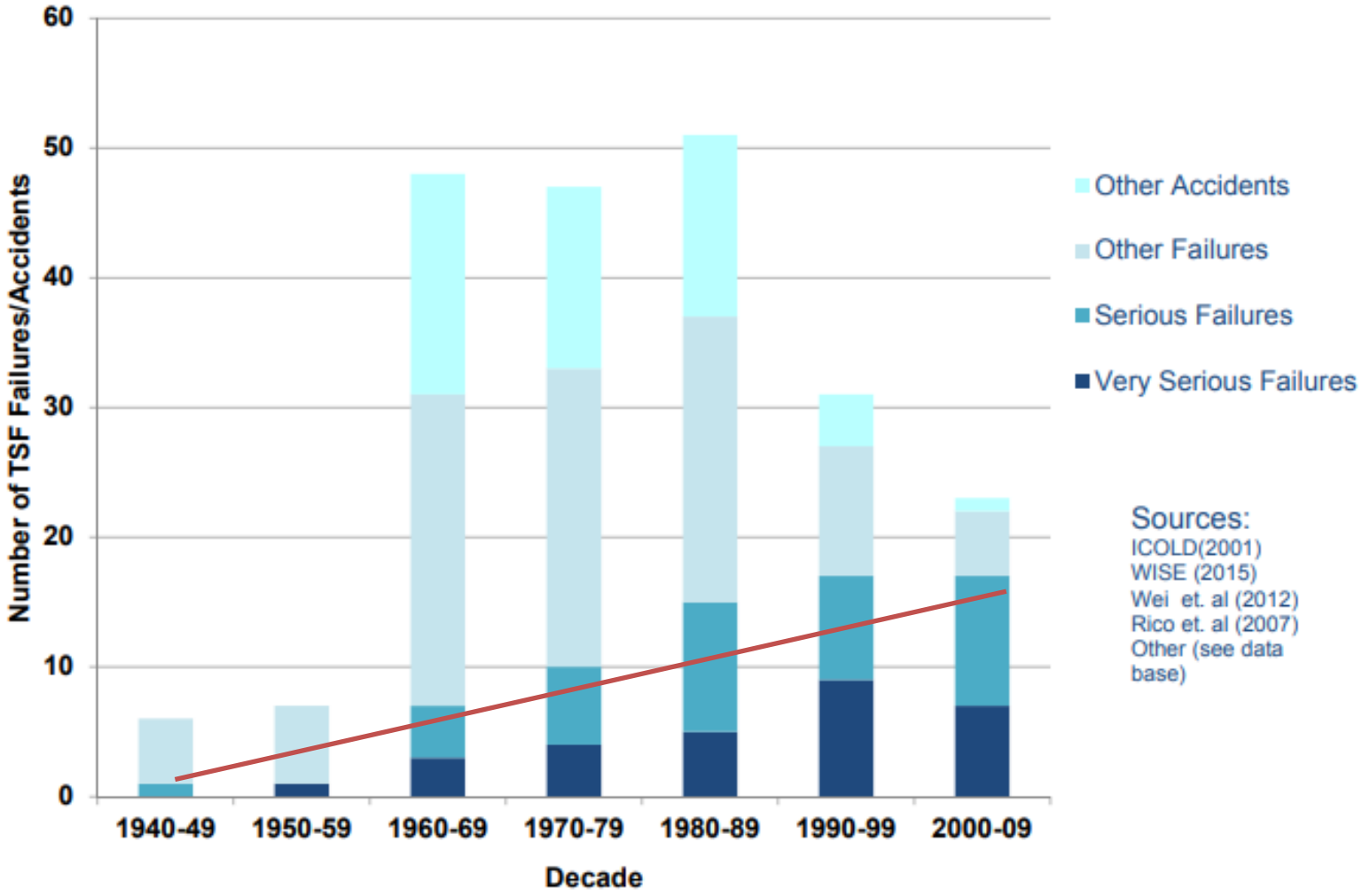
Last TMF accident in Brazil (Vale dam, Jan 2019)

Incidents at TMFs in XX-th century (ICOLD Bulletin No. 121)



- **Dramatic increase in the mid 1960s due to the intensive development of mining industry and construction of a large number of TMFs,**
- **Reducing the number of incidents since 1990s due to the introduction of stricter safety standards, contraction of mining production in some countries, the introduction of new technologies of sustainable mining.**

Growing risk of TMF failures last decades

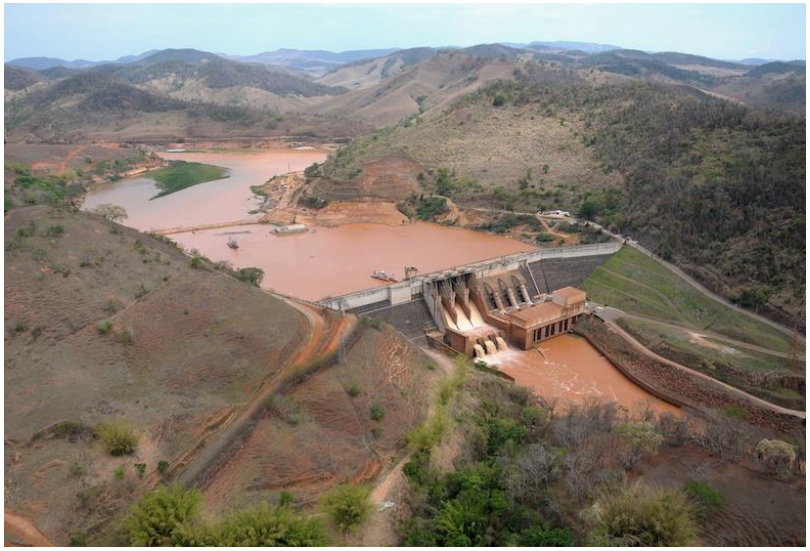


Bowker & Chambers . The Risk, Public Liability & Ecomonmics of Tailings Storage Facility Failures. July 2015.

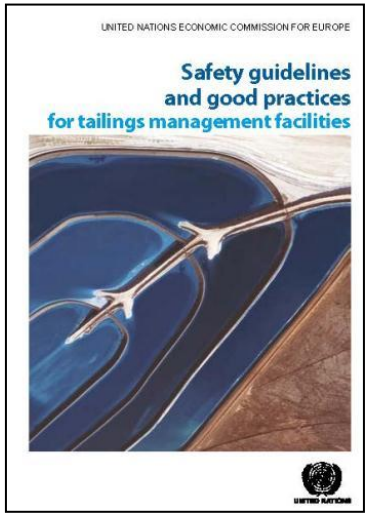
Environmental after-effects of TMF accidents

Between 2007 and 2017, there were at least 10 very serious mine tailings dam failures around the world. These involved multiple loss of life, approximately 20 lives per incident and/or the release of at least one million m^3 of water. The waste in some of these cases travelled 20 km or more.

https://www.unenvironment.org/fr/node/21331



The base for the projects



Improving the safety of industrial tailings management facilities based on the example of Ukrainian facilities (UBA project, 2013-2015)

Methodology to improve the safety of tailings management facilities (TMF Methodology) as a practical tool for the implementation of the UNECE Guidelines with minimum requirements to tailings safety

TMF Methodology

Method of Evaluation "Tailings Hazard Index" (THI)

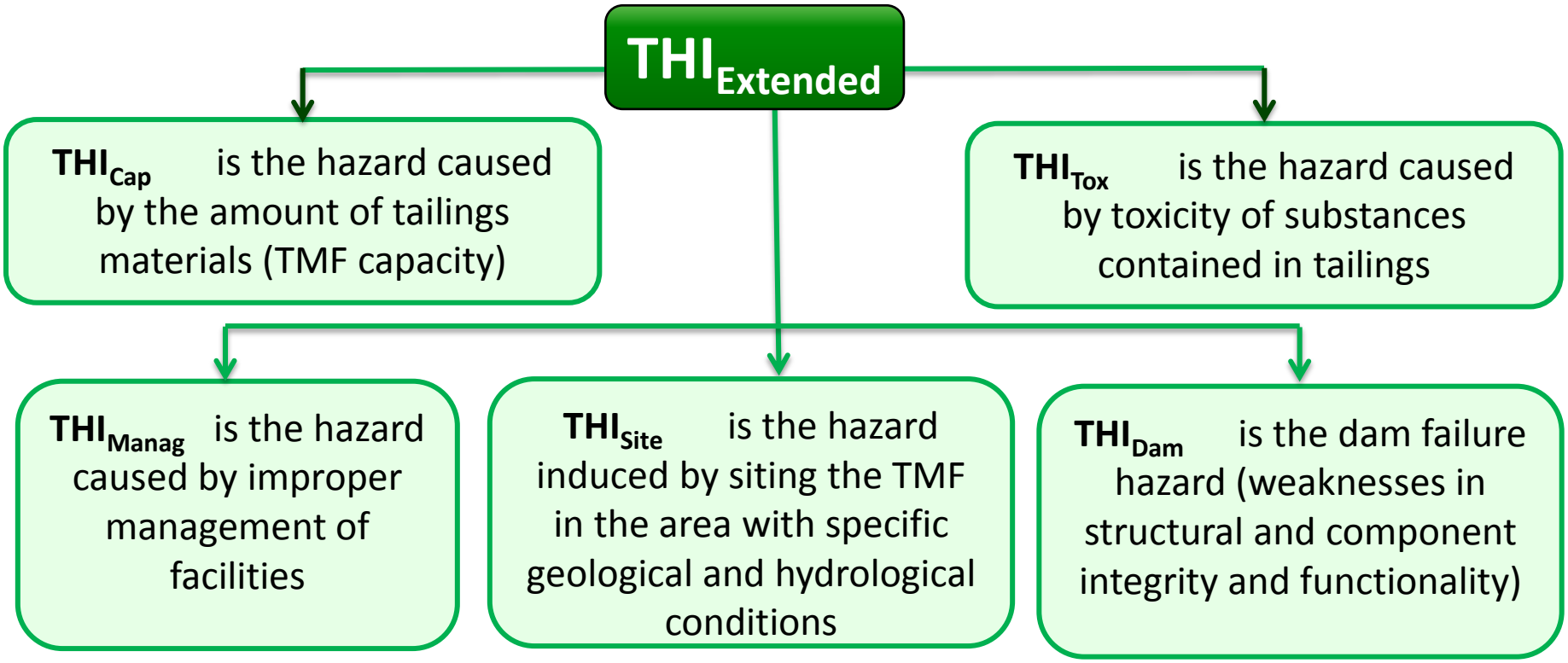
is intended for prompt and preliminary **evaluation of tailings hazard for the large amount of TMFs** on the national/regional level

TMF Checklist

is developed for **evaluation of the safety level for a TMF** using the test question method

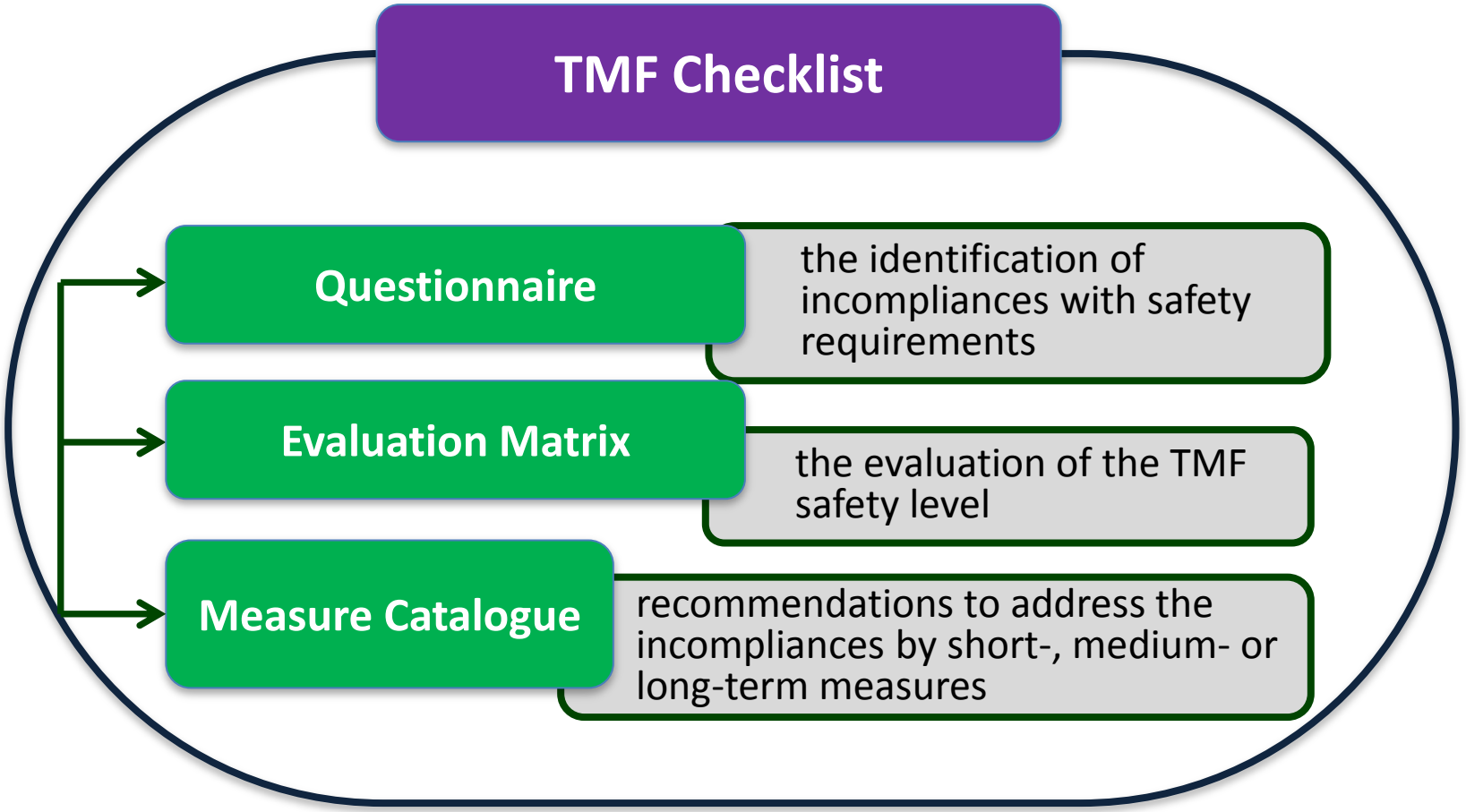
Tailings Hazard Index (THI)

$$THI_{Extended} = THI_{Cap} + THI_{Tox} + THI_{Manag} + THI_{Site} + THI_{Dam}$$



TMF Checklist

TMF Checklist is based on minimum safety requirements adopted in the UNECE **«Safety guidelines and good practices for tailings management facilities»**

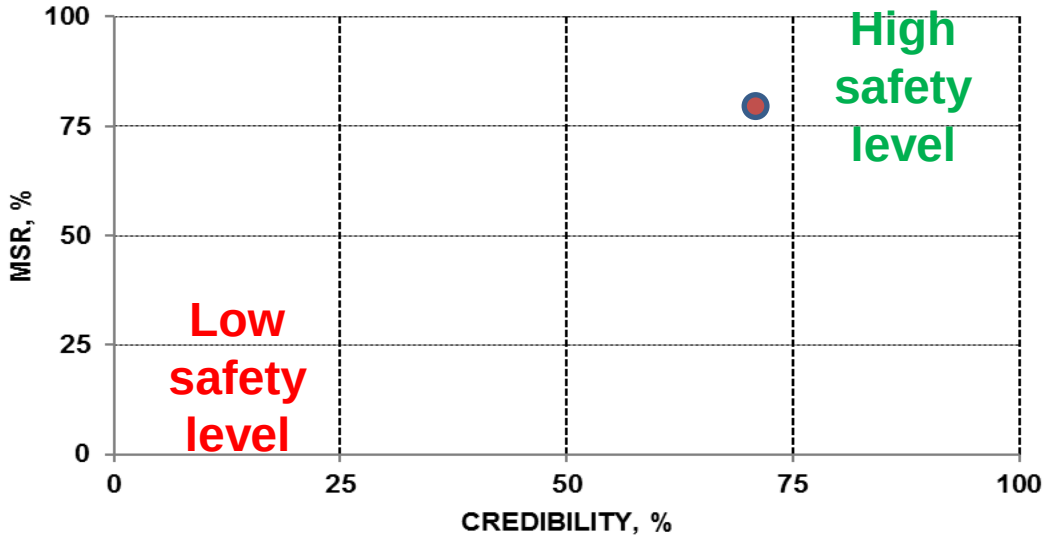


Groups of Checklist questions

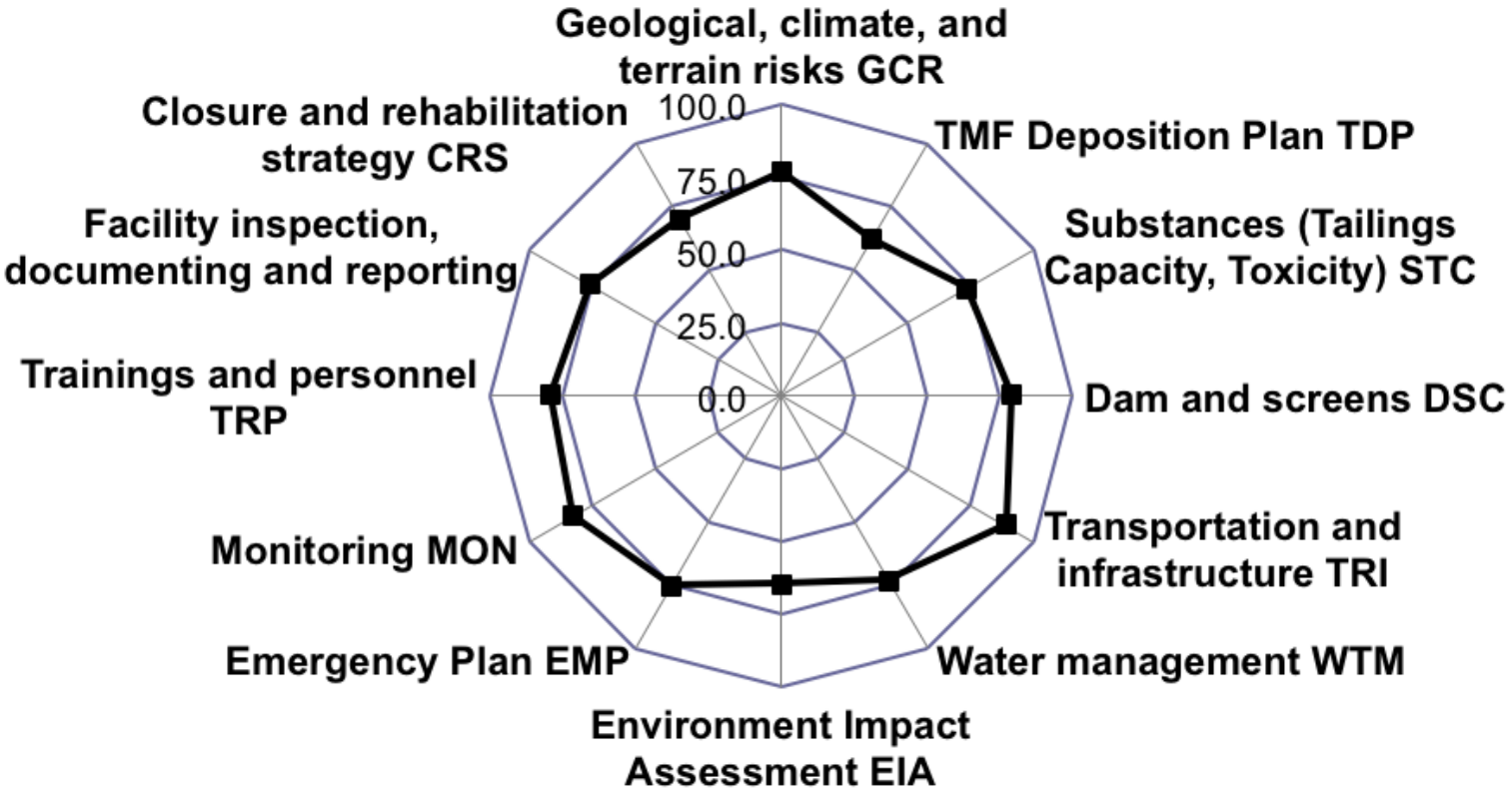
Question group	Purpose
Group A "Basic Check"	Preliminary and prompt evaluation of the safety level of TMFs aimed to prioritize the following detailed check
Group B "Detailed Check"	Comprehensive and detailed evaluation of the TMF safety level aimed to identify the need for taking measures
Group C "Check of Inactive Sites"	Evaluation of the safety level of an inactive TMF aimed to identify the need for taking measures

Evaluation Matrix. Overall evaluation

- **"MSR" rank** ("Meeting Safety Requirements") quantifies how the TMF meets the minimum set of requirements of environmental and industrial safety (the UNECE "Safety Guidelines and good practices for TMFs").
- **"Credibility" rank** within the TMF Checklist quantifies the sufficiency and consistency of data used for calculating the "MSR" rank.



Evaluation Matrix. Categorial evaluation.



Spider diagram

Measure Catalogue

- includes the list of actions to be taken in case of establishing incompliances of TMF conditions to applicable safety requirements/regulations.
- includes the measures from the UNECE “Reference Document on Best Available Techniques for Management of Tailings and Waste-Rock in Mining Activities” and national practices in post-mining environment restoration.

#	Problem to be solved	Measures prescribed	Priority
PRE-CONSTRUCTTION AND CONSTRUCTTION			
1	Design documentation is incomplete	1A. Update design documentation made by a licensed company	Short-term
		1B. Update design documentation involving licensed and skilled staff	Short-term
		1C. Perform expert analysis of design documents for authorities	Short-term
		1D. Prepare or complete design documentation according to regulatory requirements	Short-term
		1E. Prepare a detailed map of the TMF site and the surrounding area	Short-term

Completed and on-going projects on TMF Methodology application

1. **Improving the safety of industrial tailings management facilities based on the example of Ukrainian facilities** (UBA, 2013-2015).
2. **Raising knowledge among students and teachers on tailings safety and its legislative review in Ukraine** (UBA, 2016-2017).
3. **Assistance in safety improvement of tailings management facilities (TMF) in Armenia and Georgia** (UBA, 2017-2019).
4. **Identification of accident risk hot-spots related to tailings management facilities** (ICPDR, 2018-2019).
5. **The project to strengthen the safety of mining operations, in particular tailings management facilities (TMF), in Kazakhstan and beyond in Central Asia** (UNECE, 2018-2019).

First project (UBA). Testing TMF Methodology. The site of Kalush (Western Ukraine)

Location. Ivano-Frankivsk region 0.85 km from the city of Kalush,
Name. TMF No. 2 of State Enterprise "Potassium Plant" JSC "Oriana"
Constructed in 1984
Tailing materials. Solid waste of potassium production including halite, sludge, gypsum and brines

Waste volume.
Solid phase 9 x$10^6 m^3$,
liquid phase 1.7×$10^6 m^3$

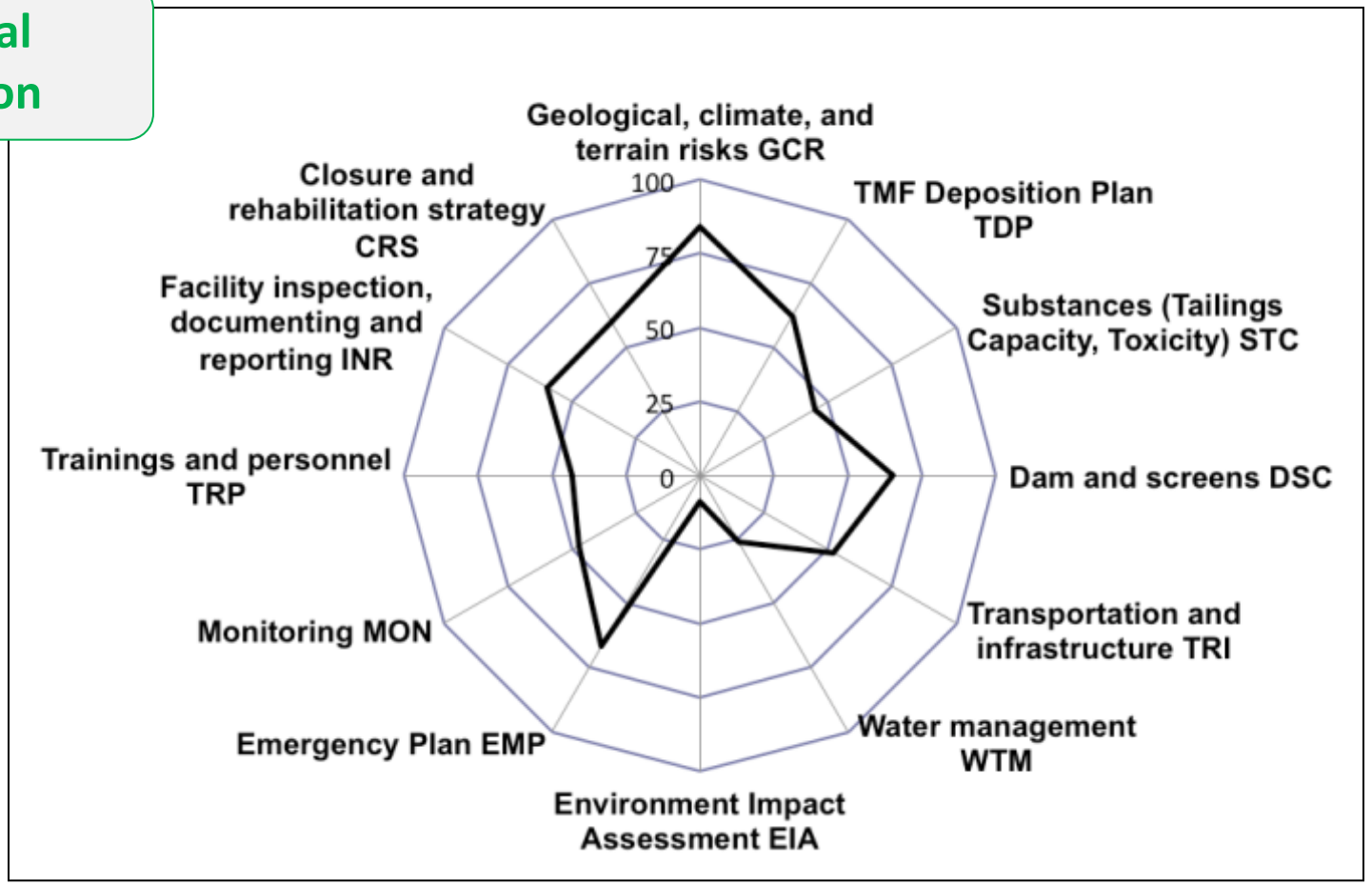
Kalush TMFs threat to
•Safety of population (66.500 people),
•local aquifers,
•and rivers in the Dniester basin

Safety Evaluation for the TMF site in Kalush

Overall evaluation

Credibility,	58.2%
Overall Safety evaluation	51.7%

Categorial evaluation



Second project (UBA). Addressing the TMF problem in Ukraine at the educational and legislative levels

- Raise the knowledge in the TMF safety among Ukrainian students in environmental and mining sciences and young university teachers dealing with education on environmental protection.
- Develop an educational course based on the TMF methodology

Education

- Improve the TMF safety level by addressing this issue on the legislative level in terms of how Ukraine fulfils its obligations under the EU-Ukraine Association Agreement, Directive 2006/21/EC on the management of waste from the extractive industries

Legislative area

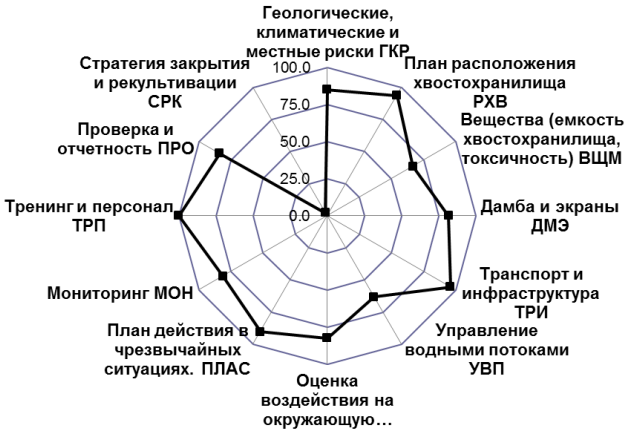
Trainings on tailings safety with TMF Methodology application

First Training
3–7.10.2016
Second Training
22–26.11.2016
TMF of the Thermal Power Plant, city of Dnipro

- **Lectures on the TMF Methodology**
- **Site visit to the TMF, filling in the TMF Checklist**
- **Presentation on TMF safety level evaluation by students**

Training results

- Safety evaluation
- Testing of the Methodology
- Safety improvement program
- The on-line education course on TMF safety in the Moodle platform



TMF safety level

Credibility	**85%**
Overall safety evaluation	**77%**

Mapping of TMFs in Ukraine

The map of 344 tailings facilities ranked by their hazard (tailings capacity and toxicity) has been created in **Google Map** and presented at Round Table for competent authorities (Kyiv, February 7, 2017) as a practical tool for implementation Directive 2006/21/EC provisions.

Waste classification

- **Highly hazardous**
- **Very hazardous**
- **Hazardous**
- **Low hazardous**

https://www.google.com/maps/d/viewer?amp%3Busp=sharing&mid=1RFomCn9uKponcHnFrK3XG997AEU&ll=48.74972991354911%2C30.694941406249995&z=6

Third project (UBA). Training on TMF safety in Armenia

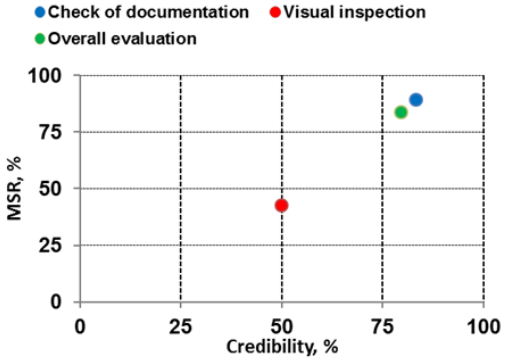
TMF Nahatak of Akhtala ore dressing plant (Armenia)

The training at Tsaghkadzor (Armenia) on 3-6.09.2018 includes

- Theoretical studies,
- Site visit to the TMF,
- Safety evaluation and selection of safety improvement measures.

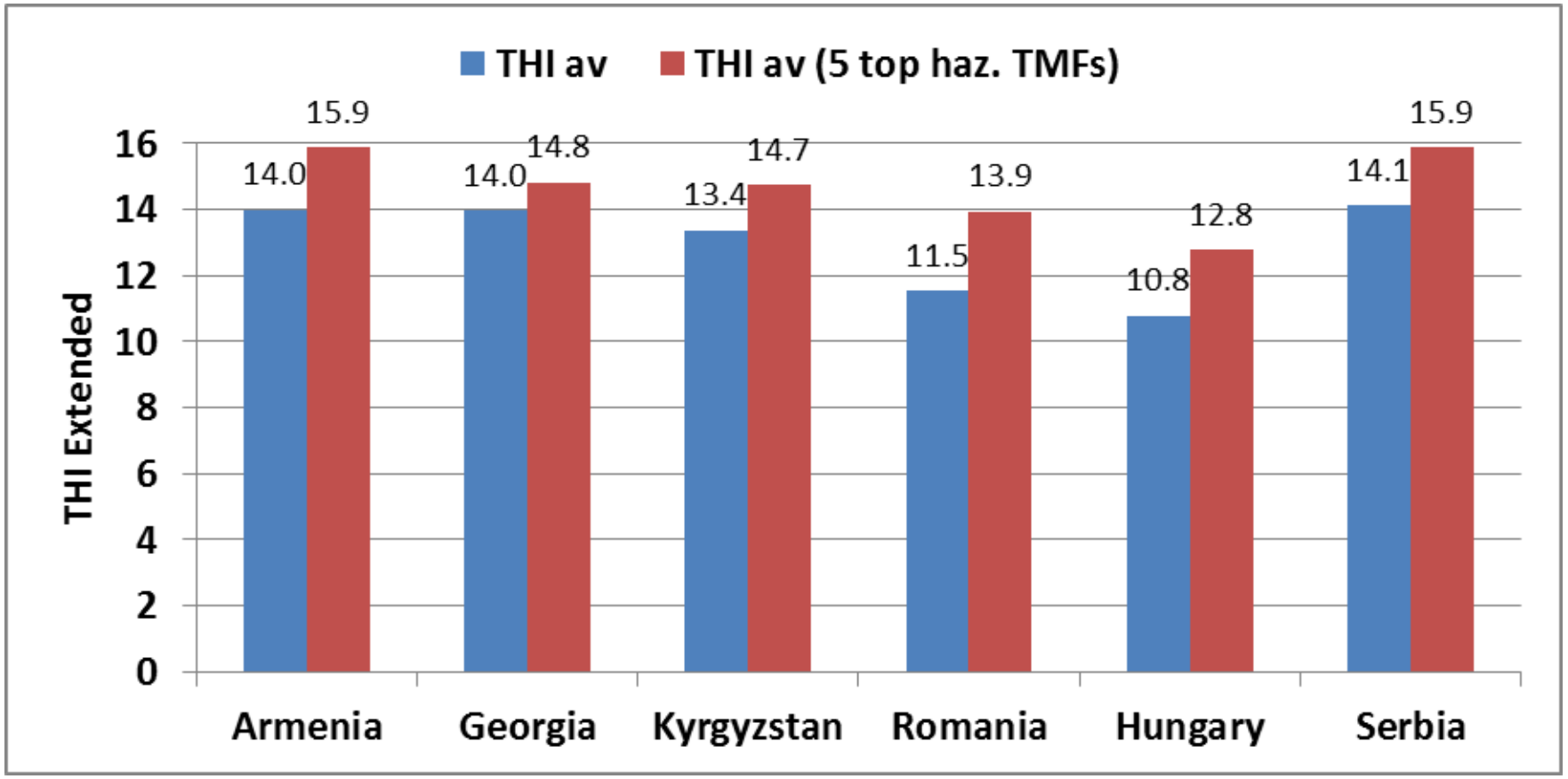
52 participants and experts from 13 countries

The participants' feedback was taken into account in improvement of the TMF Methodology.



Graphical interpretation of TMF safety level evaluation by Group 1 of training participants

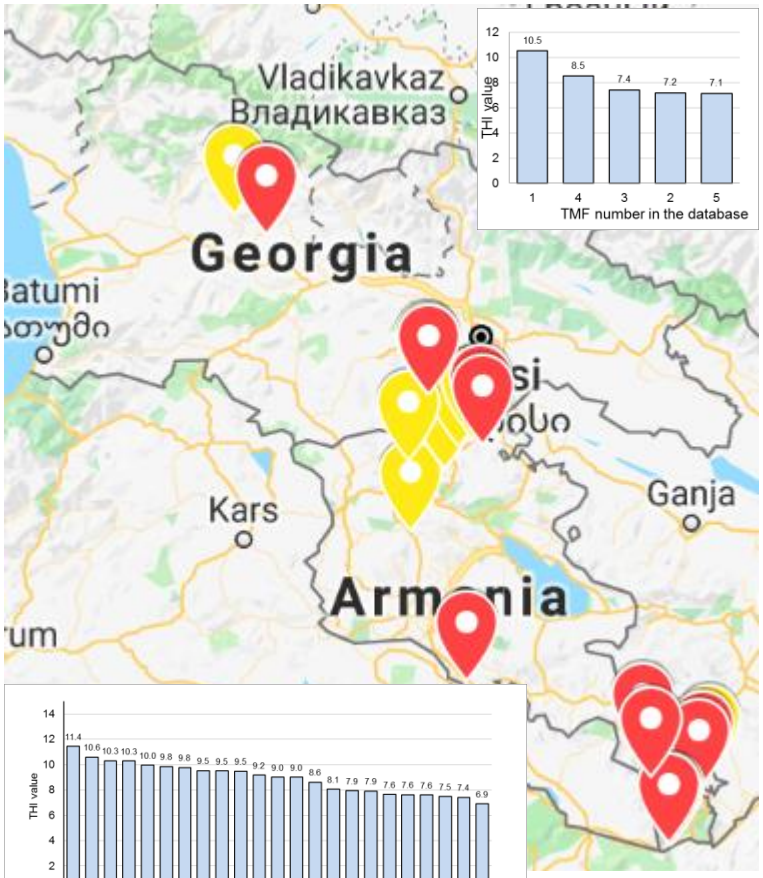
Evaluation of tailings hazard for the participating countries



TMF number	23	5	16	119	39	23

THI av = THI average for all TMFs in the country,
THI av (5 top haz. TMFs) = THI average for top 5 hazardous TMFs in the country (for 3 top hazardous TMFs in Georgia).

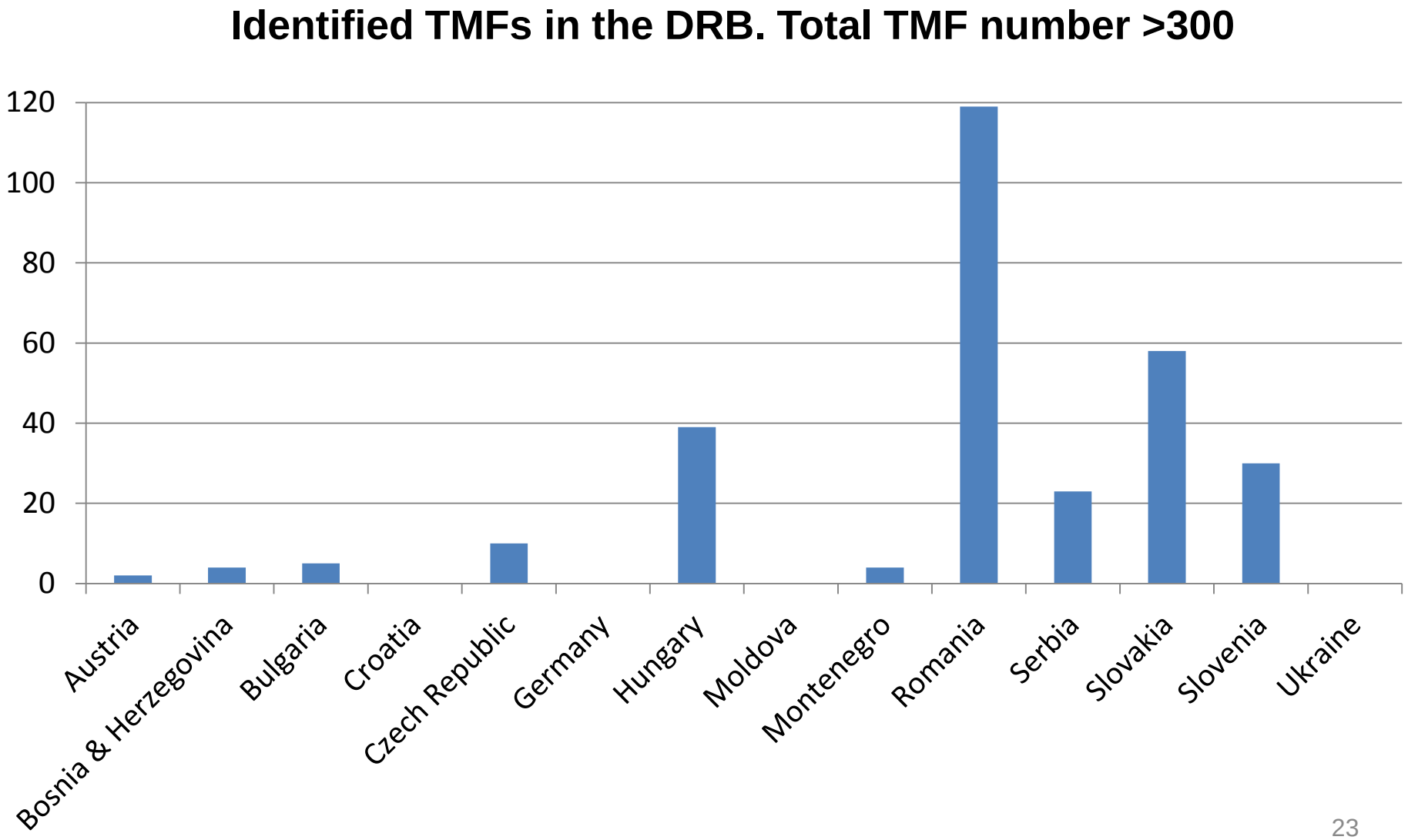
Mapping the TMFs for the participating countries



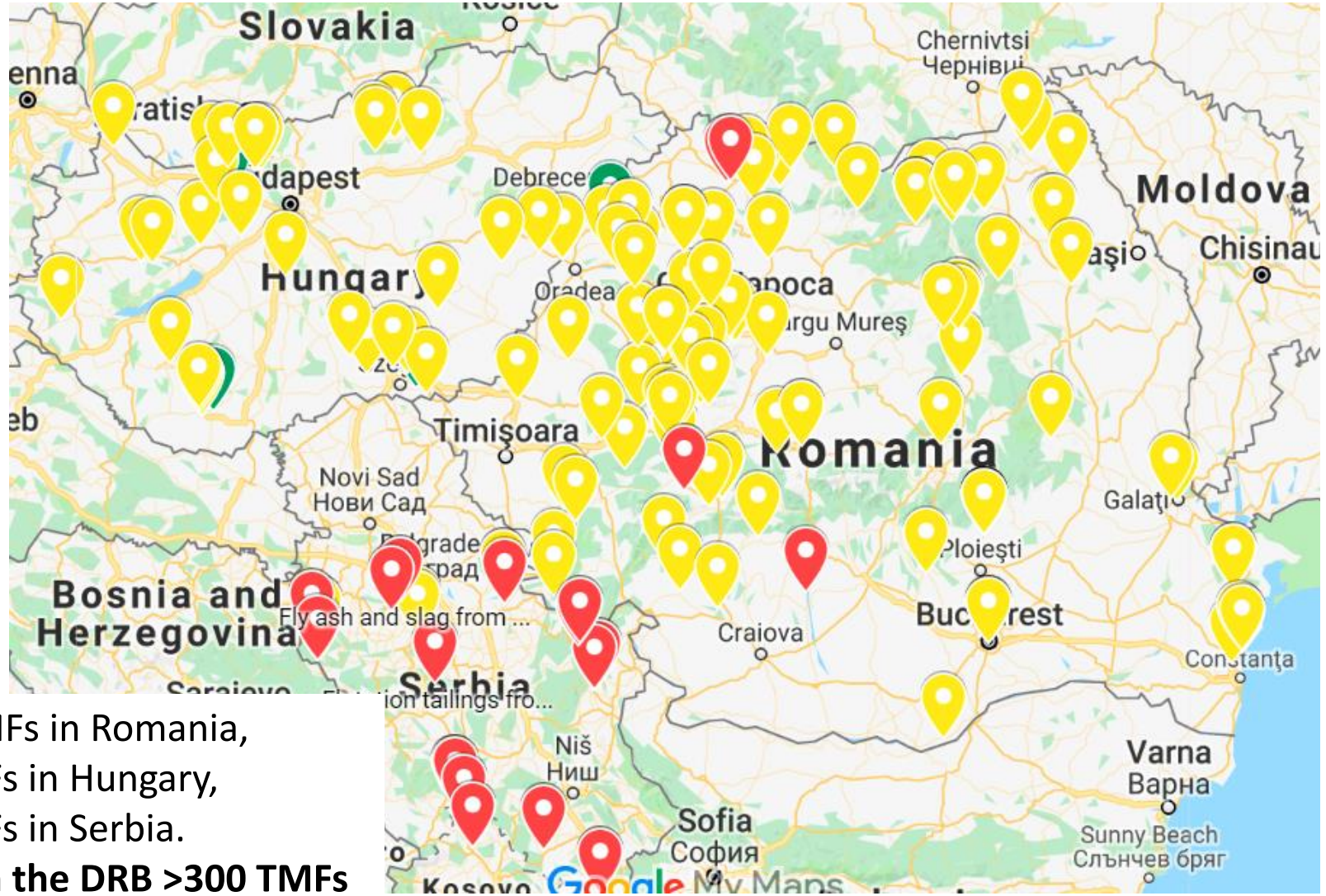
23 TMFs in Armenia,
5 TMFs in Georgia,
16 TMFs in Kyrgyzstan,

THI from ..to	5.5 .. 9.4	9.5 ..13.4	13.5 ..17.5

Fourth project (ICPDR). TMF hot-spot identification in the Danube River Basin (DRB)



On-going TMF hazard identification and TMF mapping in the DRB



119 TMFs in Romania,
39 TMFs in Hungary,
23 TMFs in Serbia.
Total in the DRB >300 TMFs

THI from ..to	5.5 .. 9.4	9.5 ..13.4	13.5 ..17.5

Strengthen the safety of mining operations, in particular tailings management facilities (TMF), in Kazakhstan and beyond in Central Asia (UNECE)

Project objectives

- Training at a TMF site to apply the Checklist (to be held in 2019)
- The national TMF database (under construction)

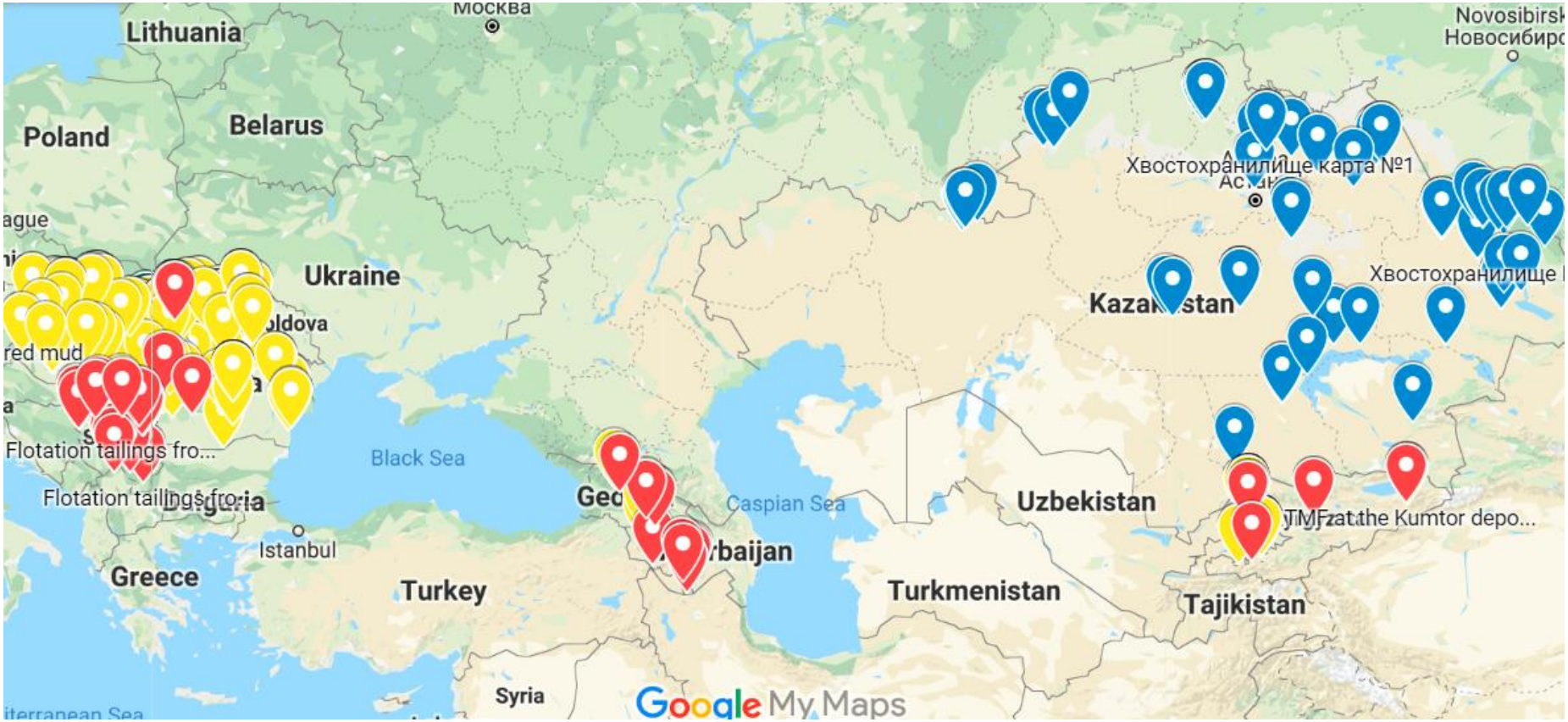
Currently identified

76 TMFs in Kazakhstan,

16 TMFs in Kyrgyzstan.

TMF mapping in the UNECE region
(under development)

- **Tailings Hazard Index (THI) and TMF mapping are powerful tools to prioritize their environment hazard and improvement interventions at national and regional levels.**
- **One of the objectives is to create the THI-based map of TMFs in the UNECE region.**



THI from ..to	5.5 .. 9.4	9.5 ..13.4	13.5 ..17.5	To be identified

Outlook for further developments

1. Identification and prioritization of TMFs in UNECE countries
2. Development of a methodology for land-use planning
3. Development of a methodology for contingency planning

Thank you for your attention!

Learn more about the TMF Methodology and project activities on our websites

http://science.nmu.org.ua/en/conferences/grant-of-german-environment-agency/

http://ecopeace.am

Activities in these projects were funded by the German Federal Environment Ministry's Advisory Assistance Programme (AAP) for environmental protection in the countries of Central and Eastern Europe, the Caucasus and Central Asia and other countries neighbouring the European Union. It is supervised by the German Environment Agency (UBA).