DOKUMENTATIONEN

01/2016

Improving the safety of industrial tailings management facilities based on the example of Ukrainian facilities

For our Environment

Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety

Umwelt Bundesamt

DOKUMENTATIONEN 01/2016

Advisory Assistance Programme (AAP)
of the Federal Ministry for the Environment,
Nature Conservation, Building and Nuclear Safety

Project No. (FKZ) 26206
Report No. (UBA-FB) 002317/ENG

Improving the safety of industrial tailings management facilities based on the example of Ukrainian facilities

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Imprint

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06844 Dessau-Roßlau
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Fax: +49 340-2103-2285
info@umweltbundesamt.de
Internet: www.umweltbundesamt.de/en
www.uba.de/en/advisory-assistance-programme
www.uba.de/en/project-database-advisory-assistance-programme

/umweltbundesamt.de
/umweltbundesamt

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Study completed in:
November 2015

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Publication as pdf:
http://www.umweltbundesamt.de/publikationen/improving-the-safety-of-industrial-tailings

ISSN 2199-6571

Dessau-Roßlau, April 2016

This project was financed 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 EU. It was supervised by the German Environment Agency.

The responsibility for the content of this publication lies with the authors.

Abstract

Within the framework of the Federal Environment Ministry's Advisory Assistance Programme for Environmental Protection in the Countries in Central and Eastern Europe, the Caucasus, Central Asia and other countries neighbouring the EU and on behalf of the German Environment Agency (UBA), the project “Improving the safety of industrial tailings management facilities based on the example of Ukrainian facilities” was implemented.

The failure of tailings management facilities is a major problem worldwide that regularly leads to severe disasters. To address this problem, the United Nations Economic Commission for Europe (UNECE) developed “Safety Guidelines and Good Practices for Tailings Management Facilities” [4].

These comprise recommendations to authorities on the necessary legal basis for issuing permits for the safe operation of tailings management facilities as well as recommendations to operators on their safe design. The UNECE called on the governments of UNECE countries to incorporate the safety guidelines into their national regulations and technical standards and to apply them. In subsequent years it became apparent, however, that the implementation of the safety guidelines poses problems because they set out safety standards only in general terms.

The aim of the project was to overcome the problems in the implementation of the UNECE Safety Guidelines for tailings management facilities and to thus permanently reduce the risk posed by these facilities. The practicality of the project outcomes, a Checklist and a Tailings Hazard Index (THI) was successfully tested at two Ukrainian facilities.

Введение

В рамках Программы консультационной помощи по охране окружающей среды в странах Центральной и Восточной Европы, Кавказа и Центральной Азии с 29-ого сентября по 3-е октября 2014 года, по заказу Федерального ведомства по охране окружающей среды (Umweltbundesamt, UBA) был разработан проект “Повышение безопасности промышленных хвостохранилищ на примере украинских объектов” [2].

Аварии на хвостохранилищах являются большой проблемой во всем мире, которая регулярно приводит к серьезным катастрофам. Для решения этой проблемы Европейская Экономическая Комиссия Организации Объединенных Наций (ЕЭК ООН) в 2009 году разработала «Руководящие принципы обеспечения безопасности и надлежащая практика для хвостохранилищ» [4].

Документ содержит рекомендации для представителей власти о необходимой законодательной базе для выдачи разрешений для обеспечения безопасной эксплуатации хвостохранилищ, а также рекомендации операторам по их безопасному проектированию. ЕЭК ООН призывает правительства стран-членов внедрять эти руководящие принципы по безопасности в национальные требования и технические стандарты, а также применять их на практике. Однако в последующие годы стало очевидно, что внедрение руководящих принципов является проблематичным из-за того, что они устанавливают стандарты только в общих чертах.

Цель проекта заключается в преодоление проблем внедрения Руководящих принципов обеспечения безопасности хвостохранилищ ЕЭК ООН, и таким образом, уменьшение риска, создаваемого такими объектами. Результаты проекта проверены на практике на двух украинских хвостохранилищах.

Kurzbeschreibung

Im Rahmen des Beratungshilfeprogramms (BHP) des BMUB für den Umweltschutz in den Staaten Mittel- und Osteuropas, des Kaukasus und Zentralasiens sowie weiteren an die EU angrenzenden Staaten und im Namen des Umweltbundesamts wurde das Projekt “Verbesserung der Sicherheit industrieller Rückhaltebecken am Beispiel ukrainischer Anlagen” durchgeführt.

Das Versagen industrieller Rückhaltebecken ist weltweit ein enormes Problem, das regelmäßig zu großen Katastrophen führt. Um diese Problematik anzugehen, wurden durch die United Nations Economic Commission for Europe der Vereinten Nationen (UNECE) bereits im Jahre 2009 „Sicherheitsleitlinien für den Betrieb von Rückhaltebecken“ erarbeitet. Sie beinhalten sowohl Empfehlungen an die Behörden hinsichtlich der erforderlichen rechtlichen Grundlagen zur Erteilung von Erlaubnissen zum sicheren Betrieb industrieller Rückhaltebecken, als auch Empfehlungen an die Betreiber zur sicherheitstechnischen Ausgestaltung von industriellen Rückhaltebecken.

Die UNECE rief die Regierungen der UNECE-Länder und die Betreiber auf, die Sicherheitsleitlinien in die nationalen Regelwerke und technischen Standards aufzunehmen und anzuwenden. In den Folgejahren stellte sich jedoch heraus, dass die Umsetzung der Sicherheitsleitlinien mit Schwierigkeiten verbunden ist, da in den Leitlinien die Sicherheitsstandards lediglich allgemein umrissen werden.

Mit den Projektergebnissen, einer nutzerfreundlichen Checkliste sowie eines Tailing Hazard Index (THI) liegen nun zwei Werkzeuge vor, die Anlagenbetreibern und zuständigen Behörden eine klare, vergleichbare und einfach durchführbare Bewertung des Sicherheitszustandes industrieller Rückhaltebecken erlaubt. Damit sollen die Probleme bei der Umsetzung der UNECE-Sicherheitsleitlinien für industrielle Rückhaltebecken behoben und daran anknüpfend das von diesen Anlagen ausgehende Risiko nachhaltig gesenkt werden. Die Praxistauglichkeit der Projektergebnisse wurde in zwei ukrainischen Anlagen getestet.

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List of Abbreviations

BAT	Best available technologies
CRS	Closure and rehabilitation strategy
DSC	Dam and screens
EIA	Environmental Impact Assessment
EMP	Emergency Plan
GCR	Geological, climate, and terrain risks
INR	Facility inspection, documenting and reporting
MON	Monitoring
STC	Substances (Tailings Capacity, Toxicity)
TDP	TMF Deposition Plan
THI	Tailings Hazard Index
TMF	Tailings Management Facility
TMFs	Tailings Management Facilities
TRI	Transportation and infrastructure
TRP	Trainings and personnel
UNECE	United Nations Economic Commission for Europe
WTM	Water management

Summary

I. Background

Since the early 1990s the United Nations Economic Commission for Europe (UNECE) has committed itself to the prevention of, preparedness for and response to industrial accidents, especially those with transboundary effects in its region. The 1992 UNECE Convention on the Transboundary Effects of Industrial Accidents helps protect human beings and the environment against such accidents by preventing them as far as possible, by reducing their frequency and severity and by mitigating their effects. Issues related to the prevention of accidental water pollution are addressed in close cooperation with the 1992 Convention on the Protection and Use of Transboundary Watercourses and International Lakes.

Industrial accidents at Tailings Management Facilities (TMFs) may indeed lead to accidental water pollution. TMFs store large amounts of mining waste, which are generated as a by-product when extracting minerals. As such, they can pose serious threats to humans and the environment, especially in case of their improper design, handling or management. Thus, a failure may result in uncontrolled spills of tailings, dangerous flow-slides or the release of hazardous substances, leading to major environmental catastrophes. The devastating effects on humans and the environment of such incidents as well as their farreaching and severe transboundary consequences have been demonstrated by major past accidents in the UNECE region, such as the dam break of a tailings pond at a mining facility in Baia Mare, Romania, in 2000 and, more recently, the aluminium sludge spill in Kolontar, Hungary, in 2010 or the 2012 accident at the Talvivaara Mining Company in Finland.

The effective and safe disposal of mining wastes presents technical and environmental challenges. Each facility is unique, so a tailor-made and sound approach is needed to ensure that the TMF is safe, environmentally sound and economical. Although TMFs are operated with increasing care in many UNECE countries, the safety of their operations and their afterlife needs further improvement. This should also be seen in the light of the challenges posed by climate change, which may increase the probability of industrial accidents caused by natural disasters, such as earthquakes and flooding that pose a major risk to TMFs.

As a consequence of these accidents, for example the International Commission for the Protection of the Danube River (ICPDR) urged for measures to improve the safety of tailings management facilities. The by far highest risk potential of retention reservoirs was determined in the Danube countries Ukraine, Romania and Hungary. Furthermore, an UNEP expert group assessed the problems of retention reservoirs in Ukraine, near the town of Kalush, to be exceptionally critical because of the significant dam failure risk posed by snowmelt and heavy spring rains. In addition, the problems in Ukraine are not only limited to the Danube basin (Carpathian region): There are also giant retention reservoirs in the Dnieper River Basin (Dnipropetrovsk region), and they pose an enormous threat to the entire Black Sea region. An accident in the Ukrainian city Nikolayev in January 2011 illustrated another potential danger of retention reservoirs: Due to a long period of drought, the reservoirs of an aluminium

plant (see Kolontar, Hungary) dried out. Strong winds led to the deposition of residues that were stirred up and extensively contaminated the environment and ground water in the vicinity.

II. UNECE Strategy

Based on these findings the United Nations Economic Commission for Europe (UNECE) started a joint activity between the "Industrial Accident"- and "Water"-Convention to develop tools for improving the safety of TMF. As a result in 2008/9 *Safety guidelines and good practices for tailings management facilities* [4] were published. The UNECE safety guidelines include both recommendations to UNECE countries and authorities on the necessary legal basis for issuing permits for the safe operation of tailings management facilities as well as recommendations to operator on the safe design of tailings management facilities. UNECE called on the governments of UNECE countries and on TMF operators to include the safety guidelines in the national regulations and technical standards and to apply them. In the subsequent years, it emerged however that the implementation of the safety guidelines was fraught with difficulties.

As a consequence the 7th CoP to the "Industrial Accident"-Convention pointed out the need for an additional tool to support the implementation of the Guidelines in the UNECE member countries: a user-friendly checklist combined with a catalogue of measures is developed to facilitate the implementation of the UNECE safety guidelines.

This activity was supported by the German Environment Agency and by request of the Ukrainian Ministry of the Environment the practical approach was carried out in Ukraine.

The practical implementation was done within the project "Improving the safety of tailings management facilities (TMF) in Ukraine" [2] by IHPA, Denmark and Ecoaudit, Ukraine, funded and supervised by the German Environment Agency (Umweltbundesamt, UBA).

III. Project

The aim of the project was to overcome the problems in the implementation of the UNECE Safety Guidelines for tailings management facilities [4] and to thus permanently reduce the risk posed by these facilities. The practicality of the project outcomes was tested at two Ukrainian facilities.

Following a fundamental analysis of the legal framework with respect to tailings management facilities in Ukraine, a checklist was developed which can be used by inspectors and operators of tailings management facilities to identify safety shortcomings of these facilities and to derive short-, medium- and long-term measures to address those deficiencies.

The checklist was developed in consultation with the current international expertise in this area and was based in particular on a catalogue of measures prepared on the basis of international standards.

The TMF Methodology includes the evaluation of the tailings hazards for large numbers of TMFs at national level, the overall and detailed evaluation of the TMF safety level and the prescription of protective and preventive measures based on BAT (Measure Catalogue).

The developed TMF Checklist is based on the *test-question-method*, which implies answering the questions especially selected by expert judgement to identify the main problems of the current case and come to the best available and suitable solutions.

The advantages of the developed TMF Methodology are that

- all Methodology users (competent authorities, inspectors and operators) comply with the same inspection procedure;
- TMF operators can detect non-compliances with a minimum set of the safety requirements at the TMF prior to check and start getting them fixed in advance,
- all Methodology users work with the same Measure Catalogue that has compiled the best available technologies in sustainable mining.

The practicality of this checklist was tested in cooperation with inspectors and operators by applying it to two selected Ukrainian facilities. After completion of the practical test, the checklist is intended to be available for use in the entire UNECE region.

Furthermore a method for evaluating “Tailing Hazard/Risk Index” (THI) was developed. This method is intended for the use by competent state authorities in order to create an overview of potential hazards/risks posed by TMF or a large number of TMFs as hazardous facilities by analysis of a few critical parameters. Taking into account limited financial and institutional capacities the evaluation results can be used for decision makers on the national level or regional authorities responsible for environmental safety to plan investigation and measures efficiently for the potentially most hazardous objects.

As a result of the application of the method 15 potentially most hazardous objects have been identified from 153 TMFs in Ukraine. This result was mapped and presented by project managers as a part of slideshow on the Conference of the Parties to the UNECE Convention on the Transboundary Effects of Industrial Accidents in Geneva, 3-5 December 2014 [1].

For applying the TMF Methodology in a proper way detailed instruction manual for users was developed. This document includes explanations for all aspects of the Methodology from the rules of safety level evaluation to the site visit procedure and template for making the report.

On a general level also training moduls were elaborated to support the implementation of the Methodology in other countries facing comparable problems.

The final version of the TMF Methodology was agreed with the participants of an UNECE Workshop to the results of the project in Kyiv, 19 – 20 of May 2015, and approved by German Environment Agency in September 2015.

Both UNECE and the German Environment Agency encouraged Parties and other UNECE member States to disseminate the TMF Methodology for use by the appropriate authorities. Competent authorities, TMF operators, and the public are invited to apply this Methodology, which is intended to contribute to limiting the number of accidents at tailings management facilities and the severity of their consequences for human health and the environment.

IV. Resulting documents:

1. Methodology for TMF safety improving including:

- TMF Checklist (MS Word and MS Excel formats, with explanation and examples). The checklist makes it possible in a short time to determine the degree of TMF conformity to the European and national safety requirements of such objects;
- The method of evaluation "Tailings Hazard/risk Index" (MS Word and MS Excel formats, with explanation and examples). This method can be applied for a big amount of the TMFs and prioriticise such objects for the further actions in contry/region safety improvement. Special form in Excel helps to make this evaluation quickly and graphically;
- Educational course in Methodology, which represents the productive way to familiarize professionals effectively with the principles and approaches of the methodology, features of its application in practice, working with spreadsheets and processing of the results of calculations.

2. Analysis of Ukrainian legislation and administrative situation on TMF. This document showed all points of discordance between Ukraininan and European laws and rules in this field and can be a starting point of harmonization of the Ukraininan legislation with the legislation of the EU.

3. Ukrainian TMFs database including:

- THI ranking of TMFs
- TMFs mapping.

The database is a unique document with information from different sources and geographical coordinates of the each object. Therefore it was possible to create an up-to-date map of all Ukraininan TMFs and detect the most vulnerable regions in the country. This experience can be repeated for any region in the world.

Zusammenfassung

I. Hintergrund

Seit dem Anfang der 1990er Jahre, hat sich die United Nations Economic Commission for Europe (UNECE) zu der Prävention und Bekämpfung von Industrieunfällen, insbesondere solche mit grenzüberschreitenden Auswirkungen, in seiner Region verpflichtet.

Ein Hauptaugenmerk liegt dabei mittlerweile auf möglichen Unfällen bei industriellen Rückhaltebecken. Industrielle Rückhaltebecken (Tailings Management Facilities (TMFs)) beinhalten große Mengen von Abfällen, welche als Nebenprodukt aus der industriellen Erzaufbereitung entstehen.

Ein Dammbruch solcher Becken und die damit verbundene unkontrollierte Freisetzung der Rückstände führen regelmäßig zu weitreichenden und schwerwiegenden ökologischen und wirtschaftlichen Katastrophen. Beispiele dafür sind der Deichbruch der Rückhaltebecken bei der Goldaufbereitung in Baia Mare und Baia Borsa in Rumänien, im Jahr 2000 und in jüngerer Zeit, die Aluminiumschlammkatastrophe in Kolontar, Ungarn, im Jahr 2010 oder der Unfall 2012 in der Talvivaara, Finnland.

Jede Anlage ist einzigartig. Deshalb ist ein maßgeschneiderter und vernünftiger Ansatz notwendig, um sicherzustellen, dass Rückhaltebecken sicher, umweltverträglich und wirtschaftlich sind. Obwohl industrielle Rückhaltebecken mittlerweile mit erhöhter Überwachung in vielen UNECE -Ländern betrieben werden, muss ihre Betriebssicherheit weiter verbessert werden. Dies sollte auch vor dem Hintergrund der Herausforderungen durch den Klimawandel erfolgen, da die Wahrscheinlichkeit von Betriebsunfällen durch Naturkatastrophen wie Erdbeben und Überschwemmungen weiter ansteigt.

Auch die Internationale Kommission zum Schutz der Donau (IKSD) fordert Maßnahmen, um die Sicherheit von industriellen Rückhaltebecken zu verbessern. Das mit Abstand höchste Risikopotenzial von Rückhaltebecken im Donau-Flusseinzugsgebiet wurde dabei z.B. in den Donauländern Ukraine, Rumänien und Ungarn festgestellt. In der Ukraine beurteilte eine UNEP-Expertengruppe die Probleme der Rückhaltebecken in der Nähe der Stadt Kalush als außergewöhnlich kritisch wegen seiner erheblichen Dammbruchgefahr durch Schneeschmelze und starke Frühjahrsregen. Die Probleme in der Ukraine sind dabei nicht nur auf das Donaueinzugsgebiet, (Karpaten-Region)begrenzt. Auch im Dnjepreinzugsgebiet sind riesige Rückhaltebecken (Dnipropetrovsk- Region) vorhanden und stellen eine enorme Bedrohung der gesamten Schwarzmeer-Region da. Ein Unfall in der ukrainischen Stadt Nikolayev im Januar 2011, verdeutlichte ein zusätzliches Gefahrenpotential von Rückhaltebecken: Aufgrund einer langen Dürreperiode, trockneten die Rückhaltebecken eines Aluminiumwerks (vgl. Kolontar, Ungarn) aus. Starke Winde führten dazu, dass die abgelagerten Rückstände aufgewirbelt wurden, und großflächig die Umwelt und das Grundwasser im Umkreis kontaminierten.

II. UNECE-Strategie

Aufbauend auf diesen Erkenntnissen, begann die UNECE eine gemeinsame Aktivität zwischen den Konventionen für Industrieunfälle und Wasser zu etablieren, um gemeinsame Instrumente zur Verbesserung der Sicherheit von Rückhaltebecken zu entwickeln. Als Ergebnis, wurden in 2008/9 UNECE-Sicherheitsleitlinien für industrielle Rückhaltebecken [4] veröffentlicht. Diese beinhalten sowohl Empfehlungen an UNECE Länder und Behörden hinsichtlich der erforderlichen rechtlichen Grundlagen zur Erteilung von Genehmigungen zum sicheren Betrieb industrieller Rückhaltebecken, als auch Empfehlungen an die Betreiber zur sicherheitstechnischen Ausgestaltung von industriellen Rückhaltebecken. Die UNECE rief die Regierungen der UNECE-Länder sowie die Betreiber von Bergbauunternehmen dazu auf, die Sicherheitsleitlinien in die nationalen Regelwerke und technischen Standards aufzunehmen und anzuwenden. In den Folgejahren stellte sich jedoch heraus, dass die Umsetzung der Sicherheitsleitlinien mit Schwierigkeiten verbunden war.

Im Zuge der 7. Vertragsstaatenkonferenz zur Industrieunfallkonvention wies die UNECE auf die Notwendigkeit für ein zusätzliches Instrument hin, um die Umsetzung der Leitlinien in den UNECE-Mitgliedsländer zu unterstützen: eine benutzerfreundliche Checkliste zusammen mit einem Katalog von Maßnahmen sollte die Umsetzung der UNECE-Sicherheitsleitlinien für Betreiber und für die zuständigen Behörden erleichtern.

Diese Aufgabe wurde von Deutschland unterstützt. Auf Antrag des ukrainischen Umweltministeriums, sollte die Ausarbeitung der Checkliste und des Maßnahmenkataloges anhand praktischer Beispiele in der Ukraine erfolgen. Die konkrete Umsetzung erfolgte dann im Rahmen des Beratungshilfeprogramms des BMUB im Projekt "Verbesserung der Sicherheit von industriellen Rückhaltebecken (TMF) in der Ukraine“ [2].

III. Vorhaben

Das Ziel des Projektes war es, die Probleme bei der Umsetzung der UNECE-Sicherheitsleitlinien für industrielle Rückhaltebecken zu beheben, um das von diesen Einrichtungen ausgehende Risiko dauerhaft zu reduzieren. Die Praxistauglichkeit der Projektergebnisse wurde an zwei ukrainischen Einrichtungen getestet.

Im Anschluss an eine grundlegende Analyse der rechtlichen Rahmenbedingungen in Bezug auf die industriellen Rückhaltebecken in der Ukraine, wurde eine Checkliste entwickelt, die von Inspektoren und Betreibern von industriellen Rückhaltebecken angewendet werden kann um Sicherheitsmängel dieser Anlagen zu identifizieren und um kurz-, mittel- und langfristigen Maßnahmen zur Behebung dieser Mängel abzuleiten.

Die Checkliste wurde in Absprache mit anerkannten internationalen Experten in diesem Bereich entwickelt und integriert einen Maßnahmenkatalog, der auf der Grundlage internationaler Standards erstellt wurde.

Die entwickelte Checkliste beruht auf einem Fragebogen. Dieser führt den anwendenden Experten durch iterative Fragen, die speziell die bekannten sicherheitstechnischen Hauptprobleme des vorliegenden Falles abprüft, um damit im Idealfall zu den besten verfügbaren und geeigneten Lösungen zu gelangen.

Die Vorteile der entwickelten TMF Methodik sind:

- alle Benutzer der Methodik (zuständigen Behörden, Inspektoren und Betreiber) können die gleiche Kontrollprozedur einhalten;
- TMF Betreiber können schon sehr früh sicherheitstechnische Defizite am unterscuhten Rückhaltebecken erkennen und diese umgehend beheben.
- alle Benutzer der Methodik arbeiten mit dem gleichen Maßnahmenkatalog, in welchem Beispiele für die besten verfügbaren Technologien zusammengestellt sind.

Die Praxistauglichkeit dieser Checkliste wurde in Zusammenarbeit mit Inspektoren und Betreibern durch Anwendung auf zwei ukrainische Rückhaltebecken getestet. Nach dem Abschluss des Praxistests in der Ukraine steht die entwickelte Checkliste beispielhaft für den Einsatz in der gesamten UNECE-Region zur Verfügung. Außer der Checkliste wurde darüber hinaus ein Verfahren zur schnellen Gefahren-Bewertung von Rückhaltebecken entwickelt. Dieser sogenannte "Tailing Hazard / Risk-Index" (THI) ermöglicht es, durch die Analyse einiger weniger kritischer Parameter einen Überblick über mögliche Gefahren und Risiken einer großen Anzahl von Rückhaltebecken zu bekommen. Unter Berücksichtigung der begrenzten finanziellen und institutionellen Kapazitäten in vielen Ländern der UNECE-Region können die Bewertungsergebnisse für die Entscheidungsträger auf nationaler Ebene oder für die auf Landesebene zuständigen Umweltsicherheitsbehörden genutzt werden, um die verfügbaren Resourcen effektiv auf die potentiell gefährlichsten Objekte zu konzentrieren.

Als ein Ergebnis der Anwendung des Verfahrens sind 15 der potentiell gefährlichsten Objekte aus 153 Rückhaltebechen in der Ukraine identifiziert worden. Dieses Ergebnis wurde kartiert und auf der Konferenz der Vertragsparteien des UNECE-Übereinkommens über die grenzüberschreitenden Auswirkungen von Industrieunfällen, in Genf, am 3-5 Dezember 2014 [1] vorgestellt.

Um die TMF-Methodik richtig anzuwenden, wurde eine ausführliche Bedienungsanleitung für Nutzer entwickelt. Dieses Dokument enthält Erläuterungen zu allen Aspekten der Methodik: von den Regeln der Bewertung der Sicherheitseinstufung bis zum Verlauf des vor Ort Besuches und den Berichtsvorlagen.

Auf einer allgemeinen Ebene wurden auch Ausbildungsmodule erarbeitet, um die Umsetzung der Methodik in anderen Ländern, die vor vergleichbaren Problemen stehen, zu unterstützen.

Im Rahmen der 8. Vertragsstaatenkonferenz zur UNECE „Industrieunfall“-Konvention wurde die erarbeitete Methodik gewürdigt und die Mitgliedsländer aufgefordert mit diesem Werkzeug das Sicherheitsniveau ihrer Rückhaltebecken entsprechend zu verbessern.

IV. Resultierende Dokumente:

1. Methodik zur Verbesserung der TMF Sicherheit, einschließlich:

- Checkliste TMF (MS Word und MS Excel-Formate, mit Erläuterungen und Beispielen). Die Checkliste macht es in kurzer Zeit möglich, den Grad der TMF-Konformität mit den europäischen und nationalen Sicherheitsanforderungen zu bestimmen;
- der Beurteilungsmethode "Tailings Hazard/Risk-Index" (MS Word und MS Excel-Formate, mit Erläuterungen und Beispielen). Dieses Verfahren kann für eine große Zahl der TMFs angewendet werden und priorisiert Objekte, für die weitere Maßnahmen zur Verbesserung der Sicherheit umgehend notwendig sind. Ein Sonderformat in Excel unterstützt eine schnelle Auswertung und die grafische Darstellung
- Einführung in die Methodik. Diese macht Fachkräfte effektiv mit den Prinzipien und Ansätzen der Methodik vertraut und erklärt verständlich ihre Praxisanwendung, die Arbeit mit Spreadsheets und die Verarbeitung der Ergebnisse von Berechnungen.

2. Analyse der rechtlichen Rahmenbedingungen in Bezug auf industrielle Rückhaltebecken in der Ukraine. Dieses Dokument gibt einen Überblick über die Abweichungen zwischen ukrainischen und europäischen Gesetzen und Regeln in diesem Bereich und kann ein Anfang sein für die Harmonisierung der ukrainischen Gesetzgebung mit den Rechtsvorschriften der EU.

3. Ukrainischen TMFs Datenbank, einschließlich:

- THI-Einstufung der TMFs
- TMFs Kartierung.

Die Datenbank beinhaltet weitreichende Informationen aus verschiedenen Quellen und geografischen Koordinaten des jeweiligen Objekts. Dies ermöglichte die Bereitstellung aktueller Karten aller ukrainischen Rückhaltebecken und hilft dabei die am meisten gefährdeten Regionen des Landes zu identifizieren.

1 Introduction

In order to understand the reasons for the implementation of the project, various cases of disasters and accidents are briefly described in this chapter, so the reader gets acquainted with the importance of the problems in the UNECE region and the needs for the solutions proposed in the project. Then follows a short description of the tasks that had to be completed in the project, and the parties that have implemented the project. The related details can be found in the respective Annexes.

The failure of tailings management facilities (TMF) is a major problem worldwide that regularly leads to severe disasters. To address this problem, the United Nations Economic Commission for Europe (UNECE) comprise recommendations to authorities on the necessary legal basis for issuing permits for the safe operation of tailings management facilities as well as recommendations to operators on their safe design. The UNECE called on the governments of UNECE countries to incorporate the safety guidelines into their national regulations and technical standards and to apply them. In subsequent years it became apparent, however, that the implementation of the safety guidelines poses problems because they set out safety standards only in general terms. The aim of the project is to overcome the problems in the implementation of the UNECE Safety Guidelines for tailings management facilities and to thus permanently reduce the risk posed by these facilities. The practicality of the project outcomes was tested at two Ukrainian facilities.

1.1 Background

In January 2011, in the Ukrainian Nikolaev city at the Nikolaev alumina refinery plant, the tailing had dried up and the wastes were emitted in the form of dry red dust. Soils, atmosphere, ground and surface water and human settlements were contaminated in an area of tens of square kilometers.

Earlier, in 1983, the discharge of potash fertilizers was released in the Dniester at Stebnikovskiy enterprise “Polimineral”. In 2008, due to the dam destruction the poisonous waste products from potash fertilizers tailings (“dead lake”) were dumped in the Dniester at the Kalush chemical enterprise, which caused serious concern of the Government of the Republic of Moldova.

Accidents caused by dam destruction and tailings design defects have repeatedly occurred at enterprises situated in Kryvyy Rih, Dneprodzerzhinsk, Dnepropetrovsk cities. This led and still leads to the contamination with hazardous chemicals in the Dnieper Basin Rivers such as Ingulets, Saksahan and Dnieper itself.

Not only in the Ukraine but also in other eastern European countries such accidents occur. Thus in October, 2010 there was an environmental disaster in Kolontar in Hungay. The cause of the accident was the destruction of a reservoir with toxic waste at the large plant producing aluminum. As a result of this disaster nine people died and large areas of the landscape were contaminated for years with so-called red mud, and the whole Danube basin was contaminated with poisonous substances. This accident is till present the biggest environmental catastrophe in the Danube River Basin.

Serious environmental damage was made to the environment of the Danube River Basin, for instance, due to the dam break of liquid waste storage at gold mining plants in the Romanian cities of

Baia Mare and Baia Borsa about 12 years ago. The analysis, conducted by ICPD, shows that the large tailings at the mining processing plants represent the greatest potential risk in the Danube River Basin. The same applies to the basins of major Ukrainian rivers - the Dnieper, the Dniester, the Danube, and Southern Bug River.

A brief statistics analysis on accidents in tailings demonstrates the need to improve the safe tailings operation through the implementation of this type of project in Ukraine with further transfer of experience to other CIS countries.

The international community has long known about the need to improve the safety of industrial tailings. Specifically the Secretariat of International Commission for the Protection of the Danube River has submitted a proposal “Environmental Safety Danube Strategy Program” to develop a checklist for safety of tailings. Based on the UNECE "Convention on the Transboundary Effects of Industrial Accidents" the UNECE has supported further implementation of “Safety Guidelines and Good Practices for Tailings Management Facilities”, which was proposed by German Environmental Agency in the form of the TMF Methodology.

1.2 Aim and tasks of the Project

The aim of the project was to over-come the problems in the implementation of the UNECE Safety Guidelines and Good Practices for tailings management facilities and to thus permanently reduce the risk posed by these facilities.

The main project tasks, declared in the project concept were:

- to assess the degree of the compliance of Ukrainian legislation and the realization by administrative agencies with requirements of "Safety Guidelines and Good Practices for Tailings Management Facilities" [4], developed by the UNECE;
- to develop the checklist for examinations of the technical safety of specific Tailing Management Facilities;
- to develop technical measures for implementing European standards for the safe operation of Tailings Management Facilities in Ukraine.

Solution of these tasks and successful implementation of this project will contribute to the promotion of sustainable development in Ukraine and other countries.

The project Parties, which have been actively involved during the 2-year period of the project are listed in Annex 4, Tables A 4.1, A 4.2, A 4.3 and A 4.4.

2 Legal assessment „Analysis of the Ukrainian legislation and administrative situation on TMF“

This section describes the key findings and recommendations, which are derived from the analysis of the legal framework. For the full text of the legal assessment „Analysis of the Ukrainian legislation

and administrative situation on TMF“ (including the table of compliance of the legislation of Ukraine with the UNECE TMF Guidelines [1]) refer to the Annex 1.

In order to start the technical works of the project, it was necessary to make first a status of how the present legislation works in Ukraine and then compare it with the specific requirements of the UNECE Guidelines. As the UNECE Guidelines form the basis of the project, it was necessary to make a gap analysis, which helped to make a list of detailed recommendations for the necessary adaptations in the Ukrainian legislation. It made possible the legal base establishing for the full implementation of the UNECE guidelines in the country.

The overall **objective** of the legal assessment for the TMF project was to evaluate the existing legislation of Ukraine on tailings management facilities on its accordance with the UNECE TMF Guidelines. Much attention was devoted to the UNECE Convention on the Transboundary Effects of Industrial Accidents [6] (hereinafter referred as UNECE TEIA Convention), which aims at protecting human beings and the environment against industrial accidents by preventing such accidents as far as possible, by reducing their frequency and severity and by mitigating their effect

The legal assessment methodology comprised of five phases. Each phase have formed a chapter in the final report. The phases are:

Phase 1: Mapping the state of art on the implementation of the Ukrainian legislation.

Phase 2: Comparative analysis of the accordance of the legislation of Ukraine with the requirements to the UNECE TMF Guidelines.

Phase 3: Benchmarking analysis for the implementation of the UNECE TEIA Convention and criteria applied for Ukraine.

Phase 4: State of the accordance of the regulatory acts of Ukraine on tailings management facilities with the recommendations of the UNECE TMF Guidelines.

Phase 5: Conclusions and recommendations.

The assessment is useful in supporting policymakers and representatives of civil society in their efforts to improve environmental management and further promote sustainable development in Ukraine.

2.1 Mapping the state of art of the implementation of the Ukrainian legislation

Key findings

- Ukraine has not yet ratified the UNECE Convention on the Transboundary Effects of Industrial Accidents, although signed it on 21 May 2003.

- It should be noted that there are a large number of legal acts relevant for tailing management facilities in Ukraine. Those Laws have been adopted during different time periods, but are not connected with each other. In addition, each of the Laws mentioned above has its own scope of regulation and objectives (in spite of the environmental focus of all of them). In parallel with the primary legislation, acts of secondary legislation, which include a lot of aspects on the safety management of tailings, were implemented and developed in the recently.
- The level of compliance of the legislation of Ukraine with the requirements of the UNECE TMF Guidelines can be considered as medium since the main safety principles are included into the primary national legal acts, but at the same time they lack technical specifications and implementing measures which result therefore in violation of the principle of legal certainty and real enforcement of the provisions.
- However, the provisions of Ukrainian legislation are in accordance with the provisions of the UNECE TMF Guidelines – de jure, as they have rather declarative character, it is difficult to implement them in practice.
- Therefore, it can be recommended to develop implementing regulations and guidelines, in particular, to amend the State Construction Norms by adding missing practical provisions on the necessary international cooperation and requirements for the training and certification of the personnel of tailings management facilities.
- The legislation of Ukraine should clearly specify that TMF operators have a primary responsibility for ensuring the safety of TMFs and indicate in relevant national laws what would be the responsibility (civil, administrative or criminal) in cases of non-compliances.
- In light of that, following the principles of the UNECE TMF Guidelines, it can be concluded that Ukraine has created a minimum administrative framework for the development, safe operation and decommissioning of the tailings management facilities.

2.2 Comparative analysis of the compliance of the legislation of Ukraine with the requirements of the UNECE TMF guidelines

Key findings

The level of compliance of the legislation of Ukraine with the UNECE TMF Guidelines recommendations for member countries can be assessed as “medium” since more specific legislation is needed in terms of the establishment of a coordinated mechanism between public authorities (considering the multiple numbers of ministries and agencies involved in dealing with the TMFs in Ukraine). Lack of the coordination among the competent authorities and proper administration could undermine the established provisions of the national law. Harmonisation of the legislation of Ukraine with the UNECE TMF Guidelines recommendations for competent authorities is also not fully achieved and can be considered as “medium”. One of the major points is absence of the legal requirement for the external emergency plans designed by the competent authorities together with operators, community groups, local authorities and rescue services. Such plans have to be used in the events of accidents

for the tailings facilities with significant risks to outside communities. Another issue worth mentioning concerns management of closed and abandoned tailings facilities, therefore it is recommended to add the provisions on the assessment of closed, abandoned or orphaned tailings by competent state authorities, as well as on the creation of the inventory of the closed and abandoned tailings management facilities to the of Ukrainian legal requirements. Further, certain specific legal amendments are needed in terms of the management of closed TMFs and in relation to responsibilities of the TMF operators for ensuring the safety of tailings. The level of compliance of the legislation of Ukraine with the UNECE TMF Guidelines recommendations for tailings management facilities operators can be certainly rated as "high". The legislation of Ukraine similarly to the UNECE TMF Guidelines outlines the competences and responsibilities of TMF operators referring to all the necessary requirements for the safety management of tailings. The only recommendation of the TMF Guidelines which has "medium" level of compliance is one for the tailings management facilities operators to implement safety audits for their facilities and to promote the use of environmental management systems based on international standards. However, this is an essential element for ensuring safety.

- As a result, it can be concluded that the overall level of harmonization of the legislation of Ukraine with the recommendations on the UNECE TMF Guidelines can be considered only partly in compliance and therefore "medium" in general. However, the specific competences, responsibilities and obligations of the TMF operators in terms of safety management of tailings are reflected in the legislation of Ukraine similarly to the UNECE TMF Guidelines and fully comply with them.
- Certain modifications into the legislation of Ukraine specifying the obligations and responsibilities of the public authorities and TMF operators for ensuring the safety of tailings have been suggested by the Annexes with Tables, attached to the Legal assessment „Analysis of the Ukrainian legislation and administrative situation on TMF" (Annex 1).
- It is also recommended to highlight in the legislation of Ukraine the importance of trainings and include specific provisions on training the trainers. Creation of the national register of the closed tailings management facilities and proper management of such facilities should be a priority for the competent authorities in Ukraine as without that element the risk remains extremely high. Finally, inclusion of certain practical aspects of international cooperation in the field of prevention of transboundary effects of industrial accidents would be strongly suggested in order to comply with the international requirements.

2.3 Conclusions and recommendations

After the detailed analysis of the Ukrainian legislation on compliance with the main principles and recommendations of the UNECE TMF Guidelines it can be concluded that the overall level of harmonization could be ranked as "medium". Indeed, a lot of progress was made by Ukraine in the past few years; however, full compliance cannot be reported at present. It should be pointed out that the current legislative framework on waste management lacks stimulating measures and the competences of the public authorities often overlap.

There are a number of provisions of the legislation of Ukraine on tailings management facilities, which are identical to and fully respect the principles and recommendations of the UNECE TMF Guidelines. But at the same time, there are certain legal provisions, which require further clarification, specification and amendments in light of the provided recommendations. One of the priorities in Ukraine is the creation of a separate national register of closed, abandoned or orphaned tailings management facilities, and the implementation of Article 5.1.9 of the State Construction Norms (B.2.4- 5:2012) that only properly certified personnel should be engaged in the planning, design, construction, operation/management. Also closure of TMFs and the relevant competences should be described in the operation and management plan, etc.

The following conclusions can be made:

1. There is a large number of the legal acts in Ukraine on tailings management facilities, sometimes with the similar or overlapping scope, which certainly do not align with the principle of 'legal certainty'. It is undisputable that further work on streamlining, transparency and simplification of the legal framework would be required for the effective functioning of the national legal system.
2. The legislation of Ukraine has a fragmented character with a majority of declarative provisions – every law refers to a number of other legal acts, which would not provide a direct answer to a particular query and that leads to confusion about who should apply and enforce these provisions. As a result, it is not surprising that most of the legal norms remain non-operational and their effect is minimal.
3. There is a clear need to harmonize the legislation of Ukraine on tailings management facilities into one single act, according to the UNECE TMF Guidelines and best international and EU practices.
4. Coordination among the competent authorities in charge of the TMF is a challenging task and therefore, creation of a main governmental institution (competent authority) that will be in charge of all issues of safety of the tailings management facilities interlinking with all the engaged governmental bodies could be recommended. This institution should be also responsible for coordination of work of all the main state bodies that have competency regulating the questions of construction, design and reconstruction of the TMF.
5. Ratification of the Convention on Transboundary Effects of Industrial Accidents by Ukraine will contribute to the effective cooperation between the competent authorities of the Parties to the UNECE TEIA Convention in order to protect people and the environment from the effects of industrial accidents in the interest of present and future generations.
6. According to the indicators for self-evaluation of progress achieved in the implementation of the Convention on the Transboundary Effects of Industrial Accidents, Ukraine does not have fully operational legislative mechanism yet and still needs to take actions to address challenges.

List of detailed recommendations based on the assessment conducted:

1. To ratify the UNECE Convention on transboundary effects of industrial accidents. By acceding to the Convention, Ukraine will protect human health and the environment against industrial accidents capable of causing transboundary effects, and prevent such accidents and will promote active international cooperation between the contracting parties before, during and after such accidents.
2. To harmonize the fragmented legislation of Ukraine on tailings management facilities by drafting the separate legislative or by making the necessary amendments to the existing legal acts which would include all the necessary principles and recommendations of the UNECE TMF Guidelines. In particular, further harmonization will be achieved by:

   2.1. Providing in Articles 5.1.5, 5.1.6 of the State Construction Norms (B.2.4-5:2012) that TMF operators have a primary responsibility for ensuring the safety of TMFs;

   2.2. Specifying in Article 5.1.9 of the State Construction Norms (B.2.4- 5:2012) that only properly certified personnel should be engaged in the planning, design, construction, operation/management and closure of TMFs and the relevant competences should be described in the operation and management plan;

   2.3. Adding to the State Construction Norms (B.2.4-5:2012) special provisions on the adequate qualification and certification of the personnel and responsible individuals of the TMF;

   2.4. Supplementing the State Construction Norms (B.2.4-5:2012) by special provisions on the international cooperation in case of industrial accidents for its prevention and eliminating of the effects;

   2.5. Amending the State Construction Norms and taking into account provisions on monitoring of TMFs by its operator;

   2.6. Adding to the State Construction Norms (B.2.4-5:2012) provisions on the need to perform (fire) safety audits for the TMF facilities;

   2.7. Incorporating to the Ukrainian legislation the provisions on implementation of the Aarhus Convention, in line with the results of the round table held on April 23, 2013 in the Ministry of Ecology and Natural Resources of Ukraine;

   2.8. Establishing a coordinating mechanism between the competent state authorities;

   2.9. Creating and maintaining a separate national register of closed, abandoned or orphaned TMFs and require the implementation of a risk assessment to assess possible risks for future accidents and spills;

   2.10. Adding provisions on the development of external emergency plans by relevant state authorities to apply to the tailings management facilities with significant risk in case of accidents to Article 11 of the Law of Ukraine 'On highly hazardous objects';

   2.11. Requiring assessment of closed, abandoned or orphaned TMFs by competent state authorities, by the State Construction Norms;

2.12. Supplementing the legislation of Ukraine provisions on the need for competent authorities to make plans for risk reduction measures and/or monitoring for closed, abandoned or orphaned TMFs;

2.13. It is also recommended to highlight in the legislation of Ukraine the importance of trainings and include specific provisions on training the trainers.

3. To identify the responsible governmental body for monitoring and coordination of work of all the public authorities in charge of the safety, construction, design and reconstruction of the TMFs. Such a role of the Authorized body could be played by the Ministry of Ecology and Natural Resources – coordinating the work of all the other governmental institutions dealing with the questions of construction, design, reconstruction and safety of the TMFs. To that effect, special powers and functions of this body should be envisaged in the Regulation on the Ministry of Ecology and Natural Resources, approved by the decree of the President of Ukraine.

3 Methodology for improving TMF safety

This chapter contains the largest section of this Report on the main works of this project. Here are the elements of the TMF methodology explained. One of the biggest achievements and advantages of this method is the development of an intelligent and simple tool the socalled “Tailings Hazard/risk Index” that competent authorities can use to obtain a very fast overview of potential hazards/risks of a TMF but especially of large numbers of TMFs as hazardous facilities by analyzing only a few critical parameters. The important advantage is also that this evaluation can be done within a short period based on the available documentation. Examples of mapping of Ukrainian’s15 most hazardous/risky TMF locations, taken from a Ukrainian database consisting of 153 TMF locations, using this index are shown in this chapter and make it clear how powerful and simple the application of this instrument is. Other explanations about the TMF Checklist, include definitions, objectives, the evaluation system, the evaluation matrix and the measure catalogue. This measure catalogue includes selected measures that are based on the activities necessary to maintain the safety of TMFs, which are adopted by national and international documents.

TMF Methodology structure

The developed TMF Methodology (Annex 2) includes the method of evaluation of the tailings hazard/risk index for large amounts of the TMFs at national level; the overall and detailed evaluation of the TMF safety level, prescription of protective and preventive measures based on the best available technologies (BAT), implement them as common practice.

The developed TMF Checklist is based on the test question method, which implies answering the questions that are specially selected to identify the main problems of the studied case and come to the best available and suitable powerful solutions.

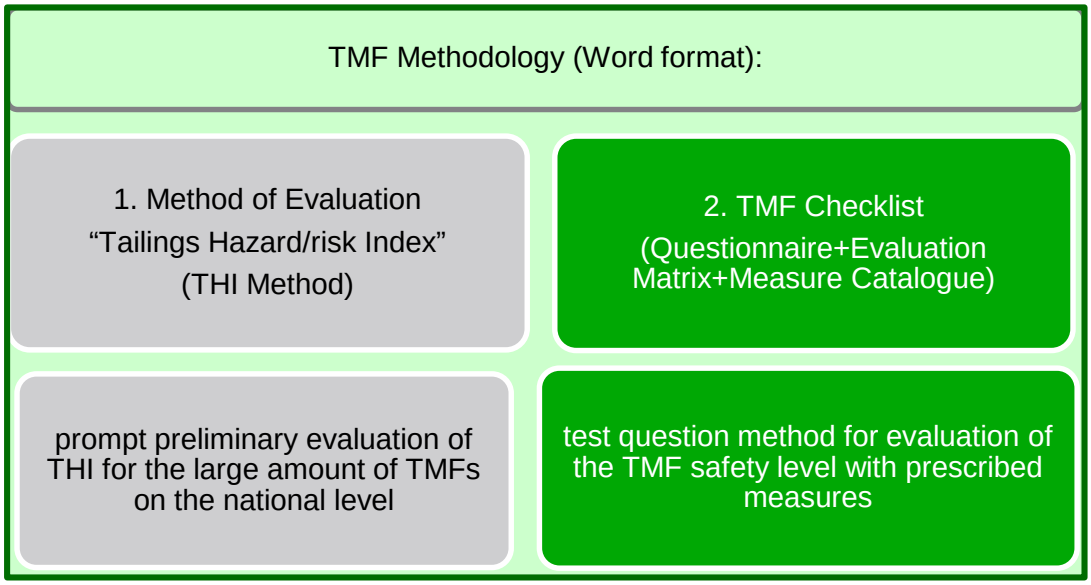
The TMF Methodology includes the following elements:

1. The Method of evaluation of Tailings Hazard/risk Index (THI Method) (Annex 2, Chapter 2 of the Methodology).
2. The TMF Checklist (Annex 2, Chapter 3 of the Methodology), which includes:

- The Questionnaire (3 groups of questions) (Annex 2, Chapter 3.1).
- The Evaluation Matrix (for the TMF safety level) (Annex 2, Chapter 3.2).
- The Measure Catalogue (for taking actions to improve TMF safety) (Annex 2, Chapter 3.3).

Figure 1 pictured main parts of the TMF Methodology with their short descriptions.

Figure 1: TMF Methodology short structure



The THI Method and the TMF Checklist for the practical application are available in Excel format, which facilitate its use due to automatic calculation. The Excel files are developed in form of the templates that are "Annex 13. Template for calc tailings hazard index_THI method.xls" (Annex 13) and "Annex. 14. Template for calc TMF safety_TMF Checklist method.xls") (Annex 14) with the first sheet with explanations how to use this template. Excel files you can obtain by request from UBA, contact information for request: Mr. Gerhard Winkelmann-Oei, email: gerhard.winkelmann-oei@uba.de.

3.1 Method of the evaluation THI

3.1.1 Description of the THI method

Tailings Hazard/risk Index (THI method) is intended for the use by state competent authorities in order to create an overview of potential hazards/risks posed by TMF or a large number of TMFs as hazardous facilities by analysis of a few critical parameters only. The THI evaluation can be performed

based on the documentation available within a short period. The evaluation results can also be used for making decision makers at the state competent authorities responsible for environmental safety to plan investigations and measures for the potentially most hazardous objects. In the first instance, the THI has to be applied to a large number of TMFs on the national level.

The THI method is used for:

- creation and/or update of the country's Catalogue of TMFs
- ranking of all country's TMFs under the index of their hazard/risk
- identification of the most dangerous TMFs (the TMFs of highest concern) in the country
- optimization of limited available financial and institutional resources to improve safety at TMFs.

The THI is the index that demonstrates the order of magnitude of specific hazards/risks posed by tailings facilities to the environment, infrastructure, and humans. The THI is calculated by summing up the major TMF parameters that significantly effect on the level of its safety. These are:

- volume of tailings
- toxicity of substances in tailings
- TMF management status
- natural conditions (geological, seismological, and hydrological conditions) specific to the TMF site
- and dam safety.

Tailings Hazard/risk Index can be calculated in two ways depending on the availability of data on TMFs:

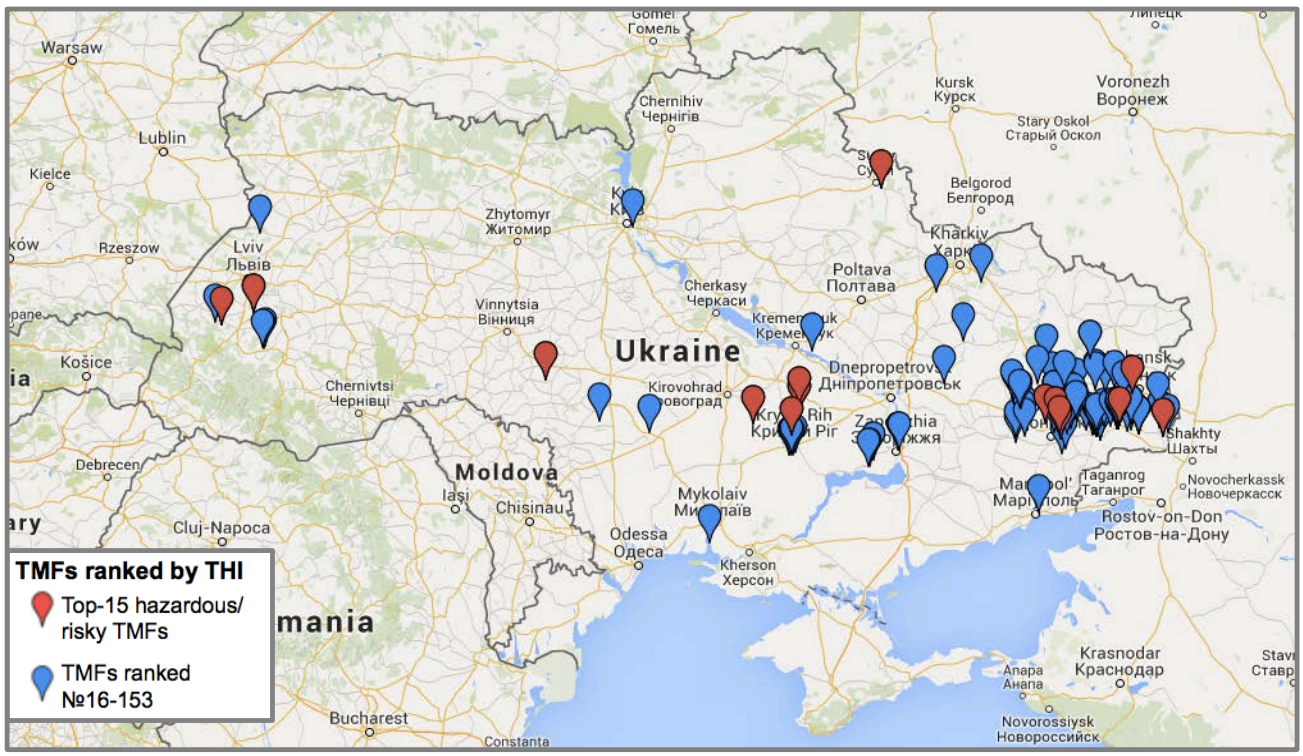
1. Basic THI is a simple calculation approach by using the data on two major parameters which are volume and toxicity of tailings material;
2. Extended THI is a detailed approach by using the data on two major parameters of Basic THI and additionally three other parameters clarifying TMF status, natural conditions and dam safety.

3.1.2 Ukrainian TMFs database

The practical application of the THI method for a large amount of objects was conducted on the example of the Ukrainian TMFs. As a result, the ranking of all country's TMFs under the index of their hazard/risk was obtained and the potentially most dangerous TMFs were identified (see Figures 1 – 3).

Figure 2 demonstrates the disposition of all Ukrainian TMFs at the territory of the country (by Basic way of the THI evaluation). Red signs show the most hazardous/risky object, which make it easy to understand whole national situation of the TMF safety level and most loaded areas.

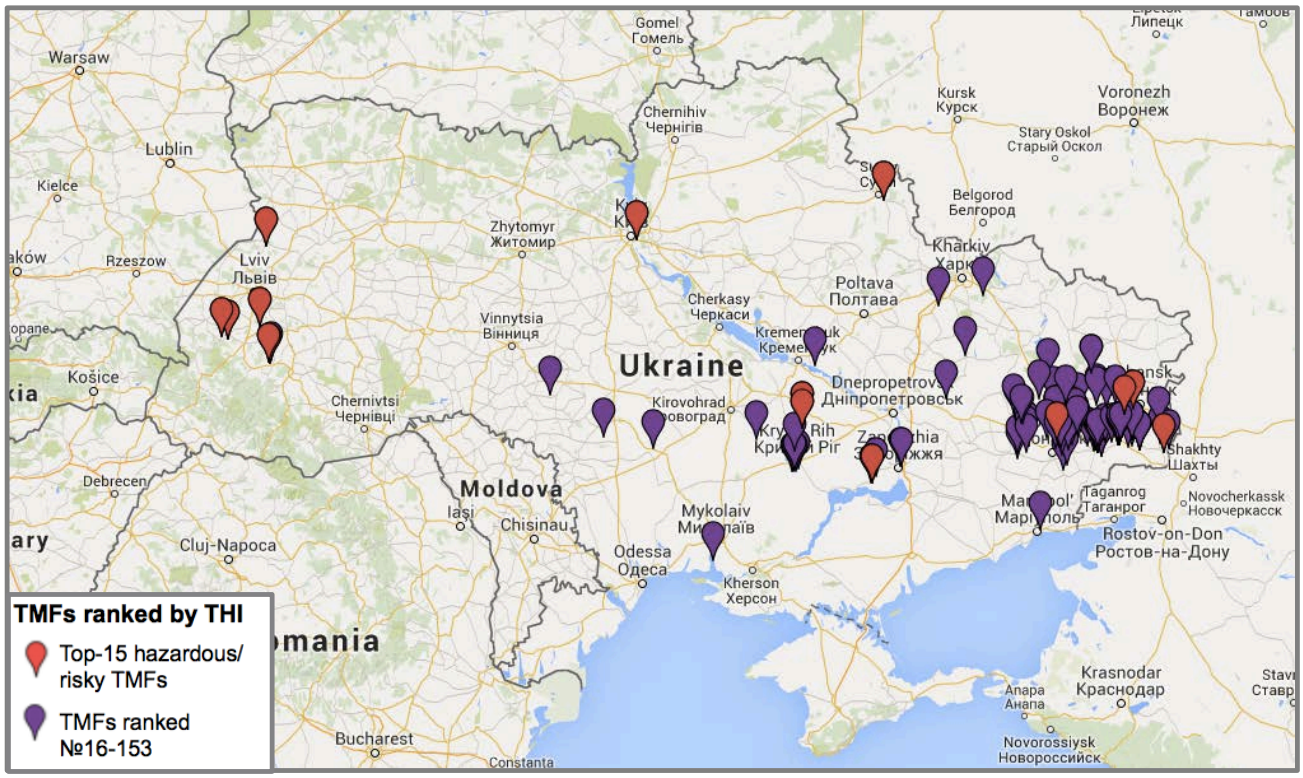
Figure 2: Ukrainian TMFs location map, THI_basic (153 items)



Created with ©google my maps, data source: Research Institute of Micrographs, State Archival Service of Ukraine

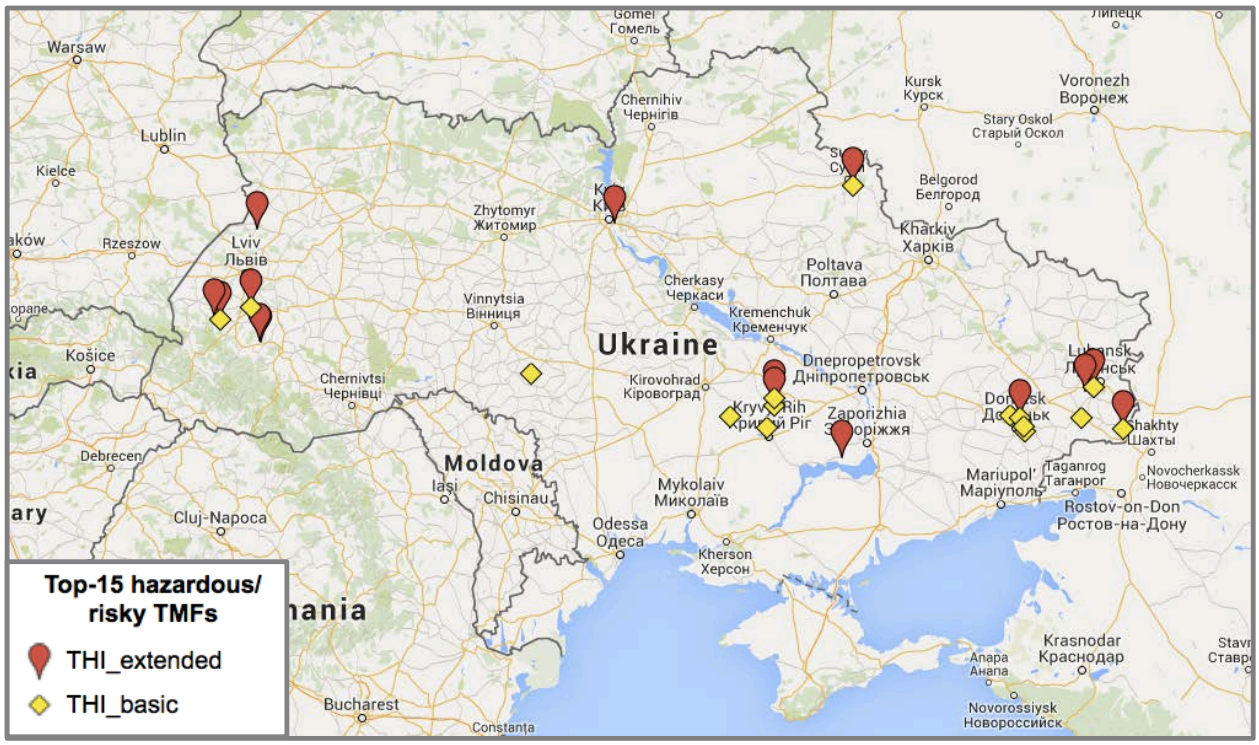
Figure 3 shows the same evaluation but by Extended way of THI calculation. Comparison the Figure 2 and Figure 3 shown on the Figure 4 and allows to see the difference, caused of more exact information of the TMFs in the second way of calculation.

Figure 3: Ukrainian TMFs location map, THI_extended (153 items)



Created with ©google my maps, data source: Research Institute of Micrographs, State Archival Service of Ukraine

Figure 4: Ukrainian 15 most hazardous/risky TMFs location map



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Maps, accessed online, graphically show all the information in the database. Database of the Ukrainian TMFs and links are provided in Annex 3.

Results of the identification will be further elaborated in cooperation with Ukrainian institutions (see letter of the Ministry of Ecology and Natural Resources of Ukraine in Annex 12).

3.2 TMF Checklist

The project team examined following relevant documents and used them for developing a TMF Checklist (Annex 2, Chapter 3):

1. Checklist System for Safety Reports. Instructions for preparation and inspection of a safety report (SR) in accordance with UNECE Convention on the transboundary effects of industrial accidents and the EU Directive 96/82/EC (SEVESO II) by a consistent Checklist system. Umweltbundesamt (2003) Germany.
2. Safety guidelines and good practices for tailings management facilities. (2014) UNECE. New York and Geneva.
3. Reference Document on Best Available Techniques for Management of Tailings and Waste-Rock in Mining Activities (2004) UNECE.
4. Developing an Operation, Maintenance and Surveillance Manual for Tailings and Water Management Facilities (2011) Mining Association of Canada.
5. Tailings management. Leading practice sustainable development program for the mining industry (2007) Commonwealth of Australia.
6. South African Bureau of Standards “Code of practice for mine residue deposits” (1998) South Africa.
7. The mines and quarries (Tips) Regulations (1971) United Kingdom.
8. The Surface Mining Control and Reclamation Act (1977) United States.
9. Monitoring of Tailings Dams – Review and Recommendations. (1996) Bulletin #104 of International Commission on Large Dams (ICOLD).
10. Tailing pits and sludge stores. National Standard of Ukraine. ДБН В.2.4-5:2012. Part I. Planning. Part II. Building (2012) Ukraine.

The TMF Checklist is based on the technical explanations to the safe operation of TMF [4] and includes all references to the newest presently available standards and guidelines as well as an assessment of recent disasters.

The questions of the Questionnaire are formulated in such way to encompass the minimum set of the requirements critical for TMF safety, which allows evaluating the TMF conditions.

The developed Evaluation Matrix of TMF safety level gives the assessment of TMF being checked in compliance with applicable safety requirements formulated in the Questionnaire. The Evaluation Ma-

trix unifies the answers to the questions; it includes evaluation using specific categories, which allows thorough checking all TMF elements. Besides, the Matrix enables evaluating uncertainties caused by the lack of data on the inspected TMF.

The application of the TMF Checklist is supported by a Measure Catalogue with short-, medium- and long-term safety measures. The short- and medium- term measures should be based mostly on economic aspects, the long-term measures should meet high international safety standards.

The Excel file "Annex 13. Template for calc tailings hazard index_THI method.xls" developed for the Checklist application provides an automatic calculation of the relative TMF safety level using numerical analysis of the answers to the questions of Groups A, B and C. In addition, the Excel file also contains a Measure Catalogue, which allows automatic transition to recommended action(s) by choosing appropriate hyperlink(s) provided for each Checklist question (Annex 14). Thus, it is not required that Checklist users have to remember or to learn the formulae used for calculating the TMF safety level and all actions prescribed by Measure Catalogue. Users only need to fill in correctly the answers to the Checklist questions and select one or more appropriate measures from the proposed list.

Testing of the TMF Checklist on practice

To test TMF Checklist on practice two trainings were conducted in May and November of 2014 (see Annexes 8-9).

The main idea of the TMF Checklist testing was to explain the principle and procedure of the checklist to the experienced auditors, inspectors, representatives of TMF operators and competent authorities, so that they could conduct a field exercise on the specific object and make an evaluation of its level of correspondence to the minimum set of the TMF technical safety requirements.

TMF Checklist field test included selection and training of the group of Ukrainian, Georgian and Armenian trainees (familiar with the TMF safety problem and regularly working in this field) within educational course in Methodology for improving TMF safety. Main goal of these exercises was to receive the necessary input such as conclusions, comments and recommendations from specialists from different countries about practicability, completeness, suitability and necessary amendments of the TMF Checklist. The project team also had an opportunity to apply checklist to the selected TMF and gained their own experience of practical work for better understanding of all peculiarities of this process.

3.2.1 Questionnaire

The Questionnaire of the TMF Checklist consists of 3 main groups of questions, which are sorted by the TMF lifecycle.

Each question's group does contain relevant questions applied to the 4 specific life-cycle stages that are the same and in the following sequential order:

- Pre-construction and Construction;
- Operation an Management;
- Emergency planning;
- Closure and Rehabilitation.

The groups called as follows:

- "Basic Check" (Group A);
- "Detailed Check" (Group B); and
- "Check of Inactive Sites" (Group C).

Each group includes two subgroups; the first subgroup is intended for visual inspection, the second subgroup is elaborated to work with documentation. Detailed descriptions of Questionnaire's groups see in Annex 2, Chapter 3.2 of the Methodology.

3.2.2 Evaluation matrix

The Evaluation matrix is developed for the TMF Checklist for the overall and detailed evaluation of the TMF safety level (Annex 2, Chapter 3.2 of the Methodology).

Interpretation and quantification of answers

- **"Yes"** is applied if a Checklist user has enough data or information to give the positive answer. Interpreted as the maximum level of TMF safety per the evaluated factor (3 balls).
- **"No"** is applied if a Checklist user has enough data or information to give the negative answer. Is considered as the minimum level of TMF safety per the evaluated factor (0 balls).
- **"Mostly yes"** is applied if a Checklist user does not have enough data or information to give the definitive answer ("Yes" or "No") but the user has more arguments to accept the positive answer "Yes" rather than "No". Allows the Checklist user to be flexible in evaluations taking into account availability and credibility of data sources (2 balls).
- **"Mostly no"** is applied if a Checklist user does not have enough data or information to give the definitive answer ("Yes" or "No") but the user has more arguments to accept the negative answer "No" rather than "Yes". Allows the Checklist user to be flexible in evaluations taking into account availability and credibility of data sources (1 ball).

Types of TMF safety level evaluation

The overall safety level summarizes numerical contributions of all answers to Checklist questions.

- The overall safety level calculated by Group A determines the need for further detailed check of the TMF.
- The overall safety level calculated by Group B identifies the TMF state and quantifies the priority of recommended interventions and remedial actions.

The categorical evaluation reveals the TMF safety in different aspects and details of the TMF performance and conditions of tailing facilities.

Characteristics of TMF safety level

- "MSR" rank ("Minimum Safety Requirements") within the TMF Checklist is the index quantifying how many parameters of components and characteristics of the inspected TMF meet the modern requirements of environmental and industrial safety. "MSR" rank is calculated by summing the values of quantitative answers.
- "Credibility" rank within the TMF Checklist is the index quantifying the sufficiency of data amount while calculating the "MSR" rank. "Credibility" rank is calculated by summing the values of definitive answers ("Yes" or "No") divided by the total number of answers.

3.2.3 Measure Catalogue

The Measure Catalogue (Annex 2, Chapter 3.3 of Methodology) includes the list of actions to be taken in case of establishing non-compliances, partial or full, of TMF conditions to actual safety requirements or regulations.

Experts should determine the appropriate action(s) for each problem detected at the TMF.

The measures are grouped in such a way to solve specific problems (non-compliances) detected during TMF inspection; the measures are specified according to their priorities.

Measure Catalogue includes:

- Detected problem at the TMF – clearly and briefly formulated non-compliance between applicable safety requirements and the actual state of TMF components or TMF performance.
- Each question of Group B or C refers to a certain problem in the Measure Catalogue, to which some solutions are proposed; this way facilitates selection of appropriate measures by Checklist users.
- Intended (prescribed) measures – are one or more actions aimed to improve the TMF safety level. There can be several measures proposed to solve or mitigate the same problem. The user task is to select those most appropriate for the specific case taking into account TMF and site's specific features.
- Measure priority – is dependent on urgency and costs of prescribed action(s) and can be defined as short-, mid-, and long-term.

Selected measures are based on the activities for maintaining TMFs safety adopted by national and international documents:

- For Ukraine this document is „Tailing pits and sludge stores. State Construction Standards 2012...", where many activities with the range of process parameters are identified in sufficient details.

- The international document "Reference Document on Best Available Techniques for Management of Tailings and Waste-Rock in Mining Activities (2004) UNECE" has been used that accumulated advanced experience of safe operation and rehabilitation of TMFs and other mining sites.

The Measure Catalogue could be improved by taking into account all appropriate measures in national documents in EU countries and Reference Document on Best Available Techniques for Management of Tailings and Waste-Rock in Mining Activities (2004) UNECE.

The Measure Catalogue is an integrated part of the TMF Checklist and is available in Excel file "Annex 14. Template for calc TMF safety_TMF Checklist method.xls", which facilitates automatic use of the catalogue due to inner links (Annex 14).

3.3 Benefits of TMF Methodology application

The TMF Methodology was conceived as a toolkit to improve public safety in the areas (potentially) affected by tailings. The TMF Methodology may bring many organizational and managerial benefits listed below.

- The approval of the usage of the Method of evaluation of Tailings Hazard/risk Index on the governmental level will enable the introduction of a primary check of all TMFs and the creation of the country's catalogue of TMFs. This catalogue has to rank all checked TMF according to their hazard and safety conditions, and then prioritize the further safety measures. This is one of the major benefits.
- The usage of the Method of evaluation of Tailings Hazard/risk Index will also give stronger tools to political decision-makers to request and/or generate the necessary financial means for TMF improvement at national and/or subregional level in the countries.
- At regional level and specifically related to transboundary issues, the usage of the Method of evaluation of Tailings Hazard/risk Index, can create major improvements in case neighboring countries. Such a development could strongly increase regional cooperation and be a ideal tool for the regional organisations such as ICPDR and UNITAR, but also within the European Union and its neighboring countries.
- The TMF Checklist imposes unified strict qualification requirements both to TMF operators and state inspectors. Thus, systematic application of TMF Checklist will enforce both TMF operators and state inspectors enhance their skills and qualification permanently.
- The TMF Checklist specifies the requirements to the operator how to raise the awareness of the local communities in case of emergencies and accidents. Discussions with local communities in the form of public hearings, necessity to consult with local authorities and receive their approval of the project design documents of a TMF will be mandatory.
- The TMF Checklist unifies the procedure to evaluate the safety of various TMFs, which complies with EU policy in harmonization of legislation.

- The TMF Checklist requires obligatory development of Closure and Rehabilitation plans to all TMF, both operated and designed; the availability of these plans have to be the common practice. In this way no new closed and abandoned tailings management facilities will be generated.
- The TMF Checklist requires also that the existing closed and abandoned sites are being assessed as part of the national and/or subregional catalogue, and as such its potential existing hazard/risk will be determined and governmental control will be obtained and plans can made for regular monitoring or other actions as part of action plans.
- Regular trainings for the TMF personnel, which are obligatory required in the TMF Checklist, will enhance staff preparedness to emergencies and accidents and continuously improve their skills. Application of the trainers' principal will facilitate fast spread and increase of TMF personnel in the regions of each country.
- Systematic application of the Checklist to various TMFs in different countries will contribute to better understanding the risks posed by TMFs and lowering vulnerability of tailings in terms of natural and man-made risks.
- The Method of evaluation of Tailings Hazard/risk Index (see chapter 5 below) may be transforming into a widening database/GIS very helpful to competent authorities responsible for environment rehabilitation of post-mining sites. This could also create new economic incentives for the TMF sector.

4 Educational course in Methodology for improving TMF safety

Full information about the course is described in detailes in Annex 2 (Appendix 6. Educational course to the Methodology).

Description

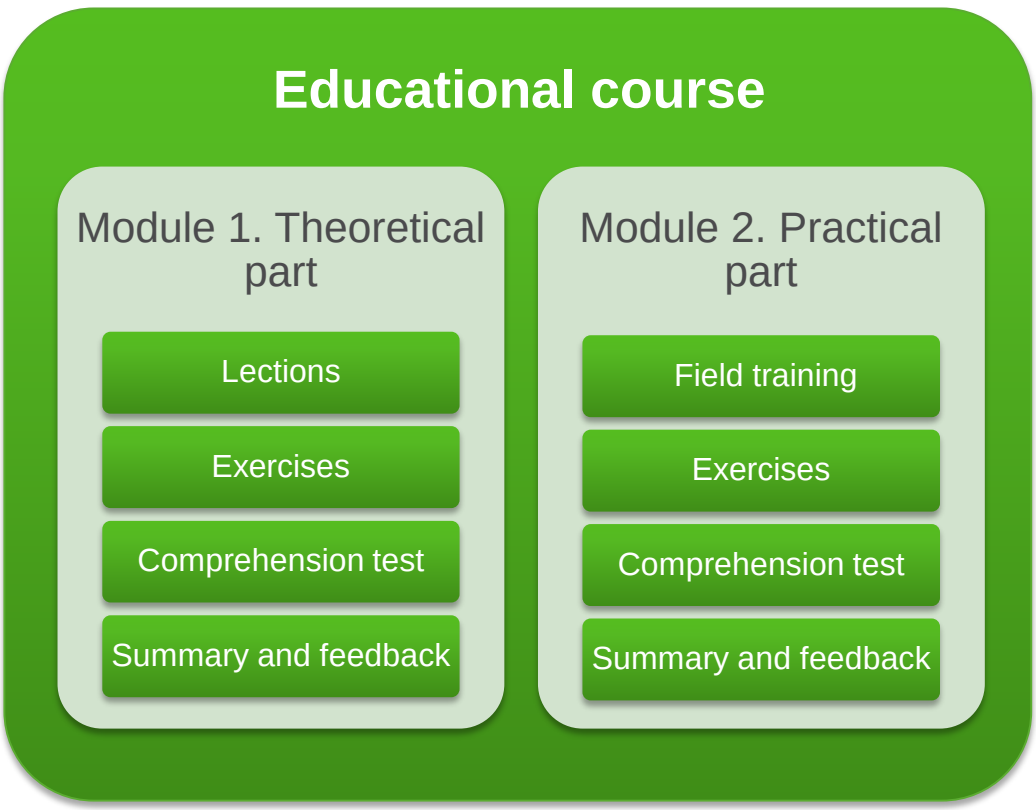
To acquaint as many concerned people with the developed methodology in a complete and optimal way the training course in this approach was created.

The **purpose of the course** is to ensure a clear understanding of the hazard/risk problems of the TMF and knowledge of the ways of its solutions of the specialists of all levels and all related areas pertaining to the operation of any such object at any stage of its life cycle.

The **objectives of the course** is to train representatives of the TMF operators, state inspectors, ecological auditors of Ukraine and other countries – that are potential Checklist users – in how to apply the TMF Methodology in the practice.

Controlling the safety of tailings management facilities is a quite complicated task. One has to take in mind the different levels of expertise of different investigators. Therefore it makes sense to raise the knowledge of analysers and conduct them according to different stages and step-by-step through the whole safety needs of TMF. For this purpose different educational Moduls were worked out.

Figure 5: Schematic structure of the educational course in the TMF Methodology



Module 1 - Theoretical part of the course

This module contains information about history of the problem, earlier experiense, regulating documents, essence of the method etc. Themes of basic **lectures** provided below

1.1 Introduction to the topic:

Problems and experiences of Ukrainian TMF operation.

Review of the previous documents regulating the procedure of checking TMF in different countries. TMF Guidelines as a legal regulatory base of checklist development.

Description of the TMF hazard/risk index (THI) evaluation method for a large number of the objects.

The essence of the Checklist method (global practice).

Basic information on the TMF Checklist.

TMF Inspection procedure with TMF Methodology and reporting

1.2. Acquaintance with the object of Methodology approbation:

Brief information about enterprise history and technology, including TMF chosen for Methodology approbation.

Review of information about the TMF for use in training purposes.

Exercises in this module aimed to train TMF Checklist form filling and practical skills of work with enterprise technical documentation

Module 2 - Practical part of the course

This module contains practical work on the enterprize and TMF, which include visual inspection, collection of the evidences, calculation of the safety level, etc. Themes of basic **practicl activities** provided below

2.1 Practical work at the enterprise

Visiting the enterprise.

Visual inspection of TMF.

Fill in TMF Checklist. Answering questions according to the visual inspection

2.2 Computer practical work

Final filling of the TMF Checklist, answering questions in MS Excel, using technical documentation of the enterprise and information from site visit.

Obtaining results of the safety evaluation of the examined TMF in the MS Excel file.

Exercises in this module aimed to train field work on the object, proper use of the TMF Checklist both paper and Exel versions, choosing measures from "Measure Catalogue", reporting etc.

An educational course was developed for conducting the workshops of the TMF Checklist Method application – part of the Methodology for improving safety of Tailings Management Facilities. Detailed information on the course see in Annex 2 Methodology for improving TMF safety, Appendix 6 Educational course in Methodology for improving TMF.

This course was developed for the participants with different levels of education, occupation and work experience in the fields related to TMF operation: final users of the Methodology are representatives of the competent authorities, inspectors, TMF operators and independent auditors – relatively wide audience. Course flexibility was achieved by use of separate educative modules. The quantity of the modules, their sequence, details, and time to be spent for each module can be modified.

This flexible course provides an opportunity to get full and consecutive information including the introduction to the theme, importance, scopes, operation problems of the TMFs as a high-risk facilities, and application of the Methodology in practice.

Here has to be emphasized that the only key for any training method that has to be spread into countries and their regions is the trainings for trainers. Methodology will start in a country with a central training in capital to train around 15 people of national and regional authorities. In the next phase these regional experts have to be the trainers of the following regional training. All these trainers will get not only theoretical knowledge and practice at the object, but also a ready instrument to convey the methodlology's idea, principles and its practical implementation peculiarities – matherials of the educational course.

The course structure is described detailed in Annex 2. Methodology for improving TMF safety, Appendix 6 Educational course in Methodology for improving TMF.

Knowledge assessment, comprehension tests

To assess the effectiveness of studying, these course standard methods were used, which are adopted for practical application in Ukrainian and European universities. These methods include test questions for distant learning on knowledge assessment, oral and written surveys, control exercises on the acquisition and use of the knowledge gained, trainer observation, self-esteem of the participants.

Knowledge assessment should be conducted on each stage of the course for duly program adjustments: providing additional counseling, clarification, other personal assistance to participants of the course. The questions for assessment were tested at two trainings.

The form of teaching of the educational course in the Methodology for improving TMF safety depends on the audience and requires an appropriate adaptation to each particular case.

5 Project activities

This chapter briefly describes each of the activities that have been implemented over the time for each phase of the project. More information is available on the website of the project [5] and in the respective annexes, pointed below.

Kick-off meeting of project Parties

Meeting took place according to project timetable – 8-9th of August 2013 in Kiev.

The first meeting within project, main objectives were: to clarify tasks and expectations, to introduce participants, to explane in details the implementation of each step of the project activity, to describe organizational procedures.

Agenda, meeting protocol and photos are provided in Annex 5.

First Steering Committee Meeting

The meeting took place according to the project timetable – 14th of November 2013 in Kiev.

This meeting was attended of six international experts in TMF safety. Objectives:

- Explanation of project objectives and main tasks;
- Introduction of Ukrainian and International meeting participants;
- Presentation of the first drafts of project materials by Ukrainian team;
- Providing the observations and recommendations by International experts;
- Analysis and discussion of the observations and recommendations of experts;
- Adjustments of the action plan.

Agenda, meeting protocol and photos are provided in Annex 6.

Internal Meeting

The meeting took place according to the project timetable – 25th of February 2014 in Dniprope-trovsk.

Objectives of the meeting included discussion of the legislation analysis draft, planning of training program content and procedure of TMF Checklist testing on practice.

Meeting protocol is provided in Annex 7.

First Testing of the TMF Checklist on practice and second Steering Committee Meeting

The meeting took place according to the project timetable – 13-15th of May 2014, Lviv, Ukraine.

The meeting included a theoretical and practical part of the TMF Checklist implementation. Main objective was to train the TMF operators, state inspectors, ecological auditors from different countries how to practically apply the “TMF Checklist” document.

Agenda, meeting protocol and photos are provided in Annex 8.

Second Testing of the TMF Checklist on practice and third Steering Committee Meeting

The meeting took place according to the project timetable – 4-7th of November 2014, Ivano-Frankivsk – Kalush, Ukraine.

Meeting included theoretical and practical part of the TMF Checklist implementation. Main objective was to train the TMF operators, state inspectors, ecological auditors from different countries how to practically apply the "TMF Checklist" document.

Agenda and activity report are provided in Annex 9.

Fourth Steering Committee Meeting

The meeting took place according to the project timetable – 7th of November 2014, Ivano-Frankivsk, Ukraine.

Main objective of the meeting was to discuss and evaluate current results of the project, comments and difficulties for project resulting documents.

Agenda, meeting protocol and photos are provided in Annex 10.

Final workshop and Fifth Steering Committee Meeting

The meeting took place according to the project timetable – 18-20th of May 2015, Kiev.

Main lines of activity: discussion on remaining issues on finalization of Project Documents, report on TMF Methodology, international experiences with assessment of TMFs, strategies for the TMF methodology application, future plans and actions.

Agenda, conclusions and photos are provided in Annex 11.

6 Evaluation of the project results

A thorough evaluation of the results of the project is a must, as the project had very clear defined tasks and related outcomes that had to be fulfilled. But even more important were the estimates of the so-called potential impacts of the project, with the highest potential in the Ukraine for the Ukrainian authorities and the TMF-operators and other UNECE member countries like Armenia and Georgia and so on. Special importance has to be given by the beneficiaries who evaluated the project, as they are the ones that have been trained in the courses and been testing the checklist system in the field on its practicability!

6.1 Assessment of the achieved results

During the project:

- 23 Ukrainian experts, representatives of the governmental and non-governmental organizations helped, consulted and shared information with the project team (see list of experts in Annex 4, Table A 4.3)
- 17 international experts from 11 countries (Armenia, Austria, Czech Republic, Georgia, Finland, Germany, Hungary, Romania, Sweden and USA) participated in all main activities, consult and check the work of Ukrainian specialists (see list of experts in Annex 4, Table A 4.2)
- 14 persons were trained in TMF Checklist – state inspectors, auditors, representatives of enterprises with TMFs from Ukraine and Georgia (see list of trainees in Annex 4, Table A 4.4)
- after the project 37 people (all experts and trainees) will be actively involved in exercising the checklist in their daily work
- 37 people (all experts and trainees) were acquainted with UNECE TMF Safety Guidelines
- 6 international meetings were conducted in three Ukraininan regions (Kiev, Lviv and Ivano-Frankivsk)
- 2 Testings of the TMF Methodology (trainings) were conducted, including theoretical lectures and practical works at the TMF (for detailed information see Annexes 8 and 9)
- 2 facilities have been introduced new safety guidelines
- 1 educational course in TMF Methodology were developed and tested
- From 91% to 100% of the training participants highly assessed the quality of the documents developed in project and the whole event (see Annex 9, Fig. A 9.25, A 9.26).

According to the objectives declared in the project's concept all of them were successfully achieved, as it approved in Table 1.

Table 1: Tasks, anticipated outcomes and corresponding results

No	Tasks and anticipated outcomes	Project Results
Tasks		
1	To assess the degree of the compliance of Ukrainian legislation and the realization by administrative agencies with requirements of "Safety Guidelines and Good Practices for Tailings Management Facilities", developed by the UNECE	Legal Assessment „Analysis of the Ukrainian legislation and administrative situation on TMF“ including gap analysis and recommendations (Annex 1)
2	To develop the checklist for examinations of the technical safety of specific Tailing Management Facilities	TMF Checklist (Annex 2, Appendix 2 of the Methodology)
3	To develop technical measures for implementing European standards for the safe operation of Tailings Management Facilities in Ukraine	Measure Catalogue (Annex 2, Appendix 4 of the Methodology)
Anticipated outcomes		
1	Introduction of all project participants with the requirements of the UNECE Guidelines	Lectures of the team members during meetings (see Agendas in the Annexes 8-9)

No	Tasks and anticipated outcomes	Project Results
2	Development for the two user groups, state inspectors and TMF operators methodology the Checklist for assessing the safety tailings facilities for its further use in rules of procedure of users	Groups B and C of the TMF Checklist (Annex 2, Appendix 2 of the Methodology)
3	Development of a catalogue of technical measures for its further use by operators of tailings facilities in the development of programs for the implementation of the modernization of tailings facilities of the European requirements for safe operation of the TMF in Ukraine	Measure Catalogue (Annex 2, Appendix 4 of the Methodology)
4	Development of the "Instruction for use the Checklist" for two groups of users, inspectors and operators of tailings facilities	“How to use the TMF Checklist” – instruction for the users (Annex 2, Appendix 3 of the Methodology)

Some minor deviations were take place in comparison with the preliminary plan: the THI method was not planned in the original project Concept. The idea to develop it arose in the progress of the work under the prioritization of the Ukrainian TMFs. The UBA project coordinator stimulated and approved the idea.

The planned location of conducting the Second Methodology testing was the Dnipropetrovsk region, which was replaced to Ivano-Frankivsk region because of the war conflict in the east part of the Ukrainian territory (Annex 9). These circumstances were a force major situation. UBA project coordinator approved changes in order not to get behind on the planned time plan.

6.2 Estimation of the potential impacts of the project

The potential impact of the Project is very important for Ukraine and whole UNECE-region.

- The Ministry of Ecology and Natural Resources of Ukraine approved the results of the project and intended to use them for improving situation in Ukraine. The Ministry examined the documents that have been developed within the project and informed the project developers about the need for a more detailed revision of documents with the participation of its employees. The Ministry also expressed the intention of its willingness to take a coordinating position and allocate experts for the work on legislative framework, subject to the continuation of the project activities (Annex 12).
- Members of the International Commission for the Protection of the Danube River (ICPDR) and UNITAR took an active part in the project. ICPDR highly evaluated Methodology for improving TMF safety and THI method itself and made a decision to use it within the implementation of in internal procedures.

- Representatives of the Ministry of Environment and Natural Resources Protection of Georgia took an active part in the project, evaluating Methodology for improving TMF safety and expressing their intention to apply it in practice on the few tailing management facilities in Georgia and to get support in analysis of the Georgian legislative framework on tailings.

Besides of the current results the potential and sustainability of the project are as follows:

1. During the project around 30 trainees (representatives of the enterprises, local authorities, environmental auditor etc.) were trained in TMF safety principles, methodology and theory. These people will use obtained knowledge, information and documents in their work and further actions.
2. Developed educational course in Methodology for improving TMF safety contained copious information in TMF problems and approaches, can be widely disseminated and raise awareness level of population in all region where it is relevant.
3. The Ukrainian project team has gained a large experience and will be able to assist the Ukrainian government and Ukrainian TMF owners to set up training programs and to implement investigations and plans to improve TMF safety in Ukraine, and also in other UNECE countries.

6.3 Evaluation of the project by the beneficiaries

The main beneficiary of the project is Ministry of Ecology and Natural Resources of Ukraine. However, taking into account that the tailings are also within the competence of other institutions, representatives of environmental inspection and emergency services have been involved in the implementation of the project. The project's results are highly appreciated by beneficiaries, especially in following points:

1. The Methodology for TMF safety improving was approved as a useful instrument that can be used on the national level;
2. The THI method by itself can be used on a national level for prioritization of the individual TMFs. These evaluations have been stated in the official letters of the Ukrainian institutions:

- Letter No 5/4-7/8082-15 dated July 06, 2015 from Ministry of Ecology and Natural Resources of Ukraine (Annex 12)
- Review of methodology dated May 15, 2015 from Institute of Emergence Service of Ukraine (Annex 12).

Emergency simulation department of the Research Center of innovative technologies of the Ukrainian Research Institute of Civil Protection make a review of the Methodology for TMF safety improving (May 2015). In the review particularly underlined, that Methodology is relevant, understandable and easy to use. It was described as a progressive tool for evaluation of the safety level and its use can provide benefits for operators and competent authorities.

Chief of the department of Emergency simulation Serhiy Chumachenko in this review gives appreciation to the project and makes a conclusion, that adoption of its results on the national level can be the beginning of the harmonization of the Ukrainian legislation to the legislation of EU.

This review recommended to form a group of experts of the NAS and State Emergency Service of Ukraine for final adaptation and application of the Methodology for TMF safety improving.

7 Conclusions and recommendations

The project "Improving the safety of industrial tailings management facilities based on the example of Ukrainian facilities" was implemented during the 2013-2015 and all the initial objectives that were set are fulfilled successfully.

1. Analysis of Ukrainian legislation and administrative situation on TMF (Annex 1).

Project developers have embarked on project tasks from performance of the corresponding analysis of the national legislative base for tailings at its compliance with European standards and legislative requirements.

Conclusion:

The recoomendations and conclusions, which are stated in the legal report can be used as a starting point for the competent authorities for the improvement and harmonization of the Ukrainian legislation in this area.

2. Methodology for TMF safety improving (TMF Methodology) (Annex 2).

Conclusions:

- The TMF Methodology provides an easy-to-use THI method by which the competent authorities can perform the TMFs prioritization according to their potential hazard/risk.
- The THI method can be used by the competent authorities of the countries with large number of tailings as a first step before the detailed evaluation of the objects applying the TMF Checklist method.
- Various checklists provide an ability to the user to evaluate the safety level of an individual facility, identify bottlenecks and get recommendations on actions to address them in the Measures Catalogue.
- The TMF Checklist method is intended for applying by different type of the users – operators, state inspectors and environmental auditors or other representatives of the competent authorities/ institutions.
- The methodology provides clear and simple instructions on how to conduct TMF evaluation: preparatory works, visual inspection, documentation review, application of the Excel forms and reporting on the evaluation results, etc.

- The methodology can be applied at both the national and regional level. Also its application relevant for countries with large number of objects to create long-term programs to improve their security, as well as for regions that need to evaluate and take appropriate measures for individual tailings.

3. The educational course in the TMF Methodology (Annex 2, Appendix 6)

Particular attention was paid to training on the application of the methodology of the different types of users. Thus, the relevant educational course was developed within the project (Chapter 4).

Conclusions:

- potential users (state inspectors, operators, auditors) can easily use the modules of the educational course to carry out similar trainings locally of their professional activity, so-called "training of trainers" to spread the knowledge on the TMF subject;
- educational course can be easily applied further to increase the knowledge level in higher education institutions of any country due to its different topics including a lectures of the initial character, such as: "What are tailings management facilities", "The problems and risks of tailings", "Review of accidents at tailings in the world", "History of the checklist method", etc.

The conclusions and recommendations of the international and Ukrainian project Parties on the further prospects were expressed on the final workshop in May 2015 in Kiev, Ukraine (Annex 4).

CONCLUSIONS OF THE FINAL WORKSHOP
within the project
of the German Environment Agency (Umweltbundesamt),
"IMPROVING THE SAFETY OF INDUSTRIAL TAILINGS MANAGEMENT FACILITIES BASED ON THE EXAMPLE OF UKRAINIAN FACILITIES"
May 19-20, 2015, Kiev, Ukraine

The Deputy Minister of Ecology and Natural Resources of Ukraine Sergey I. Kurykin highlighted in his opening remarks, the importance of the issue of tailings management facilities (TMFs) for Ukraine and stressed that the project created a chance to move forward to increase safety of TMFs. He also stated that the tailing materials contained in such facilities are an alternative source of raw materials and this resource is not widely used yet in Ukraine. The participants agreed with his conclusion that the subsequent development of a strategy for extracting valuable resources from TMFs should be the important part of work in Ukraine to improve the TMFs safety level.

During the workshop the participants discussed and highly valued the TMF methodology, which was developed within the project "Improving the safety of tailings management facilities based on the example of Ukrainian facilities" [2, 5]. In particular, the workshop participants unanimously agreed that it is:

- a useful methodology for Ukraine and likewise other countries in the UNECE region;
- a living document as a Multipurpose and Multi aspect tool that could be adjusted to country specific needs and that could be improved with increasing experience;

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- a powerful tool for the process of harmonizing technical standards throughout the UNECE region.

Furthermore the THI method, can be easily used by competent authorities and state inspectors. In particular, they agreed that the proposed evaluation method:

- is a practical tool to create a first preliminary overview and for prioritisation of TMF sites likely to be of most concern on a national and international level;
- supports the efficiency of limited financial and institutional capacities in directing the available resources;
- helps to define first actions to be taken on the national and international levels.

Participants further emphasized the important role that training would play in ensuring the application of the TMF methodology, stressing that the TMF methodology constitutes a practical tool for trainings of inspectors, operators, decision-makers and other stakeholders that can be easily applied. The past experience has shown that "training of trainers" programmes are most efficient in this respect.

Participants agreed further that the provision of training in various forms can be an effective tool for the practical usage of TMF methodology (e.g. face-to-face as well as online through webinars and other distance education tools).

Participants also discussed other project findings and outcomes, concluding on the following:

- The training in November 2014 at the TMF in Kalush city found that no changes since the emergency situation have occurred related to salt leaching and lack of maintenance works at the dams. Support for competent authorities is urgently needed to improve the unchanged situation since 2010.
- The legal assessment for TMFs made for Ukraine shows that this should be the starting point for long-term actions to reach clear legislation with clear responsibilities for operators and competent authorities.

Participants discussed possible next steps to ensure the future use of the TMF methodology in Ukraine and other countries in the UNECE region. The following was recommended:

- **Ukrainian participants** urged that the TMF methodology was to be assessed by the concerned national authorities and suggested that thereafter it could be used by the Ukrainian government as methodology for inventory of the TMFs, their prioritisation and establishment of action plans to reduce the risks of TMFs in the country. It was also recommended that this process should be guided by the Ministry of Ecology and Natural Resources of Ukraine and include all concerned stakeholders;
- **Representatives from other countries** should initiate the reports to the respective national authorities to create awareness on the increasing dangers of TMFs and to request the inclusion of TMF problems as high priority of their national environmental action plans. They should also request considering their concerned institutes for the assessment of the TMF methodology in order to propose adaption for national implementation. This should be done in order to start

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training of trainers for initiating the inventory of the TMFs, their prioritisation and establishment of action plans to reduce the risks of TMFs in their countries. The process should be guided by the concerned Ministry/Ministries and should include all concerned stakeholders;

- **International Organisations (e.g. ICPDR and UNECE)** should support the sharing and future application of the TMF methodology in their regions, through communicating with member countries to facilitate its distribution and possible training opportunities. In particular, it was recommended that Ukraine is preparing a self-assessment and action plan in the framework of the Assistance Programme of the UNECE Convention on the Transboundary Effects of Industrial Accidents, which would provide the basis for needs-driven external assistance projects designed to overcome the shortcomings. For the ICPDR it might be worth to get an overview to the country specific problems within the Danube River Catchment. The TMFs inventory based on application of the THI method might be the first step for further actions.
- **EU Delegation in Ukraine:** The representatives of EU countries welcome the TMF initiative and understand the importance of the issue for Ukraine. They encourage the Ministry of Ecology and Natural Resources of Ukraine to make prioritisation of TMF issues and request EU support. Subject of safe operation of the tailings has a high relevance in many countries of the world, therefore the results of the project implementation in Ukraine have received genuine interest from the side of the competent authorities of Ukraine, Georgia, Armenia, Kazakhstan, Azerbaijan and other countries of Eastern and Central Eurasia, as well as member countries of the UNECE. Based on that the all project parties agreed on the necessity for follow up activities in other countries/regions on the implementation of the TMF methodology, conduction of the "trainings for trainers" for competent athoryties, state inspectors, operators and auditors; and its usage at Universities for educational needs.

The implementation of the project "Improving the safety of industrial tailings management facilities based on the example of Ukrainian facilities" assisted:

- to provide the Ukrainian competent authorities by the way how to harmonize the legislative framework according to the European standards throughout the developed Report on "Analysis of Ukrainian legislation and administrative situation on TMF" and by the relevant tools for managing more than 150 TMFs in Ukraine by using methods of the "Methodology for TMF safety improving";
- to draw attention to the TMF's safety issues of the relevant experts from different countries of Central and Eastern Europe, the Caucasus and Central Asia and other countries neighbouring the EU by involving them in the project;
- to disseminate the UNECE TMF Guidelines as European standards to the TMF's safety due to the developed "Methodology for TMF safety improving" and Report on "Analysis of Ukrainian legislation and administrative situation on TMF", which mainly based on defined requirements in the UNECE TMF Guidelines.

8 Follow up proposals of the TMF project

As a follow up of the current project three different projects could be proposed, provided below in separate subchapters.

8.1 Raising of the knowledge on tailings safety among teachers and students using TMF Checklist Methodology

Country of the project implementation: Ukraine

The proposed duration of the project: 01.01.2016 – 31.12.2016 (1 year)

Background

In 2013-2015 a Methodology to improve the safety of Tailings Management Facilities (TMFs) has been developed by the Ukrainian team in close cooperation with international experts within the project "Improving the safety of industrial tailings management facilities based on the example of Ukrainian facilities" [2] financed and coordinated by German Environmental Agency. The Methodology based on TMF Checklist was tested on two mining sites in Ukraine; then it has been accepted by the Final workshop of this project held in May 2015 in Kyiv and then finally approved by UBA in October 2015. The Methodology has been recommended for further application as the advanced approach that allows optimizing the efforts in improving the safety of many hazardous mining sites including tailings management facilities.

Because the TMF Checklist is a living document there is the growing need for broader introduction and dissemination of this Methodology among the potential future users, which are graduated and postgraduate students in environmental and mining sciences starting to work in various institutions/organizations responsible for environmental safety, including in mining industry. National Mining University (Dnipropetrovsk) as the only one educational establishment specialized in mining in Ukraine is suggested as the principal university for implementation of this project. The university provides its students with comprehensive education programs in mining and environment; its collaborators have close ties with mining industry stakeholders and managers, which can amplify the project outcome. National Mining University is located in Central Ukraine which is one of mining centers of the country where some tens tailings and hundreds other mining sites are located.

Aim and tasks

The aim of the project is to introduce the Checklist approach on the example of TMF Checklist Methodology to Ukrainian students and young educators dealing with environmental safety of mining sites.

The following tasks will be addressed during the project

1. Education of trainers able to deliver and explain the TMF Checklist Methodology to Checklist users at the high professional level.

2. Active familiarization of best students in environment and mining sciences with the TMF Checklist by gaining the practical experience of efficient environmental audit/inspections and safety improvement procedure.
3. Testing and improvement of the TMF Checklist Methodology through new application experience.
4. Improvement of teaching modules for the TMF Checklist Methodology based on educational experience.

Project participants

The project targets two groups of participants who are trainers and trainees.

1. Trainers (4-5 persons) will be selected from experienced educators affiliated at the universities in Dnipropetrovsk region that are ready to become the experts in follow-up TMF Checklist application. The trainers will be prepared by the experts of the Ukrainian team of the previous UBA project on TMF safety and tested by their advances during the project. The trainers' task is to facilitate the educational activities and help trainees during the period of learning the TMF Checklist Methodology.
2. Trainees (20-25 people at the age from 20 to 30) will be selected from graduated and post-graduate students from the Dnipropetrovsk region largely affected by mining activities. Engaging the participants on the competitive base from several universities will allow

- sharing knowledge among the broader audience,
- delivering the TMF Checklist Methodology to the most interested people, and
- testing and improving the education modules in the mixed audience.

Also the leading Ukrainian and international experts experienced in tailings safety (up to 5) will be invited to share their experience and make contribution to the educational process, which will make it more comprehensive and illustrative for young trainees.

All workshops will be held in Dnipropetrovsk. National Mining University will be a platform for the study process. The tailings of Prydniprovsky Power Plant are suggested as the site for visit during the workshops. Working languages will be English and Russian. Lectures will be held in English with simultaneous translation.

Work packages

1. PREPARATORY WORKS

Selection of trainers. It will be made from the educators affiliated at the universities and other institutions with the proven expertise in environment and/or mining industry. The final decision on the selection from all candidacies will follow their passing through the tests/interviews before the workshop for trainers.

Selection of trainees. It will be made from the students of universities located in the Dnipropetrovsk region. The final decision on the selection from all candidacies will follow their passing through the tests/interviews before the workshop for trainees.

Contacting the managers of the TMF. The contacts will aim to get documentation for practical work with the TMF Checklist, arrange the logistics during site visits, and get permits for making photos at the site.

Arrangement of logistics of all events and activities at the university.

Amendment of the available education modules. The available modules on the TMF Checklist Methodology will be updated and disseminated among the trainers. Training materials will include

- the theoretical knowledge package (the basic document "TMF Safety Guidelines...", TMF Checklist Methodology, Checklist questionnaire, and Excel files),
- tests and examples based on the experience of tailings management facilities in Ukraine, templates and recommendations to reporting.

2. WORKSHOP FOR TRAINERS

Dissemination of educational materials. The trainers will be provided with all necessary materials on the Checklist Methodology listed in item 1.5.

Elaboration of the workshop program and schedule. The program and schedule will include theoretical part (lectures) and site visit during 3-4 working days.

Theoretical education. All materials will be explained in details during workshop sessions.

Site visit. Visual inspection and interviewing the TMF personnel are suggested during the second working day.

Office work. The results of site visit will be processed

Workshop assessment. The knowledge gained will be consolidated by tests and discussions. The result of the workshop will be

- deeper understanding of the TMF Checklist by trainers,
- preliminary testing of educational modules, and
- familiarization with site specifics and local features,
- adaptation of education modules (content, scope) to the audience.

3. WORKSHOP FOR STUDENTS (TRAINEES)

Dissemination of educational materials. The trainees will be provided with all necessary materials on the Checklist Methodology listed in item 1.5.

Elaboration of the workshop program and schedule. The program and schedule will include theoretical part (lections) and site visit within 4-5 working days. The international experts will be invited to the workshop from Georgia, Armenia and other countries.

Theoretical education. All the materials will be explained in details within workshop sessions.

Site visit. Visual inspection and interviewing the TMF personnel are suggested during the second working day.

Trainer-trainee interaction. Each trainer will act as the supervisor guiding the group of 3-4 students (trainees) while filling in the Checklist.

Work after the site visit. It will include filling in the Checklists and selection of the measures from Measure Catalogue, reporting on the work done with the recommendations on tailing safety improvement.

Closure. The workshop ends with summing up of its outcomes, validation of reports, collection and outlooks.

4. WORKSHOP ASSESSMENT

Analysis of workshop outcomes. The feedback and proposals to improve the TMF Checklist and education modules done during two workshops will be summarized by the trainers and analyzed by the Ukrainian and international experts.

Home work. The students will prepare the final work to present it at the final workshop. It includes compilation of some relevant issues in the inspections of hazardous sites and generalization of safety level evaluation of the TMF. The trainees will prepare for the final consolidation knowledge testing to confirm their level to be certified.

FINAL WORKSHOP

Elaboration of the program. Final Workshop will be held with the participation of all the trainers and students within one working day with the engagement of local competent authorities and representative of local administration.

Students will make their presentations; the trainers will pass the test and get certificates.

Participation of representatives of the local competent authorities is expected.

5. REPORTING

8.2 Improving the safety of industrial tailings management facilities in Georgia

Country of the project implementation: Georgia

The proposed duration of the project: 01.01.2016 – 31.12.2016 (1 Year)

Background

In 2013 German Environment Agency has initiated a project “Improving the safety of industrial tailings management facilities based on the example of Ukrainian facilities”. The main project aim was

to develop a Methodology for improving safety of Tailings Management Facilities (TMFs) with the TMF Checklist (hereinafter TMF Methodology) as a toolkit for competent authorities and inspecting bodies in UNECE countries responsible for the safety of facilities storing hazardous mining waste. The TMF Methodology is mainly based on the document "Safety guidelines and good practices for tailings management facilities" endorsed by the Conference of the Parties to the UNECE Convention on the Transboundary Effects of Industrial Accidents at its fifth meeting (Geneva, 25–27 November 2008). This document was updated by the request of the seventh meeting (Stockholm, 14–16 November 2012) of the Conference of the Parties to the Industrial Accidents Convention.

The resulting version of the TMF Methodology was approved by German Environment Agency in September 2015.

Georgian experts have been actively involved in the project as members of an international group of the project experts and expressed interest in the adaptation and application of the developed methodology in Georgia. The initiative of the project was supported by the governments of Georgia and the Ministry of Environment of Georgia sent a letter to the German Environment Agency to support the idea of the project activities.

To date, Georgia has no legal base in the field of the management of high-risk objects such as tailings. Description of the situation with historical points – why there is no legal base.

The project idea includes 2 types of project activities:

- Assessment and development of the legislative framework of Georgia on tailings
- Training course for trainers on the use of the TMF Methodology.

Brief description of the project activities

1. The main objective of the analysis of the Georgian legislative framework will be the development of new regulatory legal acts in the area of tailings management, based on European requirements, which are defined in the UNECE "Safety Guidelines and Good Practices for Tailings Management Facilities".

To achieve the most effective result, the working group for work on the creation of the legal framework should consist of professional lawyers from non-governmental organizations and representatives of the legal departments of the competent authorities.

Based on the results of the legal assessment the competent authorities of Georgia will be provided by constructive proposals, recommendations to enact the legal framework for the management of tailings.

2. The idea of training for trainers on the TMF Methodology is as follows:

First, it is necessary to form a group of trainers in the composition of 15-20 people from stakeholders Georgia, which are associated with the work on the tailings.

For example.

- Representatives of the competent authorities of 10-12 people:

Environmental Inspectorate 2 people,

The Ministry of Emergency Situations - 2 people,

Ministry of Environment - 2 people.

- Representatives of the operators of tailings - 5-8 people (1-2 specialist from each company with tailing).

The Ukrainian team (developers of the TMF Methodology) with involving of international experts will hold two training courses for Georgian trainers group, which then conduct the same trainings under the supervision of developers to staff their place of work.

As a result of consistent implementation of 2 project objectives will be achieved two main objectives of the project idea:

1. Report on the legal assessment - professional proposals and recommendations for the creation of the legislative base of Georgia in tailings management. The evaluation criteria will be the requirements of the European Union, which in turn will allow the competent authorities to harmonize the existing regulations with the European law and to move towards sustainable development, which corresponds to the state policy of Georgia.
2. Training course on the application of the TMF methodology allows potential users in Georgia to study in detail and learn how to use all the methods with the aim of a comprehensive assessment of the tailings to take timely preventive and protective measures. Based on the methodology application both the authorities and the TMF operators will be able to develop strategic programs to improve the TMFs safety on the state as well as local levels.

8.3 Implementation of the methodology to improve the safety of tailings management facilities (TMFs) in Ukraine

Country of the project implementation: Ukraine

The proposed duration of the project: 01.01.2017 – 31.12.2018 (2 years)

Background

The international project “Improving the safety of industrial tailings management facilities based on the example of Ukrainian facilities" (hereinafter TMF project) has been implemented during 2013-2015. Main tasks of the TMF project were:

1. to analyze the Ukrainian legislation on TMF on its compliance with European law;

2. to develop a methodology for improving TMF safety based on European standards.

The objectives of the project activities are fulfilled and its results the two main project documents:

1. Report "Analysis of the Ukrainian legislation and administrative situation on TMF";
2. Methodology to improve the safety of Tailings Management Facilities (TMF Methodology).

The project team has provided all the documents to the Ministry of Ecology and Natural Resources of Ukraine. The official response of the Ministry (letter №5/4-7/8082-15 dated 06.07.2015) stated position that the documents of the project are important for Ukraine, but need improvement and adaptation for further implementation of the methodology at the national level. It is also determined that subject to minor additions legal assessment results can be a starting point for further harmonization of legislation on tailings with EU law (see Annex 12, Figure A 12.1).

ASSOCIATION AGREEMENT between the European Union and its Member States, of the one part, and Ukraine, of the other part committed Ukraine to undertake gradually approximation its legislation to the EU legislation within the stipulated time-frames including Directive 2006/21/EC on the management of waste from extractive industries and amending Directive 2004/35/EC:

- adoption of national legislation and designation of competent authority/ies
- establishment of a system to ensure that operators draw up waste management plans (identification and classification of waste facilities; characterisation of the waste) (art. 4 and 9)
- establishment of a permit system, of financial guarantees and of an inspection system (art. 7, 14 and 17)
- establishment of procedures for the management and monitoring of excavation voids (art. 10)
- establishment of closure and after-closure procedures for mining waste facilities (art. 12)
- drawing up an inventory of closed mining waste facilities (art. 20).

Timetable: these provisions of the Directive shall be implemented within 5 years of the entry into force of this Agreement.

The TMF methodology and the Report on Ukrainian legislation contain the necessary recommendations for the majority of the above paragraphs of the Directive 2006/21/EC in regulatory and technical parts of their performance.

Further the TMF methodology and recommendations in the Report on Ukrainian legislation have been developed based on the provisions as defined in the normative document of UNECE “Safety guidelines and good practices for tailings management facilities (2008, updated version 2014)” (UNECE TMF Guidelines). UNECE TMF Guidelines developed by the Joint Expert Group on Water and Industrial Accidents in line with principle of the UNECE Convention on the Transboundary Effects of Industrial Accidents and Convention on the Protection and Use of Transboundary Watercourses and International Lakes. Ukraine is a party to both Conventions.

Thus, the project activity is fully in line with the political direction of Ukraine in the European integration and the sustainable development of the country.

Project activities

Based on the above there is a proposal to continue the project activities in Ukraine as the second phase to improve the safety of tailings along the following main lines.

1. **Harmonization of the legislative framework** of Ukraine on the basis of the Report "Analysis of the Ukrainian legislation and administrative situation on TMF" developed in the framework of the international project “Improving the safety of industrial tailings management facilities based on the example of Ukrainian facilities".
2. **Approval (adaptation) of the TMF Methodology** by Ukrainian expert group, which will consist of potential users (representatives of the competent authorities, relevant institutions, operators, environmental auditors and other stakeholders).
3. **Creation of a software product "Tailings management"** for the competent authorities based on the method Tailings Hazard/risk Index (THI method) and the method of the TMF checklist.
4. **The development of State Investment Programme** to improve the TMFs safety on the evaluation results of objects using the Methodology.
5. **Conducting training seminars** on the application of the TMF Methodology for the state inspectors, operators and environmental auditors.

Because of the implementation of the second phase of the project activities, Ukraine will harmonize legislative base on tailings, will perform a part of the commitments under the "Agreement on Association with the EU" in the scope of "Waste and resource management" [3] etc.

9 List of annexes

The annexes are devided in two blocks (project documents and project activitis) and include all details of the documents and activities can be used depending on the interest of the readers. For those who want and/or need to work with the TMF Methodology, it is of the highest importance to read and work with Annex 2 as it forms the core of all technical works and the necessary explanations. For the legal experts, for example of other UNECE countries, is of course Annex 1 important and can be used as an example to make a first assessment in their own country.

Project Documents

- Annex 1. Analysis of the Ukrainian legislation and administrative situation on TMF
- Annex 2. Methodology for improving TMF safety
- Annex 3. Database of the Ukrainian TMFs

Project Activities

- Annex 4. List of participants
- Annex 5. Kick-off meeting of project Parties (08-09.08.2013)
- Annex 6. First Steering Committee Meeting (14.11.2013)
- Annex 7. Internal Meeting (25.02.2014)
- Annex 8. First Testing of the TMF Checklist on practice (13-15.05.2014)
- Annex 9. Second Testing of the TMF Checklist on practice (04-07.11.2014)
- Annex 10. Second Steering Committee Meeting (07.11.2014)
- Annex 11. Final workshop (18-20.05.2015)
- Annex 12. Letters from project beneficiaries

Project Documents for practical application

- Annex 13. Template for calculation tailings hazard index, THI method (exel file “Annex 13. Template for calc tailings hazard index_THI method.xls”)
- Annex 14. Template for calculation TMF safety level, TMF Checklist method (exel file “Annex 14. Template for calc TMF safety_TMF Checklist method.xls”)

10 References

1. Eighth Meeting of the Conference of the Parties to the Industrial Accidents Convention, Palais des Nations, room VII. http://www.unece.org/env/teia/cop8.html#/
2. Improving the safety of tailings management facilities based on the example of Ukrainian facilities. Project description https://www.umweltbundesamt.de/en/topics/sustainability-strategies-international/cooperation-eeca-centraleastern-european-states/project-database-advisory-assistance-programme/improving-the-safety-of-tailings-management
3. Official Journal of the European Union, Vol. 57, 29.5.2014, L 161/1951
4. Safety guidelines and good practices for tailings management facilities. (2008, updated version 2014) UNECE. Geneva.
5. TMF project in Ukraine. www.tmf-ukraine.org
6. UNECE Convention on the Transboundary Effects of Industrial Accidents. http://www.unece.org/fileadmin/DAM/env/documents/2006/teia/Convention%20E%20no%20annex%20I.pdf