

Brussels, 12 May 2023

COST 048/23

DECISION

Subject: Memorandum of Understanding for the implementation of the COST Action “Recovery of Mining District Network” (REMINDNET) CA22138

The COST Member Countries will find attached the Memorandum of Understanding for the COST Action Recovery of Mining District Network approved by the Committee of Senior Officials through written procedure on 12 May 2023.

MEMORANDUM OF UNDERSTANDING

For the implementation of a COST Action designated as

COST Action CA22138 RECOVERY OF MINING DISTRICT NETWORK (REMINDNET)

The COST Members through the present Memorandum of Understanding (MoU) wish to undertake joint activities of mutual interest and declare their common intention to participate in the COST Action, referred to above and described in the Technical Annex of this MoU.

The Action will be carried out in accordance with the set of COST Implementation Rules approved by the Committee of Senior Officials (CSO), or any document amending or replacing them.

The main aim and objective of the Action is to compare present legal framework, governance structures and management approaches for closed mines across the COST Action member countries and harmonise best practices, standards and lessons learnt for a comprehensive and sustainable management of raw materials' extraction legacies. This will be achieved through the specific objectives detailed in the Technical Annex.

The present MoU enters into force on the date of the approval of the COST Action by the CSO.

OVERVIEW

Summary

The extraction of minerals and metals from the earth crust is as old as human mankind. The management of mine closure and post-closure is getting more and more attention because in Europe as well as worldwide many regions are affected by environmental residues such as tailings, waste dumps, subsidences, contaminated water which is the result of unsatisfactory environmental performance of the mining industry in the past. All European countries are facing these problems and many of these countries are lacking funds and capacity in managing these old mine sites. This network of proposers with 74 scientists and practitioners from more than 60 organisations from 28 EU countries focus on legislation, governance and management of these legacies, financing as well as rehabilitation and monitoring techniques to improve implementation to minimize post-closure mining legacies. It will establish an European mining legacy database, compare present legal framework, governance structures and management approaches, provide input to mine authorities, regulators and financial institutions on a social balanced and environmental friendly management of mine legacies, harmonise best practices, standards and lessons learnt for a comprehensive and sustainable management of raw materials' extraction legacies and disseminate the results to the public through an open access visualization platform. The network pools experts from currently separated fields (e.g. geologists, economists, engineers, environmental and social scientists, metallurgists, legal representatives, etc.) to consolidate knowledge and foster mutual exchange of knowledge between researchers.

Areas of Expertise Relevant for the Action	Keywords
<ul style="list-style-type: none"> • Environmental engineering: Mining and mineral processing 	<ul style="list-style-type: none"> • Postmining • Abandoned mine • Environment • Sustainable management of closed mines • Raw materials

Specific Objectives

To achieve the main objective described in this MoU, the following specific objectives shall be accomplished:

Research Coordination

- Develop a common understanding of sustainably managing mine legacies
- Compare present legal framework, governance structures and management approaches
- Establish an European mining legacy database and visualisation on QGIS
- Provide input to mine authorities, regulators and financial institutions
- Open access visualization platform

Capacity Building

- Establish and maintain a community of practice
- Pool experts from currently separated fields
- Involve special target groups (focusing on the management of mine legacies, Early Career Investigators, under-represented gender, experts from countries with less capacity in the field of management of mine closures and mining legacies)

TECHNICAL ANNEX

1. S&T EXCELLENCE

1.1. SOUNDNESS OF THE CHALLENGE

1.1.1. DESCRIPTION OF THE STATE OF THE ART

Over the past five decades, our global population has doubled, the extraction of raw materials has tripled and gross domestic product has quadrupled. The extraction and processing of natural resources has accelerated over the last two decades [1] and requires a **sustainable management of extractive legacies**. The shift to Renewable Energies demands raw materials for instance to windmills in form of concrete (limestone) and steel (iron ore). These raw materials already make up around 90 – 95% for the construction of a single windmill [2]. Therefore, extraction of raw materials will still be essential for a long time in the future. Present, future as well as past consequences of mining activities must be addressed in a responsible and sustainable manner. The design of a sustainable raw material management takes into account the entire mining life cycle, beginning with granting mining rights and licenses, during exploration and production stages and finally ending up with mine closure and reclamation [3, 4, 5]. Only in this way a responsible raw material extraction in Europe, but also outside of Europe, can be planned and implemented and makes a valuable contribution to implementing the UN Sustainable Development Goals. Furthermore, according to the 2020 Circular Economy Action Plan, besides to the attention that must be paid to the environmental and social impacts of the production of primary raw materials both in the EU and in non-EU countries, circularity in production processes should be boosted and waste policies should be enhanced in order to drive and regulate environmentally sound mining activities from their inception to their functioning and through to their closure [6].

The **management of raw materials' extraction legacies** is getting more and more attention because in Europe as well as worldwide many regions are affected by former mining activities. There are several initiatives worldwide for managing mining legacies (sometimes also referred as “abandoned mines”, “orphan mines”, “derelict mines”). Risk-based approach is mostly the basis for their management and their subsequent handling are documented in guidelines for risk mitigation/treatment. Some of these initiatives are in the form of abandoned mines land programs: NOAMI in Canada, abandoned mines program in Western Australia and the abandoned mines program of the US EPA. Also, worldwide Brazil [7], Canada [8] and Australia [9, 10] have worked out guidelines for mine closure and post-closure. Multinational organisations like APEC [11]; World Bank [12] or ICMM [13, 14] have also developed procedures entailing environmental and social issues. Furthermore, the ISO standardisation organisation is working on a standard regarding the management of mining legacies. On national level, Finland so far has elaborated a mine closure handbook already in 2008 [15, 16]. Within the RFCS project MISSTER Mine shafts: improving security and new tools for the evaluation of risks a Handbook was created. The German Federal Institute of Geoscience and Natural Resources has developed a guide for Latin American countries [17].

Post-closure activities encompass actions such as rehabilitation, re-utilisation, repurposing, environmental monitoring etc. The probability of the occurrence of risk-related events increases with the age of the mines, therefore the same problems will increasingly have to be solved in Europe in the course of time. In particular in densely populated areas the end of mining has made it an imperative to scientifically address the consequences of mining and the processes that will have to be controlled in the future with eternal effects, such as mine water rebound, groundwater management and geo stability of waste dumps and tailings storage facilities. All European countries with a long mining history have similar pressing problems and their solving require a multinational approach and exchange of knowledge.

All mining sectors pose risks to varying degrees like coal, lignite, metal ores (Fe, Cu, Al, Pb, Zn, etc), precious metals and Rare Earth Elements, industrial minerals (potassium, salt, phosphate, etc.) as well as construction minerals and aggregates (sand and gravel, limestone, etc.). The extraction of these raw materials from the surface or subsurface leads inevitably to an intervention in the landscape and in the natural environmental compartments of air, soil and water as well as in biodiversity and habitats change, even in the social surroundings and in the life of the local population. Depending on the technology in use and the management practices adopted, mining and raw material processing can cause considerable environmental degradation and industrial pollution, loss of vegetative cover, land degradation, and ecosystem disruption. Mining dumps and tailings are frequently the principal source of solid waste as well as liquid waste pollution affecting public health and social community development. Mining, concentration and refinement processes may also cause the contamination of ground and surface waters with toxic chemicals and metals. Excess copper, nickel, mercury, cyanide, zinc, lead and cadmium all have negative biological effects on the human body and other beings in the food chain, while the dust and the water in the mining environment can make it a hazardous workplace. In addition, inefficiencies related to under-utilized capacity, equipment malfunctions, lack of reagent controls, irregular operating regimes and the use of high-sulfur fuels contribute significantly to adverse environmental impacts. The management of environmental impacts of extraction during operations can help to minimise these impacts and the future cost of environmental management. However, with the cessation of the mine these adverse environmental impacts will not stop, in contrast they remain existing. Most of the environmental issues at closed mine sites (Fig 1), both open pit and underground, are the same as those at active sites. The only major difference might but does not have to be in the grade of severity and areal extent of the impact. In the social dimension the post-mining facilities including waste dumps strongly grow into the landscape and social awareness. Over time they are viewed as an integral part of the neighbourhood and place's identity.

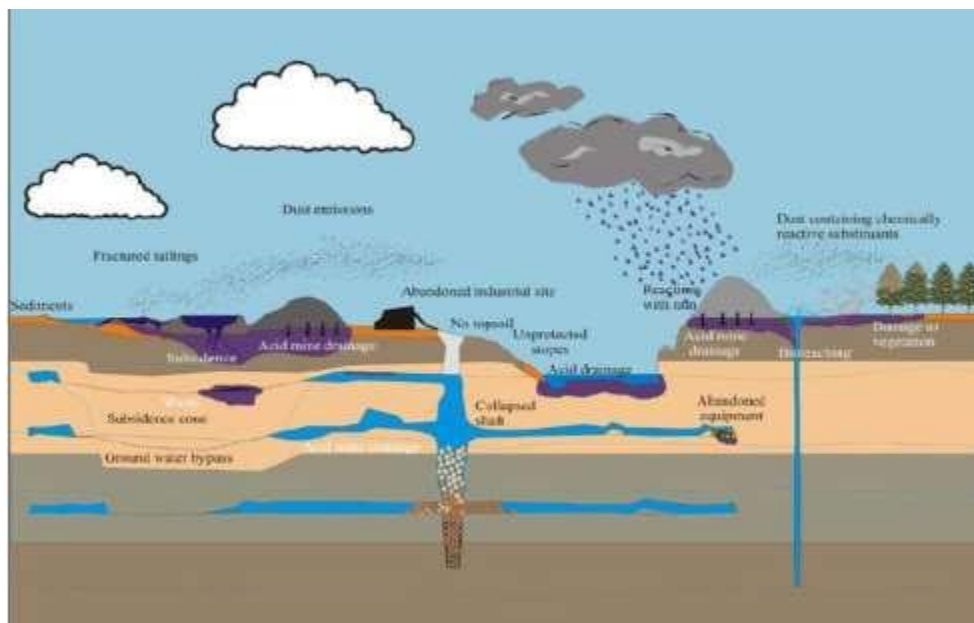


Figure 1: Environmental effects of closed and abandoned mines (by the proposers)

In Europe, mine closure planning is mostly part of the approval process and numerous general legal obligations are relevant during the mining process and the closure. Therefore, mining companies are responsible to return the disturbed land to a stable and productive condition. However, there are closed and abandoned mines whose activity is based on old operations and which may not have worked according to modern environmental standards. Europe has a huge legacy of these mines, which is the result of unsatisfactory environmental performance in the past. The table below highlight some legacies.

Country	Legacies
Czech Republic	As of January 1, 2022, 1871 abandoned mines are registered in the Czech Republic that have no or unknown owner. In case it is an old mine that threatens the public interest, the government takes responsibility for its rehabilitation.

Germany	Saxony 75% of the territory and North Rhine-Westphalia 1,000 km ² influenced by former mining, 60,000 old mine openings not rehabilitated.
Romania	No statistics regarding abandoned mines are available, 52 lignite mines closed till 2016, open-pit mines occupy 10,500 ha. affected land only partially rehabilitated.
Spain	Inventory of Abandoned and Decommissioned Mining Waste Facilities: 44 ponds and 29 dumps classified as having a "serious environmental impact".
Kosovo	Lack of statistics of former mine openings and abandoned mines; 60 million tons of mine waste in 9 tailing ponds
N.Macedonia	Abandoned Lojane Mine complete infrastructure like underground workings, processing facilities, ore waste dump and tailings ponds without any rehabilitation. Remainings with heavy and toxic metals (As, Hg, Cr ⁶⁺ and Sb). The Lojane tailings pond is the "ecological bomb" and is on the list of ecological hotspots
Belgium	Pb/Zn mining, the old mines are still present in the east of Belgium
Slovakia	17,852 objects, including 6,545 waste rock piles and 53 tailings ponds. 16,000 of them abandoned, 535 mining waste repositories subject to long-term monitoring, 25 areas classified as hazardous and in need of remediation
France	National extractive waste inventory: 800 former mine sites; 2,100 metallic and 1,300 coal tailings, 53 sites with major environmental issues
Finland	The KAJAK projects (KAJAK I 2012-13; KAJAK II 2015-16) commissioned by the Ministry of Environment reported a total of 53 mining waste areas in 40 mining sites and a follow up measures on 30 of these mining areas (Tornivaara et al. 2018). A further assessment (KAJAK III) highlighted the need for rehabilitation of these areas (Tornivaara et al. 2020). [23, 24]

Poorly closed and abandoned mines provide a difficult legacy issue for governments, communities and mining companies. Both the closure of current mines and improperly closed or abandoned mines are a potential threat and require knowledge and methodologies to ensure a resilient rehabilitation in post-closure landscapes [18]. Especially in the absence of identifiable owners or operators of the site which would normally be responsible for the implementation of long-term environmental monitoring and reclamation programs, potential hazards often become real impacts. In these cases, the state can initiate a legal process in order to identify the former owners and operators of the site, who will then be held responsible financially for clean-up costs at the site. However, there are many cases in which the former owners cannot be identified or lack the funds to finance such a clean-up, thus the financial burden is often transferred to the state. In addition, many Integrated Targeted Countries or Near Neighbouring Countries are lacking the appropriate legal framework and governance structures as well as management processes, rehabilitation methods, risk mitigation and monitoring techniques for abandoned and closed mines. Therefore this COST Action REMINDNET includes proposers from Albania, Austria, Bosnia-Herzegovina, Bulgaria, Croatia, Czech Republic, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Kosovo, North Macedonia, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Turkey, Ukraine and United Kingdom all faced by these raw materials extraction legacies in order to create a **community of practice** that is active in all aspects and disciplines related to the management of abandoned and closed mines.

Given the critical resource situation, many countries are considering reopening mining operations, which could potentially be risky. In September 2020, the European Commission announced the Critical Raw Materials Action Plan [24]. As of 2020, 30 raw materials have been classified as critical, including several that are of growing importance in the energy sector, such as lithium and cobalt. The aim is to expand the extraction of raw materials in the EU and improve the recycling of critical raw materials.

1.1.2. DESCRIPTION OF THE CHALLENGE (MAIN AIM)

The issue of old mine workings often cannot be dealt with at the level of a single state only, due to the fact that districts may not respect national boundaries. E.g. Upper Silesian Coal Basin (PL-CZ), ore district in the "Krušné hory" (Erzgebirge - Ore Mountains CZ-DE), lignite/brown coal PL-DE-CZ (the mine

Túrow). Therefore, environmental impacts must be addressed not only at the level of the applicable national legislation, but also with international cooperation. Similarly, the consequences of accidents, contamination from old mine workings, including emissions, radioactivity, light emissions, must be dealt with internationally. Therefore, this COST Action has the aim to actuate **the sustainable management of raw materials' extraction legacies**. This requires the consolidation of existing knowledge, experience and technologies with respect to legislation, governance and management, financing as well as rehabilitation and environmental monitoring. This COST Action strives for a breakthrough in the truly integrated management of mine legacies. The following questions will therefore be addressed by the Action:

1. How to improve implementation to minimize post-closure mining legacies? (science)
2. How to assess, mitigate and monitor adverse environmental effects? (science, technology)
3. How to support mining authorities in implementing good governance and management practices? (science, social)
4. How to ensure a well-balanced financial coverage? (economy)
5. How to strengthen Community Development and stakeholder engagement? (social)

1.2. PROGRESS BEYOND THE STATE-OF-THE-ART

1.2.1. APPROACH TO THE CHALLENGE AND PROGRESS BEYOND THE STATE OF THE ART

The Commission has adopted several legislation for extractive mining operations as well as on water management:

- Directive 2006/21/EC on the management of waste from the extractive industries.
- Commission report on the implementation of Directive 2006/21/EC,
- Best Available Techniques reference document Management of Waste from Extractive Industries in accordance with Directive 2006/21/EC (MWEI BREF), [19]
- Seveso III Directive: operational tailings disposal facilities containing dangerous substances,
- 2009/335/EC: Technical guidelines for the establishment of the financial guarantee [20]
- Guidance document on non-energy mineral extraction activities in Natura 2000.
- Directive 2000/60/EC Water Framework Directive

In March 2021, the Commission has published the guidelines for mine closure activities and calculation and periodic adjustment of financial guarantees [21]. Besides the financial aspects of mine closure it describes some rehabilitation techniques.

So far, a holistic approach to bring together these parties and to manage raw materials' extraction legacies has not been undertaken. The proponents will focus on solid primary minerals such as coal, lignite, oil shale, ores, industrial minerals, construction minerals and aggregates.

Nowadays there is no unified legislation and each country has its own regulations and manuals. This unfortunate situation is already evident when a mine or deposit is located in two states. The project aims not only to survey the legislation, but also to find common points and propose new innovative solutions valid across states.

1.2.2. OBJECTIVES

1.2.2.1. Research Coordination Objectives

- Develop a common understanding of and definitions for sustainably managing mine legacies.
- Compare present legal framework, governance structures and management approaches for closed mines across the COST Action member countries.

- Coordinate information search and data collection, especially for data sets and statistics not available for research groups due to language barriers and lack of national contacts.
- Establish a European mining legacy database and visualisation on QGIS
- Compare and harmonise best practices, standards and lessons learnt for a comprehensive and sustainable management of raw materials' extraction legacies
- Input to mine authorities, regulators and financial institutions on a social balanced and environmentally friendly management of mine legacies by learning and training through a community of practice.
- Transparent dissemination of the results to the public through an open access visualization platform (derived from the GIS database).

1.2.2.2. *Capacity-building Objectives*

- Establish and maintain a community of practice, foster international knowledge exchange and develop a joint research agenda in terms of managing raw materials' extraction legacies.
- Pool experts from currently separated fields (e.g. geologists, geoscientists, economists, engineers, environmental scientists, natural scientists, metallurgists, legal representatives, spatial planners, social scientists) to consolidate knowledge for sustainably managing the legacies.
- Involve special target groups: a) new research groups focusing on the management of mine legacies, b) Early Career Investigators (ECI), c) under-represented gender, d) experts from countries with less capacity in the field of management of mine closures and mining legacies.
- Entrust ECI from less research-intensive countries and under-represented gender with leadership roles under their own responsibility and mentorship of senior professionals
- Foster mutual exchange of knowledge between researchers and practitioners by means of STSM.
- Establish annual meetings, workshops and conferences in order to strengthen the collaboration of the participants, to foster joint research and knowledge exchange. In the meetings, the status of the technologies and the trends will also be discussed.

2. NETWORKING EXCELLENCE

2.1. ADDED VALUE OF NETWORKING IN S&T EXCELLENCE

2.1.1. ADDED VALUE IN RELATION TO EXISTING EFFORTS AT EUROPEAN AND/OR INTERNATIONAL LEVEL

While many organisations and projects in Europe and internationally work on different aspects of the management of mining legacies, none brings together the issues and perspectives as this Action seeks to do. The Action will thus provide a networking stage - both in terms of building research relationships and in terms of dissemination – for and with important existing efforts. To achieve the Action's aims a coordinated community of researchers, practitioners and scholars is required:

- complementary disciplines: Traditionally, individual experts and research groups work sector specific in separated departments and often on a project basis. This COST Action is a unique opportunity to bridge various disciplines (e.g. geologists, geoscientists, mining and processing engineers, natural as well as material scientists, environmental and social scientists, spatial planners, lawyers and socioeconomists) and research aspects all along the management of mining legacies, from the technical point of view to social, financial and legal issues.

- 28 countries: The availability and access to data in different countries depends, for instance, on language skills, informal local knowledge, and barriers and contacts to local stakeholders. This prevents a pan-European assessment of the closed and abandoned mines, waste dumps and tailings residues from mineral processing plants. Having a community of practice from 28 EU countries (17 ITC, 1 NNC)

involving academia, research institutions, authorities, civil organisations and enterprises improves information seeking and data acquisition in terms of quantity and quality.

- research projects: A broad range of research projects (including different methods, data search strategies and data sources) is carried out without generating a synergy on the European level. Networking bridges existing knowledge on the national/regional/local level, creating added value on a European level by involving also experts from countries with low capacities in managing mining legacies and by coordinating the search for data. This offers the opportunity to develop existing methods further and to make them more robust and reliable. The coordination of existing and future research agendas contributes to sustainable mine closures.

The COST Action has an added value (AV) in relation to former and existing projects and networks, of which few have been selected due to the page limit of this Technical Annex.

Research projects: USAMIN (Creation of a new online study course "Use of Abandoned Mines"), REWAISE (REsilient Water Innovation for Smart Economy), MINLAND (Mineral resources in sustainable land-use planning), MERIDA (Management of environmental risks during and after mine closure); MANAGER (Management of mine water discharges to mitigate environmental risks for post-mining period), TRIM4PostMining (Transition Information Modelling for transition from coal exploitation to a re-vitalized post-mining land scape), RAFF (Risk Assessment of Final Pits During Flooding); RIS-CuRE (Zero waste recovery of copper tailings in the ESEE region), BioSolution4ZeroWaste (New environmental way of bioleaching for minerals refining and metals extraction from tailings); RIS-RECOVER (Regional innovation scheme for zero waste extraction of critical raw materials); BioLeach (Innovative Bio-treatment of RM), CE3PMI (Circular Economy & 3R Policies in Mining Industry); CAMRF (Comprehensive analysis of mining regulation framework,), H2020 NEMO "Near-zero-waste recycling of low-grade sulphidic mining waste for critical-metal, mineral and construction raw-material production in a circular economy", H2020 "Tarantula" treats the recovery of Tungsten, Niobium and Tantalum occurring as by-products in mining and processing waste streams. AV: These projects are related only to single environmental aspects of coal, lignite or metal mining. This COST Action covers all aspects of mining legacies in primary raw materials and brings together the different research results.

Some projects are already related to networking such as RE-ACTIVATE (Developing superior technical infrastructure throughout EIT RawMaterials community to foster technologies and methodologies for re-activation of former mine sites) or ReviRIS (Revitalising Post-Mining Regions). AV: The COST Action already brings together more partners from different ITC and NNC in Europe and in the long run from more countries outside the EU (Latin America, US, Canada, Australia etc) to share knowledge and expertise.

Networks and Expert Groups:

Many of the partners are already member of different networks and expert groups: ISO Working Group "mining legacies", The International Society for Rock Mechanics and Rock Engineering (ISRM), EU DG ENV "Expert Group on Risk Management in the Extractive Sector", EU Joint Research Center, European Raw Materials Alliance (ERMA), Initiative for Responsible Mining Assurance (IRMA) etc.. In addition, the proposers have contacts to the different European associations (Euromines, EuroGeosurveys, Euracoal, UEPG, etc.). These contacts enable the network to engage with the mining community from the beginning.

2.2. ADDED VALUE OF NETWORKING IN IMPACT

2.2.1. SECURING THE CRITICAL MASS, EXPERTISE AND GEOGRAPHICAL BALANCE WITHIN THE COST MEMBERS AND BEYOND

The Action covers selected experts who (a) have been personally invited to join the network, (b) declared a strong interest in the topic, (c) contributed to the Technical Annex, and (d) guarantee an optimal starting position for implementing the COST Action:

- **Critical mass:** The critical mass is achieved because it covers **74** Proposers (1) across all relevant disciplines, (2) with active involvement in research projects/implementation strategies, (3) their openness to new ideas and (4) who are well connected with relevant stakeholders on a national and international scale. This guarantees threefold: First, an excellent starting position. Second, the involvement of relevant stakeholders beyond the Network of Proposers in terms of Action Participants. Third, addresses for the dissemination of the Action outcomes.
- **Expertise:** The Network of Proposers is an interdisciplinary and intersectoral pool of experts who are needed to achieve the Action's objectives. The Proposers are well-known and recognised experts from academia, research institutions, NGOs and enterprises and being members of international expert panels. All of them deal with this topic since many years and have long-lasting experience. During the project the proposers will reach out to and integrate critical grassroots groups into the network.
- **Geographical distribution:** The Network of Proposers has 74 experts working at 60 prestigious institutions, governmental bodies, NGO and enterprises in 28 EU countries, of which 27 are COST Countries (of which 63 % are COST Inclusiveness Target Countries (ITCs) and 1 COST Near-Neighbouring Countries (NNCs).
- **Gender balance:** 43% of the proposers are **female** and the COST Action will made efforts to increase their participation by inviting more women from other institutions and encouraging female PhDs and ECI to participate.

The Action invited partners from Kosovo. The country is endowed with different kinds of mineral resources, with a long tradition of mineral extraction. The huge mineral extraction in the past, left behind lots of mining legacies, like abandoned mines and non-rehabilitated tailings, which present threats to the environment every day. The Independent Commission on Mines and Minerals in Kosovo lack funds, lack capacity in terms of managing mining legacies, tailing rehabilitation and aftercare process. Capacity building, exchanges experience and knowledge are considered just some of the mutual benefits of this Action. Considering Kosovo's commitments, to follow environmental protection standards, and developing mining as well, it is beneficial to gain and strengthen knowledge and experience on managing mining legacies.

The COST Action will strive to include additional NNGs, International Partner Countries and International Organisations to create mutual benefits: First, to gain more information about available data (e.g. on the closed and abandoned mines) in order to contribute to the European-wide assessment of mine legacies. Second, to consider more stakeholders for dissemination and exploitation. Third, for knowledge and technology transfer between countries with less management and governance capabilities.

Representatives of Germany and France are working on a draft for the ISO Standards on Management of mining legacies and on the Management of mine water. Therefore, it would be an exchange of knowledge and expertise between the ISO group and the Network. The Action extends its network to other states like Australia, Canada or USA, which are facing the similar issues as in Europe.

2.2.2. INVOLVEMENT OF STAKEHOLDERS

Stakeholders play an important role in the management of raw materials extraction and mine closure. Having organisations in the network who are experienced in stakeholder engagement the Action will establish strong relationships with stakeholders and show transparency to the public from the very beginning of our Action. A stakeholder engagement plan will be elaborated and based on the contacts the Action will be able to reach publics and stakeholders who live and work in the mining areas. This ongoing approach will create durable networks across research and practice, allowing for the early integration of interested parties as well as transparent insights into our work. The COST Action will in addition strive to engage with industry, policy makers, standards organisations, national authorities, NGOs, CSOs and with the public. Stakeholders' involvement is first relevant to problem definition and knowledge generation but also for dissemination. Stakeholders mapping, analysis, prioritisation, and engagement strategy will be initiated at the onset of the COST Action. The Science Officer is integrating the relevant stakeholders in COST Action Workshops/ Conferences as keynote speakers or in dedicated sessions during a COST Action activity.

Each thematic Working Group will have its own stakeholder engagement partners. The Working Group leaders will be responsible for involving these partners routinely in the Action. The goal here is to build relationships that are meaningful and sustainable beyond the Action and can lead to future partnerships. While each WG will have a particular focus, the Action specifically targets four communities of practice: (1) authorities, financial institutions; (2) policymakers at the local, national and European level; (3) local community groups and (4) companies with potential to use old mine workings and brownfields. The experience and outcomes of these stakeholder collaborations will be shared on the Action website through articles and digital content and expanded in the final dissemination volume, to which all partners will contribute.

The COST Action is open to all researchers, scholars and practitioners who contribute to the COST Action's objectives and strive to involve special target groups: a) new research groups focusing on the management of raw materials' extraction legacies, b) Early Career Investigators, c) under-represented gender, d) experts from countries with less capacity in the field of management of mining legacies from Europe and worldwide. The most relevant research fields are: earth science, natural science, mining and environmental engineering, spatial planning, social sciences and environmental economy.

3. IMPACT

3.1. IMPACT TO SCIENCE, SOCIETY AND COMPETITIVENESS, AND POTENTIAL FOR INNOVATION/BREAK-THROUGHS

3.1.1. SCIENTIFIC, TECHNOLOGICAL, AND/OR SOCIOECONOMIC IMPACTS (INCLUDING POTENTIAL INNOVATIONS AND/OR BREAKTHROUGHS)

The COST Action produces a broad set of impacts on scientific, technological and socio-economic changes in a short and long-term perspective (Table 1).

	Short term (4 years)	Long-term (beyond 4 years)
Scientific	Impacts on the definition of terms across research groups and disciplines in the field of raw materials extraction due to the involvement of different fields. Impacts on the available knowledge and assessment of mine legacies in Europe. Impacts on the development and integration of methods and data to investigate and evaluate mining legacies.	Impact on standards for the management of raw materials' extraction legacies like the Global Industry Standard on Tailings Management and the ISO Working Group "Managing mining legacies", Impact on international and national research programs due to the coordination of ongoing research activities and outlooks on future research needs. Impacts on legal aspects for post-closure and risk management of raw materials' extraction legacies due to the involvement of authorities
Technological	Impact on the use of best available technology and on the development of new technologies for rehabilitation and monitoring of mine water, mine waste dumps and tailings storage facilities as well as for re-utilisation and repurposing of old mine sites.	Impacts on the application of future environmental monitoring technologies (satellite, UAV, in-situ sensors such as RFID or NFC sensors) for long-term risk management due to improved knowledge about environmental impacts.
Socioeconomic	Impacts on the development and implementation of post-closure management strategies on the national and international level. Impact on the public awareness of mine legacies in general and the need for changes with respect to social and ecological concerns	Impacts on the investments for the management of raw materials' extraction legacies Impacts on the risk management with respect to a minimum of negative environmental impacts

3.2. MEASURES TO MAXIMISE IMPACT

3.2.1. KNOWLEDGE CREATION, TRANSFER OF KNOWLEDGE AND CAREER DEVELOPMENT

By bringing together researchers and practitioners from fields that do not yet routinely collaborate and by creating opportunities for open dialogue, the Action will directly contribute to the creation of new knowledge about how to manage mining legacies and tackle the adverse effects of these legacies. The Action contends that its innovative approach to working together will have a highly innovative effect.

- By creating a community of practice through Action meetings, workshops, PhD TS, and STSMs. While the Network of Proposers is composed primarily of scholars from the earth sciences and mining engineering, these already have strong working relationships with stakeholders and with academics in environmental sciences, economics and other disciplines that are not routinely engaged in this field. Through systematic training and engagement events that will take place from the beginning of the Action, the Action will thereby build structures for sustained knowledge transfer between different fields and between academia and practice.

- Absolutely central is the leadership role played by ITC Action members. The ITC partners will benefit from the experience, know-how and technologies developed in the Full COST member countries and in return will bring new application approaches to these partners. This Action was developed crucially by ITC researchers and they are indispensable to its success, taking key management roles and opening up the field to ideas with different traditions, with new linkages, and in different languages.

- The Action will maximise its impact by supporting career development and offering training to the next generation of geoscientists, mining and environmental engineers. Career development will be supported in four primary ways: (1) the Action will organise four intensive PhD Training Schools (one on government and management; one on socioeconomic and finance and the remaining on rehabilitation, environmental monitoring and risk management and use of abandoned mines) that will provide new scholars with the opportunity to receive training outside their home discipline and feedback from cutting-edge researchers; (2) the Action will organise networking events at Action meetings specifically aimed at bringing early career scholars into conversation with more senior colleagues on a level playing field; (3) the Action will systematically involve early career scholars and doctoral students in the management of the Action and in organising events in order to provide them with experience indispensable in today's academic market; and (4) the Action will make a point of supporting the research and public facing outputs by ECIs via the Action's website and print publications.

3.2.2. PLAN FOR DISSEMINATION AND/OR EXPLOITATION AND DIALOGUE WITH THE GENERAL PUBLIC OR POLICY

The Scientific Communication Manager and the Dissemination and Communication Working Group (WG 5) will present a dissemination plan during the first three months of the Action. Thereafter they will update the plan on a yearly basis and monitor implementation:

- Publications: Scientific OA papers, reports, white papers, input to Training Schools, leaflets. Most of the Action Participants have an academic background and are active as researchers. For them, publications are of high relevance for knowledge transfer. The COST Action strives to create special issues in scientific journals. For instance, at end of Y1 a publication will be issued covering the state of the art of abandoned and closed mines in all participating member countries of this COST Action. The Participants will also be encouraged to publish coauthored peer-reviewed scientific papers. Reports and leaflets are mandatory output formats of each Working Group (WG). Leaflets will contain a condensed report for promotion purposes. The input to Training Schools includes lecture slides, software and VR/AR/MR tools and manuscripts.
- COST Activities: (1) STSMs: It addresses mainly ECIs to gain working and dissemination experience abroad. Some STSM are also dedicated to participants from authorities to enhance their knowledge. Mutual knowledge transfer between the host members and the guest enhances and extends the actual state of knowledge. The STSM Participants have to contribute to achieving the Action objectives and have to profit from the other Action activities. (2) Training Schools: Training Schools will be jointly organized with other networks and associations to increase the impact. The

Training School Participants have to learn from and contribute to the COST Action. (3) Meetings: (3a) Workshops: They are implemented in order to address a specific scientific aspect in detail which goes beyond the scope of the WG meetings. They are open to everybody in order to pool additional knowledge and to disseminate intermediate results. (3b) Conferences: One scientific and one final conference will be organized to disseminate final outcomes. Proceedings will be publicly available. (4) ITC Conference grants: The COST Action partners will offer relevant calls to grant the opportunity to Early Career Investigators to attend a conference outside the COST Action.

- Webpage: A webpage will provide relevant information about the COST Action to the general public, potential future Action participants, the scientific community and stakeholders. It will (1) cover details about the COST Action itself (objectives, management structure, activities), outcomes for download and, (2) links between the COST Action and external activities such as events, research programs and networks.
- Newsletters: The news will be sent out via E-Mail to target groups and persons who want to be updated about the progress of the COST Action.
- Press releases, talks & interviews: To promote the COST Action and to disseminate major results, press releases will be distributed via multiple media channels. All Action Participants will be encouraged to give talks to promote the entire COST Action (mainly the MC) and the Action outcomes on events, and to give interviews on television and radio.
- Social media: The COST Action will also be disseminated via social media on Facebook, twitter etc and via blogs, podcasts, short videos etc.

The outcomes will be actively disseminated to target groups: (1) Research institutions and groups in the scientific field of the COST Action, (2) International organisations (e.g. EC, Society of Economic Geologists, Euromines, Euracoal, UEPG, IMA-Europe, etc), and (3) Institutions for coordination and implementation at different spatial levels (e.g. Ministries of environment and economics, networks & associations, management bodies & mining authorities) (4) the broader public to create transparency and establish trust in the sustainable management of raw materials' extraction legacies

Sustainability will be ensured in follow-up R&D projects (Horizon Europe and others), educational projects (e.g. MSCA, doctoral networks), as the Action members believe that participation to COST Action will increase the chance for success of applications to other European programmes.

4. IMPLEMENTATION

4.1. COHERENCE AND EFFECTIVENESS OF THE WORK PLAN

4.1.1. DESCRIPTION OF WORKING GROUPS, TASKS AND ACTIVITIES

At the first Management Committee meeting, the Action Chair, Vice-Chair, STSM coordinator, Science Communication Manager, and Working Group (WG) chairs and deputies will be elected. Thereafter the Action MC will meet up to four times per year (sometimes virtually), with additional meetings called as required by the Action Chair or on request of three COST participating members. The Action MC will coordinate the activities of the WGs. Membership and terms of reference of these WGs will be established by the Action MC, and will last for the duration of the Action. In addition to the general management, the Action MC will be responsible for maintaining and implementing the data management and dealing with emerging IP management issues.

Five WGs will be formed. The Working Groups 1-3 addresses the three main aspects of mine legacies management: (WG 1): Government and management practices, (WG 2): Socio-economic aspects and financing, (WG 3): Environmental monitoring and risk management and use of abandoned mines. The WG 1-3 will produce consolidated knowledge for managing mine legacies. Each of these Working Groups will be led by a WG Leader who reports to the Action MC, and will include at least one ECI. Each WG will be responsible for providing inputs onto the training schools, meetings and conferences (WG 4 and WG 5). It is expected that the thematic WGs will form the spaces of dialogue that give rise to STSMs, and the STSM coordinator will ensure that the work of each thematic WG is equally supported through these missions. Each thematic WG will have a specific stakeholder engagement focus and will be tasked with maintaining ongoing involvement of its key stakeholder groups across the life of the Action. WGs will be concerned respectively with supporting the Dissemination and Training activities of the Action as a whole. WG 5 coordinates the dissemination activities of this COST Action.

A balanced composition around international, gender, and early career representation will be maintained across all WGs. At least three of the WGs will be led by Action members from ITCs. Sub-groups within the WGs will be installed in order to achieve the COST Action objectives. Figure 2 defines the WGs.

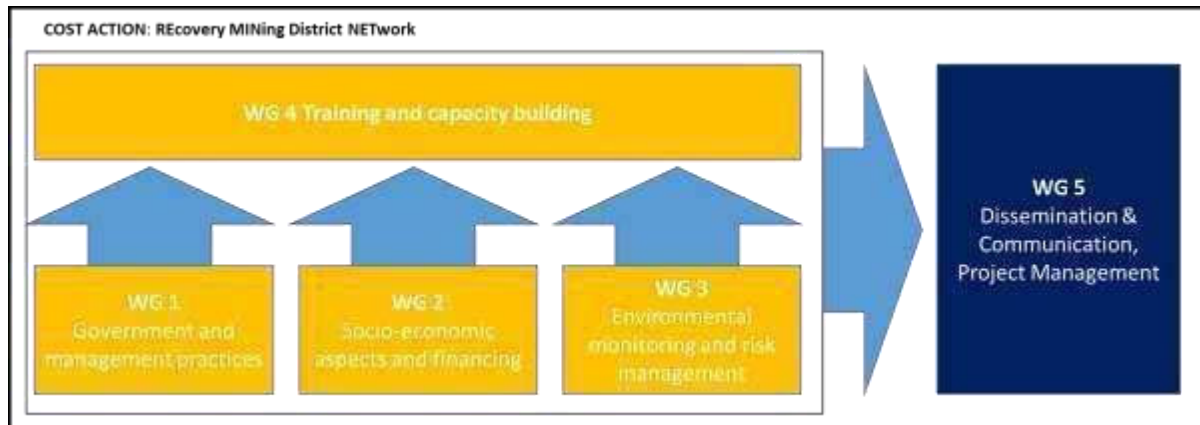


Figure 2: Proposed COST Action Working Groups

WG 1 Government and management practices

This Working Group will investigate the different legislation, governance and management practices in the European mining countries. The members of the Action regard a comparative and transnational understanding of the local implementation of the management of raw materials' extraction legacy as an indispensable underpinning to the Action. The main objective is to define a government structure and management tools for the management of raw materials' extraction legacies. The key stakeholders will be mining and other authorities.

Therefore, two subgroups will be established. Subgroup 1 will analyse the legislative aspects in the respective countries in Europe and internationally and compare them. They will determine strengths and weaknesses of the legislation and governance practices and determine obstacles. Subgroup 2 will focus on the implementation of the legislation and management practices. The participants in this subgroup will examine the respective authorities and bodies for the implementation, the relevant procedures and management tools. Like the work in Subgroup 1, the members of this subgroup will also determine the strengths and weaknesses and the obstacles. The leader of the subgroups will report to the leader of this Working Group.

WG 2 Socio-economic aspects and financing

This Working Group will work on the socio-economic aspects of post-closure and on the financing of mine legacies. Main objectives are to define a sustainable financing model for the management of legacies and to integrate Community Development strategies and methods towards a just socio-economic transition.

Two subgroups will be created: The first subgroup will analyse socioeconomic effects by collecting data from the regions, such as population, employment and skills profile, business sector, unemployment rates and the reduction of income. The members of this subgroup will also collect data about the coping strategies, such as the allocation of welfare benefits to the affected individuals and training and re-skilling opportunities. In addition, they investigate the community involvement practices to come up with a strategy for good community involvement to help the mining companies and authorities to integrate the community needs into their practice. The other subgroup will analyse the different financing models, elaborate on their advantages and disadvantages and obstacles and their influence on the socio-economic situation in a region. Key stakeholders are financial institutions like EBRD or World Bank, authorities and different mining associations. The leader of the subgroups will report to the leader of this Working Group.

WG 3 Environmental monitoring and risk management and use of abandoned mines

This Working Group will focus on the rehabilitation, monitoring and risk management of the different environmental aspects of raw materials' extraction legacies. The main objective is to map best practices for mine site rehabilitation including tailings and dumps reprocessing and provide cost-effective monitoring methods and risk management tools. The key stakeholder will be the different mining associations, companies and NGO. Throughout the COST Action duration, data on raw materials' extraction legacies will be compiled by the actors in this WG and visualised on QGIS resulting in an EU-wide assessment of mine legacies.

In this Working Group the following 4 subgroups will be established: Subgroup 1 focuses on mine water, Subgroup 2 on tailings management, Subgroup 3 on waste dumps and Subgroup 4 on brownfield rehabilitation. The actors in each subgroup will identify the risks associated with each topic and relevant monitoring techniques (from satellite imaging to in-situ technologies), discuss their pro and cons and give recommendations for their usage in risk management. In addition, technology gaps will be identified which will be the base for new research activities.

WG 4 Training and capacity building

WG 4 will have overall responsibility for planning the doctoral training workshops, ensuring early career investigator participation across the Action, and developing digital content and "good practice guides." Moreover, WG 4 will be charged with organising training events for annual Action meetings, which will encourage cross-disciplinary learning and input from the experts. WG 4 will support the STSM coordinator in the strategic planning and practical management of the missions. WG 4 will also be charged with acting as an ethics committee if any ethical issues associated with network activities arise during the life of the Action. Emphasis will be put to utilise VR/AR/MR technologies and applications and to transfer them in new educational applications like the mergecube (<https://mergeedu.com/cube>)

WG 5 Dissemination and communication, Project Management

WG 5 will be chaired by the Science Communication Manager. It will have overall responsibility for updating and implementing the dissemination plan, managing the website and associated social media channels, retaining editorial oversight of all published materials and digital content, organising the scientific and the final conference respectively. Particular attention will be devoted to offering early career and ITC and NNC scholars central roles in the scientific publication process.

Furthermore, the members of the MC will work on the internal project coordination, follow up on the achievements of the objectives and enlarge the network.

Each thematic WG will meet at least two times per year (including virtually), and will be expected to engage in regular communication and task setting between meetings. The annual meetings will serve as plenary events where the WGs are brought together to work on key objectives for the Action. They will be scheduled as three-day events, and include focused workshops, as well as joint site visits to experience mine legacies. Each will feature an annual public lecture within the timetable, open to an interested audience. While meetings will have targeted stakeholder events, stakeholders will be engaged in all Action activities. The annual meeting will occur early in each year of funding and will serve to consolidate progress towards objectives and set the agenda for the following year. Annual meetings will take place in different locations, at least half of them in institutions in ITCs.

The Action will have two major strands of capacity building activity, overseen by WG 4: Doctoral Training Schools (TSs) and Short-Term Scientific Missions (STSMs). Four TSs will be organised by WG 4 in collaboration with the WG 1-3 leaders and be open to doctoral students from partners of this COST Action. The first TS will deal with legislative and management aspects. The second TS will concentrate on socio-economic aspects and financing methodologies. The third and fourth TS will focus on latest remediation, rehabilitation and monitoring techniques and their application on the raw materials'

extraction legacies. All these TS are scheduled end of year two and in year three and will also offer training on networking and dissemination skills, as well as a mentoring component. The TSs will be co-delivered by Action members over the course of a week, with around 25 participants. The STSMs will commence in year one. The Action will concentrate on organising missions of three months or less, and will prioritise missions where there is demonstrable mutual benefit through either combining interdisciplinary skills or providing opportunities for the development of early career academics. WG 1 - 3 will provide a strategic mapping of planned work to inform the STSM scheme.

Dissemination and communication activities will be implemented by WG 5, which will have overall responsibility for establishing and maintaining the project website, associated social media accounts, developing the branding identity of the network, and ensuring that the dissemination plan is updated. Both WG 4 and WG 5 will include representatives from WGs 1 -3 to ensure effective planning and coordination.

4.1.2. DESCRIPTION OF DELIVERABLES AND TIMEFRAME

Deliverable	Team leading on deliverable	Timeframe
Action Website	Action MC Chair, Vice Chair, Science and Communication Manager and WG 5	Launched in month 3. Y1-Y4 of Action, with planning to sustain website beyond
Digital content QGIS and database	WG 1-3, STSM beneficiaries, participants in training schools	Continuously added to the website starting middle of Y1
Analysis of EU policies	WG Leaders of WG 1 and 3 with input from others	Continuously added to the website starting in Year 1
Scientific articles	WG 1-3, overseen by Science and Communication Manager	Starting at the end of Y1
Scholarly publications (peer-reviewed journal articles, 5 special issues, one edited volume) in total 20 publications	Lead by Action Chair and Science and Communication Manager, all WGs contribute, special attention to inclusion of doctoral students and ECIs	First publications are anticipated at the end of Y1; edited volume will be submitted end of Y4.
Good practice guides for each thematic working group	Leaders of workshops and trainings at Annual Meeting Y2	Starting at the end of Y2
Public-facing articles and podcasts	MC Chair, Science and Communication Manager, all participants, especially ECIs	Continuous, starting at the end of Y1
Educational material including VR/MR/AR tools and apps	WGs working with partners	From end of Y3
Policy briefings, best practices and lessons learnt	All thematic WGs, coordinated by WG 5	From end of Y3

The Action website will be one of the initial deliverables of the action (Month 3). Value will be added to this throughout the life of the network, and long-term hosting arrangements for the site and its content will be agreed at the start of the Action. The website will link to and showcase all other outputs. In particular, it will visualise mine legacy sites in Europe with explanations on raw material excavated, technologies and socio-economic and environmental impacts. The website will host an online observatory that will track and link to policies relevant to this Action in particular from the Commission or national level but also from international sources (from Month 7).

WG 1 - 3 will deliver a series of articles associated with each phase of the Action. These will be published open access on the Action website (from Month 12). At end of Y1 a publication will be issued covering the state of the art of abandoned and closed mines in all participating COST member countries. It is expected that the outcomes of network activities will ultimately be published in the form of multiple peer-reviewed journal articles, five special issues of relevant academic journals (spear-headed by the WG leaders), and a final edited collection that will integrate the outcomes of the Action (by Month 48).

A key deliverable from the second-year annual meeting will be a series of open access “good practice guides” for the management of raw materials’ extraction legacy (from Month 24). These will be aimed at a broad audience and are intended to signpost as part of the policy focus in the second half of the Action. Each thematic WG will also produce short policy briefings, best practices and lessons learnt across the life of the Action, drawing on expertise in communication with policy actors and other stakeholder from network members coordinated through WG 5 (from Month 36).

Members of the WG 1 – 3 will also produce public facing publications to bring their insights to a broader public, as well as a podcast series for download by a non-specialist audience (from Month 12). Digital content will be produced from the four TSs, in the form of short videos and worked examples of methodological practice from participants (from Month 24). Participants in the STSM programme will also be required to create brief digital content (e.g. videos, podcasts, interviews) arising from the missions (from Month 13). Each thematic WG will undertake to produce at least two sets of educational materials in collaboration with partner stakeholder groups (from month 36). These will be tailored to the specific communication media agreed with partners (e.g. written briefings, video content, graphic illustrations, VR/AR/MR tools and apps).

4.1.3. RISK ANALYSIS AND CONTINGENCY PLANS

The risk management plan will be monitored and actions initiated by the Management Committee, with the Action’s Vice Chair holding overall oversight. Each project partner will be responsible for reporting potential risks, via the regular meeting structure and as they emerge. The risk management plan will focus on the following areas:

Risk	Likelihood	Mitigating Actions
Departure of main proposers	Low	A clear Action Management structure will be established at project start, with all specified roles appointed. Established COST procedures will be followed for appointing reserve members.
Departure of participating country partners	Low	The Action MC will liaise with participating COST associations to appoint reserve country members where appropriate.
Problems with organisation of workshops	Moderate	Each workshop will have a nominated organiser reporting to the Action MC and will provide a clear action plan, including contingency planning. Each organiser will be paired with an additional Action member as back-up in case of illness etc. In case of travel restrictions due to pandemic situation or other force majeure the workshops will be organised completely virtually or hybrid.
Risks emerging from working across countries, across disciplines and policy-science	Moderate	An initial risk assessment will be conducted at project start by the Action MC, with further individual risk assessments conducted as required in advance of every formal meeting
Data management issues	Low	The data management plan will be implemented at the start of the project. It will be reviewed and updated by a nominated member of the Action MC throughout the life of the project
Protecting IP issues	Low	An IP exploitation plan will be overseen by a nominated Action MC member and will be signed by all members, with a clear mechanism for any dispute resolution.
Lack of communication between partners because of the large size of partners	Low	Clear leadership of the management committee and motivated partners enable and foster communication.

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