The impact of EXtreme weather events on MINing operations

TEXMIN

DELIVERABLE 4.3 AN INTEGRATED RISK MANAGEMENT TOOL

SUMMARY

An integrated risk management tool and monitoring strategy to reduce the vulnerability of the mining sector to extreme weather events and climate change is one of main outcomes of the TEXMIN project. The tool shows users how to proceed on a case-by-case basis to help the mining industry successfully adapt to climate change. The tool developed in the TEXMIN project consolidates the results of work related to the impact of extreme climatic events on mining and post-mining sites, including the assessment of identified impacts, and provides user-friendly guidance on which risk management strategy to choose to achieve the best results.

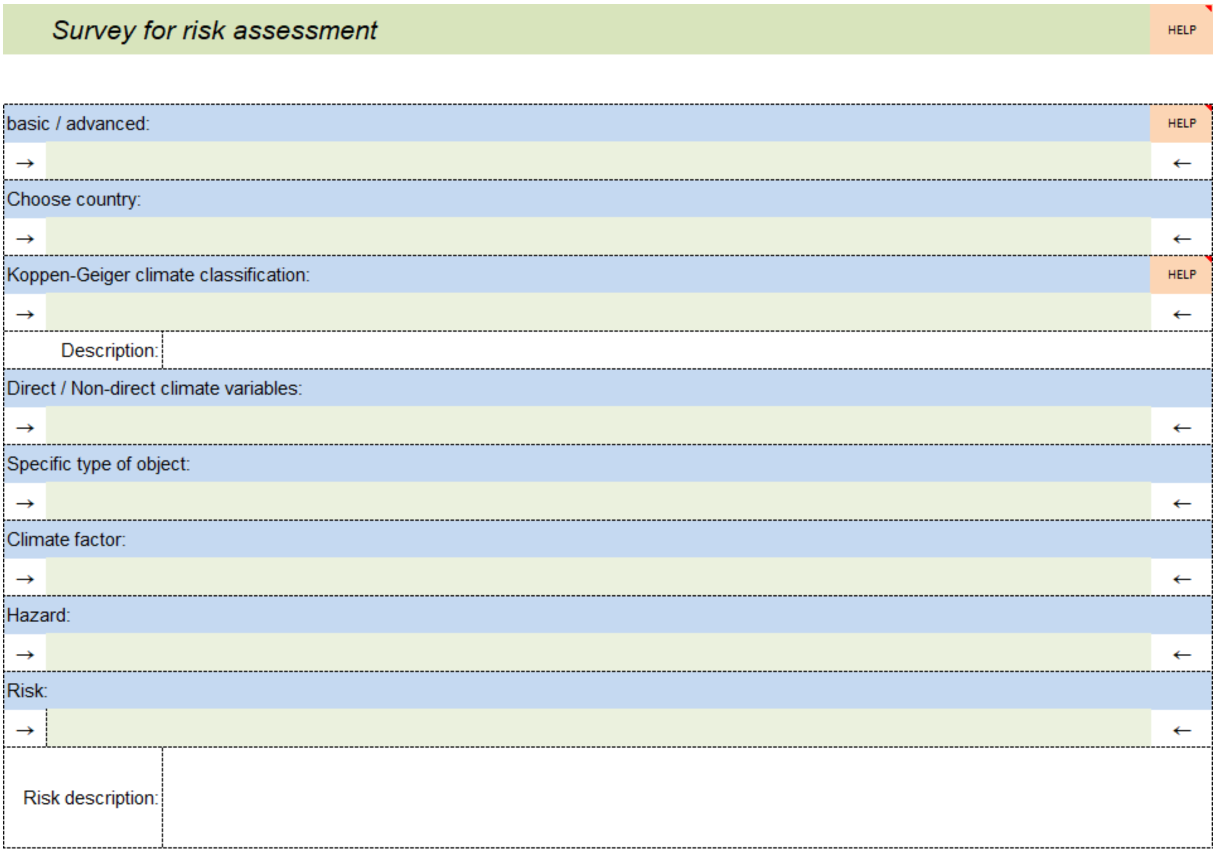

Figure 1. Worksheet in the risk management tool

The risk management tool offers two operation modes: basic and advanced. In the basic mode, the user makes a risk assessment based on the probability and consequences of an event as determined by modelling and estimated by experts for certain types of objects. The

risks ranks are based on modelling and expert-defined data. The advanced mode contains a drop-down list from which the tool calculates risk based on the user's selection of specific parameters. In this mode, the user can customize the mitigation plans depending on his company's situation. The tool takes into account the information entered by the user in the worksheet and associates it with the corresponding risk entry.

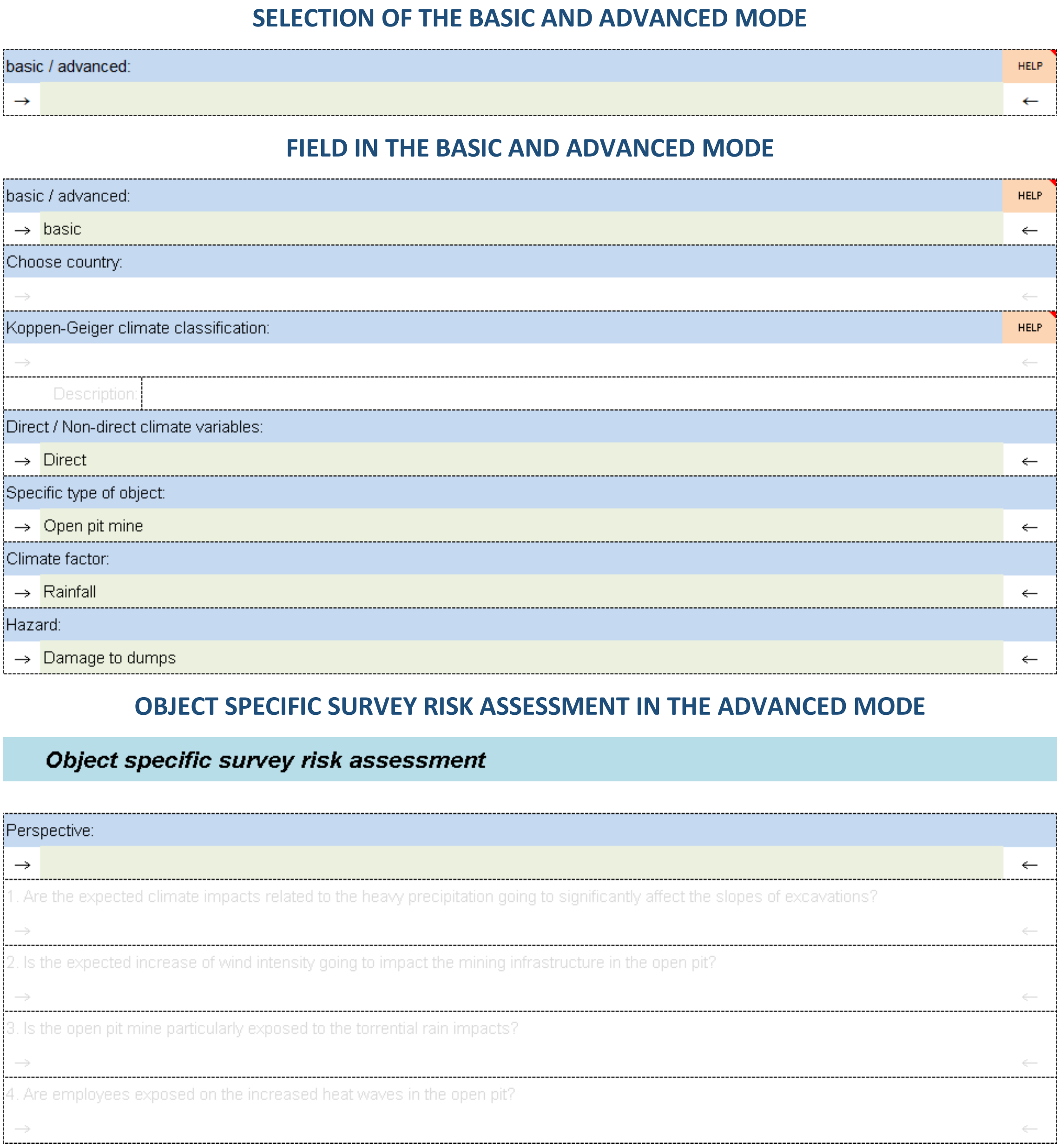

Figure 2. Fields in the basic and advanced mode of operation in the risk management tool

The tool was developed based on the analysis of an extensive literature review. The main contribution to the development of the tool was gathered by project partners experience and proprietary risk assessments and through stakeholders engagement. A part of the results are derived from modelling the effects of climate events on the mining sector. Due to the expert nature of the modelling work, some of the results may deviate from actual observations occurring in the region under study. The tool is designed to be used both by stakeholders with considerable knowledge of the impacts of climate phenomena on mining and post-mining areas and by those with less experience, who will use such information, inter alia, in designing climate change adaptation strategies. Very importantly, the tool does not identify the actors responsible for taking action to reduce or eliminate risks, as responsibilities may vary from country to country/region to region. It was assumed that the users of the tool would be able to identify the limits of their responsibility for risks.

All project partners engaged stakeholders in the analysis of the impact of extreme weather events on mining activities from the beginning of the TEXMIN project, with plans for regular engagement during the next stages of the project work. Key stakeholders were representatives of regional and local authorities and the mining sector, most of whom had an initial interest in continuing the collaboration, mainly through meetings and site visits. The risk management system used in the tool consisted of four stages (Figure 3).

Figure 3. The risk management process

The TEXMIN project developed an approach to risk analysis in relation to the impact of extreme weather events on mining operations. The development of the risk management tool followed the following sequence:

1. Identification and definition of risks caused by extreme weather events for individual mining-related facilities (the “SWIFT” method).
2. Risk assessment:
    a. Decision Matrix Risk Assessment (DMRA).
    b. Probability of adverse events.
    c. The impact and consequences of adverse events.
3. Risk calculation.
4. Risk classification.
5. Risk management.

In the TEXMIN project, the risk management tool was constructed based on a matrix consisting of parameters such as the probability and consequences of an undesirable event (Decision Matrix Risk Assessment). Risks, on the other hand, were formulated using the structured what-if technique (SWIFT), i.e. constructing risks using 'IF' and 'THEN' statements.

The decision matrix risk-assessment (DMRA) technique is a systematic approach widely used in the Occupational Health and Safety (OHS) risk assessment and incorporates of measuring and categorizing risks on an informed judgment basis concerning both likelihood and severity. The decision matrix risk-assessment (DMRA) was applied because of the following advantages of this method:

- Easy application of the technique.
- Safe results, based on the recorded data of undesirable events or accidents.
- It combines risk analysis with a risk evaluation.
- It can help the safety managers/engineers to predict hazards, unsafe conditions and undesirable events/situations, and also prevent fatal accidents.
- It can be applied to any company/corporation or productive procedure.
- It is a quantitative and also graphical method which can create liability issues and help the risk managers to prioritize and manage key risks.

The two-parameter matrix has been proposed to be used in risk analysis, based on the probability of occurrence and impact of the risk (WP2, WP3). The probability was quantified based on the statistics (mathematically calculated probability), especially for climate events or based on the opinion of experts, for non-climate events. Risk was calculated for each scenarios – climatic (water, temperature, pressure) and for non-climatic (social, economic). It should be emphasised, that the risk analysis should be performed also for non-climate events, because the non-climate factors may affect the climate events and be connected with overall decision-making criteria. Experts (project partners) and interested stakeholders were involved in the risk analysis and assessment process. Key stakeholders included representatives of regional and local authorities and the mining sector. Stakeholders were involved in the verification of the hazards, risks, and weather phenomena identified within the project, and in particular in the risk analysis process (risk assessment).

The SWIFT method offers an inquisitive analysis of all the possible causes and impacts for a broad array of scenarios, which marks its versatility. The Structured What-If Checklist Technique (SWIFT) combines the use of checklists with a brainstorming “What if?” approach. It was initially developed for hazard identification in the chemical process industry. The technique was developed as an efficient alternative to HAZOP (Hazard and Operability Studies) for providing highly effective hazard identification in situations and systems where HAZOP is not appropriate. SWIFT can also be used in conjunction with or complementary to a HAZOP. This differentiates it from its precursor, the hazard operability studies (HAZOP) method, which is similar but identifies hazards through a detailed review of low-level processes, subcomponents of equipment, etc. SWIFT method uses a set of words/sentences to stimulate participants to identify risks. The use of "what if?" phrases allows to explore how the system or procedure will work after an undesirable event occurs, and what deviations from the norm will occur. Although, the outputs of a SWIFT are qualitative, the technique can be used to identify sub-systems/processes that could benefit from a quantitative PHA approach. SWIFT is a workshop-based technique in which potential risks are elicited from participants, it is important to assemble the right team when using this approach. Ideally this should include the representation of all stakeholder groups and those with the most intimate knowledge of the system or process being assessed (often frontline workers). SWIFT is very dependent on participants' knowledge of the systems and processes being assessed. In addition to producing a more valid risk assessment, including these participants can have another important benefit - participating in the SWIFT can enhance commitment to new and existing risk controls. The purpose of asking questions such as "what if...?", "if ever...?", "what could happen...?" is to analyse potential scenarios of events that could occur in the mining sector, their causes and consequences. Both experts and stakeholders were involved in the verification of the hazards and risks and weather phenomena identified within the project, and above all in the risk analysis process (risk assessment). Experts (project participants) reviewed and assessed the identified risks.

The risk management tool analyses the input data. Regardless of the advancement option chosen, the main outcome of the risk analysis is the identification of the risk category and priority. The result of the risk analysis may be different, depending of the determined: climate variables, specific type of object, and climate factor. In the case of the "Basic mode", the level of risk will depend on the selected time perspective. For the "Advanced mode", the risk level will depend on the country, the Köppen-Geiger factor, the time perspective and the results of the "Object specific survey risk assessment" survey. The tool summarises the choices to date and generates possible mitigation methods to reduce risk and graphically shows the level of risk according to four time horizons (2022, 2030, 2040, 2050). The final result of the risk analyses is presented in Figure 5.

Outcome

Risk category:	Moderate
Risk prioritizing:	Tolerable
Risk management:	1. Tolerating 2. Prevention
Mitigate:	1. The basic measure is the annual monitoring of climate (temperature and precipitation) and monitoring of the level of damage. Results should be processed annually and on their basis adaptation measures should be proposed. 2. Adjustment of the assortment of cereals, focusing on drought-resistant crops. 3. The application of irrigation systems is also suitable, but they are demanding on water consumption.

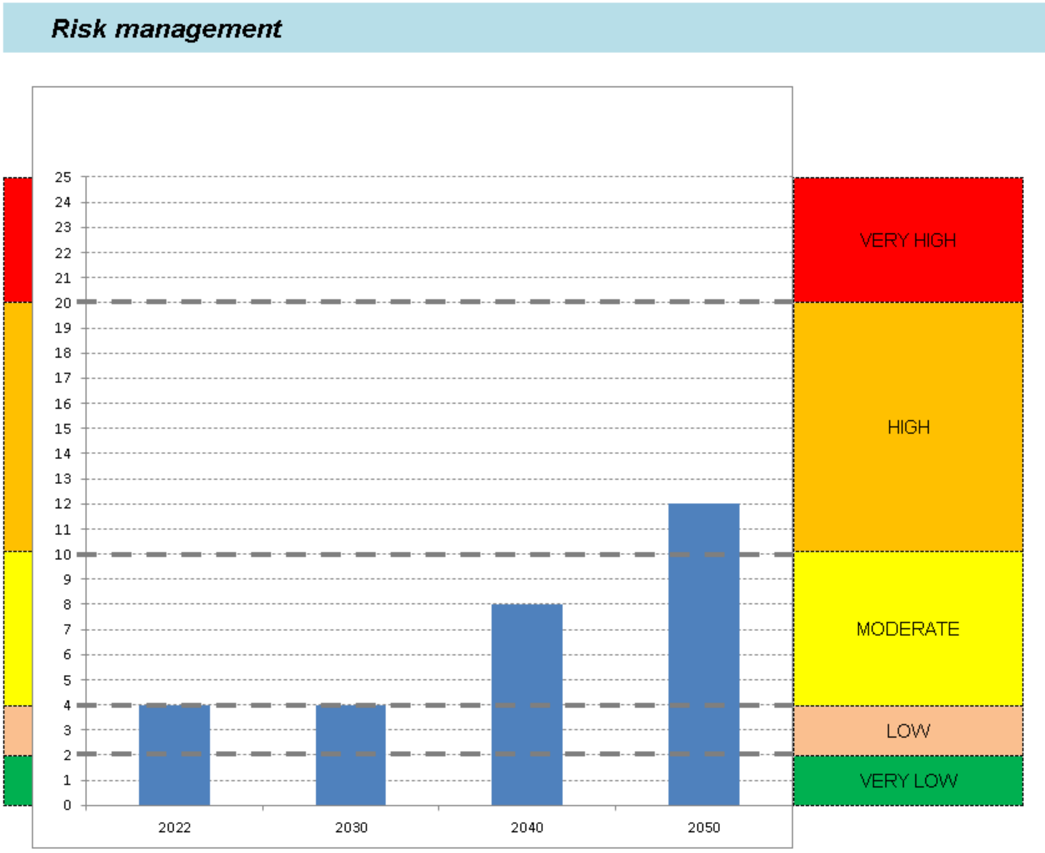

Figure 4. Outcome of the risk management process

As part of WP4, task 4.3, a manual for the use of the developed risk management tool was prepared (Figure 5). The manual is designed to facilitate and simplify the risk analysis and assessment process. It is not expected that the manual will provide an answer to every question or situation, but will give you a good understanding of the overall process of the risk assessment. The manual provides a guide of the steps and tools you will need, as you progress through each stage. At each stage of using the risk management tool, the manual provides relevant guidance.

Research Fund for Coal & Steel

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AN INTEGRATED RISK MANAGEMENT TOOL

USER'S GUIDE

AND METHODOLOGY

September 2022

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2 BASELINE RISK ASSESSMENT PROCESS

Risk is commonly defined as the product of the probability or likelihood of occurrence of a consequence. Climate represents a present-day hazard that we manage based largely on experience. Global warming may change the future probability associated with a hazard of a particular magnitude, thereby affecting the probability associated with a particular consequence. For example, intense rainfall may become more frequent, leading to an increase in flooding risk. The aim of climate change risk assessment and adaptation decision-making is to assess and manage the risk to defined receptors or exposure units. The consequence (or set of consequences or impacts) is usually associated with exposure to a defined hazard, which is often detrimental or harmful. However, risk assessment is equally applicable to the analysis of uncertain beneficial outcomes[1].

In the integrated risk management tool risk is represented by the dependence of the probability of a hazard occurrence to its consequences (effects) according to the basic formula:

$$r_{ij} = P_i \times C_j$$

where:

r_{ij} - risk value for the "i" probability and "j" loss (consequences) value.

P_i – the probability of occurrence of undesirable events, i = 1, 2,..., n,

n - the scale for the probability parameter,

C_j - consequences, relative losses associated with a given probability, j = 1, 2,..., m,

m - the scale for the losses parameter.

Risk in recent climate change assessments has been defined as the **potential for adverse consequences for human or ecological systems, recognizing the diversity of values and objectives associated with such systems**[2]. For example, a climate hazard, such as a heatwave, interacts with human exposure and vulnerability, creating a risk to human health.

Figure 5. An integrated risk management tool – an overview of the tool's manual