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Post-Mining: National Challenges and International Collaboration

After they have been discontinued, mining activities pose worldwide challenges which are often marked by similar problems. Besides a variety of risks, there are also numerous opportunities of post-mining that should be exploited. In this context, the Research Institute of Post-Mining at the TH Georg Agricola works on strategies for environmentally friendly, sustainable and economical handling of all aspects of old and post-mining. This includes intensive studies of existing experience on the closure of mines and the related risk management.

Against this background, information on German, European and international mining districts regarding experience in the post-mining phase is collected, analysed and made available to answer questions related to the abandonment of the German hard coal industry.

Based on case studies from the international sphere, the article describes the potential of problems and existing experience in an exemplary way and is linked to current challenges in the Federal Republic.

By intensifying international co-operation, the Research Institute of Post-Mining Research pursues the goal to accompany national and international decommissioning activities in the mining industry through a constructive knowledge transfer with regard to both safety and sustainability. The aim is to access the risk and opportunity potential of the specific case against the background of cultural and legal aspects.

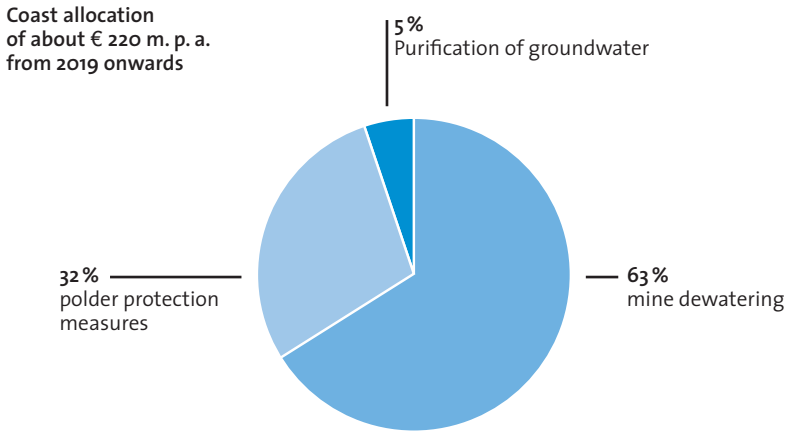

Figure 1 / Perpetual tasks in the wake of German hard coal mining (RAG-Stiftung 2014).

1 Research Institute of Post-Mining

To the end of 2018, after a long phase of continuous withdrawal, the subsidised German hard coal mining industry will abandon all mining activities for good. Consequently, the coal mining regions at the Ruhr, Saar and in Ibbenbüren will require an active planning and implementation of a comprehensive structural change. The challenges of post-mining are not only to manage risks, but also to seize the new opportunities that will emerge.

In order to tackle those challenges, a Master study programme for Post-Mining was established at TH Georg Agricola – a programme which is the only one in the world of its kind; moreover, the Research Institute of Post-Mining was founded here. Principally, the research work conducted here focuses on how to cope with the perpetual tasks that hard coal mining has left us with, both in North-Rhine Westphalia and in the Saar region. The foundation RAG Stiftung is facing annual cost of € 220m alone to ensure that mine water is pumped off (63%), that polders are drained (32%) and that groundwater is cleaned up (5%, as shown in Fig. 1).

The successful management of those tasks aims at ensuring that the former mining regions will be places worth living in. For example, the long-term RAG concept on water retention includes the unconditional protection of groundwater (i.e. drinking water) levels from mine water penetration.

One key task in this process is the education and training of specialists who will be able to take on the issues of post-mining; another core task of the Research Institute of Post-Mining at TH Georg Agricola is to gather, maintain and transfer the knowledge on mining that does exist. This includes that our international network will be extended and the collaboration within will be intensified. RAG Stiftung supports both the Master study programme and the Research Institute in a special way which also includes the establishment of an Endowment Professorship.

The challenges of post-mining involve factors of the environment, structural change, society and cost.

In summary, we are facing impact on the elements of water, soil and air: the drainage of mine water affects the hydrochemistry of the receiving waters; shaft constructions, mining works close to the surface and large-scale underground cavities can cause instabilities at the surface; the air pathway at coal heaps and settling ponds is potentially polluted by dusting.

Such problems are international problems. They also encompass the conversion of former mine works surfaces, funding the withdrawal and a successful management of structural change in the mining regions.

In many cases, the challenges mentioned have already occurred during the production stage. The conflict of interest between German mining projects and regional planning departments are conflicts that can also be observed at international levels, for example, in regions where active coal mining is going on and which are supposed to be developed as touristic regions.

Thus the potential of opportunities that post-mining provides is something that must be emphasised in the public discussion:

methane production; heat generation from mine water, the deposit itself or coal heaps; storing energy in the former mine works or in coal heaps; utilising the mining areas for biomass production and algae growth; establishing photovoltaic systems on mining structures and areas; converting surfaces for touristic and residential purposes.

In the Federal Republic of Germany, the past decades have seen a large number of mining regions abandoning mining their activities. When it comes to post-mining and risk management, there are clear legal stipulations and rulings of supreme courts. The sustainable management of the factors safekeeping, conversion and structural change has helped to establish of a huge knowledge archive.

The challenges of post-mining, when looking at sustainability, affect the areas of underground, surface and technical constructions. These three clusters can be viewed under three aspects:

1. The need to cope with the legacy of mining
2. Sustainable land management and
3. How to deal with mining as part of our cultural heritage.

The Research Institute of Post-Mining ensures the continual update and availability of this mining knowledge by focusing on the first two aspects. Nevertheless, the collaboration of TH Georg Agricola with the German Mining Museum in Bochum, the foundation of preserving industrial heritage and historic culture as well as the real estate company RAG Montan Immobilien GmbH in Essen also takes care of how to preserve the mining heritage as part of our culture.

The Research Institute is integrated into the university and thus able to maintain a network that stretches across the different faculties (Fig. 2). This network allows to address the complex issues of post-mining by drawing upon a huge pool of knowledge from the different faculties and departments.

This university-internal network is part of a larger network at national level that includes our collaboration with mining companies (including former mining companies), authorities, water associations and regional associations as well as industrial institutes, consulting, administration and other universities (Fig. 3)

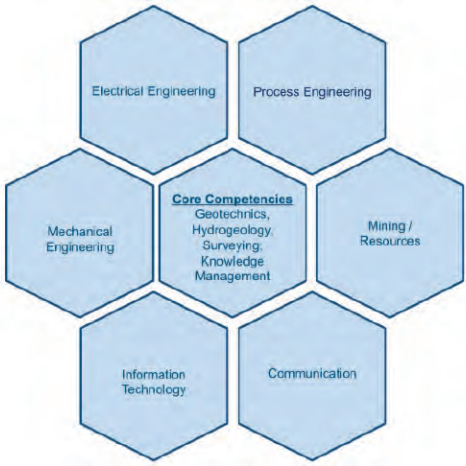

Figure 2 / Interdisciplinary network of the Research Institute of Post-Mining.

This national network is again part of a wider network: the international communication and research work done by the Research Institute of Post-Mining helps to foster this increasing global integration (Fig. 4).

2 International Collaboration

At TH Georg Agricola, international collaboration has enjoyed a long-standing tradition. The existing contacts have been put to use over the recent years to exchange information on successful projects that have been implemented in the field of post-mining. We see that the international world is interested in German experience and, vice versa, we are able to make use of internationally gained insights when searching solutions for national issues.

Solutions developed for the German framework – which is shaped by a high level of industrialisation and a high density of population as well as high environmental standards – with regards to risk management, sustainable land management and sustainable mining may become a role model for international challenges. The Research Institute is of the opinion that the knowledge accumulated

Figure 3 / National network of the Research Institute of Post-Mining

in German mining areas over the past fifty years has to be appropriately represented at the international stage. We think it suitable not only to talk about 'beacon projects', but to ensure that all of the experience made is brought to attention as something worth discussing.

Worldwide, the primary problems of post-mining are as follows: the environmentally friendly draining of mine waters; mastering the instabilities at and above mining cavities, and minimising the dust pollution caused by surface mining, coal heaps and settling ponds. Likewise, the international focus has come to include the costs incurred in the post-mining era and how to achieve sustainable structural change.

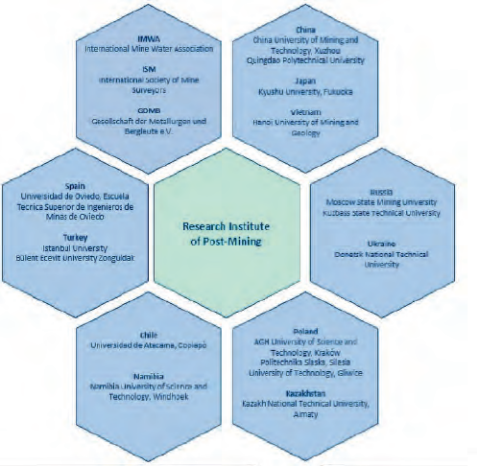

Figure 4 / International network.

Thus the issue of post-mining is being intensively discussed in many leading mining countries across the globe. It is of interest to learn that in other countries as well the mining past is not only seen as a burden – parallel to the development that has been going on in Germany. If we can manage to constructively involve all stakeholders affected by post-mining into the process of change, then the risks can be turned into opportunities (Fig. 5). The strategy required to achieve this needs to take cultural and legal aspects into account as well as the different mentalities. In many regions of the world, special care needs to be taken of those

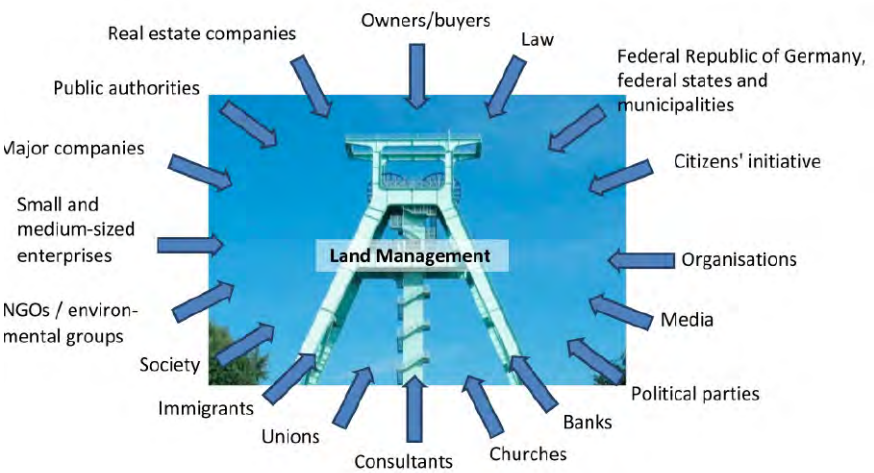

Figure 5 / stakeholders of post-mining era.

parts of the population that are immediately affected: for example, Canadian (post-)mining has a particular need to involve its First Nations in decisions on sustainability.

At TH Georg Agricola, international co-operation projects have allowed to gain interesting insights into how to shape a successful international collaboration. Those projects have been aiming at communicating the concept of sustainable mining and, in particular, the transfer of knowledge gained from beacon projects.

For example, since 2005 we have been developing the project RAME (Research Association for Mining and Environment) with our partners in Vietnam; this association is a model for ecologically focused knowledge transfer. Its central idea is to combine solutions for post-mining problems with reflections on risk management for mining processes which were complemented by issues of occupational health and safety. The social aspect of sustainable mining is a crucial factor here as international mining often shows higher accident rates and a lack of health and safety standards. Adapting such standards and regulations can help to save lives.

Experience has shown that close collaboration based on trust and mutual appreciation already enables change as the partners will discuss the problems they are facing and try to shape solutions for them. We need to find a common language and accept and integrate local know-how. The procedure of moving from the smaller to the larger can be useful: permanently staffed on-site offices are to be established. The legal and entrepreneurial framework needs to be checked and taken into account. Clear agreements should be made regarding the assignment of tasks and the funding conditions.

The challenges are how to develop competence and capacity in order to enable an active knowledge transfer. This process needs to ensure that research results can be linked to the requirements of the real world.

Regarding the overall scheduling we need to consider that R&D projects take time. This rule also applies to decision-making processes in large companies. The project timeline needs to consider this, too.

A special focal point will be the cultural differences of the partners. How to communicate and transfer knowledge; the national culture; rules of politeness and losing face; the question of individualism and collectivism are all aspects that need to be taken into account: the form may matter more than the content.

In conclusion, what are now the essential steps to be taken in order to make any project successful?

- Conducting a comparative study on aspects of mining law, standards of administration and planning; responsibility of mining companies; allocation of competencies; financial frame conditions in Germany and in its partner countries
- Developing an action plan
- Turning risks into opportunities
- Visualising beacon projects

Figure 6 / Lake Bever near Bergkamen.

3 National and international beacons of post-mining

In the north-eastern part of the Ruhr region, a wildlife sanctuary of a particular kind has emerged in a settling crater shaped by the hard coal mining activities that went on there seventy years ago. This nature reserve is Lake Bever (Fig. 6) near the town of Bergkamen. This forest lake is approx. 700 m long, 100 m wide and about 6 m deep.

The Bever brook, a tributary of the river Lippe, flows through this settling area. The water level of the lake is regulated by a pumping station. Lake Bever is part of a larger nature reserve of approx. 100 hectares and also part of the Route of Industrial Heritage, a touristic route that enjoys large popularity.

In a region of moderate climate and sufficient rainfall natural succession will help to develop valuable (protected) landscape in the wake of mining.

Increasingly, many countries around the world are focusing on how to renature and restructure former mining areas. Looking at the increase in population and thus the increasing demand for areas suitable for settlement and food production, we have come to realise that we need to take greater care of the sources requiring protection, i.e. water, soil and air. An awareness is emerging that land recultivation is important, and that we need to tackle the challenges of post-mining. The financial burden that is a part of the sustainable and environmentally friendly land rehabilitation can only be optimised if we act across disciplines and if the consequences of post-mining are already considered at the active stage of the mining process.

The rehabilitation and successive use of mined land need to be planned in good time in order to provide the financial resources by accumulating provisions.

Developing, communicating and implementing a rehabilitation concept for large areas of mined land is everything but trivial, especially in remote regions and arid areas. A prime example is one of the largest open-cast mining works, i.e. Chuquicamata in the Atacama Desert in northern Chile, where copper mining is done at an altitude of 2,800 m (Fig. 7). The copper surface mining, operated by Codelco, is approx. 4,000 m long, 3,000 m wide and down to 1,000 m deep. The annual rainfall of this region is only 0 to 30 mm.

Figure 7 / Chile, copper mining at Chuquicamata (© codelco).

Figure 8 / Sentinel 2A; a sentinel in space.

Extreme environmental conditions add another challenge to those which mining companies, but also university institutes, are already facing when developing feasible concepts for restoring sludge ponds and mined land. One successful project has been the use of typical local plants and micro-organisms to lower the pollutant load for some years now.

An essential component of both national and international post-mining is monitoring. Together with its partners, the Research Institute of Post-Mining is working on innovative procedures which will help to better understand the complex processes of (post-)mining. For example, the European earth observation programme Copernicus provides highly interesting approaches for innovative global monitoring measures. The Sentinel satellites, which are part of the space component, provide up-to-date and large-scale information on the media of water, air and soil (Fig. 8).

As part of the in-situ component such information is made available for issues of post-mining too. The integration of satellite procedures, in particular, will help to improve and deepen the understanding which risks and opportunities post-mining does provide and how to communicate those.

4 Conclusion and Prospect

Post-mining is one of the central challenges around the world. This is particularly true for the soon to be abandoned hard-coal mining areas in Germany. Competent answers to related questions can only be found if there is knowledge transfer in research and development: such transfer will also help to envisage future prospects and support their implementation. The experience TH Georg Agricola has gained in international collaboration provides a solid base when it comes to how to utilise the opportunities of post-mining and how to mitigate its risks.

The Research Institute of Post-Mining at TH Georg Agricola, supported by RAG-Stiftung, works across disciplines and with its partners in national and international networks on concepts for a sustainable and responsible management of the mining legacy. Around the

world there are exciting opportunities, but also enormous challenges, when it comes to rehabilitating mined land. One focus of our work is the application of innovative monitoring processes to monitor processes of (post-)mining.

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First published in: Proceedings of the Conference Bergbau, Energie und Rohstoffe 2015, Freiberg, pp. 126–137.

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