# Reducing Environmental Degradation Caused by the Open-Cast Coal Mining Activities

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## Abstract

*Many types of changes are distinguished as a result of mining: degradation of land and vegetation, change in the natural topography whith results in restrictions in the possibilities of using the land for othe purposes, modification of surface and ground water balance and quality, changes in air quality and finally changes in the geotechnical conditions of the rock. The impact varies with local conditions of the specific site of mining.*

*Most surface mining methods are large scale, involving removal of massive volumes of material, including overburden, to extract the mineral deposit. Because the materials disposed in refuse dumps are physical-chemically heterogeneous and extremely diverse in terms of mineralogical composition (sand, gravel, clay, marl), over time there have been many occurrences of instability phenomena. Large amounts of waste can be produced in process. Surface mining also can cause noise and disturbance and may pollute air with dust.*

**Keywords:** *prevention, monitoring, environmental,impact, mining, activities,open pit*

### Introduction

Mining and its related activities have always resulted in changes in the environment. These changes differ from one area to another.

The process of removing, storing and subsequently replacing the soil during the mining activity lead to potential problems in relation to subsequent restoration. In this respect, a major distinction should be drawn between those sites where, for operational reasons, soil has to be stored for a period of years while the mining progresses, and those, usually larger, sites where a progressive system of restoration can be practiced.

The negative impacts of surface mining on environment can following:

- occupation of large farming areas needed for excavation and dumping operations;
- alteration of land morphology;
- disturbance of native fauna and flora;
- modification of surface and ground water balance;
- resettlement of residential areas, roads and railways;
- release of air, liquid and solid pollutants and noise pollution.

Soil destruction is one of the most crucial environmental impacts of open pit mining activities. Surface mining speeds up erosion and sedimentation and short duration, high intensity storms can be a violent force moving thousands of tons of soil. Physical characteristics of the overburden, degree and length of slope, climate, amount and rate of rainfall, type and percentage of vegetative ground cover affect the vulnerability of strip mined land erosion.

### Material and methods

The sources of data for this study comprised both primary and secondary sources. The primary sources of data were observation and interview conducted at the various phases of the detailed study. Phase two involved data collection on existing land uses, thus detailed observation was made to identify the kinds of degradation that has occurred and also find out the use to which the heavily mined sites have been put.

Before starting the coal extraction there were performed the following workings: decommissioning of existing buildings, clearing the terrain, topsoil removal, preliminary excavations, achieving access routes, building production facilities and necessary annexes, building coal deposits, etc.

There were also conducted hydraulic water works like: diversion of watercourses; execution of dumps guard channels; flood embankment; shielding aquifer formations; arrangements for correcting torrents; water drainage and collection channels.

Simultaneously with the opening trenches execution there were built mounting platforms for technological equipment, slopes to access high capacity machines and for the location of belt conveyors.

Mining methods applied mainly have been those with transportation of the waste rock at dumps. They are used in all conditions and in any terrain configuration or lignite deposit settlement, whose inclination is in the range 5–8°.

Tailings disposedd in landfills comes from the work of outcropping and sterile intercalations between the mined out lignite strata.

Observations on such dumps can be quantified as it follows below:

- the presence of uneven subsidence areas, which allows accumulation of rainfall and runoff in the body of dumps and results in the change of state of consistency, with negative effects on the stability;
- the occurrence of the thixotropic or liquefaction phenomenon during the rainfall season, which leads

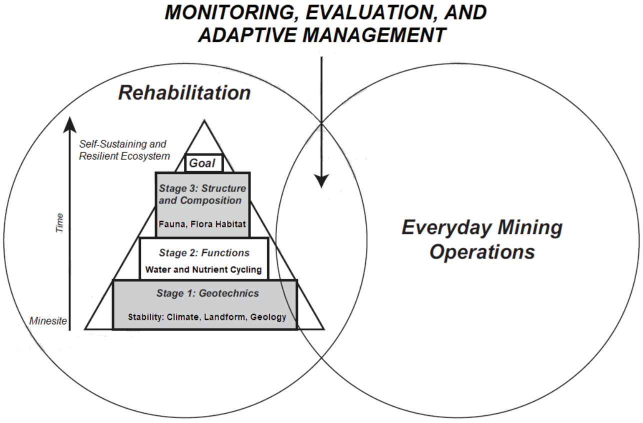


Fig. 1. Monitoring, Evaluation and Adaptive Management after mining operations
Rys. 1. Monitorowanie, ocena i zarządzanie adaptacyjne po zakończeniu operacji wydobywczych

to increased instability of dumped rock by reducing the shear strength;

- the increased humidity due to excess moisture leads to small size superficial slips of landfill slopes steps without affecting the overall stability of the;
- tilt slopes greater than 30° are crossed by ravines created by water flow.

Following the periods of excessive moisture, the presence of clays resulted in rocks swelling, leading ultimately to destabilize some of dumps.

Above realities combined with constructive deviations from the designed geometry of waste dumps favors the appearance of instability phenomena or reactivation of older, previously existing ones.

Moisture content in a dump is a fluctuating parameter which is influenced by the time of sampling, height of dump, stone content, amount of organic carbon, and the texture and thickness of litter layers on the dump surface. During the winter, the average moisture content of 5% was found to be sufficient for the plant growth. During high summer (May–June), moisture content in overburden dumps was reported to be as low as 2–3% moisture content of all the dumps was 5%.

Being loosened structures consisting of carbonaceous clay, sandy clay, dusty-marly sand and argillaceous sand, heaps are characterized by a great susceptibility to triggering geomorphological processes, of which the most common are runoff and gully, shallow landslides of steps and slopes, aslo their collapse, wind erosion, natural and anthropogenic compaction.

Rearrangement and rehabilitation works, which may be either to remove the visual effects of an existing mine site or to reduce the impact of a new mine site to a lowest degree, should be planned before starting operation and carried out in parallel with mining activities.

Rearrangement includes excavation and dumping according to the planning, stable design of dump sites and chamfers with proper slope and elevation, laying out of top humus layer and fertile soil right beneath it either directly or later, grading, drainage and water regime control, constructing surrounding drainage channels against floods, and constructing infrastructure and road network; whereas rehabilitation comprises improvement of soil conditions and re-vegetation on topographically graded lands.

**Results and discussion**

Unconsolidated surface mining operations usually require the removal of vegetative cover combined with the stripping of topsoil, overburden and spoil materials. These activities, along with construction of access roads, usually result in severe disturbance or complete destruction of soil structure, landscapes and vegetation. Without proper management and regulation, additional adverse impacts may include loss of topsoil and plant cover, changes in the quality and quantity of surface water and groundwater, and decline of wetland habitat.

After closure open pit mining activities it is necessary a monitoring management. Monitoring, evaluation and adaptive management is critical in mine rehabilitation (figure 1). Monitoring should also be used to determine the effectiveness of rehabilitation. Monitoring would become more complex over time, and together would demonstrate rehabilitation success.

Monitoring in an open pit should not only concentrate on surface movement, but systems should also be installed to monitor sub-surface movement. The timely collection and interpretation of the data, followed by distribution of the results, forms the complete slope monitoring system.

Measures commonly adopted to increase stability are draining surface water and groundwater, reducing the slope escarpment, covering them with plantations, building retaining walls.

In order to prevent instability of the surface land is used primarily the aquifer formations dewatering, process allowing that the water is drained and evacuated for operation under normal conditions. These works resulted in lowering the groundwater levels in areas with large extension.

Through the surface water drainage it is minimized the process of alteration of physical-mechanical properties of rocks. In this respect is necessary the surface land leveling and building drains for surface water leakage.

The underground drainage system lowers to groundwater levels, reducing pore water pressure and hydrostatic pressure in rocks's cracks.

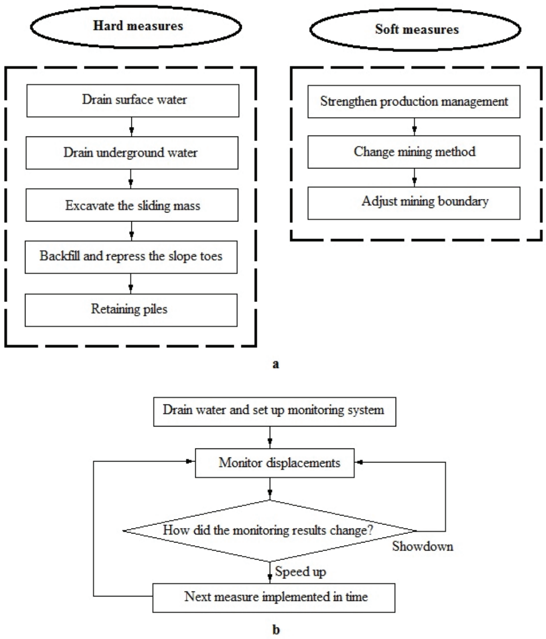


Fig. 2. Control measures and design procedures to landslides control: a – measures for landslides control; b – design procedures.
Rys. 2. Środki kontroli i procedury projektowania kontroli osuwisk: a – środki kontroli osuwisk; b – procedury projektowania

Leveling – which fall under mining units obligations – must create the conditions required to carry out the regeneration of soil fertility and plant cultivation or conditions for building and development purposes.

Creating plantations and afforestation are other measures with positive effect aimed to stabilize landslides, being applying after surface land leveling and provision of surface water drainage.

Another measure for landslide stabilization is to reduce slope gradients in order to achieve stable conditions.

Landscape and soil degradation involve a reduction in ecosystem functions and services. Thus, decisions about sustainable landscape management must consider the restoration of essential ecosystem services.

Restoration of coal mining landscapes has become an important area of focus with the presure to reduce coal combustion, since coal combustion is a major contributors to the total anthropogenetic emissions of 35 Gt $CO_2$/yr. Restoration of these lands is critical to ecosystem functions and services.

**Conclusions**

Effects of mining on the environment may not be evident immediately; many are usually noticed after some years. Surface mining requires large areas of land to be temporarily disturbed. The effects of open pit mining on the environment include a number of environmental challenges land degradation soil erosion, noise, dust, poisonous gases and pollution of water and so on. Open-pit mining changes the topography and vegetation, and include impacts on local biodiversity. From the noise and vibration point of view, drilling and blasting operations as well as application of heavy vehicles are very important. Blasting, haulage and transportation are the main reasons for the dust generation.

Depending on the technology in use and the mining methods adopted, mining activities can cause considerable environmental degradation and industrial pollution. Mining dumps and tailings are frequently the principal source of solid waste as well as liquid waste pollution. Mining may also cause the contamination of ground and surface waters with toxic chemicals

Workings performed for extracting coal in open pits are large-scale developments and can lead to significant degradation of the surrounding terrain and waste dumps resulting from this activity.

Measures to ensure slope stability dumps can be qualified as "hard" or "soft". A first measure consist in respecting working technology, followed by dewatering, and drainage of surface water and groundwater, land leveling and creating plantations

All these measures requires continuous monitoring, which is a problem often neglected, most often due to limited financial resources or lack of communication between the involved parties.

Implementing pollution control measures, monitoring the effects of mining and rehabilitating mined areas, the mining industry minimises the impact of its activities on the neighbouring community, the immediate environment and on long term land capability.

It is necessary to understand the system requirements and specifications and to address human interface issues to improve component and system reliabilities, and minimize the occurrence of environmental damages.

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## *Ograniczanie degradacji środowiska spowodowanej działalnością wydobywczą węgla odkrywkowego*

*W wyniku wydobycia wyróżnia się wiele rodzajów zmian: degradacja gruntów i roślinności, zmiana naturalnej topografii, co powoduje ograniczenia możliwości wykorzystania gruntów do innych celów, modyfikację bilansu i jakości wód powierzchniowych i gruntowych, zmiany jakość powietrza i wreszcie zmiany warunków geotechnicznych.*

*Oddziaływanie różni się w zależności od lokalnych warunków miejsca wydobycia. Większość metod eksploatacji odkrywkowej odbywa się na dużą skalę, polega na usuwaniu ogromnych ilości materiału, w tym nadkładu, w celu wydobycia surowca mineralnego. Ponieważ materiały składowane na składowiskach odpadów są niejednorodne pod względem właściwości fizyczno-chemicznych i są niezwykle zróżnicowane pod względem składu mineralogicznego (piasek, żwir, glina, margiel), z czasem pojawiło się wiele niestabilności. Eksploatacja odkrywkowa może również powodować hałas i zakłócenia oraz może generować zanieczyszczenie powietrza pyłem.*

***Słowa kluczowe:*** *zapobieganie, monitorowanie, wpływ na środowisko, wydobycie, działalność, kopalnia odkrywkowa*