ÖkoRess III

Pilot Screening of Environmental Hazard Potentials of Mine Sites

Factsheet:

Grasberg

Freeport McMoran , Indonesia

ID: 37

German Environment Agency

Umwelt Bundesamt

Note

The qualitative assessment of Environmental Hazard Potentials (EHPs) in this factsheet was conducted according to the method developed in the precursor project ÖkoRess I "Discussion of the environmental limits of primary raw material extraction and development of a method for assessing the environmental availability of raw materials to further develop the criticality concept"[1] (Dehoust et al. 2017a). The measurement instructions applied here are described in Dehoust et al. 2017b. The method is tested and further developed within this project (ÖkoRess III).

The information in this factsheet refers exclusively to publicly available, designated sources that have been classified as serious by the authors. It is specifically pointed out that no statement is made about the implementation and quality of agreements or standards that are applied. The implementation of agreements through memberships, certifications, etc. is the responsibility of the companies.

The surface extension of each mine area has been estimated based on publically accessible satellite images as official land-use plans from the public authorities or mine operators are not consistently available. It therefore only corresponds to the apparent area where mining, processing facilities, heaps, etc. and related infrastructure are clearly identifiable.

The fact sheets make no claim to completeness of all relevant voluntary standards. Mentioning a membership in one of the listed voluntary standards does not imply an assessment of the suitability of the standard in itself, nor does it make any statement about the member's success in implementation.

[1]TEXTE 87/2017 https://www.umweltbundesamt.de/publikationen/discussion-of-the-environmental-limits-of-primary

Grasberg

Copper

General information

Indicator or criteria	Description and values
Name of mine	Grasberg
Description of mining area	The Grasberg minerals district includes one open-pit mine (Grasberg open pit, final phase) and several underground developments (Grasberg Block Cave, Kucing Liar, Big Gossan, DOZ, DMLZ)(FCX 2018a; b); according to FCX (2018a) three underground ore bodies are currently being mined: DMLZ, DOZ & Big Gossan. Grasberg lies in the Sudirman mountain range adjacent to the UNESCO world heritage Lorentz National Park which according to WALHI (2006) was reduced in order to accommodate the mine. To the south lies the Arafura Sea, with ports from which ore is shipped.
Surface extension	279.05km^2 279.05 km^2 (Image date: 29.10.2018; Viewing height: 12.35 km) (Google Earth)
In operation since	1973 1973
Operator	Freeport McMoran
Owner	Freeport McMoran
Closest town	Tembagapura, 10km south-south-west Timika, 60 km south-south-west
Province	Mimika Regency, Papua
Country	Indonesia
Longitude	137.113171°
Latitude	-4.058653°

Altitude	4000 m a.s.l. Around 4,000m, Grasberg mountain now mined down to 3,000m (Mining Technology 2018). Mountains rise to over 4,800m in the immediate area of the mine (FCX 2016).
Main product and by-products	Copper (Cu), gold (Au), silver (Ag) (FCX 2018c).
On-site processing stages	Ore undergoes primary crushing at the mine, then is transported to a mill complex downhill for further crushing, grinding and flotation. Grasberg´s milling and concentrating complex is the largest in the world, with four crushers and two large grinding units (Mining Technology 2018). Concentration is done by froth flotation under addition of lime and flotation reagents (FCX 2016). Concentrator processing design capacity is 235,000 tons of ore per day (FCX 2018e).
Annual production	450 kt Cu (Copper 996 million recoverable pounds) 44 t Au (Gold 1,554 '000 recoverable ounces) No information concerning silver production volumes (FCX 2018a).
Proven Reserves	No information obtained
Probable Reserves	No information obtained

Geology

Indicator or criteria	Description and values	Explanation	Assessment result	Data quality
Preconditions for acid mine drainage (AMD)	According to FCX (2018b) the ore bodies are either igneous-hosted occurring as vein stock works and disseminations of copper sulphides dominated by chalcopyrite and bornite, or sedimentary-rock hosted occurring as magnetite-rich, calcium/magnesia skarn replacements. Also in the skarn deposits, copper mineralization is dominated by chalcopyrite and bornite.	Given the sulfidic nature of the ores the formation of AMD is possible. The preconditions for AMD are fulfilled leading to a high EHP.	High	A = high, can be derived directly from available data

Paragenesis with heavy metals	The mining operation targets the heavy metal copper. According to Walhi (2006) the large size of the deposit combined with economic interests lead to rather large quantities of copper being left in the tailings and posing a risk to flora and wildlife. Beside copper selenium, lead, arsenic, zinc and manganese are mentioned by WAHLI (2006).	Due to the presence of various heavy metals and since copper itself is a heavy metal the EHP resulting from heavy metals is high.	High	A = high, can be derived directly from available data
Paragenesis with radioactive components	No indication of paragenesis with thorium and uranium could be determined. Also, while other environmental impacts are subject to extensive criticism (mainly with respect to changes in landscape, stockpile management and tailings disposal -AMD, sediment, heavy metals), no mention of radioactivity is made (e.g. Bochove / Stringer 2018; Jensen 2018; Tarigan 2015; WALHI 2006).	In accordance with the findings the EHP is evaluated as medium. The measurement instructions indicate that copper ore deposits generally show a medium EHP with regard to radioactive components (Dehoust et al. 2017b).	Low	B1 = medium, can be estimated on the basis of available information
Deposit size	Reserves in 2018 at Grasberg amount to ca. 2,000 Mt of ore containing ca. 20 Mt of copper (FCX 2018a). The mine opened in 1973, calculating with the current production (450 kt) a total of ca. 20 Mt of copper have been mined to date (Rüttinger et al. 2014). Accordingly, in total the mine contains ca. 40 Mt of copper.	Current reserves for copper are classified as "very large" in accordance with Petrow et al. 2008. Accordingly, The EHP resulting from the deposit size is therefore high.	High	A = high, can be derived directly from available data
Ore grade	FCX (2018a): average ore grade mined in 2017: 1.01 % Cu, 1.15 g/t Au.	While literature in general speaks of the high-grade ore in the Grasberg mineral complex (e.g. (FCX 2018c), the classification according to Priester et al. (2019) classifies these values as average (copper) and low (gold). Accordingly, the EHP is medium.	Medium	A = high, can be derived directly from available data

Technology

Indicator or criteria	Description and values	Explanation	Evaluation result	Data quality
Mine type	To date most ore was mined in open pit. For the future, a transition to underground mining is under construction (FCX 2018b).	The impacts on the surface of mining projects are related to the mining method. Currently the ore is mainly mined in an open pit operation. The impact of open pit mines is usually limited to the size of the ore body. Accordingly the environmental hazard potential resulting from the mining method at Grasberg is medium.	Medium	A = high, can be derived directly from available data
Use of auxiliary substances	The processing includes froth flotation with corresponding input of lime and flotation reagents (FCX 2016).	The processing of the ore at Grasberg involves a froth flotation process where probably toxic reagents are added. Accordingly, the environmental hazard potential caused by the processing method is high.	High	A = high, can be derived directly from available data
Mining waste	Tailings are disposed off into the Ajkwa river system (Ajkwa Deposition Area ADA, and later modified ADA = ModADA) covering an area of 230km^2 (Jensen 2018). In 2017, PT FI produced approx. 50 million metric tons of tailings (Bochove / Stringer 2018). Over the whole lifetime of the mine (estimated until 2041) about 3 billion tons of tailings are expected to be generated (FCX 2016). PT FI has designed and constructed a system of	The mine waste management constitutes a major impact on the environment during the whole operating life, especially through the vast amounts of sediment being generated. Consequently, mine waste management at Grasberg poses a high EHP.	High	A = high, can be derived directly from available data

	levees to manage their deposition in a designated terrestrial area in the lowlands and the associated estuary. The transport of the tailings to this area is realized via a short river (ibd.). According to FCX (2016), several alternatives to riverine disposal have been studied, finding the current option the most viable. Other options are regarded as too risky with respect to seismic activity, heavy rainfall and steep slopes			
Remediation measures	According to PT.LAPI ITB (2014) a mine closure plan exists. It is conceptual in nature, but meets the requirements of applicable regulations and forms a reasonable basis for determining post-closure and reclamation cost estimates.	On the one hand, a mine closure plan exists and some reclamation efforts are already being made. On the other hand, further elaboration is still required, costs still need to be determined and negotiation with the government on the concrete terms is ongoing. It seems that some uncertainty is also related to the fact that the Indonesian state will take over majority ownership for the mine which may also mean a transfer of responsibility for mine closure activities. The remediation measures therefore pose a medium EHP.	Medium	B2 = medium, classified according to measurement instructions

Framework conditions natural environment

Indicator or criteria	Description and values	Explanation	Evaluation result	Data quality
Accident hazard due to floods, earthquake, storms, landslides	The rating system for the 4 sub-indicators uses georeferenced data from publicly available risk maps (see measurement instructions). Metrics are directly taken from the given risk assessment. The indicator total is determined by the highest hazard level of the sub-indicators.	The environmental hazard potentials (EHP) for landslides and floods are high and medium for earthquakes while other hazards are minor.	High	A = high, can be derived directly from available data
Water Stress Index (WSI) und desert areas	The WSI by Pfister et al. (2009) provides characterization factors on the relative water availablility at watershed level. Absolute water shortages in dry areas is supplemented by desert areas. The highest hazard level of the sub-indicators determines the total result.	The WSI around the mine is low.	Low	A = high, can be derived directly from available data
Protected areas and AZE sites	Georeferenced data for designated protected areas are used to assess hazards posed by mining extraction. The metric to evaluate EHPs corresponds to the method first described in the draft standard of the Initiative for Responsible Mining Assurance (IRMA 2014)	The mine is located within protected areas.	High	A = high, can be derived directly from available data

State Governance

Indicators	
WGI 1 -Voice and Accountability	50.74 °°°

WGI 2 -Political Stability and Absence of Violence/ Terrorism	29.05 °°°
WGI 3 - Government Effectiveness	54.81 °°°
WGI 4 -Regulatory Quality	51.92 °°°
WGI 5 - Rule of Law	40.87 °°°
WGI 6 -Control of Corruption	48.08 °°°
EPI (Environmental Performance Index)	46.92
EITI membership	Yet to be assessed against the Standard
International Agreements	
ILO 176	Not ratified
Others	No information obtained
Legal framework	

Areas of Law: Environment	The Environmental Law (Law No. 32 of 2009 on Environmental Protection and Management) addresses the mining sector. All activities that may have an impact on the environment, e.g., by changing the landscape, exploiting natural resources, polluting or having an impact on heritage areas are affected by the Environmental Law. Any mining company that applies for a mining license must provide an Environmental Impact Analysis (EIA). Mining licenses are either granted by a regional government (Mayor, Regent or Governor) or the Central Government depending on the location of the proposed project. Tailings are defined as toxic and hazardous and are therefore affected by the Regulation No. 101 on the Management of Hazardous and Toxic Material Waste from 2014. Accordingly, storage and handling of tailings requires a license. Mining project are required to conduct reclamation and post-mining activities that have to be approved by the mining authority. Non-compliance can result in fines or imprisonment of up to 15 years (Pantanto / Karyadi 2018; PWC 2017; Rüttinger et al. 2014). The Department of Mining and Energy, is responsible for mine inspection (Purwana 2013).
Areas of Law: Occupational Health and Safety (OHS)	Indonesia ratified the ILO conventions No. 045 on Underground Work of 1950, and No. 120 on Hygiene of 1969. A variety of rules and regulations address mining activities in Indonesia. Among others guidelines, Ministerial Decrees, and Laws dealing with Safety and Health for workers in mining. Holders of mining licenses or exploration licenses shall implement mine safety provisions. The Department of Mining and Energy, is responsible for mine inspection (Purwana 2013). Mining Permit holders must prepare community development and empowerment programmes (Tiess / Mujiyanto 2011).

Corporate Social Responsibility (CSR)

Voluntary Standards	
Aluminium Stewardship Initiative (ASI): Is the mine owning company a member?	Not applicable Not applicable
Aluminium Stewardship Initiative (ASI): Is the mine certified?	Not applicable Not applicable
International Council of Mining & Metals (ICMM): Is the mine owning company a member?	Yes Yes (ICMM 2018)
Towards Sustainable Mining (TSM) Is the mine owning company a member of the Mining Association of Canada (MAC)?	No No (MAC 2019)
Towards Sustainable Mining (TSM) outside Canada: Are TSM standards implemented*?	No No (MAC 2019)
Initiative for Responsible Mining Assurance (IRMA): Is the mine owning company a member?	No No (IRMA 2018)
Initiative for Responsible Mining Assurance (IRMA): Is the mine certified?	No No (IRMA 2018)
Responsible Copper (RC): Is the mine owning company a member of RC?	No information available No information obtained
Responsible Copper (RC): Is the mine certified?	No information available No information obtained
Responsible Mining Index (RMI): Has the mine been rated?	2.33 / 6.00 Yes, mine site score 2.33 / 6.00 (RMI 2018)
Responsible Mining Index Company indicator „Working conditions“	0.617 0.617 / 1.000 (RMI 2018)

Responsible Mining Index Company indicator „Environmental sustainability“	0.405 0.405 / 1.000 (RMI 2018)
Responsible Steel (RS): Is the mine owner a member of the RS?	Not applicable Not applicable
Responsible Steel (RS): Is the mine certified?	Not applicable Not applicable
Australian Steel Stewardship Forum (ASSF): Is the owner a member of the ASSF?	Not applicable Not applicable
Australian Steel Stewardship Forum: Is the mine certified?	Not applicable Not applicable

ISO and CSR reporting

ISO 14001 (ISO 14004): Is the mine ISO 14001 certified?	Yes Yes (Freeport-McMoRan 2018a)
CSR-directive 2014/95/EU: Does the mine owning company have its headquarters in an EU country?	No No (USA) (Freeport-McMoRan 2018b)
OECD Guidelines: Does the company have its headquarters in a signatory state?	Yes Yes (USA) (OECD 2019)
ISO 26000: Does the mine implement ISO 26000?*	No information obtained No information obtained

Banking Standards

WB Standards / IFC Performance Standards: Is the mine financed to a major extend by the world bank?	No information obtained No information obtained
Equator Principles (EP): Is the mine financed to a major extend by a bank adherent to the EP?	Yes Yes (Scotiabank 2016)

*by companies own account.

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A Glossary

Table 1 Legend

Environmental hazard potential

low

medium

high

Data quality

low

- No concrete information, no general specifications of the measurement instructions, expert estimation.
- Assessment not possible due to lack of data at the site, as there is also no evidence for an assessment and there are no generalized assessment rules.

medium

- Assessable on the basis of available information.
- Generalized classification according to measurement instructions.

high

- Can be derived directly from available data.

B Abbreviations

EHP	Environmental hazard potential
FY	Financial year
kt	Kilo tonnes
m a.s.l.	Meters above sea level
Mt	Million tonnes
OHS	Occupational Health and Safety
t	tonnes
TSF	Tailing Storage Facility
WGI	World Governance Indicators
WHS	Work Health and Safety

C Imprint

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