TEXTE
81/2020

Comparative analysis of case studies for mining sites worldwide

OekoRess II Working Report on environmental hazards and impacts, governance challenges and indicators

German Environment Agency

Umwelt Bundesamt

TEXTE 81/2020

Ressortforschungsplan of the Federal Ministry for the
Enviroment, Nature Conservation and Nuclear Safety

Project No. (FKZ) 3715 32 310 0

Report No. FB000275/ANH,4,ENG

Comparative analysis of case studies for mining sites worldwide

OekoRess II Working Report on environmental hazards
and impacts, governance challenges and indicators

by

Fiona Becker, Christine Scholl, Lukas Rüttinger,
Pia van Ackern
adelphi, Berlin

Aissa Rechlin, Michael Priester, Noah Schöning
Projekt-Consult GmbH, Hamburg

Regine Vogt, Claudia Kämper
ifeu Heidelberg

On behalf of the German Environment Agency

Imprint

Publisher
Umweltbundesamt
Wörlitzer Platz 1
06844 Dessau-Roßlau
Tel: +49 340-2103-0
Fax: +49 340-2103-2285
info@umweltbundesamt.de
Internet: www.umweltbundesamt.de

/umweltbundesamt.de
/umweltbundesamt

Report performed by:
adelphi
Alt-Moabit 91
10559 Berlin

Report completed in:
November 2019

Edited by:
Section III 2.2 Resource Conservation, Material Cycles, Mineral and Metal Industry
Jan Kosmol

Publication as pdf:
http://www.umweltbundesamt.de/publikationen

ISSN 1862-4804

Dessau-Roßlau, June 2020

Abstract: OekoRess II report: Comparative analysis of the case studies

In order to help ensure that the environmental impacts of mining are better taken into account in the debates on the responsible supply and sustainable use of raw materials, an evaluation method for the environmental hazard potential of mining projects and resources was developed as part of the OekoRess I project on behalf of the German Environment Agency (UBA). Simultaneously, the UmSoRess project, also commissioned by the UBA, analysed the environmental, social and economic impacts of raw material production in 13 countries. To develop the findings of both research projects (OekoRess I and UmSoRess) further, the follow-up project OekoRess II was commissioned. OekoRess II aims at enhancing both the site- and raw material-related assessment schemes. One part of this effort focused on improving the indicator for environmental sector governance used in the assessment schemes by comparing the assessed environmental hazard potentials, the observed environmental impacts and a governance analysis on the basis of existing governance indicators. The aim was to answer the questions whether existing governance indices and indicators are able to adequately reflect the capability of governments, companies and civil society to manage potential environmental hazards and avoid or reduce environmental impacts of mining.. The results of the 10 case studies were then compared with the results of the 13 case studies of the UmSoRess project and a set of governance indicators was identified that can be used to improve the environmental governance indicator of the raw material-related evaluation scheme developed as part of the OekoRess I project. This report presents the research approach and the consolidated results.

Kurzbeschreibung: ÖkoRess II: Vergleichende Fallstudienanalyse

Damit die Umweltwirkungen des Bergbaus besser in den Debatten um mehr Verantwortung in Lieferketten und der nachhaltigeren Nutzung von Rohstoffen berücksichtigt werden, wurde als Teil des Forschungsvorhabens ÖkoRess I und im Auftrag des Umweltbundesamtes (UBA) eine Bewertungsmethode für das Umweltgefährdungspotential von Bergbauprojekten und Rohstoffen entwickelt. Gleichzeitig analysierte das ebenfalls vom UBA beauftragte Forschungsvorhaben UmSoRess die Wirkungen des Bergbaus auf Umwelt, Gesellschaft und Wirtschaft in 13 Ländern. Um die Ergebnisse beider Vorhaben (ÖkoRess I und UmSoRess) weiterzuentwickeln wurde ein Folgevorhaben ÖkoRess II beauftragt. ÖkoRess II hatte das Ziel, die standort- und rohstoffspezifische Bewertung zu verbessern. Ein Fokus lag dabei auf der Verbesserung des Indikators für die Umweltsektorgovernance, der als Teil der Bewertungsmethode genutzt wurde, indem die Umweltgefährungspotentiale mit den beobachteten Umweltwirkungen und einer Governance-Analyse auf Basis existierenden Governance-Indikatoren verglichen wurden. Ziel war es, die Frage zu beantworten, ob die vorhandenen Governance-Indikatoren in der Lage sind widerzuspiegeln, inwiefern relevante Akteure (Regierungen, Unternehmen und Zivilgesellschaft) potentielle Umweltgefährdungen bewältigen und Umweltauswirkungen des Bergbaus vermeiden oder reduzieren können. Die Ergebnisse der 10 Fallstudien wurden mit den Ergebnissen der 13 Fallstudien von UmSoRess verglichen und ein Set von Governance-Indikatoren identifiziert, welches zur Verbesserung des Umweltgovernance-Indikators der rohstoffbezogenen Bewertung, die als Teil von ÖkoRess I entwickelt wurde, genutzt werden können. Dieser Bericht beschreibt den Forschungsansatz und stellt die konsolidierten Ergebnisse dieses Prozesses vor.

Table of contents

List of figures 6
1 Background of the project and objectives of this report 8
2 Objectives and research design 9
2.1 Research Design 9
3 Results 12
3.1 Assessment of environmental hazards and environmental impacts 12
3.1.1 Methodological approach 12
3.1.2 Results of the assessment of EHPs and reported environmental impacts 14
3.1.3 Discussion: Does the assessment of EHPs adequately point to the actual environmental impacts? 42
3.2 Assessment of governance challenges and indicator analysis 44
3.2.1 Methodological approach of the governance and indicator analysis 44
3.2.2 Results of the governance and indicator analysis 48
3.2.3 Discussion: Do existing governance indicators reflect the countries' governance performance in the mining sector and its gaps and challenges 56
3.3 How to include Artisanal and Small Scale Mining 59
4 Conclusion 63
5 List of references 67
A Annex 68
Overview tables on main finding of the governance and conflict analysis and governance indicators of the UmSoRess case studies 68

List of figures

Figure 1: World Map of Artisanal and Small-scale Mining: ASM Population 61
Figure 2: World Map of Artisanal and Small-scale Mining: Rural ASM Population (%) 62

List of tables

Table 1: Case Study Botswana, Selebi-Phikwe (Nickel) 14
Table 2: Case Study: Brazil, Araxá (Minas Gerais -Niobium) 16
Table 3: Case Study: Canada, Mount Polley (Copper and Gold) 18
Table 4: Case Study: DR Congo, Kamoto Mining Complex (Copper-Cobalt) 21
Table 5: Case Study: India, Bailadila (Iron) 25
Table 6: Case Study: Morocco/Western Sahara, Bou Craa/Western Sahara (Phosphate) 28
Table 7: Case Study: Peru, Cerro de Pasco (Zinc and Lead) 31
Table 8: Case study: Turkey, Kirka (Borate) 34
Table 9: Case Study: USA, Spor Mountain (Beryllium) 36
Table 10: Case Study: Vietnam, Núi Pháo (Tungsten) 39
Table 11: Case Study Botswana, Selebi-Phikwe (Nickel) 48
Table 12: Case Study: Brazil, Araxá (Minas Gerais -Niobium) 49
Table 13: Case Study: Canada, Mount Polley (Copper and Gold) 49
Table 14: Case Study: DR Congo, Kamoto Mining Complex (Copper-Cobalt) 50
Table 15: Case Study: India, Bailadila (Iron) 50
Table 16: Case Study: Morocco/Western Sahara, Bou Craa (Phosphate) 51
Table 17: Case Study: Peru, Cerro de Pasco (Zinc and Lead) 51
Table 18: Case Study: Turkey, Kirka (Borate) 52
Table 19: Case Study: USA, Spor Mountain (Beryllium) 53
Table 20: Case Study: Vietnam, Núi Pháo (Tungsten) 53
Table 21: Comparison of indicators per country 54
Table 22: Main Findings Brazil (Aluminium) 68
Table 23: Main Findings Chile (Copper) 71
Table 24: Main Findings China (Rare Earth Elements - REE) 74
Table 25: Main Findings Greenland (REE – Rare Earth Elements) 77
Table 26: Main Findings Guinea, Boké and Kindia region (Bauxite) 80
Table 27: Main Findings Indonesia, Banka-Belitung (tin) 84
Table 28: Main Findings Indonesia, Grasberg (copper) 87
Table 29: Main Findings Australia (Rare Earth Elements (REE) extraction) and Malaysia (refining) 89
Table 30: Main Findings Peru (Gold) 93
Table 31: Main Findings South Africa (Gold) 96
Table 32: Main Findings USA, Butte (Copper) 99
Table 33: Main Findings USA, Mountain Pass (REE – Rare Earth Element) 102
Table 34: Main Findings Zambia (Copper) 105

List of Abbreviations

AMD	Acid Mine Drainage
ASM	Artisanal and small-scale mining
AZE	Alliance for Zero Extinction
BMU	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (Bundesministerium für Umwelt, Naturschutz, und nukleare Sicherheit)
CPI	Corruption Perception Index
DPSIR	Driving forces, Pressures, States, Impacts and Responses
DRC	Democratic Republic of the Congo
EHP	Environmental Hazard Potential
EDI	Environmental Democracy Index
EPI	Environmental Performance Index
EU	European Union
GPI	Global Peace Index
HDI	Human Development Index
HSE	Health, Safety and Environment
MAC	Mining Association of Canada
PPI	Fraser Policy Perception Index
REE	Rare Earth Elements
RGI	Resource Governance Index
UBA	German Environment Agency (Umweltbundesamt)
USA	United States of America
WGI	Worldwide Governance Indicators
WHO	World Health Organisation
WP	Work package
WSI	Water Stress Index

1 Background of the project and objectives of this report

In order to help ensure that the environmental impacts of mining are better taken into account in the debates on a responsible supply and a sustainable use of raw materials, an evaluation method was developed as part of the OekoRess I project[1] on behalf of the German Environment Agency (UBA). This easy-to-use evaluation method uses publicly available data and allows for an assessment of the environmental hazard potentials (EHPs) of mining projects. The method can be used to support resource policies, particularly in developing countries. It is not meant to replace on-site technical inspections, but to provide a method for an initial environmental assessment of mining projects. It was designed in a way that it can be applied by technical personnel even without expert knowledge of geology or mineralogy. The evaluation method highlights the major EHPs of a mining site that require special attention, in-depth analysis and, if applicable, the implementation of actions to reduce or avoid environmental impacts. The developed methodology was tested in 40 mine-site-level desktop studies and then used as a basis for the development of a commodity-level assessment scheme, which can be used to assess environmental aspects of mining in raw material criticality studies.

Simultaneously, the UmSoRess project[2], also commissioned by UBA, analysed the impacts of raw material extraction on the environment, society and the economy of 13 countries. The project aimed at gaining a better understanding of the connections between the environmental and social impacts of the production of different metals in the context of various countries with varying problems. Furthermore, 42 standards and initiatives aiming at improving the environmental and social conditions in the mining sector were analysed in order to identify lessons learned and best practices. The findings of both the case studies and the standards analysis were used to develop specific policy recommendations to improve environmental and social standards in mining and support responsible mineral sourcing.

To develop the findings of both research projects (OekoRess I and UmSoRess) further, the follow-up project OekoRess II was established. OekoRess II aims at enhancing both the site-related and the raw material-related assessment schemes. To this end, the already advanced site-related evaluation method is applied to 10 case studies for verification and further development, while the raw material-related evaluation method is applied to more than 50 mineral commodities.

The 10 case studies combine the analytical approaches of the UmSoRess and OekoRess I projects. This effort particularly focused on improving the indicator for environmental sector governance used in the assessment schemes by comparing the assessed EHPs, the observed environmental impacts and a governance analysis with existing governance indicators. The aim was to answer the question which existing governance indices and indicators are able to adequately reflect the capability of governments, companies and civil society to manage environmental hazards and to avoid or reduce environmental impacts of mining. The results of the 10 case studies were then compared with the results of 13 case studies of the UmSoRess project and a set of governance indicators was identified that can be used to improve the environmental governance indicator of the raw material-related evaluation scheme developed as part of the OekoRess I project. This report presents the research approach and the consolidated results.

[1] "OekoRess I: Environmental Limits, Environmental Availability and Environmental Criticality of Primary Raw Materials". For further information about the project see https://www.umweltbundesamt.de/umweltfragen-oekoress

[2] UmSoRess: Approaches to reducing negative environmental and social impacts in the production of metal raw materials". For further information about the project see https://www.umweltbundesamt.de/umweltfragen-umsoress

2 Objectives and research design

The site-related OekoRess evaluation method assesses a mining site's EHPs by evaluating three main thematic clusters:

1. geological criteria such as "preconditions for acid mine drainage (AMD)" or the "specific ore grade";
2. technological criteria such as the "mine type" and the "use of auxiliary substances"; and
3. criteria related to the context of the site such as "natural accident hazards due to floods, earthquakes, storms, landslides" or "Water Stress Index (WSI).

The rating for each indicator can be low, medium or high. The site-specific EHPs were identified for all 10 selected case studies (see Dehoust et al. 2017 for an in-depth discussion of the methodology and assessment scheme).

As part of the UmSoRess project, the impacts of primary raw material production on the environment, society and the economy were analysed in 13 case studies. The goal of the case studies was to gain a better understanding of the connections between the environmental and social impacts of mining in the different governance and country contexts. As one result, the project found that governance is one major factor influencing the occurrence and severity of environmental and social impacts of mining (see Rüttinger and Scholl 2017 for further details).

Against this backdrop, the aim in the OekoRess II project is to improve the indicator for environmental sector governance, by comparing the assessed environmental hazard potentials, the observed environmental impacts and the governance analysis with existing governance indicators. The aim is to answer the questions which existing governance indices and indicators are able to adequately reflect the capability of governments, companies and civil society to manage environmental hazard potentials and avoid or reduce environmental impacts of mining. As it is the case for the other indicators of the assessment method, the new governance indicator should be easy-to-use and the data publicly available.

2.1 Research Design

The 10 case studies each cover a specific mining project in one country – as in the UmSoRess case studies. The 10 countries, commodities and mine sites under analysis were chosen based on the following criteria:

- Wide coverage of different raw materials (most-different-cases approach);
- Wide coverage of different governance contexts (most-different-cases approach);
- Balance of the selection: Various raw materials and governance contexts should be addressed to provide a sound basis for generalization (taking into account the countries and resources that have already been assessed as part of UmSoRess);
- Data availability;
- Importance of the producing countries for global production and supply;
- Topicality and environmental policy needs (e. g. with regard to current political developments such as the introduction of an EU conflict minerals legislation);
- The existing German raw material partnerships.

Based on these criteria, the expert opinion of the project team and the advisory board, and the input of BMU and UBA, the following ten countries and raw materials were chosen:

- Botswana: Nickel
- Brazil: Niobium
- Canada: Copper and gold
- Democratic Republic of Congo: Cobalt
- India: Iron
- Morocco/Western Sahara: Phosphate
- Peru: Lead Zinc
- Turkey: Borate
- USA: Beryllium
- Vietnam: Tungsten

The case studies aimed at answering the following research-questions:

1. Does the assessment of the EHPs (OekoRess I site-related assessment) adequately point to the actual reported environmental impacts (desk study)?
2. Are existing governance indices and indicators able to adequately reflect the capability of governments, companies and civil society to manage environmental hazards and avoid or reduce environmental impacts of mining? In other words, are the identified governance gaps reflected in existing governance indices and indicators?

In order to answer these guiding questions, the case studies were structured as follows:

- Chapter 1:

  Focus and relevance of the study and overview of the mining sector in the respective country. The aim is to contextualize mining in the larger country setting.

- Chapter 2:

  Overview of the geological features, the mining process and the processing of the respective raw material.

- Chapter 3:

  Evaluation of site-related environmental hazard potentials based on the methodology developed in OekoRess I. Analysis of environmental impacts per case study based on the methodology of the UmSoRess project (DPSIR framework).

- Chapter 4:

  Description of country-specific sector governance, environmental legislation and the effectiveness of government institutions. Description of the social context and the history of the mining conflicts. The information in this chapter is accompanied by a set of indicators on the prevailing governance and conflict structures.

- Chapter 5:

  Analysis of the interrelationships and interactions between identified site-related environmental hazard potentials, the reported environmental impacts that occur and the prevailing governance and conflict structures at country level.

To answer the first research question, the assessments of environmental hazard potentials (site-related evaluation) were compared to the reported environmental impacts at the mining site (DPSIR framework).

To answer the second question, a set of indicators and indices was chosen and tested to see if it reflects the governance performance identified in the analysis (governance analysis and indicator analysis).

Furthermore, an approach for the integration of the identified most suitable indicator into the existing raw material-related assessment scheme was developed. The main results of this analysis are compiled in this report.

3 Results

3.1 Assessment of environmental hazards and environmental impacts

3.1.1 Methodological approach

The case studies first give an overview of the country's economic framework and provide details about the mine site's geographical, geological and technical background. This enables the reader to understand the setting at both country and local level and, furthermore, introduces the database for the site-related evaluation of environmental hazard potentials (EHPs).

This evaluation scheme assesses the EHPs of the extraction of primary abiotic raw materials and is based on a set of thirteen indicators, which are assigned to three levels of consideration. These clusters are geology, technology and site surroundings. The cluster "Geology" comprises five indicators, which include environmental factors inherent to the geology on site. These key influencing factors are "precondition for acid mine drainage (AMD)", "paragenesis with heavy metals", "paragenesis with radioactive components", "deposit size" and "specific ore grade". The second cluster is "Technology" and includes the four indicators "mine type", "use of auxiliary substances", "mine waste management" and "remediation measures". The third cluster "Site (surroundings)" comprises the indicators "natural accident hazard due to floods, earthquakes, storms, land-slides", "Water Stress Index (WSI) and desert areas", and "protected areas and Alliance for Zero Extinction (AZE) sites". The 13th indicator, "conflict potential with local population", accounts for environment-related conflicts, which corresponds to the indicator for environmental governance of the raw material-related assessment scheme to be further developed in this study. The EHP for each indicator can be rated as low (green), medium (yellow) or high (red) For detailed information on the method, refer to Dehoust et al. (2017).

Following the evaluation of EHPs, the project team analysed the actual situation and impact of the mining activities on the environment as well as the responses from the mine site operator, the responsible authorities as well as the social communities around the mine to the situation at hand.

This information was analysed and presented using the DPSIR framework, which is a system analysis approach to better understand the interactions of humans with their environment in order to derive adequate policy measures (based on Kristensen 2004). The framework provides a bridge from the site-related indicators to the indicators at country level in chapters 4 and 5 of the country case studies and consists of driving forces, pressures, state, impacts and responses:

D – Driving forces

Driving forces may lead to pressures on the environment. They are changes in the overall levels of production and consumption. Through these changes in production and consumption, the driving forces exert pressure on the environment.

P– Pressures

The pressures result from the driving forces (e.g., emissions into air, water and soil).

S – States and I – Impacts

Description of the actual state of the environment that results from the driving forces and the pressures on the environment (e.g., water quality, heavy metal contamination) causing the environmental impacts of mining on ecosystem integrity and human health (e.g., loss in biodiversity, health problems of workers).

R – Responses

This part describes the responses to the impacts, for example actions taken by the mine site operator (e.g. water and tailings management or closure and rehabilitation plans), the responsible authorities

(e.g. health or emergency action plans and their respective execution) as well as the communities around the mine.

3.1.2 Results of the assessment of EHPs and reported environmental impacts

The following tables show the results of the site-related EHP assessment and the reported environmental impacts according to the DPSIR framework for each of the ten case studies.

Table 1: Case Study Botswana, Selebi-Phikwe (Nickel)

Thematic Cluster	Indicator	EHPs		
		low	medium	high
Geology	Preconditions for acid mine drainage (AMD)			X
	Paragenesis with heavy metals			X
	Paragenesis with radioactive components	X		
	Deposit size			X
	Specific ore grade		X	
Technology	Mine type	X		
	Use of auxiliary substances			X
	Mining waste management			X
	Remediation measures			X
Site (surroundings)	Accident hazard due to floods, earthquakes, storms, landslides	X		
	Water Stress Index (WSI) und desert areas			X
	Protected areas and Alliance for Zero Extinction (AZE) sites	X		
	Conflict potential with local population[3]		X	

[3] Based on the following Worldwide Governance Indicators: Control of Corruption/Voice and Accountability

DPSIR Results	
Pressures	• Stem from the mine itself, the tailings facilities and the smelter. • Transformation of the natural landscapes, exacerbated by the subsequent migration of workers, urbanization and population growth. • Estimated transformed area of 1m² for each tons of nickel metal mined.
State and Impact	**Land use and biodiversity** • Fragmentation of habitats and displacement of wildlife. **Water and soil contamination** • Heavy metal and AMD contamination, particularly stemming from the tailings facilities. • Soil fertility disappeared was severely degraded, with negative effects on crop cultivation and other land uses. **Air pollution** • Smelter emissions containing heavy metals and sulphur dioxide, and are being distributed by aerial transportation. • Nickel-rich dusts produced during ore crushing. • Elevated values of SO_2 and H2S in the air and acidic $SO4^{2-}$. **Health** • Direct and indirect effects of pollution (heavy metals, particular matter) severely affect the health of residents and workers. • Fatal diseases such as cancer and lung diseases in the area assumingly relate to emissions.
Responses	• The operating company has announced to implement general environmental protection measures, such as compliance with regulations, minimise waste and energy use, and to carry out internal monitoring. • The implementation, however, could not be verified with the resources at hand.

Table 2: Case Study: Brazil, Araxá (Minas Gerais -Niobium)

Thematic Cluster	Indicator	EHPs		
		low	Medium	high
Geology	Preconditions for acid mine drainage (AMD)	X		
	Paragenesis with heavy metals		X	
	Paragenesis with radioactive components			X
	Deposit size			X
	Specific ore grade	X		
Technology	Mine type			x
	Use of auxiliary substances			X
	Mining waste management			X
	Remediation measures	X		
Site (surroundings)	Accident hazard due to floods, earthquakes, storms, landslides	X		
	Water Stress Index (WSI) und desert areas	X		
	Protected areas and AZE sites	X		
	Conflict potential with local population	X		

DPSIR results	
Pressures	• Elevated concentrations of radioactive minerals in the deposit • (Radioactive) dust • Contamination of waters due to mining • Use of land
State and Impact	**Land use and Biodiversity** • The ecological zone of Cerrado is considered being a precious ecosystem rich in species. **Water and soil quality** • Water bodies of the area show slightly increased conductivity and are enriched with minerals which are abundant in the parent material, like barium; the waters show also elevated levels of chloride and sodium related to urban wastewaters. • The surface water bodies in Araxá have pH-values of 7 and slightly above. **Radioactivity** • Radioactive nucleoids occur naturally in geological formations around the mine. • No reports point at mining in Araxá being an increasing factor for the dispersal of radioactive elements in the environment. **Dust and Noise** • Load of airborne particles around the mine and in Araxá is much lower than regulatory limits. • Crushing and processing of the minerals can result in radioactive dust. The respirable particles can affect the health of the workers.
Responses	**Commitment to international standards** • The mine has several environmental and occupational safety certifications. **Rehabilitation** • No closure and rehabilitation plans in place. **Water and tailings management** • CBMM has installed a sealed tailing facility to deposit the minerals sorted out by magnetic separation. • 95% of the water used is recycled, which reduces water use and energy demand. **Community development** • CBMM is the largest employer in the region and claims to promote infrastructure and communal development.

Table 3: Case Study: Canada, Mount Polley (Copper and Gold)

Thematic Cluster	Indicator	EHPs		
		low	medium	high
Geology	Preconditions for acid mine drainage (AMD)	X		
	Paragenesis with heavy metals			X
	Paragenesis with radioactive components		X	
	Deposit size	x		
	Specific ore grade			X
Technology	Mine type		X	
	Use of auxiliary substances			X
	Mining waste management			X
	Remediation measures	X		
Site (surroundings)	Accident hazard due to floods, earthquakes, storms, landslides	X		
	Water Stress Index (WSI) und desert areas	X		
	Protected areas and AZE sites	x		
	Conflict potential with local population	X		

DPSIR results	
Pressures	• Mining leases and mineral claims, total up to almost 200 km². • Tailings dam breached in 2014 resulting in a large spill, releasing water and tailings in the surrounding area.
State and Impact	**General considerations** • Up to 25 million m³ of tailings slurry were released during the breach. **Geochemistry** • The released tailings led to changes in the soil and sediment toxicity, so that "some metals exceed guidelines and/or standards", for example copper and vanadium. However, released tailings are "not acid-generating and have low leaching potential". **Erosion and deposition of tailings and eroded materials** • Main physical impact of the event was the erosion and deposition of tailings and eroded materials: - Thick deposit layers in lakes; - Erosion and displacement of an estimated 0.6 to 1.7 million m³ of upper soils and sedimentary horizons as well as vegetation; - Widening of Haseltine Creek channel, loss of riparian vegetation and the deposition of tailings in both of the two lakes. • The tailings contain elevated levels of arsenic, lead, cadmium and selenium and therefore show a high potential for a contamination with heavy metals. • Spilled tailings are not acid generating and have low leaching potential. **Aquatic impacts/ Impacts on water quality and fish** • The inflow into lakes resulted in impacts on the aquatic sphere in several ways: - Disturbance of lake bottom layers; - Wide range of contaminants (arsenic, copper, gold, manganese, nickel, lead, vanadium); - Thick layer of material deposited on the ground of the lake permanently; - Benthic invertebrates in deeper areas of the lakes are affected in growth, survival and behaviour. **Health Impacts** • No direct impacts of the dam breach on the clinical health of people reported. • First Nation communities experienced "emotional stress". • Loss of food and medicine sources provided by the environment. • Changes in physical activity and cultural practices. • Reduced incomes and employment opportunities, because of negative impacts on First Nation communities' commercial fisheries.

DPSIR results	
Responses	• Action plans for rehabilitation where developed. • A broad process of investigations was initiated and recommendations for the company elaborated. • The dam failure had no prior human failure as cause but geological pre-conditions. • The Mining association of Canada (MAC) improved their protocols to prevent future incidents and to restore credibility in the initiative. • ICMM reviewed its tailings management guidelines in 2016.

Table 4: Case Study: DR Congo, Kamoto Mining Complex (Copper-Cobalt)

Thematic Cluster	Indicator	EHPs		
		low	medium	high
Geology	Preconditions for acid mine drainage (AMD)			X
	Paragenesis with heavy metals			X
	Paragenesis with radioactive components			X
	Deposit size			X
	Specific ore grade	X		
Technology	Mine type		X	
	Use of auxiliary substances			X
	Mining waste management			X
	Remediation measures		X	
Site (surroundings)	Accident hazard due to floods, earthquakes, storms, landslides	X		
	Water Stress Index (WSI) und desert areas	X		
	Protected areas and AZE sites	X		
	Conflict potential with local population			X

DPSIR results	
Pressures	• Areas affected exceed 19.5 square kilometres. • About 80.000 inhabitants live close to the mining site. • The activities in the mines and the refinery plant have led to contamination of ground waters and the Luilu River and have caused air pollution. • Pollution and disturbance of the environment are linked to both, industrial mining and ASM. The Kamoto mining complex is surrounded by ASM miners, who are working on abandoned larger mine sites and around the mines in use. • ASM concerns a large part of the society with particularly severe impacts on health.
State and Impact	**Water contamination and water shortage** • In an environment of limited access to drinking water, the daily water consumption of the Kamoto mine is approximately 60,000 cubic meters, with 19,000 being used by metallurgical processes in the Kamoto concentrator. • The region theoretically has good access to water sources (e.g. the Luilu river), but cases of water shortage were reported due to the mining activity related withdrawal of water -sometimes over long periods. • The mining lead to water contamination, including contamination of ground water and wells, the nearby surface waters, and in particularly the Luilu River - with Luilu metallurgical plant being one of the main polluters. • The mining company released wastewaters from the plant containing sulfuric acid, which caused and cause elevated levels of lead, zinc, copper and a pH value of 3.37 (with 6.5-9.0 required). • Polluted water is unsuitable for any type of usage, including irrigation, which has led to a loss of revenue for local communities due to difficulties in agricultural activities, a shortage of drinking water and an increasing number of sicknesses from contaminated water. • Large amounts of waste rock and tailings stored inadequately contribute to the degradation in the area and add to pollution of groundwater. • As well as industrial mining and ore processing, ASM also significantly contributes to water pollution, mainly to the pollution of surface water bodies. • Due to destruction and degradation of the natural habitats and a contamination of the mining sites (in the whole Kolwezi region), these areas are no longer suitable for agricultural activities. **Air pollution and noise** • The mining facilities and the linked transport are permanent sources of air pollution. • The dust contains ore particles, heavy metals and chemicals, which might easily enter people's lungs and can cause serious diseases and breathing problems. • For some of the mining sites, local inhabitants complain about regular blasting activities damaging their houses. **Loss of biodiversity**

DPSIR results	
	• Due to pollution and contamination, the surface waters of the area became unsuitable for water flora and fauna. • Local communities lose fish as an important source for food and as an additional income. **Health impacts** • Numerous health problems have been identified: mainly lung diseases, coughs and breathing problems from dust containing heavy metals and cobalt particles from the mines. • Concentrations of cadmium, lead, uranium and especially cobalt in the urine of people living close to mines in the province of Katanga is strongly elevated in average. Contamination results from food and dust. • Particularly the dust and smoke from mining and ore processing activities contains ore particles, heavy metals and other chemical elements, that easily enter people's bodies and cause serious diseases and breathing problems, including asthma, impaired lung function and pneumonia. • Especially miners report the listed health problems but as the mines and plants are exceptionally close to residential areas, entire communities suffer from pollution and contamination.
Responses	**Environmental and social monitoring** • As required by the DRC Mining Code (2002) and Mining Regulation (2003), the mining company commissioned several Environmental Impact Statements (EIS) and Social Impact Studies. • KCC reports internally: a) a list of community incidents, complaints, contractor incidents, employee incidents, environmental incidents, environmental non-compliances, sanctions and fines and HSE incidents; b) internal audits and inspection reports; and c) monitoring reports covering surface and ground water, dust fallout, sulphur dioxide and nitrogen dioxide monitoring and surrogate stack emissions estimation. **Water and tailings management** • Treatment and neutralisation of effluents and tailings, recirculation of water, monitoring of water use, construction of dams and recycling. • KML implemented a Water Quality Management Program, Tailing Pipeline Management Program and Tailing Storage Facility Management Program, to target water control and prevent waste from contaminating natural water bodies. • In 2015, KML started a cleaning campaign for water infrastructure in Kolwezi, which works to further improve the water supply for Luilu and Musonoi and includes the construction of two water boreholes in Luilu in 2015 and 14 boreholes in different communities in 2012. • Water management and air protection: in recent years special floating covers are being used on the tailings ponds. These cover surface and reduce evaporation by 65 %. • Further degradation of the surface is not considered in Glencore's large-scale environmental actions, and there is no specific project related to soil degradation in Glencore's annual report. **Air quality**

DPSIR results	
	• Air quality monitoring is carried out, indicating (by the companies own report) that the company is in compliance with the DRC effluent quality standards. **Health** • According to the company's own reports baseline risk assessment was carried out for health and safety and trained all employees and contractors to a so called "SafeWork program". • The environmental management systems were enhanced through the improvement of various monitoring programs (recycling program and pollution prevention plan) in order to improve the health of the workers and the communities around the mining complex. • Collaboration with local health zones in order to develop strategies to address community health risks and concern, and that the company engages in training local medical stuff and building of health infrastructure. **Artisanal and small scale mining (ASM)** • Many of the health impacts are particularly reported by artisanal miners. • The miners are usually not protected from mining and processing activities. • Glencore states that it works to reduce ASM by implementing targeted programmes, such as enhancing local employment or by supporting co-operative associations that work in the communities around the mining complex in order to create new income sources and to train the people about possible dangers around ASM. • Glencore is also involved in the facilitation of ASM and the trade of ASM products: First, it is stated that ASM takes place in pits, where Glencore's subsidiary, KCC, holds the mining licence. Second, it is stated that KCC buys minerals from artisanal and small-scale miners around the mining complex.

Table 5: Case Study: India, Bailadila (Iron)

Thematic Cluster	Indicator	EHPs		
		low	medium	high
Geology	Preconditions for acid mine drainage (AMD)	X		
	Paragenesis with heavy metals			X
	Paragenesis with radioactive components		x	
	Deposit size			X
	Specific ore grade	X		
Technology	Mine type		x	
	Use of auxiliary substances		X	
	Mining waste management			X
	Remediation measures	X		
Site (surroundings)	Accident hazard due to floods, earthquakes, storms, landslides		X	
	Water Stress Index (WSI) und desert areas			X
	Protected areas and AZE sites	X		
	Conflict potential with local population			X

DPSIR results	

Pressures	• The major environmental pressures of the Bailadila mining operation impacting the environment for almost 50 years, are:
	  - Emissions of metals from tailings to waterbodies and soils;
	  - Deforestation;
	  - Waste generation.
	• Causal link between the iron ore mine and the degradation of the surrounding area as well as the impact on the populations' health.

State and Impact	**Ground water and rivers**
	• The iron ore tailings around Bailadila are proven to be contaminated with heavy metals such as Cu, Pb, Zn, Cr, Sn, Mo and U.
	• These potentially toxic elements also became pollutants to ground water along with Al, Pb and Fe.
	• Water quality around the mine is rated as being very poor.
	• The iron ore mines at the Bailadila complex daily generates huge amounts of tailings and slurry, large amounts of dissolved solids, fine ore content and clay.
	• High probability that piled up material outside of tailing ponds are eroded and might flow into the nearby river or add to land degradation.
	• Journalists report illegal dumping of iron ore fines into the rivers Indrāvati, Shankini and Dankini.
	Deforestation
	• Iron ore mining in Bailadila led to:
	  - Destruction and degradation of large forest areas - one third of Dantewada's forests areas are degraded;
	  - Extinction of many plant varieties;
	  - Deforestation results from the open pit mining itself as well as additional creation of storage facilities for the debris created by the mining activities.
	Noise and Dust
	• Noise levels exceeded the standards of the Indian Central Pollution Control Board (CPCB).
	• Noise probably causes the most prevalent environmental stress in the area.
	Health
	• There is no sufficient literature to assess the negative effects of the mine on health but hazards may be derived from the water and noise pollution as detailed above.
	• Approximately 100 villages are dependent on the rivers as a source of drinking water and for the irrigation of agricultural areas.
	• Downstream, after the Shakini feeds the Dankini, around 40,000 people are affected by the polluted rivers.
	• In total, 35,000 hectares of agricultural lands and forest are negatively affected by the Bailadila mine complex, leading to farming land being infertile and decreasing agricultural productivity.

DPSIR results	
Responses	**Reforestation** • Rehabilitation measures of the Bailadila mine include afforestation programs that to date afforested 1.100 ha of land with 1.6 million trees. **Noise** • There are noise control mechanisms in place since 2009 • If the reduction of the high noise level was successful is unknown since no information on this topic could be gathered. **Health** • Measures to increase or re-establish conditions for a healthy environment would need to include the reduction of noise level, provision of clean drinking water and clean soils. • Communities harvest rainwater to replenish drinking water. • Establishment of a storage facility to clear the water before it flows into the river possibly counteracted by inadequate piling up of the solid components. • The reforestation mentioned above is also a pre-requisite for increasing the groundwater table. This could lead to re-opening of drinking wells. How far such measures have been successful is unknown. **Commitment to UN global compact principles** • Company is applying the United Nations Global Compact Principles.

Table 6: Case Study: Morocco/Western Sahara, Bou Craa/Western Sahara (Phosphate)

Thematic Cluster	Indicator	EHPs		
		low	medium	high
Geology	Preconditions for acid mine drainage (AMD)	X		
	Paragenesis with heavy metals			x
	Paragenesis with radioactive components			X
	Deposit size			X
	Specific ore grade	X		
Technology	Mine type			X
	Use of auxiliary substances	X		
	Mining waste management		X	
	Remediation measures			X
Site (surroundings)	Accident hazard due to floods, earthquakes, storms, landslides	X		
	Water Stress Index (WSI) und desert areas			X
	Protected areas and AZE sites	X		
	Conflict potential with local population			X

DPSIR results	
Pressures	• The repeated expansion of the Bou Craa Mine is accompanied by consumption of landscape and increased pressure on the environment.
State and Impact	**Surface disturbance and wildlife** • Due to the sparse vegetation and wildlife, the effects of the mining activities on flora and fauna are expected to be low. • Rare rain events may lead to transport of materials relocated through mining processes (e.g. wind transport, tailings) into the drainage system but no verification of this assumption was available. **Noise and vibration** • Noise is generated in the Bou Craa mine by the operation of walking draglines, shovels and trucks as well as crushing and screening processes. • Since not many people live in the desert surrounding the mine and processing plants, it can be assumed that the effects of mining noise are minimal. **Air pollution** • In Bou Craa dust development is triggered by: the removal of the overburden, the extraction of the ore itself, the movement of mining machines on unpaved roads and transport processes. • As the wind drifts to south-west, the dust is mainly deposited in uninhabited areas and the marine environment. • The extraction of Moroccan phosphates also releases a great quantity of fluorine, which contaminates air, water and soil in the surrounding area and leads to health problems. **Water consumption and water contamination** • Water for processing in El Aaiun is generated in am desalination plant. • Effects of desalination on the environment can take several forms, e.g., when multi-component waste from the process is discharged directly into the sea. That it turn can lead to excessive growth of algae • However, no information on the impact of the plant were obtained. **Contamination of groundwater and soil** • As there is hardly any precipitation in the area around Bou Craa, it can be assumed that inputs of dust constituents into the soils are limited to rare rainfall events. **Health impacts** • The dust in Bou Craa contains cadmium and uranium associated with cancer and other diseases. • During the chemical processing of phosphate gases of sulfuric acid, phosphoric acid and ammonia can occur and endanger workers' health. • In the past, there have been several health studies in Bou Craa, one of them detected pulmonary emphysema in 80% of those examined. **Radioactivity** • It can be assumed that the miners in Bou Craa and the workers in El Aaiun are exposed to a certain amount of radiation.

DPSIR results	
	• The presence of phosphogypsum, a waste product of Fertilizer production, represents an additional radiation risk. **Climate** • The excessive growth of algae due to eutrophication (see above) results in so called dead zones that may intensify global warming.
Responses	• A series of measures and programmes were launched that aimed at reducing the environmental impact of the phosphate industry: a water strategy (e.g. desalination of seawater, recycling of waste water), an energy strategy (e.g. capturing energy generated by chemical processes, use of renewable energy) and a waste-management strategy (e.g. reducing waste, re-using waste). • Within the framework of the Environment Excellence Program (EEP) of OCP 1,200 shrubs and 3,000 m² of green space in Bou Craa were planted in 2015. • Over 95% of the energy consumed by Phosboucraa is provided by wind energy, saving more than 80,000 tons of CO_2 equivalent per year. • Water consumption is expected to be reduced by 20% by installing a new flotation unit. • An HSE (Health, Safety and Environment) Task Force, and a one month mobilization operation was held to make the staff aware of safety matters.

Table 7: Case Study: Peru, Cerro de Pasco (Zinc and Lead)

Thematic Cluster	Indicator	EHPs		
		low	medium	high
Geology	Preconditions for acid mine drainage (AMD)			X
	Paragenesis with heavy metals			X
	Paragenesis with radioactive components	X		
	Deposit size			X
	Specific ore grade			X
Technology	Mine type		X	
	Use of auxiliary substances			X
	Mining waste management			X
	Remediation measures		X	
Site (surroundings)	Accident hazard due to floods, earthquakes, storms, landslides			X
	Water Stress Index (WSI) und desert areas	X		
	Protected areas and AZE sites	X		
	Conflict potential with local population			X

DPSIR results	
Pressures	• The mining operation began in 1901 and has affected, directly and indirectly, an area of 893 ha, involving land loss, reducing the habitable area in the city, and leading to degradation of water, air and soil quality.
State and Impact	**Surface disturbance** • Locations of the mining operations and city of Cerro de Pasco are intertwined • Mining operations cover almost 50% of the city **Air pollution** • Operations and diverse activities carried out by the mining company are sources of air pollution (emissions from the concentrators of the Paragsha/San Expedito Plant, dust from the waste dumps and tailings). **Noise and vibration** • The main noise pollution resulted from the vibrations and detonations carried out in the Raúl Rojas open pit mine and the underground mine Paragsha. In addition, the noise from processing plants, originating from crushing and grinding operations, is also significant (Astocaza Armacanqui 2008). **Groundwater pollution** • Runoff and groundwater below and adjacent to dumps and stockpiles were strongly affected by AMD and show elevated levels of arsenic, cadmium, copper, nickel, lead, and zinc, ammonium, bismuth, chromium, phosphorus, manganese, thallium and vanadium are also high. **Pollution of nearby rivers** • The Quebrada Quiulacocha lagoon and the Quiulacocha Creek (not the tailings storage facility of the same name), which are tributaries of the San Juan river, are affected by contamination through mining, industrial water and domestic discharges (heavy metal contamination exceeding the limits determined by the WHO) **Health** • Chronic lead poisoning of children, and some cases of high contamination in several Cerro de Pasco's suburbs
Responses	**Water treatment** • In the 1980s a treatment plant was built by the Peruvian government due to the Central Government's interest in using part of the Mantaro waters for Lima's water supply, This reduced the pollution of the San Juan River but did not eliminate it completely. Paz Valenzuela (2016) presents possible measures to mitigate impacts on the water bodies in the area. If these suggestions have led to actions by the ministry could not be determined based on the information at hand. **Health**

DPSIR results	
	• Minsa (The Ministerio de Salud – Ministry of Health) published a press release to declare a formal 90 days health emergency declaration. • Minsa proposed a comprehensive health plan for 2017 to 2021, including the construction of a Specialised Heavy Metal Attention Centre in Junín • The government started a program to provide drinking water to the population of Pasco as local water was classified to be too heavily contaminated for drinking purposes

Table 8: Case study: Turkey, Kirka (Borate)

Thematic Cluster	Indicator	EHPs		
		low	medium	high
Geology	Preconditions for acid mine drainage (AMD)	X		
	Paragenesis with heavy metals		X	
	Paragenesis with radioactive components	X		
	Deposit size			X
	Specific ore grade	X		
Technology	Mine type			X
	Use of auxiliary substances		X	
	Mining waste management			X
	Remediation measures	X		
Site (surroundings)	Accident hazard due to floods, earthquakes, storms, landslides			X
	Water Stress Index (WSI) und desert areas		X	
	Protected areas and AZE sites	X		
	Conflict potential with local population			X

DPSIR results	
Pressures	• The size of the mine site and the tailings is relatively large. • Boron may act toxic depending on the dose and cause symptoms such as nausea, vomiting, diarrhoea, dermatitis and lethargy. • Only limited information was found on environmental impacts of the mining operations at the Kırka mine.
State and Impact	**Surface disturbance and biodiversity** • The increasingly deeper operations caused slope failures and erosion. • Plant species diversity declines with increasing proximity to the boron mine. **Water pollution** • Little available information on the level of water consumption of the mine. • Kırka mine produced an annual amount of 120,000 tons clay wastes, discharged to the plant area and containing about 8–22% B_2O_3, i.e. a rather high concentration. • The easily water-soluble boron reaches the groundwater and a river near the mine through precipitation with current boron contents in groundwater, three to four times higher than initially. • Boron content in drinking water is above the regulatory limits defined by WHO and the EU and others. **Health/Radioactivity** • No radioactive levels were found around the Kırka Boron Facility. • Elevated levels near Eskişehir city are caused by the strong influence from the magmatic host rock of the area. • Soils are enriched with heavy metals (As, Pb, Fe). These are related to secondary hydrothermal processes. • Samples from the waste treatment lake display elevated heavy metal concentrations (As, Pb, Fe).
Responses	• Extremely few information could be found on responses to the environmental impacts of the mine site. • There are indications of a reforestation programme and the creation of artificial wetlands.

Table 9: Case Study: USA, Spor Mountain (Beryllium)

Thematic Cluster	Indicator	EHPs		
		low	medium	high
Geology	Preconditions for acid mine drainage (AMD)	X		
	Paragenesis with heavy metals		X	
	Paragenesis with radioactive components			X
	Deposit size			X
	Specific ore grade	X		
Technology	Mine type			X
	Use of auxiliary substances			X
	Mining waste management			X
	Remediation measures	X		
Site (surroundings)	Accident hazard due to floods, earthquakes, storms, landslides	X		
	Water Stress Index (WSI) und desert areas			X
	Protected areas and AZE sites	X		
	Conflict potential with local population	X		

DPSIR results	
Pressures	• The mining operation and processing has directly and indirectly affected an area of 3,000 ha and another 89 ha is affected by a tailings pond in Delta. • Only limited information on specific pressures generated by the Spor beryllium mine as well as by the mill in Delta city.
State and Impact	**General considerations** • The data available regarding environmental impacts of the assessed mine was not sufficient to comprehensively analyse the actual environmental impacts. • Based on the available data, the environmental impacts of beryllium mining in Spor Mountain seem to be quite low. • The main environmental impact that was identified is the use of land, as mining and processing directly and indirectly affect an area of 3,000 ha. • Furthermore, there are potential health impacts, since beryllium is hazardous to humans; however, the mining company implements high health and safety standards at the mine site that reflect today's best practices. **Surface disturbance and wildlife** • Desert area, where flatlands are covered by sparse vegetation. The mountain sides have more developed flora; before the demand for beryllium increased in the 1960s, the mountain slopes, currently allocated to mining pits, used to be grazing areas for livestock and wild animals. • Some sheep and cattle are still grazing on territories belonging to the mining company. **Water pollution** • Beryllium is insoluble in water and accumulates in sludge. It is therefore unlikely to affect fish if the mineral dust reaches water bodies or if other animals drink such water. • According to the water survey of 2016 which was published by DEQ Utah, concentration of beryllium in drinking water in the state of Utah was far below the allowable limit. **Air pollution** • Beryllium entering the lungs can cause severe illness (see below) and might remain in the air for several days. • No information on the amount of beryllium bearing dust around the mine has been obtained. **Health impacts** • If the concentration of beryllium exceeds the set limits in dust, mist or fume, its small particles enter human lungs and provoke lung granulomas. This can lead to a chronic beryllium disease (CBD) or berylliosis. Additionally, beryllium can cause allergic reactions and disturbance of the skin surface. • Beryllium was at one point considered to be a carcinogen; however, the latest research shows that this element rarely causes cancer.

DPSIR results	
	• Nowadays, the risk of getting CBD during beryllium mining and processing activities is considered to be rather low due to higher safety standards and modern technologies that improve workers' protection. • There is no detailed data on the current situation in the Spor Mountain mine; however, the company provides information that the health and safety standards at the mine site are up to date and reflect today's best practices (see section "Responses").
Responses	• A range of measures are being undertaken by both Materion and the government to minimize pressures and negative impacts of beryllium mining and processing activities. • "Life-on-mine" mining strategy, includes reclamation activities on site and making sure that wild animals still have access to the area. • Ongoing mining accompanying activities of land re-cultivation and rehabilitation. • Water quality measured regularly. • Air quality: filters installed and continuously monitored. • Comprehensive and effective safety regulation measures for the employees to avoid diseases connected to beryllium.

Table 10: Case Study: Vietnam, Núi Pháo (Tungsten)

Thematic Cluster	Indicator	EHPs		
		low	medium	high
Geology	Preconditions for acid mine drainage (AMD)			X
	Paragenesis with heavy metals			X
	Paragenesis with radioactive components		X	
	Deposit size			X
	Specific ore grade		X	
Technology	Mine type		X	
	Use of auxiliary substances			X
	Mining waste management			X
	Remediation measures	X		
Site (surroundings)	Accident hazard due to floods, earthquakes, storms, landslides		X	
	Water Stress Index (WSI) und desert areas			X
	Protected areas and AZE sites	X		
	Conflict potential with local population			X

DPSIR Results	
Pressures	• Contamination of soils and water bodies with arsenic, heavy metals and cyanide • Land use • Emission of noise and dust
State and Impact	**Land use and Biodiversity** • Natural vegetation had been transformed to densely settled rural areas, cultivated areas or mining sites in the area of Nui Phao. • Deforestation of natural tropical forests and replacement by agricultural land. **Contamination of soils and water bodies** • Contaminations of soils and water bodies with arsenic, heavy metals and cyanide. • High metal contents originate from a combination of both, natural and anthropogenic sources. • 570.000 $m^3$of historic tailing material has been identified. This poses a significant source of sulphur, which produces acid solutions when it is exposed to the surface. **Air pollution and noise** • Load of particles exceeds the regulatory requirements in Vietnam in the dry season (due to drilling, blasting, traffic etc.). • Noise pollution is high due to population density, traffic and manifold economic activities (above 50 dB even during night time). **Health and livelihoods of the local population** • Permanent exposure to heavy metals from intake through different pathways (dust, drinking water, food chain) shows impacts on the health of the people living close to the mining area. • Due to mining activities loss of agricultural productivity in the communities near the mine.
Responses	**Commitment to international standards** • MASAN defines yearly sustainability targets in the categories “people”, “health and safety”, “environment” and “community”. • Social plans have been developed in accordance with IMF Performance Standards. **Rehabilitation** • A rehabilitation and mine closure plan is in progress. **Water and tailings management** • Wastewater treatment plants have been built. • The total water use of the mining operation decreased in 2016 due to a reduction in water use by optimizing the sulphuric and oxidic tailing facilities. • Treatment ponds are fully operable since 2016.

DPSIR Results	
	Noise and dust • There is a quarterly monitoring of potential health risks like noise, dust and air pollution **Health** • Employee training courses on safety and health aspects were conducted. • No accidents or lost-time-injuries since 2016 **Stakeholder engagement, grievance mechanisms and community development** • MASAN has a community development program, which focuses on infrastructure, capacity-building and agricultural extension services in the surrounding area and a complaints and grievance mechanism.

3.1.3 Discussion: Does the assessment of EHPs adequately point to the actual environmental impacts?

After completing the site-related evaluation of the EHPs for the case studies, the project team compared the results with each other as well as with the results of the DPSIR analysis to 1) draw conclusions about the applicability of the site-related assessment method and 2) to verify the selected indicators and indices.

The case studies indicate that the site-related evaluation of EHPs points quite accurately and in most cases to the reported environmental impacts. Particularly in the case studies of the DRC, Canada, Morocco/Western Sahara and Botswana, the EHPs correspond strongly with the identified environmental impacts. The results of the Peru case study indicate that the EHPs and environmental impacts correspond mainly well.

In the USA case study, the site-related evaluation points towards more EHPs rated as high than the amount of actual impacts identified. Such a result is within the range of expected outcomes, as the methodology is hazard-based. This means that the highlighted hazards do not necessarily reflect actual reported environmental impacts. Such a result can have several causes: a) the evaluation method is based on generalised indicators from which specific cases may deviate, b) appropriate countermeasures have been taken by the company and c) the mining takes place in a framework of good governance leading to appropriate supervision.

The actual impacts of mining on the environment such as impacts on human health (e.g., respiratory illnesses) or aquatic life (e.g., biomass production) as described in the DPSIR framework are not described by the site-related evaluation of EHPs, neither is this intended. Statements on actual environmental impacts require a full environmental impact assessment.

In the USA case study, the low EHP for the indicator "conflict potential with local population" that is derived from two World Bank indicators reflects well the results of the DPSIR analysis – and indicates that high EHPs have been met by adequate countermeasures. Despite the high EHPs for "paragenesis with radioactive components", "mining waste management" and "Water Stress Index (WSI) and desert areas", no impacts of the aforementioned hazards were identified. Such results should be interpreted with caution: Indicators such as "paragenesis with radioactive components" that is assigned with a high EHP could proof to be unproblematic after an environmental impact assessment that analyses the on-site conditions in detail.

In a reverse case, the non-implementation of mine closure plans in the case study of India was not identified by a high EHP for the indicator "remediation measures", as this indicator assesses solely whether plans for the closure of mines exist, but not, whether they are implemented. However, the measurement instruction for the site-related evaluation points out that the evaluation needs to be validated in countries with poor implementation or bad governance as it has been done in the DPSIR analysis, but a rule for the final evaluation is pending. The potential for non-implementation of a mine closure plan is again reflected by the indicator "conflict potential with local population", which was assigned with a high EHP in the evaluation. The lack of implementation of laws and regulations is a major problem in India, leading to widespread negative environmental and social impacts, also in the region covered by the case study.[4]

The results show how important it is to take into account the intertwining of indicator results in the site-related evaluation method, as the indicators are complementary. The indicators describing the EHPs are selected in such a way that the smallest possible overlaps between them occur. Resulting impacts on the environment can vary but – as with any hazard – do not necessarily take place.

[4] Nevertheless, the OekoRess I measurement instruction highlights that in cases where countries have known law enforcement deficits and a weak governance performance, an individual in-depth assessment of the environment hazard potentials should be considered.

The user, thus, needs to keep in mind that the site-related evaluation cannot and does not intend to replace an environmental impact assessment. Aspects that the project team identified in the results of the case studies that are not reflected in the site-related evaluation method include: proximity and quantity of population around the mine site,[5] outreach of transport through wind and water, potential hazards on human health from substances, which do not classify as heavy metals or radioactive substances (e.g. beryllium or silica).

The extreme closeness of the inhabited area (e.g., case study Peru and DRC) and the increased exposure of the population to contaminants of the mine site are not reflected in the site-related evaluation method. The reason is that the results of the evaluation are explicitly referred to as "hazard potentials" and not "risks", which means the degree of a potential damage is not considered. Thus, the developers refrained from discussing if individual risks are less valuable than risks for many people and indicators such as "population density" were not considered.

Countries such as India and Peru have a major problem with abandoned mine sites. If these are in close vicinity to active mines, as shown in the case study of Peru, it becomes very difficult to separate the environmental impacts of the abandoned and the active mine. The site-related evaluation assesses EHPs for specific mines, and does not take into account mining heritage.

Where mining affects large areas of surface, the indicator "mine type" is assessed with a high or medium EHP according to the measurement instructions. It should be taken into account that for the "mine type", a high EHP also indicates easier wind erosion or material transport into the subsurface of a mine site in alluvial or unconsolidated sediments. A presumed large target area, even when combined with the indicators from the thematic cluster geology, does not make a statement as to whether strong wind or rain prevails in the area, which potentially aggravates environmental impacts. However, not only medium and high EHPs for "mine type" indicate the effects on large surface areas. In addition, the indicators "waste material management" and "deposit size" and "remediation measures" provide further information as in the USA case study.

The indicator "Water Stress Index (WSI) and desert areas" has been classified as low in several cases where the DPSIR scheme described complaints from local communities about contaminated water. This is necessarily the case because the indicator "Water Stress Index (WSI) and desert areas" reflects the water availability in principle but not scarcity caused by water contamination that can develop if purification of large amounts of water is not carried out appropriately after its use in mining. An indicator taking into account both water quantity and quality is not available on a global level. However, the potential for water contamination through the mining process is reflected in the high EHP for "use of auxiliary substances" and "mining waste management". In several case studies, e.g., Vietnam, competition for water increased significantly due to pollution through mining even though the indicator "WSI and desert areas" showed a low EHP. At the same time, the case study showed high EHPs for "use of auxiliary substances" and "mining waste management".

As some users may not be sufficiently familiar with the connections between the indicators and interpretations, the project team recommends to develop a brief handbook that specifically details the limits and/or gives examples for the complementary aspects of indicators that need increased attention. An obvious example might be the combination of high EHP for "mine type" and for "paragenesis with heavy metals". Another, more immediate, measure to enhance the user's understanding for the indicators could be to increase references to existing reports and case studies in which further considerations are discussed.

Some case studies showed limitations of the site-related evaluation method that could be worth being revised or expanded in the future as far as possible (depending on data availability).

[5] This is normally not part of a hazard, but a risk assessment and would thus broaden the methodology to also include elements of a risk assessment.

In the case study of India, the indicator on "protected areas and AZE sites" shows a low EHP as the forest ecosystems around the Bailadila mine are not designated as protected areas. Nevertheless, these ecosystems are of high importance as they for example improve the water storage capacity of the area, serve as a habitat for plant and animal species and provide livelihoods and income for indigenous people. The indicators for the surroundings in the site-related evaluation method require worldwide applicable and accepted definitions and available data sets. For the time being only georeferenced data for designated protected areas are available on a global level. The indicator could potentially be further developed, in case more appropriate datasets become available such as publicly available georeferenced data on high conservation values (HCVs).

For Mount Polley (Canada), the high EHP for "use of auxiliary substances" indicates that very probably toxic additives were used because the material has undergone flotation before being dumped on the tailings storage facility. Even though the tailings dam breach resulted in a big amount of tailings contaminated with heavy metals being spilled and sedimented along the waterways, the reports did not specify problems due to toxic additives in the tailings. The high EHP for "use of auxiliary substances" does not point to the low actual environmental impact. However, as there is a very wide range of different flotation reagents (foaming agents, printers, stabilizers for the foam) which differ greatly from each other in terms of minerals, it is not a practical solution to subdivide the indicator further.

In the case study of Brazil, the indicator for "remediation measures" of the niobium mine shows a low EHP, because the operator carries out process-parallel rehabilitation, reports in accordance with Global Reporting Initiative standards and has been audited last time in 2017. However, the mining company has no mine closure plan in place. The reason is that the mine could operate for at least another 200 years at the current extraction levels. The analysis showed that mine closure seems to be a general problem in Brazil as legislation does not account for a proper financial plan. At the same time, the indicator for "conflict potential with local population" for Brazil points out a low EHP. Nonetheless, in addition to the above mentioned process-parallel rehabilitation, the company also creates financial accruals for rehabilitation – if these are sufficient. How much they will increase over the years was not reported.

The governance analysis showed that – in particular when focusing on the environment – Brazil's legal system is referred to as being "stringent". Nevertheless, there is a lack of implementation and enforcement, with corruption and non-compliance being a problem, which does not seem to be properly reflected in the two Worldwide Governance Indicators used ("Control of corruption" / "Voice & accountability") to assess the "conflict potential with local population". With this in mind, the non-existence of a mine closure plan could be problematic even for such a long lifespan of the mine.

The comparison between the results of the site-related evaluation and the DPSIR analysis has allowed the team to sharpen the limits of the site-related evaluation and determine some points where further adjustments of the system can be helpful. In general, the site-related evaluation reflects well the reported impacts described with the DPSIR framework.

3.2 Assessment of governance challenges and indicator analysis

3.2.1 Methodological approach of the governance and indicator analysis

To answer the question if existing governance indicators reflect the countries governance in the mining sector and its gaps and challenges in particular in regard to environmental rules and regulations, a set of indicators[6] was chosen and tested to see if they reflect the governance performance identified in the

[6] Indices are a combination of several indicators. However, for the sake of simplicity, in the following the general term indicator will be used for all, even if they are composed of several indicators.

analysis (governance analysis and indicator analysis). The indicators were chosen using a decision matrix based on the following criteria:

- Data is publicly available
- Topical coverage: The four categories of general governance, environmental governance, sector governance and conflicts are covered
- Country coverage: 75% of global production of the raw materials in focus can be covered by using the data (data is available for the major global producing countries)

The following indicators, which can be organised in four categories, were chosen and tested. Based on the first four case studies, some indicators were dropped (HDI, EDI and Fraser Investment Attractiveness Index) and one indicator (CPI) was added after the finalisation of the fifth case study (for a more detailed discussion see chapter 3.2.3):

- General governance:
  - Human Development Index (HDI): Shows countries' achievements in key dimensions of human development: health, education and the standard of living.
  - Worldwide Governance Indicators (WGI): Display countries' governance capacities for the following six dimensions: Voice and Accountability, Political Stability and Absence of Violence, Government Effectiveness, Regulatory Quality, Rule of Law and Control of Corruption.[7]
  - Corruption Perception Index (CPI): Describes the perception of the corruption in the public sector by experts and business people.
- Environmental governance:
  - The Environmental Performance Index (EPI): Ranks countries' performance on high-priority environmental issues in two areas: protection of human health and protection of ecosystems.
  - The Environmental Democracy Index (EDI): Shows countries' performance regarding national laws protecting transparency, participation, and justice in environmental decision-making.
- Sector-specific governance:
  - Fraser Investment Attractiveness Index: Assesses countries' overall investment attractiveness for extractive industries, which is based on a country's geologic attractiveness and a measurement of attractiveness of their policy environments and the effects of government policy on attitudes towards exploration investments.
  - Fraser Policy Perception Index: Ranks countries in terms of how the attractiveness of their policy environments and the effects of government policy on attitudes towards exploration investments are perceived by experts.
- Conflicts:

[7] As the majority of WGI indicators reflected the mining governance well or very well with small variations between the different WGIs, it was decided to adjust for those variations by calculating the mean (WGI mean) and the median (WGI median) of all six World Bank indicators.

- Global Peace Index (GPI): Displays a country's level of peacefulness according to a ranking in three domains: ongoing and internal conflicts, levels of harmony or discord within a nation and a country's militarization.

As part of the case studies, these indicators were compared with the qualitatively assessed governance performance and the qualitatively assessed capacity of governments, companies and civil society to manage the mining sector and in particular to manage the potentially negative social and environmental impacts at the mine site. This assessment was based on the following qualitative benchmarks.

- ++: The indicator reflects well the governance of the mining sector and the environmental performance in particular. The governance assessment and the indicator valuation show comparable results, and the indicator score also clearly reflects the assessed country's capability of managing and regulating the mining sector and in particular the environmental hazards at the mine site.
- + : The indicator reflects in most parts the governance of the mining sector and the environmental performance in particular, but can only in some points adequately reflect the capability to manage the mining sector overall. The country assessment and the indicator valuation show the same results, but the results of the assessment of the mine site and the results provided by the indicator show some differing outcomes.
- - : The indicator only reflects the general governance performance well, but does not reflect the capability to manage the mining sector. The country assessment and the indicator valuation might differ in some points, and the results of the assessment of the mine site and the results provided by the indicator show clearly differing outcomes.
- -- : The indicator does not reflect the governance performance of the country. The general governance assessment and the indicator valuation show clear differences and the results of the assessment of the mine site and the results provided by the indicator show clear differences.

After completing five out of the ten case studies (Canada, India, USA, DRC and Vietnam), the results of the governance analysis and the chosen indicators were compared for the first time in order to verify the selected indicators. The results were used to refine the set of indicators. The Resource Governance Index (RGI) was also considered as an alternative or additional sector-specific governance indicator. However, it was not added because

- It only covers 89 countries;
- It only assesses the production of mineral raw materials in 36 of the 89 cases (countries); in all other cases the focus lies on the oil and gas sector;
- One third of the indicators are based on WGI indicators, the other two thirds are of no or very little relevance for answering the project's research question.

As part of the next five case studies and the additional 13 UmSoRess case studies, the following sets of indicators were tested:

- General Governance: Set of all 6 WGI and Corruption Perception Index (CPI)[8]

[8] The CPI was introduced and analysed with respect to potential advantages compared to the WGI for Control of Corruption.

- Environmental Governance: Environmental Performance Index (EPI)
- Sector-specific governance: Fraser Policy Perception Index (PPI)

At the end, the results of the 10 case studies and the 13 UmSoRess case studies were compared (see overview tables in Annex A.1). A number of case studies had to be excluded from the comparative analysis, for the following reasons:

- Morocco/Western Sahara (OekoRess II case study on Phosphate): Phosphate mining takes place in the Western Sahara. No specific governance indicators exist for Western Sahara and the Moroccan governance indicators do not reflect the situation in the annexed territory. For Western Sahara, significantly lower values could be expected than for Morocco in general.
- Greenland (UmSoRess case study on REE): Greenland is an autonomous part of the Kingdom of Denmark. Accordingly, some indicators only offered scores for Denmark but not for Greenland in particular.
- USA (UmSoRess case study on Copper mining in Butte): The focus of the case study is on a long abandoned mining area (USA, Butte). The examples for conflict cited in this case study are mostly from the past. Based on these examples, an assessment of the most recent values of the governance indicators is not possible.

Based on this comparative analysis, the final set of indicators was identified which is most suitable to improve and refine the raw material related assessment scheme developed in the OekoRess I project and applied to wide range of materials in this project.

The remaining governance indicators were assessed for each case study and compared regarding how well they reflect the governance in the mining sector and its gaps and challenges, in particular with respect to the environmental governance of the mining sector.

Two difficulties arose when the most suitable governance indicator was chosen: First, the differences between the most suitable indicators (WGIs and EPI) were very small. Based on a first comparison, both WGIs and the EPI seemed to very well reflect the governance situation in particular the environmental governance of the mining sector. Second, it proved difficult to compare the indicators simply based on their scores as they use different scales. While for example the lowest WGI has a score of 7, the lowest EPI score is 30.41 (both scores for DRC).

In order to overcome these challenges for the final comparison, the project team normalized the values for both indicators by calculating the quartiles for those two indicators (the 25%- and the 75%-quantile as limit values)[9] and formed three categories: 1. “strong governance performance” for the first quartile (colour code green), 2. “medium governance performance” for the second and third quartile (colour code orange) and 3. “weak governance performance” for the last quartile (colour code red). As the majority of WGI indicators reflected the mining governance well or very well with small variations between the different WGIs, it was decided to adjust for those variations by calculating the mean (WGI mean) and the median (WGI median) of all six World Bank indicators.

[9] For the formation of the boundaries between the categories, the general OekoRess method was adhered to (cf. Manhart et al. 2018) and class boundaries for the indicators were formed. Manhart et al. 2018: “Limit values for the indicators on the natural environment (6 to 8) and the value chain (9 and 10) cannot be based on scientific evidence. Instead of subjective grading, we tested different mathematical approaches, and decided to use the 25%- and the 75%-quantile as limit values. Thus half of the analysed raw materials are attributed with a medium EHP and only one quarter with a high EHP and a low EHP respectively.”

The Fraser PPI was also included in this comparison even though this indicator was not amongst the final indicators due to its low territorial coverage. The reason behind is that the PPI reflects the specific mining sector related challenges very well for most case studies and thus can be used as a valuable additional source of information for those countries and regions which the PPI covers (see chapter 3.2.3). These indicator-based governance assessments were compared with the governance evaluation of the OekoRess II case studies (see chapter 3.2.2) and in a second step with all case studies including the UmSoRess case studies (see table 1).

3.2.2 Results of the governance and indicator analysis

Colour code[10]	strong governance performance (first quartile)	medium governance performance (second and third quartile)	weak governance performance (last quartile)

Table 11: Case Study Botswana, Selebi-Phikwe (Nickel)

	Botswana (Nickel)			
Main findings of the qualitative governance and conflict analysis	Overall governance performance: strong (to medium) • Botswana's mining sector is generally governed by a comprehensive legal and regulatory framework and mostly praised as being well-developed in particular compared to other African countries • The government seeks to promote a business-friendly environment for the mining sector in particular for the exploration of diamonds • However, the case of BCL and the Selebi-Phikwe mine revealed weaknesses regarding the implementation of health and safety standards and environmental obligations. • Conflicts are principally focussed around the closure of the Selebi-Phikwe mine and the resulting unemployment of workers; further triggers for conflict are the environmental effects of the mining activities and accidents at the Selebi-Phikwe mine • The government of Botswana is accused of failure to protect its citizens from these adverse effects and (by one source) for its plans to sell the Selebi-Phikwe mine without consultation and compliance with democratic steps			
Governance performance according to indicator	WGI (mean)	WGI (median)	Fraser	EPI

[10] Remarks in footnotes indicate cases where country values are close to one of the quartile thresholds.

Table 12: Case Study: Brazil, Araxá (Minas Gerais -Niobium)

	Brazil (Niobium)			
Main findings of the qualitative governance and conflict analysis	Overall governance performance: medium (to weak) • Overall sound regulations and strategies but serious lacks of implementation, especially concerning environmental and indigenous rights • Implementation hindered by lack of financial and human resources, relatively high levels of corruption, as well as the absence of effective coordination and cooperation within and between the union, federal states and municipalities that all share legislative and executive powers • Increasing opening of national reserves to mining and reduced regulations of mining operations • No accounts of conflicts at the niobium mine in Araxá but many examples of conflicts between indigenous people and illegal miners exist, such as in the hitherto undeveloped niobium-rich Morro do Seis Lagos			
Governance performance according to indicator	WGI (mean)	WGI (median)	Fraser	EPI

Table 13: Case Study: Canada, Mount Polley (Copper and Gold)

	Canada (Copper and Gold)			
Main findings of the qualitative governance and conflict analysis	Overall governance performance: strong • Standards and regulations exist and are generally strong but there could be somewhat stricter regulations regarding dam design and an independent review mechanism should be established • Due to the federal system, sometimes uncertainties emerge leaving space for interpretation which leads to conflict • Environmental legislation is existent and extensive, environmental assessments and closure and rehabilitation plans are required and generally complied with • Indigenous rights are in principle protected by a strong legal framework; however, regulations leave some ambiguity and lack clear procedures with regards to the right to explore and revenue sharing • Other conflicts have evolved around adverse impacts of mines on wildlife and the natural environment			
Governance performance according to indicator	WGI (mean)	WGI (median)	Fraser	EPI

Table 14: Case Study: DR Congo, Kamoto Mining Complex (Copper-Cobalt)

	DRC – Democratic Republic of Congo (Cobalt)			
Main findings of the qualitative governance and conflict analysis	Overall governance performance: weak • The laws relating to DRC's mining sector are well formulated • However, compliance with the law is very weak and regulations are neither implemented, nor are the violation of laws generally penalised. • DRC was shaken by various conflicts and wars during the last decades, and conflicts are still ongoing • The presence of state and non-state armed groups who profit from illegal taxation, illegal mineral extraction and mineral smuggling combined with mismanagement and corruption causes a number of serious problems in the country • The violation of human rights and negative impacts to the environment and therefore to local communities, particularly in the mining sector, are two of the major challenges			
Governance performance according to indicator	WGI (mean)	WGI (median)	Fraser	EPI

Table 15: Case Study: India, Bailadila (Iron)

	India (Iron Ore)			
Main findings of the qualitative governance and conflict analysis	Overall governance performance: weak (to medium) • Overall, India's regulation of the mining sector is poor and complex, its institutions are weak, decision-making powers are discretionary, monitoring is inadequate and enforcement weak; lack of expertise in mining related issues • Illegality and corruption, lack of transparency and corruption • India is one of the countries with the highest number of social and environmental conflicts in the world, with many of them being related to mining activities in rural areas • Since the founding of the mine-complex in the 1960s, the region has seen multiple conflicts around mining activities, most of them closely linked to indigenous rights and the larger conflict with and the rise of the Naxalites, a non-state armed group.			
Governance performance according to indicator	WGI (mean)	WGI (median)	Fraser	EPI

Table 16: Case Study: Morocco/Western Sahara, Bou Craa (Phosphate)

	Morocco/Western Sahara (Phosphate)
Main findings of the qualitative governance and conflict analysis	Overall governance performance: weak • Morocco's legislation is "relatively good" and broad. The new mining code aims to modernise the mining sector and attract more investors, by increasing transparency and promoting labour and environmental laws • However, implementation is weak and the regulatory framework incomplete; environmental legislation does not seem to be properly implemented • Corruption and nepotism are wide-spread and there is little will to implement the legislation or punish cases of non-compliance • The royal family wields a strong influence over the state-owned company OCP that manages all phosphate operations • The majority of phosphates is located in Western Sahara which is claimed both by the Moroccan government and the local Sahrawi people and Frente Polisario movement; the UN has questioned the legality of extractive activities by Morocco • Other major reasons for conflict are the economic exploitation by Morocco without sharing the profits with the Sahrawi people (which induced the UN to question the legality of Morocco's activities), human rights violations and the depletion of natural resources
Governance performance according to indicator	Morocco (OekoRess II case study on Phosphate) had to be excluded from the comparative analysis. Phosphate mining takes place in the West Sahara. No specific governance indicators exist for Western Sahara and the Moroccan governance indicators do not reflect the situation in the annexed territory. For Western Sahara, significantly lower values could be expected than for Morocco in general.

Table 17: Case Study: Peru, Cerro de Pasco (Zinc and Lead)

	Peru (Lead and Zinc)
Main findings of the qualitative governance and conflict analysis	Overall governance performance: medium • Over the last decade the institutional framework for environmental policy in Peru has advanced also in the mining sector • However, the implementation of economic liberalization policies and laws to promote and facilitate investments also in mining projects, weakened the new environmental code • Furthermore, Corruption in Peru is widespread among government officials, in the judicial system and public service; Peru's mining sector is particularly prone to corruption • The granting of a mining concession does not require prior consultation of local communities or regional governments and bears considerable conflict potential

	Peru (Lead and Zinc)			
	• Many conflicts occur between rural communities on the one hand and large mining companies and the state on the other hand; in the past mining-related conflicts were highly contentious and often ended in violence • Conflicts between communities and large-scale mines are linked land use and rights (particularly regarding mining concessions), indigenous consultations, negative environmental impacts of mining operations and the inadequate redistribution of resource rents			
Governance performance according to indicator	WGI (mean)	WGI (median)	Fraser	EPI

Table 18: Case Study: Turkey, Kirka (Borate)

	Turkey (Borate)			
Main findings of the qualitative governance and conflict analysis	Overall governance performance: medium (to weak)			
	• Sound framework of regulations and strategies in the mining sector but increasing liberalisation • Inconsistent application of the laws and operative requirements, sometimes linked to the relatively high corruption • Good health and safety regulations but poor implementation wherefore many accidents in the mining sector (especially in coal mines) have occurred • Environmental legislation improved with Tukey's ambitions to accede to the EU but stalled concomitant to the accession negotiations • Protests mainly revolve around poor working conditions and the environmental impacts of mining operations (especially of gold mines) • Increased state repression of protests			
Governance performance according to indicator	WGI (mean)	WGI (median)	Fraser	EPI

Table 19: Case Study: USA, Spor Mountain (Beryllium)

	USA (Beryllium)			
Main findings of the qualitative governance and conflict analysis	Overall governance performance: strong (to medium) • Overall there is a strong sector governance but reforms are needed, especially in terms of environmental protection and compensation for Native American communities • The major concern is the federal mining law that is in place since 1872 and allows mining companies to privatise public lands • Environmental legislation is incomplete and loopholes exist as no sector-specific legislation exists, leading to pollution affecting local environment and communities • With regards to the Spor Mountain beryllium mine, no negative impacts or conflicts could be observed			
Governance performance according to indicator	WGI (mean)	WGI (median)	Fraser	EPI

Table 20: Case Study: Vietnam, Núi Pháo (Tungsten)

	Vietnam (Tungsten)			
Main findings of the qualitative governance and conflict analysis	Overall governance performance: medium (to weak) • Overall, the governance is characterised by sound regulations and strategies; however there is a lack of coherence between them, and a lack of cooperation between the ministries in charge overall, Vietnam's governance is characterised by sound regulations and strategies, but a lack of coherence between them, and a lack of cooperation between the ministries in charge. • Country struggles to balance economic and sustainable development and lacks implementation in particularly of its environmental laws. Non-compliance with legislation is hardly ever sanctioned and close relationships between politics and economy provides ground for corruption • Conflict of interests between economic and sustainable development regarding occur in mining projects; this has caused to several conflicts around mining in the country • With regard to the Nui Phao mining project, a compensation mechanism was in place			
Governance performance according to indicator	WGI (mean)	WGI (median)	Fraser	EPI[11]

[11] The EPI value for Vietnam is part of the value category indicating medium governance performance. However, it has the weakest value in this category.

Table 21 shows an overview of all the indicators per country and the overall result of the governance analysis. Detailed results of the governance analyses of the UmSoRess case studies can be found in Annex A.1.

Table 21: Comparison of indicators per country

Overall estimation of governance[12]	WGI mean	WGI median	Fraser	EPI	Case studies
strong (to medium)	Botswana	Botswana	Botswana	Botswana	OekoRess II
medium	Brazil	Brazil	Brazil	Brazil	OekoRess II + UmSoRess
strong	Canada	Canada	Canada	Canada	OekoRess II
strong (to medium)	Chile	Chile	Chile	Chile	UmSoRess
weak (to medium)	China	China	China	China	UmSoRess
weak	DRC	DRC	DRC	DRC	OekoRess II
weak	Guinea	Guinea	Guinea (no data)	Guinea[13]	UmSoRess
weak (to medium)	India	India	India	India	OekoRess II
medium (to weak)	Indonesia	Indonesia	Indonesia	Indonesia[14]	UmSoRess
medium (to strong)	Malaysia	Malaysia	Malaysia (no data)	Malaysia	UmSoRess (on Australia and Malaysia[15])
medium	Peru	Peru	Peru	Peru	OekoRess II + UmSoRess
medium (to weak)	South Africa	South Africa	South Africa	South Africa	UmSoRess
medium	Turkey	Turkey	Turkey	Turkey	OekoRess II

[12] Overall estimation is based on the qualitative governance and conflict analysis (see previous country tables for details).

[13] The EPI value for Guinea is part of the value category indicating weak governance performance. However, it has one of the strongest values in this category.

[14] The EPI value for Indonesia is part of the value category indicating weak governance performance. However, it has the strongest value in this category.

[15] This UmSoRess case study focussed on two countries. REE are mined in Mount Weld, Western Australia. The refining of the ores is carried out at a refinery in Kuantan, Malaysia. The potential environmental and social impacts which occur as a consequence of the further processing of RE-ores are thus shifted to Malaysia.

Overall estimation of governance[12]	WGI mean	WGI median	Fraser	EPI	Case studies
strong	USA	USA	USA	USA	OekoRess II + UmSoRess
medium (to weak)	Vietnam	Vietnam	Vietnam	Vietnam[16]	OekoRess II
weak (to medium)	Zambia	Zambia	Zambia	Zambia	UmSoRess

[16] The EPI value for Vietnam is part of the value category indicating medium governance performance. However, it has the weakest value in this category.

3.2.3 Discussion: Do existing governance indicators reflect the countries' governance performance in the mining sector and its gaps and challenges

The comparison of the results of the ten OekoRess (chapter 3.2.2) and the 13 UmSoRess case studies (see Annex A.1) showed that the chosen indicators do reflect a country's governance – also with regard to its mining sector – overall well. However, some indicators showed a better ability to mirror the actual governance performance than others. The following indicators showed limitations:

- **Human Development Index (HDI)**: Focusing on general governance issues, the HDI reflects the general governance of the case study countries well. However, as the WGIs are far more differentiated and can be considered as the state-of the art indicators covering all aspects of governance, the HDI offers no added value in comparison for the purposes of this study. The HDI was thus dropped after the first four case studies.

- **Corruption Perception Index (CPI):** This is a perception index, which also reflects well the overall governance situation and partially the mining sector situation in the countries of the case studies. It offers a wide territorial coverage with 180 countries and regions. However, with its clear focus on the perception of corruption, this indicator reflects less well the mining sector situation than for example the WGI median (which also includes an indicator on Control of Corruption and very well reflects the governance performance).

- **Fraser Investment Attractiveness Index**: With regard to the chosen sector-specific indicators, particularly the Fraser Policy Perception Index (PPI) reflected mining specific governance problems very well. This also accounts for the Fraser Investment Attractiveness Index, except in the case of the DRC. Here the assessment was too positively affected by the very high geological attractiveness of the country. As both indicators show good results, but the PPI reflects more adequately the sector-specific governance performance for the first five cases, in the following case studies, only the PPI was considered (see below).

- **Environmental Democracy Index (EDI):** Both, the EDI and the EPI reflect the general (environmental) governance situation in the country well, with the EPI achieving better and more precise results than the EDI. The EDI lacks sector-specific significance, which means that it does not, for example, reflect the environmental governance performance of the countries in the mining sector. In addition, the EDI has certain limitations, e.g. it only measures the existence of regulations, but not whether and how well these regulations are being implemented. Therefore, the last five case studies only analysed the EPI.

- **Global Peace Index (GPI):** Regarding the Global Peace Index (GPI), the first five case studies showed that it reflects the general conflict situation well, but does not reflect mining-specific conflicts. Since general political stability and absence of violence is already covered by the WGIs, it was decided not to analyse the GPI in the remaining case studies.

The **Fraser Policy Perception Index (PPI)** reflected the governance in the country and the mining sector the most accurate of all indicators assessed.

- It is a perception-based index reflecting the "opinions of managers and executives on the effects of policies in jurisdictions with which they are familiar".

- For a significant number of the case studies the Fraser PPI reflected the overall governance and the mining sector situation with its challenges very well. With regard to the chosen sector-specific indicators, particularly the PPI reflected mining specific governance problems very well. In the case of China, India, Indonesia, South Africa and Vietnam, the PPI showed weaker governance than the WGI (both mean and median). For those countries, the qualitative governance analysis also found governance levels between medium and weak, particularly considering the challenges and gaps in the mining sector. These lower PPI ratings seem to better reflect the governance situation in particular the environmental governance of the mining sector (than the WGI mean and median) and often go in line with the EPI (see below). This indicates a link between attractiveness for investments (safety in legislation and its implementation, clarity of responsibilities, etc. – displayed by the Fraser Policy Perception Index) and the implementation of (environmental) regulations. It seems that good governance for companies/investors correlates with good environmental governance.
- Furthermore, the PPI offers mining sector specific information in extra paragraphs giving background information and comments from respondents of the survey. In some countries, it even provides sub-national assessments for different provinces.
- However, the Fraser PPI cannot be used as a general governance indicator because of its low territorial coverage (91 jurisdictions including 51 countries, plus the regions/states of Argentina, Australia, Canada, and the U.S). Another point that might speak against it are the stark variations in scores per country between only a few years (e.g. for Turkey, China and the DRC).

The two remaining governance indicators seemed most suitable to update the OekoRess methodology:

The **Worldwide Governance Indicators (WGIs)** reflect the governance in the analysed countries and their mining sector situation well to very well.

- This set of World Bank indicators has a very high territorial coverage (200 countries and regions), consists of six individual indicators covering different governance fields[17] and considers information from a wide range of sources (20 sources). Over the years, the deviations of WGI values per country are small and thus show stability. The analysis shows that for all countries analysed, the ability/precision to reflect the governance varies between the different indicators.
- Two WGI indicators that do not always reflect the mining sector situation in the specific governance field well compared to the findings of the governance analysis are indicators "Government Effectiveness" and "Control of Corruption" indicators. In the cases in which one of those sub-indicators did not adequately reflect the mining sector governance, the values were mostly too high meaning the actual performance according to the governance analysis

[17] The fields covered by the WGI indicators are: Voice and Accountability, Political Stability and Absence of Violence/Terrorism, Government Effectiveness, Regulatory Quality, Rule of Law, and Control of Corruption.

was weaker than the sub-indicators reflected. This was particularly the case in countries, which showed medium or strong overall governance (e.g. Botswana, Turkey, and Chile).

- This indicates some of the mining sector's specific weaknesses. Particularly regarding government effectiveness and corruption, the governance in the mining sector can be weaker than the general governance performance of a country due to the sector's specific challenges. The example of Botswana shows that the general governance as regards control of corruption is well reflected in the high respective WGI indicator score. However, taking into account that Botswana's government is accused of close ties to the mining industry, the score seems too high.
- For all countries analysed, both the WGI mean and WGI median reflected the environmental governance in the respective country and its mining sector in the six different fields well to very well. However, the **median** seems more robust in cases of countries that show outlier scores. This is for example the case for Turkey, which shows scores between 30 to 61, but has a very low score of 6 for Political Stability and Absence of Violence/ Terrorism.

The **Environmental Performance Index (EPI)** also reflects the governance in the analysed countries and their mining sector situation well to very well.

- This indicator offers a very high territorial coverage (180 countries) and is based on a variety of 24 performance indicators across ten issue categories covering environmental health and ecosystem vitality (60% ecosystem vitality, 40% environmental health)[18]. Unlike the WGIs, the EPI uses scientific data in order to analyse a country's performance instead of existing indicators, which are then combined to a new index. Furthermore, it does not measure for example legislations in place to protect the human health and ecosystems, but a country's performance regarding the success or the failure to achieve specific thresholds.[19]
- The EPI offers some interesting results as it shows a tendency to evaluate weaker governance performance for some countries compared to the WGI median. This is the case for Botswana, Chile, India and Indonesia, and South Africa. This evaluation seems to better reflect the mining sector's situation and its gaps and challenges. This might be explained by its focus on the actual environmental performance (instead of legislation) of a country. The WGI mean and median seems to well reflect the overall governance, which sometimes does not represent the mining sector specific challenges by evaluating the country's governance strong(er).
- However, the EPI does not show weaker governance for all countries, which were located between two categories according to the governance analysis. For China (weak to medium) and Vietnam (medium to weak) only the Fraser assigned these countries weak governance. In the case of Zambia (weak to medium) all indicators reflect a medium governance level. A

[18] "These metrics provide a gauge at a national scale of how close countries are to established environmental policy goals. The EPI thus offers a scorecard that highlights leaders and laggards in environmental performance, gives insight on best practices, and provides guidance for countries that aspire to be leaders in sustainability" (YCELP, 2018).
[19] "The overall EPI rankings indicate which countries are doing best against the array of environmental pressures that every nation faces" (YCELP, 2018).

possible explanation is that the UmSoRess case study on Zambia looks at the Mopani Copper Mines, which was rated one of the worst mining companies in Zambia in implementing safety regulations and in causing significant environmental impacts. This shows the limits of applying one governance indicator for all countries.

Overall, the analysis shows that both the EPI and the WGI median reflect the governance and the mining situation in the analysed countries well to very well. A comparison of the EPI and the WGI median (based on a calculation of quartiles) showed that both indicators reflect the overall governance performance as evaluated in the qualitative governance and conflict analysis of the OekoRess II and UmSoRess case studies very well.

3.3 How to include Artisanal and Small Scale Mining

Another factor with a strong influence on the kind and intensity of environmental and social impacts of mining, challenging the governance performance, is artisanal and small-scale mining (ASM). As ASM occurs mostly in an informal and unregulated setting, it is associated with negative and uncontrolled environmental impacts and poor health and safety practices that can trap miners in poverty cycles and leave them legally unprotected. The most important reasons leading to this risk are:

- The large number and isolated situation of operations,
- the close linkage between the ASM sector and poverty,
- the informality of many ASM operations,
- the migratory nature of many artisanal miners and their operations (especially with regard to alluvial deposits, i.e. for gold, coloured gemstones, diamonds, 3T, as well as gravel and sand),
- the traditional and indiscriminate use of toxic substances, i.e. mercury for the amalgamation of gold ores,
- shortcomings with respect to skilled staff on, both the miners' as well the state institutions' side, together with a lack of means for systematic mine inspections, and
- the involvement of local elites in the informal exploitation and consequently a limited political will to apply sanctions.

A further complicating factor is that the sector is not only characterised by the small miners themselves, but rather by a complex network of the most diverse actors in the value chain (buyers, financiers, exporters, transporters, landowners, traditional chiefs, etc.) who are intertwined by mutual dependencies and who at the same time create and defend access to raw materials by bundling complementary forces and skills (Geenen 2016). In this respect, informality often forms the basis of the business model of the sector, which in turn is beyond the control of the state or formalisation efforts and thus good mineral governance.

The case studies on Madre de Dios (gold) in Peru and on Bangka-Belitung (tin) in Indonesia underline the complex socio-cultural environment and political economy related to (mostly illegal) ASM activities compared to situations where large scale mining and formal operations are better and more stringently controlled. Both case studies showed that ASM led to severe negative

social and environmental impacts as well as high conflict potential. The EPI or the WGI median – which were identified as suitable indicators for the purpose of this project – do not sufficiently reflect the enormous local environmental threats of ASM, such as seen in the Madre de Dios region in Peru or on Bangka-Belitung in Indonesia, and related governance challenges. Both examples demonstrate the difficulty to adequately map the social and environmental of ASM by using national governance indicators.

Therefore, another approach was necessary to consider ASM as special governance challenge within the framework of the OekoRess evaluation system. The project team identified two levels of consideration to identify ASM governance challenges:

- for those commodities of which a significant amount is produced by ASM operations *and*
- for those countries which have a noticeable amount of ASM miners or where ASM plays an important role for the rural economy.

In order to identify the commodities and countries, which meet the outlined conditions, the following methodology was applied:[20]

Criterion 1: ASM commodities		**Criterion 2: ASM countries**
Different commodities tend to be exploited to a significant extent by ASM. The numbers differ greatly as does the underlying definition of the sector. Key sources: • Appel and Jønsson GEUS 2007: http://www.geus.dk/program-areas/common/geoviden-2-2007-uk.pdf • Dorner et al. 2012: Artisanal and Small-Scale Mining (ASM), http://www.polinares.eu/docs/d2-1/polinares_wp2_chapter7.pdf • Wagner et al. 2007: Zertifizierte Handelsketten im Bereich mineralischer Rohstoffe, Projektstudie BGR, https://www.bgr.bund.de/DE/Themen/Min_rohstoffe/Downloads/Studie_Zertifizierte_Handelsketten.pdf?__blob=publicationFile&v=2		Due to their geological situation, development, mining tradition etc., different countries show a significant amount of ASM miners. Key source: • Artisanal mining database 2017: http://www.artisanalmining.org

ASM commodities:

The selection of ASM specific commodities was based on the criteria of being named by multiple of the key sources listed above and an ASM production share of over 5% in at least one of the lists in the key sources. The following commodities were identified as resources with a high share of ASM production:

[20] This approach was chosen despite the methodological imprecision, as there is no mineral-specific disaggregated data available on ASM activities in a country.

- Antimony
- Barytes
- Beryllium
- Chromium
- Cobalt
- Feldspar
- Fluorspar
- Gold
- Graphite
- Gypsum
- Manganese
- Silver
- Talc
- Tantal
- Tin
- Tungsten

The ASM related governance risks are therefore relevant for all materials from this list.

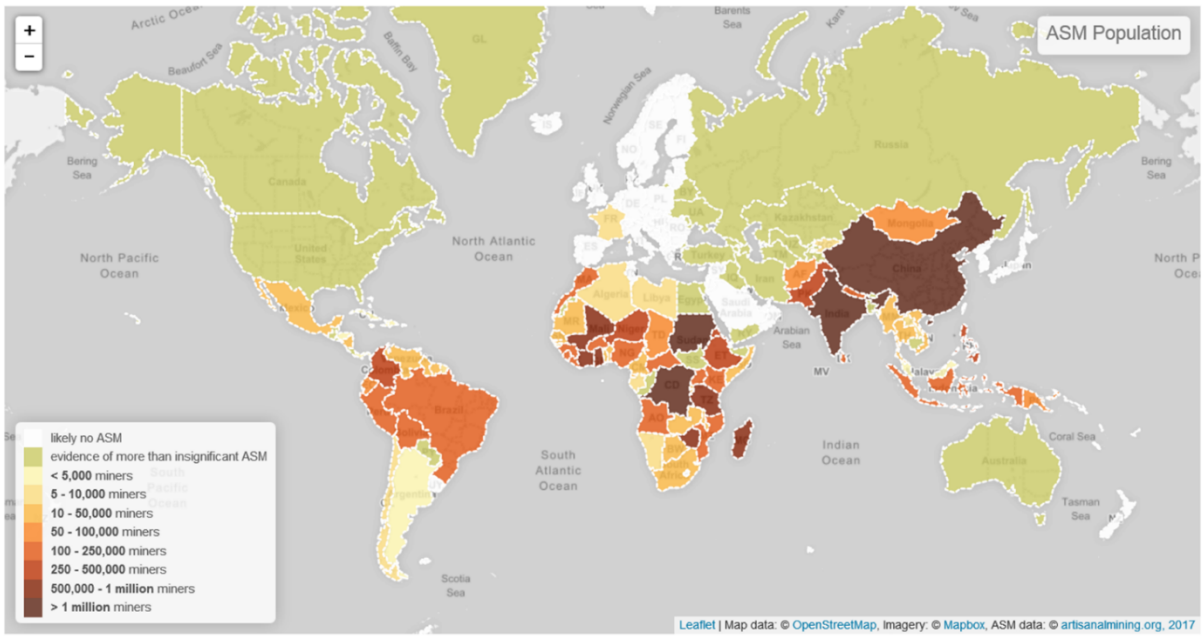
ASM countries:

In accordance with the chosen methodology, country-specific risks can only be taken into account in individual cases, i.e. when certain (ASM relevant) raw materials are sourced from countries with a high proportion of ASM. The selection of ASM countries was guided by the two following criteria:

- the overall number of ASM miners in the country: the project team used more than 20,000 ASM miners as a threshold for the characterisation as an ASM country,
- the dependency of local economies on ASM: the project team used more than 1% of rural population dedicated to ASM as a threshold for the characterisation as an ASM country.

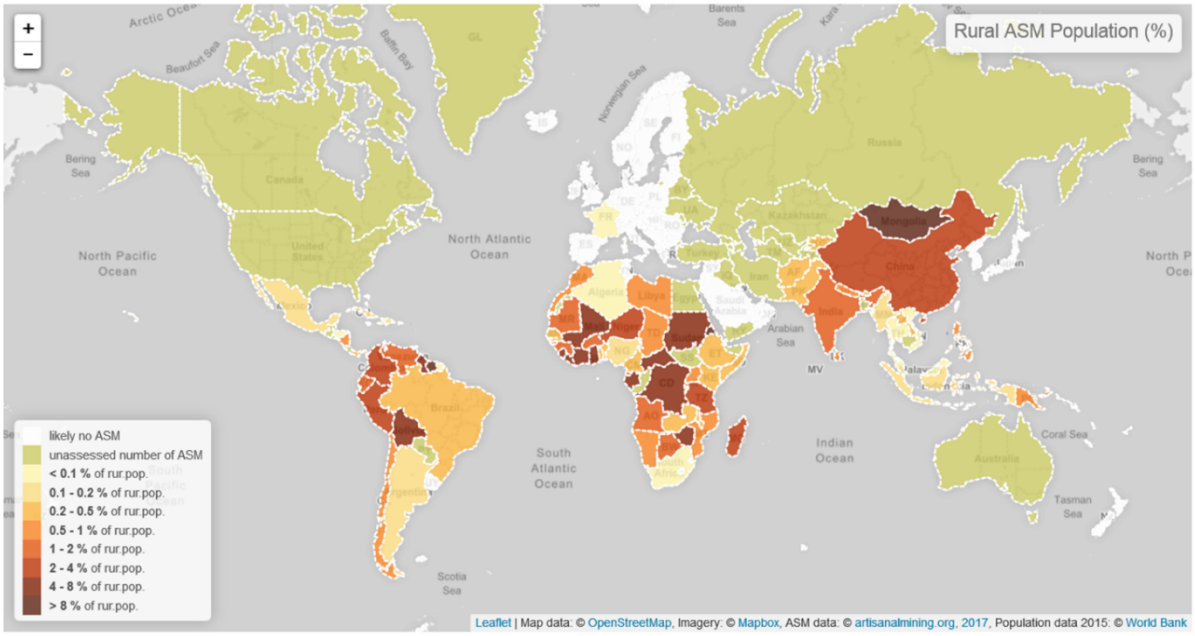
A country, in which one of the criteria is met, was defined as an ASM country. The following figures contain the global statistics on ASM population and rural ASM population, which guided the selection of countries:

Figure 1: World Map of Artisanal and Small-scale Mining: ASM Population



Estimated number of artisanal and small-scale miners per country.
Source: http://artisanalmining.org/Inventory/ (CC BY-SA 4.0)

Figure 2: World Map of Artisanal and Small-scale Mining: Rural ASM Population (%)



Estimated number of artisanal and small-scale miners as percentage of rural population.
Source: http://artisanalmining.org/Inventory/ (CC BY-SA 4.0)

According to this data, the following countries show a significant amount of ASM:

- **Afghanistan**
- **Angola**
- **Bolivia**
- **Botswana**
- **Brazil**
- **Burkina Faso**
- **Cameroon**
- **CAR**
- **Chad**
- **China**
- **Colombia**
- **DRC**
- **Ecuador**
- **Equatorial Guinea**
- **Eritrea**
- **Ethiopia**
- **Gabon**
- **Ghana**
- **Guinea**
- **Guyana**
- **India**
- **Indonesia**
- **Ivory Coast**
- **Kenia**
- **Liberia**
- **Madagascar**
- **Malawi**
- **Mali**
- **Mauretania**
- **Sierra Leone**
- **South Africa**
- **Sudan**
- **Surinam**
- **Tanzania**
- **Uganda**
- **Venezuela**
- **Vietnam**
- **Zambia**
- **Zimbabwe**

4 Conclusion

With the set aim to further enhance both the site-related and the raw material-related assessment schemes developed as part of the OekoRess I project, the comparative analysis – based on the OekoRess II case studies and taking into account the results of the UmSoRess case studies – has produced the following results:

a) Test of the (UmSoRess) DPSIR evaluation method and the site-related OekoRess I evaluation method assessing a mining site's EHPs

The comparison between the results of the site-related evaluation of environmental hazard potentials and the DPSIR analysis of reported environmental pressures and impacts has allowed to sharpen the limits of the site-related assessment and to determine some points where further adjustments of the scheme could be helpful. In general, the site-related evaluation reflects well the reported impacts described with the DPSIR method.

Furthermore, there was a higher number of EHPs than the actual environmental impacts that could be verified. This can partly be explained by the non-availability of comprehensive data on environmental impacts. In such cases, the analysis was based on general studies looking at common environmental impacts of the raw material analysed, bearing in mind the limitations of this approach. Another reason might be that appropriate countermeasures have been taken by the operating mining company or that the mine site is situated in a framework of good governance leading to appropriate supervision.

In general, the analysis showed a correlation between the severity of environmental impact and the identified EHPs. The more serious the impacts, the greater their likelihood to be reflected by the EHPs, e.g. DRC showed numerous serious environmental impacts which coincided with most of the assessed EHPs.

As some users may not be sufficiently familiar with the connections between the indicators, how they are associated with each other and how the results can be interpreted, the project team recommends creating a brief handbook that specifically details the limits and gives examples for possible combinations of indicators that need increased attention.

b) Improvement of the raw material-related evaluation by improving the governance indicator

The analysis showed that both the EPI and the calculated median of the six WGI indicators reflect the governance and the mining situation in the analysed countries well to very well. Compared to the mean value, the median is generally more "robust" against statistical outliers. A comparison of the EPI and the WGI median (based on a calculation of quartiles) showed that both indicators reflect the overall governance performance as evaluated in the qualitative governance and conflict analysis of the OekoRess II and UmSoRess case studies very well.

However, in a number of cases, the WGI median showed a more positive result than the EPI. This could be explained by its focus on the general governance and not specifically on environmental governance aspects in the respective country. In addition, the EPI focuses on the actual environmental performance (instead of legislation) of a country. The WGI seems to reflect the overall governance well, which sometimes does not represent the mining sector's specific challenges.

The cases in which the EPI showed a weaker governance (Botswana, Chile, India, Indonesia[21] and South Africa) than the WGI median were borderline cases: the qualitative governance analysis evaluated the overall governance (with a particular focus on the environmental governance of the mining sector) being in between two categories: medium with a clear tendency to weak (India, Indonesia[22] and South Africa) or strong with a clear tendency to medium (Botswana and Chile). In these cases, the EPI reflected this negative tendency while the WGI median did not. This leads to the conclusion that the stricter focus of the EPI on environmental aspects indicating a weaker governance performance seems to generally better reflect the environmental governance of the mining sector.

In a final step, the project team tried to combine the WGI median with the EPI (each with 50%). However, the results did not show an added value compared to using solely the EPI only since the combination of the two only showed a more positive result than the EPI evaluation and thus did not change the overall result.

Based on the results of the comparative analysis of the case study results, the project team concludes that the EPI is best suited to reflect the environmental governance and can thus be used to improve the environmental governance indicator of the raw material-related evaluation developed as part of the OekoRess I project. Applying the EPI's stricter evaluation one would also follow the precautionary principle of the OekoRess' hazard based assessment.

However, the EPI does not show weaker governance for all countries, which were located between two categories according to the governance analysis. For China (weak to medium) and Vietnam[23] (medium to weak) only the Fraser Index assigns these countries weak governance. In the case of Zambia (medium to weak), all indicators reflect a medium governance level. This shows the limits of applying one governance indicator for all countries. The nuances of a detailed governance analysis with a specific focus on the mining sector and in particular, the environmental governance (as conducted in the UmSoRess and OekoRess case studies) generates valuable additional information. The project team thus recommends carrying out this type of analysis in borderline cases.

Furthermore, the case studies showed that the Fraser Index was the index that reflected the specific challenges of governance best, which might be explained by the fact that it is a perception index based on an expert survey. Another strength of this indicator is that it looks at specific regions or federal states for a small number of countries (USA, Australia, Canada, and Argentina). Yet, it only covers a limited number of countries and regions and therefore cannot be used for the resource-specific evaluation of OekoRess. However, for countries for which a value is available, it could be used for site-specific assessments.

c) How to include the specific governance risks of ASM?

Given the limitations of national governance indicators, such as the EPI or the WGI median, to adequately map the social and environmental of ASM, the project team evaluated different ways of reflecting the specific governance risk that ASM poses and to include ASM into the raw material-related assessment scheme.

First, a combination of the EPI with an ASM indicator was tested. The idea was to reduce the result of the EPI based governance indicator by a certain percentage in those cases where both

[21] Although the EPI value for Indonesia is part of the value category indicating weak governance performance, it has the strongest value in this category.
[22] Although the EPI value for Indonesia is part of the value category indicating weak governance performance, it has the strongest value in this category. .
[23] Although the EPI value for Vietnam is part of the value category indicating medium governance performance, it has the weakest value in this category.

above mentioned conditions (ASM relevance for the commodity as well as for the producing country) apply. However, this approach was rejected mostly because of insufficient data, but also out of concern about undermining the integrity of the EPI concept.

1. The relevant literature offers different numbers on the proportion of global ASM production. Some of them differ greatly from one another, as do the different definitions of ASM (and the sector in general) which they refer to.

2. Numbers of ASM production per country is rarely specified in tons of different resources or as share of the national production.

3. Statistics on ASM must be treated with caution and are often limited due to the informality of the sector as well as the trend of industrial mines to buy production of ASM miners operating in or around the area of the industrial mining title. Examples are the cobalt production in DRC (Poldi, 2018) or gold production of Gran Colombia Gold in Colombia. As a consequence, significant amounts raw materials produced in ASM are listed under "industrially" produced raw materials.

Therefore, the data did not allow for the development of a graduated ASM indicator, which would have been a necessary requirement for combining the ASM indicator with the EPI.

The team therefore identified a second option to include ASM governance risk into the raw material-related assessment schemes: ASM governance risks could be indicated for raw materials that have a high share of ASM production and therefore were identified as ASM commodities. In addition, ASM countries could be indicated, when applicable (see chapter 3.3 for details). Based on this approach, the raw material fact sheets could specifically highlight ASM commodities with information on the ASM share of global production as well as mentioning the countries, which are producing the particular ASM resource.

d) Relation between governance and EHPs

The case studies and the comparative analysis clearly show that governance – particular environmental governance – is a significant factor in determining the actual impacts related to the assessed EHPs of mining. With strong environmental governance and institutions in place, environmental violations can be detected, punished and, in the long term, reduced. Vice versa, the impacts often increase in the context of weak(er) governance. Where no appropriate environmental legislation and enforcement exist, the probability of EHPs translating into actual environmental impacts is higher.

One crucial element is the implementation of existing legislation, in particular the effective enforcement of existing standards. This is also an important argument for a performance-based governance indicator such as the EPI, which does not measure the quality (environmental) legislation but the actual environmental performance of a country.

In addition, a number of interesting results emerged regarding the links between EHPs and governance:

- The case study USA indicated a number of high EHPs, for example the "paragenesis with radioactive elements" in conjunction with a low EHP for governance. As discussed, this might indicate that the good governance in the country led to an appropriate establishment of countermeasures and long-term monitoring. This is also supported by the countermeasures identified in the DPSIR analysis.

- The tailings dam breach considered in the Canada case study on Mount Polley was met by a number of investigations and adaptations of regulations. It seems save to say that despite justified criticism, such a massive and comprehensive response could not be expected in countries with poorer governance. All case studies indicating poor governance (low EHP for indicator ”conflict potential with local population“) showed impacts on the environment that could have been prevented, it seems, if countermeasures had been taken.

5 List of references

Appel, P. W. U. and Jønsson, J. B. (2007): Small-scale Gold Mining in Developing Countries, in: Geoviden Geology and Geography (2007, No. 2), Geocenter Copenhagen, Copenhagen.

Artisanal Mining (2017): The Artisanal and Small-scale Mining Knowledge Sharing Archive. Online: http://artisanalmining.org/ (13.11.2018).

Dehoust, G.; Manhart, A.; Möck, A.; Kießling, L.; Vogt, R.; Kämper, C.; Giegrich, J.; Auberger, A.; Priester, M.; Rechlin, A. and Dolega, P. (2017): Erörterung ökologischer Grenzen der Primärrohstoffgewinnung und Entwicklung einer Methode zur Bewertung der ökologischen Rohstoffverfügbarkeit zur Weiterentwicklung des Kritikalitätskonzeptes (ÖkoRess I): Konzeptband. Commissioned by the Federal Environment Agency (UBA), Dessau-Roßlau. Online: https://www.umweltbundesamt.de/publikationen/eroerterung-oekologischer-grenzen-der (13.11.2018).

Dorner, U.; Franken, G; Liedtke, M. and Siever, H. (2012): Artisanal and Small-Scale Mining (ASM), POLINARES Working Paper No 19. Online: https://www.polinares.eu/wp-content/uploads/2017/12/polinares_wp2_chapter7.pdf (13.11.2018).

Kristensen, Peter (2004): The DPSIR Framework. Paper presented at the 27-29 September 2004 workshop on a comprehensive / detailed assessment of the vulnerability of water resources to environmental change in Africa using river basin approach. UNEP Headquarters, Nairobi, Kenya. Online: http://wwz.ifremer.fr/dce/content/download/69291/913220/file/DPSIR.pdf (24.01.2017).

Geenen, S (2015): African Artisanal Mining from the Inside Out Access, norms and power in Congo's gold sector, Routledge.

Manhart, A; Vogt, R.; Priester, M.; Dehoust, G.; Auberger, A.; Blepp, M.; Dolega, P.; Kämper, C.; Giegrich, J.; Schmidt, G.; Kosmol, J. (2018): The environmental criticality of primary raw materials – A new methodology to assess global environmental hazard potentials of minerals and metals from mining, in: Mineral Economics (2018), Springer, Berlin Heidelberg, pp. 1-17.

Manikandan, S. (2011): Measures of central tendency: Median and mode. In: J Pharmacol Pharmacother. 2011;2 (3): 214-5, Online: https://dx.doi.org/10.4103%2F0976-500X.83300 (15.11.2018).

Poldi, E. (2018): Congo miners achetant du cobalt à des opérateurs artisanaux pour équilibrer le marché. CTCPM - CELLULE TECHNIQUE DE COORDINATION ET DE PLANIFICATION MINIERE. Online: https://www.miningcongo.cd/ (26.11.2018).

Rüttinger, L. and Scholl, C. (2017): Responsible mining? Challenges, perspectives and approaches - Summary of the findings of the research project „Approaches to reducing negative environmental and social impacts in the production of raw materials (UmSoRess)". . Commissioned by the Federal Environment Agency (UBA), Dessau-Roßlau. Online: https://www.umweltbundesamt.de/publikationen/responsible-mining-challenges-perspectives (13.11.2018).

Wagner, M.; Franken, G.; Martin, N.; Melcher, F and Vasters, J (2007): Zertifizierte Handelsketten im Bereich mineralischer Rohstoffe, BGR (Bundesanstalt für Geowissenschaften und Rohstoffe), Hannover. Online: https://www.bgr.bund.de/DE/Themen/Min_rohstoffe/Downloads/Studie_Zertifizierte_Handelsketten.pdf?__blob=publicationFile&v=2 (13.11.2018).

YCELP (Yale Center for Environmental Law and Policy at Yale University) et al. (2018): 2018 Environmental Performance Index (EPI). Online: https://epi.envirocenter.yale.edu/downloads/epi2018policymakerssummaryv01.pdf (20.11.2018).

A Annex

Overview tables on main finding of the governance and conflict analysis and governance indicators of the UmSoRess case studies

Colour code	strong governance performance (first quartile)	medium governance performance (second and third quartile)	weak governance performance (last quartile)

Table 22: Main Findings Brazil (Aluminium)

	Brazil (Aluminium)					
Main findings of the qualitative governance and conflict analysis	Overall governance performance of Brazil: medium • The governance analysis showed that, overall, Brazil's governance is characterised by existing regulations and strategies. However, with regard to the implementation of legislation, considerable shortcomings persist. • Some of the main problems are a lack of funding at state and local level for effective implementation and other capacity shortages, which can delay the granting of environmental licences. Furthermore, the Environmental Institute does not have the necessary financial resources for monitoring the implementation of environmental protection laws. • Environmental impact studies are not always conducted before the start of construction works, but in parallel. One mining case showed that the environmental impacts were correspondingly high due to a lack of previous analyses and precautions. • Conflict potential is particularly caused by violations of the rights of indigenous populations, infrastructure projects such as the damns Altamira and Tucuruí with significant social and environmental impacts, forced resettlements and unfulfilled expectations of local populations as regards development opportunities of mining projects.					
Do existing governance indicators reflect governance	Indicator	Sub-Indicator	Values	Year	Applicability	Benchmark
	WGI Estimate: between -2.5 and 2.5 Percentile rank: between 0 and 100,	Voice and Accountability	Estimate: 0.47 Rank: 61.58	2016	Best WGI result for Brazil for Voice and Accountability, showing a result above average. The indicator seems to represent well the overall governance and the situation in the mining sector in Brazil. Based on the information of the analysis,	+

gaps and challenges?	with higher values corresponding to better outcomes				representatives of indigenous populations were able to assemble and protest against the damming of a river. As a result they were invited to mediation talks. However, no solution was found and thus the interests of the indigenous population were not considered.	
		Political Stability and Absence of Violence	Estimate: -0.45 Rank: 30.00	2016	Brazil's lowest WGI result reflects very well the weak overall governance as well as the situation in the mining sector in particular. Political riots and corruption scandals are common. The analysis does mention violent clashes in cases of strikes and protests against infrastructure projects.	++
		Government Effectiveness	Estimate: -0.18 Rank: 47.60	2016	Reflects well the overall medium governance performance in general and in the mining sector. Despite extensive legislation in the mining sector, the analysis has shown that implementation is still weak due to weak capacity of the responsible agencies to monitor and control the implementation. An Environmental Impact Assessment is mandatory before the start of a project, but was delayed and prepared in parallel with construction in the case of Tucuruí damn. No life cycle assessment was prepared for the dam construction, ecological follow-up costs not included in analysis.	+
		Regulatory Quality	Estimate: -0.21 Rank: 46.63	2016	Reflects well the overall medium to weak governance performance in this area. The private sector is faced with a complex tax system in the mining sector which can hamper private sector development.	+
		Rule of Law	Estimate: -0.08 Rank: 51.92	2016	Brazil's second highest WGI result indicates an average rank for Rule of Law. This reflects well the overall medium governance performance and the situation in the mining sector.	+

					The analysis shows a likelihood of violence in case of protests and strikes against infrastructure projects related to mining.	
		Control of Corruption	Estimate: -0.44 Rank: 38.46	2016	Brazil's second lowest WGI result for Control of Corruption reflects well the overall medium to weak governance performance in this area. This seems to reflect well the overall governance and in some points also the mining sector. A provisional licence was granted even though the conditions defined in the provisional licence, such as the provision of sufficient infrastructure and health care for the local indigenous population and the workers moving in, were not met.	+
	EPI Score: between 0 and 100, with higher values corresponding to better outcomes Rank: amongst all assessed countries		Score: 60.70 Rank: 69 out of 178,	2018	This index reflects well Brazil's overall above the medium governance performance in general but does not fully reflect the mining sector governance. Local populations suffer from contamination of rivers, deforestation and ecosystem damages caused by damns. The Amazon is particularly threatened by severe environmental impacts of mining projects. Therefore the EPI score seems too high.	-
	Fraser Policy Perception Index Score: between 0 and 100, with higher values corresponding to better outcomes Rank: amongst all assessed countries		Score: 55.66 Rank: 66 out of 91	2017	Reflects well the overall medium to weak governance in the mining sector in this specific area. The tax system in Brazil is seen as a medium to high investment risk and the granting of exploration licenses was suspended in most states (Fraser Institute Annual Survey of Mining Companies 2017).	+
	CPI Score: between 0 and 100, where 0 is		Score: 37 (global average: 43.07) Rank: 96 out of 180	2017	This indicator seems to reflect well the overall governance and in points the mining sector. In the case study, a provisional licence was granted even though the conditions defined in it, such as the	+

	highly corrupt and 100 is very clean Rank: amongst all assessed countries				provision of sufficient infrastructure and health care for the local indigenous population and the workers, were not met.	
Conclusion	• Brazil's overall medium sector governance is well reflected in all key governance indices of the WGI. Brazil's lowest WGI result for Political Stability and Absence of Violence very well reflects the weak sector governance in this area. • The Fraser Policy indicator and the CPI also reflect the governance well. • However, the EPI does not fully reflect the governance sector. Considering the severe environmental impacts caused by mining and related infrastructure projects – particularly to the sensitive ecosystems of the Amazon - the EPI score, which is above average, seems too high.					

Table 23: Main Findings Chile (Copper)

	Chile (Copper)					
Main findings of the qualitative governance and conflict analysis	Overall governance performance: strong (to medium) • Chile's environmental governance has improved over time. Nevertheless, there is still a lack of monitoring environmental, safety and health standards, partly due to a lack of personnel capacity. • Conflicts with trade unions regarding poor working conditions have been violently addressed by the government in the past. • The privatisation of water in favour of mining companies and large corporations caused many conflicts. These remain unsolved due to a lack of governmental control. Although measures are planned, they are not actually implemented. The relocation of indigenous people is the consequence of water pollution and water scarcity caused by mining companies, as the example of Chuquicamata demonstrates.					
Do existing governance indicators reflect governance gaps and challenges?	Indicator	Sub-Indicator	Values	Year	Applicability	Benchmark
	WGI Estimate: between -2.5 and 2.5 Percentile rank: between 0 and 100, with higher values corresponding to better outcomes	Voice and Accountability	Estimate: 1.00 Rank: 76.85	2016	This reflects well the overall governance in the country and in parts the situation in the mining sector. Despite the evident public interest the population did not have a say in the privatisation of water and mining companies (as a main user of water). Demonstrations against mining activities, though rather peaceful, have been met with military action in the past.	

		Political Stability and Absence of Violence	Estimate: 0.51 Rank: 63.81	2016	This is Chile's lowest score amongst the WGI indicators, yet is still above average. This reflects the overall governance situation and in some points the situation in the mining sector. In the past, government violence (including torture, murder and internment) has been committed against regime opponents. In 1990, the government was brought down. The state has not yet fully recovered from this.	+
		Government Effectiveness	Estimate: 1.02 Rank: 79.33	2016	This indicator reflects well the overall governance but not the situation in the mining sector according to the results of the present analysis. In the area of environmental protection, the government has made some efforts to improve the situation, which resulted in declining emission levels. However, as regards water rights, which play a crucial role in the mining sector, the government is unable to solve the problems of the local population caused by the water privatisation. The compensations of current proprietors of water rights would mean high financial burdens which the government cannot bear. Furthermore, the control of environmental, safety and health standards' implementation remains a weakness. In spite of the progress mentioned, the main problem is the lack of comprehensive monitoring. In that regard one could even expect a lower value for Government Effectiveness.	-
		Regulatory Quality	Estimate: 1.37 Rank: 89.90	2016	This represents Chile's best WGI result. According to the results of the analysis, this reflects very well the overall governance situation and in parts also that of the mining sector in particular.	++

					The government has established numerous standards and legal frameworks for the mining sector and promotes private sector development.	
		Rule of Law	Estimate: 1.13 Rank: 84.62	2016	Chile's second highest WGI result. This indicator is difficult to evaluate given that the analysis does not describe significant cases of criminality and contract breach (only a few cases of corruption - see Control of Corruption). The analysis also mentions that the protection of property rights is particularly encouraged. Thus, a strong rule of law can be assumed.	+
		Control of Corruption	Estimate: 1.11 Rank: 82.21	2016	This value belongs to Chile's higher rated WGIs. It only partly coincides with the results of the analysis which mentions illegal practices of authorities as regards the assessment of environmental impacts. Numerous complaints have been filed by local communities against decisions of the responsible authorities on environmental impact assessments. In view of these weaknesses, the value for Control of Corruption seems rather high.	-
	EPI Score: between 0 and 100, with higher values corresponding to better outcomes Rank: amongst all assessed countries		Score: 57.49 Rank: 84 out of 178,	2018	This value corresponds very well with Chile's governance performance (slightly above average) in general and in the mining sector, as described in the analysis. Although efforts were made with numerous regulations to support the protection of the environment, implementation is not sufficiently monitored and environmental impacts are severe, particularly those caused by copper extractions.	++
	Fraser Policy Perception Index Score: between 0 and 100, with		Score: 80.55 Rank: 25 out of 91	2017	A strong score for Chile. Such a positive result does not match the results of the analysis and seems to be too high.	-

	higher values corresponding to better outcomes Rank: amongst all assessed countries				Chile has 30% of the world's copper reserves. Its mining sector is regulated on market-liberal principles and appears to have few barriers. However, the strong conflicts over working conditions and water use are considerable.	
	CPI Score: between 0 and 100, where 0 is highly corrupt and 100 is very clean Rank: amongst all assessed countries		Score: 67 (global average: 43.07) Rank: 26 out of 180	2017	This value is well above the global average. It reflects the overall governance situation and in some points that of the mining sector. The analysis mentions illegal practices of authorities as regards environmental impacts assessments. Numerous complaints have been filed by local communities against decisions of the responsible authorities on environmental impact assessments.	+
Conclusion	• On the whole, the indicators only partly reflect the situation in the Chilean mining sector. It seems that there is a tendency towards a too positive rating. • However, the indicators for which Chile received its lowest or highest rates indeed reflect the trend present in the UmSoRess analysis. Chile's highest WGI value (Regulatory Quality) represents the results of the analysis very well. • Chile's rating in the EPI is significantly worse than those for the WGI, which is very well reflecting the situation in the mining sector with regards to the environmental performance. • The high value for the Fraser Policy Perception Index does not adequately reflect Chile's governance of the mining sector.					

Table 24: Main Findings China (Rare Earth Elements - REE)

	China (Rare Earth Elements - REE)
Main findings of the qualitative governance and conflict analysis	Overall governance performance: weak (to medium) • To better control the mining sector – particularly the pricing, demand and supply – China has introduced economic measures e.g. tighter export regulations and strategic (mineral) reserves. • The mining sector inflicts severe negative impacts on the environment. Therefore, stricter environmental regulations for REE extraction were introduced in 2011. The government's new strategy is to first close the most polluting mines/plants with obsolete production capacities. This includes a restructuring of the entire REE sector to enable more efficient and sustainable extraction of resources. The goal is to have a mining sector which consists of only a few market-leading conglomerates instead of numerous small companies that are difficult to control. The effectiveness and implementation of environmental standards in the mining sector is still deficient due to inadequate governmental control and supervision mechanisms, land rights issues and conflicts of interest between smaller local and large national companies as well as between private and public investors.

	• Due to an increasing awareness for environmental problems in the country, there has been a drastic increase in environmental protests in China as a whole, but also specifically regarding the mining sector. One fundamental problem which spurs conflicts is the lack of involvement of the local population in decision-making processes and insufficient compensation mechanisms. • Conflicts have ignited over the resettlement of villages from contaminated areas around the Baotous ponds and related compensations. There are also a number of reports on the migration of entire villages due to the significant impacts on health and livelihoods. • Another problem is the widespread use of illegally operated mines and processing plants. Due to a lack of control over their activities, most of these companies do not comply with environmental and safety standards. These companies are also associated with the smuggling of large quantities of REE and concomitant corruption as well as organised crime.					
Do existing governance indicators reflect governance gaps and challenges?	Indicator	Sub-Indicator	Values	Year	Applicability	Benchmark
	WGI Estimate: between -2.5 and 2.5 Percentile rank: between 0 and 100, with higher values corresponding to better outcomes	Voice and Accountability	Estimate: -1.62 Rank: 6.90	2016	China shows its lowest WGI score for Voice and Accountability. This reflects very well the overall situation in the country. Free media, freedom of association and expression are strictly limited, which is partially shown in the governance analysis. The government has intervened in a large number of protests and conflicts between mine operators and local shepherds. However, the governance analysis does not provide for enough details to assess whether the index reflects the situation even very well.	+
		Political Stability and Absence of Violence	Estimate: -0.52 Rank: 27.14	2016	In this index, China has its second lowest WGI score. This seems to reflect the situation well. However, the governance analysis did not find substantial information on this topic.	+
		Government Effectiveness	Estimate: 0.36 Rank: 67.79	2016	Government Effectiveness is the index showing by far China's highest WGI score and relatively strong governance in this specific area compared to its ratings for other WGI indices. This reflects well the governance performance in general and the active measures taken by the government to regulate and control the mining sector e.g. stricter environmental standards. However, based on the results of the governance analysis, one could	+

					expect a lower score as regards the government's effectiveness in the mining sector.	
		Regulatory Quality	Estimate: -0.26 Rank: 44.23	2016	China has its third lowest WGI score in this index which reflects very well the situation in the country and in the mining sector particularly as regards the introduction of environmental regulations and economic policies which pose challenges for (foreign) investors.	++
		Rule of Law	Estimate: -0.22 Rank: 46.15	2016	China has a low to average score (yet, the second highest of its WGI values) for Rule of Law which represents well the governance situation e.g. as regards property rights, related degradation of farming land and a decline of grazing land caused by nearby mining activities.	+
		Control of Corruption	Estimate: -0.25 Rank: 49.04	2016	China receives an average to low score in Control of Corruption which reflects well the general governance performance and in part the mining sector governance. The government is not in control of the widespread illegal REE mining activities and related corruption and organised crime.	+
	EPI Score: between 0 and 100, with higher values corresponding to better outcomes Rank: amongst all assessed countries		Score: 50.74 Rank: 120 out of 178,	2018	The EPI displays a medium score for China. This reflects well the general situation in China and to some degree also the mining sector in particular. Even though the government has introduced stricter environmental legislations aiming at closing down the most polluting mines/plants, the environmental implications of mining activities have been severe and the implementations of regulations are lagging.	+
	Fraser Policy Perception Index		Score: 37.46 Rank: 86 out of 91	2017	China falls under the "10 least attractive jurisdictions for investment based on the PPI rankings" which reflects very well the situation in	++

	Score: between 0 and 100, with higher values corresponding to better outcomes Rank: amongst all assessed countries				the Chinese mining sector which is strictly regulated.	
	CPI Score: between 0 and 100, where 0 is highly corrupt and 100 is very clean Rank: amongst all assessed countries		Score: 41 (global average: 43.07) Rank: 77 out of 180	2017	The CPI indicates a low to average score for China, reflecting very well the governance performance in the country and the mining sector. Corruption in the mining sector – including REE – persists.	++
Conclusion	• Overall, the selected set of WGI indicators reflects the governance situation for China well. • WGI Regulatory Quality, the Fraser PPI and the CPI reflect China's governance performance very well.					

Table 25: Main Findings Greenland (REE – Rare Earth Elements)

	Greenland (REE – Rare Earth Elements)[24]
Main findings of the qualitative governance and conflict analysis	Overall governance performance of Greenland: strong • Overall, Greenland shows strong mining governance. Several stages have to be completed before mining projects are authorized. Before a company in Greenland is granted a licence to exploit a deposit, it must conduct an EIA (Environmental Impact Assessment) and a SIA (Social Impact Assessment). • Kvanefjeld is one of the largest deposits of REE worldwide. Climate change and overfishing of the seas are posing a risk to Greenland's most important exports. This economic pressure and Greenland's increasing political and financial independence from Denmark have encouraged Greenland's government to attract foreign investors and to promote the local mining sector and REE extraction as a further source of income. A previous ban on the extraction of uranium-containing substances was lifted despite strong protests. • Background: The environmental impacts of REE extraction and their radioactive by-products such as uranium are associated with many risks. The Arctic is a particularly important and fragile ecosystem and the extraction of SEE poses significant risks in terms of potential environmental impacts, especially as regards biodiversity. However, the potential major environmental impacts can only be estimated.

[24] Greenland is an autonomous part of the Kingdom of Denmark. Accordingly, some indicators only offered scores for Denmark but not for Greenland in particular. Therefore, the Greenland case study was excluded from the comparative analysis.

	• Potential social conflicts are expected with indigenous/local populations. With a regulation introduced in 2012, it is possible to pay lower wages to migrant workers. Locals therefore fear that they will not benefit from the job opportunities in the mining sector. To address such conflict potential, more incentives were created to employ Greenlanders and a minimum wage for foreign workers was introduced.					
Do existing governance indicators reflect governance gaps and challenges?	Indicator	Sub-Indicator	Values	Year	Applicability	Benchmark
	WGI Estimate: between -2.5 and 2.5 Percentile rank: between 0 and 100, with higher values corresponding to better outcomes	Voice and Accountability	Estimate: 1.47 Rank: 98.03 *(For Denmark)*	2016	Voice and Accountability represents Denmark's second highest WGI value. This reflects the study's findings well. Before a mining project is approved, a social impact assessment is carried out to ensure that all interest groups are involved. Furthermore, the legislation was partially adapted due to strong criticism from the population regarding low wages for foreigners.	+
		Political Stability and Absence of Violence	Estimate: 0.85 Rank: 74.76 *(For Denmark)*	2016	Denmark receives its lowest WGI value for this indicator. This somewhat reflects the findings of the study. The governance analysis found no indications for violence. Furthermore, there are no major political instabilities. Greenland has distanced itself from Denmark over time but responsibilities are still shared between Denmark and Greenland. The value could thus be expected to be significantly higher for Greenland.	-
		Government Effectiveness	Estimate: 1.89 Rank: 99.04 *(For Denmark)*	2016	Denmark receives its highest WGI score in Control of Corruption. This reflects Greenland's governance regime and to some degree also the situation in the mining sector. However, one could expect the extraordinary high value to be slightly lower for Greenland compared to Denmark.	+
		Regulatory Quality	Estimate: 1.58 Rank: 92.31 *(For Denmark)*	2016	The WGI Regulatory Quality reflects the study's findings well. Greenland has formulated and implemented several policies and regulations that promote private sector development.	+

		Rule of Law	Estimate: 1.90 Rank: 97.60 *(For Denmark)*	2016	The high WGI Rule of Law value for Denmark represents well the findings of the governance analysis for Greenland. No events have been reported that would explain a low rule of law (e.g. crime)	+
		Control of Corruption	Estimate: 2.24 Rank: 99.04 *(For Denmark)*	2016	Denmark receives its highest WGI score in Control of Corruption. However, this very good rating does not fully reflect the situation in Greenland. Experts from Transparency International Greenland warn that Greenland does not have enough institutions to control the corruption risks of the growing mining sector and the associated payment flows.	-
	EPI Score: between 0 and 100, with higher values corresponding to better outcomes Rank: amongst all assessed countries		Score: 81.60 Rank: 3 out of 178 *(For Denmark)*	2018	Denmark's high EPI score does not fully reflect the findings of the governance analysis and could be expected to be lower for Greenland. The financial pressure to promote the mining sector seems to outweigh environmental concerns. The pollution of the Lake Taseq is to some degree accepted for the sake of the REE extraction project. There are risks of groundwater contamination as well as potential disposal of mining waste into the ocean which has already occurred in Greenland.	-
	Fraser Policy Perception Index Score: between 0 and 100, with higher values corresponding to better outcomes Rank: amongst all assessed countries		Denmark: n.d. *Greenland:* *Score: 63.07* *Rank: 54 out of 9)*		The medium value for Greenland, which is slightly above the average, corresponds well with the study's findings. To date, planned projects have to pass an environmental impact assessment as well as a social impact assessment, which can take up to several years. Furthermore, in some cases there is no infrastructure and insufficient manpower. This lowers the attractiveness for investments in Greenland's mining sector.	+
	CPI Score: between 0 and 100, where 0 is		Score: 88 (global average: 43.07)	2017	This extraordinary high score and rank of Denmark is not entirely in accordance with the	-

	highly corrupt and 100 is very clean Rank: amongst all assessed countries		Rank: 2 out of 180		study's finding for Greenland's governance situation. Greenland may be more vulnerable to corruption due a lack of institutions and to a lack of institutions to control the corruption risks of the growing mining sector and the associated payment flows.	
Conclusion	• Being - from a political point of view - an autonomous part of the Kingdom of Denmark, the case of Greenland shows the difficulty to compare indicators from another country (Denmark) with the governance in the specific mining country (Greenland), as Greenland is not listed separately for several indicators. • Furthermore, REE extraction in Greenland is still at the beginning and not fully developed yet. Hence, the findings of the analysis were in parts based on assumptions. None of the governance indicators reflect the governance situation very well. The Danish indicators do not fully reflect the situation in Greenland. Overall, Denmark has a very sound and strong governance. In parts this is true for Greenland. However, the extraction of REE is related to several environmental risks and conflict potential which do not correspond with the governance indicators for Denmark. • Thus, for four indicators (WGI Political Stability and Absence of Violence, EPI and CPI) the values for Denmark do not fully reflect the mining governance in Greenland.					

Table 26: Main Findings Guinea, Boké and Kindia region (Bauxite)

	Guinea, Boké and Kindia region (Bauxite)
Main findings of the qualitative governance and conflict analysis	Overall governance performance: weak • The analysis describes weak governance and rule of law, high levels of corruption and conflict (over working conditions, payment, living conditions), political instability and a lack of environmental protection and control. • Despite existing difficulties, the government has lately made efforts to improve governance in the mining sector e.g. an attempt to join EITI and a revision of the Mining Code. The government's main focus is on improving transparency and fighting corruption. • The introduction of new tax, customs and financial regulations through the new Mining Code, including the abolition of tax exemptions, led to a strong decline in investment in the mining sector. After massive criticism, the taxes were revised and reduced. • Guinea's political instability not only prevented important governance reforms, but also creates political risks for mining companies and conflicts. The most crucial conflicts in Guinea's mining sector have arisen between companies and mining workers due to inadequate working conditions, poor pay and poor living conditions. These have repeatedly led to strikes and protests.

Do existing governance indicators reflect governance gaps and challenges?	Indicator	Sub-Indicator	Values	Year	Applicability	Benchmark
	WGI Estimate: between -2.5 and 2.5 Percentile rank: between 0 and 100, with higher values corresponding to better outcomes	Voice and Accountability	Estimate: -0.73 Rank: 26.11	2016	This low WGI result reflects very well the overall governance and the situation in the mining sector. Many strikes by workers' organisations have taken place, but their demands have not been addressed. In fact, RUSAL closed down operations, stopped salary payments and dismissed employees as result of strikes. They also asked to declare the strikes illegal. The resulting negative effects are immense.	++
		Political Stability and Absence of Violence	Estimate: -0.41 Rank: 30.95	2016	Guinea's second highest, yet very low, WGI result. This clearly matches the analysis of the overall situation in the country and in the mining sector. Guinea has been deeply influenced by the French occupation and long dictatorial governments and military putsches that followed. Numerous demonstrations against the authoritarian government were violently dissolved. However, there are not enough examples regarding the nature of protest in the mining sector to evaluate whether the indicator reflects this specific governance area in more detail.	+
		Government Effectiveness	Estimate: -1.01 Rank: 14.90	2016	Guinea's lowest WGI result. This reflects the overall governance of Guinea and partially also the situation in the mining sector. The Government Effectiveness is very low which is partially due to the government's weak control and a lack of capacity. Some progress has been made in recent years such as the examination of mining licensing practices, the revision of the Mining Code and the introduction of new financial provisions). However, though the engagement has visibly increased, there is no clear improvement regarding implementation practices.	+

		Regulatory Quality	Estimate: -0.87 Rank: 19.23	2016	This low WGI result reflects well the overall governance and the situation in the mining sector according to results of the analysis. The Mining Code regulates the mining sector. Since the revision, concession holders are required to give preference to national companies in awarding contracts. However, implementation is still insufficient. The revised code introduced new tax, customs and financial regulations. Mining companies complained that these levies significantly reduced the profitability of the mining sector which led to an investment stop in the sector until the code was revised again.	+
		Rule of Law	Estimate: -1.29 Rank: 8.65	2016	Guinea's lowest WGI result. The indicator reflects the overall governance and partially the situation in the mining sector. Very little transparency and dominant corruption indicate a poor rule of law. However, there is a lack of concrete examples for a better evaluation.	+
		Control of Corruption	Estimate: 0.94 Rank: 14.90	2016	Guinea's highest WGI result. The indicator reflects the overall governance regime and partially the situation in the mining sector. In Guinea, corruption is prevalent. Tax payments and fees paid by mining companies were not transparently listed by the government, leaving unclear whether and where these payments were channelled to. Nevertheless, the government has introduced measures to combat corruption. The case study mentioned corruption several times, but did not give enough concrete examples to adequately evaluate this value.	+
	EPI Score: between 0 and 100, with higher values		Score: 46.62 Rank: 134 out of 178,	2018	Guinea is on a low EPI rank and has a score just below average, reflecting well the findings of the governance analysis.	+

	corresponding to better outcomes Rank: amongst all assessed countries				The mining sector in Guinea has a significant impact on the biodiversity and health of the population. Freshwater systems are contaminated due to a lack of environmental protection. Miners with silicosis were documented. It is mentioned several times that the implementation of the legal framework is not sufficiently achieved. The value seems justified, but rather too high.	
	Fraser Policy Perception Index Score: between 0 and 100, with higher values corresponding to better outcomes Rank: amongst all assessed countries		n.d.		No score was provided for Guinea due to an insufficient number of responses (Fraser: "Any jurisdiction with fewer than 5 responses was dropped.")	
	CPI Score: between 0 and 100, where 0 is highly corrupt and 100 is very clean Rank: amongst all assessed countries		Score: 27 (global average: 43.07) Rank: 148 out of 180	2017	The low rank and score seem justified, based on the findings of the analysis. In Guinea, corruption is prevalent. Tax payments and fees paid by mining companies were not transparently listed by the government, leaving unclear whether and where these payments were channelled to. Nevertheless, the government has introduced measures to combat corruption. The case study mentioned corruption several times, but did not give enough concrete examples to adequately evaluate this value.	+
Conclusion	• Indicators have all been in accordance with the findings of the governance analysis, well reflecting Guinea's weak governance level. • Particularly the WGI Voice and Accountability index reflects Guinea's overall governance and the situation in the mining sector very well. • The EPI rating was significantly higher than the average of WGI indicators. • No data was provided for the Fraser Policy Perception indicator which shows once more the limited country coverage of the indicator.					

Table 27: Main Findings Indonesia, Banka-Belitung (tin)

	Indonesia, Banka-Belitung (tin)					
Main findings of the qualitative governance and conflict analysis	Overall governance performance: medium (to weak) • In recent years, Indonesia has made an effort to close its gaps in mining law and environmental law e.g. by introducing benefit sharing of mining companies with the local population and introducing EIAs. • However, overall the implementation of mining legislation in the province of Bangka is inadequate. Public authorities are understaffed and underfinanced, coordination mechanisms between authorities are often lacking, particularly with regard to small-scale mining activities. The involvement of politicians and elites in illegal tin trading does not contribute to an improvement of the coordination of the mining sector, which is affected by corruption and bribery. • As was shown in the Grasberg case study, the history of the Bangka-Belitung mining region too is closely linked to conflicts. In the case of Bangka-Belitung, the conflicts also received a political element from the dispute between different parties about the orientation of Indonesian tin policy in the past.					
Do existing governance indicators reflect governance gaps and challenges?	Indicator	Sub-Indicator	Values	Year	Applicability	Benchmark
	WGI Estimate: between -2.5 and 2.5 Percentile rank: between 0 and 100, with higher values corresponding to better outcomes	Voice and Accountability	Estimate: 0.1 Rank: 50.25	2016	Reflects well the medium governance performance.	+
		Political Stability and Absence of Violence	Estimate: -0.4 Rank: 33.33	2016	One of Indonesia's lowest WGI results reflects well the overall weak to medium governance and Indonesia's political stability and violence. Political decisions with regard to obligatory mining concessions have led to an open conflict between the parties as well as within the population and ended up in riots in which around 11,000 small entrepreneurs participated.	+
		Government Effectiveness	Estimate: 0.0 Rank: 55.37	2016	The indicator only reflects the general governance performance well, but does not reflect the capability to manage the mining sector. The implementation of legislation and mining reforms (e.g. addressing small-scale mining) has been inadequate and accompanied by conflicts. There is also a lack of effective environmental and social standards. In light of repeated revisions of decisions due to political or civil society pressure,	-

					the indicator does not reflect well the governance concerning the mine.	
		Regulatory Quality	Estimate: -0.1 Rank: 50.0	2016	The indicator with an average result only reflects the general governance performance well, but does not reflect the capability to manage the mining sector. Public authorities are understaffed and underfinanced, coordination mechanisms between authorities are often lacking.	-
		Rule of Law	Estimate: -0.4 Rank: 38.94	2016	This is one of Indonesia's lowest WGI results. It reflects very well the overall medium to weak governance performance. The weak rule of law in Indonesia is well represented by the case study of Bangka leadership. Child labour, injuries and accidents are not uncommon in small, illegal mines and have not yet been contained by legislation. This confirms the indicator value.	++
		Control of Corruption	Estimate: -0.4 Rank: 42.79	2016	This is one of Indonesia's lowest WGI results. It reflects very well the overall medium to weak governance in this area. The analysis showed that corruption is a major problem in the Indonesian tin industry. In the region of Bangka and Belitung a system has been established, in which many authorities and offices are corrupted and bribes are demanded for issuing licenses and documents. This is confirmed by the WGI indicator. Regarding the mining sector, one could expect an even lower value.	+
	EPI Score: between 0 and 100, with higher values corresponding to better outcomes		Score: 46.92 Rank: 133 out of 178,	2018	This index reflects Indonesia's overall weak performance very well. The implementation of existing environmental legislation is weak e.g. as regards the water pollution control. Existing	++

	Rank: amongst all assessed countries				guidelines for maximum values are not observed and are often exceeded a hundredfold.	
	Fraser Policy Perception Index Score: between 0 and 100, with higher values corresponding to better outcomes Rank: amongst all assessed countries		Score: 54.23 Rank: 84 out of 91		This average value reflects very well the weak governance in the mining sector. The indicator particularly points towards aspects, which were identified in the governance analysis (e.g. export restrictions to secure domestic raw material supplies or complications for SMEs). The expert assessment of professionals actually working in the mining sector on 15 policy factors via questionnaires seems to reflect the actual sector-governance situation in Indonesia very accurately. Thus, the Fraser Index combines qualitative with quantitative approaches.	++
	CPI Score: between 0 and 100, where 0 is highly corrupt and 100 is very clean Rank: amongst all assessed countries		Score: 37 (global average: 43.07) Rank: 96 out of 180	2017	This weak score reflects well the overall governance and that of the mining sector. Corruption is a major problem, particularly in the mining sector. Many of the responsible authorities are corrupted and benefit from the informal mining sector. Regular bribes to the authorities are common.	
Conclusion	• In most cases, the existing indices and indicators show a good ability to reflect both the overall medium to weak governance and in some cases also the specific and nuanced governance challenges in the mining sector of Indonesia. • Indonesia‘s overall medium to weak sector governance is well reflected in key governance indices of the WGI. The WGI indicators for Political Stability and Absence of Violence and Rule of Law very well mirror the weaknesses of the sector governance. • However, the average values of the WGI Indicators Regulatory Quality and Rule of Law do not reflect the reality in the Bangka region. The failure of state supervisors to reduce illegal trade in tin and the unclear distribution of tasks within the authorities are more serious than the indicator suggests. • The EPI and the Fraser index also very well reflect the overall as well as the sector governance. • Due to the inadequate action of the authorities, the illegal tin mining could not be stopped and its environmental effects are currently barely compensated. The scandals revealed in 2012, in which international electronics companies were also involved, are only examples of the dysfunctional control and supervisory mechanisms in Indonesia and especially in the province of Bangka-Belitung. • Just as in the case of small scale mining in Peru, the example demonstrates the difficulties of adequately mapping the environmental and social risks of small-scale mining using national governance indicators. It underlines the need and justification					

	to regard small-scale mining as a special challenge to governance and, within the framework of the evaluation system, to adjust the results for governance quality resulting from these national indicators with a correction factor for small-scale mining.

Table 28: Main Findings Indonesia, Grasberg (copper)

	Indonesia, Grasberg (copper)					
Main findings of the qualitative governance and conflict analysis	Overall governance performance: medium (to weak) • In recent years, Indonesia has made an effort to close its gaps in mining law and environmental law e.g. by introducing benefit sharing of mining companies with the local population and introducing EIAs. However, inadequate implementation and enforcement of environmental laws in both small-scale mining and industrial mining have led to environmental damages. • The governance analysis of the Indonesian case study (Grasberg mine) shows close links between state institutions and mining companies. A close involvement of state security forces in illegal structures and their cooperation with mining companies led to corruption, conflict and violence. • Conflicts and harsh outbreaks of violence related to the Grasberg mining operations are still ongoing. Some of the main conflicts evolved around forced resettlements of indigenous populations, accidents at the mine, working conditions at the mine and environmental damage caused by the mining activities.					
Do existing governance indicators reflect governance gaps and challenges?	Indicator	Sub-Indicator	Values	Year	Applicability	Benchmark
	WGI Estimate: between -2.5 and 2.5 Percentile rank: between 0 and 100, with higher values corresponding to better outcomes	Voice and Accountability	Estimate: 0.1 Rank: 50.25	2016	Reflects well the medium governance performance. The indicator ranges around the 50th percentile, making it an average result.	+
		Political Stability and Absence of Violence	Estimate: -0.4 Rank: 33.33	2016	This is one of Indonesia's lowest WGI results. It very well the overall weak to medium governance and Indonesia's weak political stability as well as the violent incidents particularly around the Grasberg mine. The analysis showed that the close involvement of the military and police in informal affairs points to instability of the security-system in Indonesia. Significant outbreaks of violence with numerous casualties hint to weak governance in this field.	++
		Government Effectiveness	Estimate: 0.0 Rank: 53.37	2016	The indicator only reflects the general governance performance well, but does not reflect the capability to manage the mining sector.	-

					The incomplete implementation of environmental laws and the poor conflict management in the history of the Grasberg mine are not adequately represented by this average value.	
		Regulatory Quality	Estimate: -0.1 Rank: 50.00	2016	Reflects well the overall medium governance performance in this area. However, weaknesses regarding the implementation of policies such as safety and environmental standards at the Grasberg mines might indicate an even lower value.	-
		Rule of Law	Estimate: -0.4 Rank: 38.94	2016	This is one of Indonesia's lowest WGI values. It reflects very well the overall medium to weak overall governance performance as well as weak governance in the mining sector. Human rights violations, repression and expulsion by the military and security forces have occurred on several occasions around the Grasberg mine.	++
		Control of Corruption	Estimate: -0.4 Rank: 42.79	2016	This is another of Indonesia's lowest WGI values. It reflects well the overall medium to weak overall governance in this area and in parts of the mining sector. The analysis showed that payments by the Grasberg operator to state security authorities have undermined and influenced the state security forces. This relationship of dependency has led to a complex self-dynamic, which promoted competition within the state security authorities and their legal and illegal entities. Regarding the mining sector one could expect an even lower value.	+
	EPI Score: between 0 and 100, with higher values corresponding to better outcomes Rank: amongst all assessed countries		Score: 46.92 Rank: 133 out of 178,	2018	This index reflects very well Indonesia's overall weak performance and the situation in the mining sector. Despite the passing of environmental laws in the recent past, implementation remains weak and environmental damages by mining activities have been significant.	++

	Fraser Policy Perception Index Score: between 0 and 100, with higher values corresponding to better outcomes Rank: amongst all assessed countries		Score: 39,92 Rank: 84 out of 91	2017	Reflects very well the overall governance and the weak governance in the mining sector. It points particularly to aspects, which were identified in the governance analysis (e.g. export restrictions to secure domestic raw material supplies or complications for SMEs).	++
	CPI Score: between 0 and 100, where 0 is highly corrupt and 100 is very clean Rank: amongst all assessed countries		Score: 37 (global average: 43.07) Rank: 96 out of 180	2017	This weak score reflects well the overall governance and that of the mining sector. Corruption is a major problem and the case of the Grasberg mine shows how payments to the police and military by the mining operator can trigger conflict and violence.	+
Conclusion	• In most cases, the existing indices and indicators adequately reflect both the overall medium to weak governance and also the specific and nuanced governance challenges in the mining sector of Indonesia. • Indonesia‘s overall sector governance is well reflected in key governance indices of the WGI with the exception of the average value for Government Effectiveness and Regulatory Quality which seem too high, considering the situation in the mining sector described in the governance analysis. The WGI indicators for Political Stability and Absence of Violence and Rule of Law very well mirror the weaknesses of the sector governance. • The EPI and the Fraser index also very well reflect the overall as well as the sector governance. • This comparative analysis has shown that in politically relatively stable and peaceful countries, the mining sector can be an exception to the generally peaceful situation. The ongoing escalations of violence indicate that the problems are still far from being resolved.					

Table 29: Main Findings Australia (Rare Earth Elements (REE) extraction) and Malaysia (refining)

	Australia (Rare Earth Elements (REE) extraction) and Malaysia (refining)
Main findings of the qualitative governance	Overall governance performance of Malaysia: medium (to strong)
	• REE are being mined in Mount Weld, Western Australia. The refining of the ores is carried out at a refinery in Kuantan, Malaysia. The potential environmental and social impacts which occur as consequence of the further processing of RE-ores are thus shifted to Malaysia. During the refinement of the RE-ores, emissions and waste are produced, some of which are radioactive and can have significant impacts on the environment and human health.

<table>
<tr><td>and conflict analysis</td><td colspan="6">Parts of the Malaysian population, civil society organisations and members of parliament have evaluated the environmental impact assessments carried out for the LAMP (refinery in Kuantan) as insufficient. Furthermore, they have criticised the non-transparent granting of licenses for Kuantan. Protest organisations revealed shortcomings in the handling of radioactive material and the lack of a long-term plan for their storage at the Kuantan processing plant. Against this background, the refinery in Malaysia has come under public criticism which has resulted in demonstrations and the founding of a protest movement. Of particular concern for the population are the possible radioactive contamination and accompanying health risks caused by the plant.
In 2012, trade with REE from Malaysia was stopped as the government demanded that the waste produced through the processing had to be exported by Australia, which Australia declined. As a transitional solution, the radioactive waste is stored temporarily until a permanent disposal facility is identified.</td></tr>
<tr><td rowspan="4">Do existing governance indicators reflect governance gaps and challenges?</td><td>Indicator</td><td>Sub-Indicator</td><td>Values</td><td>Year</td><td>Applicability</td><td>Benchmark</td></tr>
<tr><td rowspan="3">WGI
Estimate: between -2.5 and 2.5
Percentile rank: between 0 and 100, with higher values corresponding to better outcomes</td><td>Voice and Accountability</td><td>Estimate: -0.47
Rank: 33.00
(For Malaysia)</td><td>2016</td><td>Malaysia has its lowest score amongst the WGI indices regarding Voice and Accountability. This seems to reflect very well the overall governance situation in the country and in the mining sector. Despite strong protests by the population, the authority responsible for nuclear energy and radiation protection (AELB) issued a (temporary) operating license for the refinery in Kuantan.</td><td>++</td></tr>
<tr><td>Political Stability and Absence of Violence</td><td>Estimate: 0.10
Rank: 50.00
(For Malaysia)</td><td>2016</td><td>Malaysia receives an average score for Political Stability and Absence of Violence (however its second lowest WGI score) which reflects the governance situation in the country and that of the mining sector.
In the course of the protests, there were isolated riots and conflicts with the police as well as a fire bomb attack. However, this governance analysis comes to the conclusion that these isolated escalations are to be assessed as low in comparison to protests and the often very repressive behaviour of the police in the past.</td><td>++</td></tr>
<tr><td>Government Effectiveness</td><td>Estimate: 0.88
Rank: 75.96
(For Malaysia)</td><td>2016</td><td>For Government Effectiveness, Malaysia receives its highest WGI score. The score reflects the overall governance situation in the country but does not seem to adequately represent the mining sector. In</td><td>-</td></tr>
</table>

					the case of the LAMP, environmental legislation was not well implemented, particularly as regards the management of radioactivity. In addition, the environmental impact assessment carried out was inadequate. Thus, one would expect a lower score for this specific index.	
		Regulatory Quality	Estimate: 0.71 Rank: 75.48 (For Malaysia)	2016	Malaysia has its second highest WGI score regarding this index which reflects well the situation in the country and the mining sector, particularly regarding investment incentives such as tax exemptions granted for mining projects.	+
		Rule of Law	Estimate: 0.54 Rank: 71.15 (For Malaysia)	2016	Malaysia shows a relatively high score for Rule of Law which represents well the governance situation in general but does not concord with the experience at Kuantan where the refining company refining company – Lynas Corporation –did not abide by the rules and provided an inadequate environmental impact assessment.	-
		Control of Corruption	Estimate: 0.11 Rank: 61.54 (For Malaysia)	2016	The Control of Corruption index for Malaysia shows an average score with a tendency to strong. This reflects very well the governance situation in general and in the mining sector. The governance analysis does not mention cases of corruption but reveals allegations against the responsible authority (AELB) of non-transparency regarding the issuing of an operating license for the Kuantan refinery. On this basis, one could expect an even lower score.	+
	EPI Score: between 0 and 100, with higher values corresponding to better outcomes Rank: amongst all assessed countries		Score: 59.22 Rank: 75 out of 178, (For Malaysia)	2018	The EPI reflects a medium score with a tendency to strong. This reflects well the situation in Malaysia where the implementation of environmental legislation still shows weaknesses. Potential environmental and health impacts at the refinery are severe. With respect to the processing plant,	+

					the governance analysis identified implementation gaps regarding environmental legislation. At the same time, complaints and demonstrations about potential environmental and health impacts by the local population were successful and might have influenced the Malaysian government to temporarily stop the trade with REE.	
	Fraser Policy Perception Index Score: between 0 and 100, with higher values corresponding to better outcomes Rank: amongst all assessed countries		N.d. (For Malaysia)	2017	an insufficient number of responses (Fraser: "Any jurisdiction with fewer than 5 responses was dropped").	
	CPI Score: between 0 and 100, where 0 is highly corrupt and 100 is very clean Rank: amongst all assessed countries		Score: 47 (global average: 43.07) Rank: 62 out of 180 (For Malaysia)	2017	The CPI shows a low score for Malaysia, reflecting the general situation and the mining sector very well. The governance analysis does not mention cases of corruption but reveals allegations against the responsible AELB of non-transparency regarding the issuing of an operating license for the Kuantan refinery.	++
Conclusion	• Overall, the selected set of indicators reflects the situation for Malaysia well with the exception of the WGI indices Government Effectiveness and Rule of Law. In these categories the country receives average scores with a tendency to strong which does not seem to represent the specific situation at the processing plant in Kuantan. However, it cannot be assessed within the scope of this study whether the situation at Kuantan is an isolated case. • The Fraser PPI did not provide any data for Malaysia given that there were not sufficient responses to the survey. This shows the shortages of this index as a reliable indicator for broader cross-country studies. • The WGI indices Voice and Accountability and Political Stability and Absence of Violence, as well as the CPI (which shows a lower score compared to WGI Control of Corruption) reflect the overall governance situation and the mining sector governance very well.					

Table 30: Main Findings Peru (Gold)

	Peru (Gold)					
Main findings of the qualitative governance and conflict analysis	Overall governance performance: medium • The governance analysis for Peru has shown that Peru offers a well-structured and strong institutional framework for mining. At the same time, the mining sector in Peru is facing corruption and a lack of rule of law, leading to conflicts between small-scale miners and state institutions. • With the expansion of the mining sector, the socio-ecological conflicts in the region have increased exponentially in recent years. For example, mining activities are increasingly in conflict with the interests of the indigenous population, farmers, tourism companies and state authorities. • In the case of Madre de Dios (MDD), responsibilities for the governance of mining activities lie not at the state but the provincial level. This is based on the legal foundation (based on the Small Mining Act of 2002 (Ley 27651), as well as a political effort of the central government to get rid of "the Madre de Dios problem". • Mining penetrates the buffer zones of national parks and their core zones and poses a serious threat to the environment in protected rainforest areas. The indigenous population, which has special rights in the buffer zones, on the one hand benefits in part from mining but, on the other hand, is partly deprived of its livelihood. • As mining is by far the most important economic activity in the region, the willingness of the regional government to massively restrict it is very low. Only the bombing and destruction of dredges in the rivers by the Peruvian military has had local and temporary effects. In Madre dos Dios, serious environmental problems as well as social issues such as forced labour and child labour in particular exist.					
Do existing governance indicators reflect governance gaps and challenges?	Indicator	Sub-Indicator	Values	Year	Applicability	Benchmark
	WGI Estimate: between -2.5 and 2.5 Percentile rank: between 0 and 100, with higher values corresponding to better outcomes	Voice and Accountability	Estimate: 0.3 Rank: 55.67	2016	This average result reflects well the overall medium governance performance. However, it does not fully reflect the current governance practice at MDD. The regional governance seems to neither have the means nor the political will to implement the existing mining legal framework and formalise informal or penalise illegal mining activities.	+
		Political Stability and Absence of Violence	Estimate: -0.2 Rank: 40.95	2016	The indicator only reflects the general governance performance well, but does not reflect the capability to manage the mining sector. In the past, there has been frequent repression and violence between the state and illegal miners or indigenous people.	-

		Government Effectiveness	Estimate: 0.2 Rank: 48.56	2016	Reflects well the overall medium governance performance. The indicator ranges around the 50th percentile, making it an average result. Limited presence of national or regional authorities in the mining areas of MDD in combination with contradicting interests between economic development and environmental concerns have led to a situation where the region has developed into a quasi-lawless area.	+
		Regulatory Quality	Estimate: 0.5 Rank: 69.7	2016	Peru's best WGI result reflects well the overall medium to strong governance performance in this area. With respect to MDD, this indicator seems to be slightly misleading. The mining was the target of at least 7 national small-scale mining formalization campaigns, which have not shown any positive effect on the MDD operations.	+
		Rule of Law	Estimate: -0.5 Rank: 33.65	2016	Peru's lowest WGI value reflects well the overall weak to medium governance performance and in the mining sector.. This well reflects the repression against illegal miners and minorities and illegal use of mining taxes. As already explained above, there is helplessness and a political deadlock between the national mining administration and the regional government mandated with the administration, which the miners have taken advantage of. In this respect the reality in MDD is even worse than the indicator might suggest.	+
		Control of Corruption	Estimate: -0.4 Rank: 43.27	2016	Peru's second lowest WGI value reflects well the overall medium to weak governance in this area. The extraordinary economic importance of mining, combined with the low budgets of the provincial government, has led to asymmetric power relations	+

					between miners and state authorities and a level of corruption that is unprecedented even in Peru.	
	EPI Score: between 0 and 100, with higher values corresponding to better outcomes Rank: amongst all assessed countries		Score: 61.92 Rank: 64 out of 178,	2018	This index reflects Peru's overall medium governance performance well. In MDD there is a lack of information on the government's response to serious environmental damage in mining, especially in the buffer and core zones of the National Parks (i.e. P.N. Tambopata) However, the indicator suggests a better governance quality than that actually applied in MDD.	-
	Fraser Policy Perception Index (PPI) Score: between 0 and 100, with higher values corresponding to better outcomes Rank: amongst all assessed countries		Score: 68.99 Rank: 19 out of 91	2017	The rather high value for the PPI reflects very well the strong governance in the mining sector. As mentioned in the case study, investment in the mining sector in Peru increased 28-fold between 2003 and 2012, underlining the importance of mining. However, the indicator does not reflect the critical situation in MDD which developed over at least 30 years and made (economic and social) structures permanent as well as related problems which seem almost unresolvable.	+
	CPI Score: between 0 and 100, where 0 is highly corrupt and 100 is very clean Rank: amongst all assessed countries		Score: 37 (global average: 43.07) Rank: 96 out of 180	2017	Reflects well the overall medium to weak governance in this area. The extraordinary economic importance of mining, combined with the low budgets of the provincial government, has led to asymmetric power relations between miners and state authorities and a level of corruption that is unprecedented even in Peru.	+
Conclusion	• Peru's overall medium sector governance is well reflected in key governance indices of the WGI. • However, the existing indices and indicators show only in some cases a good ability to also reflect the specific and nuanced governance challenges in the mining sector of Peru. With regard to Madre dos Dios, the "Political Stability and Violence" index in particular cannot take into account specific local circumstances. The fact that the mandate for the Governance of MDD does not lie at the national, but the regional level, leads to a governance situation that is very particular. • Furthermore, the EPI also does not reflect the situation at MDD as it indicates a better governance performance than can be found in MDD.					

	• The government will need to improve and develop the implementation of the legal framework, especially related to environmental issues and the protection of national parks, the treatment of minorities and their land rights as well as the formalisation of the small mining sector. • Overall, the example demonstrates the difficulties of adequately mapping the environmental and social risks of small-scale mining using national governance indicators. It underlines the need and justification to regard small-scale mining as a special challenge to governance and, within the framework of the evaluation system, to adjust the results for governance quality stemming from these national indicators by expanding it.

Table 31: Main Findings South Africa (Gold)

	South Africa (Gold)					
Main findings of the qualitative governance and conflict analysis	Overall governance performance: medium (to weak) • Despite a comprehensive legal framework in the mining industry including environmentally relevant regulations, implementation remains poor. • Corruption is high and public authorities rarely sanction mining companies for environmental violations which is primarily due to close links between the government and mining companies. Another obstacle is lacking cooperation between the responsible authorities charged with the monitoring and regulation of mining activities. • As a result of weak environmental laws from the past, abandoned and contaminated sites from the past have caused serious environmental damages. • There are numerous, partly violent conflicts between miners, trade unions and mining companies regarding gold mining. • Conflicts between workers and unions on the one side and the mining companies on the other side are mostly focussed on working conditions and remuneration and must be considered in the context of a long history of colonisation and conflicts about racism. • Furthermore, (forced) resettlements and loss of farmland have caused conflict and, on some occasions, violence.					
Do existing governance indicators reflect governance gaps and challenges?	Indicator	Sub-Indicator	Values	Year	Applicability	Benchmark
	WGI Estimate: between -2.5 and 2.5 Percentile rank: between 0 and 100, with higher values corresponding to better outcomes	Voice and Accountability	Estimate: 0.64 Rank: 67.98	2016	The best WGI reflects well the overall governance but is considered to be too high. Numerous demonstrations show the possibility of the miners to express their freedom of expression. At least in one case strikes resulted in a considerable increase in wages for the miners.. However, demonstrations and strikes are mostly illegal and have been stopped by violent means (including injuries and fatalities).	-

		Political Stability and Absence of Violence	Estimate: -0.13 Rank: 42.38	2016	The lowest WGI result reflects well the overall governance and the mining sector. Violence has been used during strikes as well as in the relocation of the population. Many people have been injured and died. Police also made threats and used rubber bullets. Considering the fatalities mentioned in the analysis, one could even expect a slightly lower value.	+
		Government Effectiveness	Estimate: 0.27 Rank: 64.90	2016	This WGI result which is slightly above the average seems to too high. The governance analysis shows that control of mining activities is weak and no sanctions are imposed in case of violations.	-
		Regulatory Quality	Estimate: 0.21 Rank: 62.02	2016	This WGI value which is slightly above the average seems to reflect well the governance situation. The Mining Policy for South Africa and the Mineral and Petroleum Resources Development Act seem to cover the most essential aspects,. However, they are poorly implemented.	+
		Rule of Law	Estimate: 0.07 Rank: 58.17	2016	This average WGI value seems to well reflect the overall governance in this particular field. However, considering the many cases of violence during demonstrations and the force used by the police, the value could be expected to be lower.	+
		Control of Corruption	Estimate: 0.05 Rank: 60.10	2016	This WGI value which is slightly above average somewhat reflects the overall governance situation and the mining sector. However, several cases of strong corruption with significant effects and the non-fulfilment of EITI standards would indicate an even lower value.	-
	EPI Score: between 0 and 100, with higher values corresponding to better outcomes		Score: 44.73 Rank: 142 out of 178,	2018	The EPI value is below the average and seems to correspond to the overall governance and in particular the situation in the mining sector. Despite laws in place, environmental protection is low and	++

	Rank: amongst all assessed countries				contaminated mines from the past cause significant environmental damages.	
	Fraser Policy Perception Index Score: between 0 and 100, with higher values corresponding to better outcomes Rank: amongst all assessed countries		Score: 42,66 Rank: 81 out of 91	2017	The PPI reflects the low to medium governance situation and the mining sector very well. Despite holding significant global gold reserves, the numerous conflicts and strikes by miners, political instability and persisting corruption in South Africa are risks for investment and indicate rather low governance..	++
	CPI Score: between 0 and 100, where 0 is highly corrupt and 100 is very clean Rank: amongst all assessed countries		Score: 43 (global average: 43.07) Rank: 71 out of 180	2017	The CPI value reflects the overall governance and the situation in mining sector well with strong corruption and a lack of transparency	+
Conclusion	• The majority of governance indicators reflect the findings from the governance analysis. Nevertheless, there are inconsistencies in WGI Voice and Accountability, Government Effectiveness and Control of Corruption. The CPI reflects well the results. • The Fraser Index and the EPI seem to reflect the overall governance and in the mining sector very well, too. • Overall, the analysis has shown clear governance weaknesses and a need for action in combating corruption, controlling environmental impacts and improving working conditions.					

Table 32: Main Findings USA, Butte (Copper)

	USA, Butte (Copper)[25]					
Main findings of the qualitative governance and conflict analysis	Overall governance performance: strong • The overall governance in the USA in general and in the mining sector in particular is strong. • Conflicts in the mining sector in the past were caused by resettlements and heavy air pollution from the smelting industry and the management of contaminated sites. Even after the closure, there were lawsuits for environmental damage against the former operator, Atlantic Richfield Company. As a response, the Natural Resource Damage Program (NRDP) was set up with the objective to accurately assess the costs of damage. • Background: The region around the city of Butte in the USA state of Montana is one of the largest mining areas worldwide and today a well-known example for contamination from mining. The nowadays flooded opencast Berkeley Pit (operated from 1955 until 1983) is one of the widest areas contaminated with acid mine water, which precludes the survival of animals in the area. It was closed due to economic reasons. The nearby Continental Pit was reopened. The owner Montana Resources extracts copper out of the acid water of the Berkeley Pit. • The Berkley Pit was classified as a superfund site (meaning a site where hazardous waste has been detected). The classification as a superfund site was accompanied by several measures, e.g. the creation of a compensation fund (superfund) for environmental damages as well as a monitoring organisation (PitWatch). Costs for sanitation measures (e.g. removal of contaminated sediments, sample taking and monitoring of heavy metal concentration in soil and water, a waste water treatment plant) as well as compensations are covered by the former mining operator Atlantic Richfield Company.					
Do existing governance indicators reflect governance gaps and challenges?	Indicator	Sub-Indicator	Values	Year	Applicability	Benchmark
	WGI Estimate: between -2.5 and 2.5 Percentile rank: between 0 and 100, with higher values corresponding to better outcomes	Voice and Accountability	Estimate: 1.1 Rank: 84.24	2016	On a global level, the USA is not in the top rank. It is placed behind countries like Canada, Australia, Scandinavia and Germany. This seems to well reflect the overall governance and that of the mining sector. The analysis mentions assemblies and protests from the past, yet no recent examples.	+
		Political Stability and Absence of Violence	Estimate: 0.35 Rank: 58.57	2016	Both on a global level as well as compared to the other WGI results for the USA, this is a rather poor result which may be based on gunfights, ethnic riots or terrorism. However, it does not reflect the current	-

[25] The focus of the case study is on a long abandoned mining area (USA, Butte). The examples for conflict cited in this case study are mostly from the past. Based on these examples, an assessment of the most recent values of the governance indicators is not possible. Therefore, this case study was excluded from the comparative analysis.

					situation in the mining sector and in Butte, where no recent protests or conflicts are reported.	
		Government Effectiveness	Estimate: 1.48 Rank: 91.35	2016	The USA is in the top rank for this WGI with even a slight increase in the last 10 years. This only partially reflects the mining sector governance performance at the national level. The mining law dates back to 1872 and has been under discussion ever since. However, the responsibility of mining companies can be identified retroactively through the "Comprehensive Environmental Response, Compensation and Liability Act" of 1980, which helps to identify companies and to hold them accountable for caused environmental damages.	+
		Regulatory Quality	Estimate: 1.5 Rank: 91.83	2016	Here again the USA is in the top rank. This seems to adequately reflect the overall governance and the mining sector governance. No discriminatory taxes or obstacles for mining companies are reported. Although the mining companies have to pay for the costs for the grave environmental damages, currently copper extraction is still taking place.	++
		Rule of Law	Estimate: 1.67 Rank: 92.31	2016	This is the highest WGI score and rank for the USA Since the USA has a strong and independent judiciary, the indicator reflects very well the overall governance performance. This seems to be equally true for the mining sector and Butte, where negotiations led to reliable agreements between the parties.	++
		Control of Corruption	Estimate: 1.33 Rank: 89.90	2016	On a global level, the USA is not in the top rank. It is placed behind countries like Canada, Australia, Germany, and France. For Butte, no information is given on corruption. In the absence of other information it is assumed that the indicator is adequately reflecting the mining sector in Montana.	+
	EPI		Score: 71.19 Rank: 27 out of 180	2018	The EPI yields a good result, which consists of high scores for e.g. the sub-categories health, air quality	+

	Score: between 0 and 100, with higher values corresponding to better outcomes Rank: amongst all assessed countries				and water resources, moderate scores for e.g. air pollution, climate, ecosystems vitality and a poor score (8.84%) for forests (measured by tree cover loss). Forests are not mentioned in the Butte report. In general, the EPI seems to reflect the situation in the mining sector and in Montana well because, although the Berkeley Pit area is still degraded, first achievements of the sanitation measures can be observed.	
	Fraser Policy Perception Index Score: between 0 and 100, with higher values corresponding to better outcomes Rank: amongst all assessed countries		Results for USA (median based on state-level): Score: 82.61 Rank: 23 out of 91 *Montana:* *Score: 66.06* *Rank: 47 out of 91*	2017	The Fraser PPI shows a good score for the USA, which corresponds very well with most findings for the WGI. The PPI score for Montana is on the lower end of the states analysed for the USA, and Montana shows the second worst rank. This seems to reflect the situation in Butte only in part. Uncertainties for investors in Butte (about enforcement of existing regulations, stability of environmental regulations, transparent fair legal processes, etc.) seem to be resolved nowadays. However, the investment attractiveness may be low because interviewed entrepreneurs may fear uncertainties concerning the acquisition of possibly contaminated sites. On the other hand the portfolio of the mining sector is still remarkable in the area with active mining companies ranging from small to larger entities.	++ (for USA) + (for Montana)
	CPI Score: between 0 and 100, where 0 is highly corrupt and 100 is very clean Rank: amongst all assessed countries		Score: 75 (global average: 43.07) Rank: 16/180	2017	On a global level, the USA is not in the top rank. It is placed behind countries like Canada, Scandinavia, Germany. The rank corresponds to the rank for the WGI "Control of Corruption". For Butte, no information is given on corruption. In the absence of other information it is assumed that the indicator is adequately reflecting the mining sector in Montana.	+

Conclusion	• The selected set of indicators reflects the situation for Butte in the USA quite well. • The WGI "Political Stability and Absence of Violence" is the only indicator which reflects the general governance performance well, but not the mining sector in Butte, Montana. • The Fraser PPI reflects the national level very well. However, looking at the score at the regional level, the situation in Montana seems to be underrated. The situation nowadays seems to be transparent and clear with few uncertainties left. However, questioned entrepreneurs may react to the fact that today the mining region in Butte is the largest sanitation mining area in the USA • The CPI for the USA corresponds to the WGI "Control of Corruption". Thus for the USA the CPI does not contribute any additional benefit for the evaluation. However, this may be different for other countries. • Another important aspect is the fact that the UmSoRess case study on Butte focuses on a closed mining site (Berkeley Pit). Many of the examples cited in the governance and conflict analysis (e.g. resettlements and protests) lie in some cases far in the past. On the basis of these examples, an evaluation of the most recent values of the governance indicators may lead to distortions. A possible alternative would be to compare the values for the indicators from the respective years, e.g. the time of a mine closure.

Table 33: Main Findings USA, Mountain Pass (REE – Rare Earth Element)

	USA, Mountain Pass (REE – Rare Earth Element)					
Main findings of the qualitative governance and conflict analysis	Overall governance performance: strong • Overall strong sector governance which is reflected amongst others by strict regulations on radioactive materials. • The approval procedure of the Mountain Pass mine was complex and involved 18 different public authorities. It took several years because of environmental requirements and local protest. • In 1998, the mine operator was forced to halt production due to several lawsuits. • The mine was closed in 2002 due to price erosion and environmental problems but re-opened because of the national importance of RE metals.					
Do existing governance indicators reflect governance gaps and challenges?	Indicator	Sub-Indicator	Values	Year	Applicability	Benchmark
	WGI Estimate: between -2.5 and 2.5 Percentile rank: between 0 and 100, with higher values corresponding to better outcomes	Voice and Accountability	Estimate: 1.1 Rank: 84.24	2016	The USA receives a good result for WGI Voice and Accountability. This reflects well the overall governance in the country and in the mining sector. Amongst others due to public and legal pressure, the mine lost its licence in 1998 which reflects strong governance in this case.	+
		Political Stability and	Estimate: 0.35 Rank: 58.57	2016	Compared to the other WGI indicators, this is a poor result. It does not reflect the political stability and violence in the case of Mountain Pass. People were	-

		Absence of Violence			affected by resettlements but the case study does not mention violent encounters. Therefore, the score for the indicator seems too low.	
		Government Effectiveness	Estimate: 1.48 Rank: 91.35	2016	The USA has a top score for WGI Government Effectiveness. The value of the index reflects a higher than average quality of public services and a high independency of civil services from political pressure. It reflects well the overall strong governance and in part the mining sector governance.	+
		Regulatory Quality	Estimate: 1.5 Rank: 91.83	2016	The USA has a top-score for this index. This seems to adequately reflect the overall governance and the mining sector governance. No discriminatory taxes or obstacles for mining companies are reported. However, taking into account the difficult and long approval procedure in which 18 agencies were involved, the index score seems too positive. The situation in Mountain Pass is captured well but not fully.	+
		Rule of Law	Estimate: 1.67 Rank: 92.31	2016	This is the highest score among the WGI indicators. Since the USA has a strong and independent judiciary the indicator reflects very well the overall governance performance. In the case of Mountain Pass, a lot of lawsuits were filed which eventually led to the loss of the mining licence in 1998. However, these examples happened in the past and no current examples are mentioned.	++
		Control of Corruption	Estimate: 1.33 Rank: 89.90	2016	The USA receives a good score for WGI Control and Corruption. However, this is its second weakest result after Political Stability and Absence of Violence. This reflects the overall situation in the country very well. Today, corruption does not seem to be a critical issue. But during the first operation of the mine, a lot of irregularities had been reported which could be	+

					related to corruption. Since the mine was closed, corruption cannot be excluded categorically.	
	EPI Score: between 0 and 100, with higher values corresponding to better outcomes Rank: amongst all assessed countries		Score: 71.19 Rank: 27 out of 180	2018	The EPI yields a good score but not a top score. This reflects well the situation in Mountain Pass: It has environmental issues but high environmental requirements force mine operators to take action.	++
	Fraser Policy Perception Index Score: between 0 and 100, with higher values corresponding to better outcomes Rank: amongst all assessed countries		Results for USA (median based on state-level): Score: 82.61 Rank: 23 out of 91 *California:* *Score: 59.61* *Rank: 61 out of 91*	2017	The Fraser PPI .yields a good yet not a top score. Since the approval procedure is complex and long, the aggregated index only partly represents the situation for Mountain Pass. The result for California is located in the midfield and better reflects the situation in Mountain Pass. Regulations in California are comparatively strict, which affect the attractiveness for investors. It seems that mining policy and legal procedures are quite different at the state-level. This is also reflected by the range of rankings which covers ranks between 5 and 61.	+ (for USA) ++ (for California)
	CPI Score: between 0 and 100, where 0 is highly corrupt and 100 is very clean Rank: amongst all assessed countries		Score: 75 (global average: 43.07) Rank: 16/180	2017	The CPI yields a good score but not a top score. During its first operation, several environmental accidents occurred. Especially in the first period those accidents did not have legal consequences. However, in the recent past fees were introduced and several lawsuits were filed which was one reason for the closure of the mine in 2002. After re-opening, corruption did not appear to be a crucial issue.	+
Conclusion	• The selected set of WGI indicators reflects the situation for Mountain Pass in the USA well with the exception of Political Stability and Absence of Violence. The score seems too low considering that the analysis does not mention cases of violence. The WGI has the advantage of having sub-indicators for different categories.					

	• The Fraser PPI for the USA reflects the overall situation well. However, the situation in Mountain Pass is not fully reflected and the score seems too high. The Fraser PPI also provides individual scores at the state-level. The average score for California represents the governance situation in California/Mountain Pass much better, but not the overall USA governance. • Since the Fraser PPI reflects the perspective of exploration managers, the interpretation is not straight forward. A poor value can reflect strict and effective environmental governance. • In the case of the USA, the CPI reflects the situation well. However, most cases of corruption mentioned in the case study analysis lie in the past. • A general aspect one has to consider is the fact that the UmSoRess case study on Mountain Pass focuses in part on the long (conflict) history of the mining operation. The examples given in the governance and conflict analysis (e.g. on law suits and court decision leading to a temporary closure of the mining site) lie in the past. On the basis of these examples, an evaluation of the most updated values for the governance indicators may lead to different results. A possible alternative would be to compare the values for the indicators from the respective years, e.g. the time of a mine closure.

Table 34: Main Findings Zambia (Copper)

	Zambia (Copper)					
Main findings of the qualitative governance and conflict analysis	Overall governance performance: weak (to medium) • The governance analysis of the Zambia case study (Mopani Copper Mines) shows that the country has a weak to medium governance particularly as regards the implementation of existing regulations. This is reflected in the conditions at the Mopani Copper Mines. The Mines were rated one of the worst mining companies in Zambia in implementing safety regulations and in causing significant environmental impacts. • Due to inadequate financial and human resources, the responsible Zambian Environmental Management Agency (ZEMA) has only limited capacities to properly implement the existing legislation. The case study analysis indicates some governance improvements in recent years such as an increased intervention of the ZEMA in cases of environmental and health violations. These changes pressure mining companies to be more transparent and to ensure fair working conditions. • However, Zambia is still struggling with the changes it had to introduce during its market liberalisation and the privatisation of the mining sector in the 80s and 90s (as part of IMF and World Bank structural adjustment programmes) and the consequences of years of tolerated corruption. The privatisation had negative effects on the quality of public services, infrastructure, and the health system as well as on working conditions (low salaries, fixed-term contracts and poor safety conditions) and pensions of miners. Additional problems at the Mopani Copper Mines are negative environmental impacts and resettlement conflicts. These factors generated a significant conflict potential.					
Do existing governance indicators reflect	Indicator	Sub-Indicator	Values	Year	Applicability	Benchmark
	WGI Estimate: between -2.5 and 2.5	Voice and Accountability	Estimate: -0.30 Rank: 35.47	2016	Zambia has a low score (yet the second highest of its WGI values) for Voice and Accountability. This seems to reflect well the overall situation in the country.	+

governance gaps and challenges?	Percentile rank: between 0 and 100, with higher values corresponding to better outcomes				However, the analysis only briefly mentions strikes (for higher wages). More information would be necessary in order to assess whether the index reflects the situation very well.	
		Political Stability and Absence of Violence	Estimate: 0.18 Rank: 52.86	2016	In comparison to the other WGI indicators, this one shows Zambia's strongest result with an average score. It reflects the situation very well. The case study reveals forced settlements, evictions at the Mopani Mines as well as general strikes related to demands for higher wages. Violence is not explicitly mentioned.	++
		Government Effectiveness	Estimate: -0.66 Rank: 27.40	2016	Zambia has its lowest WGI score in Government Effectiveness. The result matches very well the low perceptions of the quality of public services, the quality of the civil service and the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies.	++
		Regulatory Quality	Estimate: -0.48 Rank: 32.69	2016	Zambia has its second lowest WGI score in this index which reflects the situation in the country and the mining sector very well.	++
		Rule of Law	Estimate: -0.30 Rank: 43.27	2016	Zambia has a low score (yet the second highest of its WGI values) for Rule of Law which represents very well the governance situation e.g. as regards property rights. At the Mopani Copper Mines, the local population experienced forced resettlement.	++
		Control of Corruption	Estimate: -0.40 Rank: 42.31	2016	The Control of Corruption index belongs to Zambia's weakest WGIs. This reflects very well the governance situation. Despite improvements, the country still suffers from years of widely tolerated corruption which is also evident in the case of Glencore, the Swiss operator of the Mopani Copper Mines.	++
	EPI Score: between 0 and 100, with higher values		Score: 50.97 Rank: 117 out of 178,	2018	The EPI indicates a medium score. This reflects well the situation in Zambia where the implementation of environmental legislation still shows weaknesses. The	+

	corresponding to better outcomes Rank: amongst all assessed countries				environmental impacts at the Mopani Copper Mines are severe. At the same time, a complaint by the local population was successful and led to environmental improvements. In addition, the ZEMA closed one of Mopani's processing plants due to its excessive pollution level.	
	Fraser Policy Perception Index Score: between 0 and 100, with higher values corresponding to better outcomes Rank: amongst all assessed countries		Score: 53.34 Rank: 71 out of 91	2017	The Fraser PPI for Zambia shows a medium score. Zambia experienced a decline in its PPI ranking down to rank 71 (of 91) in 2017 while it held rank 43 (of 104) in 2016. Reasons for the decline are concerns regarding taxation, geological database, and political instability. Overall, the PPI reflects very well the situation in Zambia's mining sector in which the implementation of existing policies is still inadequate while mining policies are investor friendly.	+
	CPI Score: between 0 and 100, where 0 is highly corrupt and 100 is very clean Rank: amongst all assessed countries		Score: 37 (global average: 43.07) Rank: 96 out of 180	2017	The CPI shows a low score for Zambia, reflecting the situation very well. Corruption was long tolerated and has only improved in recent years.	++
Conclusion	• The selected set of indicators reflects the situation for Zambia very well, particularly the WGI indices and the CPI. • The Fraser PPI also reflects the situation for Zambia well. • Zambia's weak to medium governance performance is shown in the case study as well as reflected in the chosen indices.					