MICA
Minerals Intelligence Capacity Analysis

DOCSHEET

Supply risk, an overview

Supply risk defines the potential of an interruption in the availability of a particular mineral or material at a particular point in time or over a period of time. The risk can have both a material and a monetary dimension, e.g. no physical availability and/ or availability at unanticipated high prices.

Scope

Importantly, the definition of risk depends on the respective positioning of a person, and thus, the person's perception of risk from this particular positioning (Zsidisin, 2003). Therefore, risk has no single definition. A risk might not be perceived by one person, i.e. the consumer of an end-product, while it might likely be perceived by i.e. another person that is in charge of the material supply in a business manufacturing this end-product. In principle, mineral and material supply risk may be perceived by the global community, national governments and businesses.

Supply risk linkage with mineral criticality and the assessments
Supply risk and economic importance are the two major criteria upon which mineral criticality is assessed by experts, such as in the US DoE (2011) Critical Materials Strategy and the EC-JRC (2011) Critical Metals in Strategic Energy Technologies reports. Supply risk is further described by attributes or criteria (and weighed in the case of the US DoE) in these reports, see Figure 1 below.

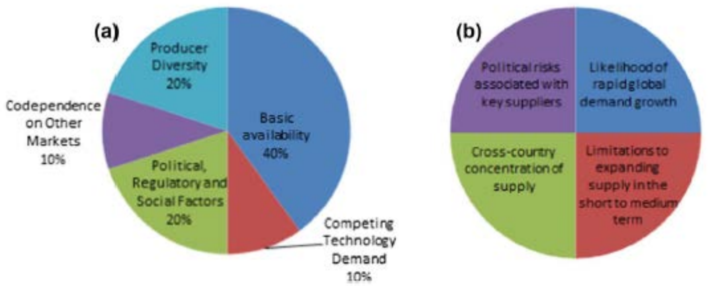

Figure 1. a (left) US DoE (2011, p. 115) Supply risk attributes. b (right) EC-JRC (2011) criteria for assessing supply chain bottlenecks.

Contexts of use, application fields	-> contexts (e.g., environmental, economic, social assessment) -> which types of stakeholder questions are concerned? -> link to published studies that implement the method

Supply risk is broadly used in the socio-economic domain.

It might be used for **policy decision-making**: The US DoE (2011) Critical Materials Strategy and the EC-JRC (2011) Critical Metals in Strategic Energy Technologies reports provide case examples of where supply risk is used as a criterion to assess mineral criticality.

The US DoE (2011) Critical Materials Strategy implements the supply risk:
https://energy.gov/sites/prod/files/DOE_CMS2011_FINAL_Full.pdf

The EC-JRC (2011) Critical Metals in Strategic Energy Technologies also implements the supply risk:
https://publications.europa.eu/en/publication-detail/-/publication/2239d6b7-cda8-4570-a9f0-13ad60ce3f11/language-en

Supply risk might also find application in **assessing industry and business vulnerability**. Often businesses draw on a risk management plan which differentiates between internal and external risks whereby the former is within business control while the latter is not. Supply risk would range among the external risks and could be resulting from events up- or downstream in the supply chain which in essence interrupt the availability of a mineral (raw) material, components or a final product. A business continuity plan is often used to address potential risks and to delineate measures to reduce impact from risk.

See the article on 'Different Types of Risk in Your Supply Chain, and How to Avoid Them: http://www.europeanbusinessreview.com/types-risk-supply-chain-avoid/

For a case study see i.e. Andersson, B.A. 2000. Materials availability for large-scale thin-film photovoltaics. http://onlinelibrary.wiley.com/doi/10.1002/(SICI)1099-159X(200001/02)8:1%3C61::AID-PIP301%3E3.0.CO;2-6/full

Input parameters	-> which parameters are needed to run the method

There is no established consensus on the parameters, however, generally, supply risk assessment for minerals and other materials draws on some or all of these parameters:

- Basic availability
- Likelihood of rapid global demand growth
- Limitations to expanding supply in the short to medium term
- Producer diversity (i.e. Herfindahl-Hirschman Index) / Cross-country concentration of supply
- Political, regulatory and social factors / political risks associated with key suppliers
- Codependence on other markets

Type(s) of related input data or knowledge needed and their possible source(s)	-> which types of data are needed to run the method, from which sources could they come… -> could be qualitative data or quantitative data, and also tacit knowledge, hybrid, etc.

A range of different data is needed to assess supply risk:

- To gain an understanding of the basic availability of a mineral or material, the following data, information and knowledge is needed:
    - Global geological occurrences hosting the mineral
    - Mine operations as and output
    - Potential secondary sources from urban mines
    - Supply chain:
        - Which and how many processing steps (segments) does the mineral pass through to become useable for off-takers?
        - Where are these processing steps located – and what is the quality/price/volume ratio from these processors?
- Likelihood of rapid global demand growth
    - Data for mineral demand foresight methods – *see DocSheet: Foresight; FactSheet: Scenario Development; FactSheet: Trend Extrapolation*
- Limitations to expanding supply in the short to medium term:
    - Knowledge on exploration phases – see also *FactSheet: Exploration Phases*
    - Knowledge on mining investment decisions
- For an understanding of producer diversity (i.e. Herfindahl-Hirschman Index) / cross-country concentration of supply the following data is needed:
    - Market share of each firm (or at least of the firms that would account for a representative sample) in the particular mineral/material market
- Political, regulatory and social factors / political risks associated with key suppliers:
    - Data on mineral policy in a particular country where the mineral is mined
- Codependence on other markets:
    - Data on which countries supply the mineral commodity and share of these countries' suppy to the total supply of the country/countries that is/are subject to the analysis
    - In addition, dependent on the scope of the analysis, such as when the analysis of supply risk is scaled down to a particular industry/market, data is needed to position the industry of one country within a global perspective (i.e. what is the particular industry's share of this country in the global market, thus, how much of the global demand by this industry will be absorbed by the industry in the country examined)

Model used (if any, geological mathematical, heuristic…)	-> e.g., geological model for mapping -> e.g., mathematical model such as mass balancing, matrix inversion, can be stepwise such as agent -based models, dynamic including time or quasidynamic specifying time series… -> can also be a scenario

Scenario analysis

Foresight studies

System and/or parameters considered	-> **the system can be described by its boundaries**. These can refer to a geographic location, like a country, or a city, the time period involved, products, materials, processes etc. involved, like flows and stocks of copper, or the cradle-to-grave chain of a cell phone, or the car fleet, or the construction sector, or the whole economy… -> **parameters** could possibly refer to geographic co-ordinates, scale, commodities considered, genesis of ore deposits and others…

Usually, the boundaries of the system would be defined by the geographic determinants, e.g. where the mining and processing segments of the supply chain are located and for which country/countries the supply risk is assessed, as well as by the extent to which all or some of the processing segments of the supply chains are to be part of the study. The parameter is the mineral commodity assessed for/ under supply risk for a particular country/countries or a particular industry/market.

Time / Space / Resolution /Accuracy / Plausibility…	-> to which spatio-temporal domain it applies, with which resolution and/or accuracy (e.g., near future, EU 28, 1 year, country/regional/local level…) -> for foresight methods can also be plausibility, legitimacy and credibility…

Near future (short- and long-term)

Global level, but dependent on the scope of the supply risk assessment (it could be i.e. assessed for EU-28, but needs to take a global perspective as the mineral might be mined in different places outside the EU and supplied therefrom).

Indicators / Outputs / Units	-> this refers to what the method is actually meant for. Units are an important part but that is most of the time not sufficient to express the meaning. For example, **the indicators used in LCA express the cradle-to-grave environmental impacts of a product or service**. This can be expressed in kg CO_2-equivalent. But also in €. Or in millipoints. Or in m^2year land use. -> for foresight methods the outputs are products or processes

Indicators used for supply risk include:
High-medium-low
Traffic-light colour scheme (red-yellow-green)

Treatment of uncertainty, verification, validation	-> evaluation of the uncertainty related to this method, how it can be calculated/estimated

The uncertainty of the method (both scenario analysis and foresight studies) will be dependent on the quality of the data used and the thorough design of the scenarios or foresight study, among other. Please also consult the *FactSheet: Parameter uncertainty in mineral intelligence analyses.*

Main publications / references	-> e.g. , ILCD handbook on LCA, standards (e.g. , ISO) -> can include reference to websites/pages -> references to be entered with their DOI

Nuss, P., Graedel, T.E., Alonso, E., Carroll, A. 2016. Mapping supply chain risk by network analysis of product platforms. *Sustainable Materials and Technologies*. https://doi.org/10.1016/j.susmat.2016.10.002

Habib, K., Hamelin, L., Wenzel, H. 2016. A dynamic perspective of the geopolitical supply risk of metals. *Journal of Cleaner Production.* https://doi.org/10.1016/j.jclepro.2016.05.118

Nansai, K., Nakajima, K., Suh, S., Kagawa, S., Kondo, Y., Takayanagi, W., Shigetomi, Y. 2016. The role of primary processing in the supply risks of critical metals. *Economic Systems Research.* DOI: 10.1080/09535314.2017.1295923

Bartekova, E. and Kemp, R. 2016. National strategies for securing a stable supply of rare earths in different world regions. *Resources Policy.* https://doi.org/10.1016/j.resourpol.2016.05.003

Mancini, L., Benini, L., Sala, S. 2016. Characterization of raw materials based on supply risk indicators for Europe. *Internal Journal of Life Cycle Assessment.* https://link.springer.com/article/10.1007/s11367-016-1137-2

Machacek, E., Richter, J.L. and Lane, R. 2017. Governance and Risk-Value Constructions in Closing Loops of Rare Earth Elements in Global Value Chains. Resources (6) http://dx.doi.org/10.3390/resources6040059

Related methods	-> List of comparable methods, their particularities… -> link to one or several other existing fact sheet(s)

Links with the following FactSheet/DocSheet:

- DocSheet '**Criticality of raw mineral materials**'
- DocSheet '**Strategic, critical, high-tech, rare, and minor metals**'
- DocSheet '**Substitution: the CRM-InnoNet vision**'

- DocSheet: Foresight
- FactSheet: Scenario Development
- FactSheet: Trend Extrapolation
- FactSheet: Parameter uncertainty in mineral intelligence analyses

Some examples of operational tools (CAUTION, this list is not exhaustive)	-> e.g., software… Only give a listing and a reference (publication, website/page…) -> **should be provided only if ALL main actors are properly cited**

- Not applicable

Key relevant contacts	-> list of relevant **types** of organisations that could provide further expertise and help with the methods described above.

US DoE
EC JRC
Universities with a risk management curriculum (i.e. Cranfield University)

Glossary of acronyms /abbreviations used	-> Definition
US DoE	U.S. Department of Energy
EC JRC	Joint Research Centre of the European Commission