Critical Raw Materials

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Aspects of criticality

**Criticality of supply**
- Central part of all studies and discussions on raw material security.
- Includes aspects like the import dependence of consumer countries, the concentration of production in certain countries or companies, the availability of secondary raw materials and substitutes, price volatility, success of exploration and new projects coming into production.
- Includes (geo)political risks associated to concentrated production in countries of ‘strategic distrust’ (which could be termed “political criticality”) or in unstable countries.

**Environmental/social criticality**
- Social and environmental risks associated with raw material production.
- Includes the conflict related mineral production.

**Physical criticality**
- Dealing with the question whether the earth can provide the resources for the global future demand.
Supply risk indicators

**Geostrategic risks:**
- Country risks
- Concentration trends
- Env./social aspects

**Geological availability:**
- Lifetime of deposits
- Exploration

**Market power:**
- Country concentration
- Company concentration

**Technical availability:**
- Supply/demand capacity, stocks
- Transport
- Production costs, technologies

**Demand changes/adaption:**
- Recycling, substitution
- Material efficiency
- Domestic raw material production
- Stock piling

**Import dependence:**
- Degree of dependence
- Importance of raw materials in the supply chain
Global raw material consumption
Share of the five major consumers of the global demand 2005

Consumption [%]
Global raw material consumption
Share of the five major consumers of the global demand 2010

<table>
<thead>
<tr>
<th>Material</th>
<th>Consumption [%]</th>
</tr>
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<tbody>
<tr>
<td>Al</td>
<td>39,8</td>
</tr>
<tr>
<td>Pb</td>
<td>45,6</td>
</tr>
<tr>
<td>Cu</td>
<td>38,0</td>
</tr>
<tr>
<td>Ni</td>
<td>39,3</td>
</tr>
<tr>
<td>Zn</td>
<td>42,5</td>
</tr>
<tr>
<td>Sn</td>
<td>41,0</td>
</tr>
<tr>
<td>Steel</td>
<td>50,5</td>
</tr>
<tr>
<td>Oil</td>
<td>51,4</td>
</tr>
<tr>
<td>Coal</td>
<td></td>
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</tbody>
</table>

Consumers:
- USA
- CN
- JP
- KOR
- IND
- ESP

<table>
<thead>
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<td>10,7</td>
<td>51,4</td>
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EU Import Dependence

(Quelle: BGR, Fraunhofer ISI)
Country concentration of the global gold and tungsten production

Weighted country risk:

\[ L_r = \sum_{i=1}^{x} P_{Länder} \times G_{WB} \]

Sum of country values (% of global production) of raw material production (P) weighted with the Governance-Index (WGI) of the world bank (WB)

Source: Raw Materials Group, 2009
Global cobalt production 2007

Data source: Worldbank, 2008; BGR database
THE RAW MATERIALS INITIATIVE — MEETING OUR CRITICAL NEEDS FOR GROWTH AND JOBS IN EUROPE
{COM(2008) 699}

Source: „Critical raw materials for the EU“, European Commission 2010
Geological availability
Ore Deposits are unevenly distributed

Global location of porphyry copper deposits

Exploration and mining projects of copper 2011
Ore grades depend on type of deposit

Porphyry copper deposits

Sediment hosted copper deposits

Fig. 2. Regional weighted average copper head grades 1987 onwards.

(Source: P. Crowson, Resources Policy, 2012)
By-products

Das Metallrad nach Reuter et al. und Verhoef et al.

- Hauptmetall
- Nebenprodukte
- von der EU als kritisch bewertet
- von der EU als potentiell kritisch bewertet

Sulfidische + oxidische Erze

By-products
By-products

(Source: European Copper Institute, 2006)
Critical raw materials – not a new topic

- Paley Commission, 1952: US President's Materials Policy Commission
- European Community 1975: The supply of the Community
- Resource Efficiency KTN, 2008: Material Security - Ensuring resource availability for the UK economy
- European Commission, 2010: Critical raw materials for the EU
1945-1980s:
State involvement in resource sector
Strategic interest, security concerns
Thinking in blocks

1980s/90s:
End of cold war increases interregional trade flows and globalization of supply
Less state engagement
Privatisation
China as producer

2000s:
China biggest raw material consumer
Protectionist measures and securing the access to resources in foreign countries
Concerns over the security of supply in EU and other industrialized countries

But the framework is changing
Criticality of materials in the long term

Long-term criticality

Herfindahl–Hirschmann–Index (Producing countries)
Criticality of materials in the long term: tantalum as example
Existing models on criticality:

- assessment of potential short term supply shortages
- do not serve as predictive model or scenarios
- models are only a snapshot in a dynamic system
- studies from 70s and 80s followed similar approach, with defining other minerals as critical
- in the 70s and 80s chromium, aluminum etc were defined as critical, today it is RE, PGM, Ge, Ga – what will be critical in 2040?

- Concern of western industrialized countries is that the raw material supply is disrupted, because a functioning supply chain is the base of their economy.
- Fear that raw materials could be used as a political instrument by countries to gain political or economic power.
- Concern that markets conditions are different for the participating stakeholders. This would not lead to supply shortages but unequal opportunities for countries.
- A further concern: extraction and production activities could be responsible for regional environmental and social problems and contribute to conflicts.
Long-term criticality

(1) Accidental supply disruptions or price hikes

supply disruption (and ensuing price hike) might be the result of, a natural disaster or political instability in a major producing country

(2) Intentional supply disruptions by the use of exports or pricing as a political instrument

concern is that raw materials could be used as a political instrument by some actors. Those in control of production or exports could use raw materials to gain political or economic power e.g. by issuing embargoes, restricting exports or price gouging. In such cases an artificial supply crisis (real or feared) could put political pressure on other countries and bring disadvantages for the industries of countries depending on raw materials imports.

potential problems: embargoes, cartels, greater processing in exporting countries (i.e. shift in the value chain), supply disruptions from events other than embargoes and exorbitant short-term price increases. (The Study on Critical Imported Materials, 1974)
(3) Unequal market conditions causing an uneven economic playing field

Tensions can arise when market conditions are different for the participating stakeholders. This need not lead to supply shortages but could cause unequal opportunities for countries, influencing economic competitiveness. Examples include:

- Different internal/external pricing of resources for different countries
- Unequal access to crisis mechanisms in case of a supply disruption or unequal impact of a price hike (price asymmetries)
- Unequal market access or investment opportunities

(4) Governance issues related to the resource sector

Concern that extraction and production activities could be responsible for regional environmental and social problems and contribute to conflicts.

Examples of measures: Kimberley Process (dealing with so-called ‘blood diamonds’) and the legislation on Conflict Minerals that is part of the Dodd-Frank Act (Section 1502) in the United States (responsibility of companies to ensure their mineral supplies are not related to any conflict zone)
Concluding remarks

- Aspects to be considered:
  - criticality of supply,
  - environmental/social criticality,
  - physical criticality

- Long-term vs short/medium-term criticality

- Views on criticality are changing over time - depending on political situation and technological development

- Important factors:
  - geological conditions (e.g. by-products),
  - emerging technologies,
  - stability of producing countries,
  - changing behaviors of stakeholders (investments, legislation, etc),
  - security of transport,
  - location of refined metal production,
  - ...