Sold Futures? The Global Availability of Metals and Economic Growth at the Peripheries: Distribution and Regulation in a Degrowth Perspective

Andreas Exner\textsuperscript{a}*, Christian Lauk\textsuperscript{b}, Werner Zittel\textsuperscript{c}

\textsuperscript{a} Papiermühlgasse 19/9, 8020 Graz, Austria. E-mail address andreas.exner@aon.at

\textsuperscript{b} Institute of Social Ecology Vienna, Alpen-Adria University (Klagenfurt-Vienna-Graz), Schottenfeldgasse 29, 1070 Vienna, Austria. E-mail address christian.lauk@aau.at

\textsuperscript{c} Ludwig-Bölkow-Systemtechnik GmbH, Daimlerstraße 15, 85521 Ottobrunn, Germany. E-mail address werner.zittel@lbst.de

* Corresponding author

Abstract

In recent years, the strategic role certain metals play is seen as central to the geopolitics promulgated by state agents in the North. While a switch to renewable energy and an increase in energy efficiency might be instrumental to reducing dependence on fossil energy, it increases dependence on metals. This paper starts from an analysis of the likely availability of metals in the near future and then proceeds to investigate political concerns raised by considering the geological fundamentals of social development at the peripheries of the capitalist world-system. The inequality of metal stocks, future metal requirements and the ensuing political challenges are investigated, taking copper as an example. The final section is dedicated to the discussion of regulatory challenges in view of multiple constraints on metal extraction. This section also highlights the preconditions of a socially legitimate transition to a renewable energy system in the coming period of global degrowth.

Keywords: crisis – resources – peak – copper – development

The multiple crises of capitalism, which have only begun to unfold, include energy provision, climate and economic stability, social security and political legitimacy. These crises are interlocked with the use of metal resources in complex ways, in terms of both supply and demand. Accordingly, in recent years, the strategic role certain metals play in the context of high technologies in general, and the energy transition in particular, is seen as central for the international geopolitics promulgated by state agents and state-oriented policy papers in countries such as the members of the European Union, Japan or the USA (EC 2008, METI 2009, DOE 2011, Mildner 2011, Moss et al. 2011). Renewable energy technologies generally have a higher metal intensity than fossil fuel-powered energy systems (Kleijn et al. 2011, UNEP 2013), a fact that the mining industry does not hesitate to highlight (ICMM 2012).

Documents outlining the new geopolitics of the centers of the capitalist world-system quite readily concede that certain metals might be of great importance for development of
peripheral or semi-peripheral countries (EC 2008, DOE 2011). This acknowledges implicitly that trade restrictions reflect the growing concern of poorer producer countries to secure the resource base of development and industrialization. However, at the same time, resource-rich peripheral countries are pressured to open markets for foreign mining operations, in order to secure the metal demand of the central countries. In this vein, the European Commission even intends to bind so-called developmental aid to compliance with EU metal demands (EC 2008).

While international institutions and national authorities of states from the capitalist center are alarmed by possible bottlenecks in supply due to political or economic factors, at the same time, they claim that the geological availability of metals is secure for many decades to come. The critical discourse on metal extraction seldom questions these projections. Under this premise, the range of issues related to mining narrows down to topics well known in the traditional developmental debate, such as international relations of dependency, disarticulated regimes of accumulation, and the destruction of indigenous livelihoods. It is notable that the range has been enriched by recently unfolding debates on new visions for social well-being such as denoted by the term bien vivir (see as an example for this approach: FDCL/RLS 2012).

Rather than take these approaches, this paper takes the geological assessment of the likely availability of metals in the next decades as a starting point, using the example of copper, which plays a crucial role in modern infrastructure. We discuss intricacies related to such an analysis of future availability, concluding with a quantitative assumption on the future availability of copper. We compare this estimate of the future availability of copper with current socioeconomic copper stocks and future copper stocks required, if an economic convergence between current developed and developing regions is envisaged. This rough picture on future availability and requirements of copper stocks is complemented by a discussion of the socio-ecological limits of mining on the one hand and new metal demands on the other, which further put the sustainability of the current trajectory of metal use into question. Finally, we elaborate on regulatory challenges in view of multiple constraints on metal extraction, highlighting the preconditions of a socially legitimate transition to a renewable energy system.

**Geological availability of important metals**

The assessment of the geological availability of metals usually relies on data of reserves and resources, which are compared with yearly production figures. This permits the calculation of reserves-to-production ratios. When the ratios cover at least 30 to 40 years, the geological supply situation is seen as uncritical.

Such a simple way of assessing availability, however, is not suited to give an adequate picture of possible supply crises. First of all, reserve data are only an approximate measure for the volume of ore that can be extracted in the future. Irregular reporting or overly optimistic estimations of reserves, as well as reserve growth due to the transfer of socio-economically non-extractable resources to economically viable reserves, all result in hugely imprecise figures concerning the total amount of reserves available in the future. In addition, the usual data on resources and reserves lump together stocks that are extremely heterogeneous from a physical, technical and economic viewpoint. The usual concept of reserves inadequately describes this variability.
Ultimately, it is the yearly potential extraction rate rather than the amount of total reserves that is the crucial parameter for the question of metal availability. This rate, however, depends on the interplay of economic framework conditions, technologies, and geological restrictions over time. In this respect, an important factor is the quality of reserves, i.e. the concentration of metal in the ore: With decreasing metal concentrations, an increasing amount of ore has to be extracted to produce the same amount of metal. This implies that over time the production of a given amount of metal becomes increasingly material-, energy-, and labor-intensive, although technical progress might (over-) compensate for this effect for some time. The relation between decreasing ore grades and technical progress can be pictured as a race, in which the first factor of decreasing ore grades successively becomes faster until it overtakes the second factor of technical progress, causing overall production rates to decrease. In addition to these techno-economic limitations, it is important not to forget social and environmental limitations such as the emission of CO₂, the production of mining waste and tailings, the use of land and water, and impacts on local living conditions. Although these factors could be seen as “soft limitations”, they can strongly influence availability, i.e. when local struggles hamper the exploitation of minerals.

Peak production can be stretched out to a plateau, assuming sufficient technological progress. Also, the ensuing fall in production is variable to a certain extent. However, the main tendency of declining raw material production cannot be altered significantly in this way, not the least because the decline in production sets in faster, the more the peak is stretched out in time.

Although future extraction rates of a certain metal thus depend on a variety of interdependent factors, historic time series for rates of exploitation in individual countries and mines allow an approximate forecast of future extraction rates, methodologically similar to the better known analysis of peak oil and future oil production (Deffeyes 2002). This analysis is based on the observation that, as in the case of oil, patterns of extraction for metals in a certain country or a certain mine follow a bell-shaped curve. As it can be expected that this basic pattern will not change in the future, we will see the same pattern on a global scale. The maximum of this bell-shaped curve and thus the worldwide peak of metal production can be expected at the point at which about half of the total explorable metal has been recovered, i.e. when new technologies fail to compensate any longer for the decline in ore content and other limiting factors discussed above.

For the case of copper, such a detailed analysis on probable future production rates can be found in Zittel (2012). The analysis is based on a mixture of mine-by-mine production data in leading countries such as Chile, USA and Canada. When these data exhibit production declines faster than reserve data would indicate, the ultimate recovery as derived from a Hubbert analysis is preferred over published resource and reserve data (Deffeyes 2002). For other countries, production profiles compatible with historical production and reserve data are constructed. According to this analysis, about half of all the copper that will ever be produced has already been extracted. The global peak of copper production has to be expected still within this decade, i.e. before 2020.

For individual countries, this analysis shows that in several previously important copper producing countries, among them Canada, the USA, Zambia and the Democratic Republic of Congo (DRC), cumulative production passed much beyond 50% of the reserves and even the
(much larger) reserve basis. This situation is mirrored by the host of lesser copper producers. It is this relation, among other factors, that strongly indicates that in these countries copper production has already passed the peak. Other countries, such as the successor states of the USSR, are probably near the peak, while Chile, Peru, Australia, China, Poland, Indonesia and Mexico will reach the peak probably within one or two decades. However, even in those cases, the quality of the remaining deposits deteriorates progressively.

In the USA, copper production reached its preliminary peak in 1997; it probably will not be surpassed in the future. Copper ore concentrations in the USA have declined since 1998. Labor productivity in copper mining stagnated after 2000 and declined a few years later. Also in Chile, today's largest copper producer, the race between the falling productivity of old mines and the development of new mines has set in, and the ore content of many mines has declined considerably. Increasingly, highly labor-productive open pit mines have to be replaced by mining shafts with much lower labor productivity. Total copper output of Chile has stagnated more or less since 2010 (Zittel 2012).

In the context of the multiple crises of capitalism and the absolute limit of fossil resources (cf. Zittel 2012, Exner 2011), the energy requirement per ton of technically and economically usable metal becomes paramount. Two factors will contribute to an increasing energy intensity of metal production in the future: Firstly, there is a very close relation between the energy demand of mining and the depth of mining shafts (Koppelaar 2011, 2012). Secondly, the energy required per ton of metals disproportionately increases with falling ore concentrations (Hall et al. 1986, Norgate et al. 2007), despite increases in the energy efficiency of the technologies used. In Canada, for instance, the share of energy required by the mining sector rose from 25% in 1990 to 36% in 2008, equaling an increase from 14 to 27 Mtoe, while Canadian metal production decreased during the same period (Zittel 2012). In the face of a near peak of total fossil fuel production (Zittel et al. 2013), this points toward a further obstacle to future metal production in general, and copper production in particular.

A less-detailed analysis by Zittel (2012), based on reserve data by the USGS (USGS 2013) indicates that other metals, i.e. antimony, asbestos, arsenic, gold, mercury and strontium, might even have passed peak production, while cadmium, chromium, copper, lead, nickel, silver, tin and zinc seem to be close to or at their peak, and bismuth, boron, germanium, magnesium, manganese, molybdenum, niobium, tungsten and zirconium might reach peak within the next two decades. Other metals such as bauxite, beryllium, cobalt, gallium, iron, lithium, platinum group metals, rare earth oxides and vanadium might reach peak production later than the next few decades.

It is clear that such an analysis of the future availability of copper is subject to uncertainties. However, the arguments discussed briefly above and detailed more by Zittel (2012) suggest that this forecast should be considered as possible at least, even if only out of precaution. It seems clear that such a future limitation of copper would have grave socio-economic implications. As the main material used for electrical conductors, copper is a vital element for the electrification of society and the growth of communications networks. If peak production of copper will be reached in the coming years, totally new and radical questions arise, relating in particular to issues of economic development and distribution. Along this line, we start with a discussion of the socioeconomic copper stocks required for the future economic catch-up of today’s developing countries and new requirements of copper for the
buildup of a renewable energy system, in comparison to copper stocks that can be produced in the future.

**Unequal stocks of metal resources: the case of copper**

According to the analysis of Zittel (2012), there are globally about 530 million tons (Mt) of copper that still can be economically exploited in the future, while 550 Mt were already extracted between 1930 and 2011. Thus, about half of all the copper that will ever be extracted from the earth is already in use (e.g. in infrastructure) or wasted (e.g. located in dumps and landfills).

What are the socio-economic consequences of such an absolute limit in future copper supplies, in particular with respect to the distribution of copper stocks in use between different world regions? One way to begin to approach this question consists of a simple but effective thought experiment: If sooner or later, all humans have access to roughly the same material possibilities, how much copper is each human individual entitled to, and what would that mean for global copper flows between regions? In contrast to energy, this question does not primarily affect the dimension of throughput, but of per capita societal stocks in use, for instance, of copper wire. It is these stocks – and not yearly production – that determine material wealth.

How did global copper stocks develop in the past and how are they distributed globally? Gordon et al. (2006) analyze the development of copper stocks during the 20th century in the USA. They show that until around 1950, a linear and considerable rise of copper stocks per head can be observed. In a second phase, between about 1950 and the mid-1990s, stocks continue to rise with linear but slower growth, while growth rates increase considerably again after 1995. In 1999, the final year of this study, per capita stocks in the USA were estimated to amount to 238 kg.

Global societal stocks of copper are distributed extremely unequally between regions. If one compares different countries, copper stocks correlate closely with the economic power of a country, measured in terms of GDP, in the same way as other metal stocks, but in contrast to metal throughput (Rauch 2009). For the group of weakly-developed countries, current studies find copper stocks of about 30 to 40 kg per person, while per capita copper stocks in further-developed countries amount to 140 to 300 kg (Gerst and Graedel 2008). The comparatively low level of copper stocks in poor countries still dominates the global picture. Gerst and Graedel (2008) estimate that, globally, the individual amount of copper ranges between 35 to 55 kg on average.

Thus, there is a tight correlation between copper stocks and economic wealth, implying that an economic convergence between countries of disparate wealth requires at the same time a convergence of their metal stocks. But what does this imply, given a strict limit of copper that still can be extracted and thus used to buildup socioeconomic stocks? On the one hand, it might be illustrative to look at the global socioeconomic copper stocks, if one assumes a global convergence to the per capita copper stock of 238 kg/capita in the USA in 1999. Such a scenario would imply strong growth of per capita copper stocks in developing countries, while per capita stocks in wealthy countries would have to remain more or less constant. Taking a future population of 10 billion people as a baseline, such a scenario would require a global socioeconomic copper stock of 2380 Mt. Even (unrealistically) assuming complete
recycling and starting from global copper stocks of 330 Mt in 2000 (Kapur and Graedel 2006), the buildup of such a stock would require about 2000 Mt of additional virgin copper and thus 4 times more than Zittel (2012) suggests can still be extracted globally.

Coming from another angle, we could ask how much copper each individual is entitled to if we assume (a) that each individual has a right to the same amount of copper stocks and (b) that from the year 2000 onwards, the globally producible copper amounts to 664 Mt. Even supposing a complete transfer of producible copper into societal stocks and the complete preservation of the stocks of 330 Mt copper of the year 2000 (Kapur and Graedel 2006) this simple projection results in a global maximum copper stock of approximately 1.000 Mt or 100 kg per person, which is less than half of the copper stock in the rich countries of today's world (see the estimation for the USA of 238 kg per head in 2000, cited above). As some of this copper will be wasted, this number has to be considered as a theoretical upper bound.

Simple projections like these suggest: If we hold on to the goal of an equal distribution of copper stocks on a global level, wealthy countries must refrain from taking further copper in use, even if we assume the extreme and thus unrealistic case of total recycling. An equal distribution implies the transfer of some copper stocks of wealthy countries to poorer countries, to enable them to build up stocks of their own. This is a radical and, for many, unthinkable implication, indeed. However, if future global copper production is limited to the extent suggested by Zittel (2012), this conclusion is unavoidable.

Urban mining, the recovery of metals from wastes and sleeping stocks such as cables no longer in use, is increasingly discussed as an option to mitigate metal scarcities. This potential, however, is limited, and will thus not alter the basic features of global copper distribution, as about 80% of all copper produced until now is still in use, showing a limited theoretical potential to recover copper from wastes or sleeping stocks. In addition to that, there are practical limits relating to the technical and economic feasibility of urban mining. The mining of copper from landfills and sleeping stocks is technically complicated, cost and energy intensive, and in many cases economically or technically not feasible at all. A review of studies on landfill mining by Krook et al. (2012) for instance shows that currently, nearly no study could demonstrate a technical and economically viable method of retrieving metals from waste (landfill mining).

Thus, the question remains to which degree copper could be substituted by other, more abundant materials with similar features. Depending on its application, potential substitutes of copper are aluminum, titanium, steel, fiberglass, and plastics (IW Consult 2011). However, even where substitutes exist in principal, copper displays a couple of features that make it the most attractive raw material in many applications (Frondel et al. 2007). In particular, copper is the metal with the best conductivity after silver, which makes it the preferred material for cables and conductors in electronics. The more abundant metal, aluminum, potentially can replace copper in some cases, however aluminum cables require a larger cross section for the same conductivity, which makes it less suitable for technological applications in which limited space is an issue.

---

1 These 664 Mt include the amount of copper that was produced 2001-2011 according to the USGS, plus an estimation of Zittel (2012), which assumes an amount of about 500 Mt that can be produced after 2011 (figure rounded due to uncertainties).
2 Currently, the degree of recycling reaches about 50% in the case of copper, Frondel et al. (2007) estimate that 90% of recycling share would be feasible in the future.
3 http://www.kupferinstitut.de/
In vehicles, for example, it is particularly problematic to substitute copper with aluminum wires, as aluminum wires of equal conductivity are much thicker, which makes them largely unsuitable for automobile construction due to the limited space available. In general, the trend toward miniaturization has unfavorable consequences for substituting copper with aluminum, especially in electronics. Against this backdrop, Erdmann et al. (2011) point out that especially in electricity transmission, the technical advantages of copper still hamper substitution, and that in automobile construction, often no good substitutes for copper are at hand. Messner (2002) illustrates that due to a variety of economic and technical reasons, copper has not been replaced to any considerable degree and, in the longer term, may not be replaced in many applications, despite the existence of substitutes that could be employed in principle.

Furthermore, it is to be expected that the transition to a renewable energy system as well as the growth of information and communications technologies (ICT) will create an additional demand for copper. The fundamental reason behind this potential additional demand is that renewable energy technologies as well as ICT both use electrical energy and, therefore, copper as electrically conductive material. García-Olivares et al. (2012) assess the potential additional demand by renewable energy technologies based on a simple projection. Using the renewable energy scenarios of Jacobson and Delucchi (2009), they start from the assumption that in the year 2030, 11.5 TW of electricity would be required, of which 10% would come from water power, 40% from concentrated solar power, mainly in deserts, and 50% from wind turbines. They further assume an electric car fleet equal in size to today’s gas fleet and a complete electrification of the current railway system. According to their calculations, the buildup of this infrastructure alone would require 290 Mt of copper (wind turbines: 147 Mt; solar power plants: 36 Mt; additional electric power lines: 38 Mt; electrification of cars: 58 Mt; complete electrification of railways: 11 Mt). This shows that the inevitable transition to a renewable energy system is a strong additional driver of the demand for copper.

Despite a range of uncertainties and complexities involved in such projections, the consequence seems to be that wealthy countries will have to accommodate themselves to dispensing with additional copper stocks, if the goal of equal chances for development is to be maintained. Even a net export of copper from richer to poorer countries then must not be treated as taboo. Copper needed for the replacement of infrastructure and basic utilities or the construction of new infrastructure or consumer goods would have to be taken from existing copper stocks. This drastic conclusion and the challenges of regulation, which can be seen as a general political consequence of material limitations in a sustainability framework, are hardly expressed in the current debate on metal extraction.

We used copper to show the potential limits of the use of a certain material in the future and the consequences of these limitations for questions of global distribution of material stocks and society’s development options in different regions. However, the same line of thought applies to many other metals. The continued growth of the world economy and of ICT, as well as the transition to a renewable energy system, contributes to a strong increase in demand for an increasing variety of metals (Graedel and Cao 2010). Besides strict techno-economic limitations of metal use, as shown for the example of copper, further factors might contribute to the limits of metal production. These limits are mainly related to local environmental destruction by mining and – often linked to this – resistance of people against
mining projects. Although these limits might be less strict than geological limits, as they depend on the outcome of social struggles, they are no less important. In what follows, we, therefore, review the socio-ecological limits of metal extraction, before concluding with regulatory challenges resulting from these limits.

The socio-ecological limits of metal extraction

The material limitation of technologies, including those necessary for the use of renewable energy carriers, have to be complemented by the social and ecological limits of mining itself. These limits obviously are relevant for metal production as a whole. While the contradiction between the dirty mining business and the green image of the energy transition at least is sometimes discussed in expert fora, this is not the case for the social and ecological limits of mining as such.

A number of critical NGOs and organizations of people affected by mining demand a moratorium on new mining sites (London Declaration on Mining 20014, EA/OX 2004, Sibaud 2012; see also the International Mining and Women Network5). The backgrounds are frequent human rights violations in the mining sector and its many social and ecological problems, with a deteriorating situation in the course of the last years. Thus, several investigations state that conflicts around mining issues in countries of the periphery are increasing (see e.g. Ballard and Banks 2003, Salim 2004: 14, Urkidi 2010, Sibaud 2012, Sawyer and Gomez 2012). This is confirmed by an industry-near study published by PricewaterhouseCoopers: “Supply is increasingly constrained, as development projects become more complex and are typically in more remote, unfamiliar territory” (PwC 2011: 1). Business statistics of top mining companies since 2002 show that profits on average are on the rise in the sector (PwC 2011). Due to this development, mining companies recognize increased incentives to penetrate as of yet undeveloped regions, which still harbor unexploited deposits.

These new target regions often are inhabited by indigenous peoples, who consequently are of growing importance in the social struggles enfolding around mining issues (Ballard and Banks 2003: 298, Gomez and Sawyer 2012). In 2004, Earthworks and Oxfam America estimated that between 1995 and 2015 around half of the global gold production will have originated in indigenous territories (EA/OX 2004: 22). Already in the more recent past, indigenous peoples have borne the brunt of the suffering caused by mining, and will continue to do so for many generations in view of the often considerable long-term damages. Thus, for instance, in the USA, indigenous peoples are disproportionately more affected by mining than other groups, without being asked for their consent (Kuyek 2011: 54).

Given the limitations of this paper, suffice it to say that in general, the expansion of mining is highly problematic due to frequent human rights violations. The principle of Free, Prior and Informed Consent (FPIC) is often ignored, probably even as a rule. This is no surprise, given the extreme asymmetry of power between local populations on the one hand, and mining companies together with the state in affected countries on the other. The structural precondition for realizing FPIC is missing: How can the consent to an extraction project be free, if local populations have to assume that a possible rejection on their behalf will not be

---

4 http://www.minesandcommunities.org/LondonDeclaration
5 http://www.rimmrights.org/statement.htm
respected anyway? Nevertheless, resistance against mining projects is frequent (see case studies in Sawyer and Gomez 2012 and literature cited therein, FDCL/RLS 2012). In those cases in which mining companies finance compensation measures, problematic and ambivalent consequences for social cohesion and future perspectives of local communities have been documented frequently (see e.g. Ballard and Banks 2003, Sawyer and Gomez 2012).

Beside those consequences that are directly negative in social terms, and above all processes of dispossession, mining also leads to a range of negative ecological changes, only the most obvious of them being the irreversible destruction of ecosystems by open-pit mining and mountaintop removal, including permanent loss of soils\(^6\), destruction of biodiversity, and annoyance of fauna and humans by noise and vibrations. Far-reaching contamination of water, soil and air, by dust and toxic substances during and after exploitation, are widely documented (see e.g. MMSD 2002, EW/OX 2004, Norgate et al. 2007, MW 2009, EW/MW 2012).

Mining depends on a high level of water consumption, resulting in sharp water competition with other water users in regions with arid and semi-arid climates. This is of particular importance given the fact that about 30% of all active mines are located in regions in water stress according to data from 2003. From these mines, about two-thirds were to be found in high water-stress regions. Twelve percent of all active mines and 7% of exploration sites were counted in regions suffering from earthquakes, which threaten the stability of tailings dams (Miranda et al. 2003). The energy consumption of the mining sector ranges between 5 to 10% of world energy production (MMSD 2002, EW/OX 2004). Others estimate that about 20% of all Green House Gas (GHG) emissions are the result of mining (Sibaud 2012).

A study by Earthworks and MiningWatch states that more than 180 Mt of the total waste of the 18 most important mines worldwide, which are contaminated with heavy metals and other toxic substances, are dumped per year in bodies of water (rivers, lakes and oceans). This amounts to a quantity 1.5 times greater than all communal waste in the USA in 2009 (EW/MW 2012).

Tailings can contain dozens of dangerous chemical substances: solid waste also can be contaminated (EW/MW 2012). Heavy metals occur together with toxic elements (e.g.arsenic, quicksilver (mercury), cadmium, uranium, thorium). They can also have toxic effects if they exist as free elements or in high concentrations (e.g. copper, zinc, aluminum). Toxic elements are partly retained in the production process, but another part remains in solid mine waste, in tailings, slags, emissions, and sometimes also in the end product. These elements enter the environment in an uncontrolled fashion. Currently, the total emissions of toxic elements are not sufficiently known (Norgate et al. 2007, EW/OX 2004). Tailings removal from aquatic bodies is extremely costly or not possible at all (EW/MW 2012).

A particular problem that is widely experienced especially in temperate regions is Acid Mine Drainage. It is a problem not readily solved for solely technical reasons. Sulfidic ores that are exposed to rain emit sulfuric acid. Mines of such ores emit acid over a range of several hundred years (BC 2006). Sulfuric acid contaminates bodies of water and dissolves heavy metals from the rock substrate in the mines and in river systems (BC 2006). A report

\(^6\) According to UNEP, in one year, mining affects a larger area than natural erosion, http://www.grida.no/publications/vg/waste/page/2858.aspx
published by BC Wild und dem Environmental Mining Council of BC (British Columbia) thus calls such mines “Perpetual Pollution Machines” (BC 2006: 5).

The International Network for Acid Prevention (INAP), an association of several of the biggest global mining companies, states in a similar vein: “Acid drainage is one of the most serious and potentially enduring environmental problems for the mining industry. Left unchecked, it can result in such long-term water quality impacts that it could well be this industry’s most harmful legacy. Effectively dealing with acid drainage is a formidable challenge for which no global solutions currently exist” (see also BC 2006). The study Mining, Minerals and Sustainable Development resumes: “So far no one has designed a passive system that will operate indefinitely without human intervention. It is therefore not free of ongoing costs. Treatment will be needed not just during the mine life, but indefinitely into the future” (MMSD 2002: 239; see Kuyek 2011).

In the USA alone, an estimated 500,000 abandoned solid rock mining sites exist, with a large part of them possibly representing an environmental hazard. In the US West, according to the Environmental Protection Agency, more than 40% of the upper river reaches are contaminated by mining. The NGO Mineral Policy Center (Earthworks) calculates the ecological safeguarding of abandoned mines in the US to cost between 50 to 60 billion USD (MMSD 2002: 246). Another estimation mentions the figures of 32 to 72 billion USD. The US Environmental Protection Agency believes that safeguarding costs amount to 35 billion USD or more.

The IUCN reports that mining and oil and gas exploitation currently threatens an increasing number of World Heritage Sites. One out of four World Heritage Sites in Africa is affected. The degree of endangerment in Africa has increased 16% (IUCN 2011). Considering that these sites only cover 1% of the total surface area of the planet, their disproportionate endangerment can illustrate the dimension of mining activities as well as the future potential for conflict. Already in 2003, about a quarter of all World Heritage Sites based on nature conservation criteria were threatened by mining or oil and gas exploitation in the past, the present or in the future. At this time, more than a quarter of all active mines and exploration sites are located in nature conservation areas of the IUCN category “strictly protected” or in a 10 km perimeter of such an area (Miranda et al. 2003).

**Regulatory challenges in a perspective of raw material equality**

The absolute limitation of metal production that will probably be reached in the near future represents a historically new challenge for the debate on regulation (see also Zittel and Exner 2013). However, the question of the possible implications of absolute quantitative limitations of metal availability has not been the subject of a thorough investigation yet. In the same way, reflections on material policies on the level of the society, concerning metals in general, have been published very rarely until now.

Two exceptions are Bleischewitz and Bringezu (2007) and Bleischewitz (2011). They argue in favor of an increase in transparency in value chains, the integral consideration of

---

8 http://water.epa.gov/lawsregs/lawsguidance/cwa/economics/liquidassets/dirtywater.cfm
9 http://www.earthworksaction.org/issues/detail/abandoned_mines
10 http://water.epa.gov/lawsregs/lawsguidance/cwa/economics/liquidassets/dirtywater.cfm
development goals in producer countries, for instance, by means of a raw materials fund, which is monitored by independent international organizations (e.g. UNO), and earmarked for certain types of investments. Furthermore, an effective increase in resource efficiency in countries of demand is seen as necessary. The authors also advocate an absolute physical limitation of raw materials extraction. Such materials should be seen as Common Heritage of Mankind, and consequently, an integrated management of resource flows must be installed.

Additionally, Bleischewitz proposes to establish strategic partnerships with central raw material producers as well as an international metal covenant, which he conceives as a contract between “automobile producers and suppliers, the recycling industry, as well as responsible public agencies in the core export and import countries” (Bleischewitz 2011: 407, authors’ translation). This contract should be enforceable in court; states would guarantee stable and favorable framework conditions over its duration. This, Bleischewitz interprets as a first step to an agreement on sustainable resource management.

To the contrary, a study by Jeremy Richards focuses on resource prices. His argumentation is based on the paradigm of the internalization of external costs. Richards also claims, like Bleischewitz and Bringezu, that an international coordination of resource pricing is necessary. The so-called true costs of raw materials are five to ten times higher than currently, he estimates. Richards thinks that leasing systems for consumer goods would be reasonable, and expects such systems to develop due to increasing resource prices, which make purchases ever more expensive (Richards 2006).

To develop regulatory perspectives that are adequate in view of historically specific societal relations, with a special focus on ecological relations, requires, first of all, a realistic model of these societal relations with nature, including the social forces that are active in this context. Secondly, an adequate conceptualization of the real regulatory challenges is necessary. In both respects, the major part of the current debate on raw materials is prone to grave inadequacies and subject to large blind spots.

Richards (2006) puts great hopes in what he calls “enlightened leadership“ and the supposed power of consumers. Only corruption and bad governance would oppose the implementation of his proposal to increase resource prices. Bleischewitz and Bringezu endorse a more differentiated conception of state power and at least peripherally mention the problem that a mode of production oriented toward profit poses for regulation. However, they do not discuss that a reasonable form of regulating resource flows can hardly be expected in the framework of such an economy, even less so on a global level. Besides, their institutional blueprint lacks any relation to the social forces necessary for implementation. Thus, they are looking for a solution in normative thinking and by adding new international institutions without systematically considering the real world challenges of such an approach.

Beside the insufficient conceptualization of societal relations and the requirements of a socio-ecological transformation, the above-mentioned studies also show deficits in terms of the definition of regulatory challenges. Possible limits to the availability of metals are not discussed, thus, eventual implications for global distribution inequalities cannot even come into view as a further important factor that resource policies have to deal with. The social and ecological feasibility of further mining is assumed. Strategies of increasing efficiencies
are not seen critically, although such approaches are not able to allow an absolute reduction of metal extraction under capitalist conditions (see Exner 2013).

In our analysis, the regulatory challenges that we propose to summarize in the perspective of global raw materials equality can be deduced in a sounder manner. Four aspects constitute this perspective: Firstly, the reduction of metal extraction for social and ecological reasons; secondly, the coordination of metal resource flows; thirdly, the step-wise transcendence of historical inequalities in stocks of metals; and fourthly, the increase in extraction income streams to the benefit of the poor at the periphery of the capitalist world-system. Each component is faced with multiple obstacles that are tightly connected to the capitalist mode of production and the state apparatuses that support and depend on it.

A realistic picture of a possible transformation pathway requires that the role of social struggles in changing economic structures and the state be made visible. For structural reasons, mining companies, in particular, and capitalist industry, in general, cannot be conceived of as leading agents of a perspective of raw material equality. In general, this is currently also true for state apparatuses. The working class in the global North cannot be expected to play a leading role currently, as it is widely characterized by an “imperial mode of living” (Brand 2008), dependent in many ways on the exploitation of the South.

Thus, the first and crucial reference point for a perspective of raw material equality is to be seen in local resistance to mining projects at the peripheries, and in the centers and sub-centers of the capitalist world-system (including inner peripheries in the global North), which are often inhabited by indigenous peoples that play a special role in this context. Such resistance has been marked by an often long struggle, with only limited success in mining regions of the USA, Canada and Australia. The EU Raw Materials Initiative explicitly targets expanding mining in the EU. This strategic orientation is quite vulnerable to social resistance, for instance, by local citizens’ initiatives. Solidarity movements in the centers for resistance at the peripheries would be of great importance strategically.

Social resistance in some instances has already led to substantial tangible success. Probably the best example is a mining law in Wisconsin, USA (Wisconsin Act 17111). This act defines conditions for conducting every new mining project in an ecologically responsible manner. Consequently, no new mining projects have been approved since the law took effect. In the Philippines, which are heavily affected by mining, a broad movement struggles for an alternative Minerals Management Bill, which would replace the current mining act with socially and ecologically responsible provisions (Breininger and Reckordt 2011). Since 2010, Costa Rica has forbidden new open-pit mining (Swampa 2012, on Latin America in general see FDCL/RLS 2012).

If such resistance efforts were successful, they would limit attempts to produce amounts of ore beyond the geological limits of availability. In the case of those metals production of which is already near or at the peak, such a further constraint would exacerbate the distribution issue in the frame of capitalist relations and associated state policies. If historical inequalities in societal metal stocks cannot or should not be closed by mining, repatriating stocks from the physical structures of the centers to the peripheries becomes particularly urgent. In the case of metals that will not reach a peak in production in the longer run, the

physical limitation and increasing prices of fossil energy will probably constrain extraction considerably.

In addition to the global social distribution issue, the question of the inter-industrial and, more generally, the regional distribution of scarce raw materials has to be considered. At least in the mid-term, recycling is the only substantial source of metals. Until now, what this means has not been included in discussions of regulating resource flows. The EU Raw Materials Initiative conceives of recycling, as do all the other agents in the debate, as a mere additional, but not the only, source of raw materials. Clearly, a (nearly) complete system of recycling for gaining metals does not allow the growth of stocks any longer. Metals, which are to be invested physically, will then have to be divested first from another type of use or of waste not subject to recycling. It seems to be quite obvious, that such a state of affairs is hardly compatible with a capitalist mode of production based on relentless growth and competition.

It should only be mentioned briefly here that a strategy of efficiency increases has the non-intended effect of deteriorating the conditions for recycling (Kümmerer 2011). The smaller the quantity of a metal in the end product, the harder it is to recycle. This fact should be discussed more in depth in the context of the general problem of recycling complex material compounds that are present in many commodities. In the respective debate, it is often stated that currently, even the necessary knowledge of the distribution of metals in the products that should be recycled, and about their qualities is missing. Whether a comprehensive labeling system as required by such a high degree of recycling would be feasible logistically, shall be left open here. That capitalist enterprises will take into account recycling issues in product design by themselves is not to be expected due to their short-term profit motive, which is compelling in the framework of market competition.

As was discussed above, the expansion of certain technologies, including those necessary for the production of renewable energy, requires metals in such an amount that competition between different technologies can arise. This very real possibility illustrates the urgency of the energy transition considered; a sensible form of resource politics is paramount, not only in a degrowth perspective, but also in a quite traditional sustainability framework. Also in this respect, the issue of distributional equality is crucial for peripheral countries, since it directly concerns the physical possibility of future (by necessity renewable) energy production.

Quite in contrast to the demands of the EU Raw Materials Initiative, for peripheral countries, a raw materials policy that conserves as much internal resources for the construction of important infrastructure is decisive. In this respect, the monetary dimension of expanding internal value chains is not necessarily the most important one. Rather, the long-term physical development options of peripheral countries are at stake, if the export of scarce raw materials such as copper will continue.

Certainly, it must be borne in mind that a considerable part of metal deposits are located in countries of the capitalist center (USA, Canada, Australia). Further mining in these regions, if it is socially and ecologically legitimate and democratically decided upon, with a special leverage of historically suppressed indigenous groups, will hardly be justifiable if physical infrastructure in the North would profit. Among peripheral countries, metal deposits are distributed in a highly unequal manner, thus, also seen from this angle, there is no simple
solution to be had in protectionist policies. In the case of already scarce but important metals such as copper, technology transfer, which is often regarded as a significant part of development aid, must by necessity take the form of net (re-)transfers of metals from the centers to the peripheries, under signs of limits to metal extraction.

In the final instance, the conscious global allocation of raw materials, including the adjustment of social and ecological debts that the capitalist centers have incurred in the peripheries is the integral precondition of a reasonable treatment of the problems associated with the extraction and use of metals. The abstract formula of a Common Heritage of Mankind, which Bleischewitz and Bringezu apply, does not contribute so much to a solution, as it threatens to further veil the very unequal significance of the environment that is negatively affected by mining for different types of populations and social strata. Raw materials are not a common heritage in the first instance, if one does not erroneously consider humanity to constitute an undifferentiated social body. Raw materials are first of all a potential quality of the area inhabited by concrete individuals, and which are constructed as a resource almost always by the profit interests of certain agents. As societal stocks, they are, quite to the contrary, integral components of a structure of global domination and, at the same time, the physical basis of this structure, which contradicts the idea of a common heritage in the sense of a heritage managed by humans on an equal footing.

Proposals for institutional innovations with respect to a global regulation of resource flows can initiate valuable discussions. Nevertheless, one should keep in mind the question of which social forces and processes have historically developed and shaped such institutions or systems of rules, especially if they are to offer points of reference for emancipation movements, particularly in societies dominated by capitalist relations. As a rule, they can be interpreted as forms of reaction by the dominant classes to social resistance that builds from the bottom up. Such institutions and systems of rules partly make concessions to popular demands and pressures of social movements or unrest, but often are (also) forms of co-optation or refined forms of oppression and the reproduction of inequality.

An example of particular relevance for the extraction and allocation of raw materials, including metals, is the history of the raw materials debate in the 1970s that centered on the perspective of a New International Economic Order (NIEO). The NIEO was an important international discourse on alternatives in global economic development and of resource use at the time, and was strongly influenced by the UN (UNCTAD 1977, Corea 1977). It alluded to a rather loosely defined perspective; nevertheless, it had some impact on decisions in the frame of the United Nations Conference on Trade and Development (UNCTAD), at an increase in life quality in poorer countries. A further goal consisted of closing the gap in wealth between raw material exporting countries and countries producing technologies. This gap was seen as the result of relations of unequal exchange, which was analyzed as the effect of a historical debt of the global North to the the South (UN 1974).

The NIEO approach found its most concrete expression in the proposal of Corea at the UNCTAD conference in Nairobi 1976 to develop an Integrated Programme for Commodities. This proposal was only partly realized (Wagner and Kaiser 1995). The rise of neoliberalism, spurred by the interest shock of 1979 in the aftermath of the Vietnam war, lead to a rapid termination of any serious attempt to close the gap between rich and poor countries.
The Integrated Programme for Commodities was criticized in the 1970s as a market affirmative approach, only aiming to strengthen the position of developing countries as raw materials exporters, but not to end this one-sided fixation (Senghaas 1977). Although this critique was justified, the NIEO debate illustrates, nevertheless, that the international allocation of resources is not to be thought of in the manner neoliberal policy-makers like to envisage.

An important precondition of these approaches in the 1970s was a position of increased power of peripheral countries, caused by three factors: Firstly, the Cold War, in general, which had put the USA politically and ideologically under pressure and thus facilitated concessions from the side of the rich countries; secondly, the Vietnam war, in particular, that had jeopardized the USA not only on an economic level, but further weakened the imperial power of the world hegemon politically and ideologically; thirdly, the success of OPEC to force the rich countries to pay substantially higher prices for a basic commodity. Fourthly, the concomitant social struggles in the centers of the capitalist world-system played an important role, since they put a comprehensive social and ecological critique of the dominant mode of production and of living on the agenda, and thus influenced the discourse of institutions dominated by the centers in a limited and selective way.

A problematic aspect of the Integrated Programme for Commodities, which was discussed in terms of the NIEO debate, consisted in its focus on market economy mechanisms. A characteristic feature of past international raw materials agreements was their monetary orientation, which constituted a formidable weakness. This entailed non-intended collateral effects, which was an important reason their success was limited.

While multilateral supply and purchase commitments can be organized in the form of an exchange of use values in principle, as illustrated by the ample existence of bilateral barter on national and international levels, the majority of such commitments were implemented as market agreements in the form of raw material supply chains. Their goal consisted primarily in safeguarding a certain price level. As a practical matter, this implied a commitment to purchase a type of raw material at a price fixed in advance by importing countries, even when the world market price was lower than the price fixed by the agreement. On the other hand, producer countries committed themselves to supply a certain quantity of the resource at the price fixed a priori, even when the world market price exceeded the agreed price. As a rule, certain contract volumes were defined as well in this type of agreement.

Often, this type of agreement can lead to a stabilization of the income of producer countries and might also stabilize raw materials costs of importing countries. However, the monetary mediation of these agreements causes a range of problems that are, for instance, analyzed by Wagner and Kaiser (1999) quite correctly, through a neoclassical lens. Indeed, raw materials agreements are not very functional in the long-run if market economy principles are assumed. Their social content and political aim, however, can be much better realized if one dispenses with these principles. A mere hint of the comparable challenges of the agricultural policies of the EU and the product subsidies coupled with this approach might suffice to illustrate the point.

A contemporary example of a barter approach to regulate resource flows might be the Alianza Bolivariana para los Pueblos de Nuestra América (ALBA) project, which is propagated
by Venezuela (Azzelini 2007, Buttkereit 2010, Williams 2011). This somehow vague political concept, which does not aim at a reduction of resource extraction – paramount in the perspective of global raw material equality – has been realized up until now mainly in bilateral raw materials agreements. The most prominent is the agreement between Venezuela and Cuba, which consists of a barter contract between a resource-exporting country – in this case Venezuela, which supplies oil – and a country that offers know-how; Cuba supplies medical knowledge and personnel.

Also for ALBA, which contradicts the neoliberal focus on market relations, in general, and free trade, in particular, substantial social struggles were decisive, and are reflected indirectly by the shape and content of this approach to regulate resource flows. Furthermore, for ALBA, the declining economic and – at least at the moment – military power of the USA is of great importance. Finally, the shift in the international relations of social forces has opened up international room for maneuvering by these forces at the national level, as is also shown by Venezuela.

A socio-ecological transformation toward a higher degree of raw materials equality amounts to nothing less than the transcendence of the capitalist mode of production, as has become clear. This insight is very much beyond the current debate on strategic metals. However, without this insight, even the mere attempt to shape resource politics in a more reasonable and just manner is futile, given the limits of metal availability and cheap fossil energy. Above all, a reasonable approach to the regulation of resource flows in the sense sketched above cannot be conceived of as long as the productive units are subject to a profit- and thus growth-oriented logic, which is narrowly focused on microeconomics and monetary indices, as the framework of a market economy requires for structural reasons.

In contrast, the necessity of developing degrowth solidarity has to be clarified. This development would support the in-depth democratization of state agencies crucial for any global perspective, and enable the subjective and objective requirements of increased cooperation geared toward social balancing between productive units. This development would, under favorable conditions, be a first step toward surmounting the “imperial mode of living” (Brand 2008), which currently might be the gravest obstacle to any transformative movement in the capitalist centers.

Acknowledgements

This work was supported by the Austrian Climate and Energy Fund project “Feasible Futures for the Common Good”. We thank Martin Bruckner for feedback on previous versions of this article. Andreas Exner thanks the ÖIE Kärnten/Bündnis für Eine Welt. Additional project results can be downloaded on http://www.umweltbuero-klagenfurt.at/feasiblefutures. The authors thank Kéllia Ramares-Watson for careful editing of the original version. We are grateful to two anonymous reviewers for their helpful comments.

Literature


Koppelaar R (2012, in prep.) *The influence of ore grades and depth on the energy costs of copper mining.*


