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Global Flow Security Working Papers

Chapter 5

Beauty and the Beast:
Opportunities and Threats Arising from Distorted Global Material Flows

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Introduction: Commodity Markets under Stress

Critical access to natural resources has led to a number of different strategies. A few countries, such as the United States, are strengthening or re-inventing national extraction policies. Other regions, such as the EU, are embarking more strongly on resource efficiency strategies to lower dependencies on natural resources.

This chapter stresses three threats that challenge both strategies -- managing functional threats of price volatility and peaks; managing political threats from new players and fragile countries; and managing ecological threats resulting from environmental pressures.

Managing the functional threats of price volatility and peaks. It is highly unlikely that a country or a company would be able to lower all dependencies on major commodities. For instance, the United States is becoming less energy dependent. But it will continue to depend on international markets for metals and critical materials, and is likely to become more vulnerable in its water consumption. All commodity markets have shown signals of increasing price volatilities and erratic peaks since the 2000s.

Managing the political threats of new major players and of fragile countries. Major suppliers such as Russia and Brazil look at their resources as strategic assets; major commodity platforms such as China and India impose all kind of policies to maintain their development interests. They all have established state-owned enterprises with tremendous power in international markets and

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do not adhere to principles of open markets and open access. Smaller but relevant suppliers such as South Sudan and the Democratic Republic of the Congo are fragile and often act to maximize the short-term profits of an elite rather than long-term yields. In more than forty countries extraction brings in more than two-thirds of total government revenues.

Managing the ecological threats of environmental pressures. The use of *all* natural resources is increasingly identified as a source of environmental pressures along their life-cycles. Extraction, processing and each phase in a product's life entail substantial harm to the environment, aggravated by the subsequent processes of recycling and waste. Rapid urbanization generates additional effects on the use of natural resources. Today's issue is how to manage such *material flows* in a sustainable manner.

The concept of global flow security, as outlined by Tomas Ries in this book, is thus appealing to scholars and for strategic intelligence. From the perspective of commodity markets and material flows it needs to be understood as a dynamic concept of global interdependencies, not just among political actors but also at the interface between economy and ecology.[2] Research increasingly realizes that global drivers can overshadow local drivers in the management of common pool resources such as river basins management and agriculture. On top of this, increasing connectivity allows local turbulence to spread rapidly, with unintended side-effects on other resources and regions.

At the heart of any such global flow security is what is now called the "global resource nexus," i.e. the increasing interlinkages across the use of a number of resources.[3] No natural resource can be utilized without using another one. No energy service reaches a final consumer without water and materials being used during earlier production stages, which in turn require energy for their production and distribution. To give an example of related risks and threats: the struggle for land and water in the Andes can put the copper production in Chile – the biggest producer worldwide - at risk with supply chain security issues for subsequent electronics production.

Response strategies fragmented at an early stage

Business and policy makers have recognized some challenges and cautiously started to formulate response strategies. Quite often, however, those strategies focus on one dimension. They tend to be either predominantly supply-oriented ("raw materials strategy," "unconventional fuels") *or* demand oriented ("resource efficiency," "sustainable consumption and production"). A comprehensive international strategy defining some early consensus while approaching critical issues step-by-step is at stake. Interests and aims tend to differ: while manufacturing companies have an interest in cutting material purchasing costs and managing volatility, their interest in long-term sustainability strategies tends to be lower. Countries with rich endowments evidently

[2] S. Bringezu and R. Bleischwitz, *Sustainable resource management: Global trends, visions and policies* (Sheffield: Greenleaf Publishing, 2009).

[3] H. Hoff, "Understanding the Nexus. Background Paper for the Bonn 2011 Conference: The Water, Energy and Food Security Nexus" (Stockholm: Stockholm Environment Institute, 2011); T. Graedel and E. v.d. Voet, eds., *Linkages of Sustainability* (Cambridge: MIT Press, 2010); Philip Andrews-Speed, et al., "The Global Resource Nexus – The Struggles for Land, Energy, Food, Water, and Minerals" (Washington, DC: Transatlantic Academy, 2012).

have other interests compared to countries depending on the imports of commodities. The United States and Canada appear enthusiastic about their new markets for unconventional gas and oil supply. Potentially, resource-rich developing countries could use revenues from oil, gas, and minerals for sustainable investments into well-being of their people. Others start to formulate and implement resource efficiency strategies, most notably in the EU as one flagship project of its 2020 strategy.

International oil markets illustrate these challenges: unconventional oil sources have led to a price gap of as much as $10/barrel between Texas and Europe (North Sea Brent). Unconventional oil, however, needs considerably more water and chemicals for extraction; new technologies such as horizontal drilling need more critical materials than previous technologies. Oil-based combustion engines for cars and trucks contribute significantly to climate change, while the production of alternative sources such as biofuels competes with food and drives up its price, and thus faces a trade-off with the overarching political aim of eradicating poverty in a number of regions. There are no easy solutions. The challenge for oil markets is to coordinate a secure supply and support innovation towards carbon reduction, food security and international security alike.

What research needs to understand are the unwanted side-effects of stove-piped management approaches that treat commodities separately, and the dynamics of impacts across multiple scales. Yet, there is no political economy analysis that captures the global material flow security along with the resource nexus. Our contribution seeks to move this objective forward.

Global Trends: More and More Demand, Slow and Uneven Decoupling

The global commodity markets have expanded both in terms of physical volume and monetary value. International trade is one of the key drivers for global connectivity. The physical volume of traded goods increased by a factor of 2.5 over the past 30 years, with more than 10 billion tons of goods now being traded around the globe.[4] Non-renewable materials account for more than three quarters of commodity trade in physical terms, dominated by oil, while renewable materials that include forests products and agricultural goods account for less than one quarter. It is worth noting with regard to global flows that international trade of water and construction minerals is almost negligible because of a good regional distribution and relatively high transportation prices. In contrast, the share of metals has increased over the years due to development needs and an uneven distribution. Extraction rates have been rising even faster than international trade, reflecting the high amount of used and unused resources that remain in the countries of origin.

The demand for almost all natural resources is widely expected to increase and tighten markets over the next years and decades:

[4] Surprisingly little data and evidence exist on the physical dimension of international trade; with bustling prices it is usually difficult to realize what amounts of commodities have exactly been traded. See e.g. M. Dittrich, "The physical dimension of international trade, 1962-2005," in R. Bleischwitz, P.J.J. Welfens, AND Z.X. Zhang, eds., *Sustainable growth and resource productivity. Economic and global policy issues* (Sheffield: Greenleaf Publishing, 2009), pp. 85 – 98; M. Dittrich and S. Bringezu, "The physical dimension of international trade: Part 1: Direct global flows between 1962 and 2005," in *Ecological Economics* 69 (9), 2010, pp. 1838–1847; see also: www.materialflows.net.

Energy: all "business as usual" scenarios forecast an increase in energy demand. The World Energy Outlook of the International Energy Agency expects an increase by 33% by 2035 compared to 2010, with over-proportionally growth for natural gas, and maintained pressure on oil prices. The shale gas revolution and the ensuing downturn of U.S. energy prices gives incentives for energy-intensive industries to relocate to the United States; gas prices in Asia are eight times and those in Europe five times the U.S. level. Solar energy producers are under enormous pressure to cut costs too, resulting in many crashes and insolvencies of previous shooting stars such as SunTech, SolarWorld, Solyndra, SpectraWatt, Q-Cells, FirstSolar and SunPower.

Minerals: there are no well-established future scenarios for minerals yet. McKinsey Global Institute expects an increase in steel demand by 80% by 2030 compared to 2000.[5] Chatham House forecasts supply gaps for a number of materials in the next few years (e.g. for copper a 30 – 50% supply gap, but also for iron and steel).[6] Many critical materials are expected to experience two-digit growth in demand. Five rare earth metals (dysprosium, neodymium, terbium, europium, and yttrium) face serious supply challenges.[7] Several clean energy technologies (wind turbines, PV, electric vehicles, lighting) use such materials at risk of supply disruptions in the short term, or others that are environmentally intensive (concrete, steel, copper).

Food: To eradicate hunger along with population growth, more food needs to be provided to people, particularly in Asia and Africa. For sure, food waste needs to be minimized along the supply chain. But supply and the resource nexus with land, water, energy, and mineral nutrients is also at stake. The FAO estimates that agricultural production needs to grow by about 70% by 2050 at a time when agricultural productivity is lower than in previous years, access to land has become difficult, and climate change comes on top of that;[8]

Water: future demand is very difficult to estimate; at least 20% increase by 2050 can be expected to follow demand for food, and much more if water-intensive food patterns, biofuel strategies, non-conventional energy sources are pushed;[9] McKinsey expects an increase by 41% by 2030 compared to 2000.[10] Scenarios done by the Water Resources Group (a public-private platform) estimate demand for water could be as much as 40% higher than supply by 2030. Especially Asian rivers are subject to a number of expected conflicts. The energy sector's water needs are

[5] B. Lee, F. Preston, J. Kooroshy, R, Bailey, and G. Lahn, "Resources Futures" (A Chatham House Report, London, 2012), p. 35.
[6] Ibid.
[7] U.S. Department of Energy, *Critical Materials Strategy* (2011); JRC (2011), R. L. Moss, E. Tzimas, H. Kara, P. Willis, J. Kooroshy, "Critical Metals in Strategic Energy Technologies: Assessing Rare Metals as Supply-Chain Bottlenecks in Low-Carbon Energy Technologies, JRC Scientific and Technical Reports," European Commission Joint Research Centre, Institute for Energy and Transport, 2011.
[8] Frank Rijsberman, head of the world's 15 international CGIAR crop research centers, estimates an additional 60% will be needed by 2050, according to *The Observer*, April 13, 2013.
[9] H. Hoff, "Understanding the Nexus. Background Paper for the Bonn2011 Conference: The Water, Energy and Food Security Nexus" (Stockholm:Stockholm Environment Institute, 2011), p.10.
[10] Richard Dobbs et al., "Resource Revolution – Meeting the world's energy, materials, food, and water needs" (McKinsey Global Institute, 2011), p.35.

expecting to grow, making water an important criterion for assessing the viability of future pathways.

These demand trends and the perspective of a tripling of global annual resource extraction by 2050 as suggested by the International Resource Panel[11] will very likely lead to intensified competition for resources. The prospect is for high volatility.[12] While some new supply will come on stream shortly (oil, gas, iron ore, copper, etc.), the mid-term perspective after 2020 is less bright due to a number of restrictions: new mining sites tend to be of lower ore concentration, in remote areas, offshore and in landlocked countries. In addition, price volatility will make all prospects much more uncertain and lowers the incentives for investments. The Chatham House report thus predicts a looming investment gap in agriculture and food, energy supply infrastructures, natural gas, and metals.[13]

A New Market Geography

Analyzing global trends for material flows is not an easy task. The geography of different scales of drivers and impacts matters. Over the past fifteen years, a new geography of commodity trade has clearly emerged. The obvious changes relate to the end of the socialist system in the 1990s and the shift from a G8 to a G20 world in the 2000s. The weight of the developing world has become more obvious, with exports and imports of commodities connecting major emerging economies.[14] A good indicator is the role of China in markets for metals, energy and forestry products, but it is also striking to note a number of other features.

North America hails the shale gas revolution and other unconventional fuels on its way to energy security and independence. However the interest in "bringing our jobs back home" by strengthening the domestic manufacturing base suggests analysis of remaining import dependencies for metals and the vulnerability towards water stress, weather extremes and climate change. Along with it, the global repercussions of ramping up the production of Liquefied Natural Gas (LNG) with potentially new global distribution systems beyond pipelines make future shifts in global gas markets very likely.

As the EU has been the largest consumer of fuels and imports a very large share of natural resources it is well aware of international dependencies; this is likely to be expanded to agriculture because the EU uses more land in foreign countries than it offers. Its emphasis on bilateral partnerships in combination with resource efficiency thus is a rational response to all those dependencies.

Strong suppliers are likely to remain strong: the major position of Russia as commodity exporter of energy and minerals, Central Asia in gas and oil, Brazil in minerals and agricultural goods are all obvious; so is the Middle East for oil, with a likely comeback of Iraq and Libya in the next

[11] UNEP, Decoupling natural resource use and environmental impacts from economic growth, A Report of the Working Group on Decoupling to the International Resource Panel," 2011, p. 10.
[12] "Commodity market review" (Washington, DC: IMF, 2013).
[13] B. Lee, et al., op. cit., p. 56f.
[14] R. Muradian, M. Walter, J. Martinez-Alier, "Hegemonic transitions and global shifts in social metabolism: Implications for resource-rich countries," *Global Environmental Change*, 2012, pp. 22, 559 – 567.

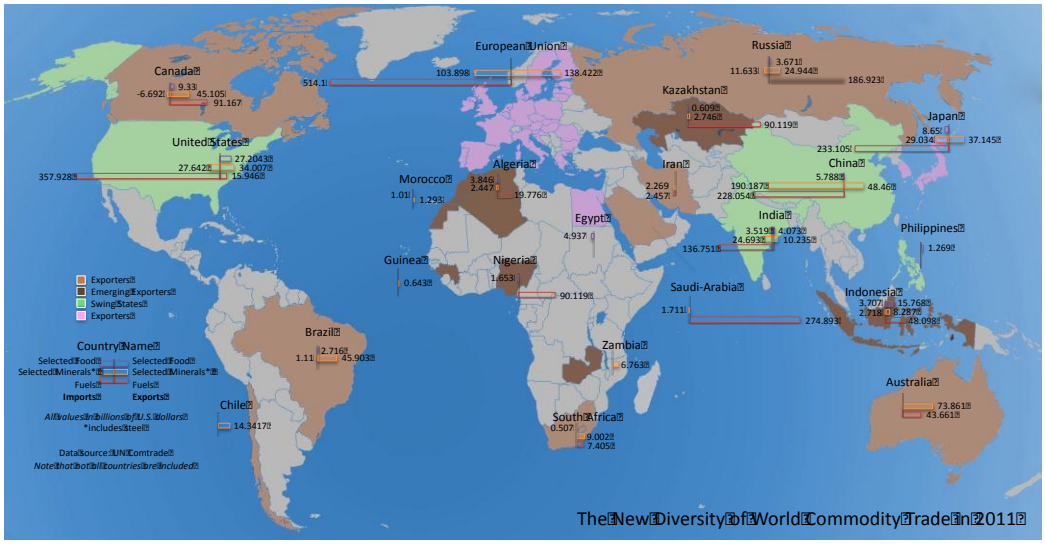
few years. However those countries underperform in terms of general economic, social and political indicators compared to other emerging economies with a more diversified portfolio and more open structures.

In addition, 'new kids on the block' are likely to be of growing importance: exporting countries of Africa (oil, minerals), Central Asia (oil and gas, minerals), and Southeast Asia (biofuels, minerals). The conundrum is that these resource-dependent countries usually rank low in the Human Development Index. The "Africa Mining Vision" and the "Africa Progress Report" express the hopes that those endowments can be turned into development opportunities for the people if managed properly.

A number of emerging economies (e.g. China, India) are increasing their production capacities for refined materials and key products such as steel and cement. India is a good case for a country with rich endowments (e.g. coal) but a challenging mining environment due to a land use conflict with forestry, local and indigenous people, and a lack of transportation infrastructure. China and India can be characterized as "swing states" for global material flows because their strategies towards either more imports or more exports will have significant impacts on international markets and politics.

The global geography of water and food is more diverse than ever before. While countries such as Brazil, China, Canada, and Turkey are water hegemons, downstream countries in Asia, Middle East and elsewhere depend on proper water supply. Food import dependencies in countries such as The Philippines, Egypt, Mexico are high and put them at risk of social unrest when food prices start soaring. It is here where the resource nexus becomes strategically important as any social unrest may jeopardize their ability to export other commodities.

Figure 1: Patterns and new geography of commodity trade



Identifying winners and losers is thus a task for research in an agenda about material flow security. Certainly big mining companies, their state-owned counterparts, and elites in resource-rich countries have benefited a lot from previous booming years. But it's far from being clear that those golden years are going to last. The emergence of a global middle class with some three billion consumers will alter the patterns of resource use globally. While the current estimation is that high consumption patterns occur in the industrialized countries, the average of the developing world is still well below, with India and many African countries at the lower end. The aspirations of market newcomers may clash with restrictions on the supply side, whether for fuels, food, or other resources.

There is neither a North-South divide nor any preoccupation favoring either OECD countries or resource-rich countries. The security angle suggests that all countries and industries should be aware of challenges resulting from unexpected shortages in areas that might have been overlooked in the past. Local and regional stress factors are likely to hit critical nerves of global supply chains, and might transform strong systems into fragile ones or even into secessionism of shattered pieces. The strategic conclusion, however, is that some thirty countries from all over the globe matter most with regard to resource supply, while no country can claim a full independence from resource risks.

International trade policy will be decisive for the nature of future competition. The dawn of a new age of resource nationalism can be observed, be it in the form of supporting large national corporations, trade restrictions of any kind, or a neo-mercantilism of favoring exports. The United States, the EU and Japan have taken China to the WTO in the case of rare earth export restrictions. According to the Global Subsidies Initiative, subsidies for fossil fuels increased almost 30% in 2011, up to $523 billion, led by the Middle East and North Africa. In comparison, subsidies for renewable energies were $88 billion in 2011.[15] Biofuels are believed to receive $20 billion in subsidies for production and consumption.[16] Countries such as India and Spain spend millions of dollars on irrigation.

In the future, a further global shift in agricultural production can be expected: the capacity to increase agricultural production in Latin America and Sub-Saharan Africa is huge, while large parts of Asia (in particular India and China) will probably have huge difficulties to increase food production along with their domestic demand and difficulties with irrigated agriculture coming under water stress.[17] The changing climate is likely leading to enhance geographical disparities. The 2012 World Bank report on the likelihood of a 4º C world warns that such change would significantly exacerbate existing water scarcity in many regions, particularly northern and eastern Africa, the Middle East, and South Asia.[18] In such world, food security could be substantially undermined. Compounding these risks is the adverse effect of projected sea-level rise on agriculture in important low-lying delta areas, such as in Bangladesh, Egypt, Vietnam, and parts of the African coast.

The new geography of bustling commodity markets requires more stringent efforts to coordinate private and public actors at a global scale while today's and tomorrow's needs ought to be fulfilled and environmental concerns should be taken into account. One may put forward the argument that the market stress ahead can only be coped with from a governance perspective that covers the levels of value chains, states, and actors on the ground – a polycentric and multilevel governance perspective comprising business, other stakeholders, governments, international organizations and the respective institutions.[19] At the same time, the paradigm of "more is better" should be put in question.

[15] D. Jones and R. Steenblik, "Subsidy Estimation: A survey of current practice,"Global Subsidies Initiative (GSI) of the International Institute for Sustainable Development (IISD), Geneva, 2010.
[16] Ibid.
[17] FAO (2011), "Anticipated trends in the use of global land and water resources," SOLAW Background Thematic Report, Nachtergaele, F., Bruinsma, J., Valbo-Jorgensen, J., Bartley, D.
[18] "Turn down the heat : why a 4°C warmer world must be avoided" (Washington, DC: World Bank, 2012).
[19] Defined by Ostrom, Tiebout, and Warren, "The Organization of Government in Metropolitan Areas: A Theoretical Inquiry," *American Political Science Review*, 55(4), 1961, pp. 831–842. Following their analysis of water management systems in California as "'Polycentric' connotes many centers of decision- making that are formally independent of each other. Whether they actually function independently, or instead constitute an interdependent system of relations, is an empirical question in particular cases. To the extent that they take each other into account in competitive relationships, enter into various contractual and cooperative undertakings or have recourse to central mechanisms to resolve conflicts, the various political jurisdictions in a metropolitan area may function in a coherent manner with consistent and predictable patterns of interacting behavior. To the extent that this is so, they may be said to function as a 'system'." See also the work of e.g. Philipp C. Schmitter on polycentric governance.

Figure 2.

The Temptation of Resource Efficiency: Decoupling Resource Use from Economic Growth?

Expectations for volatile and high prices will help to curb demand. Therefore the general trend of using lesser resources to produce one unit of real GDP is likely to be continued. The discussion is about "decoupling," referring to reducing the rate of resources per unit of economic activity and – partly as a side effect, partly as deliberate attempts – reducing their environmental impacts. If countries or the world economy manage an increasing rate of resource productivity the result is called "relative decoupling"; if an increasing resource productivity even exceeds the growth rate of an economy and, consequently, the resource use declines in absolute terms, the result is called an "absolute decoupling.[20] The empirical evidence is good because during the 20th century

[20] There is a related literature about the "Environmental Kuznets Curve," a hypothesized relationship between environmental degradation and income per capita that may take the form of an inverted U-shaped function, i.e. environmental degradation rises in early stages of development and might fall during later stages. The EKC concept emerged in the early nineties with a number of papers (e.g. by the World Bank) and is now more critically examined along with indicators such as CO_2 and biodiversity that do not appear to decline. Thus "decoupling" expresses the more recent discussion about a wider range of indicators and economic activities. UNEP, op. cit., p.8; R. Bleischwitz, "International economics of resource productivity: relevance, measurement, empirical trends, innovation, resource policies," *International Economics and Economic Policy* (7), 2 – 3, 2010, pp. 227 – 244.

global GDP rose faster than the use of resources: e.g. about 25% less material input was required in 2002 compared to 1980 to produce one unit of real GDP.[21]

The question, however, is whether this trend is likely to be continued at a rate, at a speed, and across different scales in line with the challenges ahead. If, for instance, half of future demand could be met by increasing efficiency of using resources, how could such efficiency increase be realized, and how could the remaining gap be filled? For a number of reasons, decoupling should become an issue for international policy-makers, rather than viewed as an automatic development.

Countries are not on track. While most developed and industrializing countries manage a relative decoupling, absolute decoupling is very rare yet, and some countries actually increase their resource use faster than GDP. Among those with relative decoupling, significant differences can be observed between efficiently performing countries such as the UK, Japan and Germany, and less efficiently performing countries such as the United States, Australia, Turkey, and Canada.[22]

The resource nexus is not yet accounted for. Resource categories give rise to concerns. The World Bank points to the trend that the metal intensity of global development, which should fall according to decoupling trends, has actually been increasing since the late 1990s and is now back at the levels of the early 1970s.[23]

Problems are shifted to weaker countries. A number of studies and indicators demonstrate the bias favoring industrialized countries with huge imports stemming from resource-intensive processes taking place in other regions of the world; the territorial resource use of consuming countries appears lower than life-cycle based assessments of resource use reveal. Thus the spatial dimension of more comprehensive indicators of resource use such as "ecological rucksacks", material footprints, carbon footprints, water footprints, etc. is crucial to any decoupling analysis.

Resource Efficiency as a Challenge for Business...

A key insight is to address the business dimension of using materials, energy, water and processing food. Given that resources have a price (even if negative externalities are not properly accounted for) and price expectations are generally upwards business does have incentives to perform manufacturing at lowest possible material costs. A closer look reveals that the material costs to business actually outweigh the prices of raw materials. German manufacturing firms report shares of materials in their gross production value of 40–45%: European companies have reported similar shares lately.[24] Accordingly, the potential for cutting those costs through process

[21] Fridolin Krausmann, Simone Gingrich, Nina Eisenmenger, Karl-Heinz Erb, Helmut Haberl and Marina Fischer-Kowalski, "Growth in global materials use, GDP and population during the 20th century," *Ecological Economics* 68(10),2009, pp. 2696-2705.
[22] Dittrich and Bringezu, op. cit., pp. 1838–1847.
[23] World Bank, 'China, global metal demand, and super-cycle hypothesis' in Global Economic Prospects 2011, Commodity Outlook Annex, p. 57. Available at http://go.worldbank.org/DA78QLAEI0.
[24] EIO (2011): The Eco-Innovation Challenge; Pathways to a resource efficient Europe, Funded by the European Commission, DG Environment, Brussels. www.eco-innovation.eu

innovation is high. The German program DEMEA reports average savings per company in the order of some €200,000, with increases of marginal returns to sales of 2.4%. Similar experiences have been made in the UK and other EU member states.

It can be assumed that a majority of manufacturing companies have strong incentives to get engaged in efforts to save material purchasing costs. They will consider making resource efficiency a core element of their strategy and business models. Early barriers are the lack of attention and information deficits, followed by availability of financing and uncertainties about future demand.[25] Many of those early improvements will be on-site at the level of individual companies and incremental process innovation rather than addressing the whole life cycle of products or material flow systems.

Given that most business operations are value-chain oriented and on an international scale, it could become good management to monitor the flow of materials along value chains and to establish material stewardship where by-products could be re-used and recycling offers tangible benefits.[26] Our suggested approach offers potential benefits of reducing operating costs through improved internal management of water, waste, energy, materials, carbon and hazardous materials in an integrated manner. Indeed this can and should be combined with efforts to reduce environmental impacts. While these strategies will improve the return on capital, other strategies can improve growth and contribute to better risk management:[27]

- Guide investment decisions at portfolio level based on resource trends and risk analysis
- Develop new products and services with resource-efficient features able to attract customers
- Manage risk of operation disruptions (be it from scarcities, climate change, regulatory changes, etc.).

A life-cycle approach helps to identify more tangible benefits and prioritize key initiatives such as the resource efficiency of buildings, increasing yields on large-scale farms, reducing food waste, reducing municipal water leakages and higher overall efficiency rates in end-use products such as vehicles. As the World Economic Forum points out, ambitious business will seek to transform demand through interactions with the consumer and transform value chains through new business models.[28] Value creation with less use of resources may become a strategic management profile. Worth to note: emerging economies are on the verge of entering the market for such eco-innovation; Walz points to catching up competences of countries such as South Korea, Singapore providing favorable conditions and high absorptive capacities for eco-innovation technologies, while countries such as Brazil and Malaysia show promising specialization for renewable materials and recycling.[29]

[25] Ibid.; Dobbs et al., op. cit. pp. 118ff.
[26] International Council on Mining and Metals (ICMM), "Materials Stewardship, Eco-efficiency and Product Policy" (London, 2007).
[27] McKinsey 2011 op cit; World Economic Forum, "More with Less: Scaling Sustainable Consumption and Resource Efficiency, Geneva, 2012.
[28] Ibid.
[29] R. Walz, "Competences for Green Development and Leapfrogging," *International Economics and Economic Policy*, 2010.

…and for Policy-makers

Public policies and international organizations can be influential in helping to overcome barriers and to stimulate market development in favor of developing new resource-light products and systems.[30] Hybrid forms of governance, such as agencies with partners from the private sector and public-private alliances, can certainly help to promote best practices and disseminate knowledge as well as to improve qualification and training. Nevertheless, promoting resource efficiency is also a task for policies. Without an explicit international dimension, resource efficiency strategies face an uphill battle against existing distortions and unfair competition. Volatile prices and lack of transparency about unfair production processes abroad undermine efforts undertaken by industry.

The strategy of resource efficiency is high on the European policy agenda[31] and is well-rooted in Japan, China and elsewhere, while it is still almost invisible in the United States. This is in line with a roughly 30% better performance in the EU compared to the United States or other countries. What is missing in all countries, however, is an explicit international policy dimension of resource efficiency or decoupling strategies.

More transparency of payments in the extractive industries and downstream is an important step toward properly functioning markets and good governance.[32] Combating corruption in mining countries via disclosure of payments strengthens democratic institutions and increases participation. Additionally, fair contracts can stabilize the income of producer countries. With resource revenues dwarfing development aid, it is by no means unrealistic to assume that a robust extractive industry and investment in sustainable development can offer promising economic prospects for the 100 or so resource-rich developing countries and their 3.5 billion people. The case of Ghana, where mining revenues for the state could quadruple from 2010 to 2011, demonstrates potential achievements if all partners agree.

Resource-rich developing countries may establish a prosperous financial order with extraction taxes and green sovereign wealth funds from resource revenues that potentially leverage investments in clean energy, resource efficiency, and inclusive wealth. With assets estimated worth round $3 trillion in 2011—twice as high as global hedge fund assets— such market development may enable those countries to eradicate poverty by the year 2025. But as expressed, this requires international efforts and should be done in light of the threats that may arise if nothing is done.

Accumulating Threats if Material Flows are not Managed

A comprehensive assessment of global material flows and the resource nexus should also contain a number of stress multipliers and cumulative risks. Recent evidence of the dangerous

[30] M. Jaenicke and K. Rennings, "Ecosystem dynamics: the principle of co-evolution and success stories from climate policies, *International Journal of Technology, Policy and Management*, Vol. 11, No.3-4, 2011, pp. 198 – 218; EIO 2011 op cit.; Bleischwitz, Welfens and Zhang, op. cit.

[31] See e.g. www.eco-innovation.eu; http://ec.europa.eu/environment/enveco/resource_efficiency/.

[32] RevenueWatch Institute, "Resource Governance Index. A Measure of Transparency and Accountability in the Oil, Gas and Mining Sector," New York, 2013, available at http://www.revenuewatch.org/rgi

conjunction of high prices for food and water and social tensions could be witnessed during the Arab uprisings in 2011. Sternberg points to the drought that occurred in Northern China as a global trigger mechanism for higher food prices;[33] the International Food Policy Research Institute underlines additional domestic factors such as malnutrition, the phasing out of food support programs and a high share of angry young men caring for their families. Future impacts of climate change as stress multiplier are obvious.[34]

It may also be worth noting that in historical perspective the impact of food prices on the great revolutions in France (1789), Russia (1917), and other civil wars helps to explain the security dilemmas of the population and contingent political outcomes.

All these factors and more are likely to increase in many regions of the world. Two risks are inherent to commodity markets: illicit trade and supply breakdowns.

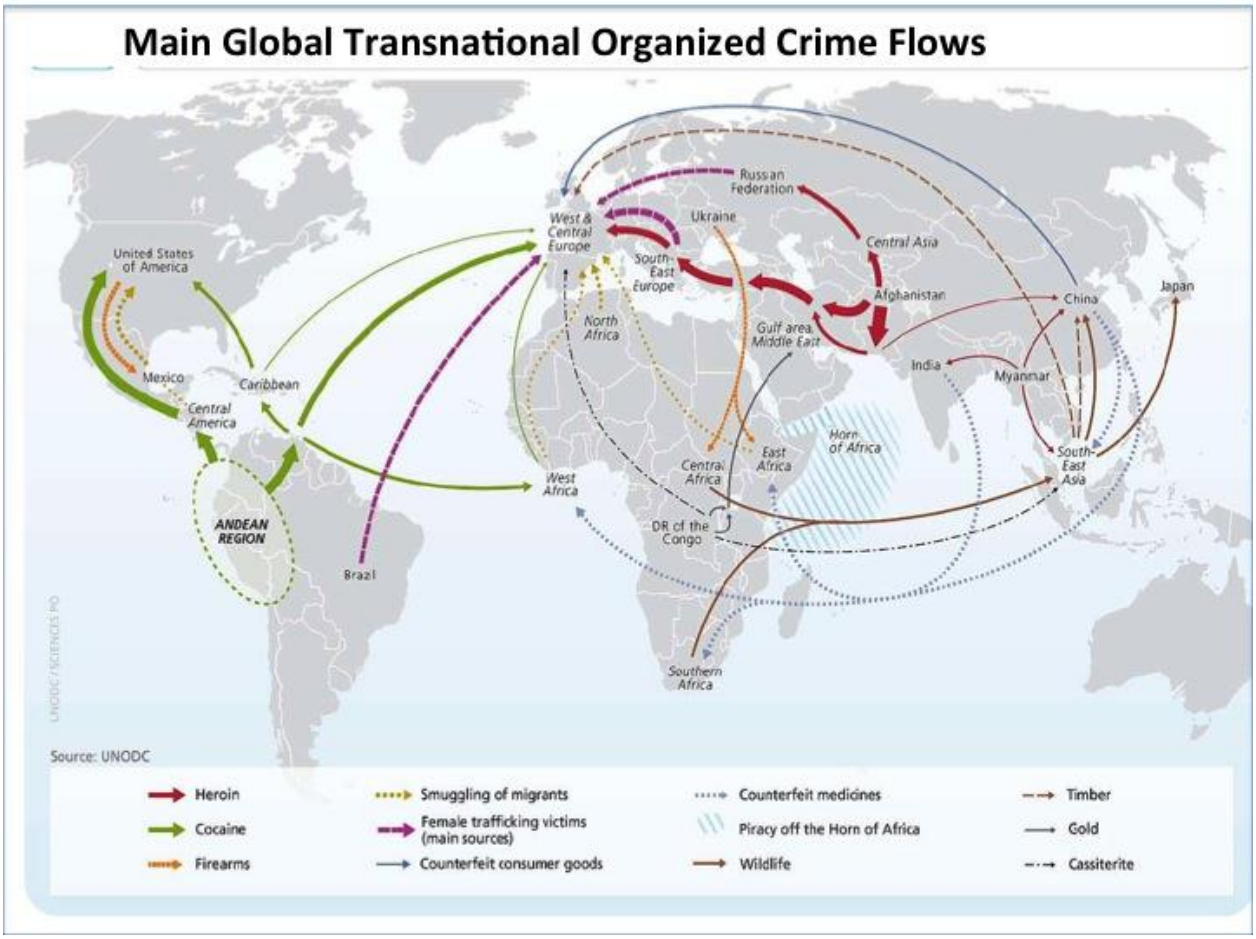
Illicit Trade and Transnational Crime

Illicit trade of so-called conflict minerals may cover some 20% of the world market, perhaps even more. But the issue goes much further. The United Nations Office on Drugs and Crime (UNODC) reports on how markets for these activities are intertwined, with markets for heroin, cocaine, firearms, smuggling of migrants, female trafficking victims, counterfeit consumer goods, counterfeit medicines, and illicit trade with wildlife, timber, gold and other minerals. Since the world's biggest trading partners are also the world's biggest markets for illicit goods and services, this is certainly a huge risk that requires tough action.

Any certification of single materials will not be sufficient, since global material flows along complex value chains can hardly be monitored[35] and organized crime will be able to switch to more profitable activities. The accumulated risks and threats can be described as follows. First, citizen attempts for smart consumption, fair trade, etc. are likely to fall short; lack of consumer confidence is likely to become an issue. Second, international markets are severely distorted, with many side effects in global business operations. Third, whole countries may be captured by organized crime, and efforts to establish resilient institutions towards sustainable development are likely to fail. At the same time, organized crime and money laundering are unlikely to be contained if no further action is taken.

[33] T. Sternberg, "Chinese drought, bread and the Arab Spring, *Applied Geography* 34, 2012, pp. 519-524.
[34] Bleischwitz, Welfens and Zhang, op. cit.
[35] R. Bleischwitz, M. Dittrich, C. Pierdicca, "Coltan from Central Africa, international trade and implications for any certification," *Resources Policy*, 2012; V. Haufler, "Disclosure as governance: the extractive industries transparency initiative and resource management in the developing world," *Global Environmental Politics* 10(3), 2012, pp. 53–73.

Figure 4: Main Global Transnational Organized Crime



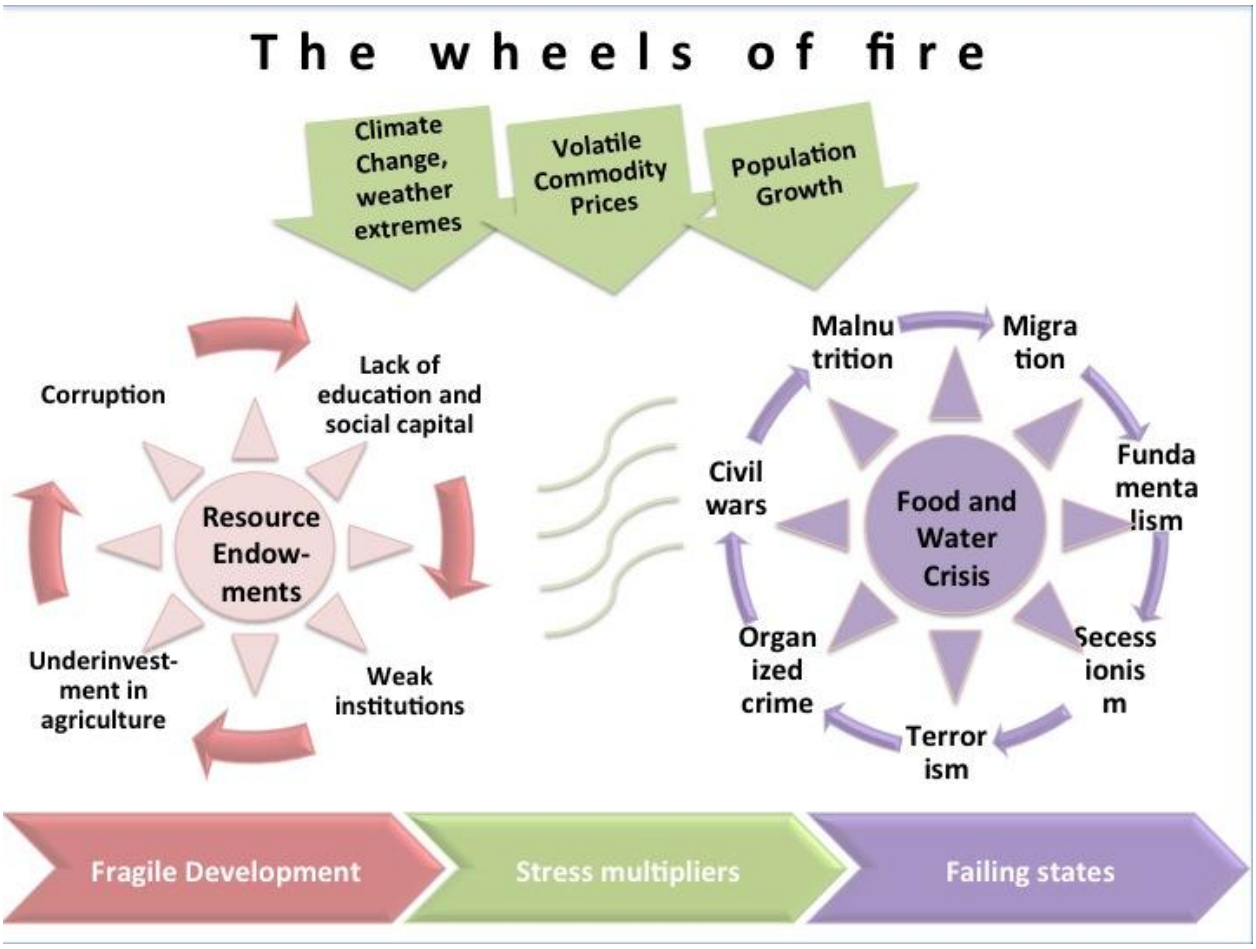
Breakdown of Fragile Suppliers and a Resource Curse Redux

Many commodity suppliers can be considered fragile; in particular new suppliers are at risk of suffering from the '*resource curse,'* the institutional inability to transform natural endowments into prosperity for the poor.[36] Sure, the price rally may offer opportunities to escape the various traps of underdevelopment.[37] But fragile states cannot yet comply with international social or environmental standards. Their institutions are not yet inclusive and still too weak.[38] According to Paul Collier, a domestic institutional capacity comparable to Portugal in the 1980s deems it necessary to embark on a path for inclusive and sustainable growth.[39] With stress multipliers such as climate change, volatile commodity prices and pressure from population growth – factors that are very difficult to be influenced by those states - they more probably stuck at the bottom,

[36] P. Collier, "Laws and Codes for the 'Resource Curse'," Oxford University; D. Lederman and W.F. Maloney, eds., *Natural Resources: neither curse nor destiny*. (Palo Alto:Stanford, 2007).
[37] P. J. Luong and E. Weinthal, E., "Oil is not a curse. Ownership structure and institutions in Soviet successor states," Cambridge 2010.
[38] D. Acemoglu and J.A. Robinson, *Why nations fail: the origins of power, prosperity and poverty* (New York: Crown Publishers, 2012).
[39] Collier, op cit.

risks of violent conflicts increase, and many of these countries may actually fail. This is especially likely in those countries that are in a post-war period such as Afghanistan, Iraq, Libya, and others.

Figure 7: The Wheels of Fire: How Stress Multipliers Exceed Institutional Resilience



The combination of these factors could translate into cumulative risks of what we call a redux of the resource curse:[40] triggered by the emergence of a food and/or water crisis -- whatever the causes may be -- local and national governance mechanisms are vulnerable and may not be able to cope with such a shock. If people start rioting for access to water and food and if the existing institutional resilience is low, fragile states and regions will be put at risk of further instability, where the above-mentioned mechanisms might escalate. Any such escalation may then lead to interruptions of supply chains for essential materials and have international repercussions.

[40] R. Bleischwitz, C. Johnson, M. Dozler, "Re-Assessing resource dependency and criticality. Linking future food and water stress with global resource supply vulnerabilities for foresight analysis," *European Journal for Futures Research*, Special issue on Futures research as instrument for policy development and strategic reasoning, 2013, http://dx.doi.org/10.1007/s40309-013-0034-1

Our mapping analysis based on (a) assessing the future likelihood of food and water stress, (b) political fragility and (c) importance for resource supply has revealed a number of countries that may potentially break down:[41]

Figure 8: Countries at High Risk and their Relevance

Country	Relevance
Afghanistan	Major resource endowments (e.g. lithium) estimated to be near $1 trillion; long-lasting war and civil war; large drug producer
Algeria	Major producer of natural gas
Democratic Republic of the Congo	Major endowments of copper, diamonds, and critical minerals; long-lasting civil war in eastern portions of the state
Guinea	Major endowments in bauxite (aluminum) and iron ore
Indonesia	Major producer of forest products and agricultural goods (e.g. bio-fuels) as well as fuels (natural gas), nickel, copper and aluminum ores; vulnerable to sea level rise and climate change; secessionist conflicts; strategic position at the Strait of Malacca
Iran	Major producer of natural gas and oil; regional de-stabilizer
Iraq	Major producer of natural gas and oil; long-lasting war and civil war
Libya	Major producer of gas and oil; recent civil war
Nigeria	Major producer of oil, including major offshore oil reserves; recent political changes towards democracy
Sierra Leone	Major reserves of bauxite (aluminum)
Somalia[42]	Holds strategic position near the Strait of Hormuz
Sudan, South Sudan[43]	Major producer of oil; currently in armed conflict about disputed areas, including oil fields; plans to erect dams for agricultural use along parts of the Nile River that may put downstream countries at risk of water shortages
Yemen	Severe water shortages; home of terrorists; strategic position at the Strait of Hormuz

[41] Bleischwitz, Johnson and Dozler, op cit.

[42] Note on Somalia and Somaliland: In this paper Somaliland is considered to be a legal part of Somalia, since Somaliland does not have internationally recognized independence. Furthermore, the data for political stability, agricultural stressors, and resource reserves does not consider the two entities separately. Therefore, on the map, the designation between Somalia and Somaliland is shown with a dotted line, but the data and evaluation does not distinguish between the two.

[43] Note on Sudan and South Sudan: The data for this chapter comes from before South Sudan's separation from Sudan proper in July 2011. Therefore, for the purposes of this chapter, assessments of Sudan and South Sudan's political stability, agricultural stressors, and resource reserves were considered as a unified Sudan. When new data for the two separate countries becomes available, new risk assessments should be made in which case both countries may not necessarily be at high risk.

Reconsidering Criticality

Altogether, these threats underline a need to reconsider the criticality of resources. The standard measures emphasize the availability of individual resources in the future, as extrapolated from reserves, production capacities and future demand, and supply bottle necks resulting from quasi-monopoly situations. Our approach however brings in a criticality of inter-linkages – the local water demand for extraction, food demand during the construction period of mining sites, etc., as well as of the security repercussions if whole regions fail. This requires a more strategic approach to any criticality assessment, environmental or social impact assessment: a need to include foresight exercises that assess ex ante potential changes in local and regional availability of water and food, intersections with global material flows, and resulting risks. The realms of material flows, inter-state and regional security thus have to be strengthened in criticality assessments..

Conclusions

Our analysis has direct implications for the two main strategies that emerge in parallel in the United States and the European Union: pushing the resource supply frontier forward through more domestic extraction has its limitations as countries and companies can only partially withdraw from global material flows. The resource efficiency strategy may look smart, but faces an uphill battle as long as international market distortions prevail. Both regions are likely to be affected if other major world regions face stress resulting from food, water and material flow security. Thus the direct implications are risks and threats for supply chain security for manufacturing companies and economies in the transatlantic space and elsewhere.

With a view towards 2030, the way forward may start along the following policy pillars:

Integrate supply and demand strategies. Good governance of commodity markets will comprise more transparency with better information in the extractive industries and downstream, stringent resource efficiency efforts, and empowerment and measures to turn natural endowments into opportunities for the world's poor.

Improve knowledge for managing global material flows and the resource nexus. The establishment of an international data hub would be an important step forward, along with expert groups on foresight and disseminating best practices for principles of stewardship and metals recycling.

Better transatlantic cooperation is crucial in both regards. Despite current tensions resulting from the energy price gap and competitiveness concerns as well as from a number of political difficulties, there is a rationale for a coordinated management of material flows. Further steps could include the establishment of a transatlantic multi-stakeholder forum on material flows security that actively promotes the inclusion of G20 and other countries.

Research is needed to understand better the interlinkages across the political, economic, technical, and environmental dimensions of both the opportunities and threats arising along global material flows. Comparative assessments of case studies as well as integrated modeling

appear to be important for any future research agenda for international scholars. No doubt that this agenda will be in demand.