Metal ores and industrial minerals

Material Flows and Resource Productivity in Latin America

The report "Recent trends in material flows and resource productivity in Latin America," published by the United Nations Environment Programme (UNEP) in collaboration with the Commonwealth Scientific and Industrial Research Organisation (CSIRO), indicates that since 1970, contrary to the global trend, Latin America has become less efficient in converting its primary resources into income. If the current trend continues, environmental pressures will intensify more rapidly than economic growth. Achieving more efficient use of resources is therefore essential to increasing environmental sustainability and maintaining competitiveness, while it can also be a powerful tool for reducing poverty and inequality.

The report's conclusions are based on the first-ever database of material flows created specifically to cover most of the countries of Latin America[1]. The database uses standardized material flow accounting methodologies to construct empirical evidence of resource productivity in Latin America. The present policy brief only touches on social and economic aspects of the extractive industries that dominate the economies of many Latin American countries. These aspects, however, remain an important concern that deserves serious consideration.

Key messages

- **Mining is one of the foundations of the economy of various Latin American countries. The region's success in international trade has become a determining factor in explaining current pressures on mining resources. Demographic growth and global patterns of production and consumption are driving up demand and extraction of raw materials.**
- **The efficiency with which raw materials are converted into income was 70% lower in Latin America in 2008 (2.84 kg/dollar of GDP) than in the rest of the world (1.67 kg/dollar of GDP). In 1970, the difference was less than 32%. This implies that extractive pressures on natural resources have increased more than the standard of living has risen in the region.**
- **Progress in industrialization and in regulating the mining industry in Latin America has not been sufficient to limit the consumption of raw materials in the last few decades. It is important that a perspective based on the efficient use of resources becomes a part of policy and practice if natural resources and economic growth are to be decoupled.**

UNEP

[1] Available at: http://www.ces.csiro.au/forms/form-mf-la-start.aspx

The quantity of mineral resources extracted in Latin America – including metals such as copper, gold, lead, zinc and silver – has grown significantly in the last few decades (5.5% annually). Production in countries such as Chile, Brazil and Peru has strongly contributed to this growth. In addition to supplying their own domestic markets, these countries exported a major portion of the mineral resources extracted. Net exports of minerals in the region increased by a factor of more than four between 1970 and 2008.

Converting mining exploitation into GDP: an important challenge

Since many ores are processed by various orders of magnitude as the metal is produced, a significant portion of the value of the mineral is exported, while most of the rock and extractive pressures remain in the region. Non-ferrous metals, for example, are generally marketed only after being turned into concentrates or raw metal ingots, rather than being marketed in mineral form. Table 1 shows the commercially profitable minimum concentrations of metals in various ores. It should be noted that the commercial exploitation of iron, which is one of the most abundant metals in the earth's crust, requires high-grade material if it is to be profitable, and to benefit from the greatest possible quantity of raw material. Profitability also depends on factors such as the international price of the metal, as well as the costs of energy and transportation.

Table 1. Some of the principal metals in Latin America

Metals		Minimum grade of material for commercial exploitation	Principal minerals
Ferrous metal	Iron	55% or greater	Hematite
Basic metals	Zinc	5 – 11%	Sphalerite
	Lead	6 – 15%	Galena
	Copper	2 – 4%	
Precious metals	Silver	20 g/ton	
	Gold	2 g/ton	

Note: The grade of a mineral is the concentration of metal that it contains.

Massive growth of mining in Latin America

During the 1990s, regulatory frameworks governing mining in South America were changed to make them more attractive to foreign investors. In most of the countries, however, impact in the form of strong investment portfolio growth has been more recent, taking place in the 2000-2008 period.

The environmental impact of the flow of metallic minerals – calculated here using the IPAT method (Box 1) – increased throughout 1970-2008 (Figure 1). The variation in grades of minerals largely explains this growth, since all of the rock extracted to produce raw metal ingots is counted as part of *domestic material consumption* (DMC). The dominant factor in the increase of the quantity of material used directly in the economy was the extraction of non-ferrous metals, which grew at a compound annual rate of 6.1%.

Box 1. Measuring environmental impact

The use of natural resources in Latin America is driven by various factors. To better understand how this has evolved and what its trajectory may be in the future, it is useful to define and analyze independently the principal driving forces.

An analytical framework often used for this purpose is the ***IPAT*** equation proposed by Ehrlich, P.R. and Holdren (1971):

$$I = P * A * T$$

where

(*I*) is the impact on the environment, which can be defined as an extractive pressure – in this case the domestic material consumption (DMC);

(*P*) is the population;

(*A*) is the affluence, or level of wealth, of the population (per capita GDP); and

(*T*) is the "technological coefficient" or "material intensity", in other words, the efficiency with which an economy is able to convert raw materials into GDP (DCM/GDP).

Figure 2 shows the trend of material intensity (MI) for Latin America. This is an indicator of the efficiency with which an economy can convert materials into GDP. In other words, the lower the MI, the more effective an economy is in producing more (i.e., generating more income) with less material. The divergence of the Latin American trend from the global trend during most of the period analysed is such that, in 2008, Latin America consumed 2.84 kg of materials per dollar of GDP generated. This is 70% more than the world´s average (1.67 kg of materials per dollar). In 1970, the difference in the material intensity between Latin America and the rest of the world was less than 32%.

This implies that one of the initial requirements for diminishing environmental impact while increasing or even maintaining material standards of living has not been met in many of the region's countries, let alone in those countries with non-ferrous metal mining sectors (Box 2).

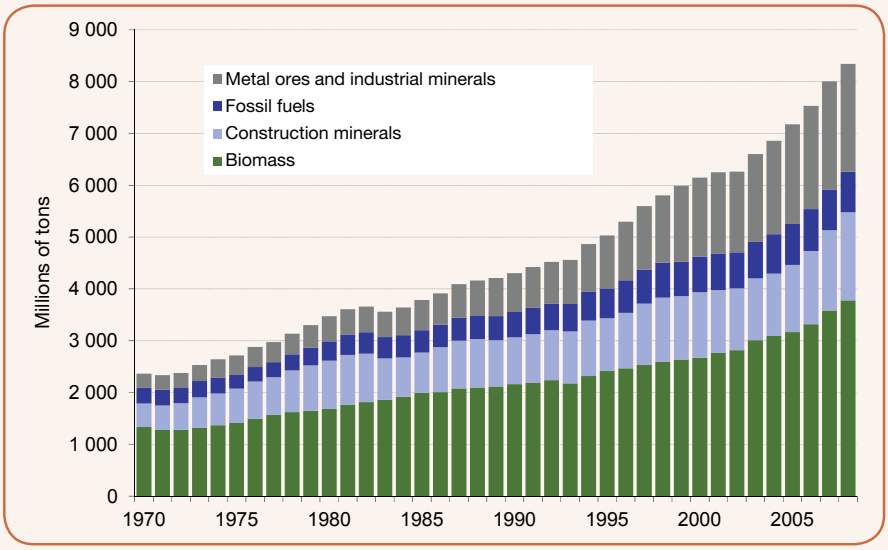


Figure 1. Domestic material consumption in Latin America, by principal categories of materials, 1970-2008

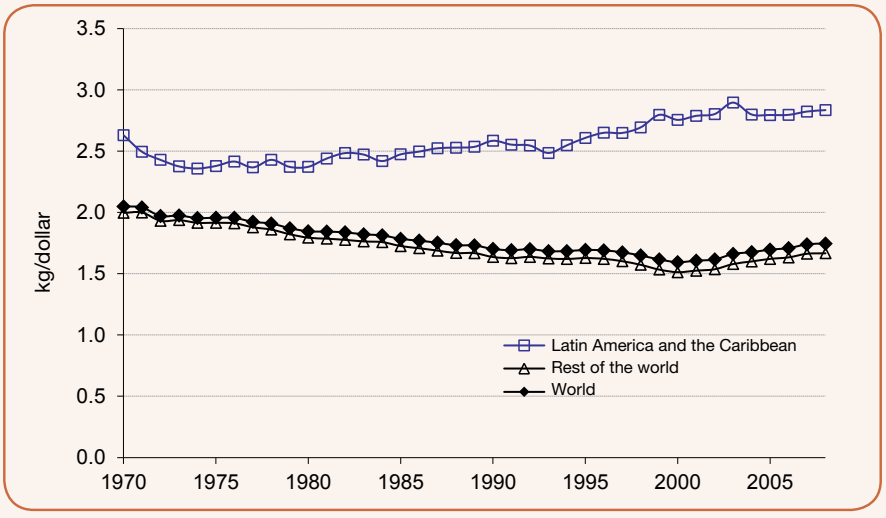


Figure 2. Domestic material consumption per US dollar of GDP (at constant 2000 exchange rate) for Latin America, the rest of the world and the world

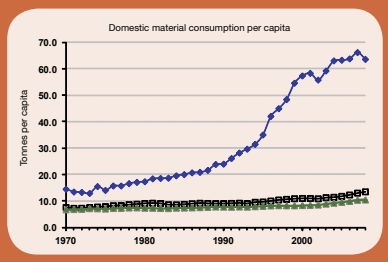
Improving resource efficiency: a pressing need

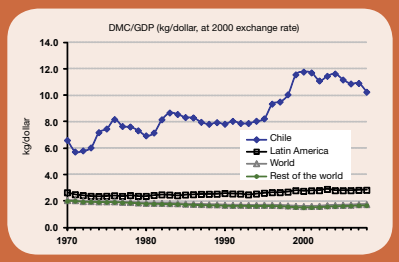
Most of the countries in Latin America have not adopted sufficient measures to improve the efficiency with which raw materials are used, despite having implemented successful initiatives such as cleaner production measures, technology substitution programmes, support for small and medium enterprises in the form of incentives, and the recovery of metals in mines' tailings.

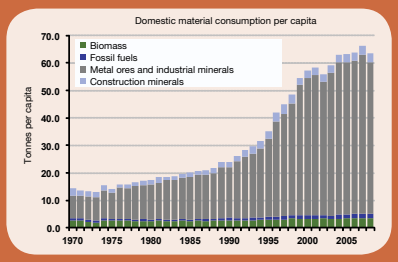
Box 2.
Mineral resources in Chile, Peru and Bolivia: contrasts and similarities

Chile

Chile has, by far, the highest DMC and MI in the region (Figure 3b), due to an enormous increase in the extraction of metallic and industrial minerals (principally copper) for export. As the predominance of copper in the material flows suggests, the long-term rising trend of MI in Chile is the result of a simple interaction between the declining averages of mineral grades and the cyclical variations in the price of copper. A closer look shows that while the considerable rise in Chile's MI during the 1990-2000 decade was the result of increased mining of non-ferrous metals, its decline in the 2000-2008 period may have been heavily influenced by higher commodity prices . Given that Chile's general orientation suggests ever larger exportation of minerals, it will probably be difficult to achieve improvements in the near future.



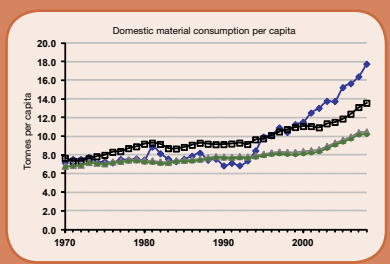


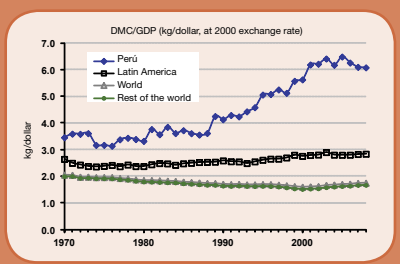


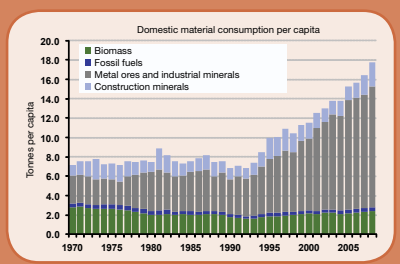
Figures 3a, 3b, 3c. Graphic overview of material flows and intensity in Chile

Perú

Chile's situation provides a good basis for understanding the composition and growth of Peru's DMC. In 2008, the DMC profile in Peru was similar to Chile's circa 1980. In 1970, Peru's DMC lay about midway between the world and regional averages, at 7.2 tons per capita. It grew at a 2.4% compound annual rate, resulting in 17.7 tons per capita by 2008 – 31% above the regional average and 74% above the average for the rest of the world (Figure 4a). Nearly all of this growth (9.6 tonnes/capita) was in non-ferrous metals. As in the case of Chile, the variations in the DMC largely reflect the fact that Peru is functioning increasingly as an extractive hinterland for other, industrialized economies.



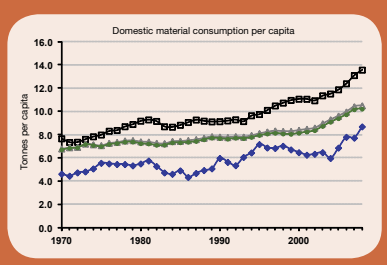


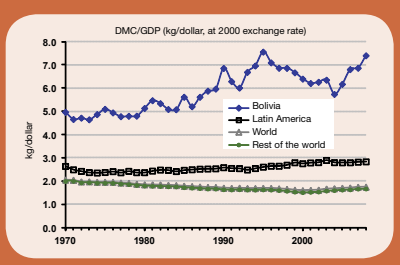


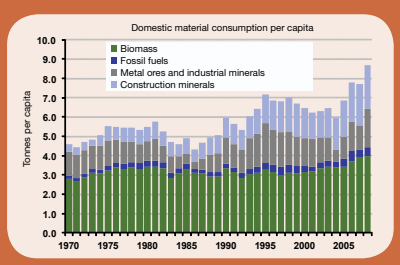
Figures 4a, 4b, 4c. Graphic overview of material flows and intensity in Peru

Bolivia

In 1970, Bolivia had a DMC of 4.6 tons per capita, far below regional and world averages (Figure 5a). Consumption rose 1.7% annually, increasing during the entire period analysed, and reaching 8.7 tons per capita by 2008. This rate of growth was greater than the regional average percentage and average percentage for the rest of the world. However, in 2008 Bolivia consumed approximately 15% less per capita than the average for the rest of the world, and 36% less than the regional average. In the breakdown of the four categories of DMC, metallic and industrial minerals show considerable instability over time. This reflects the extraction of non-ferrous metals, since the estimated 2008 extraction finally exceeded the previous peak, which occurred in 1995.







Figures 5a, 5b, 5c. Graphic overview of material flows and intensity in Bolivia

Looking toward the future: policy options

Latin America is a mineral-producing region and will continue being such in the medium term. Given the major contribution of mining to the economies of various of the region's countries, it is important to promote a comprehensive view of sustainable development ensuring that the development of the mining industry also contributes to improving the quality of life and to equitable social and economic development in mining regions. To that end, public strategies that comprehensively articulate natural resource management with the development of the different productive sectors should be implemented, taking into account the potential and limitations of the natural, social, institutional and human capital available in each country.

Robilliard, C.P. (2005, 2006) suggests that if mining investment occurs in the framework of a sustainable development policy promoted by the State, it can be the factor that gets other productive activities off the ground. For this to happen, it is considered essential to provide stability and guarantees to investors, but at the same time to move forward with policies on taxation, environmental liabilities, mine decommissioning and citizen participation, in order to create the conditions for appropriate community relations, and so that mining development provides benefits beyond the lifetime of deposits and takes place in a perspective of ongoing development (Box 3).

The recycling of metals is a way of mitigating the negative impacts of growing demand. Landfills and dumps accumulate large quantities of products with metals[2] that can be recovered for various uses. Identifying and taking advantage of these and other sources of metals (for example, old metal bridges that are no longer being used) is a key strategy in the transition to sustainable resource management. The development of infrastructure and technology for recycling should be encouraged to exploit the potential for reusing metals and reducing extractive pressures in producer countries.

Also important is funding to generate information and monitor levels of environmental contamination and degradation, and for the use of natural resources. The information should be generated before implementing projects that could significantly alter or impact the environment and natural resources. This means that in addition to earmarked financing, improvements must be made in systems for the monitoring and evaluation of national and regional development projects, as well as megaprojects, incorporating not only indicators of environmental and social impact, but also indicators of the (non)efficiency of the use of resources involved in or affected by the projects or activities in question.

Although much remains to be done in this area, it is essential that policies and practices incorporate a perspective that focuses on the efficient use of resources, and that funding be made available for the purpose. Otherwise, regardless of how much effort is invested by public and private actors at the national or local level in increasing sustainability and efficiency, their efforts will remain isolated.

Analysis of material flows furnishes important information on the scale and impact of mining growth in Latin America, including information that supports and advances efficiency in the use of natural resources. National governments could consider collecting basic data for this type of analysis. That said, it should be stressed that various environmental and social impacts of mining, including those relating to pollution, health and land ownership, are not measured directly through material flows analysis. Given the rapid growth of mining in Latin America, the prevailing economic model and trade relations both within the region and with other regions, there is a need to conduct in-depth studies on mining impacts in Latin America.

[2] In the case of copper, it is estimated to be approximately 225 million metric tons of the metal in landfills (IRP, 2011).

Box 3. Mining development and regional sustainability

Taking resource efficiency into account in mining operations is essential for the sustainability of mining activity. In terms of the relationship between mining and sustainability, the following key issues should be stressed:

- Policies to decouple natural resources and economic growth are important in increasing standards of living without continuing increases in the pressures on the region´s resource base. In the course of their life cycle, materials go through a complex process involving many actors, and accordingly policies can be targeted not only at the phase of extraction or production, but also at consumers.
- Attention is recommended to the management of mining profits so that benefits continue even after the resources have been exhausted.
- Participation of all the actors in the mining cycle is valuable in developing policies that increase socio-economic benefits and reduce environmental impacts, with particular attention to small and artisanal mining and the private sector.
- Another important consideration is the equitable distribution of mining royalties and taxes among the different levels of government and different sectors of society.
- Efforts are needed to strengthen systems of effective regulation, management and environmental impact assessment.
- It is also important to implement effective measures for the disposal of wastes from mining and smelting operations and to enforce other occupational, human health and environmental standards relating to lead, mercury and other substances.

Though they are only touched on in this document, social and environmental considerations are, of course, an important policy consideration for the mining sector. These considerations include minimizing impacts on river and groundwater levels as well as human health problems at sites where former mining and smelting operations occurred.

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