

Biofuels

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 America¹. 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

- **Between 1970 and 2008, total net exports of plant-based raw materials increased by a factor of more than three in the region, due largely to growth of the biofuels sector in Brazil and Argentina.**
- **The growth of the biofuels sector, among other factors, results in continued extraction and use of biomass, at a much larger scale than would be indicated by the level of development of Latin America’s countries.**
- **Biofuels vary in their impact on climate, energy security and ecosystems, depending on the specific processes involved in producing them.**
- **Experience in the region shows that regulatory frameworks play a central role in shaping domestic biofuels markets, and that they should be accompanied by energy efficiency measures.**

Biofuels (bioethanol and biodiesel), which are produced by processing plants, microorganisms and organic wastes, are highly important in current discussions concerning the region's environmental and energy challenges. A number of Latin American countries are among the world's top producers of biofuels and bioenergy. This is due in part to their extensive agricultural activity, to the availability of high-quality land and the relatively low cost of cultivating it. In addition to supplying their domestic markets, a large proportion of the production of these biofuels is for export. The region's net exports of biofuels increased more than threefold between 1970 and 2008, due largely to increased production in Brazil (primarily from sugar cane) and in Argentina (principally from soy and corn). This market is expected to continue growing in the coming decades, driven by high oil prices and government support for development of the energy industry.



An overview of biofuels in Latin America

Material flow accounting (Box 1) focuses on the extraction and consumption of natural resources as key factors affecting an economy's environmental impact. Analysing biomass flows is useful in understanding the development of biofuels over the last 40 years.

Biomass consumption nearly tripled in Latin America between 1970 and 2008. At the start of the 1970s, the region consumed 1.308 billion tonnes of biomass per year, and was using 3.650 billion tonnes per year by 2008, with primary crops as the principal source of supply (Table 1). This growth is attributable to the massive increase in Brazil's sugar cane crop, much of which is used to produce biofuels such as ethanol.

While in absolute terms the consumption of biomass in the region grew, in relative terms the trend has been the opposite: the percentage of biomass in relation to total domestic material consumption (DMC) fell (Figures 1 and 2). The drop in biomass as a percentage of total DMC is typical of economies transitioning from agricultural to industrialized economies. However, the transition to an industrialized economy has been slower in Latin America than in other regions of the world (e.g., Asia and the Pacific), given the large territories involved, the policies favourable to development of the biofuels sector, and accelerated growth in region's mining sector, among other factors.

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).

	1970	1990	2008	2008/1970
Primary crops (e.g., grains, root and tuber crops, nuts, fruits, etc.)	440	754	1305	3.0
Crop residues	364	595	1152	3.2
Pasture biomass	359	571	901	2.5
Wood	145	198	293	2.0
Total	1308	2118	3650	2.8

Table 1. Total changes in biomass DMC in Latin America, 1970-2008, broken down into 4 sub categories of biomass. In millions of tonnes.

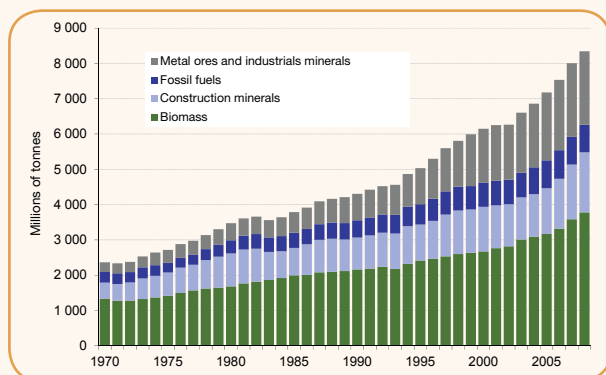


Figure 1. Domestic material consumption in Latin America, by principal category of materials.

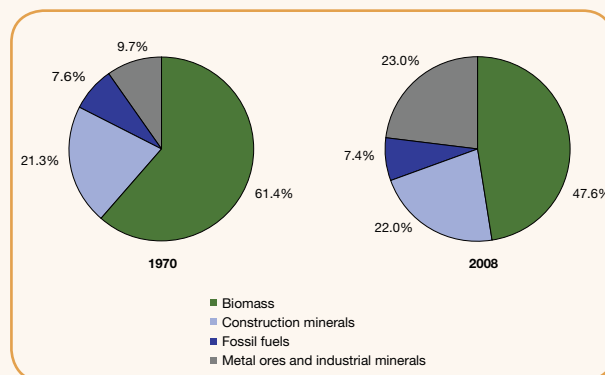


Figure 2. Percentage change in domestic material consumption in Latin America for the principal categories of materials.

Factors affecting development of the biofuels sector in Latin America since 1970

Spurred by strong agricultural potential and high-quality land, biofuels production has a long tradition in many Latin American countries. However, its systematic, articulated use as a sector of the economy first occurred in Brazil in the 1970s, in response to the first oil shock. In the following decades, various countries in the region (principally the Mercosur countries and Mexico) established standards, and mandated a mixture of biofuels and fossil fuels. Combined with population growth and increasing wealth, the favourable regulatory framework contributed to creating and/or expanding

domestic biofuels markets in a number of the region's countries.

Despite interest in replacing imported fuels, the sector's performance throughout the region also signals a significant potential for production aimed at the foreign market, with Argentina and Brazil as the principal exporters. International trade in ethanol and biodiesel began on a small scale, but is growing rapidly in countries like Brazil, which exported a record 5 billion litres of ethanol fuel in 2008.

Biofuels and environmental impact

Different types of biofuels can have different impacts on climate, energy security and ecosystems, depending on factors such as:

- Mode of production (e.g., farming in deforested areas or abandoned land)
- Energy efficiency (amount of energy obtained per litre of biodiesel or per hectare)
- Competition between sugarcane or grain monocultures and food crops

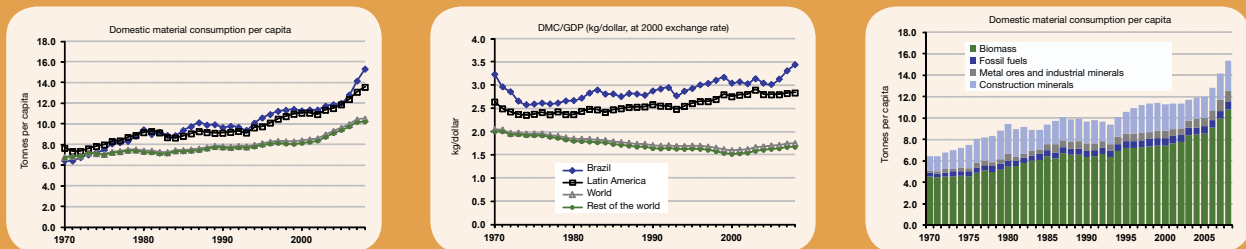
Formulating public policy for the biofuels sector is therefore a complex, multidimensional process.

According to (CEPAL, 2008), the regulatory framework for biofuels in Latin America has often failed to consider the impact that the development of the sector can have on agriculture, on natural resource use and on social welfare, as well as its effects on food prices and poverty reduction. Since the main sources of biomass are crops traditionally grown for food or feed (such as sugarcane, sunflower, soy and rapeseed), increased biofuels production can result in higher food prices.

Box 2. Biomass flows in Brazil and Argentina

Brazil

In 1970, domestic material consumption in Brazil was 6.4 tonnes per capita, close to world averages. It grew at a 2.3% annual rate, reaching 15.3 tonnes per capita by 2008, approximately 50% above the world average (Figure 3a). While countries in transition from agricultural to industrial economies normally experience a reduction in biomass as a proportion of DMC, 70% of the increase in Brazil is attributable to biomass. Thus, biomass as a percentage of Brazil's total DMC remained practically unchanged between 1970 and 2008, primarily because of the fact that the production of sugar and raw material for biofuels occurred at a sufficiently large scale to meet much of the demand required for local transportation, while at the same time making Brazil the world's largest exporter of ethanol. In 2009, Brazil's ethanol industry suffered severe setbacks as a result of a variety of factors, most notable among these being the international financial crisis of 2008. For the first time since 1990, Brazil had to import corn-based bioethanol from the United States. The use of ethanol in transportation fell from 55% in 2008 to 35% in 2012 (Angelo 2012).

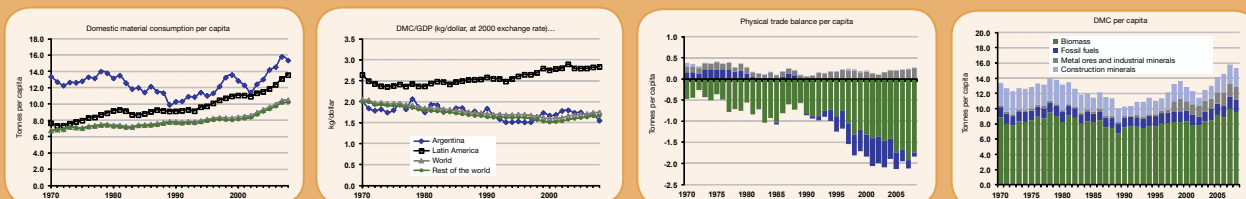


Figures 3a, 3b, 3c. Graphic overview of material flows and intensity in Brazil

From the policy perspective, the Brazilian government, the private sector and other stakeholders have been closely attuned to the debate on the “food-fuels-forest resources” competition. Social and environmental safeguards were developed to address these concerns, e.g., the creation of the “social fuel seal”, which certifies that at least 40% of production comes from small growers, a measure designed to help increase their incomes.

Argentina

At the beginning of the 1970–2008 period, Argentina's per capita domestic material consumption (DMC) was 75% above the regional average. During the last three decades of that period, however, the country's per capita DMC converged towards the regional average (Figure 4a). The erratic trajectory of the per capita DMC reflects the instability of the biomass component. This is even more evident in the physical trade balance, where biomass represents the majority of Argentina's net exports in all years (Figure 4c). The country's net biomass exports have grown, in proportional terms, far more rapidly than has the domestic consumption of biomass. The increasing importance of agricultural exports (including soy products) may explain why, despite Argentina's high level of development relative to other countries in the region, the proportionate role of various materials categories is more typical of countries that have only recently transitioned to an industrial economy.



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

Continued previous page

Seeking to reverse the mix of the country's 90% fossil-fuels-based energy supply, the Argentine government instituted a specific regulatory framework in 2006 to encourage the production and use of biofuels in its territory (UNEP, 2011). Supported by the country's competitiveness in soy production, Argentina has also become one of the world's major exporters of biodiesel. However, its achievements in the biofuels export sector could be jeopardized if the regulatory framework and the national authorities fail to address the requirements of foreign markets, which often demand environmental impact certifications and the use of "second generation" technologies that do not compete with food crops.

Policy options

Developing energy sources through the production of biofuels involves various challenges for the region's countries. These challenges vary according to the countries' characteristics and the types of biofuel concerned. Experience shows that what is common to all of the countries is the need to advance research efforts and to consider technological options capable of resolving the biofuels-versus-environmental-protection, and/or the biofuels-versus-food-production, dilemma.

Moreover, active consideration must be given to the sector's long-range sustainability, given the increasing environmental and technological demands of foreign markets. Importing countries (e.g., the United States and the European Union) are demanding certifications of environmental impact and "second generation" technologies (i.e., fuels produced from raw materials that are not food sources). Meeting these demands can be a long and costly process, since competitiveness requires creating institutions, knowledge and proactive long-range attitudes. However, failing to respond to these demands could seriously endanger competitiveness and jobs, as well as creating negative

environmental and social impacts over the medium term. The Babethanol project, a joint research project involving 13 institutions from 11 European and Latin American countries, aims to develop an innovative and sustainable second-generation process of bioethanol production based on agricultural and forestry residues, and is a valuable example of how these concerns can be effectively addressed (CIEMAT, 2013).

Also of note is the central role played by regulatory frameworks in the formation of domestic biofuels markets. Such markets arise as a result of energy policy decisions that mandate a mix of biofuels with fossil fuels, as well as from provisions involving the adaptation of vehicles. According to (Altamonte, H., 2012), although the South American countries have made major advances in the realm of regulation, the countries of Central America are exporting ethanol but have no regulatory instruments governing their domestic markets. In addition to mandatory fuel mixtures, the State's regulatory role is important in: (i) reducing economic barriers; (ii) establishing institutions concerned with renewable energy, including biofuels;



(iii) reducing financial barriers, including providing access to development loans and lowering transaction costs; and (iv) overcoming social barriers.

Lastly, regulatory support for biofuels supply must be accompanied by more efficient energy use. Thus, promoting energy efficiency measures needs to be a priority in the region.

Box 3. Biofuels and sustainability

A number of production-related factors are important in gauging the sustainability of biofuels production. These include:

- a) Direct and indirect changes in land use
- b) Resulting socioeconomic benefits
- c) Potential impacts on the availability and quality of water
- d) Impact of the use of fertilizers and agrochemicals used in biomass production
- e) Net positive carbon balances
- f) Loss of biodiversity
- g) Efficient use of biomass and biofuels

References

- Altamonte, H. (2012). Biocombustibles en América Latina: la perspectiva de CEPAL. Presentación. Comisión Económica para América Latina y el Caribe (CEPAL).
- Angelo, C. (2012). Growth of ethanol fuel stalls in Brazil. *Nature* 491: 446 – 447
- CEPAL (2008). Biocombustibles líquidos para transporte en América Latina y el Caribe. Colección documentos de proyectos. Comisión Económica para América Latina y el Caribe (CEPAL), 187 p.
- CIEMAT (2013). Proyecto internacional BABETHANOL. Official website. Online at: <http://www.ciemat.es/portal.do?IDM=61&N M=2&identificador=197>
- Ehrlich P.R. and Holdren, J.P. (1971). Impact of Population Growth. *Science*, 171, 1212 – 1217.
- IEA (2010). Sustainable Production of Second Generation Biofuels. Online at: www.iea.org/papers/2010/second_generation_biofuels.pdf
- UNEP (2011). Resource Efficiency in Latin America: Economics and Outlook. UNEP/Red Mercosur.
- UNEP (2012). GEO-5: Global Environmental Outlook.
- UNEP (2013). Tendencias del flujo de materiales y productividad de recursos en América Latina. Available at: http://www.pnuma.org/MFA_espanol%20low%20res.pdf

United Nations Environment Programme, Regional Office for Latin America and the Caribbean

This policy note is based on the UNEP publications “Recent Trends in Material Flows and Resource Productivity in Latin America”, authored by Heinz Schandl and Jim West, The Commonwealth Scientific and Industrial Research Organisation (CSIRO), and “Resource Efficiency in Latin America: Economics and Outlook.”

Production team: Charles Davies, Suzanne Howard, Maia Leclerc and Andrea Salinas

Special thanks to Luisa Madruga for assistance in revising the text

December 2013