State of Play for Circular Built Environment in Latin America and the Caribbean

Countries considered:
Argentina, Brazil, Chile, Cuba, Ecuador and Mexico

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One Planet Network

The One Planet network has been formed to implement the 10-Year Framework of Programmes on Sustainable Consumption and Production (SCP), which supports the global shift to SCP and the achievement of SDG 12. The One Planet Network acts as an enabler bringing actors from all regions to pool their expertise, resources, innovation and commitment towards a shift to more sustainable modes of production and consumption. The network comprises of six programmes: Sustainable Public Procurement, Sustainable Buildings and Construction, Sustainable Tourism, Sustainable Food Systems Programme, Consumer Information for SCP, Sustainable Lifestyles and Education.

Sustainable Buildings and Construction Programme

The Sustainable Buildings and Construction Programme (SBC) aims at improving the knowledge of sustainable construction and to support and mainstream sustainable building solutions. Through the programme, all major sustainable construction activities can be brought together under the same umbrella. The work involves sharing good practices, launching implementation projects, creating cooperation networks and committing actors around the world to sustainable construction. The goal of the programme is to promote resource efficiency, mitigation and adaptation efforts, and the shift to SCP patterns in the buildings and construction sector.

State of Play Reports

The Sustainable Buildings and Construction Programme has been preparing regional reports on the state of play for circular built environment in Africa, Asia, Europe, Gulf Cooperation Council countries, Latin America and the Caribbean, North America, and Oceania. In addition to regional outlooks, a global report has been produced to summarise and compare the state of play regarding circularity in different regions. A crucial role of the reports is not only to provide a benchmark but also recommendations on how to move forward towards a sustainable and circular built environment.

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CDW	Construction and demolition waste
CEPAL	Comisión Económica para América Latina y el Caribe
CONAMA	National Council for the Environment
ECLAC	Economic Commission for Latin America and the Caribbean
EMGIRS-EP	Empresa Pública Metropolitana de Gestión Integral de Residuos Sólidos
GDP	Gross domestic product
GHG	Greenhouse gas
GWMO	Global Waste Management Outlook
IDB	International Development Bank
LAC	Latin America and the Caribbean
MADS	Ministerio de Ambiente y Desarrollo Sustentable de Argentina
MAE	Ministerio del Ambiente
MINVU	Ministerio de Vivienda y Urbanismo
MVCT	Ministerio de Vivienda, Ciudad y Territorio
MWh	Megawatt hour
OECD	Organisation for Economic Co-operation and Development
RENAREC	National Network of Recyclers
SEMARNAT	Secretaría del Medio Ambiente y Recursos Naturales de Mexico
UNEP	United Nations Environment Programme

Executive summary

More than 620 million people in the LAC region need energy, water, food and housing. This bibliographic review provides a summary of the circular economy initiatives in the region.

About 1 kg of waste per day per person is produced and only 10% of that waste is recycled or recovered. Open-air dumpsites are commonly observed and generate greenhouse gases and leachates. About 80% of the population of the LAC region live in urban areas, putting pressure on the disposal of waste, including construction and demolition waste, and impacting protected areas and urban forests. The lack of product lifecycle studies prevents the municipalities from quantifying the social, economic and environmental impacts of construction and demolition waste. The LAC region is exposed to natural disasters that also generate construction and demolition waste and most countries do not have contingency plans for such disasters. Water used in construction processes is discarded directly as sewage without any treatment.

Solid waste management practices are scarce and only about 20% of all municipalities have waste management plans. Informal recyclers ('waste pickers') often recover materials from open dumpsites. Policies on construction and demolition waste disposal and reuse vary from country to country. There are many difficulties in implementing construction and demolition waste recovery programs/initiatives due to the low cost of dumping such waste. No or few incentives and the lack of regulations and knowledge among architects and contractors make the recycling and reuse of construction and demolition waste a very difficult prospect. Reverse design and future proofing are unknown concepts in the region. Government tenders do not require these concepts and there is no modular or flexible construction.

'Social interest housing' programs have led to urban sprawl and greater segregation, creating new pockets of poverty and exclusion on the periphery of big cities. Base recyclers undertake between 25% and 50% of all recycled municipal waste collection in the LAC region, and in so doing they reduce the costs of transporting waste, reduce the need to extract raw materials and provide environmental and public health benefits and local jobs, albeit in the informal economy. Construction and demolition waste reduction must involve all stakeholders: government, homeowners, architects, interior designers, suppliers of construction materials and energy companies. Universities must lead the way in research on the economic and environmental advantages of using construction and demolition waste in the long term. Education and training at all levels will ensure the circularity of construction and demolition waste management. Local governments must provide incentives to contractors who use responsibly sourced construction materials, including recycled construction and demolition waste. Governments must regulate such that recycled aggregates arising from construction and demolition practices are competitive in terms of price. The public sector is the biggest builder in the region and must lead by example and show leadership to the private sector.

1. Introduction

More than 622 million people live in Latin America and the Caribbean (LAC) region (Economic Commission for Latin America and the Caribbean [ECLAC], 2016). From south of the United States to Ushuaia in Argentina, governments are under pressure to respond to ensure adequate services, food and housing for growing urban populations in some of the most diverse geological places and climatic regions.

This report is a verified bibliographic and information review of circular economy initiatives in the area of building and construction and related issues in Latin America, with a focus on the following countries: Argentina, Brazil, Chile, Colombia, Ecuador and Mexico. These countries are a representative sample of the types of economies found in this region.

This report provides a summary of the current circular economy initiatives in the LAC region, public policy proposals and examples of companies and individuals working on the subject, with a particular emphasis on the construction sector. The issues covered range from responsibly sourced construction materials to the final disposal of building and construction materials and related waste.

Finally, recommendations are provided for building industry stakeholders to apply solid waste management policies for the benefit of the population and in compliance with the objectives of sustainable development.

2. Waste generated in the region

This section presents the current state of play with regards to waste generated in the region.

2.1 Population

Every person in Latin America generates an average of 1 kilogram per day of garbage. The entire LAC region generates more than 540,000 tonnes of waste per day, which represents about 10% of the world's garbage. One third of the waste ends up in open dumps and only 10% is reused or recycled (ONU Ambiente, 2018).

It is expected that, by 2050, the generation of waste will reach 670,000 tonnes per day, due to the increase in population and growing urbanisation (80% of people will be living in cities by that time in LAC), economic growth, and a significant number of people joining an incipient middle class, leading to clearly unsustainable patterns of production and consumption linked to current economic patterns of linear growth. These are some of the factors causing the constant increase in the generation of waste observed in the region (ONU Ambiente, 2018).

The population of the LAC region is expected to continue to grow until 2059 (ECLAC, 2016). By far the largest countries in the region, in terms of territory and economy, are the most populated – Brazil, Mexico, Colombia, Argentina and Peru. It is interesting to note that only Cuba's population will decline by 2025, while all other countries in the LAC region are expected to keep growing up. Figure 1 provides the population of the LAC region by country.

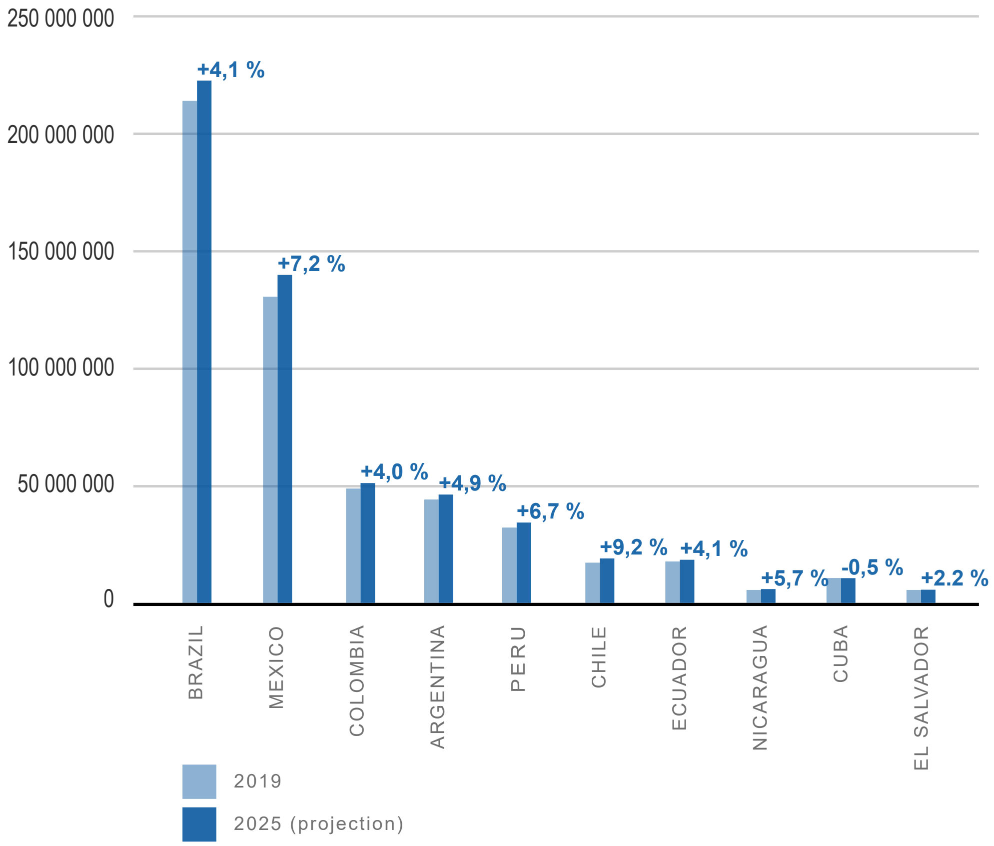


Figure 1: Population of the LAC region by country, 2019 and 2025 (in mid-year)

Source: ECLAC (2016)
Graphics: Ninni Westerholm

Although garbage collection reaches 90% in certain countries, only 10% of waste is recycled or recovered in LAC region. More than 50% of waste generated is organic and could be used for composting. Open-air dumpsites generate greenhouse gases (GHGs) and leachates that pollute air, soil and water. According to the Global Waste Management Outlook (GWMO) (United Nations Environment Programme [UNEP], 2015), costs to society and the economy as a whole derived from the improper management of waste are 5 to 10 times the cost of implementing proper waste management in a middle- or low-income city (ECLAC, 2016).

2.2 Domestic and urban solid waste

Domestic and urban solid waste includes waste from households, smaller businesses and institutions. It may include waste from mining and quarrying, and agricultural and forestry (UNEP, 2015). It does not include hazardous waste generated at houses (like mercury-based light bulbs). Some urban waste can be converted into construction materials, such as old jeans being converted into insulation material. Also, some urban waste can be used to generate energy.

2.3 Agricultural and forestry waste

Traditionally, a small farmer's agricultural practice would generate no waste: everything is reused or recycled in the form of compost, energy or biomass. With the intensification of agriculture, whether or not to include such materials in national waste control regimes has become a higher profile issue as increasing quantities of crop residues are being used as biomass for energy generation (UNEP, 2015). Husks and fibre produced by industrial agriculture processes can enter the building process as construction materials, similar to the use of hemp shives for pre-cast concrete blocks known as 'hempcrete'. Biogas resulting from biomass decomposition is a very well-known source of energy. Energy can also be produced by incineration of biomass. Fly-ash from the incineration of rice husks can be used to produce pozzolanic cement.

2.4 Industrial waste

Non-agricultural-related industries generate very different by-products, many of which can be reused or transformed into suitable construction materials, such as the use of metal, plastic and fly-ash to make pozzolanic cement.

It is beyond the scope of this report to include an in-depth classification and definition of all types of waste. However, it is important to note that, in a circular built environment, waste is a resource for other processes.

3. Economy of the LAC region

The LAC region, as is the rest of the world, is facing highly complex economic problems. The decline of developed economies and the trade and diplomatic tensions between the United States, China and Russia do not bode well for the coming years.

For 2018, economic growth across the LAC region was estimated at 1.2%, representing a slight deceleration with respect to the 1.3% reached in 2017. Economic growth has weakened in South America (from 0.8% in 2017 to 0.6% in 2018) as well as in Central America, Cuba and Haiti (from 3.4% to 3.2% for the same period). Mexico has grown at a slightly higher rate, from 2.1% in 2017 to 2.2% in 2018; while in the Caribbean recovery from the impact of the natural disasters of 2017 contributed to an acceleration of growth (from 0.2% in 2017 to 1.9% in 2018) (ECLAC, 2018). The gross domestic product (GDP) of all LAC countries is expected to keep growing, largely due to an increase in internal consumption. GDP per capita for selected countries is shown in Figure 2 and total investment as percentage of GDP is shown in Figure 3.

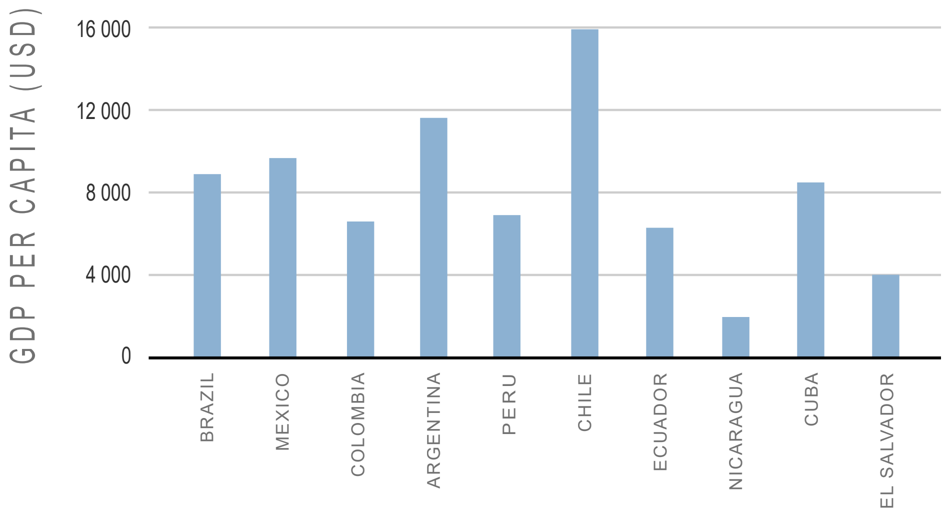


Figure 2: GDP per capita 2018 (USD)

Source: OECD et al. (2019)[1]
Graphics: Ninni Westerholm

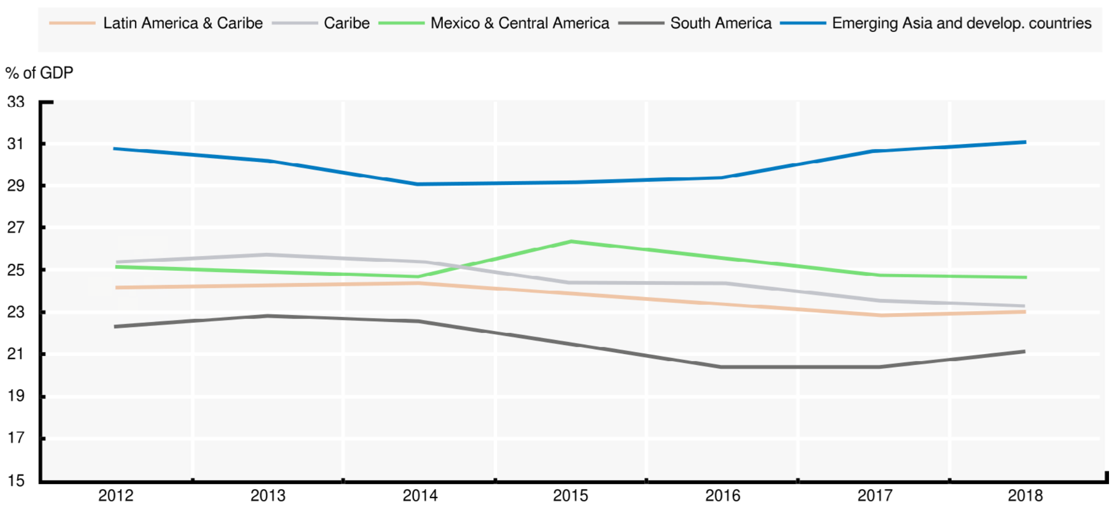


Figure 3: Total investment as % of GDP, simple average.
NB. Venezuela not included; forecast for 2018.

Source: OECD et al. (2019)

1. World Bank national accounts data, and OECD National Accounts data files.

There are large differences observed between the LAC country with the highest GDP (Cayman Islands, at USD56,334.20) and that with the lowest GDP (Haiti, at USD868.3), representing a variation 64.88 times bigger.

Since 2011, the LAC region as a whole has suffered an economic slowdown associated with slow job creation and prolonged unemployment (OECD et al., 2019).

For the whole LAC region, the manufacturing industry has failed to consolidate the recovery seen in 2017 and the stronger growth rate of 2018, and shrank in the first quarter of 2019, reflecting poor performances in Argentina (-11%) and Brazil (-1.7%). At the same time, the mining sector continued the contraction begun in the fourth quarter of 2015.

This chiefly reflects the continual decline in mining production in Venezuela, Mexico, Guatemala and Ecuador for 23, 18, 11 and 9 straight quarters, respectively, as well as downturns in mining in Chile, Peru and Bolivia. The decline experienced in the construction sector is in line with the contraction of investment in mining assets across the LAC region (ECLAC, 2019). Figure 4 shows the GDP growth rates of economic activity by sector in Latin America, 2015-18.

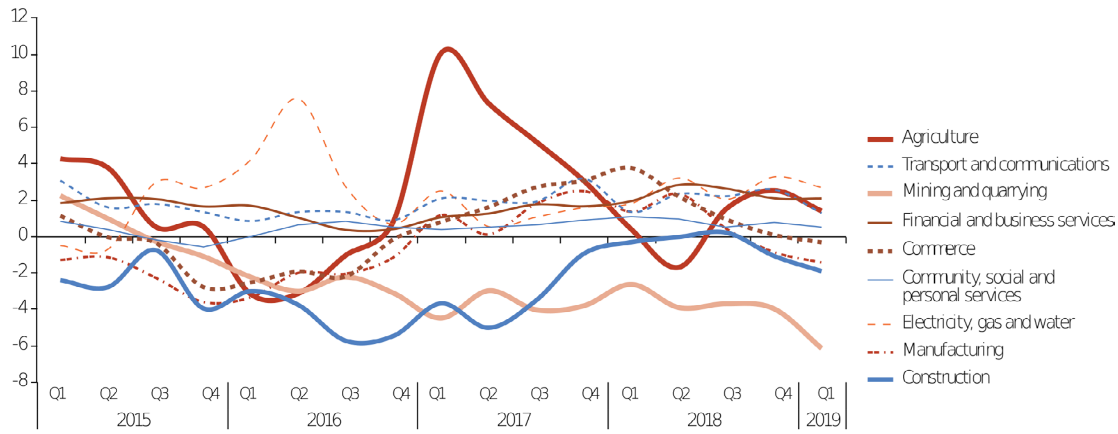


Figure 4: GDP growth rates of economic activity by sector in Latin America, 2015-18 (percentage change with respect to previous year)

Source: ECLAC (2019)

4. Impact of the built environment

The LAC region is one of the most urbanised regions on the planet, with 80% of people living in cities. This puts pressure not only on the provision of basic services but also on the disposal of waste, including construction and demolition waste (CDW). The growth of cities often involves construction on steep slopes and in protected areas or urban forests. More than 2400 square kilometres of protected areas were lost to urban growth in the region from 1996 to 2010 (Duque et al., 2019).

During the 2017–19 period, together with trade, the construction sector experienced the least amount of progress in the region against other sectors (see graphic below), despite having shown positive growth figures for three consecutive quarters in 2018. The impact took the form of a low rate of job creation (0.5%) in 2018; but this was positive because 2017 had seen a contraction of 2% in the number of jobs in the construction sector. Much of the recovery during 2018 was due to the investment in infrastructure and housing that followed the natural disasters of 2017 in Central America and the Caribbean. The socio-political crisis that occurred in Nicaragua in 2017–19 had a significant negative impact on economic activity (-4.1% GDP growth).

Figure 5 compares the interannual variation by branch of activity over the 2017–18 period. The figures reflect the average for the year 2017 and from the first to the third quarter of 2018, by percentage.

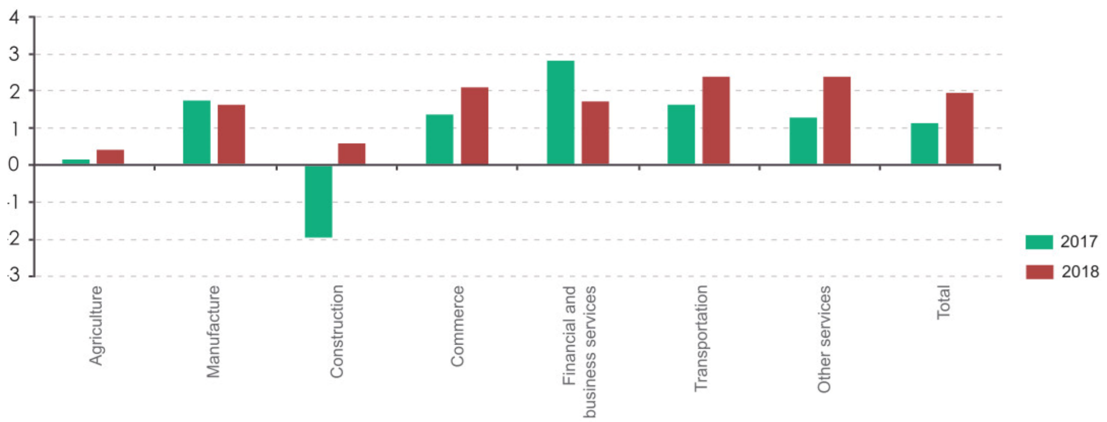


Figure 5: Sectoral variations annually, 2017-18

Source: CEPAL (2019)

Between 1993 and 2016, construction accounted for an average of 12% of GDP for Latin America; machinery and equipment accounted for a 6.7% growth rate while the total construction growth rate was 1.8% (ECLAC, 2018).

Latin America is highly dependent on concrete and steel for residential building construction, see Figure 6. The geographic variability of the LAC region impacts on the choice of construction materials (UNEP, 2018).

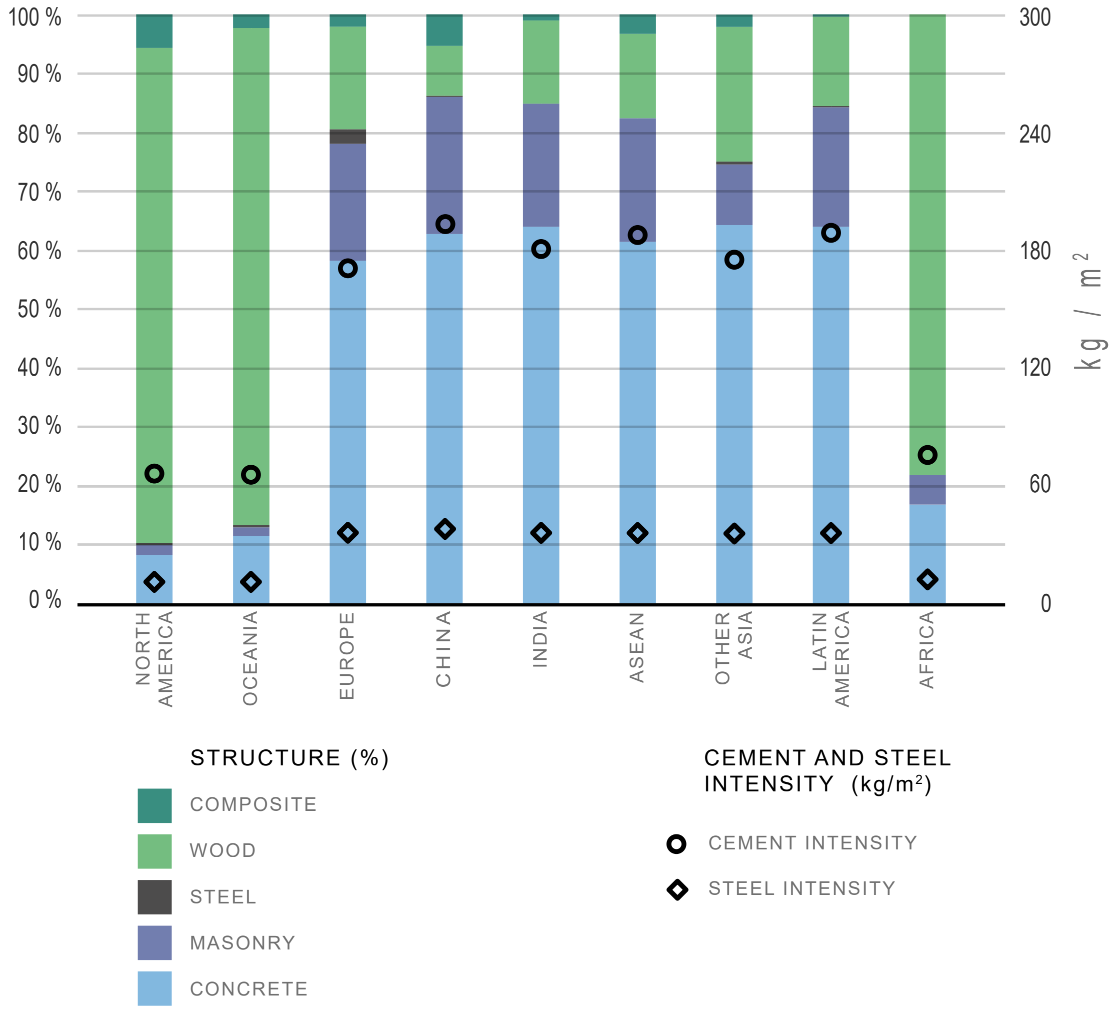


Figure 6: Global residential building structure material and material intensity, 2017

Note: ASEAN stands for the Association of Southeast Asian Nations; North America comprises Canada, the US and Mexico. Cement intensity and steel intensity refer to the average cement and steel consumption required to build 1 m² of residential floor area (in kg/m²). Masonry buildings are made of hard units such as bricks, stones or blocks sealed together with mortar. Composite buildings use several materials as structural elements (e.g. a steel structure with a concrete core).

Source: UNEP (2018)
Graphics: Ninni Westerholm

In Argentina, located close to Buenos Aires, is the Complejo Ambiental Norte III, a solid waste treatment facility that receives 16,000 tonnes of urban solid waste generated daily in the city of Buenos Aires and across 31 other municipalities in the province, accounting for 90% of the waste generated in the Greater Buenos Aires region. The Complejo Ambiental Norte includes a tyre recycling plant, a composting plant, a mechanical-biological treatment plant, and a degasification plant that generates 15 MWh of energy. All the installations of Complejo Ambiental Norte III reduce 1,048,068 tonnes/year of CO_2. This facility shows the positive impacts that can be generated from initiatives that are based in the local economy, and use local labour and materials where possible.

The lack of product lifecycle studies prevents the municipalities and respective agencies within the countries of the region from quantifying the social, economic and environmental impacts of CDW.

Natural disasters are also a source of CDW; and they often occur in the same locations, leading to the recurrence of impacts. Geohazards in the form of earthquakes have been identified as sensitive seismic areas along the Pacific coast of all the Americas that are due to the Pacific Ring of Fire. Other natural disasters such as tropical storms and hurricanes occur only in certain geographical areas in the region, often in the Caribbean and North Atlantic. However, the combined risks from natural disasters are present in all the LAC countries (ECLAC, 2015).

As an example, in Ecuador, in April 2016, a 7.8-Mw earthquake affected more than 24,000 buildings. More than 2,370,000 tonnes of debris were dumped in open landfills in places designated by the authorities. The emergency response revealed the lack of contingency planning for these kinds of natural disasters.

Comparing a high-income urban commune in Santiago de Chile (Vitacura) with a low-income peri-urban commune (Curacaví), it has been illustrated that the first municipality generates five times more solid waste per capita yet does not have its own solid waste disposal facility, while the second generates less waste and is one of the poorest communes in the capital, and has two illegal landfills (Montero and García, 2017).

Water is also used for almost all construction processes use and is discarded directly as sewage without any treatment. Despite this, there has been a significant expansion of urban wastewater treatment throughout LAC, although it remains at a very low level. In the 2005–15 period, such treatment increased from 14% to 33% of all wastewater. There are currently many treatment plants out of operation or abandoned due to inadequate economic resources and operational capacity in LAC. As a result, many bodies of water, especially those near large cities, are highly contaminated – a situation that, at the local level, constitutes a critical problem in terms of public health. The Inter-American Development Bank estimated the investments required for wastewater treatment in the LAC region at USD17.7 billion (Willaarts, Garrido and Llamas, 2014). On the other hand, it is also necessary to invest in local treatment systems such as bio digesters and filters, to service populations living in areas that are not connected to the central waste facilities, and which have less pollution (Montero and García, 2017).

As clearly shown in Figure 7, in general, countries with high GDP produce more solid urban waste.

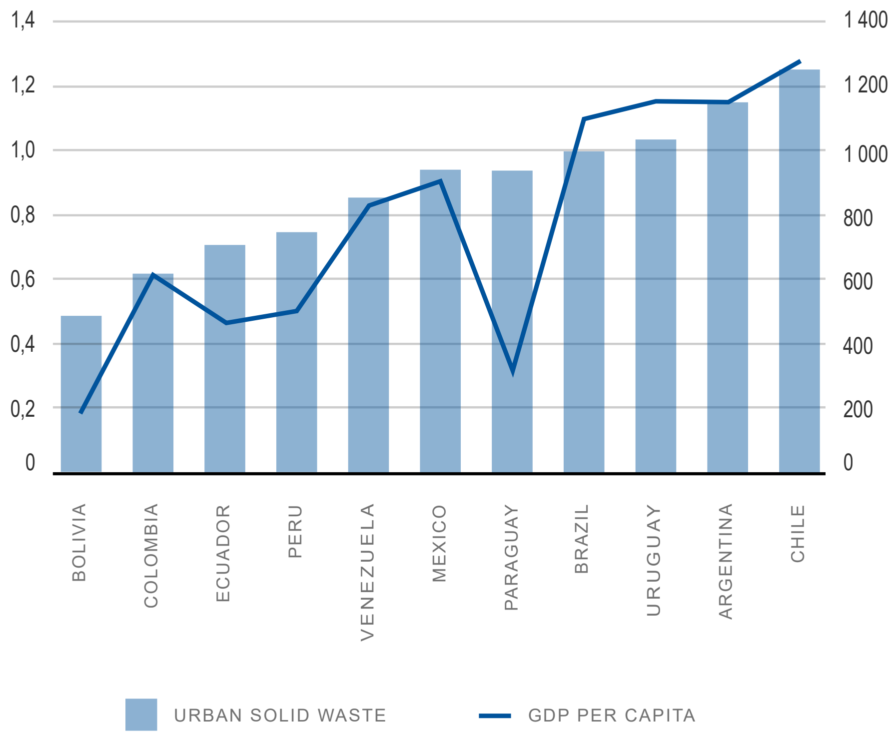
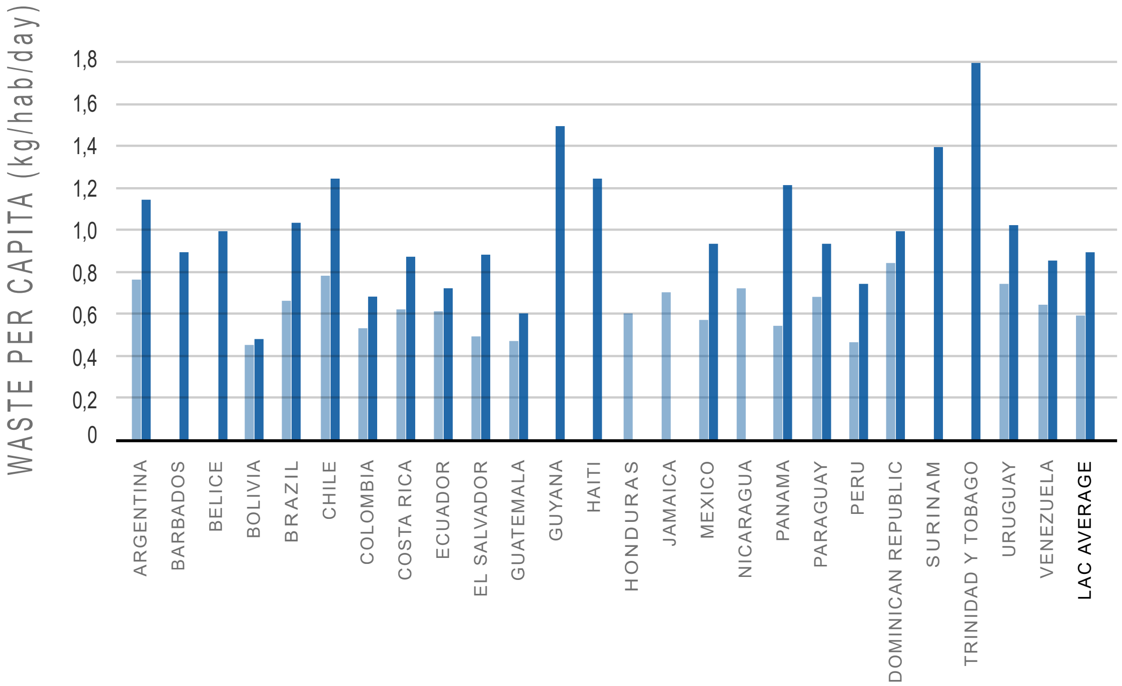


Figure 7: Link between solid urban waste and GDP per capita for LAC countries

Source: CEPAL (2019)
Graphics: Ninni Westerholm

In most of the cities throughout the LAC region, the municipality collects waste without separation, and there is generally only one recipient for all waste. Only 19.8% of all the municipalities have established solid waste management plans (Grau et al., 2015). Figure 8 shows the waste per capita in the LAC region. It is not common for residual waste to be separated, although informal recyclers do undertake this work sometimes – all the waste goes to a dump site where these informal recyclers can then separate the waste into streams that have some potential value.



URBAN SOLID WASTE

Urban (or municipal) solid waste refers to solid or semi-solid waste from urban centres in general, including from households, commercial and service activities, institutions, markets, non-hazardous hospital waste, from industries' commercial offices, from streets and public areas' sweeping and cleaning, and from street, public garden and public square tree and plant pruning.

URBAN HOUSEHOLD WASTE

Urban household waste refers to solid or semi-solid waste exclusively of residential origin caused by human activities within households.

Figure 8: Waste per capita in the LAC region

Source: BID (2015)
Graphics: Ninni Westerholm

5. Construction and demolition waste

In Ecuador, CDW is not separated at the source and therefore it is difficult to classify and recover the waste. In Quito, the country's capital, which has 2.5 million inhabitants, there are only three authorised landfills: one south, another north of the city and one more for the valleys east of the city (Valle de Los Chillos, Cumbayá and Tumbaco). According to the official website of the Metropolitan Public Company of Solid Waste Management (Empresa Pública Metropolitana de Gestión Integral de Residuos Sólidos – EMGIRS-EP), these landfills are open Monday to Friday from 8:00 am to 5:00 pm, and only the southern location opens on Saturday from 8:00 am to 1:00 pm. Builders must transport construction debris to the dump site themselves.

The EMGIRS-EP charges USD0.57 per cubic metre of sand, gravel, stones, small stones, asphalt, concrete, bricks, cement, steel, iron, metallic fences, wood, soil, excavation subsoil, or broken or damaged ceramic parts. The biggest dump site has a volume of 2,67,193 cubic metres. Informal base recyclers collect only some of the plastic bottles (made of polyethylene terephthalate) and other plastics, iron scrap and glass from construction debris before the rest goes into the dump site.

In Guayaquil, the biggest city of Ecuador, inhabited by over 3 million people, there are only two dump sites for construction debris. The municipality can collect the debris on site, but a payment is required for this service. In Quito, only plastics, iron scrap and ceramics are separated for recycling.

In Colombia, and only in Bogotá, CDW production is about 2000 kg per person per year, of which only about 10% is recycled; whereas in countries with similar amounts of debris production, the recycling rate is as high as 60%. In general, there is little or no onsite separation of CDW. Reusable parts such as windows, doors, floor tiles, roof tiles or even used bricks are sold in junkyards. Between 2010 and 2016, the demand for CDW space grew by 17% (Pinzón, 2019), demonstrating an increase in the use of materials and the attendant generation of waste.

In Brazil, about 35 million tonnes of cement are produced every year. With aggregates, 210 million tonnes of concrete are used. Sand and small aggregates have become scarce near the big cities. Near Sao Paulo there are no sand mines, so sand must be transported from 100 km or more, increasing costs and CO_2 production. Also, two-thirds of all the wood produced ends up in housing construction, but reforestation is not prioritised within public policy. Based on current estimates, copper and zinc reserves in Brazil are expected to last for about 60 years (CAMIC, 2017). In 2016 alone, 123,619 tonnes of CDW were collected per year (IBGE/Banco Mundial, 2016).

Mexico City generates 7000 tonnes of CDW (Secretaría del Medio Ambiente y Recursos Naturales de Mexico [SEMARNAT], 2013) every day. Despite this, there are only two authorised dump sites, both located at the outskirts of the city, increasing transportation costs, truck noise, CO_2 and pollution. One of the sites is a private recycling plant that only operates at 10% capacity and the other one is only a 'transfer station' to other processing plants further away, again generating more traffic, noise, pollution and costs.

The overall reuse and recycling of CDW in the LAC region is minimal. Less than 10% of residues are being reused. All the rest goes to dumpsites, shortening its life span and polluting land and water. To bring waste back into the stream, it is necessary to separate in-situ the different waste types, including CDW.

The information shown in Table 1, produced by the Mexican Chamber of Construction Industries (2016), summarises the options for the reuse of CDW.

Table 1: Potential reuse options for CDW

Source: Mexican Chamber of Construction Industries (2016)
Graphics: Ninni Westerholm

RESIDUE	RECYCLED MATERIAL	FINAL USE
Mixed debris of concrete and mortars	Recycled aggregate	• Hydraulic base in roads and parking lots • Hydraulic concrete
Asphalt from roads and others	Asphalt raw material	• Black asphalt • Hot and cold asphalt • Roads
Mixed debris	Filling material	• Terraces and embankment
Mixed debris	Recycled sand	• Filling coverage, substitute for construction stone • Raw material for blocks, cobbles, and paving stones • Small pre-cast concrete elements
Mixed debris	Recycled aggregates	• Filling for pipelines • Filling for foundations • Filling in general: terraces and gardens, landfill
Concrete residues	Recycled gravel and sand	• Walways • Retailing walls • Floors and playgrounds
Hydraulic binders	Cold recycling	• Hydraulic bases

Brazil has classified CDW into four groups, as outlined below.

Class A: Reusable or recyclable residues that can be used as aggregates:

- From construction, demolition, repairs or repaving, from infrastructure work or from embankments.
- From construction, demolition, repairs or improvement of buildings: ceramic components (tiles, bricks, siding plates), mortar and concrete.
- From construction processes or demolition from pre-cast concrete (blocks, pipes).

Class B: Reusable or recyclable for other industries: plastic, paper, cardboard, metal, glass, wood, others.

Class C: Residues for which technologies or economically viable applications that allow recycling or recovery have not been developed, e.g. gypsum products.

Class D: Hazardous waste originating from construction processes, such as paints, inks, solvents, oils and others; or those contaminated that come from fires, demolition, renovation of radiological clinics, industrial facilities and others.

6. Policies

This section summarises the policies relating to waste in the countries of the LAC region.

6.1 Argentina

Since 2004, Law No. 25,916 on Home Waste Management established the minimum environmental protection budget for the integral management of household waste of any origin. In the past 10 years, much discussion and debate has taken place around shifting the country from a linear to a circular economy.

Based on this agenda, the Ministry of Environment and Sustainable Development of the Nation, in line with the National Plan of Circular Economy of Waste, released the 'Formulation of a Provincial Strategic Plan for Waste Management towards Circular Economy' (MADS, 2019). It includes a proposal that the provinces develop an instrument, alongside municipalities, to develop sustainable waste management strategies in their territory. The purpose of these plans is to establish a system that substantially improves the management of urban solid waste (including CDW) at the provincial level, from an environmental, economic and social point of view. These plans must identify guidelines, actions and policies necessary to improve the management of solid waste; plans must include the closure of all landfills by the year 2025; and aim for zero disposal by 2035.

The waste products that should be part of the project formulation are divided into the following categories: 1) municipal; 2) industrial; 3) controlled organic waste that affects livestock agricultural production; 4) construction debris; 5) out-of-use vehicles; 6) out-of-use tyres, replacement tires; and 7) marine litter (Porcelli and Martinez, 2018).

6.2 Brazil

Brazil is one of the pioneers in the LAC region with respect to recycling waste. In 2002, it built the first industrial plant for recycling CDW, in line with legislation introduced by the National Council for the Environment (CONAMA). Resolution No. 307-/2002R from CONAMA states that 'It is the contractor's obligation to generate the Construction Waste Management Plan (PGRCC), which is a comprehensive construction permit application process, which must be ready from the beginning of the work and must be presented to the municipal level'.

The CONAMA plan also aims to establish the necessary procedures for the handling and destination of materials, based on the following main objectives:

- The builder must identify and quantify waste to be taken to specific destinations for that purpose.
- The builder must limit the collection of waste and its transport, ensuring in all cases where possible, reuse and recycling conditions.
- Transport must comply with the corresponding regulations.
- The destination of the waste must adhere to the classification of the materials. (Pinzón, 2019)

Most of the waste facilities in Brazil are private and operate without a permit (Massara, 2018). Due to a lack of regulations and laws, environmental studies on landfills or recycling plants are very difficult to conduct, especially those targeting CDW.

6.3 Chile

In 2005, Chile's National Commission of Environment approved the Integral Management Policy of Solid Waste, which was prepared by representatives of the Ministry General Secretariat of the Presidency, the Ministry of Health, the Ministry of Economy, the Under-Secretariat of Regional and Administrative Development and the National Commission of the Environment. This policy aims to 'ensure that solid waste management is carried out with the minimum risk to the health of the population and the environment, promoting a comprehensive vision of waste, which ensures a sustainable and efficient development of the sector'. One of the aspects of this policy most relevant to this report is the need to have a comprehensive waste management plan that covers all the stages of a product, from production to disposal (MINVU, 2018).

The 'Technical standards for residential housing: Volume 4 Materials and Residues', produced by the Urbanization and Housing Ministry (MINVU, 2018) states that every residential housing plan must specify at least 20% of pre- and post-consumer recycled material to be used for permanent elements of the construction. However, the inclusion of such within a housing plan is voluntary; and as of the date of this publication, there are no regulatory instruments that incentivises the use of products with recycled content.

6.4 Colombia

In 2015, Colombia issued Resolution 0549-2015, the main purpose of which is 'to establish the minimum percentages and savings measures in water and energy to be reached in new buildings and to adopt the guide to sustainable construction for water and energy saving in buildings' (MVCT, 2015a). This resolution includes measures that are primarily focused on energy and water savings, such as solar and passive water and air heaters/coolers, reuse and recycling of water, rainwater harvesting and natural light use (MVCT, 2015b). In 2019, the National Strategy for the Circular Economy was introduced by Colombia's President Ivan Duque. The main objective of this strategy is to 'Maximize the added value of production and consumption systems in economic (profitability), environmental (climate change) and social (employment) terms, based on the circularity of the flows from raw materials, energy and water'.

6.5 Ecuador

In 2002, the 'Sectorial Analysis of Solid Waste of Ecuador' was conducted, sponsored by PAHO/ WHO, based on support for the development of a systematic, multidisciplinary and intersectoral approach to waste management (OPS/OMS, 2002).

Due to the geographic and socioeconomic diversity of the Ecuadorean regions, it is essential to identify the parameters for planning, because it depends on the specific needs of each region.

Ecuador's Organic Code for Local Governments states that every municipality is responsible for its own legislation and management of solid waste. Of the 221 Ecuadorean municipalities, only 61 (including the two biggest cities, Quito and Guayaquil) have partially controlled dump sites. The city of Cuenca, in south Ecuador, is perhaps the most active in CDW management, with very progressive educational and waste reduction programmes.

The National Programme for the Integral Management of Solid Waste was implemented in 2010, with a lifespan of eight years, ending in December 2019. Its main objective is that '112 prioritized municipalities have approved pre-investment studies for the closure of their environmental liabilities, design of the different phases of waste management and recovery of materials as the axis of the integral solid waste system' (MAE, 2018).

In June 2019, an international circular economy event sponsored by the European Union with the support of some of Ecuador's ministries took place (invitation only) in Quito, at the Catholic University Auditorium, with the primary objective of defining a baseline, an agenda and a strategy for implementing a circular economy in the country (see http://www.economiacircularecuador.com/).

6.6 Mexico

Mexico's environmental regulation Norma Ambiental del Distrito Federal NADF – 007 RNTA -2004 states that, where the volume of waste is less than 7 m3, a waste management plan is not needed. However, where the waste is over 7 m3, there are penalties of up to nine years in jail if the management of such waste does not comply with the regulation.

A feasibility study carried out by (Betancourt-Quiroga, Correa-Giraldo and Betancourt-Quiroga, 2019) showed that 100% of the arid materials (sand, gravel and similar) used in construction can be replaced by recycled aggregates. In May 2019, the City of Mexico introduced the Zero Waste Plan, which aims to increase the use of recycled CDW from 206 tonnes to 8000 tonnes per annum by 2024. This plan involves a suite of changes to culture, technology and legislation designed to ensure that Mexico City is a zero-waste city by 2050. The Zero Waste Plan will invest about USD15 million into infrastructure to revalue CDW, turn it into raw materials and lower the current waste outputs from 8600 tonnes to 2000 tonnes, reducing the overall volume of waste going to the dump sites. Further, the plan is to increase recycling from 1900 to 3200 tonnes a year by 2024. Composting residues will also be increased from 1400 to 2250 tonnes per annum. Besides all this, another 2250 tonnes will be used in research around material use, and the recycling and repurposing of CDW.

In Mexico City, the integral management of solid waste is based on the Political Constitution, the General Law of Ecological Balance and Environmental Protection, the General Law for the Prevention and Integral Management of Waste and its regulation, the Solid Waste Law of the Federal District and its associated regulations, the Integrated Solid Waste Management Program for Mexico City 2016–2020, as well as various regulatory instruments at the federal and local levels (Martínez, 2015). The circular economy and circularity are expressly mentioned in these plans.

6.7 Incentives

Despite the importance and urgency of CDW management, very few or no incentives to adopt these practices are provided by governments in the LAC region. In Mexico, the General Law for the Ecological Equilibrium and Environmental Protection promotes 'Grant incentives to those who carry out actions for the protection, preservation or restoration of the ecological balance'. In Ecuador, the Constitution gives rights to Mother Nature, or Pachamama[2], but no incentives, via taxes or cash, are being paid for CDW management. However, the Ministry of Environment does provide tax deductions for machinery and technology to companies improving their ecological footprint.

Throughout LAC, no laws or regulations provide incentives. CDW recovered materials, especially recycled aggregates, face many difficulties in competing with the virgin materials that they are intended to replace. The main barriers that limit the competitiveness of the recovered products market are the low costs of dumping CDW; the absence of financial incentives to cover the costs of natural aggregates; the absence of regulations that require the use of a certain proportion of recovered materials in construction; and the lack of standards to promote knowledge of and confidence in these materials among architects and contractors.

Since 2011, the Regional Initiative for the Inclusive Recycling (IRR in Spanish – see www.reciclajeinclusivo.org) has promoted a shift in urban culture through differentiated waste collection, recognition of the role of recyclers and remuneration for the service they provide. The IRR has also promoted change in law and regulations in the LAC region.

As stated in the Zero Waste Plan developed by Mexico City, CDW reduction and management requires a multi-stakeholder approach, from producers through consumers to the final disposal sites. According to this plan, manufacturers must reduce the amount of packaging and label their products to identify waste. Also, regulations governing (and in some cases, prohibition of) single-use products have been issued. A civic campaign around waste separation is currently underway throughout Mexico. Improving the infrastructure of separation plants and recycling installations is also being considered, as is the promotion of base recyclers' associations. Most of these actions need to be implemented across all LAC countries.

In Colombia, incentives related to sustainable building are scarce and mainly oriented to big construction companies. Some of the incentives are preferential interest rates for social interest housing programmes, tax reduction and exemptions for import taxes (see above 6.4 Colombia).

2. Pachamama is a protective deity – not properly creative, interesting difference – whose name comes from the original languages and means Earth, in the sense of the world. Pachamama is the one that gives everything; but since we remain within it as part of it, it also requires reciprocity (Zaffaroni, 2011).

7. Design issues and policies/regulation

The processes of reverse design and future proofing are not widely practised in the LAC region. Few architects and construction companies know about these ideas, and very few apply them. Future proofing is an unfamiliar term for construction companies and construction professionals.

Across the LAC region, it is common to see a one-storey house with iron rods protruding from a concrete slab on the house's roof. These rods are called varillas de la esperanza, or 'the rods of hope', and represent the hopes of the family living in that house, that someday they will be able to build a second floor and expand the house vertically. In these countries, the convention is for construction to start with a small house, which then offers the potential for expansion when there is enough money to cover the costs of doing so. Thus, future proofing is already done at a very basic level.

In the LAC region, close to 32% of households have either qualitative or quantitative housing deficits (International Development Bank [IDB], 2017), of which the most prevalent are a lack of access to at least one basic service (16%), a lack of security of tenure (11%), deficient structure or construction materials (7%), overcrowding (4%) and dilapidated houses (6%) that are either unsuitable for habitation or shared with another household. Social housing projects are tendered by the government and the contractor must maximise their earnings. Therefore, the designs adopted tend to be the simplest, easiest and most cost effective, and often take the form of square houses and square blocks. There is a place for modular or flexible construction in this market, but industrial production limits the potential for auto-construction or reconstruction, and the informal sector will always use artisanal construction materials.

The reuse and reutilisation of demolition waste is not included within the policy framework of any country in the LAC region. Second-hand windows, doors, wood and the like are not used for new buildings. Indeed, second-hand materials are perceived as 'things for the poor', and a new house is expected to be made entirely from new materials.

The traditional house in the LAC region has variation in terms of the forms and materials used due to the diversity of climatic floors across the continent and the Caribbean. Over 1600 metres, the typical house is made of a timber frame plastered with lime or mud (called bahareque or quincha). Closer to or at sea level, bamboo and wood are the most frequently used materials. Throughout the heights of the Andes, due to the higher elevations, construction with earth and stone is the norm. There is a traditional method of construction, practised especially in the Andes, called 'minga' (or minka). Minga, a quechua word, refers to the social, collective work that is sometimes used to build community infrastructure (Ramírez, 1980), such as a road or an irrigation system. It draws on the principle of reciprocity, such that: 'I help you to build your house, you help me to build mine'. Usually, the owner of the house asks his community for help and, through an assembly, the community assigns resources in the form of labour and construction materials. A skilled mason leads the construction and all the villagers help by providing labour or food, or even taking care of the children so that all the adults can assist in the construction. At some time, the owner of the house must return the favour and help build a neighbour's house one day. Such collaborative approaches can bring communities together.

In some rural communities in the jungle of Honduras, for every newborn 20 trees are planted for the future. When the baby grows up and gets married, the trees are used to build a new house for the newlyweds.

Market-based, low-income housing projects implemented in the LAC region since the 1970s have led to urban sprawl and greater segregation, creating new pockets of poverty and exclusion and relegating the poor to social housing projects on the periphery (IDB, 2016).

8. Construction and demolition waste collection and the informal economy

The 'base recyclers' (a term adopted in 2008 at the World Congress of Waste Recyclers held in Colombia and still in use) belong to the poorest and most vulnerable sectors of society. Due to their work environment, they are exposed to multiple risks: heat, violence, insecurity, harassment and discrimination. Base recyclers contribute between 25% and 50% of all recycled municipal waste collection in the LAC region (EIU, 2017). A base recycler's work covers the full lifecycle of landfills, reduces the costs of transporting waste, reduces the need to extract raw materials and provides environmental and public health benefits, including the reduction of GHGs. It also provides local jobs to support the economy, albeit the informal economy.

In any case, the collection of CDW in the informal economy is minimal relative to the high volume of waste production. Windows, doors, metal pipes and copper wires, among other construction materials, are collected to be sold by weight to private collection centres.

In Ecuador, the National Network of Recyclers (or RENAREC) stated in their 2015 baseline study (IRR, 2015) that 54% of base recyclers are women, and that 83% are aged between 18 and 65 years, with the remaining 17% being elderly. There is no study on underage children working on recycling or dump sites, but one can see whole families looking for residues in garbage bins across the cities.

In all LAC countries, legislation needs to be introduced that recognises the contribution of base recyclers in terms of the services they provide to society, rather than for the profit they can make from selling the waste.

9. Analysis and evaluation

CDW reduction cannot be achieved without the involvement of a range of stakeholders, including homeowners, architects, interior designers, suppliers of construction materials and energy companies, among others. And such efforts need to be regulated by local government with the support of legislation. The raw materials needed for construction are becoming increasingly scarce and mines are taking the place of sown fields. Dump sites are also being built in the countryside, creating social conflict.

More research is needed to identify the advantages of using CDW as raw materials, not only in relation to the environment but also in terms of economic feasibility. The social return on investment should be calculated to demonstrate to the government the benefits of reusing CDW in the long term.

The cultural and geographical differences throughout the countries of LAC make it necessary for governments to seek creative solutions. Educational campaigns about generating no waste are absent from government plans. Only recycling or repurposing (such as plastic bottles or wood pallets) receives limited mention in the mass media. Yet education around producing zero waste is critical. Further, more training of construction workers is needed, for example, in relation to the efficient use of construction materials, selective demolition and waste separation in situ and the reuse of CDW. All this requires concerted efforts across all sectors of government, community and industry.

10. Conclusion

Despite the importance of recycling and the circular economy, LAC governments are only just beginning to issue rules and regulations for the recycling, reuse and upcycling of construction materials. The data shows that CDW management is not a priority across the region, with less than 10% recovery rates.

Achieving effective CDW management and implementing a plan for circular economy requires the involvement of universities, professionals, technicians, private companies and syndicates within the construction industry, all to be coordinated by government. Effective CDW management can lower construction costs, and the money saved can be invested into enhancing the climatic comfort and energy efficiency of buildings. CDW management must therefore be included in the full lifecycle of the building or structure, from planning to final disposal.

Governments must create the conditions and incentives at all levels, from local government to national authorities, to ensure compliance with international regulations, via an efficient communication and coordination strategy. CDW management that includes economic incentives remains a distant goal for most countries in the LAC region. As with renewable energy, the circular economy and total waste management is are in their infancy in the LAC region.

One of the main problems limiting efficient CDW management is a lack of environmental awareness. As with plastics and batteries, there are no public awareness campaigns on CDW management in LAC. A house (or construction in general) is seen as a 'once in a lifetime' exercise and the associated debris is therefore only produced once in a lifetime, not every day like plastic bags; the average person believes that the waste produced from such construction is negligible. A task force is needed, to educate, train and promote in relation to the sustainable use of resources in construction.

The low cost of dumping versus that of recycling, the low rate of debris separation at the source, and the absence of a competitive market for recovered materials all remain challenges. Any legislation on CDW must include the whole lifecycle of the construction process – from responsibly sourced materials, design, planning, execution, and recovery at the end of life of any building or public infrastructure. In this regard, the design stage is critical for the development of strategies that minimise CDW.

Architects have a key role to play in minimising the generation of CDW. A good assessment for the client, the use of efficient construction methods and the use of pre-cast and standardised materials are all fundamental to the reduction of CDW. Further, a plan to recover, recycle and upcycle the CDW must be included in the design proposal. A cultural shift is needed in construction companies and among professionals in order to achieve better construction and design practices. Effective CDW management will reduce costs and ensure the circularity of the building. One strategy to reduce CDW is to separate in-situ residues. Separation will reduce the cost of waste treatment and improve the quality of the recycled products from CDW.

Material controls are required at every stage of the construction process to minimise damage, loss or misuse of materials. For general building demolition, good planning for a selective disassembly will ensure that the recovery of doors, windows, roofs, water pipes, electricity, bricks and the like is part of the demolition process. Preventing the mixing of recyclable CDW with other materials will support reuse and upcycling, and in turn deliver economic advantages.

Education and training at all levels – including for architects, masons, suppliers, dispatchers and raw materials companies – will ensure the circularity of CDW management. It is necessary to promote the production of construction materials based on CDW in order to close the loop for materials and ensure that waste, as raw material, could be given a second use. Research and development around new technologies and technical standards for recycled products from CDW must be a priority.

Local governments must provide incentives to contractors who use sand and gravel or other products from recycled CDW. Further, the price and production of virgin raw materials must be regulated such that CDW recycled aggregates are competitive in terms of price. The existing virgin aggregate production plants can be used to produce CDW aggregates. They have all the necessary equipment, technicians and clients, and can be cost competitive with adequate CDW management.

The public sector is the biggest builder in the LAC region. Therefore, legislation and regulations need to be established that maximise and benefit the circular economy, taking advantage of the creativity and efficiency of the private sector, who can generate value for both themselves and society. Governments can lead by example and show leadership to the private sector.

Drawing on the findings discussed throughout this report, Table 2 depicts the waste-related impacts of the various lifecycle phases within building and construction.

Table 2: Building and construction impact for various lifecycle phases, LAC region

Source: Author
Graphics: Ninni Westerholm

CAPITAL COSTS

MANUFACTURE	By-products are generally thrown away. No recovery is undertaken or even planned for in most cases.
DESIGN	Added value to new technologies like solar or reuse of water is now being supported.
CONSTRUCTION	No reuse or repurpose. Education, awareness-raising campaigns and capacity-building across all sectors are urgently required.
OPERATION AND USE	Costs are lowered by lowering quality. No real added value is currently supported.
RENOVATION	Small markets for second-hand renovation products are currently available.
DECONSTRUCTION END OF LIFE	Only recycling of iron products gives value to demolition.

OPERATIONAL COSTS

MANUFACTURE	Spaces are generally conditioned, so renewable energy must be considered.
DESIGN	Passive design, renewable energy, water harvesting, design for durability and reuse all offer opportunities.
CONSTRUCTION	Cheap hand labour and an informal economy support construction processes.
OPERATION AND USE	Lower energy and other utility expenses and a better return on investments offer opportunities.
RENOVATION	Only new products are considered in the marketplace. Opportunities exist for extending to renovations.
DECONSTRUCTION END OF LIFE	Little CDW is recovered. Opportunities for reuse and recycling are currently non-existent.

E N V I R O N M E N T A L   I M P A C T S

MANUFACTURE	No waste, reduced or no emissions, carbon negative policies and programmes, renewable materials are considered.
DESIGN	Zero-carbon design is not known.
CONSTRUCTION	Debris is separated in-situ. Landfills are scarce.
OPERATION AND USE	Water harvesting and solar lights are currently known and used but are yet to be mainstreamed.
RENOVATION	Not yet tapped.
DECONSTRUCTION END OF LIFE	Non-practical use for CDW, 90% is not used.

NEW BUSINESSES

MANUFACTURE	Existing micro, small and medium enterprises aggregates plants can process CDW.
DESIGN	Green design services, green certification and valuation services. Solar/eolic (wind) energy.
CONSTRUCTION	Small, resilient communities with local materials are possible and offer immediate opportunities.
OPERATION AND USE	Communal buildings and construction.
RENOVATION	Reuse or repurpose of furniture would make a good starting point.
DECONSTRUCTION END OF LIFE	Use of CDW as aggregates. Assessments of new business opportunities are possible.

GREEN JOBS AND SKILLS

MANUFACTURE	Production workforce, lower costs.
DESIGN	Training and formal education in design for a circular economy.
CONSTRUCTION	Training for construction materials optimisation, zero waste and reuse.
OPERATION AND USE	Skilled hand labour for maintenance and repair.
RENOVATION	Opportunities may be identified and capacity-building plans need to be put in place.
DECONSTRUCTION END OF LIFE	Base recyclers learn selective demolition and reuse of parts from buildings.

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