PEAK Urban

LOCAL EVIDENCE
SYNTHESIS REPORT

Towards Urban Sustainability in Latin America

Lessons from research in Colombia and Latin America, with implications for global policy and practice.

With the right development approaches, Latin American cities can become hubs that relieve poverty and drive regional growth. PEAK Urban identifies the proactive policies and interventions that can produce efficient, productive, inclusive and sustainable urban futures.

The research was guided by the PEAK Urban approach to urban inquiry and action, shaped by four key pillars:

P **Prediction** – what new approaches can we take to accurately forecast cities' futures?

E **Emergence** – What types of urban structures and systems are emerging?

A **Adoption** – How do cities adopt new ideas and technologies?

K **Knowledge** – How, and with whom, can we best share knowledge globally?

Synthesis Report **Colombia**[1]

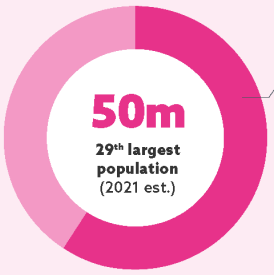
Area

1.4 million km² [2]
(2021)

Major urban areas population (2021)

- Bogota (capital) **11.35 million**
- Medellin **4.07million**
- Cali **2.84 million**
- Barranquilla **2.33 million**
- Bucaramanga **1.37 million**
- Cartagena **1.08 million**

Population

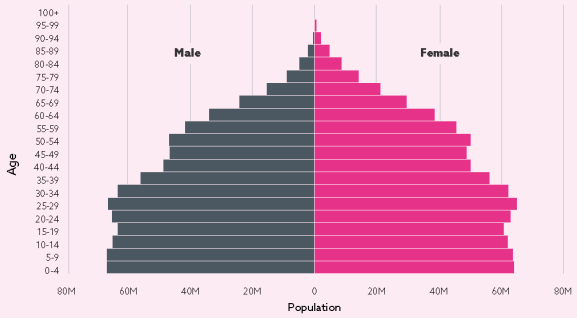


Urban population
82% (2022)

Rate of urbanisation
Annual rate of change estimated for 2020-2025
1.01%

Population growth rate
1.04% (2021 est.)

Population by age and gender



People

Literacy rate age 15+
95.6%

Life expectancy

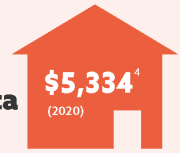
Maternal mortality
83 deaths per 100,000 live births (2017 est)

Economy

Nominal GDP

$271.44 billion[3] (2020)

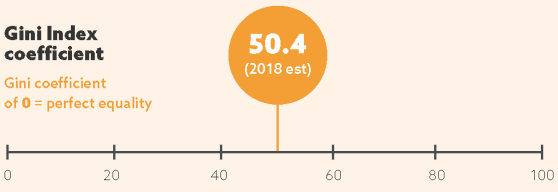
Per capita GDP



Equality

Gini Index coefficient

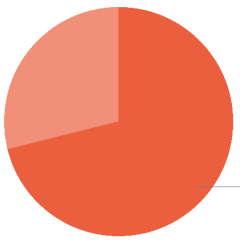
Gini coefficient of **0** = perfect equality



Lowest 10% urban household income
1.2% (2015 est.)

Highest 10% urban household income
39.6% (2015 est.)

Medellin (Colombia's 2nd-largest city)

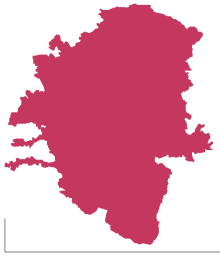


Population
4.068 million[5]

Annual population growth rate 0.84%[6]

71.2% of Medellin's population is working age (2022)[8]

Size



380.64 km² [9]

Economy

GDP (US$)

43.08 million

14.5%
of Colombia's GDP[10]

13,340
GDP per capita[11]

City Life

Population density
6,759 per km² (2020)[7]

Green space (per person)
3.6m² [12]

Sewage treatment rate of homes connected to official water system[13]
97%

Homes connected to sewers
95%

Healthcare[14]

Doctors
3.8 per 1,000 people
(for all Colombia)

Ward beds
1.7 per 1,000 people
(for all Colombia)

Transit passengers (2021)

Rail

156 million passengers on Medellin Metro[15]

See Footnotes on pg 5

Executive Summary

Colombia is a highly urbanised, populous country with abundant natural resources and huge potential for development. Despite these advantages, it faces many challenges, including high inequality, low formal employment, a lack of decent housing and services, and natural and human-made environmental fragility.

Significant attempts have been made to improve urban sustainability in recent years, with many city governments upgrading informal settlements, improving transport links and tackling violence. Yet many challenges remain if Colombia and Latin America are to meet UN Sustainable Development Goal 11 – making cities inclusive, safe, resilient and sustainable by 2030.[1]

PEAK Urban's research in Colombia and Latin America provides new evidence and insights into urban issues in the region. The PEAK approach also offers an important new method to help urban actors **Predict** and project aspects of city life, understand the interaction of **Emerging** systems, consider **Adoption** of appropriate technology and interventions, and facilitate **Knowledge** exchange to support urban inquiry and action (see Box 1).[2]

Based on research from four regional hubs – in China, Colombia, India and South Africa – the PEAK approach yields valuable new insights that can inform more effective urban policymaking in highly diverse contexts worldwide.

One of four regional reports, this paper presents key findings from PEAK research in Colombia covering five broad categories – economic growth, urban sustainability, inclusiveness, housing and localising the SDGs. It offers insights to help government and non-state actors at national and international levels shape stable, equitable cities that deliver decent lives for all residents:

• **Predicting urban growth:** New approaches to urban growth forecasting, using new data sources and analysis techniques, can achieve more cost-effective, accurate and inclusive predictions. Better forecasting will help a range of actors, including private-sector companies planning new market opportunities, local authorities drawing up development plans, and national or international bodies investing in country-level development. New models allow forecasting in any context where data is available, and will be particularly appropriate to resource-constrained areas.

• **Making existing cities more sustainable:** Dense cities offer numerous benefits for health, productivity and sustainability. Where cities are not dense, planning options can boost sustainability, through effective land-use strategies; fast, safe and efficient public transport; infrastructure to encourage cycling, walking and recreation; and well-planned amenities. Planners should recognise that city layout affects many aspects of urban life, and well-targeted interventions can achieve benefits which go beyond the remit of one department, ministry or sector.

• **Creating inclusive economies:** Social protection measures can reduce inequality, but must be targeted effectively. Multi-dimensional models which consider a range of information, such as tax or health records, can target subsidies and benefits more effectively than systems based only on one factor, such as property location. Women's employment in the formal sector is rising, along with overall formal-sector employment, but neither is rising fast enough to meet SDG targets. Policymakers have many tools to boost city-level, regional and national productivity, reduce inequalities and create decent jobs. These include using new data sources and techniques to understand formal and informal economic systems, and drawing on diverse partnerships and resources to increase productivity in areas left behind.

• **Providing decent housing:** Non-state actors in Colombia are driving gentrification and displacing communities by laundering money through the real estate market. Such gentrification is taking place in regions where the state is weak, meaning governance must be strengthened in these areas. Informal communities have knowledge and expertise in housing management, suggesting schemes to upgrade informal settlements should work with communities as partners, and make adequate housing provision for all refugees and displaced people.

• **Localising the SDGs:** Cities have a crucial role to play in implementing the SDGs, but the goals are not currently being operationalised at city level in Colombia. Cities have a range of planning tools, including master plans and development plans, which they can use to embed the SDGs in medium-term local development programmes, protecting them from political influence and ensuring ongoing professional oversight by civil servants. The responses of city administrations to the Covid-19 pandemic demonstrate their potential to contribute to global sustainability goals.

Image credit: Adobe Stock

Introduction: Urban Latin America

Latin America and the Caribbean (LAC) is a highly urbanised region. By 1960, half the population already lived in urban areas and by 2015 this figure had reached 80 per cent.[3] While the LAC population grew rapidly in the mid-20th Century, fuelled by people seeking opportunity or fleeing poverty and conflict, the rate of population growth has been declining since the1960s and is now expected to grow below the world average.[4]

Colombia is a highly urbanised, populous country with abundant natural resources and huge potential for development. Despite these advantages it faces many challenges, including high inequality, low formal employment, a lack of decent housing and services, and natural and human-made environmental fragility. The Andes mountains make it hard to move people and goods across the country, which is subject to earthquakes and other natural hazards.

The country's long-running internal conflict has had a profound impact, displacing more than 8 million people, hampering socio-economic development, and fuelling a rural exodus which has itself boosted urbanisation.[5] In June 2016, the government and FARC rebels signed a historic ceasefire, but peace in some areas is still fragile, and areas of conflict remain.[6]

Colombia is Latin America's fourth-largest economy, but relies on a commodity-dependent export base, and efforts to foster diversification have had limited success.[7] The country has one of the lowest levels of formal employment in LAC, with most adults working in the informal sector. Women experience many barriers to formal employment, including lack of childcare and appropriate transport, and domestic responsibility.

Income inequality in Colombia is the second highest of 18 countries[8] in LAC and the highest of all OECD countries. Certain population groups experience particular disadvantage, including women, indigenous communities and Afro-Colombians. Colombia has taken in more than a million Venezuelan migrants in recent years, most of whom are undocumented and unable to access essential services such as healthcare, education and housing.[9]

Towards the SDGs

Significant attempts have been made to improve urban sustainability in the past few decades, with many city governments upgrading informal settlements, improving transport links, tackling violence, and offering social protection to low-income residents. Colombia's second city, Medellin – the centre of PEAK's research in the region – has itself been the focus of a "social urbanism" led by former mayor Sergio Fajardo. This has seen Medellin transformed from the violent, insecure and divided city of the 1990s into a prime example of urban development in the early 2000s. Measures have included better transport links, new parks and public spaces, upgrading informal settlements and introducing social programmes to reduce inequality.[10]

However, many challenges remain if Colombia and LAC are to meet the UN Sustainable Development Goals (SDGs) by 2030, particularly SDG 11 – making cities inclusive, safe, resilient and sustainable.

PEAK in Colombia: building urban connections

The PEAK Urban approach allowed researchers in various locations, led by the Research in Spatial Economics (RISE) group at Medellín's EAFIT University, to explore innovative methods of diagnosing urban problems. Working with diverse stakeholders – including communities, local authorities, national bodies and international agencies – they designed interventions and approaches to tackling them.

PEAK's approach was essential in encouraging collaboration across disciplines that are not obvious partners, such as sociology, computer science, architecture and geography. It also fostered use of new data sources and analysis techniques, and collaboration with stakeholders, elected politicians and government officials across the public policy domain. The approach illustrates the interconnectedness of policy areas such as health, transport and economic development, and the value of breaking down silos in urban policy.

Much of the EAFIT research focuses on Medellín and Colombia, although the scope of some is LAC-wide, and collaborations with PEAK partners include international research sites. The findings have implications beyond LAC, and are relevant to all global actors concerned with urban sustainability.

The PEAK Urban Approach

An innovative approach to urban inquiry and action guided the research that informs this report. It defined a way of asking questions, employing methods for research, gathering and analysing data and reflecting or acting on the implications of findings. Organised into the acronym PEAK – Prediction, Emergence, Adoption and Knowledge – and underpinned by principles that apply to all urban contexts globally, the approach is useful in guiding urban interventions, including policymaking, placemaking and investments.[11] The research considered the four constituent elements of PEAK together, leveraging each as required. This report demonstrates how use of these elements supports urban inquiry and intervention.

P – Prediction and projection

PEAK emphasises interdisciplinary inquiry into city futures, based on urban sciences that use new sources of urban data, providing unprecedented – often real-time – information on urban dwellers' activities. This includes tracking telecoms data, satellite imagery and street photography; personal and environmental statistics from mobile apps and fixed sensors, and social networks via online platforms. However, the increasing pace of urban change limits the accuracy of longer-term predictions from new data and methods. Predicting urban futures also requires other forms of understanding the city, including institutional analysis and ethnography.

E – Emergence

Cities are constantly evolving and building on what already exists. They are never finished. The concept of emergence rests on the understanding that city systems are rarely in equilibrium. The urban health system, for example, is made up of components including individuals, collective actions, technologies, markets and infrastructure. As the system and its parts change, interactions with other city systems result in newness emerging. In particular, technological changes within systems can reconfigure city economic and social life. Even minor changes at the interface of different systems can generate major changes in the complex system of the whole city.

A – Adoption

Histories and geographies matter in understanding how city systems work and evolve, shaping the ideas and technologies a city adopts. Complex systems display characteristics of "lock in" and "path dependency", with the city's past and its geography shaping but not necessarily determining its future. As a result, knowledge and technologies are taken up, valued and captured differently by cities. Residents may use and be affected by technologies in ways different from other cities or neighbourhoods. The future city is shaped by the needs of both present and future generations.

K - Knowledge

Different approaches to understanding, and alternative models of scientific knowledge, are rooted in diverse moral values and valuation scales, which can at times be competing, contested and not directly comparable. For example, the values informing an economist's analysis of developing housing in a forested area may clash with those of an environmentalist. These values influence how the city is understood from alternative vantage points. However, different perspectives – including those of urban actors such as elected officials, appointed professionals or community groups – have merit. Through dialogue between these perspectives, policymakers can avoid sub-optimal interventions that affect parts of the city, rather than the city as a whole. Urban futures are shaped by balancing often competing elements, and power structures affect how loudly different voices are heard. This demands an ability to see the city from different perspectives, to recognise structures of power and influence, and to mediate, evaluate and understand such trade-offs.

Footnotes to accompany visual on page 2:

1 Source unless otherwise indicated: CIA World Factbook. 2021. **https://www.cia.gov/the-world-factbook/countries/colombia/**

2 Economist Intelligence Unit. 2021. **https://store.eiu.com/product/country-report/colombia**

3 World Bank data. 2020. **https://data.worldbank.org/country/colombia**

4 World Bank data. 2020. **https://data.worldbank.org/country/colombia**

5 CIA World Factbook. **https://www.cia.gov/the-world-factbook/countries/colombia/**

6 World Population Review. 2022. **https://worldpopulationreview.com/world-cities/medellin-population**

7 City population. 2020. **https://www.citypopulation.de/en/colombia/admin/antioquia/05001__medell%C3%ADn/**

8 World Population Review. 2022. **https://worldpopulationreview.com/world-cities/medellin-population**

9 World Population Review. 2022. **https://worldpopulationreview.com/world-cities/medellin-population**

10 US Department of Commerce. International Trade Administration. Medellin Profile. **https://www.trade.gov/sites/default/files/2021-03/Medellin%20Profile_0.pdf** GDP

11 Teleport Cities. **https://teleport.org/cities/medellin/**

12 Urban Green Up. **https://www.urbangreenup.eu/cities/followers/medellin.kl**

13 Americas Quarterly. **https://www.americasquarterly.org/article/medellins-other-success-story-how-the-city-cleaned-up-its-water/**

14 Colombian Urban Passenger Transport Survey. **Boletín Técnico Encuesta de Transporte Urbano de Pasajeros (ETUP) Cuarto trimestre de 2021**, p.14.

15 World Bank. **https://data.worldbank.org/indicator/SH.MED.PHYS.ZS?locations=CO**; **https://data.worldbank.org/indicator/**

PEAKUrban in COLOMBIA

The **PEAK** approach helps urban actors **PREDICT** aspects of city life, understand **EMERGENCE**, **ADOPT** appropriate interventions, and facilitate **KNOWLEDGE** exchange to support urban inquiry and action.

PREDICTION

Look ahead through a powerful lens, using data and new analytics

Example of PEAK in action:

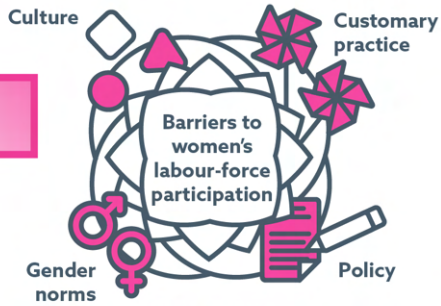
See p. 7

13-32% predicted increase in the share of the working population in formal employment in 62 Colombian cities by 2030. See p. 11

EMERGENCE

Understand how different systems interact to create new consequences

Example of PEAK in action:



See p. 11-12

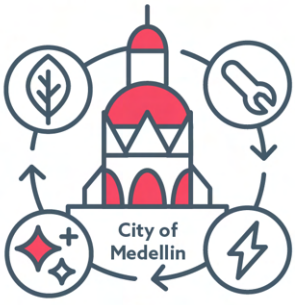
60,000 PEOPLE PER KM² urban population density associated with lower mortality rates. See p. 9

ADOPTION

Use the right technologies and solutions for each urban context

Example of PEAK in action:

Tools + Frameworks



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SUSTAINABLE DEVELOPMENT GOALS

Strengthened implementation of the Sustainable Development Goals

See p. 14

95%

accuracy of PEAK modelling of buildings' seismic risk using Google Street View data

See p. 13

KNOWLEDGE

Value and combine different stakeholders' knowledge to co-create new learning

Example of PEAK in action:

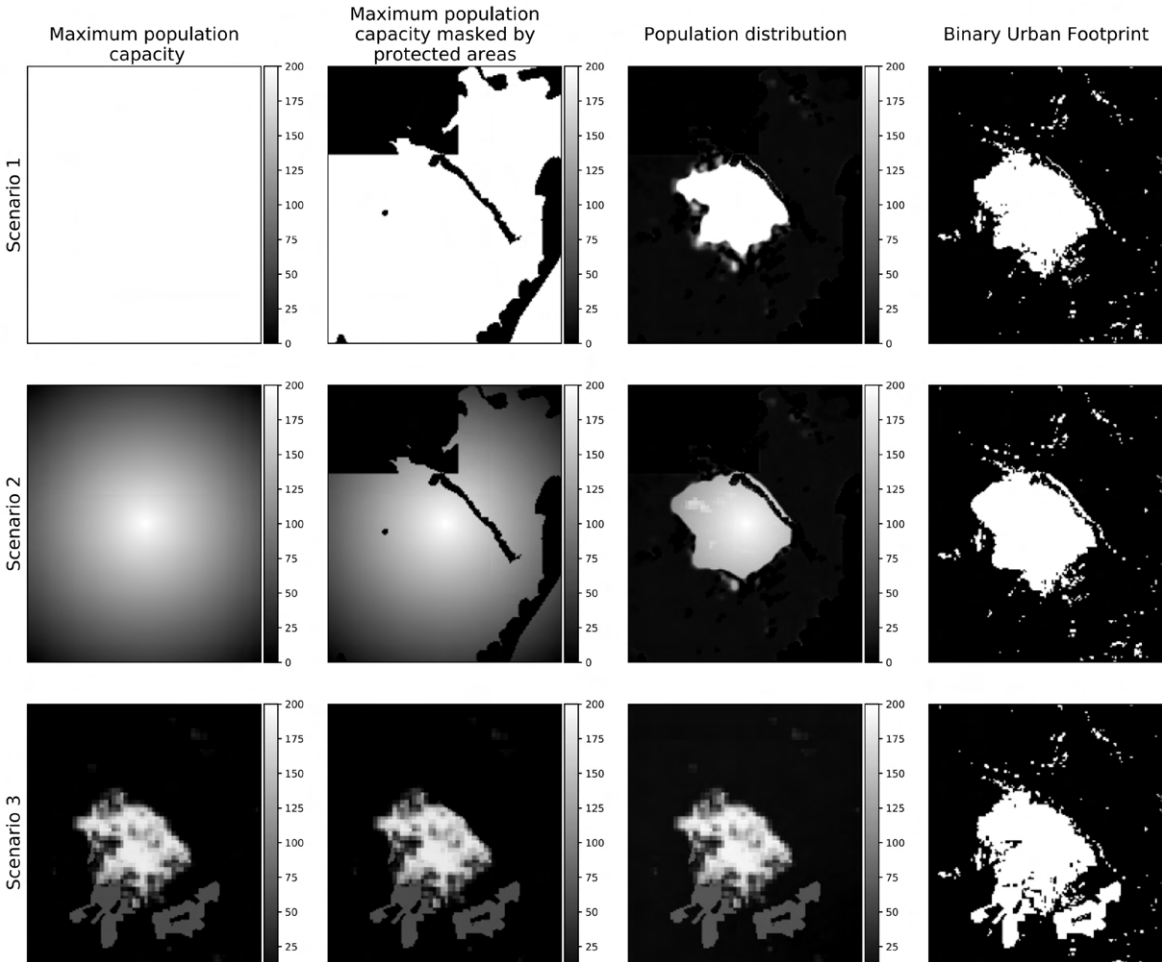
See p. 9

44-75 MINUTES

average journey time acceptable to commuters, denoting the pool of labour and skills companies can access

1. Shaping urban growth

Figure 1. Results of a case study with a sensitivity analysis of predicted urban growth for the city of Valledupar (Colombia) in 2050



Source: Gómez J.A., Patiño J.E., Duque J.C., Passos S. Towards a More Sustainable Urban Growth Through a Data-Driven Framework for Modelling.

The ability to forecast urban growth and track patterns of development over time is an important element of urban planning. PEAK's approach to prediction means forecasting can be made more accurate, flexible and cost-effective by leveraging new data and methods.

Machine learning models to forecast urban growth in any context

Drawing on expertise from machine learning, remote sensing and applied maths, researchers developed a model to forecast the size and density of urban growth using publicly available satellite images from the Global Human Settlement and Landsat programmes.[12] Unlike earlier rule-based growth forecasting models, their data-driven model, "Urban Pixel", does not assume a fixed mathematical model or require detailed historical information – which makes it easy to use and apply in any context where public data is available. The model allows policymakers to assess the impact of different policy options, such as setting an ideal maximum population capacity, on population, service demand and the environment. It also enables them to evaluate the attraction potential of planned infrastructure, and to see how city growth will interact with nearby municipalities.

Better urban growth forecasting can help a range of actors, including private-sector companies planning new market opportunities, local authorities drawing up development plans, and national or international bodies looking to invest in country-level development.

Predicting demand for utilities, Colombia

"Now it is easy for us to predict future water demand in our existing markets or those we wish to explore. We can download satellite images, feed them into the model, and quickly get a report on how an urban area is growing and what this means for water demand in 20, 30 or 40 years' time."

Juan Camilo Hurtado, EPM

Public utility company EPM supplies water, electricity, gas, sanitation and other services to residents and industrial users in the Antioquia region around Medellín. Leveraging the PEAK lens to understand how cities adopt solutions, the company asked EAFIT to develop Urban Pixel into a bespoke tool to predict water demand in any context, even where EPM had no prior experience of the market.

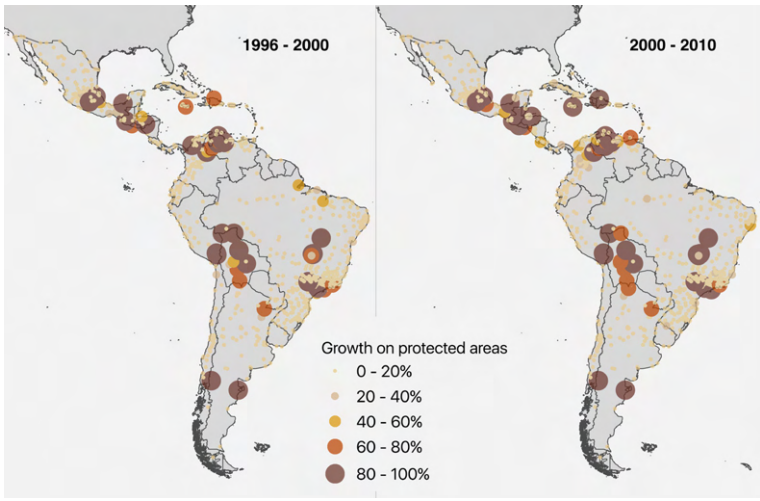
In response, researchers developed "Newton", which predicts water need from urban growth forecasts quickly and easily using satellite images. They also trained colleagues at EPM to run the software themselves. Now the company can model predicted utility demand in new markets, ensuring future service provision meets population need and is cost-effective.

Profiling LAC cities' physical development

Evidence on the changing form of LAC cities between 1996 and 2010, gathered using open access data on street networks and night-time light imagery, shows that certain cities are developing on steeper slopes and urban growth is occurring in protected areas – particularly in Bolivia and Venezuela. There is also a trend towards sprawl rather than density in some cities, although many have not changed much over time.[13]

The use of new data and analysis techniques opens the possibility of conducting massive standardised studies of urban form across cities and countries, allowing city planners to understand at scale how cities are changing and to design better land-use policies. Evidence of the impact on special areas or fragile environments should inform city-level protection efforts, including disseminating information about protected areas to developers and the public, and enforcing protection measures where they exist – as in Colombia.

Figure 2. Percentage of urban growth on protected areas in LAC. Left: 1996 – 2000, right: 2000 – 2010



Source: Gómez J.A., Patiño J.E., Duque J.C., Passos S. Spatiotemporal modeling of urban growth using machine learning.

2. Creating sustainable cities

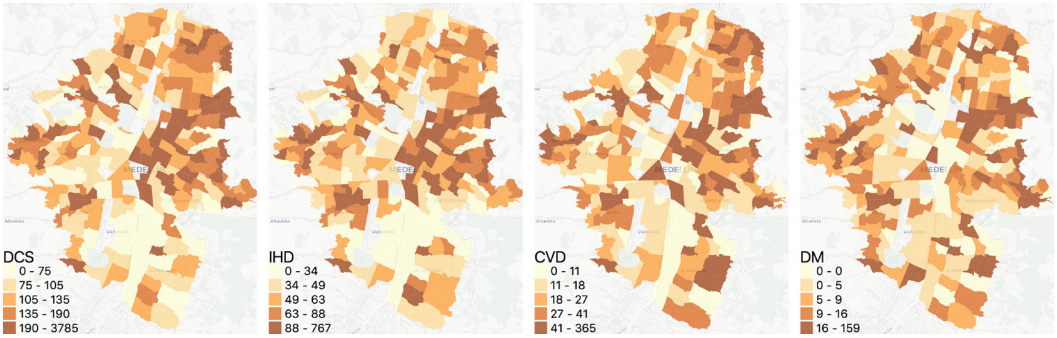
While the population of Latin America grew rapidly in the mid-20th Century, the rate of population growth has been declining since the1960s and is now estimated at under 1 per cent a year.[14] This makes it particularly important to improve and evolve existing cities, with urban redevelopment and renovation becoming the most significant way cities change.

Leveraging PEAK's emphasis on understanding how cities emerge and working with diverse stakeholders, researchers investigated aspects of urban form. They identified how one distinct area of urban policy – planning – can impact other areas, such as health, transport and productivity, demonstrating that combining knowledge across diverse disciplines leads to new insights.

Urban form impacts citizens' health

Health promotion is not the sole preserve of health departments. Urban planning professionals can also contribute to population health and wellbeing through interventions in the built environment.

Figure 3. Spatial distribution of adjusted mortality rates for the analysed disease groups (units: number of deaths / 100,000 people). Note: DCS: diseases of the circulatory system; IHD: ischemic heart disease; CVD: cerebrovascular disease; DM: diabetes mellitus.



Source: Patino J.E., Hong A., Duque J.C., Rahimi K., Zapata S., Lopera V.M. Towards a better understanding of what makes a healthy urban built environment in Colombia.

Using district-level health data, open geospatial datasets and satellite imagery, PEAK researchers found that a more walkable city is a healthier city, as shorter blocks and more intersections are associated with lower mortality rates from cardiovascular disease and diabetes.[15] The research also revealed that dense cities are better for health, up to a point. Researchers found that a population density of up to 60,000 people per kilometre squared was associated with lower mortality rates, but that higher densities were associated with higher mortality, probably due to overcrowding and poor living conditions.

Further research looked at the environmental and health benefits of green space, finding that green spaces can reduce stress and depression, but that poorer residents often lack access to such amenities.[16]

Dense cities

Are better for health, up to a point.

60,000
people per kilometre squared

lower mortality rates

But that higher densities were associated with higher mortality.

Probably due to:

Poor living conditions.

Overcrowding

Policy engagement in Medellín

Leveraging PEAK's commitment to the co-creation of new knowledge, the Medellín Health Office was involved in research on urban form and health from the design phase, and has been very receptive to the findings, which were shared with officials and disseminated more widely at a workshop in October 2021. The Health Office's Medellín Ciudad Saludable (Medellín Healthy City) plan provides a framework for potential improvements, and the office continues to engage with researchers around possible interventions. More widely, a network of practitioners, decision-makers and researchers are now aware of the health benefits of green space and are able to discuss the issue in a more nuanced and informed way with public and policy audiences.


Image credit: Adobe Stock

City layout also impacts productivity

The productivity of LAC cities is on a par with the world average, but lags behind the most productive cities of North America and Europe.[17] The importance of urban form and layout to productivity has long been explored in urban economics, with density considered to boost productivity as it facilitates knowledge sharing, increases the availability of workers, and reduces time to retail and amenity destinations.

Figure 4. Urban areas in Latin America and the Caribbean extracted from the DSMP-OLS NTL 2010 image.

Source: Duque JC, Lozano-Gracia N, Patino JE, Restrepo P. Urban form and productivity: What shapes are Latin-American cities?

Research using new indicators adapted from the planning literature and applied to open access data on street networks and night-time light imagery (as a proxy for productivity) showed that compact, dense and well-connected cities are likely to be highly productive, as expected. However, by going beyond conventional economics to consider shape, texture and land-use, PEAK researchers found that a non-compact city can still reach high levels of productivity using interventions such as well-connected street networks; safe, efficient and reliable transport, and effective land-use planning.[18]

National and international bodies should support city planners to evolve urban layout to boost health and productivity. This should include making cities more walkable and ensuring access to green space for all socioeconomic groups, and facilitating productivity via effective transport and land-use policies.

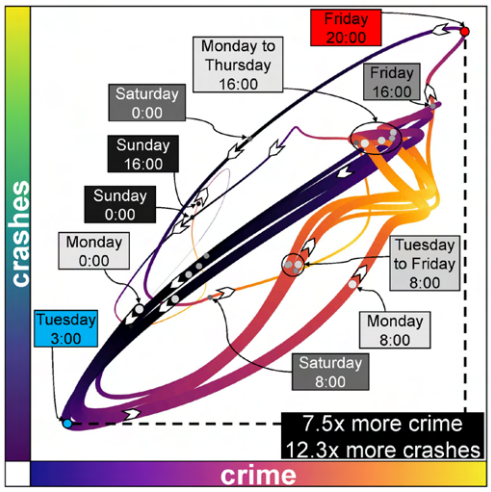
The impact of city layout on mobility and crime

Moving people and goods safely and efficiently around cities, and reducing pollution and congestion, are vital to achieving sustainable cities. Where data is available, open access models can be used to predict mobility patterns and plan infrastructure in low-resource contexts, allowing authorities to boost non-motorised transport, reduce crime and accidents, and deploy public resources more effectively.

Building on evidence that people want "connectivity" and "directness" – dedicated cycle lanes and to reach their destination by the shortest route – PEAK researchers designed models to explore trade-offs between the cost of infrastructure and cycling gains.[19] The models have been adopted by Medellín City Council's Mobility Office to boost cycling and walking as modes of transport, and can be easily adapted for use in other contexts.[20]

Open access data sources can be used to predict patterns of crime and traffic accidents, allowing authorities to deploy public resources such as the emergency services more effectively.[21] At neighbourhood level, both crimes and crashes are influenced by the location of local amenities and economic activities, such as services, education, leisure, offices, manufacturing and health facilities.

Figure 5. Heartbeats associated with crime and crashes.



Source: Prieto Curiel R., Patino J.E., Duque J.C., O'Clery N. The heartbeat of the city.

3. Inclusive economic growth

Colombia has one of the highest inequality rates in Latin America, as well as one of the highest rates of informal employment. PEAK researchers used new data sources and analytical tools to investigate and predict inequality and employment-related issues, and worked with a wide range of stakeholders to analyse findings through a multi-disciplinary lens, to understand how cities emerge and identify implications for policy and practice.

> Many policies will be within the remit of city policymakers, but should be supported by funding and advice from national and international agencies.

Social protection measures can tackle inequality – if well targeted

The social classification system currently used to allocate utility subsidies in Colombia is based only on the external appearance and location of a property, meaning subsidies are often inappropriately awarded.[22] Errors are compounded as the system is used to calculate other benefits, such as for health and education.

Figure 6. Social class income deficit

Inclusion error: Household that **should not be** subsidized and **it is**
Exclusion error: Household that **should be** subsidized and **is not**

Source: The stratification system to funding utilities in Colombia and its limits to contribute to the reduction of inequality

PEAK researchers developed an alternative multi-dimensional model which uses big data manipulation techniques to analyse a range of administrative databases now available to government, such as taxes, health records and educational enrolment. Research simulations based on a multi-dimensional index showed significant improvements in identifying those who should receive utility subsidies in Bogota compared with the current Social Stratification Index, especially for water and sewage. This enables policymakers to better identify those on the lowest incomes over time, and target subsidies more effectively.[23] After engaging with PEAK researchers, government planners committed in their National Development Plan to review the model for calculating subsidies and develop a more progressive system.[24] The plan is approved by Congress and therefore legally binding.

Analysis of mobile phone data to investigate the extent to which city-dwellers complied with mobility restrictions during the Covid-19 pandemic also underlines the importance of appropriately targeted social protection. Findings show that socio-economic status and formal employment were the most significant factors in reducing mobility during the pandemic, rather than the severity of restrictions imposed – underlining the importance of well-targeted social protection measures to enable those on low incomes to comply with social restrictions.[25]

Formal-sector employment is rising, including for women – but not fast enough

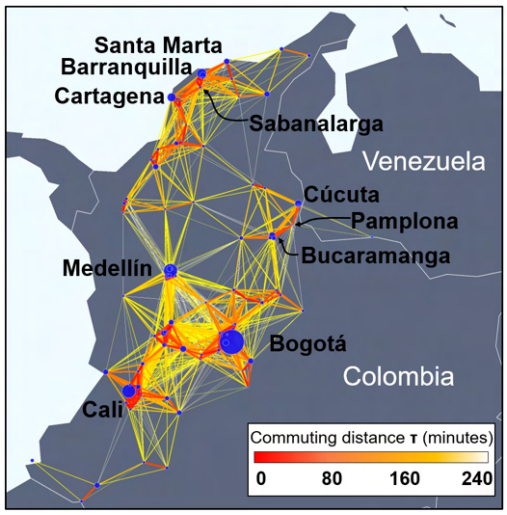
New data and analysis techniques highlight the gap between formal employment levels for women and men, and the slow increase in formal-sector employment overall. Analysis of data from 23 Colombian cities from 2008-2016, found that while women's formal-sector employment had increased, it was still lower than the employment level for men.[26] Predictions for 62 Colombian cities over time showed that the share of the working population in formal employment will increase by between 13 and 32 per cent – insufficient to achieve the goal of full and decent work for all by 2030.[27]

Policy action is needed at local, national and international level to support and promote higher paid and more secure formal-sector employment. PEAK's focus on how cities emerge shows that understanding the complex interrelation of culture, gender norms, formal policy and customary

practice is vital to identifying barriers to women's participation in the labour force, and designing appropriate policy responses. These could include challenging cultural norms, improving local transportation, and expanding and improving childcare. Many policies will be within the remit of city policymakers, but should be supported by funding and advice from national and international agencies.

New planning tools to profile economic activity, predict trends and boost productivity and employment

Figure 7: Municipality commuting network, formed by the location of 96 urban municipalities in Colombia



Source: O'Clery, N., Curiel, R.P., Lora, E. Commuting times and the mobilisation of skills in emergent cities.

Boosting productivity and ensuring this translates into decent work for women and men depends on understanding and responding to the multiple dependencies within social and economic systems. The PEAK approach provides an important new method for this. Novel data sources and analysis techniques can help planners predict a range of issues, from future rises in formal employment, to which regions have the capacity to develop more complex goods. Understanding the relationship between factors such as how far people are prepared to commute to work,[28] the potential productivity increases of less developed regions[29] and the extent of informal economic activity in the city[30] can help planners see how emerging socio-economic systems interact. Building on new low-cost techniques to gather evidence, planners in resource-constrained contexts can develop muti-level partnerships and collaborations to adopt innovative solutions for their cities – such as identifying the infrastructure, knowledge sharing, investment and resources needed to develop "ideal economic regions" and reduce regional inequality.

Making the informal sector "visible"

In developing cities with high levels of informality, including those in Colombia, information about the spatial organisation of economic activity is often not available. This means policymakers lack data on the number, type and location of jobs, and the opportunities to boost economic activity through transport, infrastructure and services. Research using Medellín as a case-study showed that informal economic activity in cities can be made visible using machine learning and street-level imagery to identify commercial activity that may otherwise be hidden.[31]The research detected five distinct clusters of economic activity, located in both the established centre and the periphery, with informal activity largely concentrated in poor but densely populated areas. This challenges previous work suggesting a monocentric structure in Medellín, and highlights the large gap between what is captured in official data and the reality on the ground.

> Informal economic activity in cities can be made visible using machine learning and street level imagery to identify commercial activity that may otherwise be hidden.

4. Decent housing

Much of the housing in Medellín, and across Colombia and Latin America, has developed informally – often on marginal land, vulnerable to earthquakes and flooding. Informal settlements often lack adequate services and have been established over time by displaced people moving to urban areas. Although many local authorities have attempted to upgrade such settlements in recent years – particularly as part of the "social urbanism" movement in Medellín – much remains to be done to ensure decent housing for all, including migrants and refugees.

PEAK's emphasis on new, collaborative knowledge creation allowed researchers to develop multi-disciplinary partnerships across the urban sciences, use publicly available data and new analysis techniques, and undertake deep engagement with communities and urban actors to investigate many

aspects of decent housing. Their findings highlight little-understood issues and underline the range of socio-economic, technical and human forces driving emergent and interconnected issues in urban housing in the global South.

Conflict, criminal activity and speculation are driving gentrification

Since 1964, Colombia's long-running conflict between government troops, left-wing guerrillas (the FARC) and right-wing paramilitary groups has had a profound impact on the country's people, leaving 250,000 dead and more than 8 million displaced, and hampering socio-economic development. The conflict also led to a huge rural exodus, which has boosted urbanisation. From the mid-1970s, Colombian drug cartels have been major exporters of illegal drugs, primarily marijuana and cocaine. In June 2016, the Colombian government and FARC rebels signed a historic ceasefire deal, bringing them closer to ending five decades of conflict.

While in many contexts, property development or speculation are fuelled by companies and individuals acting largely within legal constraints, PEAK researchers noted the significant role of armed and criminal actors in a gentrification process displacing low-income residents in Colombia.[32] In Quibdó, on the country's Pacific coast, the state is weak and local armed elites are extremely powerful. Laundering of money from illegal mining and narco-trafficking has driven up prices for commercial premises in the city centre, forcing low-income residents into poor-quality housing in the periphery. Gentrification fuelled by illegal activity is prevalent in areas where state control is weak – whether due to lack of capacity, administrative decentralisation or economic liberalisation. International governance institutions should recognise the role of illegal activity in displacing low-income communities and support national governments to strengthen governance and ensure adequate regulation in such areas.

Communities are central to management and redevelopment of informal settlements

In Medellín's Juan Bobo community, public-sector agencies built trust with the local community to undertake an inclusive and effective upgrading of an informal settlement.[33] Decisions were made through dialogue and discussion, responding to the specific needs of the community – even where this seemed to contradict established practice.

City authorities, supported by national governments and international agencies, should work with communities to upgrade, evolve and improve existing settlements in response to residents' needs and aspirations, rather than relying on top-down development plans. Given Colombia's role in hosting regionally displaced migrants, international bodies with responsibility for refugees should work with the authorities to develop policies for the reception of migrants arriving in Colombia.

New techniques identify seismic risk and strengthen disaster preparedness

Assessing seismic exposure is normally a slow and difficult process, requiring engineers to observe and analyse individual buildings in person. PEAK researchers developed a rapid, low-cost alternative, using neural data-processing networks to analyse Google Street View images. Their technique is around 95 per cent accurate in identifying the rigid, inflexible buildings most likely to be damaged in an earthquake.[34] While this model was developed to analyse buildings in Medellín, it can be applied to other resource-constrained contexts, allowing public authorities to run assessments more frequently and develop a more accurate picture of the changing risk over time. This will better inform disaster risk planning and help authorities protect vulnerable citizens and their homes.

Figure 8. Building typologies for the residential building stock of Medellín (names according to the GEM taxonomy) Jan 2018.

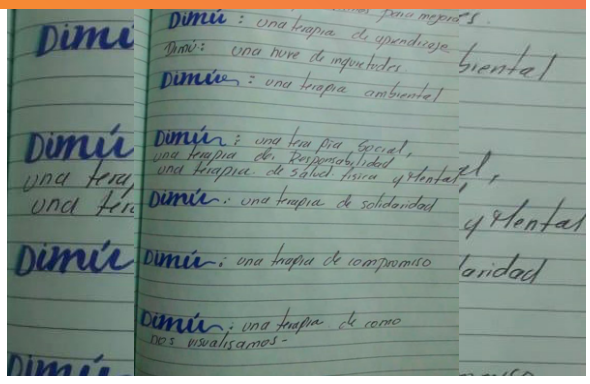
Source: Gonzalez D, Rueda-Plata D, Acevedo AB, Duque JC, Ramos-Pollán R, Betancourt A, et al. Automatic detection of building typology using deep learning methods on street level images.

Influencing local development in Itagüí, Colombia

A PEAK project working with low-income women in Itagüí, Colombia, influenced the local development plan to better reflect residents' needs. In early 2020, researchers worked with local women's group Dimú (meaning "Dialogue with Entrepreneurial Women"), while also engaging with representatives from local government, who asked the community group to respond to the proposed Local Development Plan.

Researchers analysed the development plan in detail and produced Youtube videos summarising the proposals and their implications for **health**, **the environment** and **mobility**. They invited the group to provide feedback and to answer to a detailed questionnaire on local services, collating the women's responses into a policy brief and submitting it to the Mayor's office.

The final Local Development Plan, published in June 2020, reflected key points raised by the group, including pledges to invest in neighbourhood pedestrian walkways, reinstate the local environmental leaders programme, support development of farmers' markets, and recognise that participatory processes should engage rather than educate citizens. The project showed the importance of including marginal groups in local planning, and the additional knowledge and experience this can bring to the process.



Colombian local women's group Dimú ("Dialogue with Entrepreneurial Women") defines itself as "reflecting on what we can do to improve; a learning therapy... a solidarity therapy; a commitment therapy; a therapy for how we visualise ourselves".

5. Localising the SDGs

While national governments and international bodies have committed to the UN Sustainable Development Goals (SDGs), there is a growing appreciation of the role of cities in ensuring implementation. Yet despite this recognition – and increased city autonomy and decentralisation in many parts of the world – city governments' role in planning, monitoring and implementing the SDGs is still underdeveloped.

Using the PEAK approach to create new knowledge and understand how different cities can best adopt solutions, PEAK investigated city-level responses to the SDGs. Working with public-sector bodies and local communities, researchers found that the goals are not currently being effectively operationalised, but that there is significant potential and existing tools and frameworks to strengthen local implementation.

City-level responses to Covid-19 contain lessons for sustainability

The global nature of the PEAK programme made it possible to investigate the challenge of localising the SDGs in Bengaluru (India), Medellín (Colombia) and Cape Town (South Africa).[36] While measures to address Covid-19 varied across cities, each city mounted rapid, innovative responses, drawing on city-level governance structures, working with local technical expertise (such as universities) and engaging with communities as effective partners. Medellín has been hailed as a regional pioneer for its pandemic response, acting rapidly to introduce measures to slow the spread of the disease and protect low-income residents from its impact. City authorities realised early on that they had to ensure the poorest people, many of whom are informal workers relying on daily wages, had access to food and cash so they could stay at home and limit the spread of infection. Officials also worked with local universities and technical experts to help monitor and predict cases, and make crucial decisions about economic support, protecting the supply chain and distributing goods across the city. The flexibility and innovation demonstrated by cities such as Medellín in responding to the pandemic reinforces their potential to make a significant contribution to meeting global challenges such as the SDGs.

City planning frameworks can support implementation of global goals

Medellín has already made great efforts to use planning instruments to improve performance in areas such as utility coverage, violence and public space, and has defined indicators to contribute to national SDG reporting. Yet the SDGs are still not being effectively operationalised at city level. However, by using municipal planning instruments, such as master plans and local development plans, and involving citizens in diagnosis and formulation, stakeholders can create more effective urban policy and ensure local plans link directly to long-term goals and monitoring efforts.[37] This will support required national-level reporting against SDG targets, capture progress towards the goals, and help international bodies identify local sustainability initiatives that merit support.

Towards achieving the SDGs in Medellín

PEAK researchers developed guidance for policymakers on the localisation of SDGs, building on existing city planning systems and focusing on diagnosing challenges and formulating strategies to tackle them. The research and recommended planning process have been adopted by Medellín's Planning Department.

Recommendations

PEAK research findings highlight the value of a systematic, wide-angled approach to urban policymaking at all levels. This entails using innovative prediction tools, understanding the interactions that shape how cities emerge and the ideas they adopt, and targeting knowledge exchange across sectors.

The recommendations apply to all actors who shape the urban ambit at all levels and through different lenses. In particular, they are aimed at Latin America-focused international agencies and donors, development banks and investors, national and city-level governments, ministries and departments, urban activists and practitioners, academic and research institutes, international and national non-governmental organisations, and civil society organisations.

Each recommendation can be interpreted by these actors according to their role and responsibilities and adapted for use in their context. Global actors can play an important role in encouraging their colleagues, partners and grant recipients to adopt these approaches.

Build effective partnerships across levels, sectors and disciplines.

By developing strong cross-sectoral, multi-level and multi-disciplinary partnerships, urban actors can diagnose urban challenges and formulate effective solutions. As those closest to the city, local authorities will often be the drivers of such initiatives, but they require creative support from all actors – including academic and technical experts, national governments, and international donors and investors – taking a far-sighted and flexible approach to funding and implementing new multi-disciplinary solutions.

Use open access data sources and new methods of analysis.

PEAK research in Colombia demonstrated that where administrative data is scarce or unreliable, planners can use multiple data sources to make visible the working of city systems. Using open access data sources and publicly available models of artificial intelligence and machine learning gives planners and policymakers low-cost, effective tools to investigate urban issues, predict future trends and understand how emerging systems interact.

Local authorities should investigate the potential of open access data and analysis for applications such as forecasting urban growth, understanding informal economic activity and assessing seismic risk.

Policymakers should seek expert advice and build partnerships with other stakeholders, such as scientists and academics, in their contexts. National governments and international bodies can facilitate the use of these approaches, helping to share knowledge about what is possible, and funding and supporting uptake.

Use urban form and layout to support diverse objectives.

Dense cities offer benefits for health, mobility, productivity and sustainability. Where cities are not dense, interventions can help compensate for lack of density and achieve similar benefits. City-level administrations should understand how urban form affects citizens' health, behaviour and economic activity, and what interventions will increase sustainability and achieve multiple SDG targets, even where these go beyond their own portfolio. International agencies should consider the wide-ranging impacts of city layout within their funding and support offer, even where this may exceed their usual interests and parameters, such as health or governance.

Build on knowledge from diverse sources.

Policymakers at all levels should build on the widest possible knowledge base to inform action. This should include the knowledge and views of communities gained through ethnographic enquiry (whether face-to-face or virtual), evidence from data analysis, the input of technical and subject-matter experts, and consultation with elected politicians, professional managers and other stakeholders. Knowledge exchange should be an ongoing, iterative process, with information from all sources and levels enriching understanding and building the picture. Planners should revisit projects frequently to see whether new knowledge challenges their diagnosis or proposed solutions.

Use the PEAK approach to investigate complex urban issues.

The PEAK framework is particularly useful to underpin planning on complex, multi-faceted urban issues such as economic development. The approach can be used to diagnose barriers and enablers to productivity at city, regional and national levels – such as conflict, skills shortages or the untapped potential of informal enterprise. It can also help design area-based economic development programmes which draw on the skills and resources required for diversification. Such programmes should be supported by national, regional and international investment, partnerships and coordination mechanisms.

Understand city systems.

PEAK's research in Colombia highlights the inter-relationships and interaction of different city systems, and how interventions in one system can have positive or negative effects in others. For instance, planning interventions in city layout can bring improvements in health, while improvements in public transport can facilitate women's employment, increase productivity and reduce air pollution and congestion. By understanding how urban features emerge and interact, and seeing the city as a "system of systems", urban actors can solve problems in one system via interventions in others, or achieve multiple targets across systems with a single intervention.

Conclusion

While local and national governments have made great efforts to increase the sustainability of Latin American cities in recent years, there are still many challenges ahead if the region is to meet the SDGs by 2030 and ensure healthy, productive and enjoyable lives for all city dwellers. Encouragingly, there is a wide range of tools to help policymakers predict urban trends, understand how urban systems interact and emerge, and design evidence-based interventions to promote sustainability for their context.

Collaborative solutions targeting multiple SDGs

New data sources and analysis techniques give insights into all aspects of urban life, from the mobility patterns of residents during lockdown, to predicted population growth and service needs, or the future increase in formal employment. Working with the widest range of stakeholders across all sectors, and linking local to global, building knowledge and taking a "systems thinking" approach, urban planners can identify innovative solutions which address multiple SDG targets simultaneously.

The PEAK approach offers an important new framework to navigate this process and guide prediction, understand emergence, inform adoption and share knowledge. This can support policymakers in transforming the sustainability of urban Latin America and other cities worldwide over the next decade.

Resources

For a wide range of project overviews, journal articles, policy and research briefings, and blog discussions, visit our Latin America research pages, including:

• The past, present, and future of urban footprint growth of Latin American cities **https://www.peak-urban.org/project/past-present-and-future-urban-footprint-growth-latin-american-cities**

• Urban form and its impact on sustainable development **https://www.peak-urban.org/project/urban-form-and-its-impact-sustainable-development**

• Urban morphology of displacement **https://www.peak-urban.org/project/urban-morphology-displacement**

• Economic challenges of Latin American cities within the framework of the SDG: a disruptive vision on how to tackle them **https://www.peak-urban.org/project/economic-challenges-latin-american-cities-within-framework-sdg-disruptive-vision-how-tackle**

• Communities, accessibility, and healthy living in Itagüí **https://www.peak-urban.org/project/communities-accessibility-and-healthy-living-itagui**

• Transitional cities in the global south and their contribution to SDG implementation: governance and power relations in Medellín **https://www.peak-urban.org/project/transitional-cities-global-south-and-their-contribution-sdg-implementation-governance-and**

To find out more, visit the PEAK Urban website or contact **peakurban.director@compas.ox.ac.uk**

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About us

The PEAK Urban programme aims to aid decision-making on urban futures by:

1. Generating new research grounded in the logic of urban complexity;

2. Fostering the next generation of leaders that draw on different perspectives and backgrounds to address the greatest urban challenges of the 21st century;

3. Growing the capacity of cities to understand and plan their own futures.

In PEAK Urban, cities are recognised as complex, evolving systems that are characterised by their propensity for innovation and change. Big data and mathematical models will be combined with insights from the social sciences and humanities to analyse three key arenas of metropolitan intervention: city morphologies (built forms and infrastructures) and resilience; city flux (mobility and dynamics) and technological change; as well as health and wellbeing.

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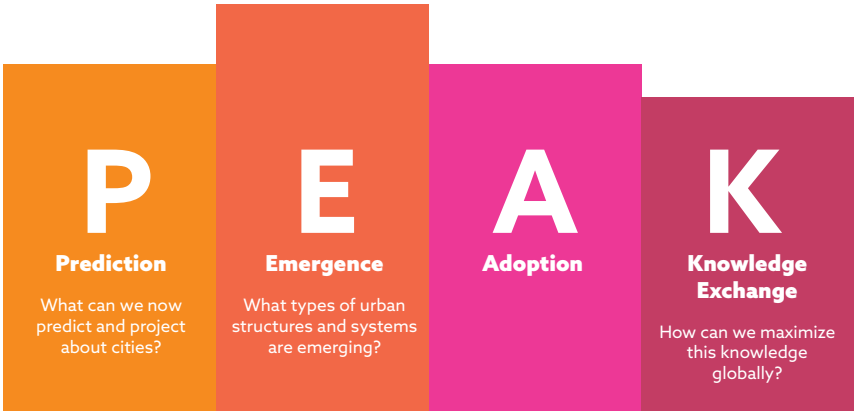
Our framework



The PEAK Urban programme uses a framework with four inter-related components to guide its work.

First, the sciences of **Prediction** are employed to understand how cities evolve using data from often unconventional sources.

Second, **Emergence** captures the essence of the outcome from the confluence of dynamics, peoples, interests and tools that characterise cities, which lead to change.

Third, **Adoption** signals to the choices made by states, citizens and companies, given the specificities of their places, their resources and the interplay of urban dynamics, resulting in changing local power and influencing dynamics.

Finally, the **Knowledge** component accounts for the way in which knowledge is exchanged or shared and how it shapes the future of the city.

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