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How to Manage Urban Development in Central America: Using Remotely Sensed Data to Better Understand Cities

by Jessica Grisanti and Devyn Paros

Abstract

Central America is the second-fastest urbanizing region in the world, with most of the urban population growth taking place in intermediate or secondary cities. While urbanization can generate economic opportunities and improve life for urban dwellers, many of these cities are challenged by existing deficits in public services, infrastructure, and institutional capacity. In order to harness the benefits of urbanization, cities will require more information about the ways in which their urban areas are growing and developing. Examples from secondary cities in the region show how innovations in GIS and remote sensing technology – like satellite imagery – can help to fill critical information gaps and prepare cities to manage their urban transformations.

Introduction

Central America (CA) is undergoing an urban transformation. According to the World Bank, 59.0 percent of the region's population lives in urban areas. Within the next generation, however, an estimated seven out of 10 people will live in cities – an increase of nearly 20.0 percent.¹ Governments at the national and local levels face serious challenges managing this urban transition. Cities already suffer deficits in public services, infrastructure, and institutional capacity. As larger numbers of people concentrate in urban areas, it will become increasingly hard for governments to provide basic services, build new infrastructure, alleviate urban poverty, and establish sound policy and regulatory frameworks.

Two factors exacerbate the challenges posed by rapid urbanization in the region and weaken governments' ability to manage growth. First, the rural-to-urban transition is expected to concentrate in secondary cities – meaning urban settlements outside of primary or capital cities in developing

countries – which historically have lower capacity and fewer resources.² Second, policymakers, particularly at the local level, lack the information and data necessary to respond effectively to the rapid urbanization.

Experience from countries around the world shows that if urban growth is met with weak planning and investment then the growing populations in these cities will remain underserved, disconnected from jobs and markets, and cities will expand at costly rates. Well-managed and well-planned urbanization, however, can generate economic opportunities and improve the quality of life for the majority of urban dwellers. It can also drive productivity, innovation, and regional development while helping to alleviate poverty and improve social inclusion.³ In order to harness these benefits, CA must leverage better data and use it to inform urban development policies and planning at the national and local levels. Several countries and cities in both Central and South America are already doing this, empowered by geographic information system (GIS)

technology and data derived from satellite images about the composition of cities and land use.

The next section will provide insight into the urbanization process of Central America, followed by two case studies in Guatemala and Bolivia to show how satellite imagery can help to characterize the land use and show trends that can better inform the territorial development of the region and its cities.

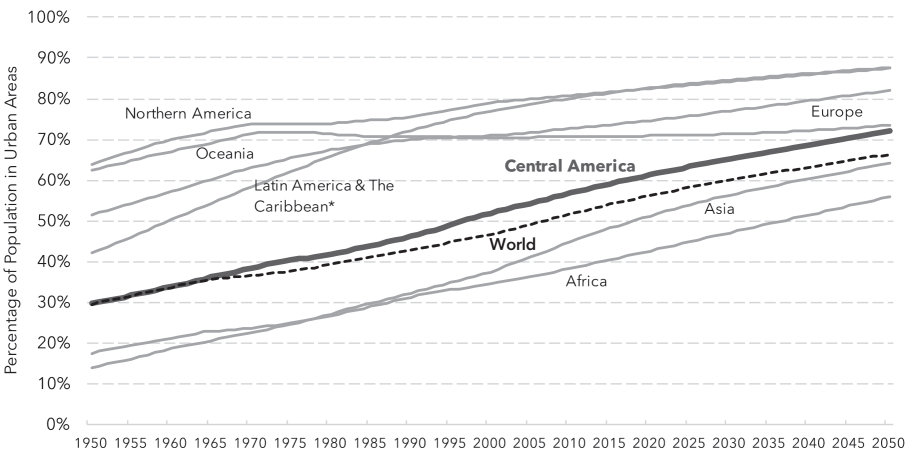
The Ups and Downs of Rapid Urbanization in Central America

CA is the second-fastest urbanizing region in the world after Africa (see Figure 1). The region’s urban population is growing faster than other countries at similar stages of urbanization. Under current urbanization rates, the region’s urban population will double by 2050, making it equivalent to Australia’s total population. The urbanization process has been unequal across the region. Nicaragua and Panama’s urban

populations surpassed 50.0 percent in the late 1970s and early 1980s. Guatemala and Honduras became predominantly urban in 2008 and 2012. The region’s urban population is projected to exceed 70.0 percent, with the exception of Guatemala (67.3 percent). Costa Rica and Panama’s urban populations are projected to reach close to 90.0 percent.⁴

An important driver of the urbanization in CA is rural-to-urban migration. Rural populations are migrating to cities looking for job opportunities, access to education, and overall better quality of life. The level of urbanization rate is often associated with economic growth,⁶ but the urban transformation presents several key challenges to the region: providing better infrastructure, expanding coverage and improving the quality of urban services (water supply, waste management, transport, street lighting, etc.), and providing greater employment opportunities. These challenges are further tied to problems that have long plagued CA countries such as lack of social inclusion, vulnerability to

Figure 1. Central America is the second-fastest urbanizing region in the world



Source: UN World Urbanization Prospects (2014)⁵
 *Latin America & The Caribbean excludes Central American countries.

natural disasters, and lack of economic competitiveness.⁷

While population growth and migration have caused cities in the region to expand, quality and access to housing have fallen short of demand. Slums⁸ and informal settlements in CA house on average about 29.0 percent of urban residents, though the share is higher in the case of Guatemala, where 39.0 percent of the population lives in slums.⁹ Informal settlements are a concern when they are located in areas at risk of natural disasters or are overcrowded.¹⁰ In CA, this is the case for both informal dwellers and the total housing stock in the region – about 10.0 percent to 20.0 percent of the current housing stock in the region is in high-risk areas or is overcrowded. In terms of access to services, statistics show that 50.0 percent of urban poor in Nicaragua don't have access to basic services, while Guatemala and El Salvador have 20.0 percent less coverage in terms of basic services than the average for all urban households.¹¹ Congestion and pollution are also challenges in the region.¹²

While the region has made progress in reducing poverty, as people move to cities the number of urban poor in absolute terms continues to increase. In 2011, the urban poor in CA numbered more than 8.3 million people.¹³ Crime and violence also tend to be higher in urban areas; international evidence shows that rapid and mismanaged urbanization can be linked to higher levels of crime and violence.¹⁴ To tackle urbanization's negative impacts and harvest its intended benefits, management at the city level is crucial. Governments in the region are presented with both an opportunity and a challenge to address urbanization. This is particularly true for local government as cities take ownership of these development challenges.

According to the World Bank, 81.0 percent of GDP in CA is concentrated in the countries' largest primary and secondary cities.¹⁵ Hence municipalities have a central role to play in territorial planning in the region.

Although capital cities and major metropolitan areas represent a large portion of total urban population today, these cities are expected to contribute less than 15.0 percent of the projected increase in urban population over the next decade. By contrast, secondary cities represent between 15.0 percent and 65.0 percent of the national urban systems and are becoming the focus of the region's urban agendas. Cities with populations between 15,000 and 100,000 accounted for between 20.0 percent and 30.0 percent of the population growth in urban areas. For example, official census data indicate that secondary cities in Guatemala and Nicaragua have contributed nearly two-thirds of the total urban population growth in the last decade.¹⁶

City-level policies and planning can help effectively manage the benefits and drawbacks of rapid urban growth. However, accurate, timely information, spatial data, and analysis are necessary for governments to improve urban policies and make sound investments for inclusive urban development. Many cities lack this information. This is especially true for secondary cities, which have been relatively neglected when compared to large metropolitan areas.

This information gap can be filled with innovation and technology. GIS technology and satellite imagery are powerful tools that are increasingly being looked at to fill the information gaps cities face. The types of information derived from these technologies can help assess and mitigate natural disaster risk. Other applications are more modest, but equally important,

for example local governments using technology to improve service delivery and citizen engagement. The next section will provide examples of how technology – particularly satellite imagery – can help decisionmakers understand urban conditions and make informed decisions.

Filling Information Gaps with Remotely-Sensed Data in Guatemala and Bolivia

Examples from Guatemala and Bolivia provide insights into how countries in both Central and South America can actively prepare for urban growth and equip themselves with the knowledge, policies, and institutions necessary to successfully manage urban transitions.

In both cases, remote-sensing technology was used by applying a land-classification algorithm to high-resolution satellite images of the respective cities. The algorithm – developed by the World Bank – categorizes each pixel of the image as a land cover type, such as informal or formal settlement, commercial, vegetation, water, roads, etc. This effectively creates a map of the land cover and use in the cities.

Case Study 1: Chimaltenango, Guatemala

Chimaltenango is a secondary city 50 kilometers outside of Guatemala's capital, Guatemala City, and serves as a gateway between the country's western region and its capital. From 1994-2002, the municipality of Chimaltenango almost tripled its population and had one of the highest population growth rates among secondary cities in Guatemala. In 2002, the municipality had the second-highest urban population (84.9 percent) among secondary cities in the country.¹⁷

With no formal urban plan, Chimaltenango has suffered from a disorderly growth model that hinders more rapid

economic development and contributes to an urban environment suffering from social, health, and environmental problems. The city's educational and health services are no longer sufficient to meet recent and future demographic growth.¹⁸ The aging water and sewer systems are overburdened, and the absence of a sewage treatment plant and comprehensive waste management, combined with illegal dumping, have implications for human and environmental health.¹⁹ The city's insufficient road infrastructure results in intense congestion along the busy Pan-American Highway.²⁰

In 2014, the cadastre of the municipality conducted a city-wide census in order to fill gaps in information about the city's development patterns and land use. The census collected household characteristics and enabled the city to geo-reference land parcels and public service coverage. Through the census process, the cadastre also assigned street names and addresses, which did not exist previously. A study of Chimaltenango in 2017 paired this local census data with the satellite-image-generated land cover data from the World Bank to evaluate how these data could be used to inform urban planning and management.²¹ The map of the city's land cover alone provided useful insights. However, the study took a step further by applying metrics to the data to quantify the urban form of Chimaltenango. The metrics focused on two dimensions – development patterns and connectivity – and measured indicators such as road density and intersections, compactness and fragmentation of the city, and time and distance to residential areas from the center business district.

Paired with the local census data, the study found that access to municipal water service, solid waste management, and electricity is significantly lower or

entirely absent for large portions of residential settlements outside the city center. The study also found that residential areas farther from the center business district have developed in a non-centralized, fragmented fashion. While this may be inevitable or even desirable given that much of the undeveloped land is at high risk of landslides (see Figure 2). This has implications for the costs of extending not only public services, but also improved road surfaces to new developments at the city's periphery.²² To underscore this point, while Chimaltenango has a relatively low share of informal settlements, they are farther away from the city center in both time and distance than formal residential settlements.²³

Ultimately, combining satellite imagery, urban form metrics, and local census data generates a more holistic picture of urban development. This could potentially help the Chimaltenango government to map human settlements, assess access to services, and assess the risk of settlements to landslides, among many other facets of urban life. Following this study, the cadastre requested access to the World Bank data and satellite imagery. While the study described here focused on a single point in time, the city plans to use the information and techniques to allocate resources more effectively and monitor development over time.

Case Study 2: Trinidad, Bolivia

The city of Trinidad, Bolivia is also leveraging insights from land classification data produced by the World Bank to support urban management. In Trinidad's case, the World Bank evaluated not only the present state of development, but also patterns over time.

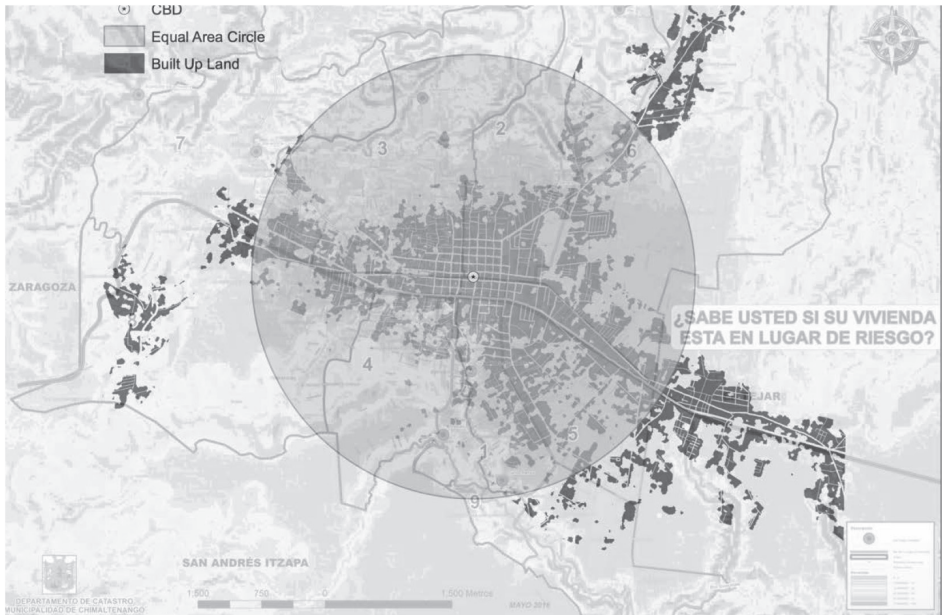
Trinidad – the 10th largest city in Bolivia – is expanding rapidly with the population

growing by nearly 3.0 percent and the urban footprint growing by 4.9 percent annually.²⁵ In 2012, the city developed an Urban Development Plan, Land Use Plan, and a Territorial Development Plan, but the city has yet to actively apply those tools. Since then, the city's population and urban footprint have expanded rapidly due to domestic migration without the proper basic services (water, sewerage, solid waste management). As a result, the urban footprint increased by 38.9 percent in the last few years.²⁶

Bolivia's Ministry of Development Planning commissioned the World Bank to study its intermediate cities. As part of the study, the World Bank compared satellite images of Trinidad in 2007 and 2015; this allowed one to study changes in the urban footprint and land use patterns. The World Bank had two key findings. First, the development of new informal settlements drove most of Trinidad's growth from 2007 to 2015.²⁷ In 2015, informal settlements occupied 40.0 percent of the city's urban land – compared to 31.0 percent in 2007 – and were concentrated at the periphery of the city. This is important because it creates pressure on the city to deliver services in areas far away from the city center. Second, many of these new settlements have developed in areas at risk of flooding.

The World Bank study recommended that Trinidad prioritize investments to extend the coverage of basic services and infrastructure. Many urban planning and diagnostic tools are available to Trinidad to support the implementation of these recommendations and to monitor how conditions evolve over time. However, there is no system in place yet to share or integrate information about service coverage and development across levels of government.²⁸ Such a system would enable government actors at the national and local levels to coordinate

Figure 2. Chimaltenango's Urban Extent overlaid with Risk Map



Source: Chimaltenango Cadastre (2016)²⁴ and Author's Calculation

and prioritize investments, which is critical considering resource constraints. The lack of systemization, and whether it can be addressed, will affect Trinidad's ability to actively manage urban development and to successfully guide investments.

What's Next for Central America?

Secondary cities in Central America face significant challenges as more and more individuals leave the rural areas of their countries in search of opportunities in cities.

Despite existing deficits in local capacity, services, and resources, cities have the opportunity to not only mitigate the challenges, but also be strategic in harnessing the many benefits of urbanization. City leaders and other stakeholders must be equipped, however, with more and better information in order to make effective urban policies and investments.

Not all the responsibility lies with the municipalities, however. Central governments also play an important role in strengthening institutions and building local capacity. Effective city management depends on vertical coordination between local and national governments as well as inter-municipal coordination. This allows cities to better cope with the demands of the urbanization process, and hence become more competitive, inclusive, and resilient.

Moreover, we must acknowledge that measuring urban development and using such information to make decisions is inherently a political process. When measuring urban development, someone must decide what the unit of analysis is. Do we care only about the land within our municipal boundaries, or are we looking at the urban area more holistically?

There are also normative considerations around how a city aspires to develop. To

be sure, there are global and regional best practices promoted in the urban planning literature and by globally influential actors such as the World Bank and UN Habitat. However, a city must ultimately decide whether being more compact or having higher road density is desirable, and to what end. Does the city care about being walkable? Does the city want to reduce the cost of extending sanitary sewer infrastructure? Does the city want to promote socially inclusive development?

These are not questions that we seek to answer here. What we do know is that those decisions can be informed and supported using information generated by satellite imagery and other technological advances. Furthermore, any tracking of urban development will require the political will to invest in capacity and technical knowhow. Ultimately, the effectiveness of any policies or regulations informed by data will also require buy-in from a wide variety of stakeholders, including governments, the private sector, NGOs, and the public at large.

NOTES

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