Chapter 2
Population Behavior and Land Occupation Trends

World urban population will grow 75 % in the next four decades and will reach 6.3 billion by 2050 as a result of the unprecedented growth that Asian and African cities will experience, as stated by the United Nations Department of Economic and Social Affairs (DESA) in the World Urbanization Prospects Report, 2014 Revision (United Nations, DESA 2014), while by the same year 89 % of the population in Latin America will live in towns and cities (IADB 2012).

Population growth defines the demand for water, for human consumption purposes and sanitation requirements, and we can compare countries' current coverage with the per capita demand. In addition, we can compare the countries' population densities with water resources or water supply coverage, in other words, identify the demographic pressure trends on such a fragile resource.

In this chapter, the existence and management of water resources is treated as an important part of water supply management. In the case of Latin America, the availability of water sources depends on geographical conditions that determine the generation and storage of this resource through ecosystemic services. These services transcend national borders and emerge in shared territories. These territories where the macro biophysical processes that help maintain and generate water resources take place may be termed ecoregions, which is a systemic concept that describes a territory's performance and that can be used at different scales. This document identifies ecoregions, macro territories, in Latin America that need to be managed to ensure the existence of water sources in the region.

Latin American countries process statistical information in different ways, and just a handful of countries have detailed, up-to-date information available. At the same time, just a few countries have official projected data. This is especially important when trend comparisons need to be made to identify common social weaknesses, as in the case of water supply and sanitation. To an even lesser degree are the statistics organized in relation to those shared resources, like water, that each country depends on for its survival. The ecoregional approach represents a way to see the management of these water resources from their origin, from the headwaters, and

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even their management lies far beyond the scale of independent nations; these resources present an opportunity for neighboring countries to work together to establish new cooperative mechanisms for common interests.

1 The Ecoregional Approach

The ecoregional approach is applied in different ways by different organizations and constitutes the conceptual basis on which sustainable development projects can be built, especially when the ecological conditions of the territory, like water, must be considered for further analysis. While the ecoregional approach has been subjected to different interpretations, all of which point to sustainability as a supreme goal, the approach is now more interdisciplinary and transdisciplinary than merely an issue mainly related to biological or agricultural sciences. These sciences allow other disciplines to collaborate in the development of this approach. At the same time, social, ecological, and productive demands promote the development of complementary and more integrated approaches to linking social, economic, land, and ecological management sciences.

In Latin America, poverty and environmental degradation have become part of an increasingly entrenched vicious cycle. Food insecurity and other conditions that threaten the quality of human life become permanent when this vicious cycle asserts itself. The application of development and conservation approaches, like the ecoregional approach, helps to break the links that cause the vicious cycle of poverty–environmental degradation, positively impacting families and organizations that need sustainable change.

The ecoregional approach can be applied to environmental conservation programs and to the relationships between conservation, food security, and production, which are mainly linked by water. However, still, one of the challenges lies in its integration with other disciplines and scenarios present in the same territory. In this way, the ecoregional approach is applied to the territorial scale beyond the basin level, integrating the role of other basins and the interdependency between ecosystems to ensure the biophysical dynamics on which natural resources, including water, depend.

The concept of an ecoregion comes from four different clearly identified streams. The first one, mainly promoted by conservation organizations, may define it as “An area of similar climate, landform, soil, potential natural vegetation, hydrology, or other ecologically relevant variables” (USGS 2015). The World Wildlife Fund defines an ecoregion as a “ large unit of land or water containing a geographically distinct assemblage of species, natural communities, and environmental conditions.”

The second one comes from eco-development streams, where an “ecoregion is an urban-rural unity that maintains productive and environmental relations.” For eco-development, the satisfaction of socioeconomic needs is a priority, even if it means reaching the environment’s carrying capacity. Ecological concerns are important, especially if they promote socioeconomic development. The third stream,

which is more recent, emphasizes the productive-ecological relationships within an environmental unit, defining ecoregions as "agroecological zones with regional character," giving special emphasis to agroecological sustainability, which implies agricultural development.

In addition to these concepts, a fourth one defines ecoregion, based on systems theory, which interprets meaning in a different way, so that "an ecoregion is a set of elements that interact," defining their depth of analysis, using only biophysical variables, socioeconomic relationships, or both. So an ecoregion's boundaries change depending on the sectors involved and the depth of analysis.

Nevertheless, despite these four different ecoregion concepts, this document uses the eclectic version that considers the previous ones and defines an ecoregion as "a territorial unit, or a set of territorial units, characterized by similar and interdependent biophysical conditions with the capacity to maintain these conditions and to develop human activities" (Arana 2006).

In South America, and for the purposes of this research, four main ecoregions have been identified: the Andean ecoregion, the Amazon ecoregion, the Dry Chaco ecoregion, and the Paraná-La Plata ecoregion. These ecoregions are defined based on similar climate conditions, physical conditions, and altitude that determine the ecosystems that characterize them and on the existence of an independent regional scale headwater, set of headwaters, or water sources (Map 2.1).

1.1 Andean Ecoregion

The Andean ecoregion is well defined since it has natural homogenous conditions and water sources originating in the Andes headwaters, also called water towers, which provide water to neighboring regions that share similar historic processes. The Andean ecoregion has a cold sea and high cordillera and gives birth to the Amazon, another important ecoregion. The Andean ecoregion mainly includes the countries of Bolivia, Ecuador, Chile, Colombia, Peru, Venezuela, and parts of other neighboring countries.

1.2 Amazon Ecoregion

The Amazon ecoregion is an area that has a tropical humid climate that allows a high density of unique flora and fauna species and biodiversity, which makes this ecoregion an ecologically differentiated area. The main water sources come from the Dry Chaco and Andean ecoregions. However, the capacity of the Amazon to retain water is one of the features of this impressive ecoregion. The Amazon ecoregion includes mainly Brazil and some areas of neighboring countries.



Map 2.1 Graphic scheme to identify Andean ecoregion, Amazon ecoregion, Dry Chaco ecoregion, and Paraná-La Plata ecoregion. *Sources:* Rowntree, Lester; Lewis, Martin and Price, Marie. 2002. Diversity Amid Globalization: World Regions, Environment, Development, 2nd edition. Prentice Hall, Englewood Cliffs, NJ. Mediateca – Biblioteca digital. 2015. Available at: http://mediateca.cl/. Reviewed on 13 September 2015. Map elaboration: Vladimir Arana

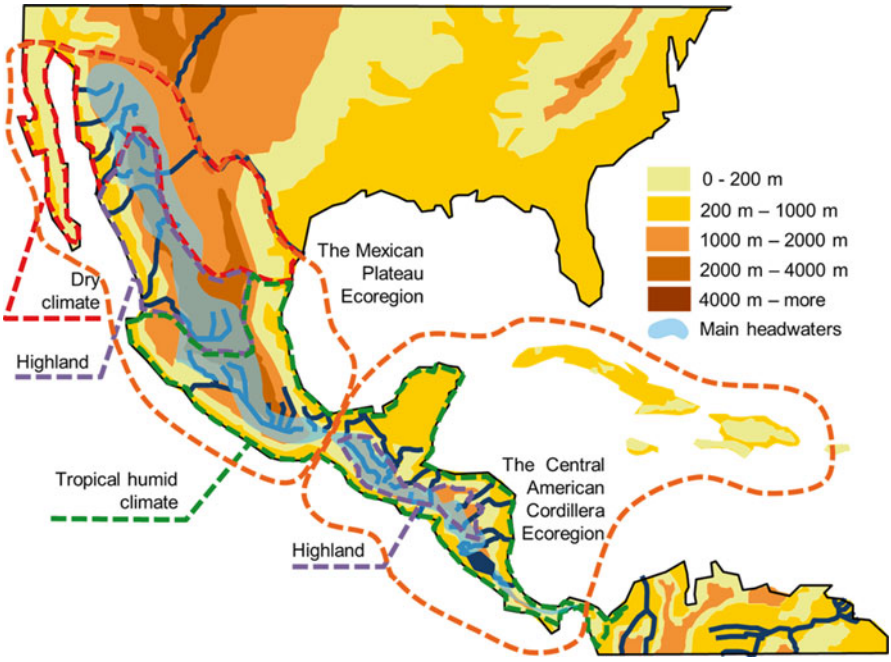
1.3 Dry Chaco Ecoregion

The word *chaco* comes from the Quechua *chaku*, which means "hunting land," which is also an ancient South American practice of capturing animals by surrounding them. It includes the territory that contains Paraguay and part of the neighboring countries of Argentina and Bolivia. This ecoregion presents a dry vegetation ecological systems transition, from tropical savannas to thorny scrubs, and dunes with vegetation.

1.4 Parana-La Plata Ecoregion

The dry climate that starts in the southern part of the Andean ecoregion transforms into a mild climate, and both comprise the Parana-La Plata ecoregion. This area combines several ecosystems, including the delta, semiflooded lands, and the subtropical upper territories. This ecoregion includes mainly Argentina and Uruguay.

In Central America, and for the purposes of this research, two main ecoregions have been identified: the Central American Cordillera ecoregion and the Mexican Plateau ecoregion. These ecoregions are defined on the basis of similar climatic conditions, physical conditions, and altitude that determine the ecosystems that characterize them and based on the existence of an independent regional-scale headwater or set of headwaters (Map 2.2).



Map 2.2 Graphic scheme to identify Mexican Plateau ecoregion and Central American Cordillera ecoregion. *Sources*: Rowntree, Lester; Lewis, Martin and Price, Marie. 2002. Diversity Amid Globalization: World Regions, Environment, Development, 2nd edition. Prentice Hall, Englewood Cliffs, NJ. Mediateca – Biblioteca digital. 2015. Available at: http://mediateca.cl/. Reviewed on 13 September 2015. Map elaboration: Vladimir Arana

1.5 Mexican Plateau Ecoregion

The Mexican Plateau ecoregion is a large arid-to-semiarid plateau, and it is mostly covered by deserts and xeric shrub lands, with pine-oak forests covering the surrounding mountain ranges and forming sky islands on some of the interior ranges. This ecoregion combines the biodiversity and tropical humid highlands and dry climates. This ecoregion mainly related to the country of Mexico (Ricketts et al. 1999).

1.6 Central American Cordillera Ecoregion

The Central American Cordillera ecoregion combines the highlands of the Cordillera climate with the highlands climate, all in a very narrow strip of land. Climates and biodiversity interact closely since this ecoregion the Pacific and Atlantic Oceans are located at very close distances. It includes mainly the countries of Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, Panama, and other neighboring countries.

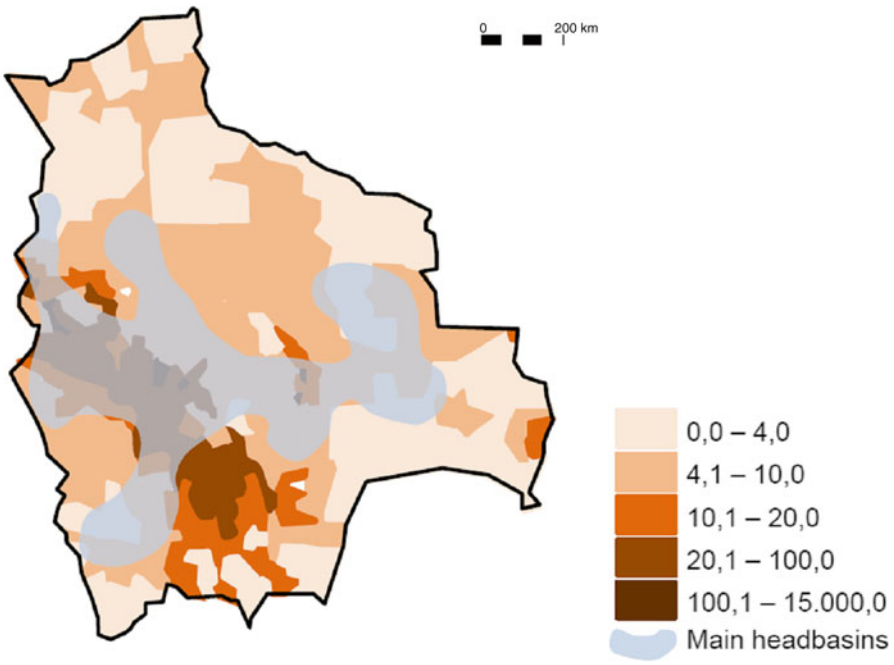
2 Population Behavior, Land Occupation Trends, and Water in the Andean Ecoregion (Ecuador, Colombia, Venezuela, Peru, Bolivia, Chile, Part of Argentina)

The Andean ecoregion is formed by the countries of Ecuador, Colombia, Venezuela, Peru, Bolivia, Chile, and part of Argentina. However the information about this last country will be treated with more detail in the Paraná-La Plata ecoregion chapter. The Andean ecoregion extends around the ecosystems of the Andes Cordillera, a South American chain of mountains from 11° latitude N–S and 56° latitude S. The average altitude is 4000 m, with many places reaching latitudes higher than 6000 m above sea level.

It is the largest cordillera on the American continent and one of the most important in the world. This enormous mountain mass runs in a north–south direction along the south Pacific coast for more than 7500 km. The southern tip of this cordillera descends into the Atlantic Ocean east of the Staten Island (Wegener 1983).

In Bolivia in 2004, the percentage of the total population living in cities reached 64 %, while the rural population decreased to 36 % of the total (PAHO 2004). By 2015, the urban population was around 68.5 % and will reach 70.4 % in 2020 (United Nations, DESA 2014). On the other hand, the capital of the country, La Paz, is located in the central part of the country on the Andes, and it is growing and concentrating ever greater numbers of people (Map 2.3).

Most of the population of Bolivia is located on the southwestern part of the country, where there are important water sources called headwaters. Other important headwaters are located in the eastern part of the country, where the areas with the lowest

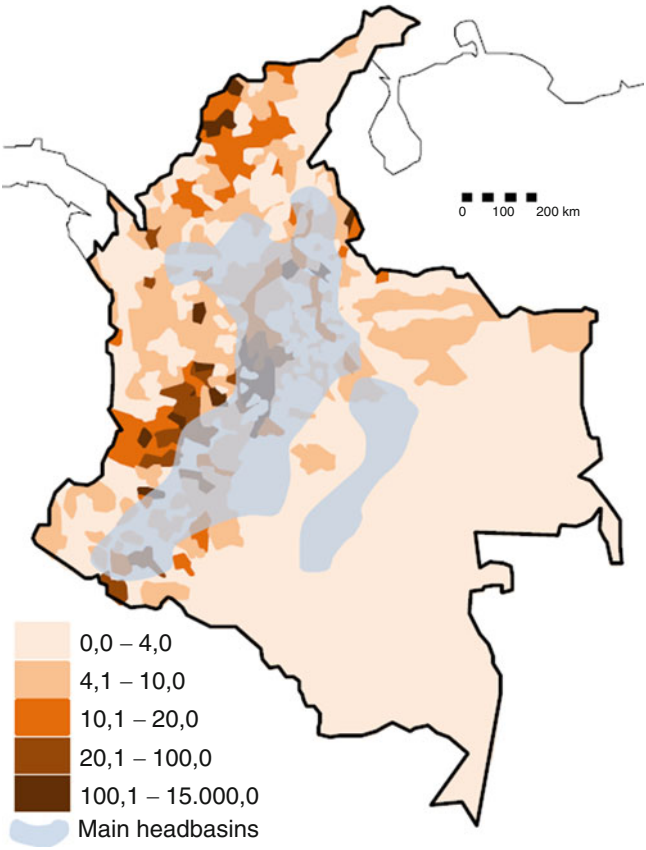


Map 2.3 Bolivia: population density (population per square kilometer) and main headwaters approximate location 2014. *Source*: ORELLANA 2003a. Observatorio de las Redes y de los Espacios en los Llanos, las ANdes y la Amazonia. Population density of Andean Community of Nations. Available at: http://www.mpl.ird.fr/crea/orellana/eorellana/epays/eandes1.html. Map elaboration: Vladimir Arana

population densities are located, and since the country is undergoing rapid urbanization, the two major trends are, on the one hand, depopulation in the eastern rural areas where important headwaters are located and, and on the other hand, destruction of the headwaters in the western part of the country owing to the rapid urbanization, which is in general illegal and irregular.

In Colombia, an analysis by the Pan American Health Organization reveals that the country is consolidating its urban primacy, which went from 69 % of the total population in 1990 to 72 % in 1995 (PAHO 2004), 76 % in 2015, and around 80 % in 2020 (United Nations, DESA 2014). By 2020, Colombia will have a population of around 51 million inhabitants, of which around 40 million will live in towns and cities (DANE 2011). These data demonstrate the abandonment of rural areas, especially isolated areas such as headwaters, a situation that is confirmed by the urban consolidation in areas containing headwaters.

As in Ecuador, the capital of Colombia, Bogota, is also located in the Andes, not in the coastal zone. However, strong urban coastal development is taking place in the country that is being firmly consolidated, as can be seen in the map of population densities and headwater locations in Colombia (Map 2.4).

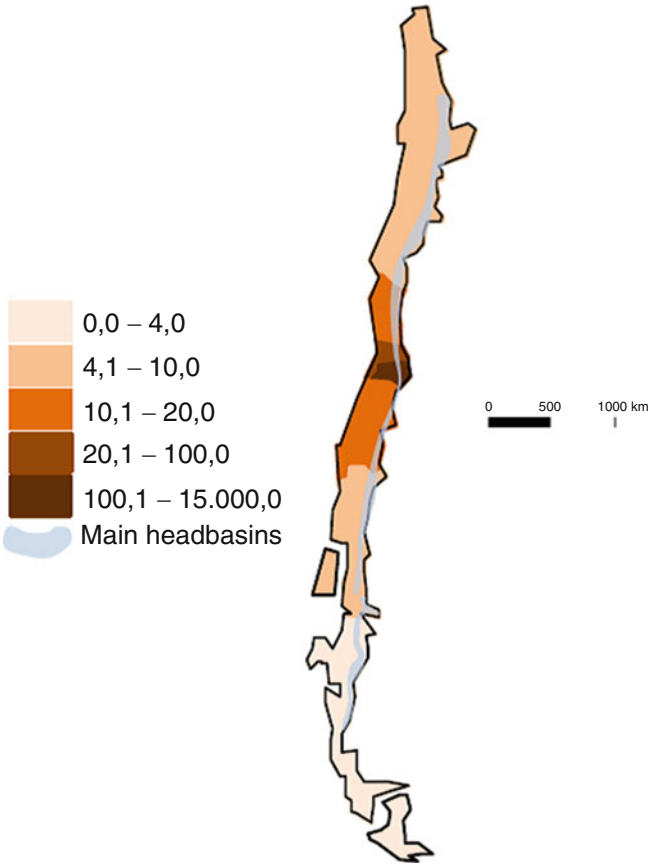


Map 2.4 Colombia: population density (population per square kilometer) and main headwaters approximate location 2015. *Source*: Paez, Gustavo; Jaramillo, Luis and Franco, Camila. 2013. Estudio sobre la geografía sanitaria de Colombia. Ministerio de Salud, Bogota. Research on the sanitary geography of Colombia. Ministry of Health. Available at: https://www.minsalud.gov.co/Documentos%20y%20Publicaciones/Estudio%20sobre%20la%20geograf%C3%ADa%20sanitaria%20de%20Colombia.pdf. Reviewed on 26 September 2015. Instituto Geografico Agustín Codazzi. 2012. Densidad de la Población. IGAC, Bogotá. Available at: http://sigotn.igac.gov.co/sigotn/PDF/Densidad_Poblacion_Nal_Soc_V2.pdf?. Reviewed on 26 September 2015. Map elaboration: Vladimir Arana

This urban consolidation phenomenon is concentrating population in the western part of the country and depopulating the eastern, mainly rural, part, where most headwaters are located. The depopulation of the eastern part is caused by different factors, such as the absence of the state and the presence of the terrorist-military conflict in this part of the country that has resulted in the expulsion of large numbers of people and the attracting force of the economically flourishing urban coastal areas. These combined situations have created a trend in which the population is flocking to urban areas, and mainly on the coast.

Chile is a long strip of land located in the southwestern part of South America. In 2015 it had an urban population of 89.5% of the total, which will grow to 90.3% in

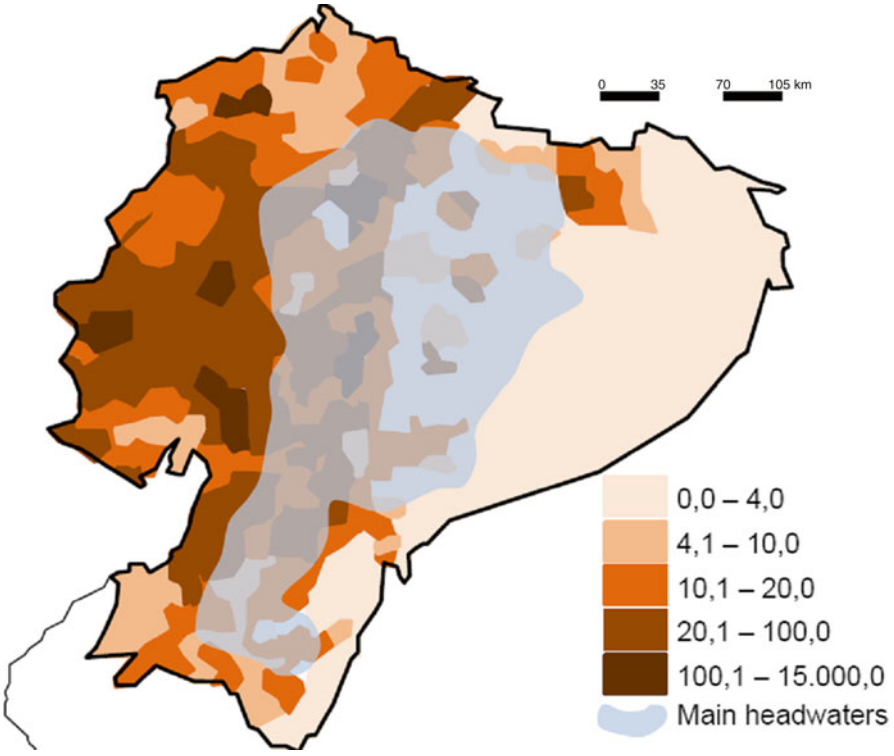
2020 (United Nations, DESA 2014). Most of the population is concentrated in the central part of the country, with the extremes being less populated; the southern part of the country has the lowest population density. Analysis shows a trend whereby people are concentrating in the central part of the country, around the metropolitan region. There are no rivers in the northern part of the country, except some land-locked streams and the Loa River. The central part of the country contains more rivers, which irrigate the agricultural valleys, and in the southern part of the country rivers have a special importance in terms of hydroelectric production (Niemeyer and Cereceda 1983). According to the general direction of waters, from the northern part to the metropolitan region water availability per capita is less than 1000 m^3 per year, which is lower than international standards. From the metropolitan region to the south per capita water availability increases up to 100,000 m^3 (Biblioteca del Congreso Nacional 2006), and it is this area that has the lowest population density in the country (Map 2.5).



Map 2.5 Chile: population density (population per square kilometer) and main headwaters approximate location 2014. *Source*: Sala de Historia. 2014. Geografía de Chile. Available at: http://www.saladehistoria.com/geo/Cont/C029.htm. Reviewed on 28 September 2015. Instituto Geográfico Militar de Chile 2008. Hidrografía de Chile. Available at: http://www.educarchile.cl/Portal.Base/Web/VerContenido.aspx?ID=132525. Reviewed on 28 September 2015. Map elaboration: Vladimir Arana

Ecuador is a country with a strong tendency toward urbanization: the population went from 58 % urban in 1995 to 60 % urban in 2000 and around 64 % in 2015 (United Nations, DESA 2014). It is estimated that the country will have a population of 17 million inhabitants by 2020 (Wikipedia 2012a) of which 65 % will live in towns and cities.

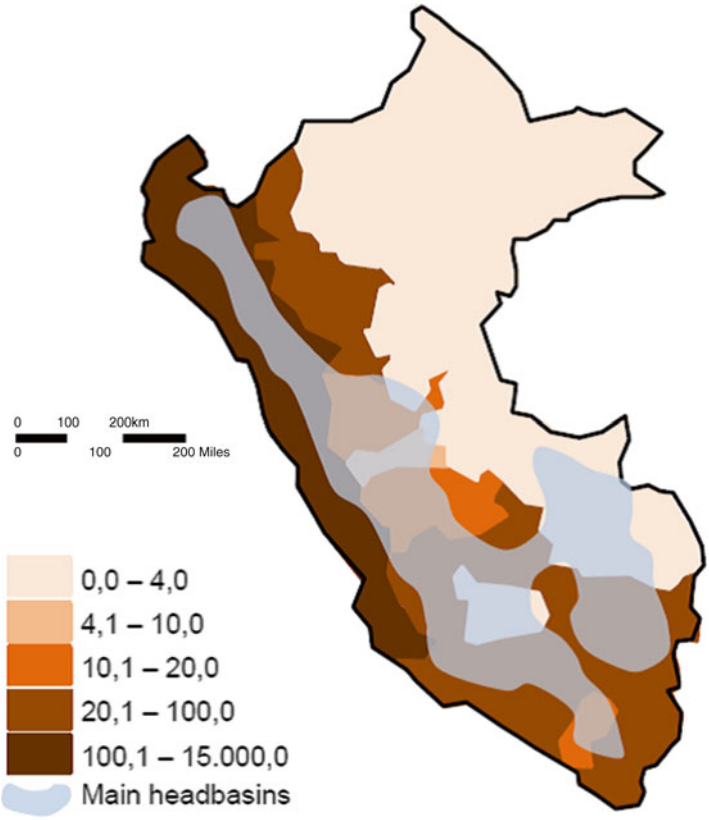
Analysis of the country's population density and the location of water sources shows that most of the population is moving to the western part of the country, occupying some of the headwaters, but depopulating many important areas where headwaters are located, especially those that discharge their water into the Amazon Basin. Unlike other Latin American countries in which the capital was located on the coast during colonial times to enable the export of minerals and spices to Spain, the capital of Ecuador was located in the Andes, which for many years served as the main attracting force in the country. However, in the last 20 years, density has been steadily increasing in the Pacific territories. This trend will continue in the near future, and urban consolidation in Ecuador will take place mainly on the coast. This is creating a gradual abandonment of the territories that contain the main water sources, or headwaters, of the country (Map 2.6).



Map 2.6 Ecuador: population density (population per square kilometer) and main headwaters approximate location 2014. *Source*: ORELLANA 2003a. Observatorio de las Redes y de los Espacios en los Llanos, las ANdes y la Amazonia. Population density of the Andean Community of Nations. Available at: http://www.mpl.ird.fr/crea/orellana/eorellana/epays/eandes1.html. Reviewed on 27 September 2015. Map elaboration: Vladimir Arana

In 2004 (PAHO 2004), the urban population in Peru was around the 74 % of the total and the rural population around 26 %. In 2012 the urban population reached 76 %, which means that around 7 million inhabitants were living in cities by that year (INEI 2006). The Peruvian urban consolidation is unstoppable. By 2020 around 78 % of Peru's population will live in towns and cities, and with the 22 % of the population living in rural areas, the total population of the country will be around 31 million (Peru Experience 2006).

The highest population density in Peru is in the western part of the country next to the Pacific Ocean, which has lower water availability than in other parts of the country. The Andean region and the Amazon, which contain more important water resources, have the lowest population density. The urban concentration on the coast and the high population density in the capital are a consequence of the Spanish heritage, which located the capital of the viceroyalty in the center of the coastal part of the country (Map 2.7).

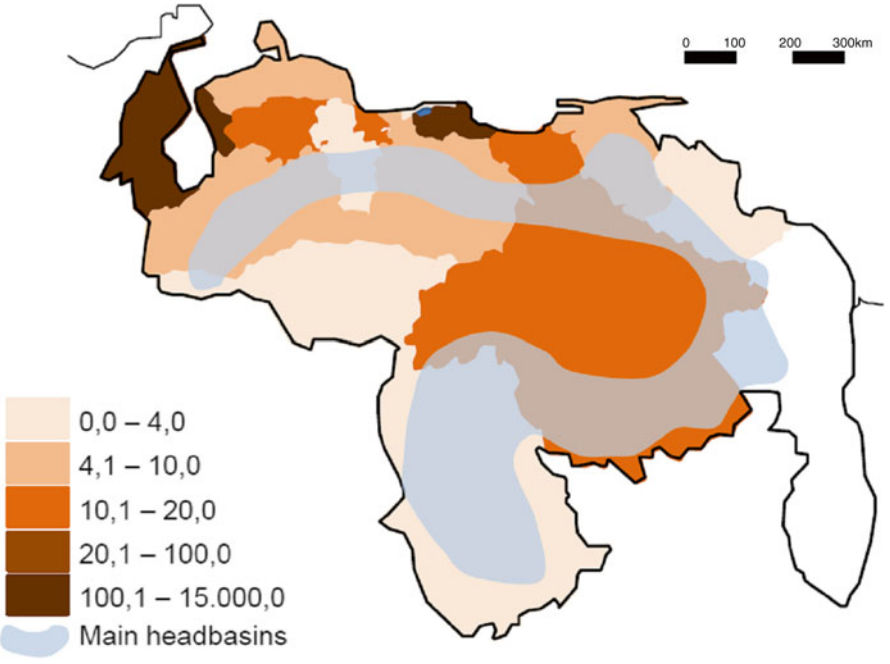


Map 2.7 Peru: population density (population per square kilometer) and main headwaters approximate location 2012. *Source*: Abad, Tito 2012. Situación del Agua y Saneamiento en el Peru. Available at: http://es.slideshare.net/abadtito/giz-ppto. Reviewed on 28 September 2015. Map elaboration: Vladimir Arana

In Venezuela, 88 % of the population was urban in 2004 versus 12 % in rural areas (PAHO 2004). the urban population was 89.0 % in 2015 and will grow slowly to 89.3 % in 2020 (United Nations, DESA, 2014). However, other estimations predict that around 95 % of the population will live in towns and cities by 2020 (Fundación Escuela de Gerencia Social 2001) versus 5 % rural. This by itself shows the gradual migration from rural to urban areas that has been taking place; in this case, the highest-altitude territories are the first to be abandoned (Map 2.8).

In the case of Venezuela, most of the population, that is, the urban population, is now concentrated in the northern part of the country, leaving the southern part for rural activities and population, where most of the headwaters are located. This situation will continue and the headwaters will eventually be abandoned.

In the Andean ecoregion the urban primacy is led by Chile and Venezuela. Peru and Colombia are witnessing a steady increase in their urban populations, as are Bolivia and Ecuador, but at a slower rate. This urban growth is occurring in areas far from the main headwaters of these countries, and this could increment the costs of obtaining water in the future or the loss of headwaters due to the abandonment of forest and agricultural activities that contribute to the maintenance of ecosystemic services that help conserve these resources (Fig. 2.1).



Map 2.8 Venezuela: population density (population per square kilometer) and main headwaters approximate location 2014. *Source*: Ministerio de Poder Popular para el Ecosocialismo, Habitat y Vivienda. Instituto Geográfico de Venezuela Simon Bolivar. 2014. Sistema de Información para la Gestión Integral de las Aguas. Available at: http://visor.ide.igvsb.gob.ve/sigia/portal.php. Reviewed on 15 September 2015. Map elaboration: Vladimir Arana

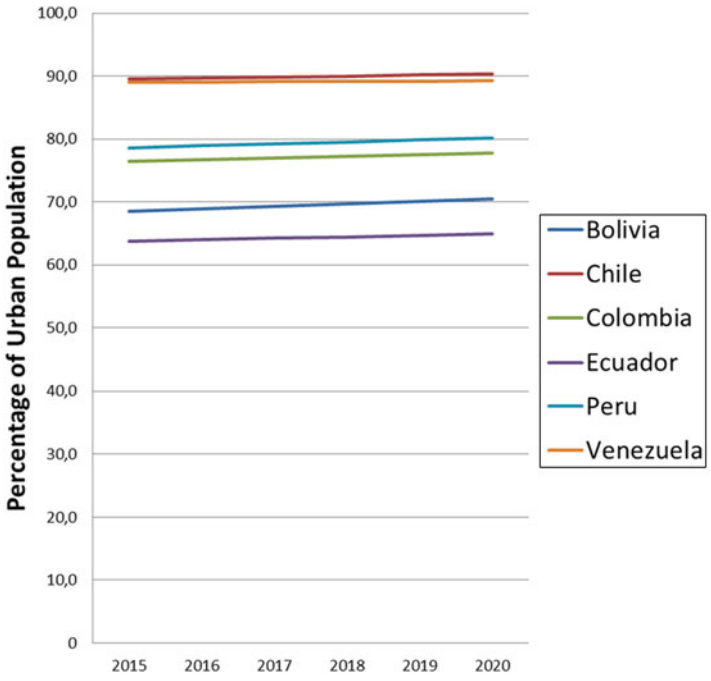


Fig. 2.1 Andean ecoregion: percentage of urban population, 2015–2020. *Source*: United Nations, Department of Economic and Social Affairs (DESA), Population Division (2014). World Urbanization Prospects: The 2014 Revision, Highlights (ST/ESA/SER.A/352). Available at: http://esa.un.org/unpd/wup/Highlights/WUP2014-Highlights.pdf. Reviewed on 29 September 2015. Elaboration: Vladimir Arana

3 Population Behavior, Land Occupation Trends, and Water in the Amazon Ecoregion (Mainly Brazil and Parts of Bolivia, Colombia, and Peru)

The southwestern Amazon forest is an ecoregion that stretches from western and central Brazil to southeastern Peru and northern Bolivia, covering around 2,093,811 km^2. The population of Brazil is growing fast, and the urban population reached 84 % of the total in 2004 and the rural population 16 % (PAHO 2004). By 2020 the total population of this country-continent will be around 209 million, with a strong increment of elderly people and a decrease in the number of child (Folha 2004); the urban population will be around 89 % by 2020 (United Nations, DESA 2014) (Fig. 2.2).

The Brazilian population is located mainly in coastal zones, where important urban centers have developed over the years and where there is the highest population density, while the central part of the country has a low population density. In Brazil the main headwaters are located in the central, northwestern territories and part of the southeastern area of the country. It is in this last area, where some head-

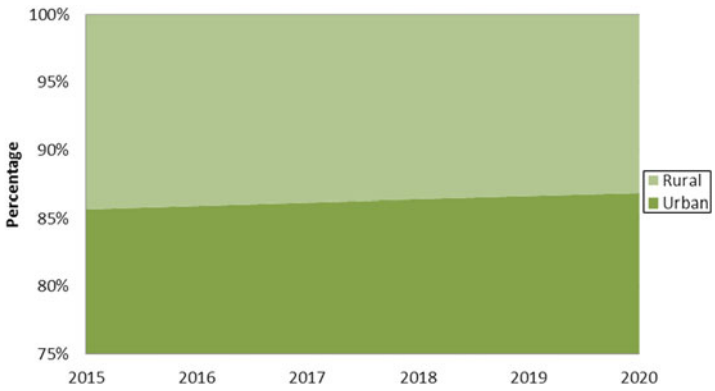


Fig. 2.2 Brazil: urban trends, 2015–2020. *Source*: United Nations, DESA 2014. Elaboration: Vladimir Arana

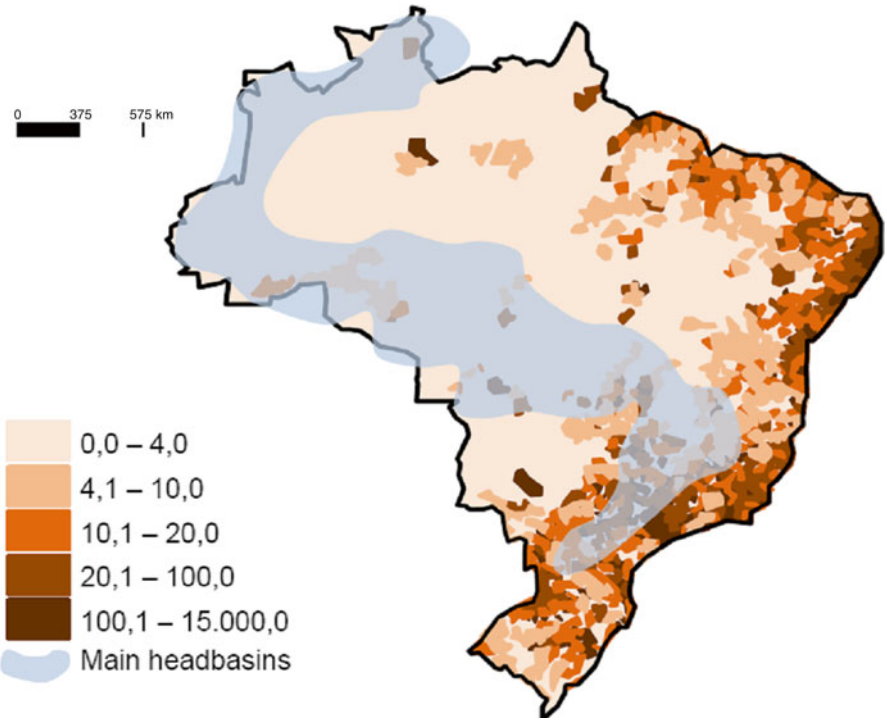
waters are located, that there is a large population density. However, another important population is located in the coastal north-eastern part of the country where headwaters are not located, even though important rivers and water sources cross this part of the territory. As shown by the map of the region, the lowest population density in the country is located where the main headwaters are, on the western side of the Amazon ecoregion. The urban primacy is concentrated, and will continue concentrating, on the coastal side of the country (Map 2.9).

4 Population Behavior, Land Occupation Trends, and Water in the Dry Chaco Ecoregion (Mainly Paraguay and Parts of Bolivia and Argentina)

The Dry Chaco ecoregion is located mostly in Paraguay; and it is composed of a wide sedimentary plain in the cordillera from where a large amount of sediments are transported and silt up the rivers beds, causing increased flows and floods (Torrella and Adámoli 2005).

Paraguay is undergoing an inexorable urban primacy, though not as strong as in other South American countries. In 1990, the urban population was 51 % of the total, while the rural population was 41 % of the total population, marking a slow decrease (PAHO 2004). After some years the slowing urban primacy started growing steadily, mainly as a result of internal migration processes, and in 2004, the urban population reached 58 % of the total (PAHO 2004).

The urban primacy in Paraguay is unstoppable, and in 2015 the urban population comprises 59.7 % of the total population, and in the medium term, by 2020, around 61 % of the country's total population will live in cities and towns (United Nations,



Map 2.9 Brazil: population density (population per square kilometer) and main headwaters approximate location 2014. *Sources*: IBGE 2010. Sinopse do Censo Demografico 2010. Available at: http://www.censo2010.ibge.gov.br/sinopse/index.php?dados=10&uf=00. Reviewed on 28 September 2015. Portal São Francisco. 2010. Bacia Hidrografica. Availabe at: http://www.portalsaofrancisco.com.br/alfa/bacias-hidrograficas/bacia-hidrografica-2.php. Reviewed on 28 September 2015. Map elaboration: Vladimir Arana

DESA 2014). The population is mainly located in the eastern part of the country, east of the Paraguay River, which crosses the country from north to south and occupies 39 % of the national territory, where 97.3 % of the total population lives (Fig. 2.3 and Map 2.10).

The map of the population density and main headwater locations shows headwaters located in and around those areas of the country with the highest population density. This might be positive if the urbanization patterns corresponded to the hydrological functions and incorporated these criteria in the urban design and construction of new urban areas. If informal settlements occupy the land where the headwaters are located, then there is a big risk that these headwaters will be lost. The other important headwater is located in the western part of the country in areas with the lowest population density. Since an important percentage of the population

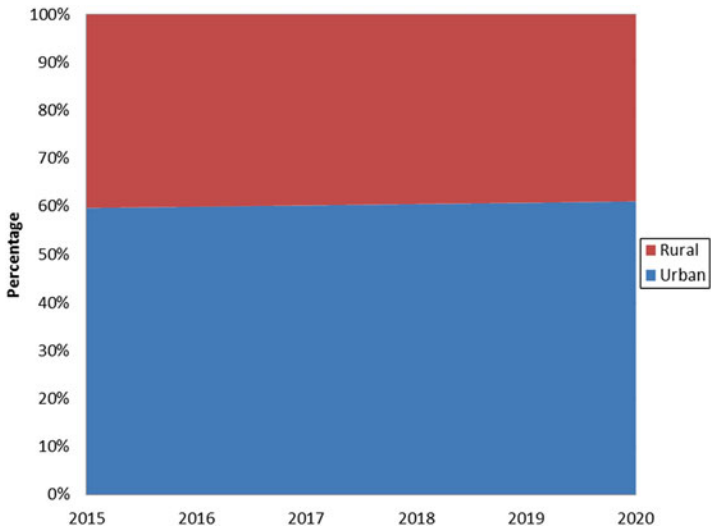


Fig. 2.3 Paraguay: urban trends, 2015–2020. *Source*: United Nations, DESA 2014. Elaboration: Vladimir Arana

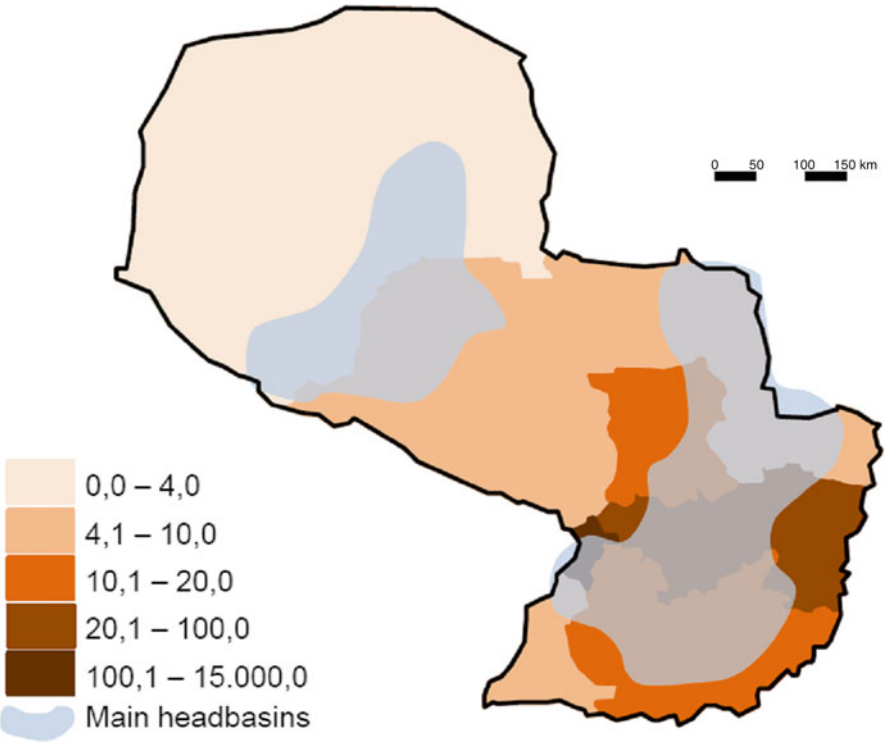
remains rural, there are opportunities to incorporate productive rural activities with ecosystemic services and conservation actions that might allow the conservation of these water sources.

5 Population Behavior, Land Occupation Trends, and Water in the Paraná-La Plata Ecoregion (Mainly Uruguay and Parts of Argentina and Paraguay)

In this ecoregion we find the La Plata Basin, with an approximate surface of 3,200,000 km^2; it is the second largest hydrographical basin in the world. It abuts territories that belong to Argentina, Bolivia, Paraguay, and Uruguay. The precipitations that fall accumulate in two of the most important rivers of the La Plata Basin, the Paraná and the Uruguay, which have a large number of tributaries, streams, and affluents and that subsequently flow down to the La Plata River, which finally discharges into the Argentine Sea in the Atlantic Ocean.

In 2004, Argentina, one of the most urbanized countries in Latin America, had 38,372,000 inhabitants, of which 90 % was urban and 10 % rural (PAHO 2004), showing a slow trend toward urbanization; by 2020, the country's population will be around 45,347,000, of which 94 % will live in urban and 6 % in rural areas (Torrado 2004).

In contrast, in 2004, Uruguay had a population of 3,439,000, with 93 % in urban and 7 % in rural areas (PAHO 2004), with estimates projecting that by 2020 the country will have around 3,441,000 inhabitants (INE 2005b), with an urban primacy



Map 2.10 Paraguay: population density (population per square kilometer) and main headwaters approximate location 2014. *Source*: DGEEC 2002. Densidad de la población según el censo del 2002. Available at: http://www.comercioexterior.ub.edu/correccion/05-06/paraguay/geografia_econ3_poblacion.htm. Reviewed on 23 September 2015. Paraguay Educa. 2000. Mapa Hidrografico del Paraguay. Available at: http://biblioteca.paraguayeduca.org/biblioteca/contenidos_educativos/recursos-pedagogicos/mapas/Mapa%20hidrografico%20del%20Paraguay.jpg/view. Reviewed on 23 September 2015. Map elaboration: Vladimir Arana

of 96 % (United Nations, DESA 2014). The southern part of the country contains 96 % of the country's total population, mainly located in its capital, Montevideo, and in neighboring urban areas. The northern and western parts of the country have a dispersed population with less than ten people per square kilometer. The western side of Uruguay is very important for the country and is home to the Uruguay River Basin, which starts out in Brazil, runs through Argentina, flows into La Plata River, and ends in the Atlantic (El Uruguayo 2008) (Fig. 2.4).

Argentina is a country with a specialized economy whose population resides largely on the Atlantic Coast, as a heritage of Spanish colonial times, during which the main cities were founded next to the sea. Some Argentine headwaters are located in the western part of the country, fed from the Andes, and important water sources are located in the southern part of the country, which has the lowest population densities. Also, the northernmost part of the country contains

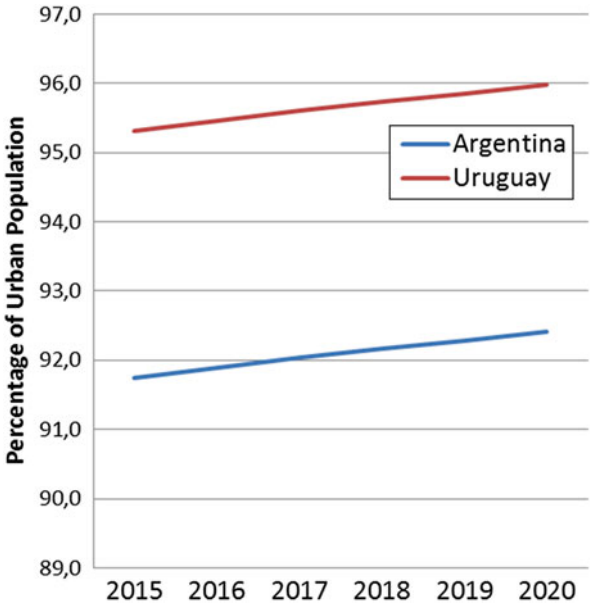


Fig. 2.4 Paraná-La Plata ecoregion: urban trends, 2015–2020. *Source*: United Nations, DESA 2014. Elaboration: Vladimir Arana

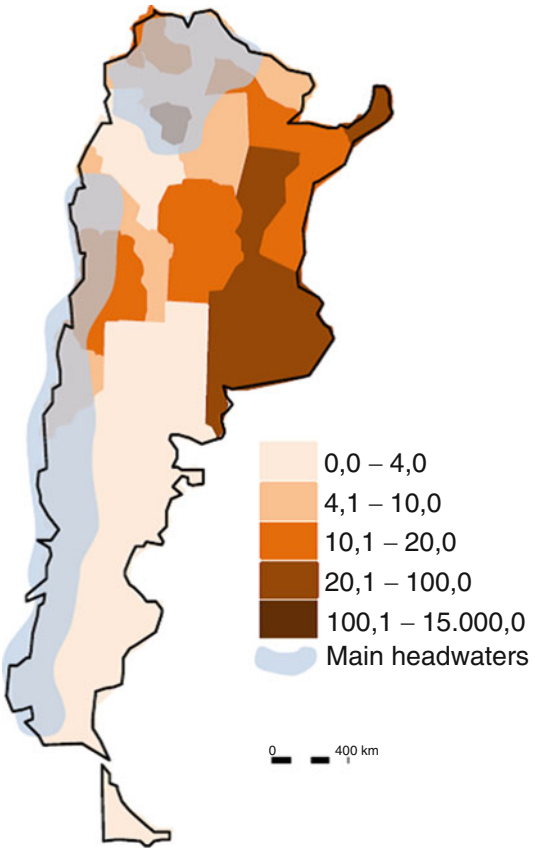
important headwaters with the lowest population density. Argentina has followed and consolidated the urbanization pattern imposed during colonial times in which urban growth was organized around the export of silver from Bolivian mines to Spain through the La Plata River (Silver River in English), a trend that has continued to this day.

The area around La Plata River has the highest population density in the country, consolidates the Argentine urban primacy, is home to most services, and accounts for most of the GDP of the country. La Plata Basin is not just a geographical basin; it is an economic basin on which Argentina depends (Map 2.11).

In Uruguay, the consolidation of urban primacy has taken place mainly in the southern part of the country; the central and northern parts of the country have the lowest population densities, which are where the main headwaters are located. This shows a clear abandonment of headwater areas that could create additional costs to obtain freshwater resources for human consumption and economic development (Map 2.12).

6 Central American Cordillera Ecoregion (Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, Panamá and Part of Mexico)

The Central American Cordillera is the only mountain range in Central America and crosses all continental countries of the region, having different names in each country. It is formed by several plateaus, volcanoes, hills, and mountains, where dozens of rivers and streams start out, filling lakes and ponds that traverse all Central



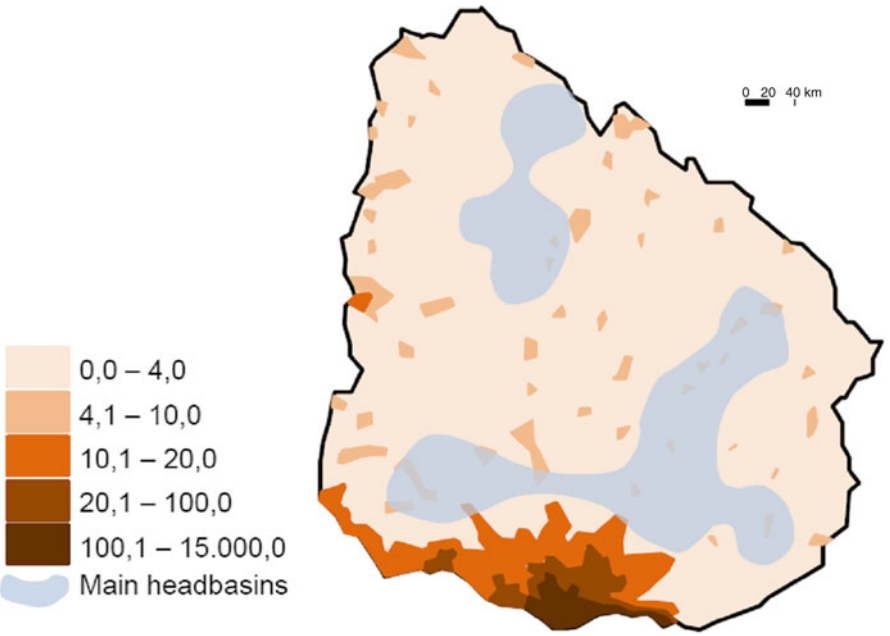
Map 2.11 Argentina: population density (population per square kilometer) and main headwaters approximate location 2014. *Sources*: INDEC (Instituto Nacional de Estadística y Censos). 2010. Argentina: Density of the Country. Available at: http://www.sig.indec.gov.ar/censo2010/. Reviewed on 26 September 2015. Map elaboration: Vladimir Arana

American countries, discharging their water in the Pacific and Atlantic Oceans. Six countries are considered in the analysis of the Central American Cordillera ecoregion: Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, and Panama.

In 2004, Costa Rica had 4,253,000 inhabitants, of which 61 % lived in urban and 39 % in rural areas (PAHO 2004). By 2010, Costa Rica had a population of 4,695,000, of which 66 % were in urban and 34 % in rural areas (RUTA 2007). By 2020 Costa Rica will have 5,084,000 inhabitants (INEC 2008). The country will consolidate its urban primacy, and the population will tend to concentrate in the central part where the capital is located. It, too, will concentrate most of the infrastructure and services of the country.

El Salvador had a population of 6,762,000 in 2004, of which 60 % were in urban and 40 % in rural areas (PAHO 2014). By 2020, it is estimated that the population will reach 8,533,700 inhabitants, where 69 % will be in urban and 31 % in rural areas (United Nations, DESA 2014).

Guatemala went from having 12,295,000 inhabitants in 2004, with 43 % in urban areas (PAHO 2014), to 18,055,025 inhabitants by 2020, with 53.9 % living in towns and cities (United Nations, DESA 2014). In contrast to other Latin American



Map 2.12 Uruguay: population density (population per square kilometer) and main headwaters approximate location 2014. *Source*: La Academia. 2014. Geografía de Uruguay. Available at: https://academiapaso.wordpress.com/2014/01/31/geografia-de-uruguay/ Reviewed on 25 September 2015. Map elaboration: Vladimir Arana

countries before 2010, Guatemala's population was largely located in rural areas, developing essentially primary economic activities. Honduras' population will go from around seven million inhabitants, with 54 % in urban areas in 2004 (PAHO 2004), to around ten million in 2020, with 57.6 % of the people living in towns and cities (United Nations, DESA 2014). Like Guatemala, just a few years ago Honduras had a rural population predominance, which explains the large amount of primary economic activities.

Nicaragua will consolidate its urban primacy, passing from 58 % in 2004 (PAHO 2004) to 61 % urban in 2010 and 66 % urban in 2020 (Instituto Nacional de Información del Desarrollo 2010), while the UN projects that Nicaragua will be 60 % urban in 2020 (United Nations, DESA 2014). In any case, the urbanization trends will remain strong in Nicaragua, and the country will consolidate its urban primacy in subsequent years.

Panama, with a total population of around three million people in 2004, had a 57 % urban and a 43 % rural population (PAHO 2004). In 2020 Panama will have around four million inhabitants (Contraloría General de la República 2006), of which 68.1 % will be urban (United Nations, DESA 2014). The urbanization process in Panama has been steady and not accelerated as in other Latin American countries.

In 2015, the average percentage of urban dwellers was 62.5 % with Costa Rica having regional urban primacy with 76.8 %, followed by Panama with 66.6 %, El Salvador with

66.7%, Nicaragua with 58.8%, Honduras with 54.7%, and Guatemala with 51.6%. In 2020, the Central American Cordillera ecoregion will have an average percentage of urbanization of 65%, led by Costa Rica with 80.6% of its population in urban areas, El Salvador with 69%, Panama with 68.1%, Nicaragua with 60.5%, Honduras with 57.6%, and Guatemala with 53.9% (United Nations, DESA 2014). In the next 5 years, urban population projections show that Costa Rica and El Salvador will have more dynamic urban and economic forces, and a faster consolidation of the urban primacy is predicted for those areas. Costa Rica will see a 3.8 % increase in its urban population and El Salvador's will increase by 2.2%. Note that El Salvador and Panama have almost the same percentage of urban population in 2015, but in 2020, just 5 years later, El Salvador's urban population will surge and surpass that of Panama by a wide margin (Fig. 2.5).

The highest population density in Costa Rica is located in the central part of the country, and the Costa Rican headwaters traverse the country from north to south; the area with the highest population density, which includes the capital, is located near the central headwaters. The northern and southern parts of Costa Rica have the lowest population densities, also located on important headwaters.

The main basin of El Salvador is the Lempa River Basin, which starts out in the neighboring country of Honduras. The highest part of this basin contains the lowest population densities in the country, which is mainly a declining rural population. Most of the population is concentrated in the capital and neighboring areas, especially in the northern and eastern parts of the country. The urban primacy tends to consolidate along the Pacific coast, and, as in other countries, headwaters showing a declining rural population.

In Guatemala, rivers are short, fast, and irregular with a shallow depth on the Pacific side. On the Atlantic side, in contrast, rivers are larger and deeper, which

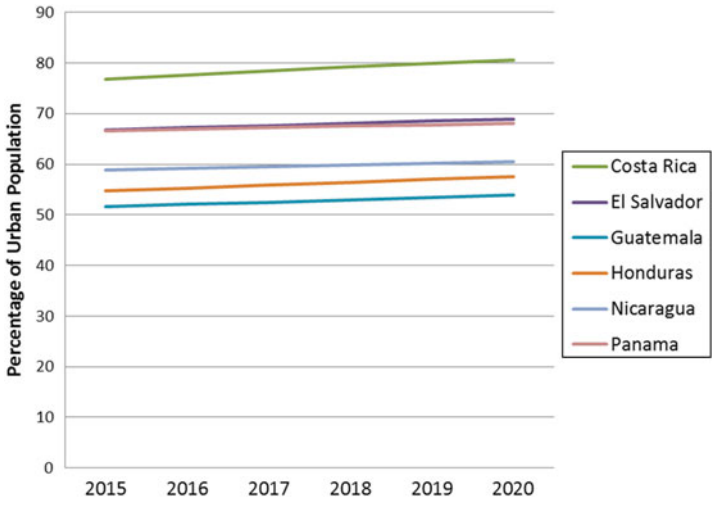
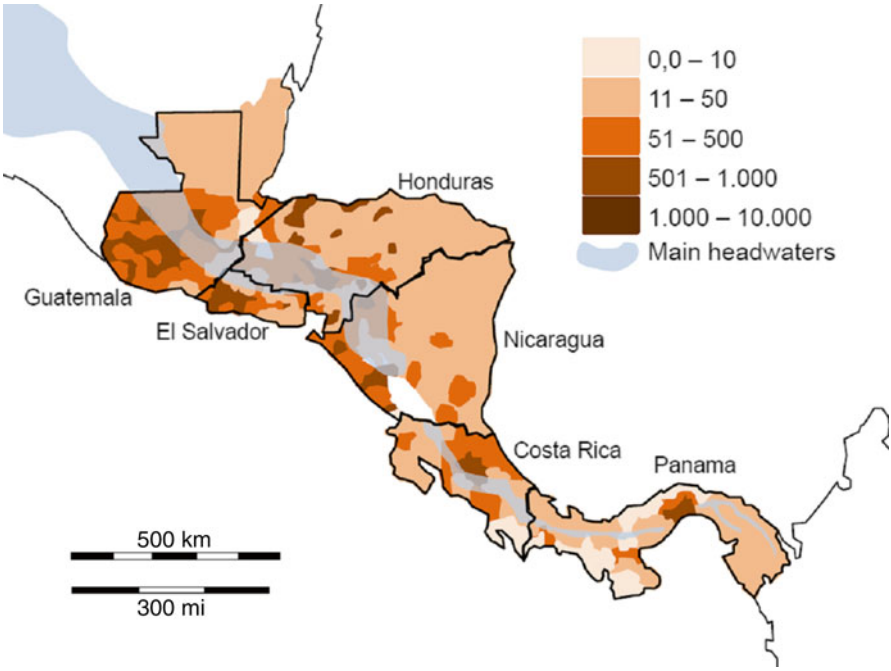


Fig. 2.5 Central America: urban trends, 2015–2020. *Source*: United Nations, DESA 2014. Elaboration: Vladimir Arana

makes them navigable. Most of the population of the country, including in the capital, is concentrated in the central and eastern parts, where there are important headwaters; the northern and western parts have the smallest population density, which is where the largest rivers are. The Motagua River is the most important of Guatemala's rivers and discharges into the Caribbean Sea (Geografía La Guía 2000, 2007a). Illegal settlements around the capital threaten the conservation of the country's headwaters.

In Nicaragua most of the population is concentrated in the western part of the country, and since the country is undergoing a pronounced urban consolidation, it is estimated that the Pacific territories will experience increasing density and see the emergence of important informal settlements. The eastern part of the country has the smallest population density and the most important river basins. Headwaters are located closer to the Pacific side next to the main urban areas, which will threaten these water sources in the medium term.

In Panama, relatively small headwaters traverse the country longitudinally, and the main urban areas are settled in the center of the country on the Pacific side. The eastern and western sides of the country have the smallest population densities and some important water sources (Map 2.13).



Map 2.13 Central American Cordillera ecoregion: population density (population per square kilometer) and main headwaters approximate location 2014. *Source*: UNISDR (United Nations Office for Disaster Risk Reduction). 2007. Change of population density in Central America. Available at: http://www.eird.org/cd/redlac/capitulo1/temas-ambientales.html. Reviewed on 26 September 2015. Map elaboration: Vladimir Arana

7 Mexican Plateau Ecoregion (Mexico)

Mexico is a country with a predominantly urban population. Already in 2004, Mexico had about 105 million inhabitants, and the urban population was around 76 % and the rural population 24 % of the total (PAHO 2004). By 2020, it is estimated that Mexico will have around 115 million inhabitants (CONAPO 2005), of which 80.6 % (United Nations, DESA 2014) will live in cities and towns, and the rest, 19.4 %, in rural areas. In the heartland of the country is located Mexico DF, the capital city, and the surrounding urban areas, one of the largest urban conglomerates in the world that contains around one quarter of the country's total population with the highest population density in the country. This urban mass has an overwhelming attracting capacity, which is now consolidating from the Pacific to the Atlantic Oceans and will soon form a complete urban continuum, becoming the largest conurbation in Latin America (Fig. 2.6).

The capital has the highest population by territorial unit. The northern and southern parts of the country have the lowest population densities. The country's headwaters go from north to south, and while the southern headwaters overlap with high and medium population densities, the northern headwaters overlap with low population densities. The largest water availability is located in the southern part of the country, which has a tropical humid climate, while

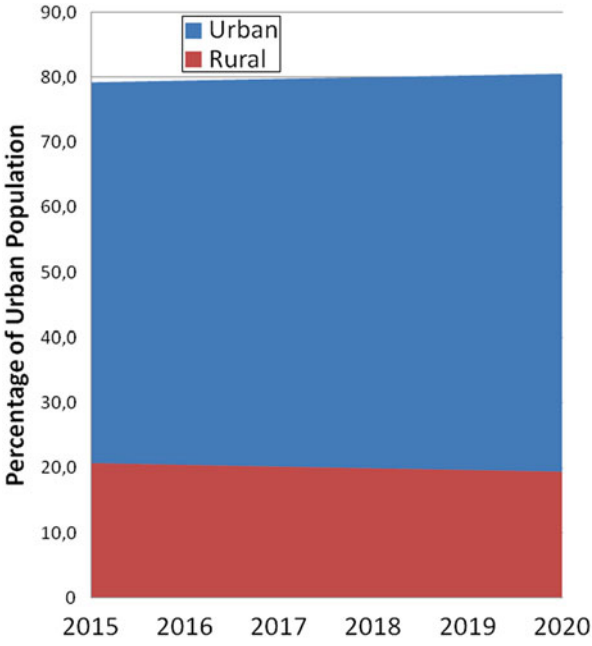
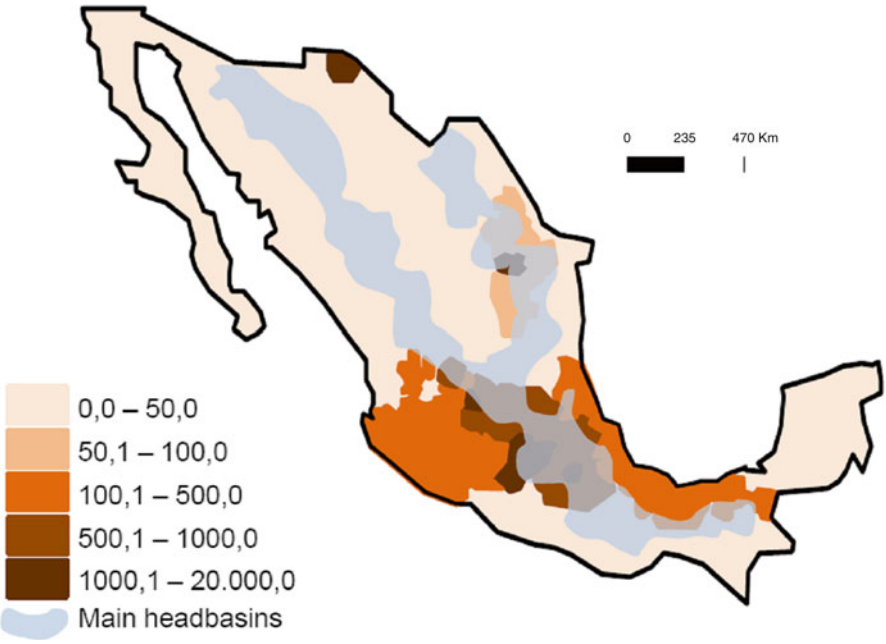


Fig. 2.6 Mexico: urban trends, 2015–2020. *Source*: United Nations, DESA 2014. Elaboration: Vladimir Arana



Map 2.14 Mexican Plateau ecoregion: population density (population per square kilometer) and main headwaters approximate location 2015. SEMARNAT 2005. Densidad de población. Availabe at: http://app1.semarnat.gob.mx/dgeia/estadisticas_2000/incendios/estadistica-am/informe/polacion/demografica/mapa%20densidad.htm. Reviewed on 28 September 2015. Ediciones Culturales Internacionales. 2015. Mapa Mexico Hidrografia. Available at: https://www.ediciones.com.mx/?attachment_id=5722. Reviewed on 28 September 2015. Map elaboration: Vladimir Arana

the northern part has a dry climate, desert in many places. Urban growth in Mexico is a legacy of colonial urbanization patterns that have consolidated over the years (Map 2.14).

Latin America had a high rate of urbanization between 1950 and 1990, where most of the urban centers and capital cities emerged very quickly, spurred in particular by migration from rural areas. Since 1990 the rate of urbanization has slowed down a bit but has maintained a steady rhythm that will consolidate the region as predominantly urban; there is a large tertiary economy where headwater territories will be abandoned in the medium and long term. By 2050, the urban population of Latin America will be close to 90 % (United Nations, Department of Economic and Social Affairs 2014), and the rural population of the region will be around 10 %, meaning a very small percentage of the region's population will be producing agricultural products or engaged in agricultural activities, which could help conserve water resources (Fig. 2.7).

However, the urbanization process in Latin America has created a positive impact on personal incomes. Analysis has shown that a higher degree of urbanization has a strong correlation with higher per capita GDP. Countries such as

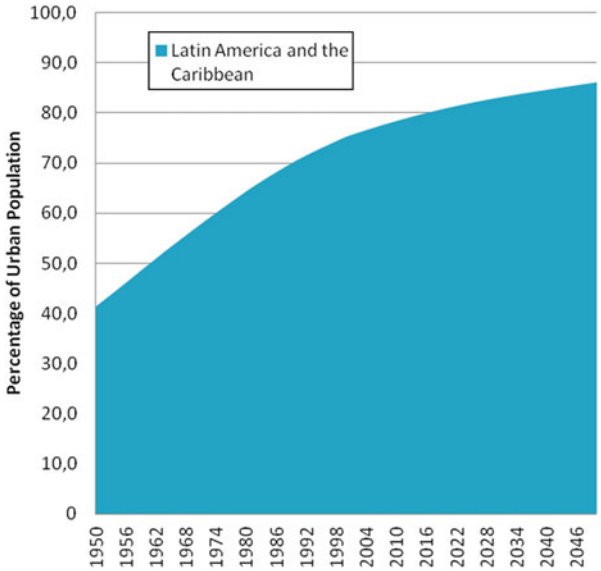


Fig. 2.7 Latin America and the Caribbean: urban trends, 1950–2050. *Source*: United Nations, Department of Economic and Social Affairs, Population Division (2014). World Urbanization Prospects: The 2014 Revision, Highlights (ST/ESA/SER.A/352). Available at: http://esa.un.org/unpd/wup/Highlights/WUP2014-Highlights.pdf. Reviewed on 29 September 2015. Elaboration: Vladimir Arana

Argentina, Uruguay, and Chile have the highest urbanization primacy in the Latin American region and the highest per capita GDP. Countries such as Haiti, Honduras, and Nicaragua have the lowest degree of urbanization and the lowest per capita GDP. However, Guatemala has a lower degree of urbanization than the last mentioned countries but a higher per capita GDP than any of those three countries. This means that, even if there is a strong relationship between GDP and degree of urbanization, this relationship does not necessarily correlate with economic growth, which could be based on rural economic activity or larger specific economic activities with a large scale market. In the case of Guatemala, among the most important factors in Guatemala's economic growth are the maquila factories. There are a significant number of Korean-owned maquila factories in the highlands of Guatemala. Korean entrepreneurs have adopted a buyer-driven commodity chain process that depends on the existence of a large labor force, low capital investment, and low skills. Korea's presence in Guatemalan industry and ultimately among Guatemalan workers is through subcontractors that are responsible for delivering finished orders to multiple buyers, mostly located in the USA. Buyers include Macy's and JC Penny and brands such as Liz Claiborne, OshKosh, and Tracy Evans (Wikipedia 2009) (Fig. 2.8).

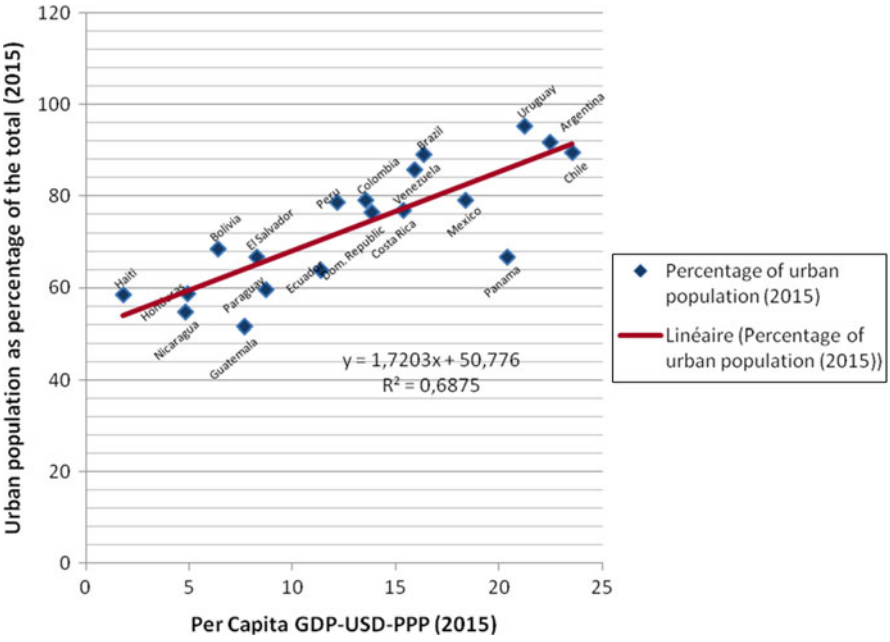


Fig. 2.8 Links between urbanization level and GDP per capita 2015. *Sources*: International Monetary Fund (IMF) 2015. World Economic Outlook, April 2015. Uneven Growth, Short and Long Term Factors. IMF, Washington, DC. Available at http://www.imf.org/external/pubs/ft/weo/2015/01/pdf/text.pdf. Reviewed on 29 September 2015. United Nations, Department of Economic and Social Affairs, Population Division (2014). World Urbanization Prospects: The 2014 Revision, Highlights (ST/ESA/SER.A/352). Available at: http://esa.un.org/unpd/wup/Highlights/WUP2014-Highlights.pdf. Reviewed on 29 September 2015. Elaborated by Vladimir Arana

8 Conclusions

Most of the Latin American population lives and will live in towns and cities, reducing the rural population and reducing the population density in headwater areas. Rural populations are migrating to intermediate cities and to capital cities, in many cases to towns and cities under water stress.

A low population density in vast Latin American territories means a high population dispersion rate, which makes more difficult the presence of the state, or the provision of infrastructure and services, such as police stations, health clinics, environmental monitoring, or rural water supply and sanitation infrastructure.

Urban populations in Latin America are agglomerating in either marine coastal zones or, in the case of Mediterranean countries, a specific part of the country. This settlement process is mostly due to the Spanish colonial legacy, when towns and capital cities were founded to allow easier export of minerals and spices to the Spanish metropolis. This urbanization process is abandoning important headwaters and water sources.

Latin America has many shared water sources with transboundary interests. However, headwaters and water sources located in rural areas are now witnessing declining rural populations. On the other hand, headwaters located in important urban areas are suffering under pressures of urbanization and informal occupation that have a greater negative impact on environment and water resources. In other words, territories where flowing water originates will reduce their population, a key factor in maintaining agricultural, forestry, and pastoral activities that have a favorable impact on headwater conservation, ecoregional dynamics, and ecosystem service maintenance.

In many countries, populations located in headwater areas possess important traditional knowledge that can be used to help conserve natural resources and water dynamics. For this reason, rural depopulation means not only a population decline but also the fragmentation of societies that possess traditional knowledge that could be important in the conservation of water resources and protection of territories containing river basins. This process can be called basin social decapitalization.

Some of the causes of basin social decapitalization are the progressive transition of household economies to tertiary economies that increment and consolidate the countries' urban primacy. Also, the unbalanced services of urban Latin American areas compared to rural areas makes capitals and, mainly, intermediate cities more appealing to migrants who are looking for a better quality of life. In addition, companies with economies of scale from Asian and North American countries that receive significant subsidies from their governments generate products and commodities with lower marginal prices with which smaller-scale Latin American economies cannot compete, and so the Latin American countries find it more difficult to sell their agricultural surpluses on international markets. On the other hand, it is important to mention the strong relationship between the degree of urbanization and per capita GDP, which is indicative of the intense pressure that urban areas place on rural territories, which consolidates with public investments, especially in infrastructure mainly developed in urban areas.

Opportunities for growth in urban areas, including employment and quality of life, exert a strong pull on rural inhabitants. Governments could create incentives to maintain the population in rural areas, but no policies would create incentives like market-based initiatives, which would boost rural economies and spur sustainable development in rural areas and in headwater territories that are being gradually abandoned. The Latin American rural depopulation phenomenon is creating the need for a broader research agenda that will explore new state policies and strategies to ensure headwater and agricultural production, especially in urban areas.

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