THE VARIOUS SHAPES OF THE INSULAR CARIBBEAN: POPULATION AND ENVIRONMENT

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When we look at a map, we expect to see the portrayed landmasses (e.g., countries) reflecting their actual sizes and shapes. If it is a thematic map; this is, a map that displays information about a specific theme; the different units are colored according to the information displayed (what is known as a choropleth map), or with symbols representing either quantitative or qualitative information (for example, a proportional symbol map). In the case of the insular Caribbean, logically, the Greater Antilles occupy a larger extent than the Lesser Antilles and the small islands in the northern Caribbean (Map 1). Oftentimes, geographic patterns displayed on regional maps are not easily discernible, particularly for those islands with smaller sizes (this will depend, of course, on the scale and extent of the map). This can be problematic because the information, and ultimately the message that wants to be conveyed through a map, can be overlooked or missed due to the inherent size differences.

There is a type of map that allows us to “redraw” conventional maps by varying the size and shape of the geographic units in relation to the quantity they represent. Such maps are called cartograms. Cartograms can be very effective in conveying messages that otherwise could be missed if mapped following the “true” geography (size and shape) of the mapped area. In the case of the insular Caribbean, it is possible then to visualize the Lesser Antilles in a larger size than the Greater Antilles if the data for the Lesser Antilles has higher values than that of the Greater Antilles. When interpreting a cartogram, it is important to keep in mind that geographic precision (i.e., geographic position, land size and shape) is not the focus of the map; these elements will, in fact, be distorted. What is important, and what makes cartograms useful, is to be able to easily identify geographic pattern and the message carried by the map by comparing and analyzing the sizes of the displayed geographic units. Such maps provide an alternative way of viewing and interpreting the mapped area.

In this Cartographic Essay we present a series of cartograms of
the insular Caribbean that portray different themes about population, economy and the environment with the aim of presenting a regional “snapshot” of a variety of topics related to such themes. Our objective is to provide information that can allow the reader to make connections between the mapped topics and among the islands. Additionally, the cartograms present information that is related to, and further discussed in the articles that constitute this Special Issue.

We start the essay by displaying information about regional population dynamics, including total population, population change, urbanization, and population density (Maps 2 to 6). A look at these maps shows extreme differences within the region. In the case of total population, for example, numbers range from 11 million in Cuba, to only about 5,000 in Montserrat (Map 2). One phenomenon that characterizes most of the Caribbean countries is the high percentage of population living in urban areas. In 2010, more than half of the countries in the insular Caribbean had an urban population of more than 50%, and for some islands (like Anguilla and the Cayman Islands) urban population was 100% (Map 3). The region is also characterized by rapid rates of urbanization. For some islands, changes in urban population have been extraordinary, as in the case of Turks and Caicos (800% between 1980 and 2010), Haiti (345%), the British Virgin Islands (233%), and the Caiman Islands (229%). Regional change in urban population between 1980 and 2010 was, in fact, higher than the change in total population (81% change in urban population versus 40% change in total population) (Maps 4 and 5).

Population density provides a relation between size (available space) and number of persons which, in the case of many islands in the Caribbean, is critical. In a cartogram, when density values are taken into account, the population factor within the region presents a different picture: the smaller islands become larger and the larger islands smaller (Map 6). Population densities are generally higher in the Lesser Antilles than in the Greater Antilles (with the exception of Puerto Rico and Haiti). Regional population densities vary from 664.3 people/km² in Barbados to 31.0 in The Bahamas.

Another interesting density indicator in the region is the physiological density (Map 7). Physiological density represents the number of people per unit of arable land. This measure indicates the pressure of population over agricultural resources. A higher physiological density suggests that available agricultural lands are under more pressure than in those cases where values are lower. In the insular Caribbean, physiological densities vary from 41.0 in Turks and Caicos to 1.7 in Cuba. Even if land suitable for agriculture is not being used as such, this indicator gives an idea of the potential capacity of a country to supply food for its population, having implications concerning food security. In terms of
agriculture and agricultural production, this is one, among other problems facing the region, as Barker (this issue) elaborates in his article.

High population totals and densities, and particularly increasing urban population, require and demand more materials and energy; a situation that can put increasing pressure on natural resources and the environment. Without proper management at different levels, these demands can put at risk and affect ecosystems and resources, as described in the case of agricultural lands, and as discussed by Heart-sill Scalley (this issue) regarding management of urban sewage and freshwater resources. From another point of view, population trends, particularly urbanization, puts Caribbean inhabitants at risk, as it is in the case of exposure to natural hazards. This is especially true when increasing urbanization is not necessarily accompanied by enhancement in infrastructure and access to resources and services. Moreover, since urbanization occurs mostly in lowlands and coastal areas, it increases exposure and vulnerability to current hazard events (such as hurricanes, floods and tsunamis) and to those associated to potential climate change and sea level rise (Taylor and coauthors, this issue). Being hazard-prone, it is common that the region experiences the impacts of hazards and disasters (Map 8), yet disaster impacts differ within the region (Map 9). As López-Marrero and Wisner (this issue) discuss in their article, differences in disaster impacts result in part because of the human conditions in which a hazard develops into a disaster. Disaster outputs also reflect determinants of vulnerability and capacities, which include access to various natural, physical, economic, human, social, and political resources; resources that are not accessible equally to everyone in the region.

Proper ecosystem management and facilitating people’s access to resources to enable them to cope with environmental change is critical, particularly within the context of the expected impacts of climate change. Uneven impacts of climate change are expected to occur within the insular Caribbean, as Taylor and co-authors (this issue) discuss in their article. Increases in natural hazards and disasters, and their effects on national economies and infrastructure are some potential impacts that can affect the development of countries in the region (Bueno et al. 2008). Yet, not everyone will be impacted equally (Map 10); those countries with less capacity to resist, cope, and adapt to changes will suffer more, especially if their present condition is one of impoverishment and lack of resources, as is the case, for instance, of Haiti.

Another example of the potential impacts of climate change is related to freshwater resources (including water storage and availability) which are driven by regional climate patterns (Taylor and coauthors, this issue). Rainfall patterns already vary within the region because of different factors such as island position in relation to easterly winds,
topography and island size (Map 11). There are already many islands with low rainfall that, along with other trends such as decreases of recharge surfaces for streams and aquifers (due to increasing paved/built up lands), affect water availability to the population (Heartsill Scalley, this issue). If to those conditions we add the effects of climate change, which include predictions of a drier climate (Taylor and coauthors, this issue), then problems of water availability and access to freshwater resources will be exacerbated.

Carbon dioxide (CO$_2$) emissions into the atmosphere contribute to global warming and climate change. Compared to global contributions, CO$_2$ emissions from the insular Caribbean are minimal. While regional CO$_2$ contributions are relatively small at the global scale, there is a large range of CO$_2$ emissions per capita in insular Caribbean countries (Map 12). The U.S. Virgin Islands, Trinidad and Tobago, and the former Netherlands Antilles are the countries with higher emissions per person. In fact, Trinidad and Tobago, the former Netherlands Antilles, and Aruba rank among the top-ten per capita emitters globally (Boden, Andres, and Marland 2009). The effects of high CO$_2$ emission levels within the local Caribbean region, and studies of its impacts on the local environment have only recently begun.

We finish this cartographic essay by showing two maps that display indicators of countries’ development and achievement: Gross Domestic Product (GDP) per capita and Human Development Index (HDI). Using GDP per capita as an economic indicator, we can see the great disparity in economic terms within the region, from $54,827 in the Cayman Islands to $1,200 in Haiti (Map 13). The economy of a country can be related to potential environmental impacts in at least two ways. From one point of view, high economic means can result in higher purchasing power and consumerism, use of materials, and energy; all of which can negatively impact natural resources. Alternatively, having access to economic resources can allow investing in cleaner technologies and infrastructure that can be beneficial to natural resources and the environment. Moreover, access to economic resources can assist Caribbean inhabitants to better cope and adapt to changing environmental conditions, as is the case, for example, of disasters and freshwater resource management (López-Marrero and Wisner; Heartsill Scalley, this issue).

Economic resources alone are not always what drive sound environmental management practices and the way people cope with environmental changes; human resources and capacities need to be taken into consideration and invested in. The Human Development Index (HDI) is an alternative way to assess countries’ development and achievements that goes beyond economic growth alone; it combines elements of health, knowledge, and income. In the insular Caribbean, Barbados is the
country with the highest HDI, followed by Cuba. Haiti, in contrast, has
the lowest index (Map 14). If one compares regional GDP per capita and
HDI, there are some instances where there is a correspondence between
both indicators, but there are other cases where this correspondence
does not exist. One example of the latter case is Cuba, which is among
the insular Caribbean countries with lowest GDP per capita, but high
HDI. If one was to evaluate Cuba’s performance on risks and disaster
management by just looking at the economic indicator, for example, then
one might conclude that Cuba will do very poorly because does not have
the economic resources to anticipate, prepare, and respond to hazards
and disaster events. Cuba’s risk and disaster management is, however,
impressive and loses of lives are minimal despite high occurrence of
hazard events (refer to Maps 8 and 9). Cuba’s success in risk reduction
and disaster management has been achieved through an investment in
human and social resources (López-Marrero and Wisner, this issue).
This is just one example that shows how environmental management and
promoting people’s capacity to cope and adapt to environmental change
requires an integrative, holistic approach that makes use of all possible
resources available within a country, and among which and foremost, is
their population.

A note about the data and cartograms

The geographic database used to develop the cartograms was
generated with the open-source, on-line software ScapeToad <http://
scapetoad.choros.ch/>. The data used to develop the geographic data-
base was collected from various secondary sources. Data appeared in
aggregated forms (at the country level) in the various data sources used,
consequently it was not possible to provide disaggregated data for differ-
ent islands that are grouped, such as Antigua and Barbuda, the Cayman
Islands, the Bahamas, Saint Kitts and Nevis, Trinidad and Tobago, the
British Virgin Islands, the U.S. Virgin Islands, and the former Neth-
erlands Antilles. There were cases where data did not exist for some
countries, usually for those islands that are overseas departments, non-
independent states, or overseas territories. This was the case for the
following cartograms: Physiological Density, GDP per capita, and HDI.
In those cases, the name of the islands was included in the cartogram to
show their relative position, but no land masses where displayed associ-
ated to the names.
Acknowledgments

The Critical Caribbean Studies at Rutgers University provided funds to support Kae Yamane’s work, who assisted on data gathering, geographic database development and cartographic design. We thank the review and suggestions of Antonio González Toro (Bloustein School of Planning and Public Policy, Rutgers University).

References and data sources


Carbon Dioxide Information Analysis Center (CDIAC) <http://cdiac.ornl.gov/trends/emis/tre_carib.html>.


National Oceanic and Atmospheric Administration (NOAA) Monthly Review:


University of the West Indies Disaster Studies Unit: <http://www.mona.uwi.edu/uds/>.


Map 1. A conventional map of the insular Caribbean displaying actual island size and geographic shape.
Total population in 2010

By 2010, the region reached a total population of nearly 41 million, ranging from 11.1 million in Cuba to about 5,000 in Montserrat. Population totals are usually proportional to the size of the islands; consequently, about 90% of the population was concentrated in the Greater Antilles. Of the Lesser Antilles, Trinidad and Tobago had the most population (1.2 million), whereas Montserrat and Anguilla had the least (5,718 and 4,766, respectively).

Urban population in 2010

Sixty six percentage of the population in the region in 2010 was urban. Most of the countries (more than half) had more than 50% of its population living in urban areas. Anguilla and the Cayman Islands had the highest percentage of urban population (100%), whereas Montserrat and Trinidad and Tobago had the lowest (16.7 and 13.9%, respectively).

Data source: FAO - Statistical Division

Population change between 1980 and 2010

The region experienced a 40% of population increase between 1980 and 2010. Turks and Caicos (47.9%), the Cayman Islands (19.4%), the British Virgin Islands (17.0%), and Anguilla (12.7%) had the highest percentages of population change; all of them more than doubled their population during the period. In contrast St. Vincent and the Grenadines and the US Virgin Islands had the lowest percentages of population change (6% and 10% respectively), while Montserrat and Dominica experienced population decrease (57% and 2% decrease, respectively).

Data sources: Calculations are based on total population for 1980 and 2010 from US Census Bureau - International Data Base and FAO - Statistics Division.

Urban population change between 1980 and 2010

Urban population increased by 81% in the region between 1980 and 2010. Turks and Caicos had the highest increase (800%), followed by Haiti and the British Virgin Islands (346 and 233%, respectively). St. Kitts and Nevis, and Antigua and Barbuda had low increases (13 and 12%, respectively). Urban population totals did not change for Montserrat, while Dominica’s urban population decreased by 4.2%.

Data source: FAO - Statistics Division.

Population density in 2010

In 2010, the region had a population density of 180 people/km square. Barbados had the highest density, with 664 people/km square, followed by Puerto Rico with 449. The Bahamas, Turks and Caicos, and Montserrat had the lowest densities (31, 46 and 50 people/km square, respectively).

Data sources: Calculations are based on total population for 1980 and 2010 from US Census Bureau - International Data Base and FAO - Statistics Division.
Physiological density in 2009

The physiological density represents the number of people per unit of arable land within a country. The small islands in the northern Caribbean and many of the Lesser Antilles had a high physiological density, with Turks and Caicos having the highest density (41 people per unit of arable land), followed by the USVI (27.5) and the former Netherland Antilles (24.8). The Greater Antilles generally had the lowest density, with Cuba having the lowest value within the region (1.7). An exception in the Greater Antilles was Puerto Rico, which had among the highest densities of all the insular Caribbean (21).

Data sources: Calculations are based on total population for 2009 from US Census Bureau - International Data Base and on total agricultural land for 2009 from FAO. There was no data for Anguilla.

Natural disasters between 1980 and 2010

The Greater Antilles were the most disaster-prone countries, with Haiti and Cuba reporting the most events (67 and 57, respectively), followed by Dominican Republic (42), Jamaica (30), and Puerto Rico (29). Montserrat, was the country with the most disaster events (22) in the Lesser Antilles. Anguilla and the British Virgin Islands reported the least (3 in each case) in the region.

Data sources: EM-DAT, Lindsay et al. (2009), Longshore (2008), NOAA Monthly Review, USGS. Disaster events include tropical cyclones, floods, land and mudslides, earthquakes, volcanic eruptions, and droughts (see López-Marreño and Wisner, this issue, for more information).
People killed by natural disasters

Between 1980 and 2009, there were about 9,700 reported deaths from natural disaster in the region. Haiti had the most of these deaths (7,637), followed by Dominican Republic (1,121). In relation to its population and to the number of reported disasters, Cuba had relatively low number of fatalities (198). Barbados (1) and the Cayman Islands (2) were the countries with the least number of people killed by disasters; whereas there were no reports of deaths for Anguilla and the British Virgin Islands.

Data sources: EMDAT, Gubbels and Brakenridge (2004), Lindsay et al. (2007), Longshore (2008), NOAA Monthly Review, USCG, USGS. Unit of Disasters Studies. Disaster events include tropical cyclones, floods, landslides, earthquakes, volcanic eruptions, and droughts.

*Numbers are midpoint estimates (see López-Marrero and Wisner, this issue, for more information and data ranges).
Map 10. Projected costs of global inaction on climate change in the insular Caribbean in 2025.

Cost of global inaction on climate change in 2025

The projected cost of inaction for the region in 2025 based on three indicators (hurricane damages, loss of tourism revenue, and infrastructure damages due to sea level rise) is 5% of its GDP. Impacts are expected to be higher for Haiti (30.5%), followed by Grenada (21.3%) and Saint Lucia (21.1%). Puerto Rico, Martinique, and Guadeloupe are projected to have the lowest impacts (1.4, 1.9, and 2.3% of GDP, respectively).

Data source: Bueno et al. (2008). Projections were made by the authors combining the three categories of potential effects: increased hurricane damages, loss of tourism revenue, and infrastructure damages due to sea level rise.
Rainfall

Rainfall varies widely within the region, as it is influenced by different factors such as position in relation to easterly winds, topography and island size. Islands with greater topography, like many of the volcanic islands of the Lesser Antilles had high rainfall values, with Grenada reporting the highest value (2350 mm/yr), followed by Saint Lucia (2301 mm/yr). In the Greater Antilles, Puerto Rico had the highest precipitation (2054 mm/yr), whereas Cuba had the lowest (1335 mm/yr). The lowest reports of rainfall were from the former Netherland Antilles, Turks and Caicos, and Anguilla (550, 680, and 890 mm/yr, respectively).

Data sources: FAO - Statistical Division and AQUASTAT, World Bank, Individual island's governmental websites.
*Data are estimated island averages for 2008-2012.

Carbon dioxide emissions in 2008

The US Virgin Islands and Trinidad and Tobago are, by far, the top emitters of carbon dioxide per capita, with emissions of 25.41 and 10.18 metric tons of carbon, respectively. These countries were followed by the former Netherland Antilles and Montserrat. Haiti, on the other hand, was the country with least emissions per capita (0.07 metric tons of carbon). Saint Vincent and the Grenadines, Dominica, and Dominican Republic also had low emissions per person.

Data source: CDIAC.

Gross Domestic Product per capita in 2010

As an economic indicator, the Gross Domestic Product (GDP) per capita shows the great disparity within the region, with GDPs ranging from $54,827 (Cayman Islands) to $1,200 (Haiti). After the Cayman Islands, the British Virgin Islands and the Bahamas had the highest GDP per capita. All the Greater Antilles, except for Puerto Rico, had low GDP per capita. Montserrat, in the Lesser Antilles, had the lowest GDP per capita.

Data sources: World Factbook, United Nations Country Profiles. Data for Cayman Islands, the former Netherland Antilles, and the British Virgin Islands is from 2009; for Anguilla and Montserrat is from 2008. There was no data for Turks and Caicos, U.S.V.I., Guadeloupe, and Martinique.
Map 14. Human Development Index in the insular Caribbean in 2010.

Human Development Index in 2010

The Human Development Index (HDI) combines measures of life expectancy, education, and income. Within the region, Barbados had a very high HDI, followed by Cuba among those classified as having a high index. All of the Lesser Antilles for which data exists fall within a high HDI category. The Dominican Republic was classified as a medium-index country, whereas Haiti had a low index.

Data source: UNDP - Human Development Report (2010). There was no data for Anguilla, Cayman Islands, Guadeloupe, Martinique, Montserrat, Aruba, Curacao, Bonaire, Puerto Rico, BVI, and USVI.