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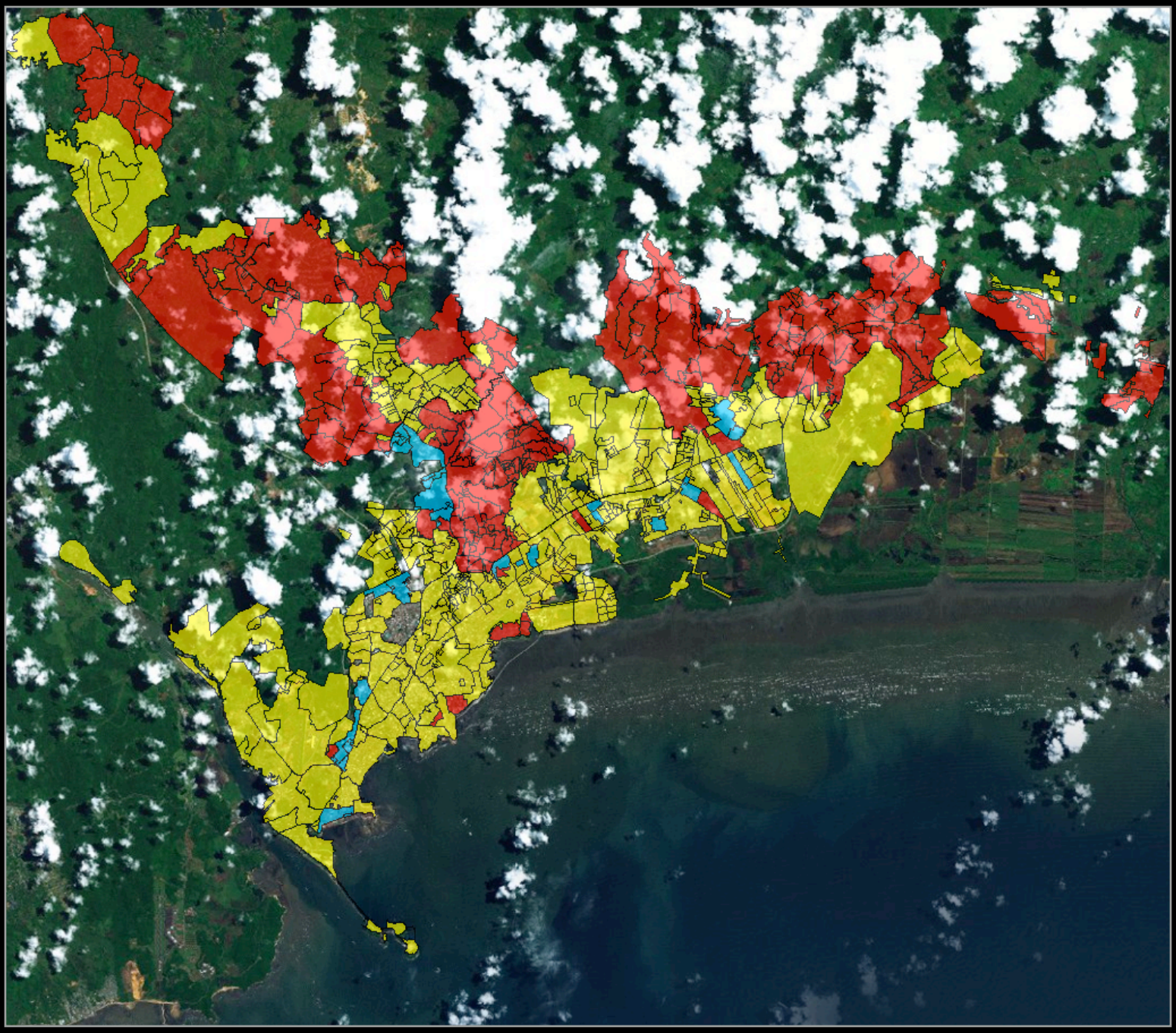
Redefining Urban Sprawl:
A GIS Approach to Mapping Sustainability Indicators



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Executive Summary

Redefining Urban Sprawl: A GIS Approach to Mapping Sustainability Indicators

Maya Fromstein and Per Kraut
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The world is rapidly urbanizing and Panama is no exception. It is predicted that six out of every ten people will live in a city by the year 2030, growing to seven out of ten by 2050. If the majority of our world's population in the near future will be living in these urban environments, the sustainability of these cities is of utmost importance. Cities are a platform for social, political, and ideological conflicts related to sustainable resource use, inequality, and the implementation of alternative development models. These characteristics show no sign of changing in the near future.

Panama City is disproportionately larger than any other city in the country. It dominates the country's urban system and accounts for almost half of the national population. Historically, it has always been an urban magnet for national and international migration, with a highly globalized service economy of tourism, banking, and international trade. Over time, rural migration has increased with industrialization as people move to the city in search of better employment opportunities. The growth of Panama City is creating social and environmental crises and challenges related to coastal and forest ecosystems, urban transport, social inequality, and the focus of this particular study, affordable housing.

All of these factors make Panama City the ideal laboratory for studying the relationship and the links between urban and rural trends and growth models. In order to envision an urban growth model that is more participatory, socially inclusive and sustainable, well-informed debates are needed. For this reason, four research groups are coming together to create the Urban Systems Forum and Observatory. This project will gather much needed information on urban transportation, sprawl, social exclusion, and population trends. It will create a permanent forum for discussion to evaluate existing urban development models and propose new initiatives through the promotion of wide consensus among all social actors on urban and environmental policy. This particular study has focused on initiating a GIS database, which can be used to map out geographically population and social trends. An initial research question was proposed as a pilot study for the database, asking what proportion of the population in the metropolitan area of Panama City and San Miguelito currently live in informal types of housing.

This was done by obtaining GIS shapefiles and demographic information from Panama's National Institute for Statistics and Census (INEC). The demographic information included 2010 census data on three sustainability indicators: housing units, family units, and number of people in each neighbourhood. The files and information were then compiled and merged using ArcGIS, creating an initial database of five districts around Panama City: Panamá, San Miguelito, Arraiján, La Chorrera, and Capira. The focus of the project then moved to answering the question of informal housing settlements. Each neighbourhood in Panama City and San Miguelito was categorized into one of three types of residential development: Formal Private, Government Projects, and Informal Housing. The amount of each indicator found in each type of residential development was then summed and analyzed.

The study size was made up of 824 neighbourhood units. It was originally intended to be a population study, but soon became a convenience sample based on the shapefiles available

from INEC. Of the total population sampled living in Panama and San Miguelito, 47.60% lived in informal housing, while only 45.12% lived in the formal private sector. A total 42.66% of the sampled housing units were found in the formal private sector, while 49.57% were informal. Of the family units sampled, 44.71% were formal private, and 47.33% were informal. Government projects hovered between 7-8% in each indicator category.

These numbers were strikingly high. According to UN Habitat, the proportion of the urban population of Latin America and the Caribbean living informal settlements in the year 2010 was 23.5%. At over twice this figure, the results of this study suggest that it is time for Panama to take some action when it comes to public policy and housing in the informal sector. Such conditions are unsustainable, and can in turn hurt the greater private sector in the longrun. The Urban Systems Forum and Observatory will eventually be making the results of its studies publicly accessible, offering a conversation space for public debate. Policymakers and urban planners can then work together to take the next steps forward in terms of development.

If no action is taken, urban migration will only continue and these numbers will increase. The informal sector often relies on siphoning resources from the private sector, and so the quality of life in the longrun could decrease for all. The Panamanian government is at a point now where it must prioritize and decide the kind of country it wants to be in the future, because the time to plan for the future is today.

Resumen Ejecutivo

Redefiniendo la expansión Urbana: Un enfoque de GIS para mapear los indicadores de sostenibilidad

Maya Fromstein y Per Kraut
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El mundo se está urbanizando rápidamente y la ciudad de Panamá no es una excepción. Se prevé que seis de cada diez personas en el mundo vivirán en ciudades en el año 2030, aumentando a siete de cada diez en el año 2050. Si la mayoría de la población mundial en un futuro próximo va a vivir en estos ambientes urbanos, la sostenibilidad de estas ciudades es de suma importancia. Las ciudades son una plataforma para que los conflictos sociales, políticos e ideológicos relacionados con el uso sostenible de los recursos, la desigualdad y la implementación de modelos de desarrollo alternativo. Estas características no muestran ningún signo de cambio para el futuro próximo.

La Ciudad de Panamá es desproporcionadamente más grande que cualquier otra ciudad en el país. Se domina el sistema urbano del país y representa casi la mitad de la población nacional. Históricamente, siempre ha sido un imán para la migración urbana nacional e internacional, con una economía de servicios altamente globalizado. Con el tiempo, la migración rural se ha incrementado con la industrialización como la gente se mueve a la ciudad en busca de mejores oportunidades de empleo. El crecimiento de la Ciudad de Panamá está creando crisis y desafíos sociales y ambientales relacionados con los ecosistemas costeros y los bosques, el transporte urbano, la desigualdad social y el enfoque de este estudio en particular, la vivienda accesible.

Todos estos factores hacen que la ciudad de Panamá sea el laboratorio ideal para el estudio de la relación y los vínculos entre las tendencias urbanas y rurales y los modelos de crecimiento. Con el fin de imaginar un modelo de crecimiento urbano que tenga más participación, socialmente inclusivo y sostenible, se necesitan debates bien informados. Por esta razón, cuatro grupos de investigación se unen para crear el Foro y Observatorio de Sostenibilidad. Este proyecto reunirá información muy necesaria sobre el transporte urbano, la expansión, la exclusión social y las tendencias demográficas. Se va a crear un foro permanente de discusión para evaluar los modelos de desarrollo urbano existentes y proponer nuevas iniciativas a través de la promoción de un amplio consenso entre todos los actores sociales en las políticas urbanas y ambientales. Este estudio en particular se ha centrado en la iniciación de una base de datos GIS, que se pueda utilizar para mapear las tendencias de la población geográficamente y social. Una pregunta inicial de investigación se propuso, preguntando cuál es la proporción de la población en el área metropolitana de Panamá y San Miguelito viven actualmente en los tipos informales de vivienda.

Esto se hizo mediante la obtención de archivos shapefiles de GIS y la información demográfica del Instituto Nacional de Estadísticas y Censos (INEC). La información demográfica incluye los datos del censo 2010 sobre tres indicadores de sostenibilidad: las unidades de vivienda, hogares y el número de personas en cada barrio. Los archivos y la información a continuación fueron compilados y fusionados con ArcGIS para una base de datos de cinco distritos cerca de la ciudad: Panamá, San Miguelito, Arraiján, La Chorrera y Capira. El foco se trasladó a responder a la cuestión de los asentamientos informales de vivienda. Cada

barrio de la ciudad de Panamá y San Miguelito se clasifican en uno de los tres tipos de desarrollo residencial: Formal Privado, Proyectos del Gobierno, o Asentamientos Informales. La cantidad de cada indicador que se encuentra en cada tipo de construcción de viviendas se resume a continuación, y se analizó.

El tamaño del estudio estaba compuesta por 824 unidades vecinales. Originalmente la intención de hacer un estudio poblacional, se convirtió en una muestra de conveniencia basada en los shapefiles disponibles INEC. De la población total muestreada vivir en Panamá y San Miguelito, 47,60% vivía en viviendas informales, mientras que sólo el 45,12% vive en el sector privado formal. Un total de 42,66% de las viviendas de la muestra se encuentra en el sector formal privado, mientras que 49,57% eran informales. De las unidades familiares incluidas en la muestra, 44,71% era privado formal, y 47,33% eran informales. Los proyectos del gobierno cernían entre el 7-8% de cada categoría de indicador.

Estos números fueron sorprendentemente altos. Según ONU-Hábitat, la proporción de la población urbana de América Latina y el Caribe viven en los asentamientos informales en el año 2010 fue de 23,5%. En más del doble de esta cifra, los resultados de este estudio sugieren que es hora de que Panamá tome algún tipo de acción en lo que respecta al orden público y la vivienda en el sector informal. Estas condiciones son insostenibles, y a su vez puede dañar la mayor parte del sector privado a largo plazo. Con el tiempo, El Foro y Observatorio de Sostenibilidad hará de los resultados de sus estudios para el acceso público, que ofrece un espacio de conversación para el debate público. Los formuladores de políticas y los planificadores urbanos pueden entonces trabajar juntos para dar el siguiente paso hacia adelante en términos de desarrollo.

Si no se toman medidas, la migración sólo continuará y estas cifras aumentarán. El sector informal a menudo se basa en desviar recursos del sector privado, por lo que la calidad de vida a largo plazo podría disminuir para todos. El gobierno de Panamá se encuentra en un punto en el que se debe priorizar y decidir el tipo de país que quiere para el futuro, porque el tiempo para planificar el futuro es hoy.

Acknowledgements

The success of this project would not have been possible without the hard work, patience, and inspiring qualities of many people. We would like to thank the Smithsonian Tropical Research Institute for use of their facilities during our time in Panama. There would have been no project without our supervisor Dr. Ariel Espino, who continuously impressed us with his generosity of his time and guidance, and his comprehensive knowledge of Panama and urban planning. Deepest gratitude is also due to Milton Solano, whose patience and GIS proficiency were fundamental to our project and our experience in general. We are thankful to Álvaro Uribe for his invaluable contribution and enthusiasm, especially during the final stages of our project. Additionally, we would like to thank Maria, Lady, and all the staff at STRI for making us feel welcome. We appreciate the help and time saved given by INDICASAT and INEC for facilitating and easing our gathering of data. We would also like to thank Dr. Catherine Potvin for organizing our program and putting us in contact with Dr. Ariel Espino. Finally, we are grateful to our professors Dr. Rafael Samudio and Dr. Roberto Ibanez, and to our teaching assistant, Victor Frankel, for their guidance and assistance during times of stress.

Host Details

Dr. Espino is an architecture graduate from Universidad de Santa Maria La Antigua in Panama. He earned a master's degree in urban planning from the University of Arizona, and then received his PhD in Social Anthropology at Rice University in Houston. He is now a member of the American Planning Association and the American Institute of Certified Planners. Dr. Espino worked formerly with the Panamanian government on projects including the restoration of Casco Antiguo, but has since opened up his own private practice under the name Grupo Suma. This firm provides comprehensive architecture and urbanism to individual, institutional, and commercial projects of various scales. Their work places special emphasis on environmental sustainability and social responsibility, and their experiences highlight master plans, landscaping, and urban studies. Never one to sit still, Dr. Espino is continually embarking on multiple projects at once, including the Urban Systems Forum and Observatory with which we have assisted throughout the duration of our internship.

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Number of full days spent on the project:

January	February	March	April	Total
5	9	7	14	35

Introduction

Background

The world is rapidly urbanizing, and with 79.4% if its population living in cities in 2010, Panama is no exception (UN Habitat, 2007). The global urban population surpassed the global rural population for the first time in history in 2009, and it is predicted that six out of every ten people will live in a city by the year 2030 (WHO). This number will likely increase to seven out of ten people within the twenty years following (WHO). If the majority of the world's population in the foreseeable future is to be living in urban environments, the sustainability of these cities is of the utmost importance. Cities are one of the main platforms for social, political, and ideological conflicts related to sustainable resource use, inequality, and the implementation of alternative development models, and will likely continue to function this way into the future.

Panama City is an ideal laboratory for issues like these because it is constrained by the need to maintain nearby environmentally sensitive areas including the Panama Canal watershed, natural parks, historic zones, and extensive wetland areas of mangroves (Espino, January 2013). Key industries that sustain the local and national economy depend on the protection of these surrounding ecosystems—industries including the Panama Canal, the tourism industry, and the fishing industry. In the city, however, urban growth persists because of a strong economy, sparking conflict between the conservation requirements and the increasing demand for land for development, drinking water, and other resources.

Panama City is disproportionately larger than any other city in the country. It dominates the country's urban system and makes up almost half the national population. Historically, it has always been an urban magnet for local and international migration, with a globalized economy dedicated mostly to services such as tourism, banking, and international trade. Over time, rural

migration has swelled with industrialization as people have moved to the city to pursue more advantageous employment opportunities. The growth of Panama City is creating social and environmental crises and challenges related to coastal and forest ecosystems, urban transport, social inequality, affordable housing, and urban services. Accompanying this growth also comes traffic congestion, increased crime rates, central city gentrification, deterioration of basic services and environments, heightened social segregation, and escalating housing costs.

All of these factors make Panama City a perfect setting for studying the relationship and the links between urban and rural trends and growth models. In order to envision a new urban growth model that is more participatory, socially inclusive, and sustainable, well-informed debates are needed. For this reason, The Urban Systems Forum and Observatory has been proposed (El Foro y Observatorio de Sostenibilidad). The aim of this project is to facilitate the gathering of much needed information on urban transportation, sprawl, social exclusion, and population trends. The observatory will create a permanent forum for discussion to evaluate existing urban development models and propose new initiatives through the promotion of wide consensus among all social actors on urban and environmental policy. In order to develop this forum, our study involved the creation of a GIS database featuring population and census data of the city's urban core and surrounding areas.

McGill University and the Smithsonian Tropical Research Institute have collaborated on this project with the Universidad de Santa Maria La Antigua (USMA), as well as the Institute for Science and High Technology Services of Panama (INDICASAT). These four groups held an open workshop on August 3, 2012 to welcome inputs from the public and structure its goals. Over seventy participants from various backgrounds came together to attend this workshop. These four groups will work together with the input of government agencies, NGOs, research

and academic institutions, private sector, communities, and indigenous groups to create a user-friendly online database featuring a comprehensive aggregate of data from multiple sources to aid in the future research projects of anyone who so chooses.

Context

The main geographical constraint that Panama City faced in the twentieth century was the canal and the Canal Zone. Panama started as the fortified peninsula of Casco Antiguo with the large hill now known as Cerro Ancón acting as protection in the back. Because of the canal, growth towards the west and the north was blocked, and so the city could only grow towards the east along the coast. This produced a linear city in contrast to a concentrical one. Since employment has remained fairly centralized, the linear shape means outskirts tend to be very far.

Another issue is that the city's outskirts were traditionally private lands. Panama has a weak industrial economy, and so land speculation and real estate have been historically a very important source of wealth for the nation's elite. This left the poor with very few options after the 1950s when renting declined and the housing industry focused on building for homeownership. Squatting soon developed as an alternative. The state had a large intervention in the 1970s, either building social housing, buying land, or improving squatter settlements. From the 1980s onward, this chapter was closed, and today housing projects are not a main focus for the Panamanian government.

One common measure of inequality is the Gini coefficient. This index measures the degree of inequality in distribution of a family income. A coefficient closer to 100 means a higher level of inequality, while a lower number translates to less. It is interesting to note that in 1979, the Panamanian Gini coefficient was at its lowest in recent years with 48.74 (CIA – The

World Factbook). Over the next ten years, the national Gini rose to 58.9 in 1989, and has since settled back down to 51.9 in 2010, putting it at the sixteenth highest in the world (CIA – The World Factbook; UN Habitat, 2007).

High levels of inequality translate to large numbers of rich and poor in a population, and typically a smaller or non-existent middle class. When the urban poor cannot afford to hire a construction crew or buy a pre-existing residence, the next logical step is often to take the process into their own hands. Informal housing is often built by the residents at their own pace as they can afford the materials. This is advantageous in the fact that those who cannot afford to do not have to finish the construction of their homes all at once. The disadvantages are that often those building their homes do not have access to the proper infrastructure, water or sanitation systems to make their homes truly sanitary and sustainable in the long run.

Given the gravity and pace of urbanization in Panama, informal settlements and the living conditions they house necessitate greater attention, along with their broader reaching social impacts and insufficient political reactions. Placing this in the context of the local as well as regional developmental history, it is clear that informality has had a formal place on the landscape for decades already; in order to effectively prevent informal settlements from continuing to characterize the Latin American city centre, a deeper understanding catalyzing more appropriate responses is required.

Informal settlements are complex and dynamic establishments with modern footprints rooted in a rich developmental history. Traversing national borders, two informal communities may not resemble one another for their diverse attributes despite sharing certain fundamental commonalities. Satisfying an individual characteristic does not constitute informality, but the presence of many, to varying degrees and strengths, can indeed qualify a community as informal.

There is not one consistent definition across countries and even amongst cities of the same nation due to distinct local conditions and histories. There even lacks a common language; what is colloquially a *favela* in Brazil is known as an *etio* in Mexico and a *barriada bruja* in Panama (Fernandez, 2011; Espino, personal communication, 22 April 2013). In the literature, they may be referred to as informal, irregular or illegal settlements (Fernandez, 2011; Brakarz, Green & Rojas, 2002). While a single definition reduces the precision and complexity to minimal, it can prove useful in consolidating data and providing a much-needed general image. The UN Habitat thus defines informal settlements based on what the inhabitants have, as opposed to what they lack. According to UN Habitat (2007), those living informally are characterized as having (i) a lack of formal land titlage; (ii) inadequate access to potable water; (iii) insufficient basic infrastructure and community services such as access to sanitation; (iv) unreliable housing structure; and (v) overcrowding, meaning more than three persons per room (United Nations, 2004; Durand-Lasserve, 2006). The literature agrees on these characteristics, and stresses defocusing the role that socioeconomics play while emphasizing the significance of the legal aspect (Fernandes, 2011). Poverty and informal employment may often coincide with irregular housing, but many of the urban poor reside outside of informal settlements. Data from Pereira Passos Institute (2002) in Brazil note that 64% of Rio de Janeiro's poor live outside *favelas*. While informal settlements and poverty do coincide, it is important to remember that it is not restricted to such conditions.

Nearly all types of informal living violate legal order in one way or another. This is both a common denominator for the various settlements in a range of countries and simultaneously a source of uniqueness as the specific legal programs may each have distinct implications (Fernandes, 2011). Settlements typically qualified as informal refer to three main types: invasion

of public or private land; illegal subdivisions of commercial suburban land providing precarious land 'titles'; and occupation of overcrowded, dilapidated, and often abandoned buildings in city centres or densely populated areas (Durand-Lasserve, 2006). The prominence of irregular housing throughout Latin America avoids a unified definition; nevertheless, it is accepted that informality in large urban areas from one tenth to one third of residences (Fernandes, 2011), and this number is growing.

Furthering our understanding of what comprises informal living enhances our capacity to create an environment that fosters appropriate, effective, and positive change. The aforementioned UN Habitat characteristics delineate that which is visible on the surface, but the report does not extend to their implications. The nearly uniform absence of formally recognized land tenure is compounded by the unavailability of financial and other resources, such as literacy, education, access to lawyers, to increase the vulnerability of those living in irregular settlements to eviction and relocation (Fernandes, 2011). Citizenship and the ability to vote are often contingent on providing a permanent address (Brakarz, Green & Rojas, 2002), disqualifying a portion of the population most disproportionately affected by policy action. While for some it does not cause of lack of belonging, a lack of formal land title may not necessarily contribute to feeling insecure due to de facto property rights derived from customary practices (Fernandes, 2011). This is reflected in surveys about informal living. Often there is a sense of permanence and just ownership such that responses to questions regarding occupation of illegal land are unreliable (Brakarz, Green & Rojas, 2002). The significance of these alternative land ownership rights ought to be considered by judges and policy makers alike—it is all too common for policy makers to overlook the legal dimensions of informal development by classifying them all as 'illegal' (Fernandes, 2011).

The causes of informality are as manifold and situation-specific as the consequential manifestations. Low income plays an important role, but studies reveal that rates of increase in informality sometimes exceed those of poverty (Fernandes p. 14, 2011), highlighting the importance of considering additional factors. A study on household income in Panama City concludes that 40% of households in the metropolitan area could not afford the houses in the lowest price bracket as supplied by the private sector (Espino, personal communication, 21 April 2013; Fernandes p. 15, 2011; Brakarz, Green & Rojas p. 11, 2002). This estimate likely increases when considering those who have sufficient incomes, but do so through the informal sector and are thus not eligible for bank loans. Given that 44% of the country's employment is informal, this increase may be significant (Espino, personal communication, 21 April 2013).

With a large proportion of the city effectively removed from the housing market, their remaining options are government projects or informal housing. Informal settlements are thus not only indicators of unequal wealth distribution and poverty, but also of market failures and shortages of social housing. Rapid urbanization in Panama City brought to light the inadequacy of Panama's development regulations (Brakarz, Green & Rojas p. 13, 2002), unrealistic urban planning (Fernandes p. 15, 2011), and bureaucratic complexity that deters, and financially inhibits, individuals from registering their land (Fernandes p. 16, 2011). The urban poor bear the consequences of an exclusive private market; lack of investment in public housing; and urban planning that fails to integrate the needs of the environment, its inhabitants and factors like transportation and taxation. The door then opens to the development of informal housing, especially in the outskirts of the urban core.

The reach of these informal settlements' impacts is not as clearly outlined, as are their geographical limits. Within the slum's boundaries, lack of legal land titles deprives inhabitants of

basic citizenship rights. Those living in irregular housing cannot access bank or shop credit without an official address, nor can they restrict police entrance to having a warrant (Fernandes, 2011). The cost to the government is that those without formal tenure do not pay property taxes and distort long-term planning goals (Durand-Lasserve, 2006). Social stigma and physical distance from dense sources of employment make finding, and then accessing, jobs difficult and inhibitively time consuming for residents (Fernandes, 2011; Durand-Lasserve, 2006; Brakarz, Green & Rojas, 2002). Fire-fighters and medics cannot enter the areas because there are often no paved roads to accommodate their vehicles. This has an obvious negative effect on safety and quality of life, as does deficient access to public services and spaces, and basic infrastructure like sewage, electricity, and running water (Fernandes, 2011). These communities' trademarks become substandard health, environmental, and sanitary conditions (Brakarz, Green & Rojas p. 17, 2002). This is partially emphasized by their fragmentation from the formal city, and also because the locations occupied are often precariously nestled into a sensitive environment unsuitable for dense and growing populations (Fernandes p. 12, 2011).

It is substantially more expensive to pay for these services outside of the grid than if they were integrated into it. For example, water from a tank is a common alternative to receiving water through pipelines, but costs seven times the price (Brakarz, Green & Rojas, 2002). This decreases the efficiency of existing formal systems as those living in informal settlements resort to illegally dipping into resources. The inadequate living conditions of irregular housing affect not only those who endure it, but also the rest of society. Studies show that there are a resultant increased number of hospital patients that incur additional costs to the health system and occupies space that may be otherwise used (Brakarz, Green & Rojas p. 17, 2002). The impacts of informal housing on its inhabitants are many and severe, yet they are not even the sole

recipients—informal housing developments affect everyone, including those living in formal environments.

Question

This information brought us to ask: What proportion of the urban population of Panama City currently lives in informal neighbourhoods? Three indicator categories were chosen to examine. These categories were number of housing units, of family units, and of persons in each respective neighbourhood. This study sought to understand what informality physically, through aerial photography, and proportionally, through census data, looks like in Panama City.

Justification

Rapid urbanization will ultimately impact the extent and state of informal housing in Panama City. Policy has the potential to play a large role in the future image and inclusion, or exclusion, of all of its inhabitants (Brakarz, Green & Rojas p. 20, 2002). Policy may affect existing settlements and direct potential future communities before they become established, but it cannot be driven by rhetoric alone—it must be supported by facts. However, given the various characteristics and thus possible definitions of informality, it is challenging to precisely quantify the extent of informal living in Panama City (Fernandes, 2011). The situation in how it appears in numbers changes dramatically depending on which definition is applied, and the data available tends to be fragmented and imprecise (Fernandes, 2011). To date, there is no publicly accessible database with such information (Espino, personal communication, 15 April 2013). Indeed, according to census data Panama City does not suffer from a housing shortage; the amount of housing units may well exceed those of family units in certain neighbourhoods, but these counts do not take into consideration the liveability of said houses.

It is essential to supplement such information with a thorough understanding of the nature and dynamics of informal development processes, a constituent that policymaking all too often lacks (Fernandes, 2011). To be effective, policies must regard the holistic backdrop of poverty in its entirety upon which the growth of informal living and housing shortage is strewn (Brakarz, Green & Rojas, 2002). This means that while the problem may appear to be a lack of liveable housing, it more accurately comprises all the factors that contribute to why liveable housing is economically inaccessible to 40% of the city's population. In doing so, it is necessary to consider the area's history and future projection simultaneously.

Part of revisiting the past to more sustainably build the future is recognizing that reactive behaviour (relocating communities, building infrastructure post-establishment) is two to three times more costly than proactive behaviour such as providing sufficient government housing (Espino, personal communication, 18 April 2013; Brakarz, Green & Rojas, 2002). Detailed current information on urban dynamics and a forum to make this information accessible is critical in ensuring that growing urban areas become ecologically, economically, and socially more sustainable cities in the future.

Methodology

Data Collection

Panama City is divided into many districts extending in all directions from the city centre, following its growth trajectory. The five focused on in this study are: Panamá, San Miguelito, Arraiján, La Chorrera, and Capira. This study was completed with knowledge of and in accordance with the McGill University Code of Ethics.

Multiple forms of information were required for the completion of this study. In order to retrieve the necessary shapefile data from the Instituto Nacional de Estadística y Censos (INEC), a letter was needed from INDICASAT, an internal government institution and fellow collaborator on the Urban Systems Forum and Observatory. Once this letter was obtained, it was delivered to INEC in order to permit the release of the shapefiles compatible with GIS, representing the physical layout of each neighbourhood in the five districts of study. A second trip to INEC was later necessary when the data was available for collection.

Demographic census data was not included within the obtained shapefiles. Information regarding number of persons, housing units, and family units per neighbourhood was retrieved online from the INEC website. The most recent census was conducted in 2010, and this provided the demographic information used in the study. The original formatting of the demographic information available online was incompatible with ArcGIS, and thus needed to be reformatted manually before it could be used.

Data Analysis

Once the information for each individual neighbourhood had been properly formatted in Microsoft Excel for each of the three indicator categories, the figures were joined to the

shapefiles using ArcGIS. This allowed for maps of the districts of Panama City to be created based on population, housing unit, and family unit distributions as shown in Figure 1.

These new shapefiles synchronized with the census data of the three indicators were then superimposed over a basemap of aerial imagery available through ArcGIS with each neighbourhood outlined (Figure 2). These aerial photos of Panama City were taken between the years of 2002 and 2010. The aerial photos of each neighbourhood allowed for easier identification, as the administrative boundaries were delineated clearly on a geographical map of the city. Each neighbourhood was then analyzed visually and divided into one of three categories of residential development: Formal Private, Government Project, or Informal. Only the districts of Panama and San Miguelito were analyzed to this extent. The visual categorization of the three types of residential development was defined as follows:

Formal Private: These were the majority of areas in the city proper unless they specifically looked visually different. The neighbourhoods were characterized by paved roads and modern infrastructure. The buildings appeared to be planned out and things were generally organized but still showed some level of variation (Figure 3).

Government Projects: These areas were very structured and had visibly been planned out in advance. Neighbourhoods were characterized by grid-like sections of identical buildings in otherwise lower-income or informal zones (Figure 4).

Informal: The main indicator for these areas was a lack of organization. Informal housing was often very clustered without any indication of prior planning, nor a formal road system. In the city, where these neighbourhoods were often confined to a limited amount of space, the residences appeared to nearly layer on top of one another. Sheet metal roofs often reflected the sun, which was visible in the aerial photograph. There was characteristically less

vegetation in informal settlements established closer to the city centre, while settlements in the outskirts were more spread out and amidst yet undeveloped land (Figure 5).

Once each neighbourhood was classified, a spreadsheet was created to once again join the identifications to the shapefiles on ArcGIS in order to help visualize their locations. A colour-coded map was then created to show which types of residential developments could be found where. This map was first revised by Ariel Espino, and then again by Álvaro Uribe, who has many years of experience working in the development sector of Panama. The resulting map can be seen in Figure 6.

Using Microsoft Excel, the number of persons, housing units, and family units in each development category were then summed, and graphs were created to outline the relationships existing between them.

Results

The resulting quantities and proportions of each of the three indicators in each of the three levels of residential development were as follows:

Type of Residential Development	Housing Units		Family Units		Number of People	
Formal Private	171 373	49.57%	147 714	47.33%	497 114	45.12%
Government Project	26 847	7.77%	24 854	7.96%	80 209	7.28%
Informal	147 477	42.66%	139 547	44.71%	524 487	47.60%
Total	345 697	100%	312 115	100%	1 101 810	100%

The figures show that in the metropolitan area of Panama City, there are 524 487 people living in the informal sector, while only 497 114 people live in formal private housing. This means there are 27 373 more people living in informal housing than in private. Meanwhile, only 80 209 people are living in government projects. These numbers are directly proportional to the resulting figures in the amounts of housing and family units. These quantities can be found displayed visually in Figure 7.

The proportions show that the informal sector in Panama and San Miguelito makes up between 40-50% of each category of indicator. Government projects hover between 7-8%, and private property amounts to under half of the metropolitan area. There are almost the same amounts of people living in private residences. These proportions can be found displayed visually in Figure 8.

Discussion

It is worth noting that the number of physical housing units in each development category exceeds the number of families, most prominently in the private sector with an extra 23 659. What this means is that there are a number of unoccupied homes while almost half of the urban population is lives in informal housing. This suggests that even though these empty homes may exist, they are still economically inaccessible to many. In economic terms this is called a market failure, a failure of the unregulated market to achieve allocative efficiency (Ragan and Lipsey). There is excess supply in the Panamanian housing market, yet in the absence of government intervention, it will fail to fully achieve allocative efficiency. Nevertheless, the housing market does not appear to be high on the government's list of priorities.

According to the UN Habitat, the proportion of the urban population of Latin American and the Caribbean in 2010 living in informal settlements was 23.5%. With 47.6%, Panama sits at twice this figure. This is a call to action. Now that these numbers are available, there is more to officer policymakers and politicians than simply saying there is a housing problem. Having almost half the population living in such conditions is not only dangerous for the inhabitants. It is equally unsustainable for their neighbours, the environment, and the economy. This is only heightened by the fact that without any serious action, these numbers will only increase.

Limitations

There are some factors to consider about the data in this study. Although 824 neighbourhood units should be more than representative of the population, this was a convenience sample and was not random. The study was meant to take into account the entire population, yet there were an additional 209 neighbourhood units of data in Panama and San Miguelito from the INEC website that did not match up with any of the received shapefiles. In addition, the map created by the shapefiles in ArcGIS had a few holes where information was lacking.

Of the 209 neighbourhood units that did not match up with shapefiles, 39 had names, suggesting the possibility that they may be formal and private, potentially meant to fill some of the holes in the middle of the city left out of the ArcGIS map. The remaining 170 however, do not even have names. This suggests that they are likely informal developments on the outskirts of the city. If this is the case, the estimates of this study on the proportion of people living in the informal sector may in reality be conservative estimates.

Conclusion

Urban growth is far from reaching its peak. This means that infrastructure deficits, informal urbanization, and urban poverty will continue to be among the most serious problems on the social agenda of virtually all developing countries (Brakarz, Green, & Rojas, 2002). The population of informal dwellers around the world grows every year by around 10%, globally intensifying the problem (UN Habitat, 2007). Unless governments begin to adopt targets for their countries and allocate sufficient budget resources to these issues, the lives of those living in informal settlements will remain unchanged. Individual countries must create their targets taking into account both existing and potential new slums, considering the abundance of migrants consistently moving to the city. This is an essential building block in bridging the urban divide. Those that take these targets seriously can increase the prospects for millions to escape poverty, as well as disease illiteracy, and to simply lead better lives.

If the results of this study could be made public, perhaps they could spark a conversation or some public debate. If Panama wishes to maintain its place in the rapidly developing world, it must look out for its people and for the sustainability of its development. Policymakers must start thinking about why the proportion of Panamanians living in the informal sector is so high and much greater than the regional average. What makes Panama so different from its neighbouring countries and the rest of the world? This is a conversation that needs to occur.

Future Recommendations

Although this study focused on the housing sector in and around Panama City, its longterm impact will be its contribution in starting a GIS database for the Urban System Forum and Observatory. Next steps for future internships could include extending and assigning housing categories to neighbourhoods to the districts of La Chorrera, Capira, and Arraiján. These shape files are already synchronized with 2010 census data on housing units, family units, and population.

Additionally, the distribution of informal to formally organized neighbourhoods, while important and indicative of the current extent of informal living, is only one indicator of the state of urban sustainability and implications for its future projection. In order for the Urban Systems Forum and Observatory to provide a more comprehensive vision for a sustainable future for Panama City, more indicators must be concurrently considered.

In total, the Urban Observatory currently spans ten prospective indicators. These include access and affordability of potable water; establishment and access to sewage systems; dispersion of an efficient and effective garbage collection service; and affordability and condition of housing.

Census-sourced indicators for these exist. Just as this study attained census data on demographics, so too can information be found on the aforementioned indicators. However, indicators such as mobility (travel time, mode of transportation, usage) require surveys to be created and distributed before the data can be analyzed spatially using ArcGIS. Data must also be gathered about accessibility and utilization of public spaces, families, and children. It may be the case that this information does exist, but is not made available by the pertinent institutions.

The Urban Systems Forum and Observatory is a massive undertaking by four principal stakeholders that seeks to affect and influence many more. The information included in this report summarizes some primary findings; important headway has been made, but a long road still lies ahead.

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Appendix

Figure 1: Once the information for each individual neighbourhood had been properly formatted in Microsoft Excel for each of the three indicator categories, the figures were joined to the shapefiles using ArcGIS. This allowed for maps of the districts of Panama City to be created based on population, housing unit, and family unit distributions. Shown here is the population distribution for Panama, San Miguelito, Arraiján, La Chorrera, and Capira.

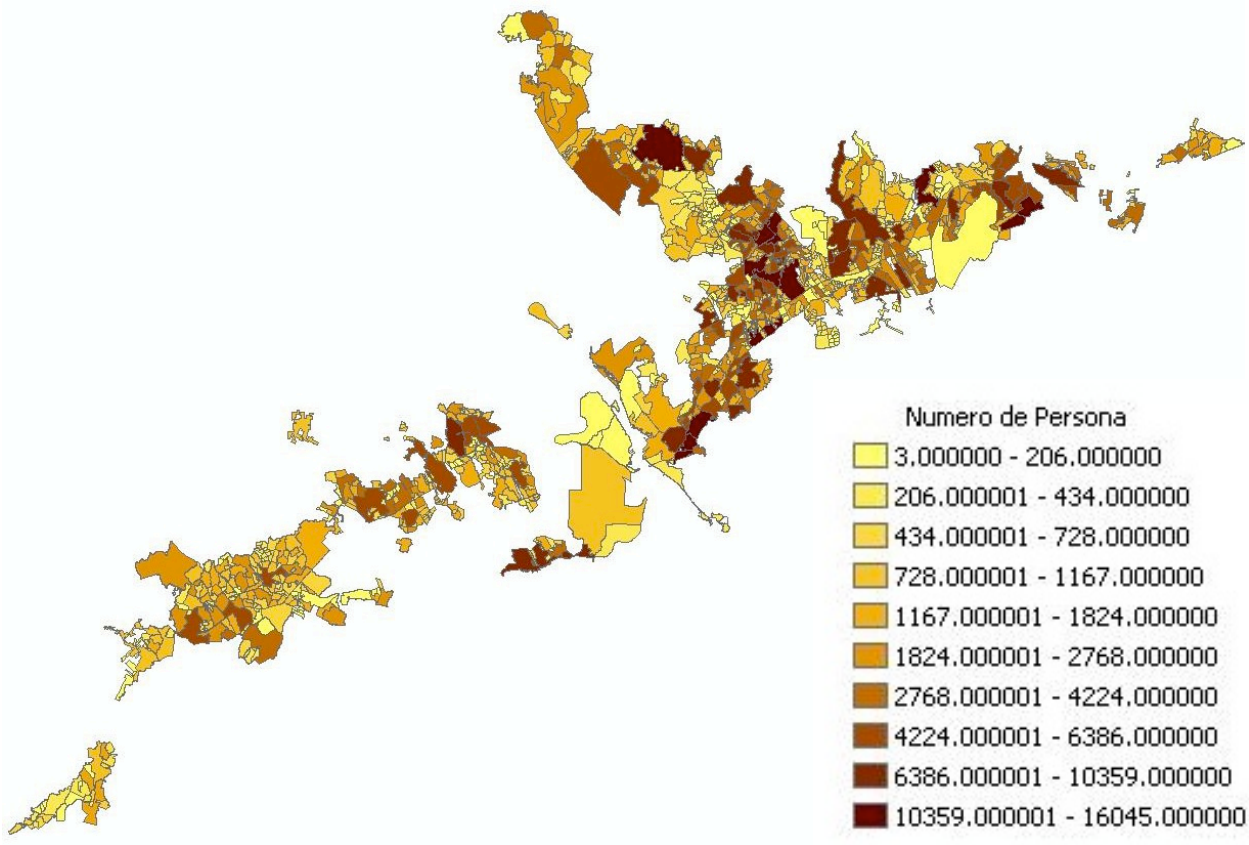

Figure 2: The shapefiles were superimposed over a basemap of aerial imagery through ArcGIS, outlining each neighbourhood. These aerial photos of Panama City were taken between the years 2002 and 2010.

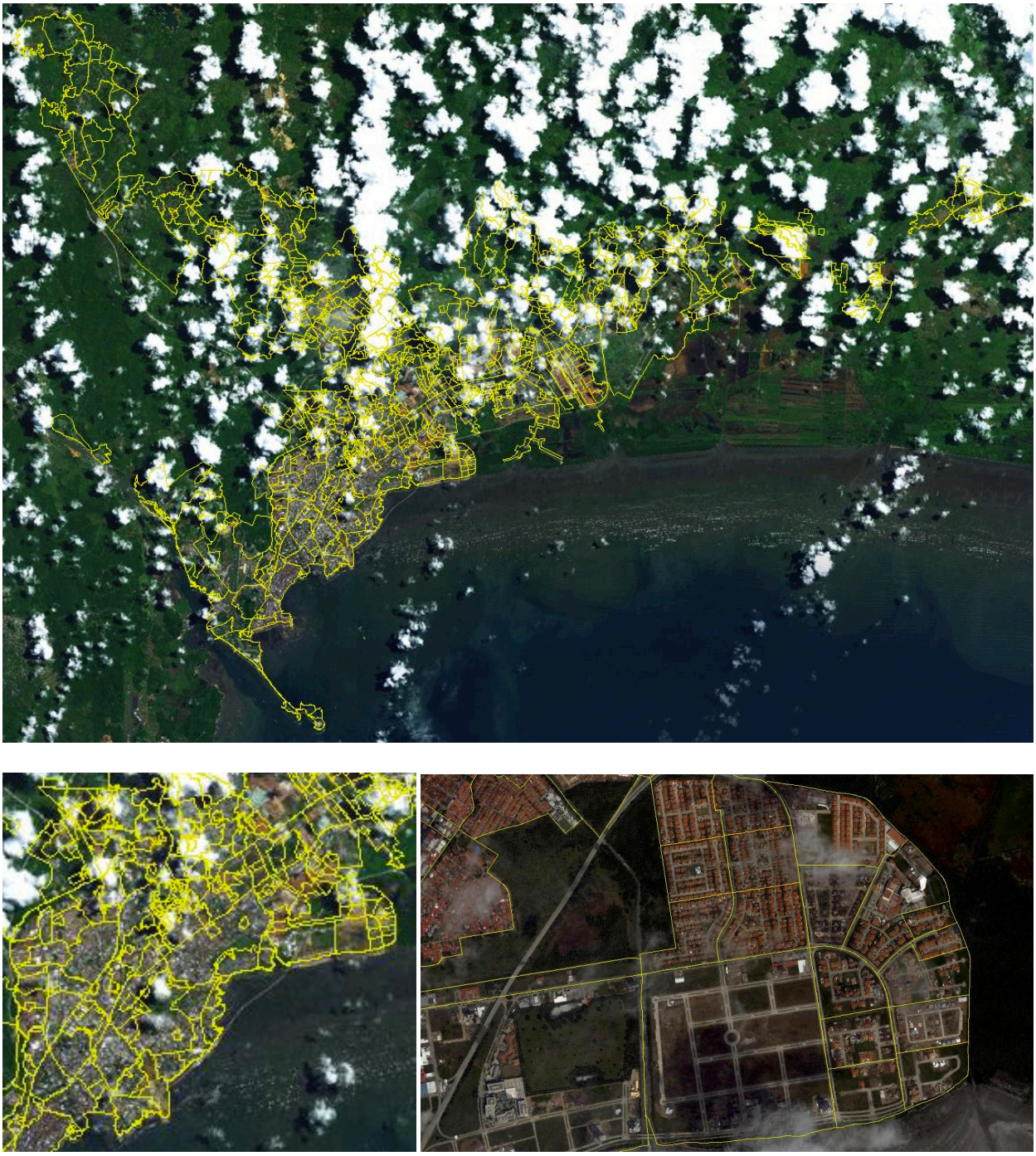

Figure 3: Formal Private neighbourhoods were characterized by paved roads and modern infrastructure. The buildings appeared to be planned out and things were generally organized, but still showed some level of variation.

Figure 4: Government Projects were very structured and had visibly been planned out in advance. Neighbourhoods were characterized by grid-like sections of identical buildings in otherwise lower-income or informal zones.

Figure 5: Informal housing was often clustered without any indication of prior planning or a formal road system.

Figure 6: A colour-coded map was produced to show where each type of residential development could be found. There were some holes in the map created from the shapefile data obtained from INEC.

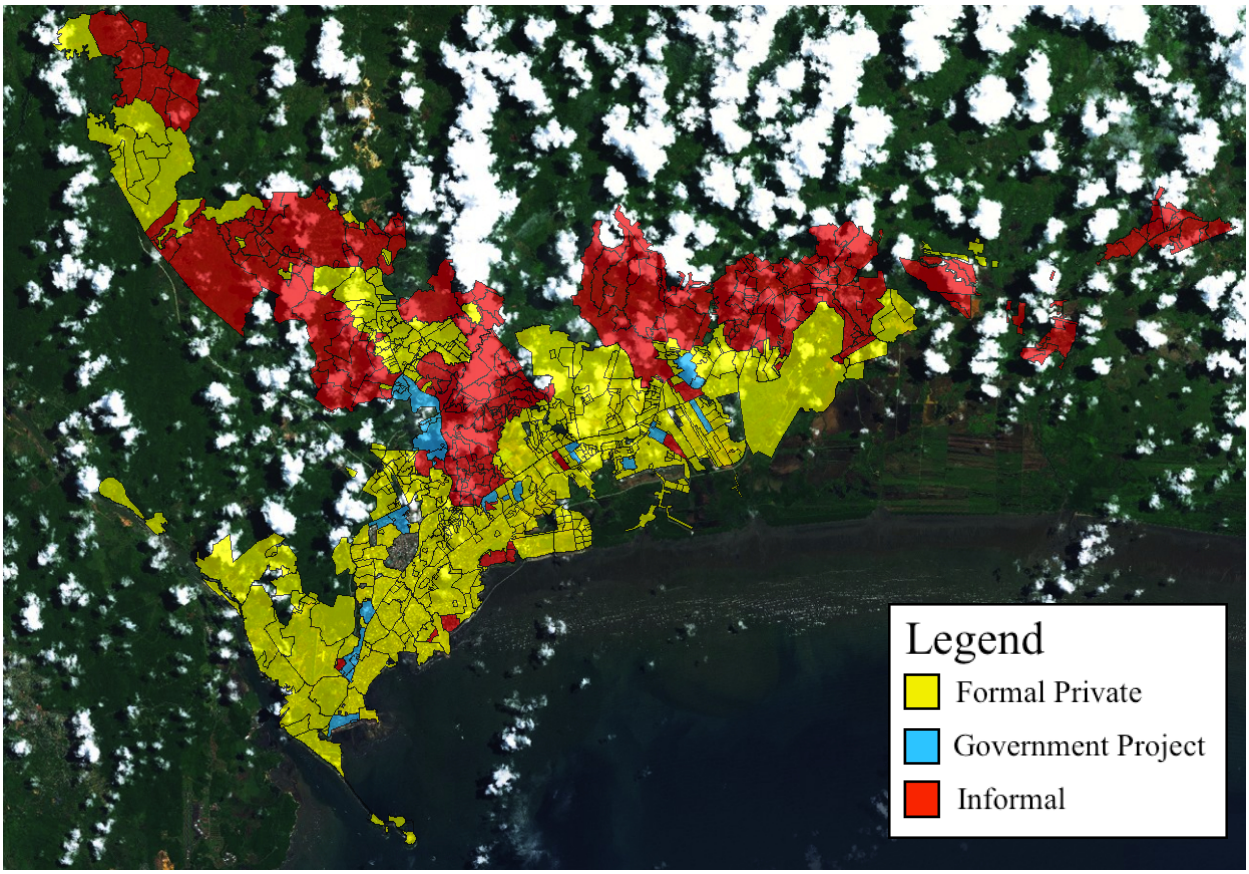

Figure 7: Quantities of sustainability indicators in each development category

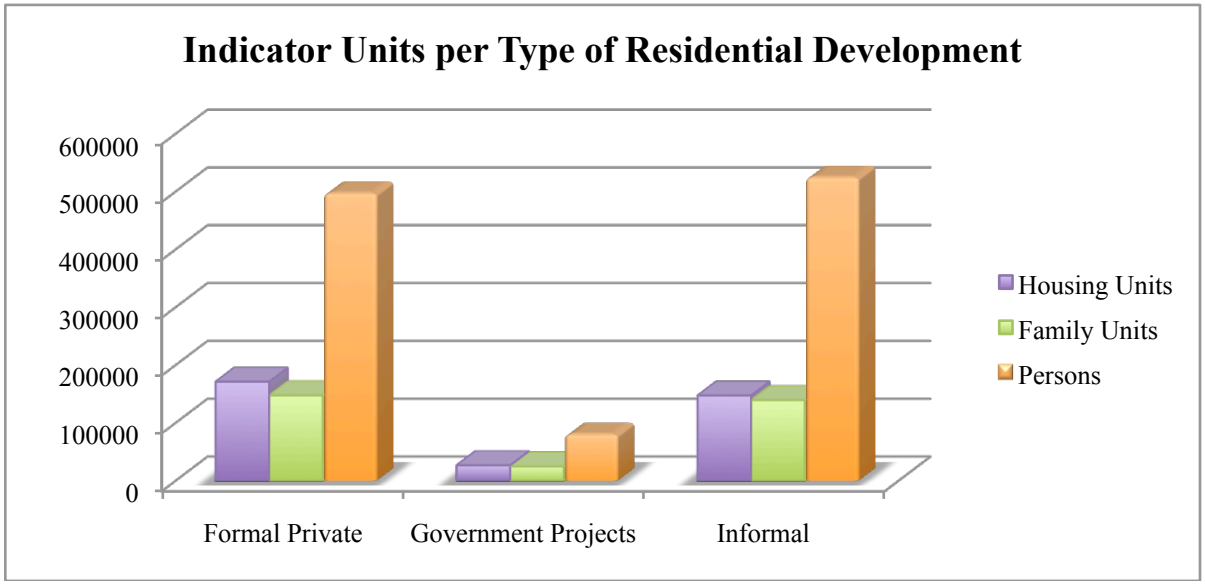

Figure 8: Proportions of residential developments types per sustainability indicator category