# Rapid Urbanization in Tegucigalpa, Honduras

Preparing for the Doubling of the City's Population
in the Next Twenty-five Years

Shlomo Angel with Katherine Bartley,
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## I. Introduction

This report is presented to Mr. Miguel Rodrigo Pastor Mejía, Mayor of Tegucigalpa, the
capital of Honduras. It is the culmination of the work of a team of graduate students at the
Woodrow Wilson School of Public and international Affairs at Princeton University, led
by their instructor, Dr. Shlomo Angel. The team collected large amounts of data available
on the city, visited the city in October of 2003 at the invitation of the Mayor, interviewed a
large number of informants, analyzed the available materials, conducted a number of field
trips in the city and its environs, and prepared an analysis and a list of key
recommendations. The analysis and the recommendations are the substance of this report.

The Mayor was invited to Princeton for the presentation of this report, along with other
members of the Princeton community, and with invited guests from the Inter-American
Development Bank and the World Bank in Washington. The Mayor has already
demonstrated that he has a broad vision for the future of the city, and that he plans to give
this vision a concrete footing before he leaves office. This report is submitted while the
Municipality, under the leadership of the Mayor, is in the process of contracting an
international planning firm to prepare a long-term plan for the city—Plan Metropoli 2029.
Our report is submitted to the Mayor in the hope that its fundamental assumptions and
findings provide a conceptual framework to guide the preparation and—most
importantly—the effective implementation of Plan Metropoli 2029.

Tegucigalpa is expected to double in population, and—most likely—more than double in
area before 2029. The main aim of our report is to refocus the Municipality, the
Government of Honduras, and multi-lateral support organizations on minimal, realistic
preparations to meet this challenge.

We strongly believe that the unplanned growth of the city in past decades, and the presence
of a majority of its population in informal, unplanned, and under-serviced settlements was
not a failure of planning. It was a failure to plan with the realistic conditions of
Tegucigalpa in mind—the poverty of its population; the limited availability of long-term
credit for financing housing and land subdivisions; the limited availability of fiscal and

financial resources for infrastructure investments; the limited political will to enforce unrealistic zoning laws, land subdivision regulations, and building codes; and the preponderance of wishful thinking among decision-makers. It is wishful thinking to believe that the city will not grow as fast, that the growth can be regulated and controlled by municipal officials, or that somehow its poverty will not be reflected in its houses or in its infrastructure.

The most basic assumption underlying our recommendations is that Tegucigalpa will continue to grow, albeit at a slower rate, and will reach a population of close to 2,000,000 by the year 2029. This growth will occur regardless of any labor of the central government to promote rural development to keep people from coming to the city, commendable as those efforts may be. Detailed analysis of rural-urban statistics for the region suggest that Honduras is still under-urbanized compared to most other countries in Latin America, and will, in all likelihood, continue to urbanize, until some three-quarters of its population live in cities. Most of the people coming to the city and most of the natural growth of the city's population will be poor. The Municipality would do well to prepare for this growth, rather than to hope against hope that it will not occur.

Secondly, the doubling of the population of Tegucigalpa by or before 2029 will entail at least a doubling of its built-up area. Tegucigalpa, as we shall explain below, is already quite dense in comparison with other cities, and is not likely to densify significantly in the future. As economic conditions improve, land consumption per capita will increase, as its does everywhere else. The Municipality has to prepare new areas for the expansion of the city that more than match its present built-up area, now estimated at 90 square kilometers.

The city can expand practically in all directions. Topographic limitations seem quite severe, but they have not prevented people from building on rather steep slopes. Only the steepest slopes to the East would pose a strong barrier to expansion in that direction. The flattest areas are to the West, but development there should be regulated because it is in the watershed of the reservoir now supplying 30 percent of the city's water. The most likely areas for expansion, therefore, will be to the South, the Southeast, the North, and—to a more limited extent—the Northeast. Efficient expansion will entail building at the higher elevations as well, removing the artificial zoning restrictions of the past, restrictions that have failed to halt development. Some 10 percent of the built–up area of the city is at elevations higher than the maximum allowable elevation in municipal regulations.

The expansion of the built–up area is likely to take place under economic and institutional conditions that are quite similar to those of the past two decades, hopefully with substantial improvements. We cannot, however, expect a fast disappearance of informal land subdivisions, a sudden availability of ample finance for housing and infrastructure, or a massive increase in municipal budgets for planning, enforcement, or infrastructure investments. Any realistic improvements in the future are likely to be marginal ones. In addition, improvements are likely to be selective, for there is too much to do and too few resources with which to do it.

We strongly believe that most of the attention, as well as most of the resources, of both the municipal and the central government will be directed towards solving immediate, short–term problems. We recommend, however, that some minimal actions be made to prepare the metropolitan area for growth and to manage this growth.

We believe that a minimal set of six plans should be prepared now so that feasibility studies—and, in some cases, pilot projects—can be initiated by the end of 2004. These plans include:

1. **A Preliminary Urban Land Use Plan:** We estimate that the built-up areas will more than double in size by 2029. There is a need to identify new land areas for expansion, and to identify a limited amount of land that needs to be aggressively protected from expansion. Identifying these areas will be more important than determining the specific land uses in the new built–up areas. We have made an initial effort to identify these areas. Our findings and recommendations include:
   a. Taking into account Tegucigalpa's declining growth rate, the city's population is still estimated to double in size by 2029. In order to accommodate this population growth at current levels of per capita land consumption, the city will need to grow in size by more than 10,000 hectares.
   b. In 2000, roughly 640 hectares of the urban area were identified as high-risk due to landslides. In order to prevent further growth on steep slopes or along the flood plain, the municipality should plan for new development on flat lands above the current legal limit of 1,150 meters.
   c. Plans for Tegucigalpa's growth must recognize the capacity of the municipal government, and avoid the trend of passing additional regulations which cannot be enforced. Rather, the city should identify specific high priority areas for direct intervention, such as protection of key watersheds, while using the provision of infrastructure, such as roads, to direct new development.
   d. The Municipality should reform land subdivision regulations to allow for incremental improvements, which promote less costly development of smaller, very low income plots with a bare minimum level of services. The city should also develop new regulations which provide minimal standards (*normas minimas*) in the construction of low income housing. These minimalist safety regulations should recognize the poverty of many of the city's inhabitants, and the conditions in which current informal construction takes place.
   e. The failure of the central government to decentralize funding, enforcement, and delivery mechanisms for services, particularly water, sanitation, and transportation, which are essentially local in nature, has compounded the City's problems. The municipality should develop a political strategy to speed the rational devolution of authority from the central government to the municipality.

2. **A Transport-Guided Land Development Plan:** There is a need for a physical plan and an investment plan for expanding the secondary road network to serve new built-up areas with private and pubic transport.  This Guided Land Development Plan should focus on the secondary road network, assuming that (a) plans for roads at the block level will be undertaken in conjunction with developers over time, and that (b) the primary road network will always be a part of the national road network.  Investments in line with this plan will be the principal tool for guiding the direction of development of the city.  We have made an initial effort to sketch the road network that can guide land development in the city in the years to come.   Features of our secondary road master plan proposal include**:**
   a. Low-cost.
   b. Pedestrian friendly.
   c. Ecologically sensitive.

3. **Low-Income Housing Plan:** Given the low-incomes of the majority of the population, land readily available close to the city center, growing migration to Tegucigalpa as well as the absence of long-term finance, there is a need to promote a housing strategy that relies on the gradual construction of houses and infrastructure.  There is a need to include in Plan Metropoli 2029 feasibility studies for (three) pilot housing projects focused on a new macro-block approach to the development of sites-and services schemes.  This approach uses intermediaries—private developers of civic society groups—for developing land subdivisions.  These projects should follow certain guidelines:
   a. Build secondary roads, potable water and sewage infrastructure in areas where growth should be directed.
   b. Choose areas of growth outside of watershed regions, away from designated park land and away from areas vulnerable to landslide and flood.
   c. Establish an easier legal process by which land can be acquired and homes built.

4. **Open Space and Disaster Mitigation Plan:** The presence of settlements on land subject to landslides or floods, on land within the watershed of reservoirs, and on land required for open space use, is also not due to the absence of planning, but to the absence of effective enforcement.  Open space preservation and expansion should be part of an overall land use plan that includes a plan for a city park system and a plan for managing hazard prone areas.  In particular these plans should cover the following:
   a. Enforcement that involves civic sector organizations, environmental groups, and communities, combined with economic and infrastructure incentives for settlers
   b. Considerations of both watershed quality and ecosystem sensitivity in selecting protected areas on a regional level
   c. Prevention of further settlement in areas prone to landslides, flooding, and on stream banks should be prevented by converting these areas into open spaces, green spaces, and parks.

d. Vulnerability mitigation in current settlements through low-impact structural and non-structural measures: re-forestation of some slopes and river banks; distributed stormwater management techniques such as rain gardens, rainwater harvesting, and cisterns for containing runoff; and public education, household disaster insurance, and increased access to credit

5. **Water Supply and Distribution Plan:** There are already serious water shortages in the city. There is a need for a feasibility study leading to concrete decisions on how to double the water supply from 2 $m^3$/s to 4 $m^3$/s by 2029 and the mechanisms that will be used to finance the development of these supplies. This study must incorporate issues of governance and privatization, as well as issues of the pricing and distribution of water. There is no question that the new reservoirs will need to be financed by public funds and international loans, both of which are in short supply. We have investigated the potential alternatives for supplying the city with adequate water as it doubles in size, and provided an initial evaluation of these alternatives. In particular, we argue that:
    a. The most straightforward approach to resolving Tegucigalpa's current water supply problem is to implement effective, market-based, conservation programs for households on the piped network, thereby reducing water usage.
    b. To improve water delivery and financing, water authority should be decentralized to the municipality, later privatized with regulation, and eventually deregulated.

6. **Sewerage Plan:** There is a need for initiating pilot projects and for designing a comprehensive plan for developing and executing community-based sewage treatment. At present, piped sewerage is only available to communities on the piped water network, which means that, at the very most, 87% of the city's residents have access to the sewerage system. Community-based sewerage treatment, focused on medium-sized septic tanks at the community level is a cost-effective way of taking care of large quantities of the city's sewage. This plan should form an integral part of a comprehensive sewerage plan for the city, including the reconstruction of the sewerage networks destroyed by Hurricane Mitch. We have sketched the outlines of such a plan.

In the following sections of this report, we analyze the available data and describe these six plans in broad outline.

# II. Demographic Analysis

## Background

Between 1950 and 2000, the percentage of Latin America's population living in urban areas climbed from 40% to 75%[1]. In spite of this development, Honduras remains one of the least urbanized countries in the region; the 2001 census reports that only 46% of the population resides in urban areas. Historical patterns of urbanization suggest that these figures represent a midpoint in Honduras' urban transition.

The process of urbanization results from economic and demographic shifts. On the economic side, shifts from agricultural to industrial bases necessitate rural-to-urban movement. While these shifts are not new to Honduras, recent evidence includes the 1992 *Ley para la Modernizacion y Desarollo del Sector Agricola (LMDSA),* which marked the official decline of the cooperative (ejidal) lands. This law expanded land market liberalization and increased the share of privately owned land that employed modern farming techniques in order to compete in international markets[2]. Trade policy reform and international business also stimulated agricultural development by promoting crop switching and other crop augmenting behaviors. Such changes lead both to a disrupted rural environment, and to increases in agricultural productivity. Both of these factors facilitate the process of rural-to-urban migration, as modern agriculture requires a smaller labor force to sustain the entire population. Between 1983 and 2003, the percentage of Honduras' population employed in agriculture declined from 43% to 34%[3]. Such economic transitions have formed the basis of rural-to-urban movements since the industrial revolution, and Honduras is no exception to that pattern.

What begins as a rural disruption quickly infects the urban environment through the onset of migration flows, and ultimately the management of a rapidly growing urban population becomes the larger concern of such transitions. While disruption is inevitable, strong policy intervention can prevent these periods of disruption and displacement from evolving into periods of depravation and despair. Effective policy planning must consider both the past history of similar regions and the factors of time and place that shape individual transitions. These factors include geography, natural resources, current infrastructure, and the intervening momentum of demographic change that determines the magnitude of present and future growth.

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[1] Wilke, Richard. Latin American Population and Urbanization Analysis, (UCLA Latin American Center Publications:1984). UN Chronicle, Online Edition 2003.

[2] Thorpe, A. (2000). "Modernizing" agriculture: neo-liberal land tenure reform in Honduras. Current land policy in Latin America: Regulating land tenure under neo-liberalism. Zoomers, Annelies and Gemma van der Haar (eds.). Amsterdam, KIT Publishers.

[3] Instituto Nacional de Estadistica (INE): Programa de Encuesta de Hogares Vigésima Séptima Encuesta Permanente de Hogares, Tegucigalpa, M.D.C, Mayo 2003, Naciones Unidas Centro Latinoamericano de Demografia (CELADE): Encuesta Demografica Nacional de Honduras: EDENH II 1983, San Jose, 1985: Abril.

## Historical Population Growth

The importance of population growth in the midst of urban transition cannot be understated. Honduras' population has doubled more than seven times since its first census count of 93,505 inhabitants in 1791, and the population continues to grow steadily into the 21$^{st}$ century. While the population growth rate has slowed in recent years due to declining fertility, the consequences of population growth have increased due to the large starting base and to the fact that the majority of this growth is occurring in already dense urban areas. In 1961, approximately 440,000 Hondurans lived in urban areas; by 2001 this number had risen to over 3 million, at a notably faster growth rate than the overall population. Table 2.1 provides population totals for Honduras and its two largest cities: Tegucigalpa's Districto Central (DC) and San Pedro Sula (SPS).

### Table 2.1: Population Totals, Honduras and Major Cities: 1961-2001

|  | April 1961 | March 1974 | May 1988 | March 2001 |
|---|---|---|---|---|
| Honduras | 1,107,859 | 2,653,857 | 4,248,561 | 6,535,344 |
| DC | 164,941* | 302,483 | 595,931 | 850,227 |
| SPS | 95,464 | 161,700 | 319,740 | 515,458 |

Source: National Government Census': 1961, 1974, 1988 and 2001
* Note: The 1961 census included Tegucigalpa, but not the entire Districto Central.

Table 2.2 shows the intercensal growth rates and reveals that there was a large decline in population growth rates from 1961-1974 and 1974-1988, from 6.76 to 3.30, yet Honduras' population growth in the next period, 1988-2001, went up slightly to 3.38. Additionally, urban growth rates exceeded overall population growth rates from 1974-1988, and were fairly comparable with overall growth rates in the later period. Thus, in spite of some initial decline in population growth rates, the rates indicate that steady growth will continue into the 21$^{st}$ century.

### Table 2.2: Annual Growth Rates, Honduras and Major Cities: 1961-2001

|  | 1961-1974 | 1974-1988 | 1988-2001 |
|---|---|---|---|
| Honduras | 6.76 | 3.30 | 3.38 |
| DC | 4.69 | 4.76 | 2.79 |
| SPS | 4.08 | 4.78 | 3.75 |

Note: The above are exponential growth rates according to the formula: [ln(population end/population beginning)]/time in years. The base figures are those shown in Table 1.

The population figures in Table 2.2 also hint at differences between San Pedro Sula and the Districto Central. While the rate of growth was higher in SPS in the most recent period, the numeric growth was still larger in the Districto Central. The numeric population increase between 1988 and 2001 was 334,769 in DC, and only 276,191 persons

in San Pedro Sula. Declining growth rates can mask substantial population flows or numeric increases in already large populations, yet ultimately policies must consider the actual population residing in a particular region and not its rate of growth.

## Population Distribution

The dominance of urban areas in Honduras can be seen in the distribution of Honduras' population, shown in figure 2.1 below.



Figure 2.1: Honduras' Population Distribution, by Department: 2001

Source: Instituto Nacional de Estadistica: Censo de Población y Vivienda 2001
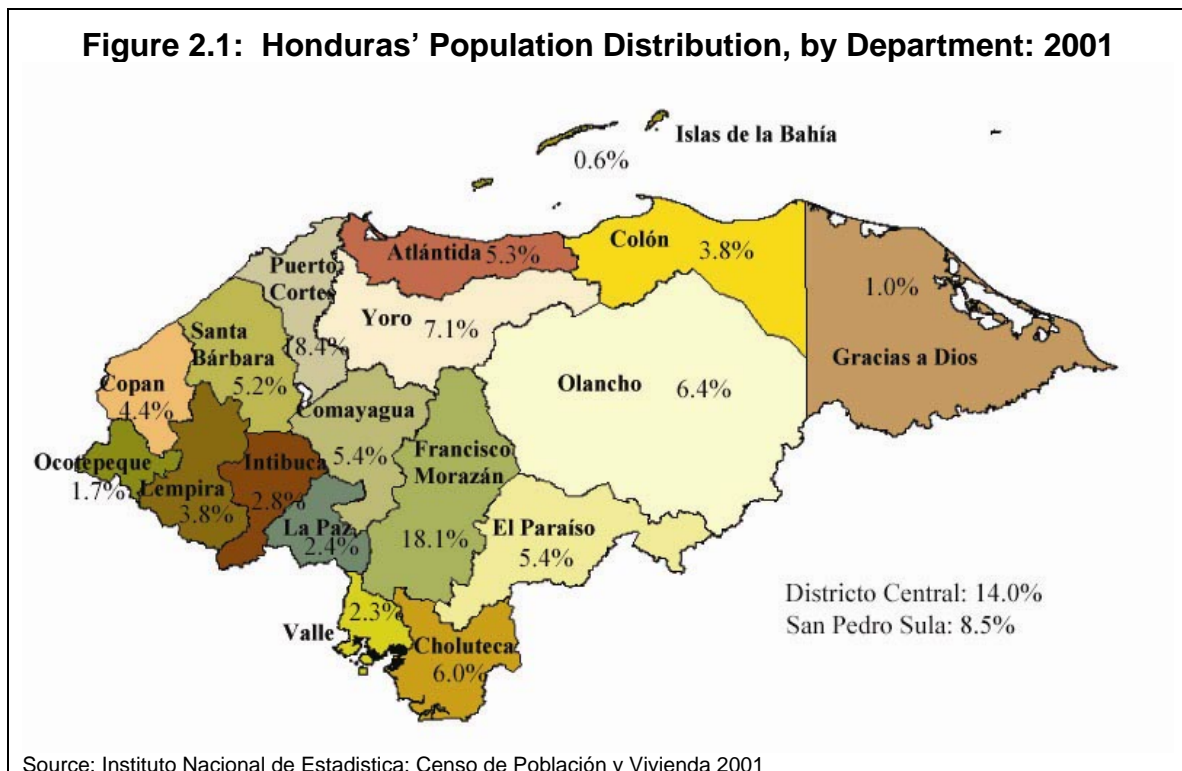
In 2001, 18.4% of Honduras' population resided in Puerto Cortes, which contains San Pedro Sula, and 18.1% of the population lived in Francisco Morazán, which includes the Districto Central (DC). While both departments have comparable shares of the overall population, municipal level examination reveals a number of distinctions. In Cortes, 12 of 12 municipalities are considered urban, whereas only 16 of 26 of Francisco Morazán's municipalities are urban. While the Districto Central contains the vast majority of the population living in the Department of Francisco Morazán, San Pedro Sula contains less than half of Cortes' population. These figures indicate differences between San Pedro Sula and the Districto Central that translate into different policy needs. In spite of the rapid urban growth in Cortes, especially from 1988 to 2001, much of this growth occurred outside of SPS, whereas almost all the urban growth of Francisco Morazán has occurred in the Districto Central. In 1974, 7.6% of Honduras' population lived in San Pedro Sula, by

2001 this figure was 8.5%; the comparable figures for the Districto Central are 11.5% and 14.0%. Thus the Districto Central maintains a larger share of Honduras' population and experienced a larger proportionate population increase over a period in which Honduras' population more than doubled. As a consequence of these developments, the Districto Central has a higher level of density than San Pedro Sula. This fact is surely related to the topological differences between the regions. The physical growth of the Districto Central is constrained by mountains on all sides, while the industrial factories of San Pedro Sula can expand facilities and infrastructure in any direction. These observations shape the planning needs of the Districto Central, which does not have the freedom to suburbanize in the same way as other urban areas of Honduras.

## Internal Migration into Urban Areas

The patterns of internal migration flows, as illustrated in figure 2.2, demonstrate the differences between the Districto Central and San Pedro Sula and its suburbs.



**Figure 2.2: Internal Migration Flows to Cortes and Francisco Morazán: 1996-2001  (Sending department rates of over 15 per 1000)**
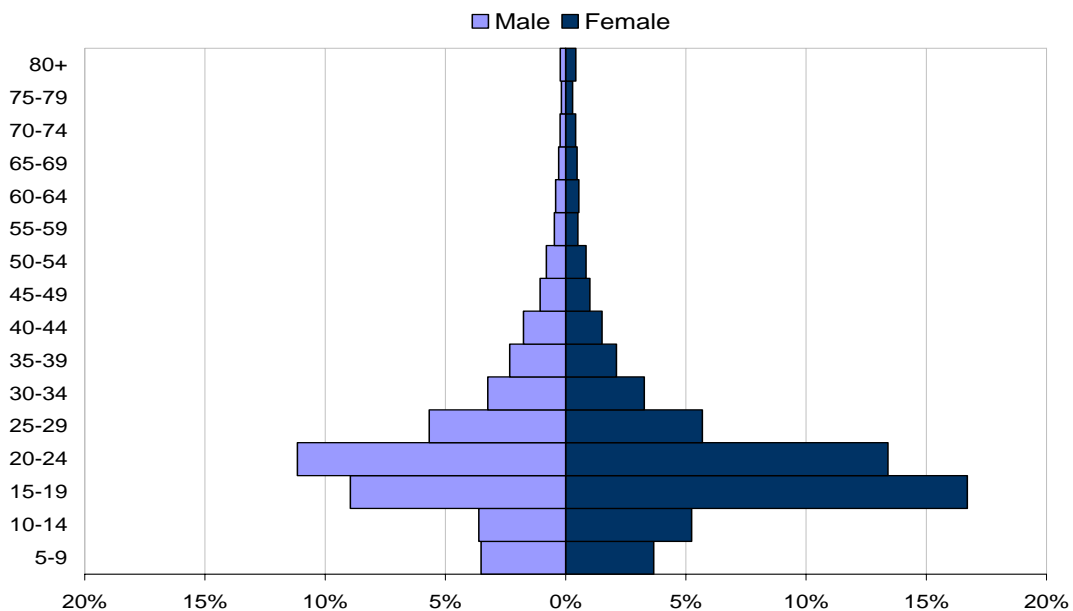
Source: Instituto Nacional de Estadistica: Censo de Población y Vivienda 2001

The 2001 census reports that between 1996 and 2001 the Districto Central received 32,179 in-migrants, or 88% of the migrants to Francisco Morazán, whereas San Pedro Sula received 34,513, or 44% of the migrants to Cortes. These figures are indicative of the fact

that much urban growth in Cortes occurred either on the periphery, or in neighboring cities, of the main city of San Pedro Sula, a possibility that the topography of the Districto Central prevents.

Beyond the sheer numbers, the characteristics of the migrant population influence the direction and pace of urban growth. Figure 2.3 below illustrates the age and sex distribution of the migrant population that entered the Districto Central between 1996 and 2001, as recorded by the 2001 census. These figures report that 56% of all migrants to the Districto Central were female. Additionally, the migrant population is predominantely young, with few migrants over age 30. This trend is particularly notable for females, who migrate primarily between ages 15 to 19 with some spillover into the 20 to 24 year-old category. While more males migrate between ages 20 to 24 than in any other category, the decline is not as steep over the older age categories as it is for females. These age patterns are presumably a reflection either of employment differences or differences in marriage patterns between males and females. The age structure of migrants into the Districto Central will also lead to further population growth of the city, as these individuals are primarily of reproductive ages.



**Figure 2.3: Age Structure of Migrants to the Districto Central: 1996-2001**

Source: Instituto Nacional de Estadistica: Censo de Población y Vivienda 2001

* Note: Age is as of the 2001 Census. The graph includes respondents who resided in the Districto Central in 2001, but outside the Department of Francisco Morazon in 1996.

## Future Population Growth

Population projections, based on current migration and predicted trends in mortality and fertility, suggest that the Districto Central will double in population in the next 25 years.

### Table 2.3: Projected Population of the Districto Central

| 2001 | 2006 | 2011 | 2016 | 2021 | 2026 | 2031 |
|------|------|------|------|------|------|------|
| 850,227 | 1,016,124 | 1,187,363 | 1,365,484 | 1,548,784 | 1,751,875 | 1,979,452 |

1) The above projection is based on standard life table techniques and accounts for the current age structure and declines in fertility and increases in life expectancy. Net migration figures are based on the migrant flows into the Districto Central from 1996-2001.
2) Base data comes from the 2001 Censo de Población Y Vivienda, Instituto Nacional de Estadistca.
3) More Information is included in the appendix.

In addition to the doubling of the population, the age structure will grow somewhat older due to declining fertility rates and increases in life expectancy, even though the influx of a young migrant population will pull the average age downwards.



**Figure 2.4: Age Structure of the Districto Central**

Sources: 2001 data from the Instituto Nacional de Estadistica: Censo de Población y Vivienda, 2031 data based on the projection in Table 3.
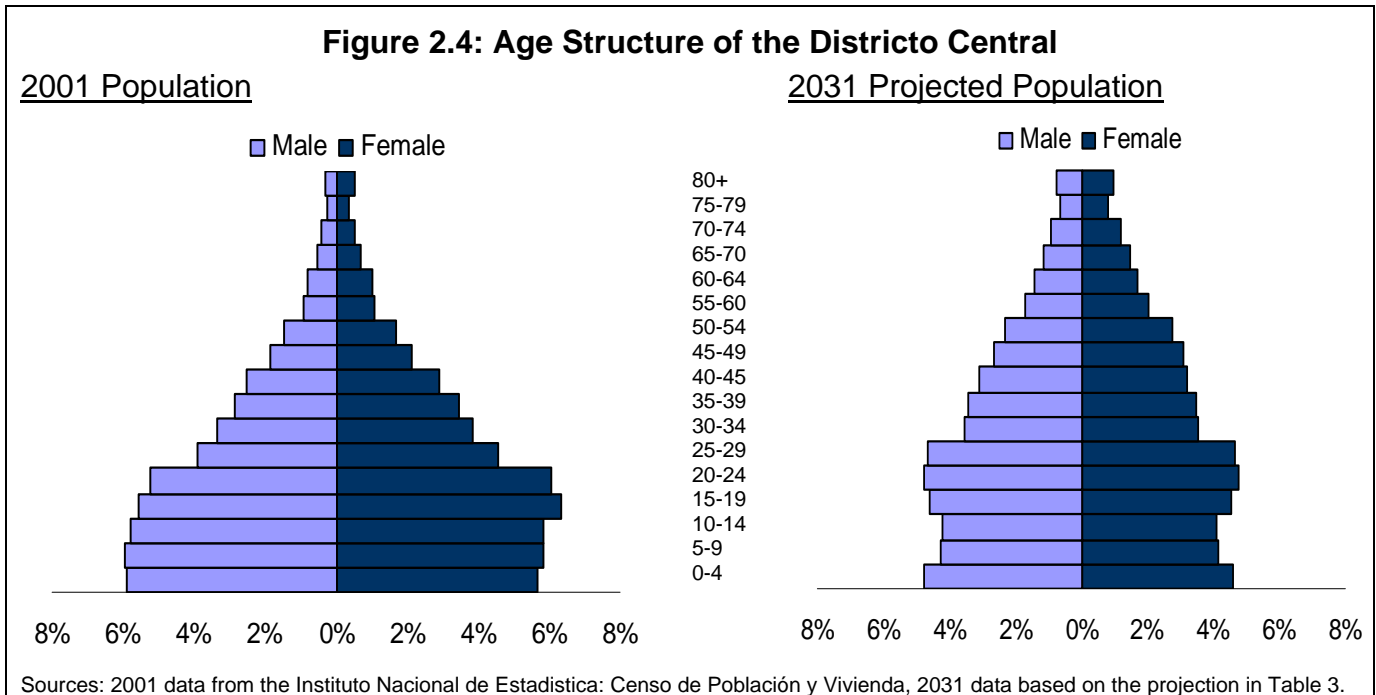
Figure 2.4 shows the age structure of the Districto Central's current population and of the population projected for 2031. These graphs illustrate the aging of the city's population, which will alter its dependency ratio (i.e. the ratio of those below 15 or above 65 to the working age population). Of the 2001 population, 35% were under age 15 while 4% were over age 65; for the 2031 projection, 26% are under age 15 and 8% are over age 65. Thus,

overall the projections predict a decline in the dependency ratio, although the share of elderly population will continue to increase. Nonetheless, the declining dependency ratio could potentially produce economic gains if the economy is able to absorb the additional workers. Other factors to consider regarding the changes in the age structure include accompanying changes in housing needs, as individuals over age 15 will be more likely to require their own dwellings. Since the population growth between 2001 and 2031 will occur disproportionately among individuals over age 15, the need for housing will increase even more rapidly than the increase in the total population would suggest. Also, these changes will affect the need for schools and services for the elderly. Yet the city's primary needs take the form of water, sewerage, and transportation, which equally affect all age groups.

As Honduras continues to industrialize its economic base and open its borders to international trade, modernization and urbanization will inevitably continue. The rural population will continue to flow into urban areas and Tegucigalpa will continue to grow at a substantial pace; the evidence indicates that the population will double within the next 25 years. In this same time frame, changes in fertility and mortality patterns will substantially alter the age structure of the population, which will have a number of economic and policy consequences. The specific characteristics of the migrant population, with a large proportion of young females of childbearing ages, will also contribute to the future growth of the city.

Additionally, geographic and topological factors will constrict the geographic growth in the Districto Central, and will hinder the development of neighboring edge cities or sprawling suburbs that have developed in other parts of Honduras. Since population growth is unavoidable, Tegucigalpa must begin to prepare and must focus on the most urgent needs of water, sewerage, and transportation. Urbanization will continue to cause short-term disruption and displacement, yet foresight and assertive planning can minimize these effects and build a foundation upon which the city can flourish.


**Country Urbanization Model**

The following section presents empirical evidence on the role of economic, geographic and demographic factors that determine the pace and direction of urbanization on a worldwide scale. The model uses available information on 2,663 cities in 120 countries (including Honduras)[4]. While the model is based primarily on country-level information, it also includes basic population information on the entire sample of individual cities to further increase the specification of the model.

The three separate models presented in table 2.5 below find that basic economic, demographic and regional variables can explain approximately 80% of the variance in country-level urbanization rates over the period 1990 to 2000. The dependent variable in

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[4] All information for cities was obtained from Alan Bertraud's city matrix, while all information at country level was obtained from the World Development Indicators published by the World Bank. Information was available for the years: 1960, 1970, 1980, 1990, 2000 and for some of the variables, also 2002.

these models is growth rate of the total urban population within a country. The independent variables in this model include country-level information on the following: initial level of gross national product (GNP) per capita adjusted for purchasing power parity; initial percentage of urban population; initial crude birth rate per 1000 people; and real GDP growth per capita over the period 1980-1990, and regional dummy variables for: the Americas, Africa and the Middle East, Asia and Europe. Using the growth of GDP in the period immediately before the period of urbanization prevents the possibility of a bi-causal relationship between urbanization rates and GDP growth. It further assumes that the influence of economic growth on the pace of urbanization will not be immediate, but will rather have a short time lag.

The estimates on the above variables reveal that having a high GNP per capita, and a high initial urban percent of the population inhibits the growth of the urban population. The basic interpretation behind these findings is that countries that are largely urbanized have a slower growth rate of the urban population. On the other hand, the growth of GDP from 1980-1990 has a positive and significant influence on the rate of urbanization from 1990-2000. Therefore this model demonstrates that, on average, urbanization occurs most rapidly in countries with comparatively low levels of GNP per capita, but whose economies are have recently expanded through a growth in GDP.

The model also reveals striking regional differences between the urban growth rates in countries in the Americas, Africa and the Middle East, Asia and Europe. The regional patterns are apparent from the means and standard deviations of the key variables, provided in table 2.4, and also remain strong in the regression models in table 2.5. The regression model demonstrates that, assuming equal economic and demographic characteristics, the rate of urbanization in countries in the Americas is 1.6% higher than in European countries and .79% higher than in Asian countries and, there is no statistically significant difference between the urbanization rate in the Americas and in Africa and the Middle East.

Models 2 and 3 include the crude birth rate (CBR) of a country's population, which is positively associated with the pace of urbanization in a country. This result indicates that the higher the birth rate, the faster the growth of the urban population. This measure can also serve as a proxy for a country's age structure, as high crude birth rates are indicative of countries with young populations.

In conclusion, the empirical evidence shows that urban growth is occurring most rapidly in countries with relatively low initial levels of GNP per capita, but high levels of recent economic growth. Additionally, low initial rates of urbanization and high crude birth rates (i.e. young populations) contribute positively to the pace of urban growth. Finally, when controlling for economic and demographic factors, the regional variation within the model suggests that urban growth is occurring fastest in the Americas and in Africa and the Middle East.

Honduras remains one of the least urbanized countries in the Americas; it also possesses a comparatively low GNP per capita, yet its GDP is likely to continue to grow. Thus these

factors in combination suggest that, according to worldwide patterns, Honduras is fertile ground for rapid urbanization.

### Table 2.4: Means and Standard Deviations of the Key Variables, By Region

|  | Africa & Middle East | | Americas | | Asia | | Europe | |
|  | N=42 | | N=25 | | N=26 | | N=27 | |
|---|---|---|---|---|---|---|---|---|
| Urban Growth Rate from 1990 to 2000 | 3.82 | (1.09) | 2.48 | (0.96) | 2.57 | (1.54) | 0.31 | (0.81) |
| Log of GNP per capita 1990 (PPP) | 7.37 | (0.91) | 8.30 | (0.83) | 8.07 | (1.07) | 9.29 | (0.71) |
| Real GDP per capita growth from 1980 to 1990 | 0.64 | (5.61) | 0.03 | (3.74) | 1.71 | (3.94) | -0.64 | (4.23) |
| Urban population (% of total) 1990 | 39.03 | (23.19) | 60.53 | (17.47) | 44.39 | (27.91) | 68.65 | (15.30) |
| Crude Birth Rate 1990 (Births per 1,000 people) | 40.11 | (7.98) | 27.73 | (8.81) | 27.21 | (9.48) | 14.47 | (4.87) |

Note (1): All Variables are Measured at the Country-Level  * Note (2): Standard Deviations in Parentheses,
Note (3): Number of Countries is Listed Below Regional Categories

### Table 2.5: Country-Level Urbanization Rate 1990-2000 on Selected Independent Variables

|  | OLS | | | | | |
|  | (1) | | (2) | | (3) | |
|---|---|---|---|---|---|---|
| Constant | 7.69 | *** | 2.48 | *** | 0.67 | * |
| Log of GNP per capita 1990 (purchasing power parity) | -0.48 | *** | -0.08 | | | |
| Real GDP per capita Growth from 1980 to 1990 | 0.05 | *** | 0.05 | *** | 0.06 | *** |
| Urban Population (% of total) 1990 | -0.02 | *** | -0.02 | *** | -0.02 | *** |
| Crude Birth Rate 1990 (Births per 1,000 people) | | | 0.06 | *** | 0.10 | *** |
| **Regional Dummies (Reference=Americas)** | | | | | | |
| Africa and Middle East | 0.15 | | -0.01 | | | |
| Asia | -0.79 | *** | -0.29 | | | |
| Europe | -1.61 | *** | -1.04 | *** | | |
| # of observations | 120 | | 120 | | 120 | |
| Adjusted R-squared | 0.80 | | 0.84 | | 0.80 | |

*** Significant at .01, ** Significant at .05, * Significant at .10
Note (1): All regressions are weighted by the number of cities with more than 100,000 inhabitants in 2000,
      for a total of 2,663 cities in 120 countries.
Note (2): Urbanization is measured as the growth rate of the urban population within a country.

# III. Urban Expansion and Land Use

## Urban Expansion

Over the past 25 years, the urban area of Tegucigalpa has more than tripled in size. Most of this expansion occurred between the mid 1970s and late 1980s. Fueled by rapid population growth, the urban area of the city grew from approximately 2,360 hectares in 1975 to 6,020 hectares in 1987. During this period the city experienced declining population density, as the percent growth in urban expansion (155%) outpaced the percent growth in population (83%). By 1987 per capita land consumption had grown to more than 0.01 ha/person from roughly 0.007 ha/person in 1975. Tegucigalpa continued to grow between 1987 and 2000, expanding by roughly 2,340 hectares. However unlike the previous period, the percent growth of urban expansion (39%) was only slightly lower than the percent growth of the population (42%). The increase in densification in this period was evident in the 2% drop in per capita land consumption, decreasing from 0.0103 ha/person in 1987 to 0.0101 ha/person in 2000.

### TABLE 3.1: POPULATION AND URBAN GROWTH

| Year | 1975 | 1987 | 2000 |
|---|---|---|---|
| Population | 317,225 | 581,919 | 828,702 |
| Percent change from previous period | - | 83% | 42% |
| Urban Area (ha) | 2,360 | 6,020 | 8,360 |
| Percent change from previous period | - | 155% | 39% |
| Population Density (persons per ha) | 134 | 97 | 99 |
| Percent change from previous period | - | -28% | 3% |
| Land Consumption (ha per person) | 0.0074 | 0.0103 | 0.0101 |
| Percent change from previous period | - | 39% | -2% |

Population figures were calculated using population numbers from the 1974, 1988, and 2001 Honduran census. Urban area figures are based on visual analysis of Landsat satellite images using ESRI ArcView.

# Figure 3.1:  Urban Expansion Of Tegucigalpa: 1987 TO 2000
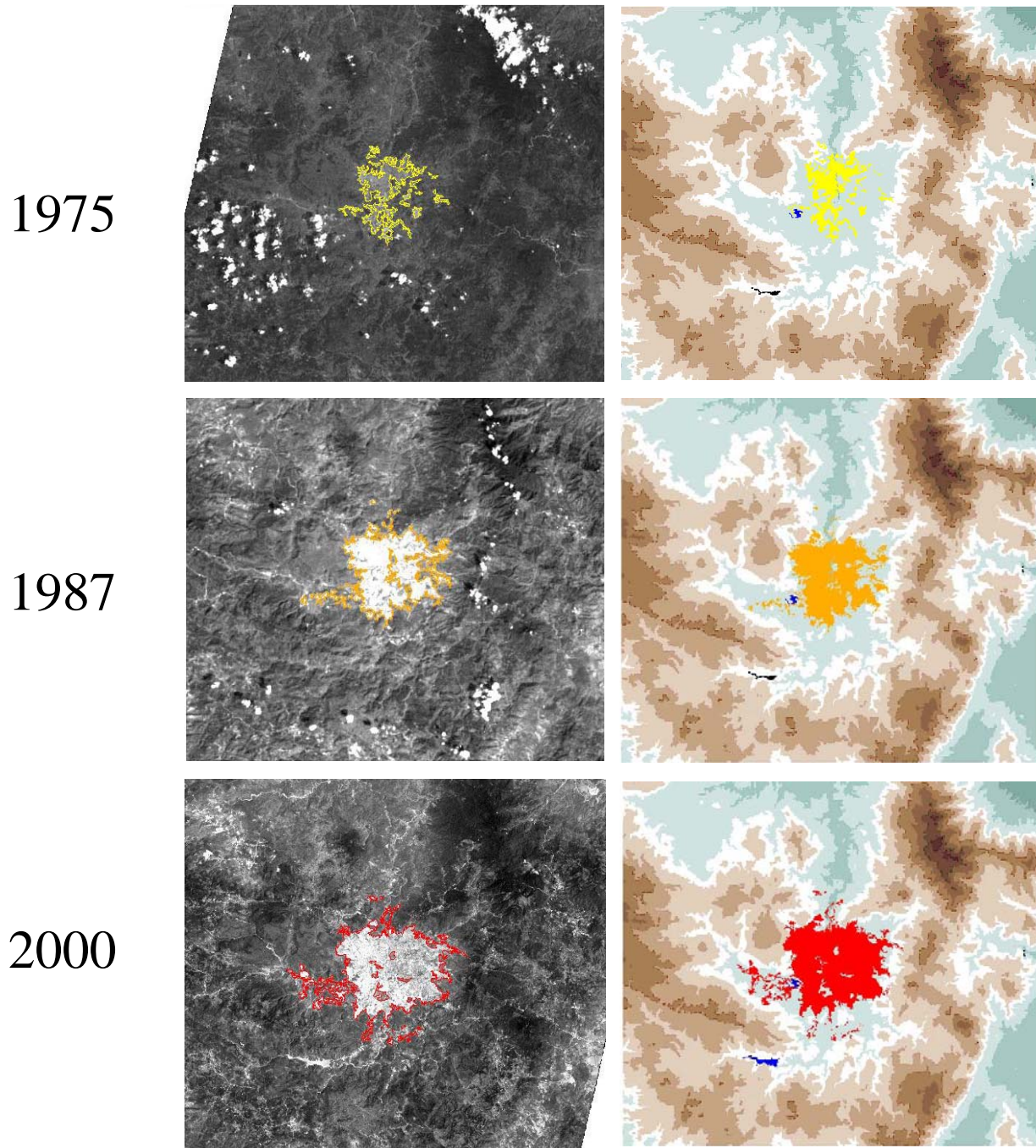


1975

1987

2000

Landsat satellite images were downloaded from the University of Maryland's Global Land Cover Facility website.

http://glcf.umiacs.umd.edu

IMAGE DATES

March 23, 1975

December 7, 1987

March 29, 2000

Digital Elevation Model (Meters)

| | |
|---|---|
| 49 - 113 | 1256 - 1320 |
| 113 - 176 | 1320 - 1383 |
| 176 - 240 | 1383 - 1447 |
| 240 - 303 | 1447 - 1510 |
| 303 - 367 | 1510 - 1574 |
| 367 - 430 | 1574 - 1638 |
| 430 - 494 | 1638 - 1701 |
| 494 - 557 | 1701 - 1765 |
| 557 - 621 | 1765 - 1828 |
| 621 - 684 | 1828 - 1892 |
| 684 - 748 | 1892 - 1955 |
| 748 - 811 | 1955 - 2019 |
| 811 - 875 | 2019 - 2082 |
| 875 - 939 | 2082 - 2146 |
| 939 - 1002 | 2146 - 2209 |
| 1002 - 1066 | 2209 - 2273 |
| 1066 - 1129 | 2273 - 2336 |
| 1129 - 1193 | 2336 - 2400 |
| 1193 - 1256 | No Data |

*Rapid Urbanization in Tegucigalpa, Honduras*
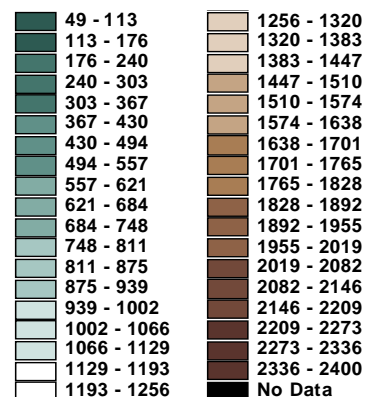
## Population Density and Housing

From 1987 to 2001, population density in Tegucigalpa increased from an average of 97 persons per hectare to 99 per hectare.  However this increase in population density is not representative of the population density of the city as a whole, as population density varies significantly across different portions of Tegucigalpa.   As seen below, population density is highest in the northwestern area of the city and along much of the urban periphery. Conversely, population density is lowest in the center-eastern portion of the city.
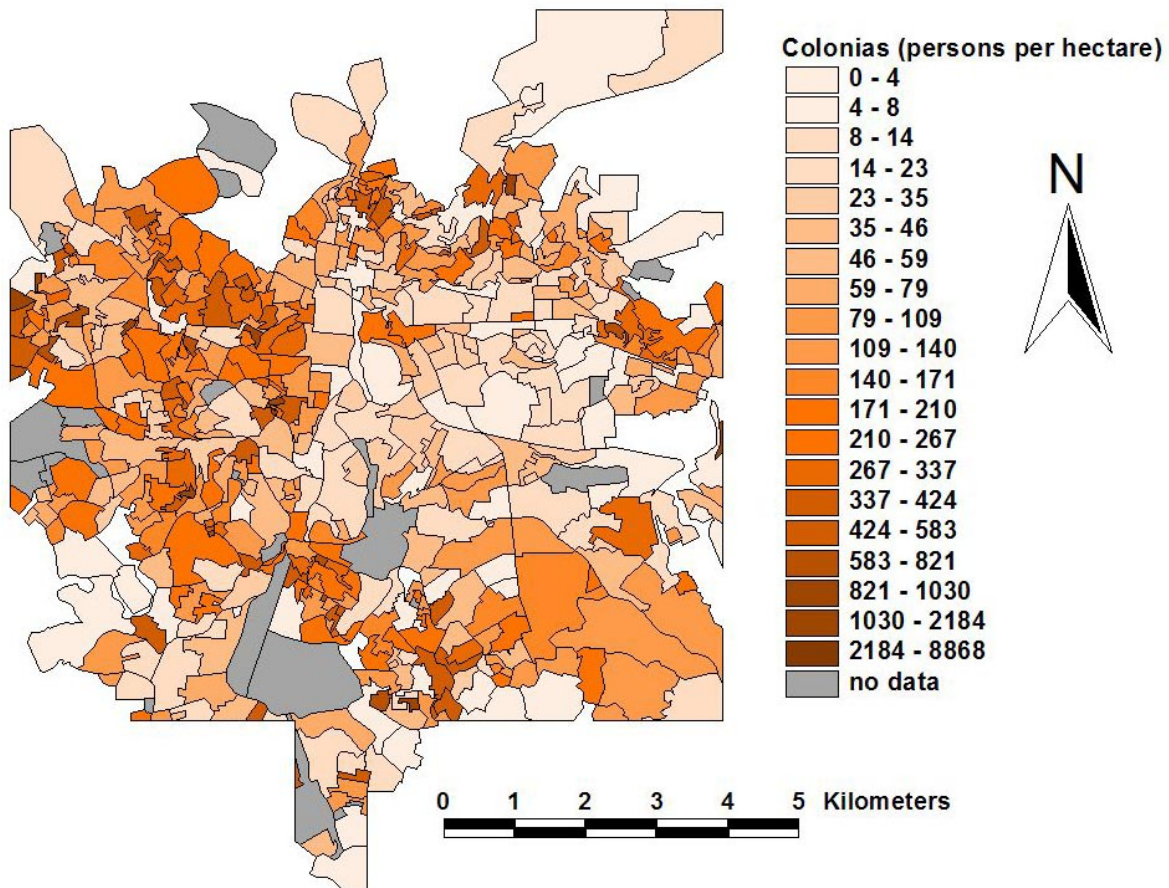
As Tegucigalpa grows, it is important to understand the changing socio-economic conditions of its inhabitants and how these conditions impact land use patterns and intra-city migration.  Unfortunately annual income, a fundament indicator of wealth, was not included in the last INE census (2001).  The city should work with INE to ensure that economic figures are incorporated into future censuses.

### Figure 3.2:
## Population Density (2001)



**Colonias (persons per hectare)**

- 0 - 4
- 4 - 8
- 8 - 14
- 14 - 23
- 23 - 35
- 35 - 46
- 46 - 59
- 59 - 79
- 79 - 109
- 109 - 140
- 140 - 171
- 171 - 210
- 210 - 267
- 267 - 337
- 337 - 424
- 424 - 583
- 583 - 821
- 821 - 1030
- 1030 - 2184
- 2184 - 8868
- no data

0 1 2 3 4 5 Kilometers

The above image was created using a colony map from the 2002 Flood Control and Landslide Prevention Study financed by the Japanese International Cooperation Agency and Population 2001 and INE (Instituto Nacional de Estadística) population figures from the 2001 Census.

Areas shaded grey represent colonies for which population figures could not be confirmed.

## Table 3.2: Future Land Consumption[5]
(assumes constant land consumption ratio of 0.01 hectares per person)

| Year | 2001 | 2006 | 2011 | 2016 | 2021 | 2026 | 2031 |
|---|---|---|---|---|---|---|---|
| Urban Area (ha) | 8,502 | 10,161 | 11,874 | 13,655 | 15,488 | 17,519 | 19,795 |
| Population | 850,227 | 1,016,124 | 1,187,363 | 1,365,484 | 1,548,784 | 1,751,875 | 1,979,452 |
| % change from previous period | - | 19.5% | 16.9% | 15.0% | 13.4% | 13.1% | 13.0% |

**Projected Growth**

According to demographic projections based on 2001 census figures, although Tegucigalpa's rate of growth has declined, by 2031 Tegucigalpa's population is expected to be more than double the size of its 2001 population. If land consumption trends continue as they have since the mid-1980s (at roughly 0.01 hectares per person), the city will need to expand an additional 10,000 hectares from its current size to accommodate the increasing population.[6] The projected changes in population growth and consequent urban expansion from 2001 to 2031 are listed above.

Assuming that new urban development follows growth patterns similar to those of the past 25 years, by 2031 Tegucigalpa will expand into an urban space resembling the purple-shaded area in the image "2031 Projected Unplanned Growth" on the following page. The projected area of this urban expansion is based on four key variables influencing new housing developments in Tegucigalpa: (1) proximity to the city and existing infrastructure, (2) transportation systems, (3) elevation, and (4) slope. As illustrated in the various satellite photos presented earlier, urban expansion in Tegucigalpa occurred as a result of new developments that filled in available open space in the city center. Over time, as open space near the city center and existing infrastructure has become scarcer, new developments have grown along major transportation rotes and where infrastructure has been provided for formal developments.
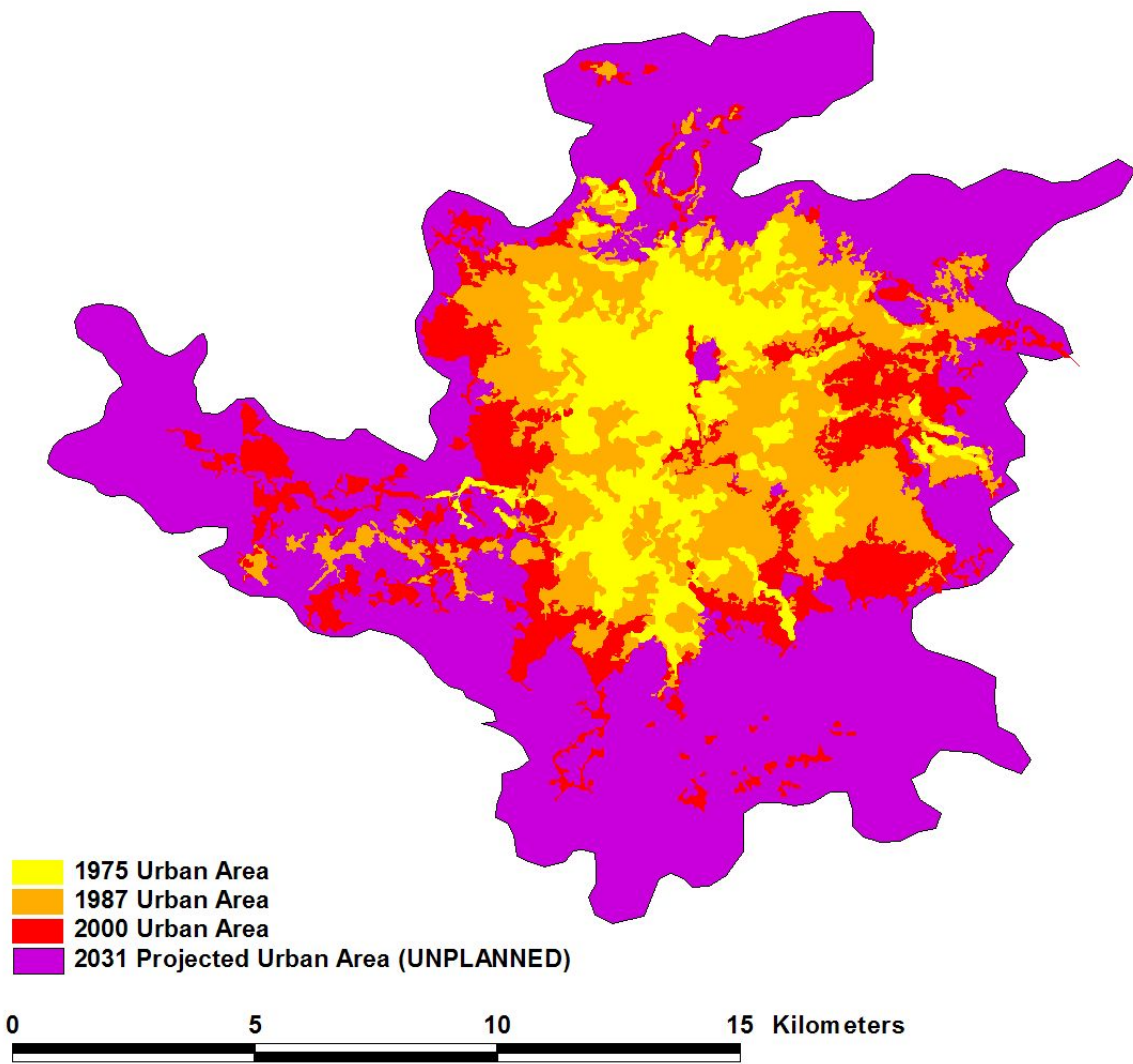
Today most of the urban area of Tegucigalpa lies between 900 and 1150 meters above sea level. Some of this land is on steep slopes and is prone to landslides. Similarly, much of the lower elevation land is located along riverbanks, which is prone to flooding. Although flat, open land is available at higher elevations, historical development patterns suggest that Tegucigalpa residents prefer to build homes in higher risk areas near the city center than to build on safer land, located further away from the city or at higher elevations. If urban expansion continues in this (unplanned) fashion, by 2031 most of the urban area will continue to be located at or below the official limit of 1150 meters, but much of this new development will continue to occur in high risk areas.

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[5] The figures provided in this table are likely to be conservative estimates, as land consumption generally increases with economic development. Assuming that the economic conditions in Tegucigalpa improve relative to the past 25 years, land consumption should increase beyond the historical level of roughly 0.01 hectares per capita.

[6] This figure does not include additional land that will be necessary to relocate persons currently living in high risk areas, such as areas prone to landslide or floods.

# 2031 Projected Unplanned Growth



- 1975 Urban Area
- 1987 Urban Area
- 2000 Urban Area
- 2031 Projected Urban Area (UNPLANNED)

0     5     10     15  Kilometers

As of 2000, roughly 640 hectares of urban area was located in areas identified as prone to landslides according to SERNA. In order to prevent future development in unsafe areas and relocate existing development away from such areas, the government needs to promote growth in other parts of the city. However, much of the available flat is located at elevations higher than the current limit of 1,150 meters, or along the flood plain. As of 2000, only 8% of the urban area rested at or above the 1,150 meter limit. If the city is successful in preventing development in unstable, and other high risk areas, current elevation restrictions will have to be revised to allow for development at elevations above the current limit of 1,150 meters.

In addition to limiting growth in high-risk areas, intervention is necessary to ensure the protection of Tegucigalpa's water supply. Urban expansion has already started to penetrate important watershed areas, such as the Guacerique watershed, an area of roughly 2000 hectares, which is one of only three future water sources for the city. In order to protect this watershed, the municipality should continue to prevent further development in this area. The gray-shaded area of the image on the following page, "2031 Projected Planned Growth", reflects where growth should be redirected in order to protect the boundary of that watershed, while also preventing growth in unsafe areas.[7] The "planned" area also includes 385 additional hectares of land that will be necessary for relocating existing development in the Guacerique watershed. The boundary of the Guacerique watershed is outlined in the image "Protection of Guacerique Watershed", later in this section.

To avoid significant urban expansion in the flood plain area to the north, and to minimize future development around existing watersheds and reservoirs to the south, the "2031 planned urban area" presupposes some development will take place at elevations above 1,150 meters (on areas without steep slope). Of the roughly 20,760 hectares included in the "planned" area, approximately 5,275 hectares or 25 percent is located above the current limit of 1,150 meters. Future development (2031) above this limit, as well as current development (2000), is identified in the image "Higher Elevation vs. High Risk Areas."

As the city grows beyond the boundary of the Distrito Central, growth-related planning efforts will likely require coordination with neighboring municipalities, as they will need to share in the responsibility of preventing development near protected areas and watersheds. Similarly, as urban growth and congestion from Distrito Central pour into Santa Lucia, it will be important for both municipalities to work jointly to mitigate the impacts of Tegucigalpa's expansion. The need for regional planning is illustrated in the image "Regional Protection of Natural Resources."

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[7] The shape of the "2031 Planned Urban Area" includes those areas that have been identified as prone to landslides, but that assumes that growth in those areas will be prevented. As such, additional land has been included to compensate for those areas where development is unsafe.

**Figure 3.4:**
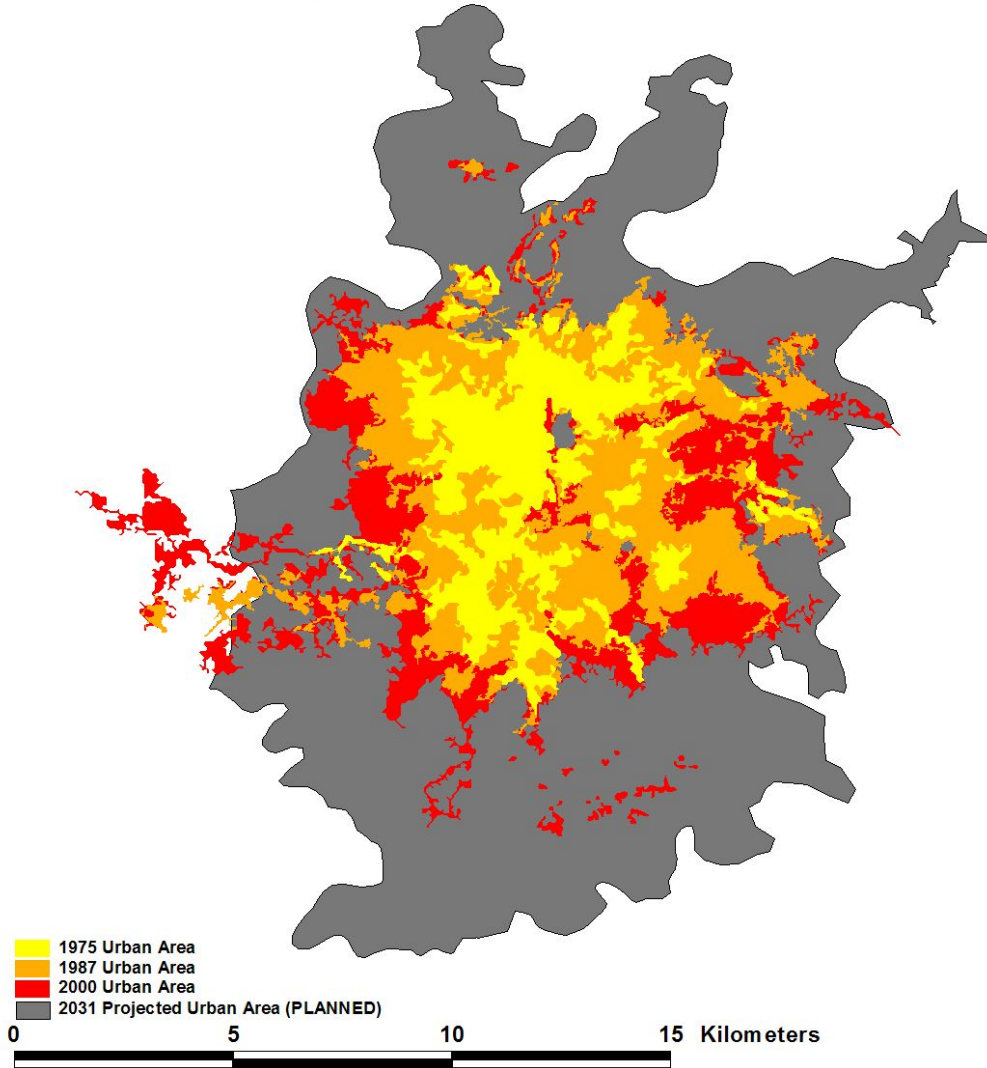
# 2031 Projected Planned Growth



- 1975 Urban Area
- 1987 Urban Area
- 2000 Urban Area
- 2031 Projected Urban Area (PLANNED)

0     5     10     15   Kilometers

**Figure 3.5:**

## 2031 Planned Urban Area: Protection of Guacerique Watershed
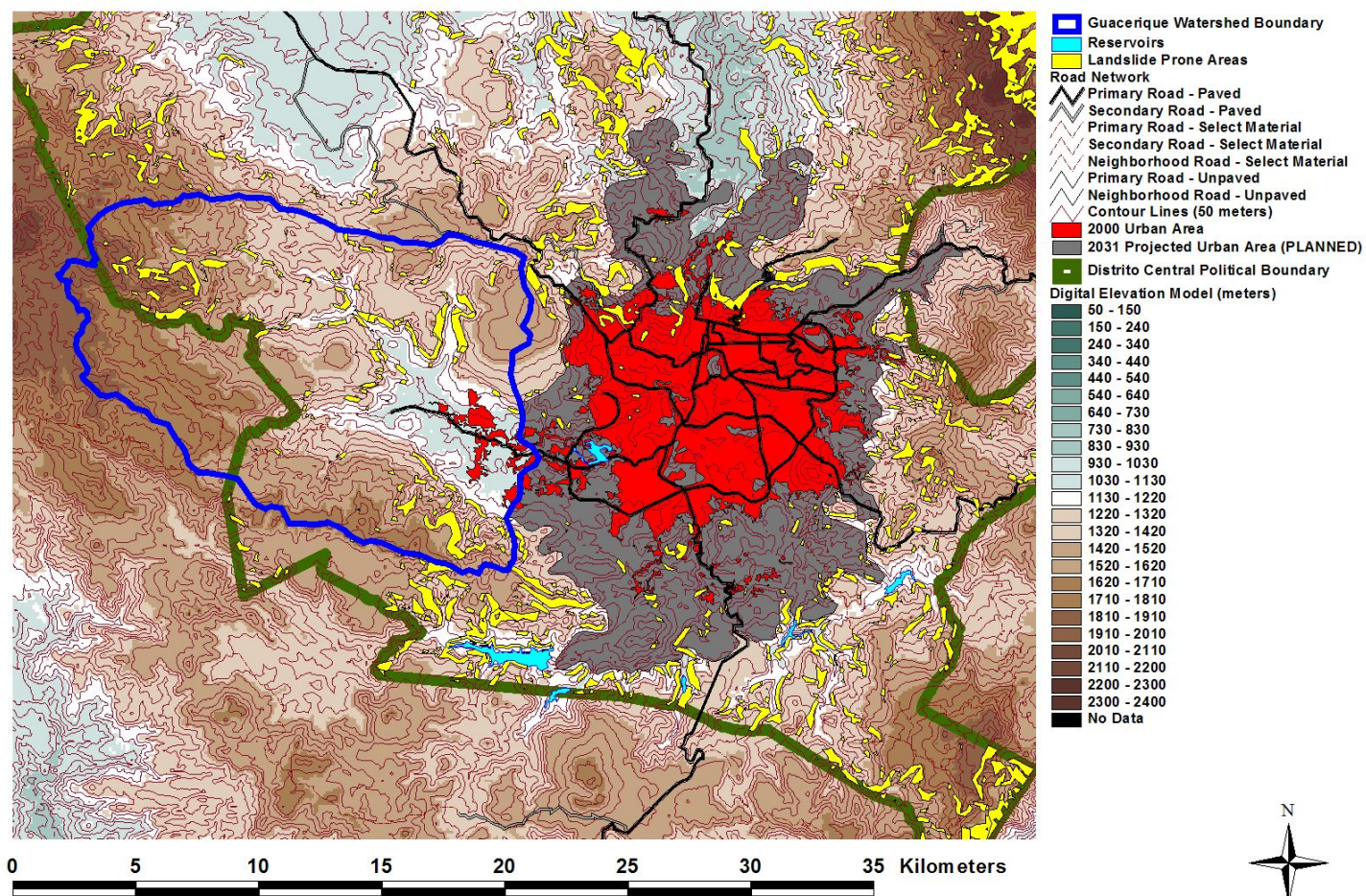
**Figure 3.6:**

## 2031 Planned Urban Area: Higher Elevation vs. High Risk Areas



Legend:
- Reservoirs
- Landslide Prone Areas
- Road Network
  - Primary Road - Paved
  - Secondary Road - Paved
  - Primary Road - Select Material
  - Secondary Road - Select Material
  - Neighborhood Road - Select Material
  - Primary Road - Unpaved
  - Neighborhood Road - Unpaved
- 2000 Urban Area : 1150+ meters
- 2031 Projected Urban Area (PLANNED) : 1150+ m
- Flood Plain
- 2000 Urban Area
- 2031 Projected Urban Area (PLANNED)
- Distrito Central Political Boundary
- Contour Lines (50 meters)
- Digital Elevation Model (meters)
  - 50 - 150
  - 150 - 240
  - 240 - 340
  - 340 - 440
  - 440 - 540
  - 540 - 640
  - 640 - 730
  - 730 - 830
  - 830 - 930
  - 930 - 1030
  - 1030 - 1130
  - 1130 - 1220
  - 1220 - 1320
  - 1320 - 1420
  - 1420 - 1520
  - 1520 - 1620
  - 1620 - 1710
  - 1710 - 1810
  - 1810 - 1910
  - 1910 - 2010
  - 2010 - 2110
  - 2110 - 2200
  - 2200 - 2300
  - 2300 - 2400
  - No Data

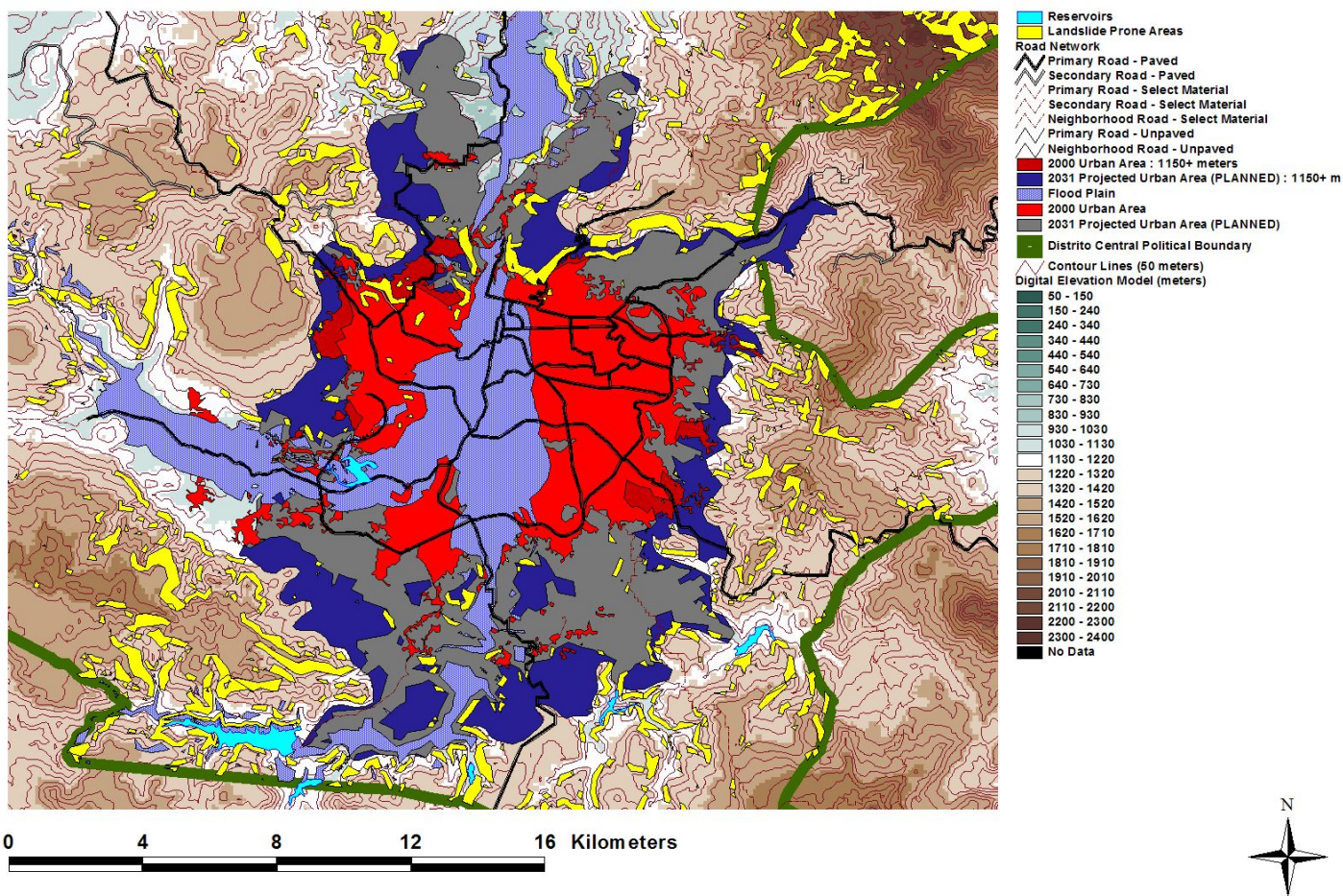0    4    8    12    16   Kilometers

N

**Figure 3.7:**



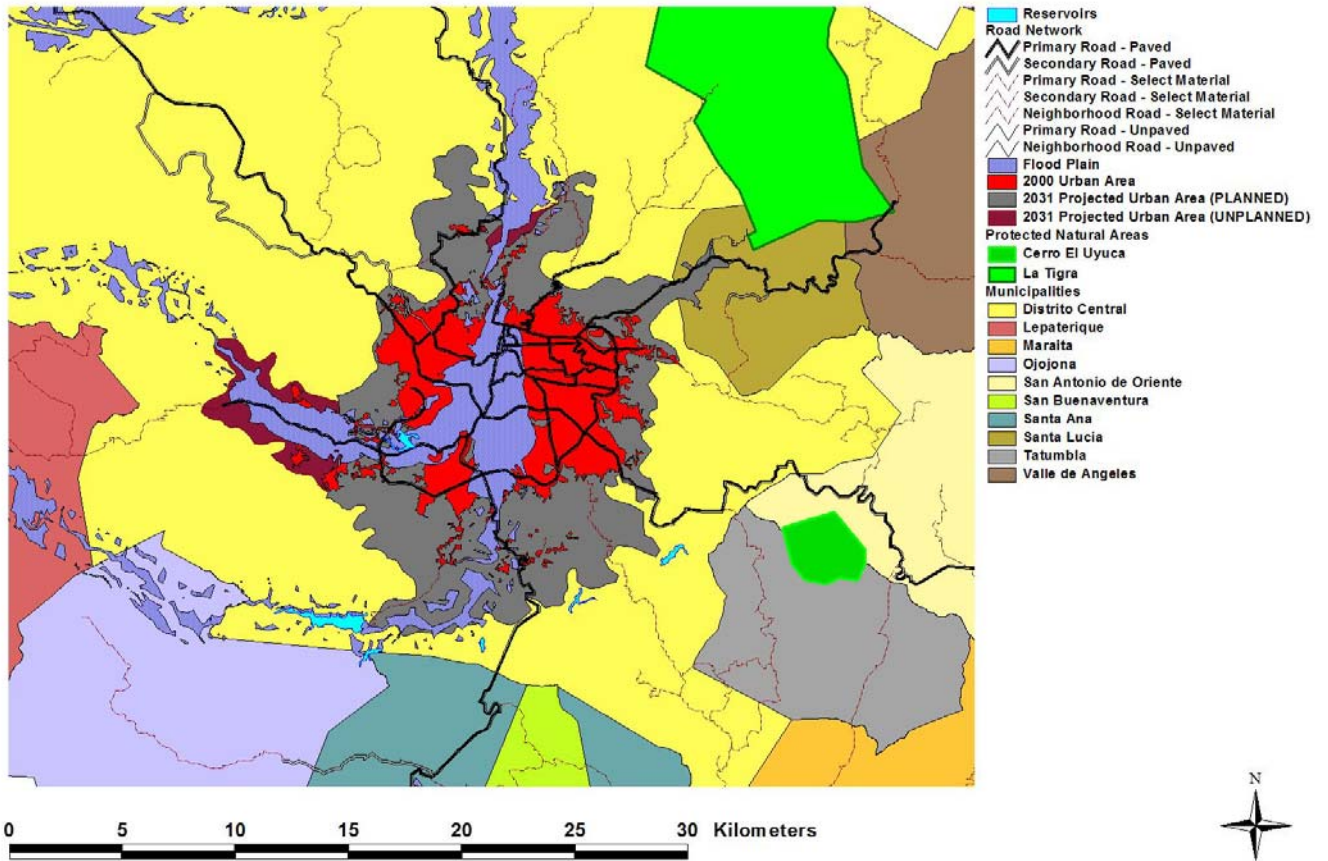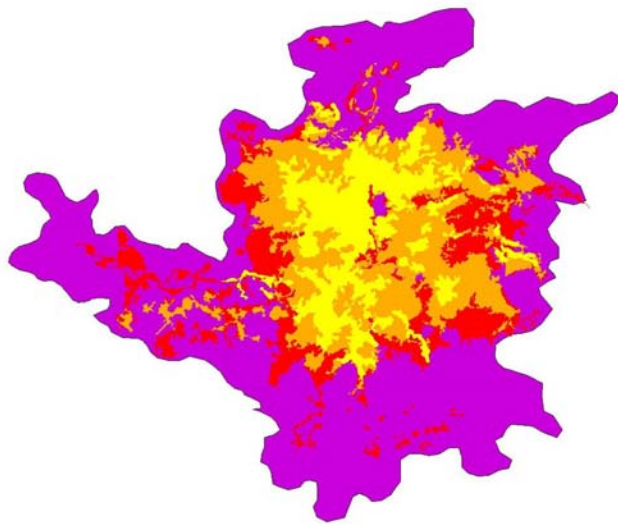2031 Projected Urban Growth: Regional Protection of Natural Rescources
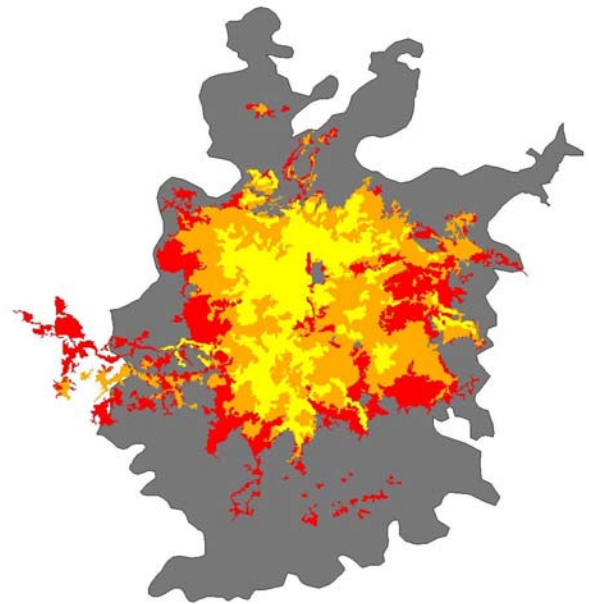
**Figure 3.8:**



2031 Projected Unplanned Growth

2031 Projected Planned Growth

1975 Urban Area
1987 Urban Area
2000 Urban Area
2031 Projected Urban Area (UNPLANNED)

0   5   10   15   Kilometers

1975 Urban Area
1987 Urban Area
2000 Urban Area
2031 Projected Urban Area (PLANNED)

0   5   10   15   Kilometers

## Land Use

The urban story of Tegucigalpa is a tale of chaos leading order: the "development" of neighborhoods through unplanned and random settlements by "invaders," followed by attempts of the Municipality to bring basic services and system to these *colonias*. The unregulated urban sprawl of Tegucigalpa is best explained by frozen laws and fixed mindsets, unable to grapple with the influx of people. The problem has been exacerbated by an asymmetrical distribution of power and responsibility. The Municipality has most of the responsibilities, but few powers, while the Central Government has almost all the powers but few direct responsibilities.

In Tegucigalpa, like many cities of the developing world, informal development dominates formal development. According to a November 2001 study by the ILD, 55% of total properties in the Central District were "extra-legal" invasions on public and private lands. An additional 23% were considered extra-legal because they had been sold without "free-and-clear" legal title, or without regard to deed or usage restrictions that should have limited or prohibited their sale. As there is no citywide survey of land, there is no good estimate of the total land consumed by informal development. Estimates indicate that about 45-55% of the total land area in the city is made up of illegal developments, housing more than 60% of the total population.

Important causes for the explosion of the informal sector are the shortage of developed land at affordable prices for the urban poor, and an unwritten public policy that encourages informal development (or at the very least, fails to discourage such development). The result has been, as stated above, completely unchecked and unplanned development along the city's periphery, with social and fiscal costs that continue to increase to the present day.

What factors have constrained the supply of land? The most important include the colonial legacy of inequitable distribution of land rights, complex land tenure system and unclear titles. The Spanish colonial system gave full title on land to only a few. Today, three percent of the population is said to own forty percent of land in Tegucigalpa. Additional complexity is added by the fact that the colonial system only loosely defined the boundaries of each property, frequently defining them through reference to neighbouring properties. The problem of inequitable distribution of land was multiplied by a fragmented system of land usage rights, including the legacy of the ejido system in rural lands surrounding the city, which were subsequently converted into urban areas. As a result of these, and other factors, we were informed that more than 60 percent of land in Tegucigalpa does not have clear title.

## Land Types and Ownership

Under current law, lands in Tegucigalpa can be classified into three types: Government land, comprising primarily agricultural and forestry lands (managed by the Federal Government), but also including lands which are purchased or acquired by diverse State entities (including municipalities, ministries, etc.) through seizure, expropriation or other legal methods; ejido lands (where the State has ceded management to the Municipalities for use by its citizens); and private land. Illegal land invasions began in Tegucigalpa in the

1960's, with relatively limited occupation of lands bordering urban rivers, slopes of surrounding hills, and highway borders. It was not until the late 70's that intensive invasion of ejido lands began. These invasions continued throughout the 1980's.

Eijido lands constitute approximately 30 percent of the total land in the Central District, and have been the prime site of urban invasions, representing 51% of the invasions.[8] As stated above ejido lands have no exclusive owner as they provided only usufruct rights. Since these lands did not belong to anyone, there was nobody to protect them. Also, the usufruct rights provided insecurity of tenure. Consequently, those who held these rights sold their interests to potential invaders.

Ejido lands were not the only lands on which invasions took place. Invasions also took place on privately owned lands. These were however, in reality, land sales masquerading as invasions.[9] Sale of land to groups of invaders by landowners have been used to get around the extant laws which prohibited construction on such lands, or made the cost of land development unattractive. The growing influx of job seeking population needed space to live but the zoning laws and building laws especially those relating to subdivisions choked the supply of private land from entering the land market. The demand was therefore met through the illegal land market.

When invasions began the municipality did not take action because the massive influx of families to the city, and the absence of affordable land and housing provided a strong political disincentive. A former Mayor informed us that the military regime was the first to "encourage" invasions. Apparently the civilian governments were no better. Any attempt to remove the encroachers was stoutly resisted and after major law and order problems created by such attempts in 1989, attempts at removing invaders were largely abandoned. The internal dialogue of city authorities has shifted to such an extent that land invasion is not referred to as "illegal," but rather as "extra-legal." The Municipality does not classify construction of housing on private land as illegal if the construction has been done with the consent of the land owner and if the land owner has been paid. Such construction has been construed only as a technical violation of building code. As a result of these changes, it is possible for the administration to claim that there have been no "illegal" settlements in the last two years.

**Land Titles**

Lack of clear land title has compounded the problem of shortage of developed affordable land. The uncertain nature of land titles makes most land transactions risky and expensive, and undervalues the price of land. It is also an important factor in properties finding their way to the informal sector. Historically, groups of people have been ready to risk and buy a piece of land without clear title at a lower value and remain there with political support, whereas few would be ready to buy it legally.

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[8] Information was provided during a discussion with representatives of the Municipal Cadastral Department in October 2003.

[9] Numerous examples can be found throughout the city. For example, see the reference to *Alta de la Laguna*, on page 41 of Angel, Dr. Shlomo, "Housing Policy in Honduras: Diagnosis and Guidelines for Action," IDB 2002.

The legal standing of invaders is further strengthened because of land tenancy laws, which provide specific legal rights for lands which are successfully occupied for at least 10 years, regardless of prior legal title. Lack of clear title causes fraudulent and contested claims leading to costly litigation. A developer told us that he did not even rely on his lawyers to verify title and preferred to go to the National Registry himself and check the records. Furthermore, he was ready to invest only on such lands where ownership had not changed for a long time, or where previous development provided a clear title. It can thus be seen that long-term capital investment in land has shied away due to unclear title, leading to suboptimal investments. Several sources revealed that private sector investors preferred to sell unimproved land (both through legal and illegal channels), or to add value to already developed land, as opposed to investing and developing undeveloped land.

There are many institutional reasons that have caused the supply of land in the formal sector to be restricted.  The Master Plan was last framed in 1974. The plan was completely out of synch with a realistic assessment of the financing available to complete it. Residential zoning regulations and building construction regulations were written with a failure to plan with the realistic conditions of Tegucigalpa in mind. As a result zoning and planning has remained on paper. The planners could not assess the quantum of land required for housing and the rigid land use made legal land for housing scarce and expensive. The procedure for obtaining permission to construct in deviation to the Master Plan is difficult and time consuming. Furthermore, land regulation standards restrict intensity of land use. Also land subdivision regulations provide for limited densification, which would otherwise have been possible with increased land prices.

It is our impression that onerous laws and procedures make transactions of land in the formal sector cumbersome, slow, tedious and expensive. For example, we were told that registration of a property transfer has, historically, taken from six to eight months, and building permission requires compliance of a large number of specifications. In contrast, if a person builds a house in violation of code, he is given three warnings after which the municipality has to go through a tortuous legal process before it can secure a demolition order. Thus, while the formal system is hemmed by laws, regulations, and time-consuming and costly procedures, the informal system flourishes under a regime of lax implementation and enforcement, and encourages corruption.

The government's response to these issues has been three-fold: a) the targeted legalization of informal settlements; b) the unification of the Property *Register* and the Property *Cadastre*, and their gradual upgrading[10]; and c) the rationalization of current law through passage of a new *Ley General de Ordenamiento Territorial (LOT)*. Although implementation of these initiatives has been slow and irregular, they hold the potential for creating a stable basis for future institutional reform. The legalization of informal settlements has not yet been undertaken at a scale that will significantly address the problem (both because of insufficient financial resources, and because of coordination issues between the Federal Government, and the Municipality—see below). The unification of property records, has been proceeding very slowly, and additional resources and emphasis needs to be focused in this area in the coming year. The *LOT*, has moved

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[10] Angel, Dr. Shlomo, Housing Policy Advisor, "Housing Policy in Honduras: Diagnosis and Guidelines for Action," Inter-American Development Bank (IDB), New York, June 2002.

forward legislatively, but in and of itself, is not sufficiently transformative to change the current dynamic.

## Multiple Authorities

Another cause confounding development and planning in the City is the overlapping and at times conflicting responsibilities and powers of Central and Municipal authorities. For example, many sources of revenue are vested with the Central Government and funds devolve to the Municipality in indirect ways, limiting both effective use and accountability. As a result, decentralization is a critical issue for transforming the current negative dynamic. As an example, as mentioned above, the national and the municipal government retain separate registries of land titles and values. In reality, these records seem to apply to the minority of land in the Central District, since more than 60 percent of land in Tegucigalpa does not have clear title.

The current system (represented by an inefficient and out-of-date land registry, and limited coordination between the central and municipal governments), and the breakdown of the rule of law (with regard to development in the Central District) are a key contributing factors that help to create a municipal finance system which is unsustainable and woefully under-financed to meet the needs of the majority of the city's residents, particularly the poor. The failure of the central government to decentralize both funding, enforcement, and delivery mechanisms for services which are essentially local in nature (particularly water, sanitation, and transportation) has compounded this problem.

Another example is the legalization of informal settlements. Since 1998, the Municipality has been working on the expensive process of legalizing marginal colonias. The land is assessed, and the occupiers are charged 10% of the cadastral value (not market value) of the land. The money charged is deposited in a separate account so that it can be wholly utilised for improvement of the infrastructure in the colonia. The urbanization is designed so that consultation with the patronatro, a governance committee representing the people of the colonia is an integral component. This can be compared to a national legalization program, PROLOTE, which was initiated in 1990, but has not been activated. Clearly, there is a marked advantage in devolving both resources and responsibilities for certain activities to the municipal level.

## Zoning and Building Regulations

If Tegucigalpa is to plan with the realistic conditions of Tegucigalpa in mind, it is critical that the current zoning and construction regulations be addressed. Rather than "setting the bar" as high as possible, with the hope that the will and funding required for implementation will appear, it makes sense for the Municipality to make a realistic assessment of the private sector resources available for land development, and take account of the way in which housing development currently occurs. In the informal sector, which as we have stated above, houses the majority of the cities inhabitants, development of both housing and services occurs over time. Zoning and construction regulations, on the other

hand, assume that legal development can take place only when all infrastructure is in place, and all building conditions and codes have been met. This provides for a strong disincentive (primarily financial, but also in terms of the time required for approvals, etc.) to legal development.

As a starting point, the Municipality should look to the reform of land subdivision regulations to allow for a minimum initial level of urban services and for their progressive development over time.[11] There are several countries in the region that have adopted such regulations, and which can serve as models. Additionally, the city should develop new construction regulations which provide for certain minimal standards (*normas minimas)* in the construction of housing, recognizing the poverty of many of the city's inhabitants, and the actual conditions in which current informal construction takes place. These reforms have been extensively developed and implemented in Colombia, with great success in legalizing current land development and construction (as opposed to retroactively legalizing construction and development, which has been the Honduran model).

## Urban Growth and Land Use Resources

Special thanks to the following agencies for providing data which contributed to the Geographic Information Systems (GIS) section of this report:

- Catastro – Alcaldía de Tegucigalpa
- Centro de Manejo y Distribución de Información Geográfica (CIGEO) en las Instalaciones de la Universidad Tecnológica Centroamericana (UNITEC)
- Comité de Emergencia Municipal (CODEM)
- Instituto Geográfico Nacional de Honduras (IGN)
- Instituto Nacional de Estadística de Honduras (INE)
- Inter-American Development Bank (IDB)
- Proyecto Administración de Areas Rurales (PAAR)
- Servicio Nacional de Acueductos y Alcantarillados (SANAA)
- Sistema de Obras Públicas, Transporte y Vivienda (SOPTRAVI)
- United States Census Bureau, International Programs Center
- United Status Geological Survey (USGS)
- University of Maryland, Global Land Cover Facility (UMD-GLCF)
- University of Princeton, Digital Map and Geospatial Information Center

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[11] Angel, Dr. Shlomo, Housing Policy Advisor, "Housing Policy in Honduras: Diagnosis and Guidelines for Action," Inter-American Development Bank (IDB), New York, June 2002, pg. 55.

# IV. Housing and Informal Settlements

Approximately 9,000 houses are constructed in Tegucigalpa every year with only one-third constructed in the formal sector – a marked increase in informal settlement from years past. These figures coupled with population growth translate into approximately 135,000-155,000 new informal settlements by 2025, housing 675,000-775,000 residents.

Some 46% of all current residential properties in Tegucigalpa were obtained through illegal land invasion. An additional 13% have unclear or restricted land titles. Only 40% of the residential properties in the city have proper legal titles and authorized construction. Approximately 125,000 residences have been built illegally in Tegucigalpa. The process of constructing an informal settlement includes purchasing a sizable plot of land for the equivalent of only a few hundred dollars, and constructing a home for a few hundred more. An entire extralegal construction industry has been created because of the common practice of building in illegal settlements.

Since informal settlements are common and cultural norms dictate that individuals take care of family members in need, homelessness is a relatively minor issue in Tegucigalpa. Yet other housing problems include: extremely tight living quarters and a lack of infrastructure, especially availability to water and roads.

At first glance it appears that the city is hemmed in by steep mountains and the city can not grow. However, an in-depth view demonstrates illegal settlements have been built on very steep slopes and only the steepest slopes remain unsettled. Furthermore, in almost all directions of the city, there is flat land on which houses can be built – north of the city in the Rio Bajo region, northeast toward Valle de Angeles, south toward Nueva Armenia and the Districto Central border, and west of the city in the Lepaterique valley.

Previous national government efforts have focused on increasing the number of houses built and not on improving infrastructure to existing houses or the quality of existing homes. The fact that many government-constructed housing projects remain uninhabited or partially inhabited demonstrates the failure of this emphasis.

Instead of building new housing, the city should emphasize five main objectives:
1) direct expansion by creating 3 pilot projects in desired areas
   a. work with neighborhood intermediaries to help settle areas
   b. build secondary road, potable water and sewage infrastructure
2) guard certain natural areas from invasion
   a. preserve watershed regions and park land
   b. protect areas vulnerable to landslide and flood
3) upgrade infrastructure in areas where urban settlements already exist
4) formalize the high number of extralegal settlements throughout the city
5) establish an easier legal process by which land can be acquired and homes built

"In the absence of effective property rights, physical occupation or use becomes an important element in forcing legal or de facto resolution to land tenure. Therefore, available, fallow land at the margins of Tegucigalpa and its surroundings, as well as large tracts of communally held land in rural areas, are susceptible to contested land tenure, causing potential obstruction and delays in real estate development."[12]

## Land Availability

There are primarily three factors that determine where residents of Tegucigalpa decide to live – access to basic infrastructure, access to urban employment markets, and access to common public areas.[13] All three factors are influenced by proximity to the center of Tegucigalpa. Therefore, the most attractive land has been the vacant land that is closest to the city center. Much of this land is privately owned, municipal land, or ejido land. The urban poor tend to have the most access to the least valued land with difficult topography, which are thus the primarily sites for illegal settlements. Because of a lack of public or private alternatives, the municipality has tolerated land invasions of their own land as an expedient way of sheltering the city's residents.[14]

In 1998, 225 of Tegucigalpa's 340 neighborhoods were illegal settlements. In total, 450,000 people resided in these neighborhoods.[15] Some 60% of all residents live in extralegal settlements. According to city figures, 200 new invasions have started in the last 20 years.[16] Formal means of acquiring property are beyond the income capacity of many residents of Tegucigalpa, 49% of whom live below the poverty line with average monthly incomes of US $167.[17] Yet there are many types of informal properties, which can be segmented into seven categories:

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[12] Pearce-Oroz, Glenn, *Causes and Consequences of Rapad Urban Spatial Segregation: the New Towns of Tegucigalpa*, United States Agency for International Development, p. 6.
[13] Ibid, Pearce-Oroz, p. 2.
[14] Ibid, Pearce-Oroz, p. 7.
[15] PADCO (1998), Diagnóstico Rápido: el Mercado de Terrenos y Los Barrios Marginales, Ciudad de Tegucigalpa, Washington, D.C.
[16] Gallegos, Eris, "Amarateca y Zambrano, Las Alternativas" Diario Tiempo, p. 1.
[17] UNDP (2000), *Informe Sobre Desarrollo Humano: Honduras 2000*, Tegucigalpa.

## Table 4.1:  Types of Urban Informality in Tegucigalpa [18]

| Category | # of Dwellings | Percent of Total |
|---|---|---|
| Extralegal holdings on ejido and government-owned land | 48,706 | 38.89% |
| Extralegal holdings on privately owned land | 44,417 | 35.47% |
| Dwellings built by trade guilds, associations and cooperatives with titles that limit transfers or encumbrances | 18,230 | 14.56% |
| Government built dwellings without a title or with a title that places restrictions or prohibits its transfer or encumbrances | 6,866 | 5.48% |
| Extralegal holdings on land where it is unknown whether ownership is public or private | 2,875 | 2.30% |
| Dwellings built without a building license or in areas where land development has not been authorized | 2,098 | 1.68% |
| Real estate with unclear ownership as a result of unregistered transfers, undetermined inheritance and various litigation | 2,036 | 1.63% |
| Total | 125,228 | 100% |

The Instituto Libertad y Democracia classified illegal homes according to three criteria: quality of materials used in construction, compliance with land development laws and available infrastructure.

## Types of Neighborhoods

Type A Neighborhoods: Built according to land development laws. Have water, sewerage and electricity. Main streets are paved.

Type B Neighborhoods: Built in partial compliance with land development laws. Have water, but supply is intermittent. Some lots connected to sewerage system. Have electricity. Streets are unpaved.

Type C Neighborhoods: Built in violation of land development laws. Not all dwellings are connected to water system, which supplies water intermittently. Lack a sewage system. Have electricity, but mains and lines are laid haphazardly. Streets are unpaved.

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[18] Consejo Hondureño de la Empresa Privada and Instituto Libertad y Democracia, Activos Prediales y Empresariales Extralegales en Honduras, November 2001.

## Types of Dwellings

Type I Dwellings: Steel-reinforced concrete foundation. Reinforced brick or concrete block walls. Top quality wood or metal roof with fiber-cement or top quality tiles. Red brick or ceramic tile floor. Embedded electrical wiring and outlets. Hot and cold water.

Type II Dwellings: Stone and mortar foundation with a concrete plinth. Non-reinforced brick or concrete block walls. Average wood roofs covered with cement or handmade tiles. Mosaic brick and cement floors. Embedded electrical wiring and outlets. Cold water.

Type III Dwellings: Stone and poor quality cement foundation. Unfinished concrete block walls, with no reinforcing. Low quality wood frame roofs sheathed in zinc. Smoothed cement slab floors. External electrical wiring and outlets. Cold water.

**Figure 4.1: Types of Extralegal Dwellings in Tegucigalpa[19]**



| Type A-I Average Value: US$ 36,082 | Type B-I Average Value: US$ 35,371 | Type C-I Average Value: US$ 29,791 |
|---|---|---|
| Type A-II Average Value: US$ 17,383 | Type B-II Average Value: US$ 16,955 | Type C-II Average Value: US$ 13,665 |
| Type A-III Average Value: US$ 7,833 | Type B-III Average Value: US$ 7,439 | Type C-III Average Value: US$ 5918 |

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[19] Ibid.

## Land Cost

The number of households in Tegucigalpa exceeded the total of occupied dwelling units in 2001 by 4%.[20] This relatively low figure relates to the fact that homelessness is a minor issue in the city. A visual survey of the city further supports this finding. Besides cultural factors which dictate taking care of family members, the paucity of homelessness is at least partially due to very low land costs.

In May 2002, one could to buy a 15m x 8m plot in a new invasion for as little as L.3,100 ($190). In October 2003, invaders paid L.4,000 ($234) for a 16m x 9m plot in the Estanzuela invasion. Additionally, advertisements in the well-established barrio of La Era offered 15m x 10m plots for L.5,000 ($292). Although this colonia has water and electricity, a formal settlement could never sell at these low prices.

The direct construction cost of a median-priced formal house in Tegucigalpa is currently L.1,800 ($110) per $m^2$. Construction costs in the informal sector for a basic $36m^2$ starter house in a new invasion costs only L.10,000 or L.275 ($17) per $m^2$.

## Colonia Estanzuela

The following information comes from extensive interviews with settlers in Colonia Estanzuela. These settlers reported that the land was cleared of trees and invaded. The municipality declared Estanzuela a case of self-invasion whereby the land owner allows invaders to settle, accepts small payments from them and then seeks payment from the city for the value of the land. Cross-referencing the cases of three settlers in the Estanzuela settlement reveals the several steps and costs of land invasion:

| Table 4.2: Colonia Estanzuela Settlement Costs | |
| --- | --- |
| Infrastructure Cost | Lempira Per Lot |
| Initial Costs | |
| Land acquisition | 3,000 |
| Organizer (Coyote) fee | 1,000 |
| Fee to land owner upon legalization | 25,000 |
| Electricity Costs | |
| Study | 300 |
| Installation (homeowners provide labor) | 1,200 |
| Meter fee paid to electric company | 350 |
| Monthly bill | varies |
| Other | |
| Street Construction | 300 |
| Topographical Survey | 200 |
| Telephone (optional) | 500 |
| **Total Infrastructure Cost in Lempiras** | **31,850** |
| **Total Infrastructure Cost in $US** | **1,790** |

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[20] Angel, Shlomo, Study on Housing in Tegucigalpa.

The types of housing on these lots varied according to the income of its inhabitants. As families earn more money, they typically expand these homes with higher quality materials. Of three households interviewed, all were starter, one-room homes.

| Table. 4.3: Colonia Estanzuela Housing Types | | | | |
|---|---|---|---|---|
| Housing Type | Size in m$^2$ | Cost per m$^2$ | Construction Cost in L | Construction Cost in $US |
| Wood | 30 | 87 | 2,600 | 146 |
| Adobe | 48 | 67 | 3,200 | 180 |
| Brick | 15.75 | 279 | 4,400 | 247 |

*\* Labor costs are included in the cost of only the brick house. Costs for the wood and adobe house will increase when this labor cost is taken into account.*

## Improving Quality of Life vs. Increasing Quantity of Homes

The availability of municipal services is key to the quality of life in Tegucigalpa settlements. Water delivery, availability of electricity, sewage pipelines and refuse collection are fundamental to the health and well being of settlers, legal and extralegal.

Currently colonias without piped drinking water pay up to ten times more for water delivery by truck while water service to established neighborhoods is subsidized. The government of Tegucigalpa should establish real costs for water delivery so that true costs are paid by those that receive water allowing the municipality to increase water delivery to neighborhoods without service.

The municipality reported that only 65% of the city's solid waste is collected. The rest, 300 tons annually is discarded in the streets and rivers.[21] Unfortunately, much of this refuse clogs the wastewater and storm drainage systems. The interconnectedness of municipal services is apparent. The better refuse collection, the better the wastewater system, the more effort can go into building infrastructure for needy neighborhoods.

Besides improving the quality of life for residents of Tegucigalpa, the municipality can direct settlement in areas where infrastructure extensions are made. Certainly settlements will not be abated in the near future. Therefore, the city must make infrastructure extensions in regions that are safe, environmentally feasible, and accessible for building roads and water systems. Without these infrastructure extensions, settlements will continue to occur on any vacant land that is close to the city, without considering environmental or safety concerns.

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[21] Gallegos, Eris, "Amarateca y Zambrano, Las Alternativas" Diario Tiempo, p. 2.

Lack of planning will promote settlement on potentially unsafe areas, and will result in a lack of land for public use and recreational purpose as well as increased infrastructure costs when they are finally delivered.

## Protection From Natural Disasters

Many houses are built in precarious areas, including steep inclines, areas prone to mudslides, and areas too high for water and sewage systems. Instead of condemning these houses which will force the need for costly resettlement, the municipality should instead not allow rebuilding of houses that are destroyed by natural disasters. This was the strategy followed in the case of the massive mudslide at El Berrinche which has stayed vacant since Hurricane Mitch carried its thousands of houses down the river.

Because of environmental hazards only certain areas in Tegucigalpa should be allowed to hold housing. However, only limited land should be set aside since protected land can only remain protected with commensurate policing. The city should take a realistic approach to the amount of land it can police against illegal settlement.

## Conclusion

The legal land market is small and too expensive for the majority of the residents of Tegucigalpa. High unemployment and underemployment underlie the low levels of income available for housing along with an inefficient housing finance market.

Residents of Tegucigalpa have a marked preference for living close to the city center with economic and social opportunities. Land chosen for invasion is driven by proximity to the city center, public transportation, and employment. Typically poor residents can only afford only homes built on steep slopes or otherwise difficult topography.

Dwellings are surprisingly sound in Tegucigalpa's extralegal settlements. Furthermore, houses are improved in stability and size when resources become available. The largest concerns of informal settlements include a total lack of absent infrastructure, or at least intermittent, unreliable and expensive infrastructure.

The informal structure of building and owning land has become not only a system but *the* system of building. Even the municipal government has recognized this fact through their acceptance of settlements on property owned by local government.

By working to formalize extralegal developments in Tegucigalpa, the municipality will help settlers legally own property. These assets can then be leveraged for borrowing, home improvement, and entrepreneurial pursuit. Quality of life can be enhanced by an increase in the amount and quality of infrastructure made accessible to invasions.

Most importantly, the city can control the direction of settlements through infrastructure improvements. The careful installation of a network of secondary roads, potable water supply lines, sewage systems in certain areas will provide incentive for invaders to settle. The areas selected should be in environmentally stable areas. Finally, the city should direct development to ensure protection of natural resources and watersheds.

# V. Road and Transportation System in Tegucigalpa

## Introduction

We have organized this section into two parts. The first part deals with the administrative structure and regulatory framework governing the transport sector. In the second part, we try to explain the evolutionary pattern between roads and surrounding settlements. This is followed by an analysis of the transportation sector in Tegucigalpa, which projects public transport requirements for 2028. The aim of these studies is to understand the relationship between road development and the expansion of the city and to propose a master plan of secondary roads for the sustainable expansion of Tegucigalpa. It is crucial to plan a system of secondary roads because:

- Our study of development in Tegucigalpa has shown that secondary roads drive settlement patterns.

- Our analysis of the future transportation requirements of Tegucigalpa indicates the requirement for expanding and improving the secondary road conditions.

## Previous Strategic Approaches To Planning In Tegucigalpa

Previous master plans have attempted to decongest the city center by proposing a multi-nodal approach to development. The *Esquema Director de Ordenamiento Metropolitano* (*EDOM*) called for decentralization by creating subsidiary magnets for development and linking them with an efficient road system. The next two decades did not see any radical shift in the development philosophy. However, the huge influx of overseas aid following Hurricane Mitch in 1998 made apparent the lack of an institutional structure in Honduras to absorb and manage such funds. Since the repair of roads and bridges was identified as an area requiring immediate attention, most of the reconstruction and repair happened in this sector. The *Plan Estratégico de Reconstrucción de la Ciudad de Tegucigalpa* (Strategic Plan for the Reconstruction of Tegucigalpa) made the Municipality the central player in the development of the capital. The *Plan Territorial* has evolved from the Strategic Plan and is in its first stage of implementation. It is developing several projects related to roads and transportation, which form an integral part of our master-plan solution.

## Institutions

There is a great overlap of functions between various departments within the central government and between the center and the municipal government when it comes to administering the transportation sector. In the following table we have traced the main entities and their functions with respect to the transportation sector:

## Table 5.1:  Agencies and Activities

| Entity* | Activities* |
|---|---|
| **Central Government:** | |
| 1)*Secretaría de Estado de Obras Públicas, Transporte y Vivienda* (SOPTRAVI ) | -Most important wing. SOPTRAVI is in charge of building and maintenance of road infrastructure. |
| a)*Subsecretaría de Obras Públicas y Vivienda* (Vice Ministry of Public Works and Housing) | -Intervenes in the operation of passenger urban and interurban transportation. |
| b) *Subsecretaría de Transporte* (Vice Ministry of Transportation) | -Establishes passenger fares and subsidies for urban transportation. |
| b.1) *Dirección General de Transporte* (DGT – General Office of Transportation) | -Participates in the formulation of policies within the country and the Central America region. |
| *Secretaría de Finanzas* (Ministry of Finance) | -Approves all the sector projects. |
| | -Finances urban transportation subsidies. |
| | |
| **Municipal Government:** | |
| 1) Mayor and City Council | -Build, maintain and operate urban road infrastructure. |
| | -Control over Urban planning and design initiatives. |
| | -Authorized to approve bids and sign contracts of construction, maintenance or administration of public services with both public and private entities. |
| 2) *Gerente General* (General Manager) | -Selection of programs. |
| | -Establishes priority of investments. |
| | -Monitors evolution of programs. |
| 3) *Gerencia de Desarrollo Urbano* (GDU- Office of Urban Development) | -Maintaining municipal public works. |
| | -Development of infrastructure projects. |
| | -Regulation and control of private projects. |
| | -Improvement of the road system. |

## A Strategy For Roads

As we have mentioned earlier, roads and bridges are an exception in a sector that is otherwise characterized by a lack of co-ordination between the various agencies involved. Administratively, there is a clear hierarchy established as far as roads are concerned. Principal and secondary roads are built and maintained by SOPTRAVI. The municipality is expected to build and maintain tertiary roads. Foreign aid, which accounts for a sizeable part of the funding in this sector, is channeled through SOPTRAVI for principal and secondary roads. The Municipality has been involved in the paving of some tertiary roads under the plan, *Nueva Vialidad Miguel 2002*.

One of the important take-aways from the experience of the metro plan is that multi-centric growth models are not successful in Tegucigalpa. Tegucigalpans prefer to settle close to existing development and infrastructure, and will continue to do so, despite the fact that many of these areas are hazard prone. We have found that the evolutionary nature of the relationship between roads and settlements sees informal settlements sprout alongside

secondary roads. As these settlements densify, unpaved tertiary roads develop. Integration of the marginal barrio in the mainstream political and economic canvas of Tegucigalpa ensures that the tertiary road is paved over time. **Looking at this process of evolution we are driven to the conclusion that secondary roads are a key driver of growth in Tegucigalpa.**


## Future Transport Requirements: Case For High Capacity Bus Systems

Traffic congestion is one of the main problems confronting planners in Tegucigalpa. The lack of an efficient mass transit system has forced citizens to increasingly rely on taxis or modes of private transportation. While vehicle ownership has increased sharply at the rate of 10 percent per year in Honduras, traffic flow has increased more moderately at the rate of 5 percent annually.[22] This would approximate to the doubling of traffic flow in the time frame that we have under consideration. We do not have exact figures on the total length of the road network in Tegucigalpa, but from an inventory compiled by the SOPTRAVI[23] we can estimate the total length of secondary and principal roads in Tegucigalpa to be approximately 1450km, if we were to accommodate the increase in traffic at the present levels of congestion it would require doubling the road network.

A possible solution for the congestion problem in Tegucigalpa is the development of a rail transit system. However, a rail transit system would require a large-scale capital investment estimated at nearly $90,000,000/ km. In the aftermath of Hurricane Mitch, the state's finances are engaged in more crucial repair and rebuilding activities. Besides, another advantage that buses enjoy over trains is that they can be rerouted at short notice in times of emergencies. While it is advisable to design a flexible road mater-plan, which can accommodate a rail system in the future, the present challenge must be met by addressing the shortcomings of the bus system. This is an affordable solution for third world countries as has been shown by the case of Curitiba, where a comprehensive and efficient bus system has been instituted at a cost of less than $200,000/ km. This implies that the city's requirements for an efficient bus system could be met with an investment of $580m (2900 km * $200,000), which is the equivalent of adding approximately only 6.5 km of mass transit[24].

The 1500 (900 large and 600 mini) licensed buses fulfill approximately 60 percent of the demand for public transport. This shortfall is not due to the shortage of buses. Rather it is due to the facts that buses are not running at maximum capacity[25] and that secondary roads do not adequately cover all the barrios, especially the rapidly developing suburban areas. A JICA transport study done in 1996 points out that the average length of routes is 26.5 km and there are 42 existing routes. This indicates coverage of only 1113 kms. As a result,

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[22] World Bank Group. *Projects and Programs Honduras*. November 2003.
[23] Secretaría de Obras Públicas, Transporte y Vivienda (SOPTRAVI). *Public works in principal, secondary and tertiary roads in Fco. Morazán Department*. 2002.
[24] All figures obtained from article, *Curitiba's World Class Congestion Cure*, Neil Pierce, Washington Post, available at http://www.lightrailnow.org/facts/fa_cur01.htm
[25] Figures obtained from the *Sindicato de Transporte Urbano* (S.T.U)

only tertiary roads served by taxis penetrate many of the marginal barrios. Hence, buses are an inconvenient mode of transport for many of Tegucigalpa's residents. **To ensure the efficiency of bus systems, it is extremely important to overcome this problem by making secondary road coverage more comprehensive.**

## The Road Masterplan Proposal

Our belief that, by planning secondary roads, the government of Tegucigalpa is in a unique position to effectively dictate the direction of development away from vulnerable areas is based on the following three facts:

- We have found that secondary roads drive development in Tegucigalpa. We posit that this happens because they connect the agricultural hinterland to urban markets and facilitate the provision of cheap municipal services. Efficient service provision tends to attract people into areas with effective road systems and away from potentially high-risk areas.

- The path to sustainable growth in Tegucigalpa lies in providing for a low-cost and efficient means of mass transit. We have identified buses as having this potential. We envision a system of buses that run on the principal and secondary road network.

- In an overall administrative and regulatory system that is extremely confusing, the administration of roads construction is an exception. There is clarity in demarcation of responsibilities regarding the road construction between the center and municipality. Thus, intervention in this area will not be hampered by the procedural delays and inefficiencies that are bound to hamper proposed intervention in other sectors. In other words, we are ensured maximum return for investment in this area.

The main features of our road plan are as follows:

- *Low-cost:* We recognize that many of the master plans err in trying to start afresh. This leads to procedural delays and increases in costs that eventually make the plans themselves unviable. We have tried to design our proposal around the projects already being undertaken by the SOPTRAVI and the municipal government. The main regional projects that have been incorporated in our master plan are: 1) *Highway to San Pedro Sula in the North* which is expected to be widened to 3 lanes in 34 kms and to 4 lanes in 17 kms by December 2006; 2) *Road to Chupadero in the South-East* which is going to see the development of a 5km long urban corridor in 2004; 3) *Highway to Choluteca in the South* which is going to be expanded and paved in 15 kms in the next 5 years; 4) improvements and transformation in two main routes part of the *Honduran Logistic Corridor of the Plan Puebla-Panamá*: and 5) *Corridor Lepaterique – Valle de Amarateca* which will be a four lane highway by 2007.

At the intra-city level we have tried to incorporate the *Ring Road* and the expansions that have been proposed. We would have liked to incorporate the seventeen roads that were paved as part of the *IADB loan 1024*. Unfortunately, the macro scale of our proposal puts this beyond the scope of our study. However, we encourage any future road master plan to incorporate this development.

We consider the Municipality's proposal to build four inter-urban terminals at the exit of the highways to San Pedro Sula, Choluteca, Danli and Olancho to be extremely to be an important component of our proposal.

The total length of the road network that we have proposed is approximately 110kms long. The IADB loan HO-0143, puts the cost for construction of 380 km of paved road at $17.7 million. Extrapolating from these figures the cost of our scheme comes to approximately, $5.124 million.

- *Pedestrian friendly:* It is our aim to put every citizen within walking distance of public transport. Thus, we have chosen a grid of approximately 1kmX1km. No citizen is ever more than a 10-minute walk from a bus stop. We are sensitive to the fact that it may not be possible to pave such a dense grid at one go. Thus, we propose a phased wise development in which every alternate grid is built (that is a 2kmX2km grid), with the right of way secured for our proposed grid in the first phase. The next phase would be a continuous process that would respond to evolving needs and availability of financial resources.

- *Ecologically sensitive*: The severe impact of Hurricane Mitch has emphasized the need to take into consideration the effects of any intervention on the fragile ecology of Tegucigalpa. Road construction is a principal cause of erosion, particularly in the steeper slopes of the capital, where they serve as principal drainage channels for flashflood waters.

  There are two reasons why roads have an adverse ecological impact, 1) they are built on risk prone areas (that is, areas prone to land slides, steep slopes etc.) or 2) they pave more than 10 percent of the surface area and thereby alter the natural ecology of the land. We have been careful to avoid doing either. As mentioned before, we have tried to use roads to direct growth away from potentially risk prone areas. In addressing the second concern, our model for growth promotes pedestrian movement inside every block. We envision most of the tertiary roads to be soft and have minimal ecological impact. Thus, if we assume secondary roads to have four lanes (that is approximately 25 meters wide), they account for less than 10 percent of the area contained.

A possible criticism of the plan could be that it promotes *induced growth.* Rural workers being lured to the city by improved infrastructure conditions would characterize this. However, research in Bangladesh and India illustrates that migrants are much better informed about job opportunities than previously thought, and make migration choices in a rational fashion. Our argument is that the city is bound to expand whether or not one provides infrastructure. It is better to provide for infrastructure and deal with the challenges that evolve out of rapid urbanization.

**Figure 5.1: Vision for a Road Masterplan**
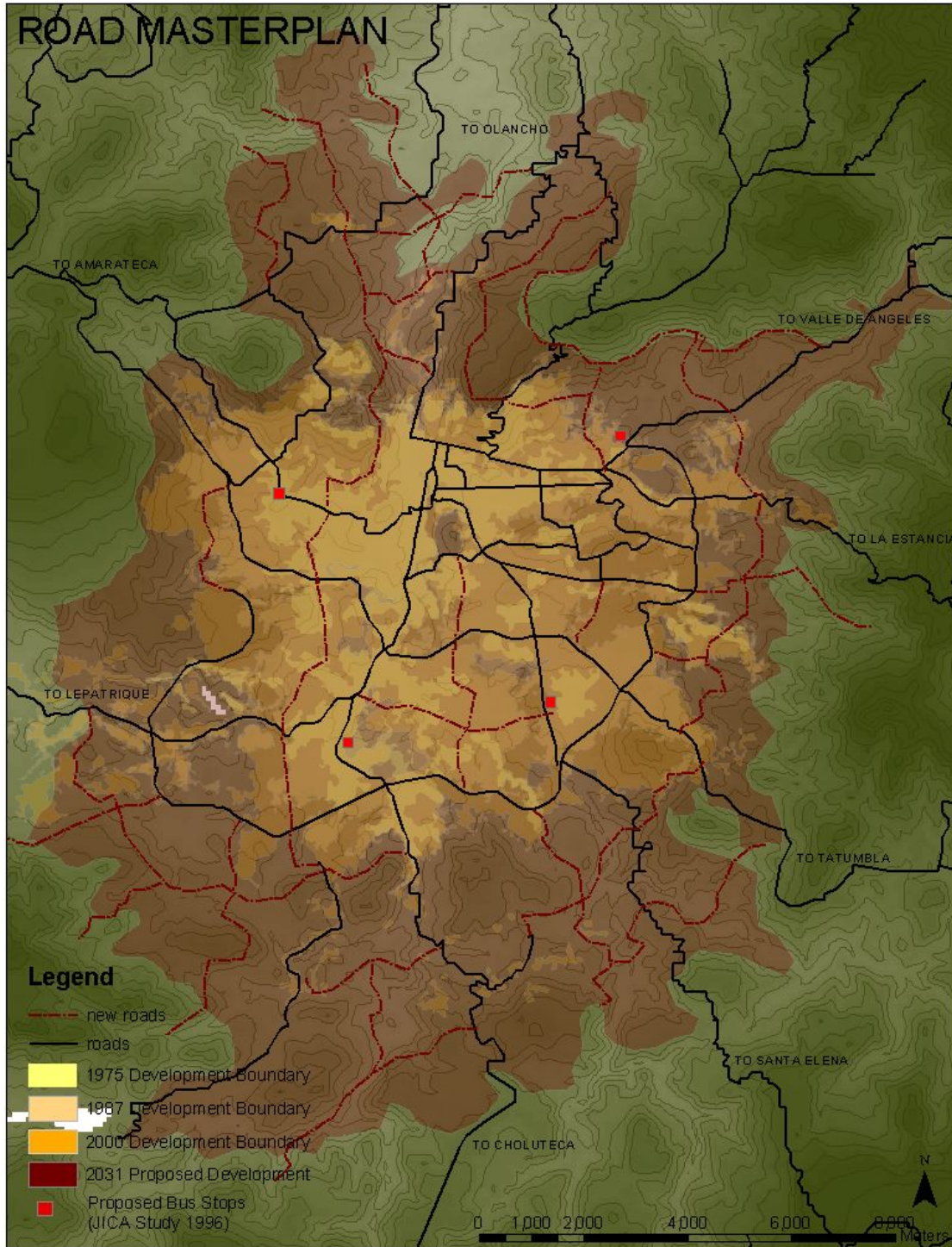
# VI. Water Supply and Distribution

Water supply and water distribution infrastructures are inadequate to serve the current needs of Tegucigalpa, much less the growing demand associated with a doubling of the population over the next twenty-five years.  The following pages provide current highlights and prospects for the future in the water supply and distribution sector.

Tegucigalpa's water situation has received extensive attention from the municipal and national governments, NGOs, and multilateral organizations (World Bank, IDB, UN, etc.) both because of the link between potable water and health, and because current inadequacies have had a disproportionately negative impact on the poor.

The National Water and Sanitation Service (SANAA) constructs, operates, and manages water infrastructure development and water service provision nationally in Honduras. SANAA controls Tegucigalpa's water policies and projects.  Several reservoirs to the south and west of the city supply Tegucigalpa with a combined flow of 2 cubic meters of water per second.  The system is predominantly gravity fed, with limited pumping to strategically-placed elevated tanks to increase water pressure in some areas.

Tegucigalpa's water problems begin with insufficient supply.  The current flow volume is not enough to meet the demand of the more than one million inhabitants living in the city today.  A 2002 World Bank study suggested that the current average supply deficit runs approximately 18% in the wet season, and rises to 45% during the dry season.[26]  Local news stories from the past ten years are replete with periodic coverage of forced rationing and shortages caused by both episodic (El Nino, etc.) and seasonal drought.  Supply problems are further complicated by other important factors, including: urban and agricultural contamination of watersheds; competition between agricultural uses (i.e. irrigation) and city uses (i.e. drinking water, sanitation, etc.); and Honduras' dependence on hydroelectric power for more than two thirds of total national power generation.

Neighborhood surveys in Tegucigalpa show that lack of access to potable water is considered the most serious problem by the poorest 20% of the population in the city, surpassing concerns of violence, bad roads, transportation, and solid waste collection.[27]  A large percentage of Tegucigalpa's bottom quintile households (38%) don't have access to the piped water network (the 62% coverage figure even includes households served by pipes from holding tanks filled by trucks from SANAA's UEDB program—to be discussed more below—that only receive four hours of water per week). For comparison, only 2% of the wealthiest households lack access to the piped water network.[28]

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[26] World Bank, "Problemática En Fuentes Para El Abastecimiento De Tegucigalpa," July 2002, pg. 6
[27] World Bank, "Urban Services Delivery and the Poor: The Case of Three Central American Cities," 2001, pg. 43
[28] World Bank, "Urban Services Delivery and the Poor: The Case of Three Central American Cities," 2001, pg. 52

Despite the problems posed by both supply and distribution, our tour of Tegucigalpa suggested that all residents of the city find a way to access the water needed to survive, through a variety of creative means. Frequently, these creative options mean that the poor pay more and use much less potable water then the middle-class and wealthy households in the city. This reality suggests the possibility of medium and long-term solutions to Tegucigalpa's water problems—in the form of improved water conservation and increasing piped water tariffs to a sustainable level, to name a few—but also hints at difficult political challenges ahead.

## Water Supply

### 1. Short- and Medium-term Options

The most straightforward approach to resolving Tegucigalpa's current water supply problem is to implement effective conservation programs for households on the piped network, thereby reducing water usage. Unfortunately, the current water tariff system favors waste over conservation, and is structured to subsidize large water consumers, particularly middle-class and wealthy households. Problems with the tariff structure find their roots in the absence of household water meters. SANAA estimates that in a city of approximately 200,000 households, there are only 62,000 water meters, and of those, only 23,000 are functional. Without water meters in many areas of the city, water fees are based upon fixed estimates of water usage. Because these estimates frequently undercount the volume of water actually drawn, there is a strong incentive for residents to disable or destroy existing water meters, and a strong disincentive for households to invest in the installation of new meters.

Provided that an adequate infrastructure of water meters existed, a market based conservation scheme could be implemented in Tegucigalpa. Such a regime would provide for progressively more expensive unitary charges (per cubic meter) as total water usage increased. Market forces (eg. the increasing marginal cost of water) would drive conservation measures at the household level. Additional water savings can be achieved by reducing losses due to illegal diversion and damage caused by informal tapping of water supply lines and reservoirs (estimated at 30% of the total water supplied by SANAA) and by improving the distribution network, which in many cases is more than 50 years old. The implications of a failure to increase conservation are summarized in the following table, which uses an average estimate of household water consumption developed by a consultant (PCI) hired by SANAA in 2001. The table employs two different water use projections to illustrate the impact of the growing population on total demand.

## Table. 6.1: Water Demand Growth Projections[29]

| | Without Conservation | | | With [Limited] Conservation | | |
|---|---|---|---|---|---|---|
| Year | Population | Water Use (ltrs/person/ day) | Total Demand ($m^3$/s) | Population | Water Use (ltrs/person/ day) | Total Demand ($m^3$/s) |
| 2001 | 850,227 | 226.5 | 2.23 | 850.227 | 226.5 | 2.23 |
| 2006 | 1,016,124 | 226.5 | 2.66 | 1,016,124 | 215.1 | 2.53 |
| 2011 | 1,187,363 | 226.5 | 3.11 | 1,187,363 | 208.6 | 2.86 |
| 2016 | 1,365,484 | 226.5 | 3.57 | 1,365,484 | 194.3 | 3.07 |
| 2021 | 1,548,784 | 226.5 | 4.05 | 1,548,784 | 194.3 | 3.48 |
| 2026 | 1,751,875 | 226.5 | 4.58 | 1,751,875 | 194.3 | 3.93 |

These projections are based on estimates provided by PCI consulting, hired by SANNA to project the city's future water demand. The PCI estimates are based on total water usage in the city, including those not connected to the piped network.

Taken from the 2002 World Bank report, the table below details possible short to medium term water supply projects for the city of Tegucigalpa.

## Table 6.2: Short- to Medium-term Options for Increasing Water Supply[30]

| | Project Title | Production ($m^3$/sec) | Cost (USD*$10^6$) | Unitary Cost (USD*$10^6$/ $m^3$/sec) |
|---|---|---|---|---|
| Lower Cost | Ojojona | 0.30 | 5.0 | 16.7 |
| | Laguna del Pescado | 0.08 | 6.2 | 77.5 |
| | Laureles II | 0.13 | 28.3 | 217.7 |
| | Sabacuante | 0.24 | 69.0 | 287.5 |
| Higher Cost | Tatumbla | 0.21 | 92.0 | 438.1 |

International consultants, the municipality, and SANAA officials generally agree that the city's water supply can be incrementally increased through the series of projects listed above (Ojojona, Laguna de Pescado, Laurales II, Sabacuante, Tatumble), but only at an increasing cost, for diminishing returns. Even if all of the projects above were implemented, total supply would increase by only 1 meter per second (at a total cost of

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[29] Pacific Consultant International (PCI) para SANAA- Estudio del Sistema de Abastecimiento de Agua Urbana para Tegucigalpa- Enero 2001.

[30] World Bank, "Problemática En Fuentes Para El Abastecimiento De Tegucigalpa Informe De Reconocimiento Consultoría de Apoyo a la Comisión Especial de Agua" July 2002.

more than $200 million USD). This would augment supply enough to meet the city's growing demand for only 5-10 additional years.

   *2. Longer-term Options*

For the longer-term, the following projects have been proposed:

**Table 6.3: Longer-term Options for Increasing Water Supply[31]**

| Project Title | Production (m³/sec) | Constr. Cost (USD*10⁶) | Operating Cost (USD*10⁶) | Total Cost (USD*10⁶) | Unitary Cost (MUSD/ m³/sec) |
|---|---|---|---|---|---|
| Río del hombre | 2.30 | 392.58 | 31.19 | 423.77 | 184.25 |
| Nacaome | 1.04 | 143.33 | 76.94 | 220.27 | 211.8 |
| Quiebramontes | 1.04 | 220.76 | ------ | 220.76 | 212.3 |

Interviews with officials at the national and municipal levels revealed the following details regarding long-term options:

1. The official position of SANAA is to construct a Guacerique II dam, just up river from the current Laurales dam. Despite this "official" position, several individuals inside and outside of SANAA suggested that the project could never be completed because the land acquisition costs have greatly outstripped the potential benefits. The bottom line is that international financing would be required in order to move the project forward, which may be impossible to secure regardless of the political desire to complete the project. The Guacerique II project is essentially a relocation of the Quiebramontes project, moved to facilitate political advantage and approval of the project.

2. The unofficial position of SANAA (i.e. their next best plan) is to construct a dam on the Rio del Hombre to the north of the city. According to SANAA, this project would double the supply of water to Tegucigalpa, from 2 cubic meters per second to 4 cubic meters per second. The Amarateca area would be the project's watershed, and as such, would mean that further development in that area would affect the quality of the water collected. SANAA estimates that if more than 70,000 people move into that region, the pollution of the watershed would balloon the cost of water treatment enough to make the project unfeasible. Estimates of the initial capital investment required for the project range from $300 to $500 million US$, but operating costs would be comparable to the existing system, because the water would be gravity fed into the city. The key question in the feasibility of this project is whether the Amarateca watershed is large enough to collect the water

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[31] World Bank, "Problemática En Fuentes Para El Abastecimiento De Tegucigalpa Informe De Reconocimiento Consultoría de Apoyo a la Comisión Especial de Agua" July 2002.

needed to support a 2 cubic meters per second flow rate. A former SANAA official interviewed questioned this estimate.

3. The municipality is promoting the development of Amarateca and surrounds for residential, commercial, and industrial uses.  As a consequence, it would like to see the city's water supply augmented from a different watershed.  Engineer Luis Moncado, a former Director General of SANAA, has proposed a Nacaome project that would pump water from an existing southern reservoir (Nacaome) to the La Concepcion reservoir.  This plan would augment the volume of water flowing to the city from the south by up to 2 cubic meters per second (like the Amerateca plan) and would utilize the existing treatment plant and distribution network at La Concepcion, which presently has underutilized capacity.  Estimates of the total potential volume produced by this project are contentious because SANAA has refused to undertake the data collection required to produce a scientifically reliable estimate.  The project would have lower up-front costs, estimated at $90-150 million USD[32], but would entail high ongoing costs to pump the water the 38 km uphill to La Concepcion.  The key question in the feasibility of this project is the cost of electricity, which subjects the project to fluctuations in the electric market at the national and regional levels.

The water supply challenges facing the city can be summarized as:
- where/when/how much investment in new dams, reservoirs, treatment plants, and supply lines to the city;
- degradation of water supply due to people living in watersheds of current reservoirs and of potential new reservoir sites; and
- unwillingness of citizens to pay full costs for water, thereby constraining the direct funding stream for infrastructure improvements.

## Water Distribution

SANAA builds and maintains the piped water distribution network in Tegucigalpa, which serves many more of the wealthy than the poor.  SANAA claims that more than 90% of all households in Tegucigalpa are served with water, although this figure is likely a maximum possible estimate.[33]  The primary challenges facing Tegucigalpa with regard to water distribution include:

1) extending service to more peripheral and informal communities;
2) addressing cost equity issues between residents with and residents without access to the piped network; and

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[32] World Bank, "Problemática En Fuentes Para El Abastecimiento De Tegucigalpa Informe De Reconocimiento Consultoría de Apoyo a la Comisión Especial de Agua" July 2002.
[33] Interview with Omar Alemendares, SANNA, 10/28/03.  This figure is likely a maximum estimate at best because it includes communities served by New Settlements in Development Program projects (described below) as "fully served by the network" and limits the total number of colonias counted in the estimate to 517 out of 555, with marginal colonias the most likely to lack water service and the most likely to be uncounted.

3) moving toward more sustainable fees for service.

The New Settlements in Development Program, UEDB, is a SANAA program that helps expand water provision in marginal neighborhoods.  It is financed collaboratively by the Honduran national government, the World Bank, Unicef, and local communities.  In order to receive a UEBD project, a community must be legalized, raise a portion of the capital costs upfront plus commit to monthly payments, and form a self-governing water board.  Depending on geography and other constraints, the distribution projects may take the form of home connections to the piped network, public taps, wells, or truck service sold by block.  140 communities are now served by UEBD projects.

| Table 6.4:  Per Person Water Use in Tegucigalpa Based on Type of Distribution[34] | |
| --- | --- |
| Service Method | Water Use (L/person/day) |
| Pipe network | 100-300 |
| UEBD project | 20-30 |
| No network, no project | 5-10 |

Service to barrios in development, however, is largely provided by cistern trucks, which deliver water to barrels outside of people's homes several times per week.  Water trucks may be owned and operated by private individuals or by SANAA.  The price to fill one 2400-gallon truck with water at SANAA's treatment facility is 450 Lempira.

An underlying issue in discussions of water distribution in Tegucigalpa is the question of cost equity between residents with access to the piped network and those without.  First, households receiving water by truck pay an order of magnitude more for water service than those on the network.  According to a 2001 World Bank study, the average payment for piped water in the city was 72 Lempira per month.[35]  In comparison, the cost per household for water delivered by truck was calculated to be roughly 780 Lempira per month in 2002.[36]  Second, people in marginal neighborhoods bear a large percentage of UEDB project infrastructure costs (in addition to operating costs) associated with establishing new water service while those who live in the heart of the city and receive piped water do not pay the full operating cost needed for the piped water system, let alone any infrastructure costs. UEDB projects in peripheral, marginal barrios require communities to pay 20% of infrastructure costs upfront, with another 60% of the total project price repaid in monthly installments.  This enables UEDB financing to be self-sustaining over time.  In contrast, on-network water prices average 1.8 Lempira/cubic meter, but only a price of 6 Lempira/cubic meter would enable the network system to cover

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[34]  Interview with Omar Alemendares, SANAA, 10/28/03.

[35] World Bank, "Urban Services Delivery and the Poor: The Case of Three Central American Cities," pg. 55

[36] Dr. Shlomo Angel, "Housing Policy in Honduras: Diagnosis and Guidelines for Action," June 2002, p38.
"A 55-gallon drum costs L.13 and a typical family buys two drums per day, or 60 per month, at a total cost of L.780 ($48)."

its costs in a self-sustaining manner.[37]  A recent attempt to increase water prices in the city was met with public outcry, and the tariff increase was subsequently scaled back by 50%.


## Devolution of Water and Sewerage Authority

The National Water and Sanitation Service (SANAA) was created in the 1960s to maintain and administer Honduras' water and sanitation systems.  Despite several reorganizations and transitions over the last five years, SANAA remains in control of water supply, water distribution, and sewerage in the Central District and nearly all of the country.  The municipality of San Pedro Sula, however, did not support the centralization of water and sewerage functions and is not included under SANNA's central umbrella.

According to a 2001 World Bank report[38], and confirmed during our interviews, SANAA's official policy on devolution of water and sewerage authority is to return control to local governments that "demonstrate" their management capability.  Not surprisingly, there is great institutional resistance to this policy, and in practice, responsibility has not yet devolved from the State to local governments in any meaningful way.  SANAA continues to own and manage Tegucigalpa's water system, but its activities have been "hamstrung by its growing institutional uncertainty."[39]  The IDB and others have financed projects to study the potential privatization of the water and sanitation system, but there is considerable political and institutional resistance to these proposals.

Opposition to decentralization and privatization in Tegucigalpa comes from several sources, including SANAA's strong union, political constituencies that benefit from the current system, and SANNA's leadership.  The union is exempt from civil service labor laws and bargains directly with SANAA managers, which gives the managers an incentive to placate the union.  Political constituencies that currently benefit from the heavily subsidized, centralized water service include almost all middle and upper-class households in the city.  The institutional leadership within SANAA has a vested interest in the status quo and some leaders have principled concerns about the capacity of local municipalities to manage the water and sanitation systems.  Municipal control holds the potential for improved accountability (Mayor must get reelected, SANAA head is appointed by the President), however corruption and machine politics remain a risk, due to the limited amount of resources, and the highly political history of infrastructure development in the city.

SANNA seems to view decentralization as an all-or-nothing proposition.  In other words, if authority is devolved to Tegucigalpa, then it must be devolved to every tiny municipality in the land, inflating costs and budgets.  A more nuanced and scaled view would provide greater potential for realistic implementation, where decentralization could be promoted in cities with a population of 500,000 or more first, and subsequent steps down to 250,000,

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[37] Interview with Omar Alemendares, SANAA, 10/28/03.
[38] World Bank, "Urban Services Delivery and the Poor: The Case of Three Central American Cities." 2001
[39] World Bank, "Urban Services Delivery and the Poor: The Case of Three Central American Cities," 2001, pg. 52

100,000, etc. Additionally, SANAA could maintain its role in financing infrastructure but transfer operation and maintenance authority to municipality.

San Pedro Sula serves as a model for local control. San Pedro Sula was successful in avoiding service centralization, securing IDB financing for water treatment infrastructure, and later merging the municipal system with private sector involvement. The water system at present is a mixed private/public enterprise managed under commercial law, which reduces the politicization of water management and service decisions. A model for the decentralization of Tegucigalpa's water system could involve three steps: devolving control to the municipality, transitioning to municipal/private cooperative authority, and eventually privatizing service provision. In the first few years, the process could be protected from political shocks by limiting the magnitude of rate increases that could be imposed on city residents. Once privatization is institutionalized, controls can be relaxed to allow fees-for-service to reach levels appropriate to sustainably support operation costs. In this scenario major infrastructure development (dams) would continue to be the responsibility of the state and would require continued federal subsidies.

# VII. Sewerage and Solid Waste

Sewerage infrastructure in Tegucigalpa is inadequate to serve the current and growing needs of the city. The city's solid waste management system meets present needs reasonably well, but faces significant challenges in the next few years with regard to its revenue stream and the need for a new permanent landfill site.

In an unusual arrangement not seen elsewhere in Honduras, SANAA operates the city's sanitation system and manages sewerage infrastructure improvements. Piped sewerage is only available to communities on the piped water network, which means that, at most, 87% of the city's residents have access to the sewerage system.[40] The remainder of residents, we assume, rely on outhouses for their sanitation needs. Given the small plots of land, steep terrain, and unfavorable soil conditions of the many informal settlements, outhouses are often an inadequate solution.

Tegucigalpa's sewerage system was severely damaged during Hurricane Mitch in 1998. Whereas the piped system previously transported waste downstream before dumping it untreated into the river, hurricane flooding destroyed the end-of-the-pipe infrastructure leaving waste to be released into the river within the city. Repairing and replacing elements of the sewerage system damaged in the hurricane is an expressed priority of the municipality.

Expansion of the sewerage network is closely tied to the paving of roads since the municipality wants to ensure that all pipes are laid before bus routes are paved. Therefore, bus route paving projects are managed (at the municipal level) in coordination with the extension of the sewerage network (under the purview of SANAA). This interconnected responsibility can lead to difficulties at times, for instance, when pipes have been laid, a community wants the road paved, yet the community has not paid its portion of the pipe connection costs. In such cases SANAA may ask the city not to pave the road until the community has paid the sewerage fees, leaving the municipality to bear the political fallout from the unsatisfied community.

SANNA has demonstrated some innovation in its approach to extending the sewerage system into un-served areas, but our interviews failed to uncover a coherent vision for how services could be expanded to reach peripheral neighborhoods. One example of a creative approach is SANNA's approval of the use of smaller diameter pipes to reduce the cost of extending the sewer network; we were told that costs were more than cut in half by using 4-6 inch pipes rather than the standard 8-inch pipe.

## Sewerage Options and Alternatives

Because adequate sanitation infrastructure is critical to the health and quality of life of Tegucigalpa's residents, the municipality, in conjunction with SANNA, should place new

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[40] World Bank, "Specialized Household Survey, Tegucigalpa." 2000

emphasis on expanding access to sewerage and on investing in waste treatment facilities. In an ideal world, the government would provide the resources to finance provision of modern, high quality, near term, widespread sewerage access and wastewater treatment. The reality in Tegucigalpa, however, is constrained, both by geography, and more critically, by lack of financial resources. Given the pressing need to expand sewerage to informal and peripheral neighborhoods, we recommend that low-cost alternatives to the city's centralized sewerage paradigm be researched and assessed. SANAA has demonstrated an ability to innovate, by extending the existing system to some peripheral areas at a lower cost (see above), however, this innovation has not reached so far as to consider alternative systems of sewage collection and treatment. Numerous innovative and alternative sewage treatment models are available globally, and have been popularized in a variety of cultural contexts. Several of these models are outlined below.

1. *Community-based Sewerage: Lessons from Indonesia and Pakistan[41]*

   Successful community-based sewerage systems have been implemented by local leaders in low-income urban neighborhoods in Malang, Indonesia and Karachi, Pakistan. In the case of Malang, neighborhood residents designed, contributed money, provided labor, built, and maintain a small-scale sewerage network and treatment system in their neighborhood. Using a simple system of gravity-fed pipes and small anaerobic septic tanks and filters[42], a typical community treatment system takes up roughly four by six meters and can serve up to 200 families.[43] The effluent from this process is not potable, but can be used for watering gardens or can be safely discharged into waterways.

   In contrast, Karachi's experiment with community-based sewerage in Orangi, one of the city's largest squatter settlements, did not involve a treatment component. It did, however, install septic tanks between each toilet and sewer line, thus removing solid waste from the sewer network. The Orangi project's leader organized residents into community groups of 20 to 30 households, informed each group of the construction process, allowed the group to decide whether to participate, and provided a technical adviser to develop plans and a cost estimate for their area. An elected group member was responsible for collecting funds from the other members while local residents and tradesmen provided the labor. Each group was an independently run organization and constructed its own sewerage network. Effluent flowed from community group networks into common lanes and eventually local waterways. Motivated by their personal investments and sense of ownership, group members largely maintained the infrastructure they had created.

   Key's to successful community-based sewerage initiatives[44]:

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[41] Vogt, Brian. "Community Based Sewerage in Developing Countries," Student paper for Professor Solly Angel's Princeton course on Housing in Developing Countries, May 14, 2003.
[42] For system specifications see: Foley, Sean, Anton Soedjarwo, and Richard Pollard. "Water and Sanitation Program," *Of the People, By the People, For the People: Community-Based Sewer Systems in Malang, Indonesia,* 2000.
[43] http://www.ashoka.org/fellows/viewprofile1.cfm?PersonID=937.
[44] Vogt, Brian. "Community Based Sewerage in Developing Countries," Student paper for Professor Solly Angel's Princeton course on Housing in Developing Countries, May 14, 2003.

- Implement projects where there is an expressed demand for sewerage among community members.
- Projects are more successful in areas with higher social capital, where residents are more likely to self-organize and keep up with system maintenance over the longer term.
- Foster community member buy-in through resident financing of the project and resident choice in project design.
- Local governments or NGOs are encouraged to facilitate the creation of community groups and provide technical assistance, but not to run or blindly finance them. Community involvement, decision-making, and ownership are fundamental to the project's success.

2. *Condominium Sewerage: Brazil*

Condominium Sewerage has been actively developed and deployed in South America. It involves the following elements:

- Setting up a local treatment facility that serves a small number of houses concentrated together at the block level. Sewer lines are set up to minimize the distance to the treatment facility, and minimize the amount of pipe needed.
- The use of an urban block as the minimum sewage unit, as the connected households represent a sort of "horizontal condominium," quite similar to what happens in terms of sewage flow in a vertical apartment building;
- Condominium sewerage systems can be set up independent of the public sewerage system, and then connected to the larger public system at a later date, when community residents have raised the funds necessary to pay for that connection and service.

Over 4,000 km of condominium sewerage is in operation in Brazil, and other countries have been encouraged by the World Bank to use similar technology. The system was invented by Mr. José Carlos Melo, a Brazilian Sanitary Engineer, and used for the first time in 1982 in the sewerage component of the Rocas and Santos Reis Subproject held in the City of Natal, State of Rio Grande do Norte, as a part of the World Bank-funded Medium-Sized Cities Project. Mr.Carl Bartone, of the World Bank has commented, "... the conjunction of low-water volume toilets with condominium sewerage is the most powerful tool to make adequate sanitation feasible even for the (urban) poor".[45]

3. *Decanto-Digestor And Anaerobic Filter System: Brazil*

Another neighborhood-level treatment alternative has been developed in Brazil as well. A system composed of a decanto-digestor with two chambers in series followed by a small ascending-flow stone filter and by saturated, descending-flow anaerobic filters is being developed and deployed in the State of Rio Grande do Norte - Brazil, but it has yet to be used outside of that area. This system has been used to successfully treat a

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[45] This description has been excerpted, more or less word for word, from the "International Source Book On Environmentally Sound Technologies for Wastewater and Stormwater Management," United Nations Environmental Program, IETC, available at
http://www.unep.or.jp/ietc/Publications/TechPublications/TechPub-15/main_index.asp

large volume of sewage from a portion of the State University system, and has been used in day-to-day operation to treat residential waste from the Pirâmide Hotel, in Natal-RN, Brazil. "The decanto-digestor in series with anaerobic filters demonstrated good performance under all operating conditions studied. In full scale, it allowed removals of 76% of soluble COD. In pilot scale it allowed removals of about 80% of total COD and 90% of the suspended solids."[46] This model is not designed to be participatory at the community level.

4. *ECOSAN: Ecological Sanitation*

Ecological Sanitation (ECOSAN) provides an alternative to conventional sanitation treatment systems, both on-site (pit toilets) and off-site (flush toilets). ECOSAN is a three-step process involving the containment, sanitization, and recycling of human excreta. "The objective is to protect human health and the environment while reducing the use of water in sanitation systems and recycling nutrients to help reduce the need for artificial fertilizers in agriculture…Ecological sanitation systems are designed around true containment and provide two ways to render human excreta innocuous: dehydration and decomposition. The preferred method will depend on climate, groundwater tables, amount of space and intended purpose for the fertilizer produced by the process."[47] Both dehydration and decomposition methods are accomplished on-site using two-stage toilets. The systems require the addition of wood ash, lime, or soil after each use of the toilet and periodic removal of the composted materials (every six months). Although inexpensive to construct and flexible in their deployment, the ECOSAN systems require extensive public commitment to new behaviors, and can be difficult to implement.

Our intent is not to provide an exhaustive survey of alternative sewage treatment systems, but rather to reference several different promising technologies as a way to whet the appetite of those with a desire to innovate.[48] These models are cost-effective alternatives that meet low-income residents' needs in the near term. Although they are described in the literature as permanent solutions, they can just as easily be considered interim solutions that will improve the health of residents and the local environment until the city develops to the point where residents are willing and able to pay the higher fees associated with connecting to and paying for expansion of the mainstream, conventional sewerage network and treatment plants.

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[46] Cícero Onofre de Andrade Neto, Patrícia Guimarães, Maria Gorete Pereira, and Henio Normando de Souza Melo. "Decanto-Digestor And Anaerobic Filters," Departamento de Engenharia Civil-UFRN. Centro de Tecnologia
Campus Universitário - 59072-970 - Natal - RN – Brasil. E-mail: cicero@ct.ufrn.br. Fax.: 55.84.215-3703
[47] www.ecosanres.org, Stockholm Environment Institute, Lilla Nygatan 1 (street address), Box 2142, SE-103 14 Stockholm, Sweden. Tel: +46 8 412 14 00, Fax: +46 8 723 03 48
[48] Additional Spanish language resources include: CEPIS, Hojas de Divulgación Technica #55: Tecnologias De Bajo Costo Para Sistemas De Alcantarillado, por Ing. Roberto Mejia; Universidad de Antioquia, Colombia. 1993.

## Solid Waste Management

A 1998 JICA study estimated that 800-850 tons of solid waste is produced in Tegucigalpa each day. However, the municipality collects only 600-650 tons per day (or 70-80% of that which is produced) for controlled disposal. Municipal solid waste service provision presently includes:

1. **Street cleaning:** 90 micro-enterprises, consisting of seven person teams, sweep 220 km of city streets each day. The teams also clean church property, green space, and cemeteries. <u>Street cleaning consumes 30% of the municipal waste management budget.</u>

2. **Trash collection for homes and businesses**: 515 barrios are served by trash pickup (42 barrios identified as not served currently, down from 69 barrios not served two years ago). 65% of the trash trucks are owned by the municipality; 35% are privately owned. Houses receive pickup twice a week, businesses 5 times per week. 93% of the municipality is served by trash pickup.

3. **Solid waste disposal:** The current landfill is located north of the city. According to officials at the municipal [name of office?], the city has only 70% of the equipment it needs to manage the landfill properly. Nearing capacity and over 30 years old, the landfill will be closed in the next few years. The city has identified a temporary landfill site to use until a permanent site can be identified, and has contracted a Colombian company to identify a new permanent site.

The primary challenges confronting the city in its effort to improve solid waste management can be categorized as revenue- and culture-based. The city charges a fee for trash collection services, and, we were told, its billings are sufficient to cover total costs. However, due to the low number of bills actually paid—on the order of 40%—fee-for-service revenues do not cover costs. The city notes that, at present, it bills roughly 152 million Lempira per year for trash collection, but receives only 60 million of that total. The Mayor has made the cleanliness of the city a priority, and his office is currently subsidizing waste collection from its own budget.

With regard to culture, educating citizens about proper waste disposal, convincing them to refrain from littering or dumping, and improving compliance in bill paying are longer-term behavioral shifts needed for a more sustainable waste management environment in Tegucigalpa. The municipal solid waste engineers we spoke with noted that considerable cost savings could be achieved if the city were able to reduce the number of "independent contractor teams" hired to sweep the streets each day and night (the crews operate 24 hours a day, with day teams and night teams), but that this would require a change in civic attitudes and behaviors.

# VIII. Open Space Preservation and Human Vulnerability

In the past 30 years Tegucigalpa has experienced unprecedented growth. The urban environmental degradation accompanying this growth has had severe consequences on quality of life, particularly for the urban poor. As the city enters the next phase of its growth, it important to consider what measures should be taken to improve urban land management so that Tegucigalpa can balance environmental protection, economic development, and still meet the basic housing needs of its citizens. These measures should provide for (1) the expansion of parks and green spaces, (2) the preservation of critical ecosystems and watershed areas, and (3) the mitigation of human vulnerability.

## Impact of city growth

Rapid growth and development in Tegucigalpa, whether formal or informal, has led to a loss of open spaces and to significant deforestation, both within the city and in surrounding areas. The city lacks recreational and park area proportional to the size of its population. Uncontrolled urban growth is encroaching on protected areas and critical watersheds serving the city.  Deforestation in the areas surrounding Tegucigalpa is driven by the need to clear space for construction, the need for fuel, and the search for timber. Deforestation and settler encroachment on protected areas is largely determined by road access[49].

Rapid growth and the consequent deforestation have also increased Tegucigalpa's vulnerability to landslide and flood hazards. Unplanned development combined with deforestation has increased susceptibility to the landslides that are often triggered by heavy rains. Landslides and debris flows triggered by heavy rains during Hurricane Mitch occurred in areas without appropriate stormwater management systems and on slopes with sparse vegetation[50]. Deforestation has led to erosion and sedimentation of several river basins, increasing the risk of flooding.

Loss of open spaces and the associated environmental degradation has affected the urban poor far more than the wealthy. The poor are typically unable to afford health care, access to recreational activities, and improved housing. High urban land prices in Tegucigalpa have pushed the urban poor into increasingly marginal areas with high probability of natural disasters.  Furthermore, poor households lack the resources or access to credit required to improve the quality of housing and infrastructure[51].

## Existing Open Space and Vulnerability

Rapid growth, combined with an outdated legal and regulatory framework in the property sector, has resulted in a sprawling and unorganized pattern of residential development.

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[49] Heckadon-Moreno, S. (1997)
[50] Harp, E.L. (2002)
[51] Charveriat, Celine (2000)

Currently, roughly 60% of Tegucigalpa's inhabitants live in informal settlements. The informal settlements are not continuous. Patches of vacant land are scattered throughout the city. A JICA study of the Tegucigalpa Metropolitan Area showed that approximately 30% of the land within the urban area is vacant space. Formally designated open spaces, either parks or green areas, make up only 2 km$^2$ (202hectares), or 2% of the metropolitan area[52]. This figure includes a part of the United Nations Park (El Picacho) which is 3.6 km$^2$ in total area. Of the parks and green areas, 0.6 km$^2$ (60 ha) is available for recreational use, and 0.25 km$^2$ (25 ha) is equipped, and actively maintained by the city for recreational purposes[53].

**Figure 8.1:** **Land Use in the Tegucigalpa Urban Area**
(Source: JICA, 2002)
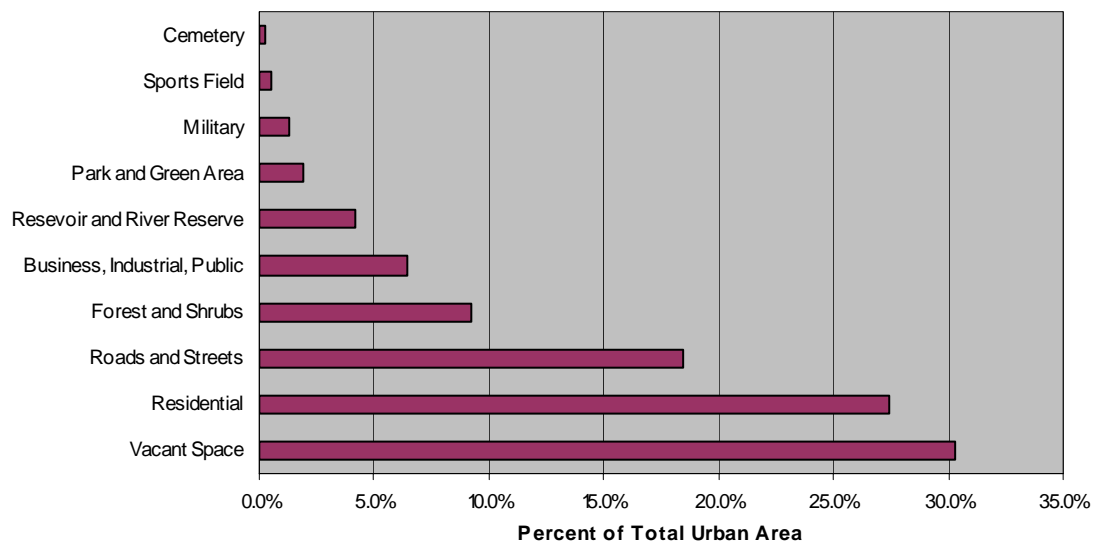


Tegucigalpa's estimated population in 2001 was 850,227. This means that there are about 0.23 ha of open space per 1,000 people. Most of the municipal parks are located in the Tegucigalpa side of the city and are concentrated in the city's historical center. There are almost no local parks distributed in city's periphery where most of the dense, informal settlement is located. Comayaguela and large areas outside the center do not have any parks or open spaces, other than vacant land.

*Parks and Open Spaces*

Most colonias do not have officially designated parks or open spaces. A few colonias do use vacant lots as informal parks and playing fields. This is the case in both the 40-year old settlement of La Esperanza and the newly created settlement of Estanzuela. Informal settlers recognize some of the benefits of open spaces, but scarcity of land means that there

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[52] JICA, 2002a
[53] Interviews with Office of Parks and Gardens

is high pressure to develop every plot. Organizers of informal settlements do not explicitly consider open space issues when making infrastructure decisions. The organizer of the invasion receives an immediate benefit from selling all the plots on a given property. No financial incentives exist to set aside parcels for a communal park or for recreational purposes.

The lack of open space is a feature of both formal and informal settlements. The historical center of the city was planned to incorporate parks, but more recent residential developments have tended to neglect them as a planning element[54]. Open spaces in the form of parks have also been excluded from recent formal development whether residential or commercial. There are no open space reservation requirements for commercial or residential developers. The few existing city parks, open spaces, and historical sites are in poor condition. The period of 1950-1990 was one of general abandonment of public spaces, parks, and historical buildings in Tegucigalpa. It is only now that the city is beginning to recover from Hurricane Mitch and rebuild the older parks by installing new equipment and facilities. The city does not have any current plans to create new parks in existing colonias or on vacant land[55].

A recent study by the municipal Office of Parks, Gardens, Open Spaces, and Town Projects showed that 70% of the demand for parks and outdoor recreational facilities is unmet. The municipality's goal is to reduce this unmet demand to 40% by reconstructing parks existing parks and equipping them with recreational facilities. The municipality is incorporating some elements of green spaces into planning new roads. The reconstructed highway which passes by the Juan Lainez park and the stadium includes a landscaped walkway and overlook. There are also proposals to turn a section of riverbank along the Choluteca into a linear park. The proposed project would canalize sections of the river and reduce flood damage. Turning the riverbank area into a park, or roadway would also help prevent settlement along flood-prone areas of the riverbank and relieve the traffic situation in the center of the city, but it will not greatly improve the river quality. Much of the pollution enters the system upstream in the Guacerique, Chiquito, and San Jose basins. Initial cost estimates for this proposal are on the order of $200 million.

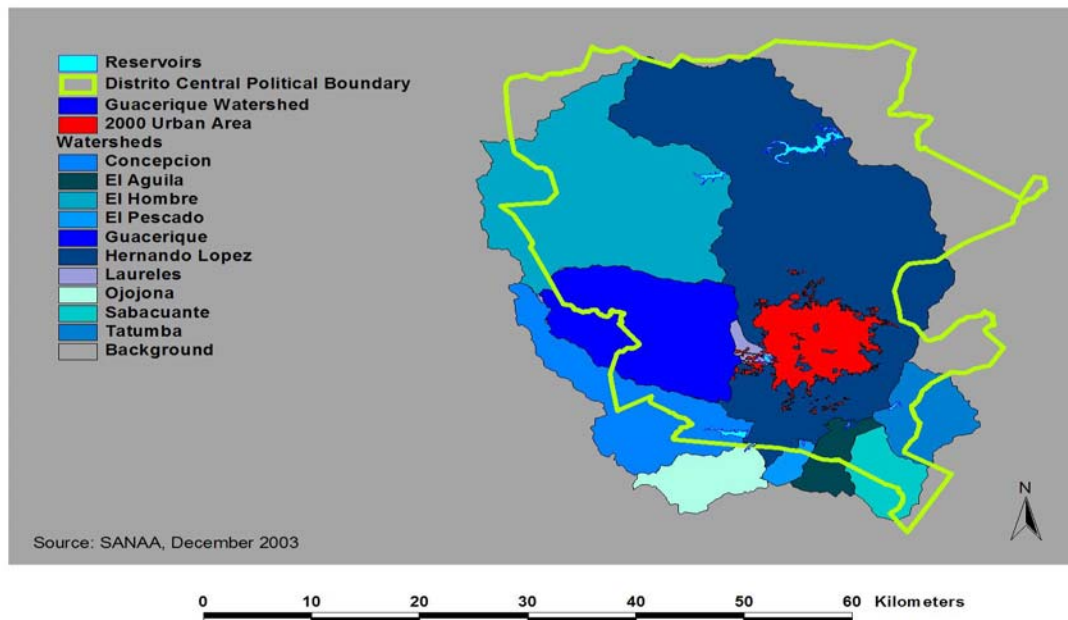### Regional Parks and Protected Areas

El Picacho, a national park located in the northwest corner of the city, comprises 3.6km² and contains several recreational and tourist attractions. La Tigra National Park, located further north of El Picacho, has been protected by different government agencies since the beginning of the twentieth century because of its importance as a water source. La Tigra has an area of over 7,571 hectares and encompasses a large cloud forest. In September, 1993, La Tigra National Park management was transferred to a non-profit private organization, Fundación Amigos de la Tigra (AMITIGRA). Both parks are major tourist destinations.

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[54] Interviews with the Office of Parks and Gardens
[55] Interviews with the Office of Parks and Gardens

Other protected areas in the area include the watersheds feeding the city's reservoirs and the biological reserves of Yuerba Buena (the headwaters of the Choluteca), Uyuca, and Los Coralitos. In the northern part of the city, urban growth is encroaching on the United Nations Parks (El Picacho) and La Tigra.

**Figure 8.2:** **Watersheds in the Distrito Central**



Legend:
- Reservoirs
- Distrito Central Political Boundary
- Guacerique Watershed
- 2000 Urban Area

Watersheds
- Concepcion
- El Aguila
- El Hombre
- El Pescado
- Guacerique
- Hernando Lopez
- Laureles
- Ojojona
- Sabacuante
- Tatumba
- Background

Source: SANAA, December 2003

0   10   20   30   40   50   60   Kilometers

National Park. In the case of La Tigra, encroaching development also threatens the quality of another of the city's watersheds. In the south, development is encroaching on the city's major reservoir, La Concepcion[56]. Deforestation in the protected areas, particularly in the watersheds, is a serious problem, which has contributed to sedimentation of river channels and increased potential for flooding on the Choluteca and its tributaries.

### Vulnerability And Settlement In Hazard Prone Areas

Vulnerability to natural disasters has not deterred settlement in most parts of the city. As much of the prime land in the city center is already built-up, informal developments increasingly are found on very steep slopes or floodplains where the risk of natural hazards is high. These colonias also tend to be relatively poor, and lacking in sewage and drainage infrastructure. Limited public transportation in Tegucigalpa means that low-income groups prefer to remain close to the city center, even though better quality land may be available on the periphery. They are willing to accept increased vulnerability to natural or man-made hazards in exchange for proximity to services and employment.

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[56] Interview with SERNA

Informal developments are typically preceded by clear-cutting of invaded sites, which results in the loss of ground cover and vegetation. Since most of these settlements also lack appropriate drainage infrastructure, this practice has led to problems with erosion and stormwater runoff. Soil erosion is high in 6 micro-basins (Choluteca, Chiquito, Sabacuente, Qebrada Grande, Laguna El Pescado, and Mololoa)[57]. Erosion and the consequent sedimentation of river channels have increased the likelihood of flooding. Large scale housing development is contributing to erosion in the Chiquito basin.

Approximately 40% of the city's capital stock was damaged or destroyed by landslides and flooding during Hurricane Mitch (JICA)[58]. Much of the damage caused by Mitch was preventable. It is estimated that 50% to 75% of the economic costs of lost property and services due to Hurricane Mitch resulted from inadequate land-use planning and management[59]. Better sitting and construction of settlements, roads, and infrastructure as well as better environmental management practices would have significantly reduced the loss of lives and property. Post-Mitch studies conducted by USGS and JICA have attempted to characterize and rank natural hazards across the city and they have produced maps identifying areas susceptible to flooding and landslides. Estimates on the hazard prone areas of Tegucigalpa vary widely.

*Landslides:* According to a USGS study 95% of the landslides triggered by Hurricane Mitch were actually debris flows, a mixture of fast-flowing rock, soil and water[60]. The occurrence of debris flows and their impact were exacerbated by deforestation and loss of vegetation throughout much of the built up area of the city. Most of the debris flows, landslides, and slope failures during the hurricane occurred in Comayaguela or the eastern periphery of the city, areas which have little drainage infrastructure. According to the JICA report about 25% of the built-up area of the city faces a high risk of landslides or slope failure in cases of heavy rainfall. Areas of steep slopes, with inclines greater than 30 degrees, make up 8.4% of total urban land area. Overall, about 26,000 households, or 105,000 people, face a landslide or slope failure hazard during bouts of intense rainfall.

*Flooding:* JICA and USGS reports estimate that the two-day rainfall amount in Tegucigalpa during Hurricane Mitch has a return period of 500 years. According to JICA estimates, a more likely 50-year flood on the Choluteca would affect about 1789 households, while another Mitch-like storm is capable of flooding 2km$^2$ and destroying at least 3000 households. However, this estimate might be an optimistic case as it does not take into account the consequences of sedimentation and resultant flooding in other river basins.

The JICA study has led to a characterization of the risk in each colonia. 141 colonias, mostly informal settlements, face a risk of flooding or landslides. Approximately 150,000 inhabitants, or 16% of the population, are in high risk areas. 76% of the households affected by landslide and slope failure hazards are poor or low income. Similarly 76% of

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[57] JICA, 2002
[58] International Monetary Fund (2001)
[59] Inter-American Development Bank (IADB) (1999)
[60] Harp (2002), Eugster (2002)

the households affected by flooding in the 50-year flood case are poor and low income. In the 10-year flood case, 83% of affected households are poor and low income. The Municipal Emergency Committee (CODEM) has further identified 8 colonias, requiring immediate intervention. CODEM is also training local volunteers in each at-risk colonia on emergency preparedness and response.

Attempts to mitigate vulnerability by controlling settlement have not been successful. Previous attempts to resettle communities from disaster areas, such as Amarteca, have failed either because new sites were not easily accessible or because resettled households tend to move to back to their original sites and sell off the new property acquired through the resettlement program. Resettlement costs are estimated to be about $100,000 La/household[61].

## Management Of Existing Parks And Open Spaces

City parks and green spaces are currently under the management of the Division of Parks and Gardens (DPG). DPG is administratively associated with the headquarters of the municipal Director for Urban Development and Infrastructure (DDUI). DPG is only minimally involved in the broader issues of land use planning and enforcement in the city[62]. Metroplan is responsible for overall planning and land use decisions in Tegucigalpa and it is the only authority capable of bringing legal action against squatters on parks, open spaces, or undeveloped municipal lands. The city's Unit for Environmental Management (UGAM) is a quasi-municipal body, operationally linked to the national Secretariat for Natural Resources and Environment (SERNA), and funded through the municipal budget. UGAM is part of the Executive Secretariat of the Municipality with its head appointed directly by the Mayor and charged with implementing national environmental laws at the local level[63]. In collaboration with SERNA, it also monitors some of the national protected areas and parks surrounding the Central District. However, UGAM seems to be only minimally connected with the rest of the municipal government. There is no regular collaboration with the DPG or Metroplan on planning and environmental issues.

### *Regional Protected Areas Management*

Efforts to manage protected areas and parks around Tegucigalpa have had mixed results. A FAO report notes that problems arise from a marked lack of environmental legislation and inconsistency among the existing legislative acts applying to natural resources in Honduras. Conflicts between local and national legislation has led to confusion over division of responsibilities for ensuring environmental quality and monitoring protected areas. Monitoring agencies lack the resources and staff to adequately monitor and enforce measures concerning protected areas and natural resources. In many cases, parks and protected areas have been decreed without consulting local communities and farmers.

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[61] Interview with CODEM
[62] Based on interviews

Cooperation between the agencies responsible for managing the forests, parks, and protected areas, which (SERNA, CODEHFOR, SANAA, INA, UGAM and Metroplan) is limited. What little collaboration exists does not extend to planning for future urban growth and new open spaces or parks. There is also a division between the monitoring agency and the agency capable of bringing legal action against settlers in protected areas. Within the Central District, legal authority resides with the Metroplan office, which is the only body capable of taking legal action against illegal settlement. Areas outside the Central District are under the jurisdiction of the Technical Environmental Unit of SERNA rather than the watershed division of SANAA or CODEHFOR, which are actually responsible for monitoring.

There is also little collaboration between NGOs and government agencies on protected areas management. Amigos de la Tigra (formerly Honduran Ecology Association / Asociación Hondureña de Ecología) supported and promoted the establishment and maintenance of protected areas through publications and public awareness campaigns. It is directly involved with managing El Tigre National Park in coordination with park personnel and has been active in lobbying the national government to create new national parks, wildlife reserves and biological reserves. NGOs such as Honduras Conservation Corps, IDIH, and Ecología are also involved in working directly with communities on sustainable environmental management practices.

### Managing Hazard Prone Areas

Since the Hurricane Mitch disaster, the Honduran government has established an emergency response committee (COPECO) to plan for and respond to natural hazards. The municipality of Tegucigalpa has also created its own municipal emergency committee (CODEM), as the entity responsible for disaster preparedness, warning and response. CODEM has brought together several different organizations to coordinate emergency planning and responses. The agencies involved in monitoring hazard prone areas include UGAM, Metroplan, and COPECO. Metroplan is the legal authority for enforcing zoning rules regarding settlement in hazard prone areas. CODEM has taken few steps to mitigate vulnerability to natural hazards. Its strategy has been reactive than proactive towards hazard prevention and vulnerability mitigation.

## Strategies for Expanding Open Space and Mitigating Vulnerability

Land use decisions concerning open space will be critical for reducing environmental degradation in Tegucigalpa, improving quality of life, and mitigating the vulnerability of residents in hazard prone areas. Conventional approaches to open space planning focus on considerations of the landscape, recreational requirements, environmental and ecosystem impacts, and vulnerability. However, in the case of Tegucigalpa, the enforcement of land use decisions is also a major consideration. Until the municipality develops the administrative and monitoring capacity to enforce zoning laws and regulations, it will have to find other means to persuade residents to follow its plan for the city. Alternate

enforcement strategies include economic incentives, guided infrastructure investment, road construction, controlled service delivery, and community education.

We propose a two-pronged strategy for expanding open space and mitigating vulnerability:

       1. Identifying areas where development should be limited such as parks, protected areas, flood plains, and steep slopes.

       2. Enforcing the limits on development in these areas through economic incentives, education, and the provision of affordable alternate sites.

*Open Space Expansion*: Meeting the current demand and planning for the demand of future residents will require expanding open spaces. The municipality will have to create new parks in all colonias. The majority of Tegucigalpa's residents are poor and interested in the tangible benefits of parks. This means the city needs to focus on projects for upgrading or building new local parks, community gardens, pedestrian walkways and tree planting along streets. Land for parks and open space can be acquired from vacant land and undeveloped plots. The table below illustrates one possible plan open space expansion plan for Tegucigalpa which would increase open space per 1000/persons to 2 hectares by 2026.

| Table 8.1: Expansion of Open Space, Greenspace, and Parks | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Year** | **2001** | **2006** | **2011** | **2016** | **2021** | **2026** | **2031** |
| Population *(000,000)* | 0.85 | 1.01 | 1.19 | 1.37 | 1.548784 | 1.75 | 1.98 |
| Land Consumed *(hectares)* | 8502 | 10161 | 11874 | 13655 | 15488 | 17519 | 19795 |
| Parks and Green Space *(ha)* | 202 | 700 | 1400 | 2100 | 2800 | 3500 | 4000 |
| Parks and Green Space *(% of Land Consumed)* | 2.4% | 6.9% | 11.8% | 15.4% | 18.1% | 20.0% | 20.2% |
| Parks and Green Space *(ha/1000 persons)* | 0.24 | 0.69 | 1.18 | 1.54 | 1.81 | 2.00 | 2.02 |

Economic and infrastructure incentives for open space preservation will be necessary to ensure compliance with the plan. Open space requirements for sewerage and road access may compel both formal and informal developers to better plan new settlements and upgrade old ones. Residents could be mobilized to participate in open space planning through NGOs and community outreach from the municipal government. Participation in the planning process instills a greater sense of ownership over the space and, in long run, leads to better maintenance and preservation.

*City wide park system*: Tying open space expansion to the larger urban land use and transport plan would result in a more integrated vision for the city's growth. A city-wide strategy for open space, which incorporates local parks and regional protected areas, can help incorporate factors such as environmental degradation, vulnerability mitigation and ecosystem enhancement. Larger parks should be planned to coincide with areas unsuitable for development such as flood basins, and landslide prone areas. Linear greenspaces, which take up little space, could be molded to follow natural features or roadways, linking

parks, protected areas and historical centers, commercial and residential areas. A park and greenway system can also be incorporated into existing infrastructure projects such as road and highway construction, river basin remediation, drainage system development.

*Regional protected areas*: The municipality will have to work with national government agencies, communities, and NGOs to develop a coordinated strategy to improve the quality of its watersheds and develop new ones. Selection of areas for protection should include considerations of city water supply, watershed quality, and sensitive ecosystems. Critical ecosystems such as cloud forests are located at high elevations, suggesting that high plateaus and peaks should be protected from development and deforestation. SERNA is looking at creating new protected areas in the Quiera Mountains particularly on the Yuerba Buena and Azaculapa peaks.

Creation of new protected areas must involve affected communities inside those areas and draw more on the experience of NGOs. NGOs have been more active and more effective than the government in managing protected areas in Honduras. La Tigra National Park has been managed by an NGO for over a decade. NGO management presents a viable option for management of future watersheds and protected areas.

*Vulnerability mitigation*: To reverse the trend of poor urban resident moving into hazard prone areas, the city will have to densify existing settlements on hazard-free land and make better quality land on the periphery easily accessible for development.  Some hazard prone areas can be blocked off from settlement by converting them into parks and open spaces. The vulnerability of current settlements must be mitigated through a combination of structural and non-structural measures. Low cost structural measures include:

- Micro-forestation of selected slopes and stream banks;
- Distributed stormwater management at the household and neighborhood level rain through rain gardens, planting buffers, and using rain barrels and cisterns to capture and control rainwater runoff; and
- Small-scale terracing to reduce runoff velocity and soil erosion.

Non-structural measures for mitigating vulnerability should focus on making households more resilient. These measures should include:

- Community education and outreach through the municipal government, local schools, and NGOs such as the Honduras Conservation Corps;
- Schemes for buying residents out of hazard prone areas and then converting the area into a park or protected area; and
- Increasing poor households' access to credit so that they can buy land in safer areas, improve their housing quality, and better recover from disasters.

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