URBAN INFRASTRUCTURE GROWTH IN DEVELOPING COUNTRIES
Case Study: Bogotá, Colombia

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ABSTRACT

This elementary study briefly surveys the physical growth of the Road, Public Transport, Water, Sewer and Drainage, Electricity, Telephone and Refuse Systems of Bogota, as compared to the growth of the city's Population, Urbanized Area and Dwellings.

These systems are considered indispensable to support and/or to improve urban life; Its development and availability of the service they provide are matters of survival and progress for any modern city.

Using information provided by local authorities in charge of the different systems, the growth of selected basic components of each system is presented here by means of statistical and comparative diagrams. The thesis intends to dramatize the growth and demand of these systems in Bogota during the century; and to show the disparity between the Population explosion in the urban areas of developing countries and the supply of services.

Thesis supervisor: Horacio Caminos
Title: Professor of Architecture

TABLE OF CONTENTS

ABSTRACT.....PAGE 1
ACKNOWLEDGEMENT..... 2
INTRODUCTION..... 3

CONTEXT: COLOMBIA. BASIC DATA..... 4
BOGOTA. BASIC DATA..... 6
INFRASTRUCTURE. BASIC DATA..... 10

SUMMARY: INFRASTRUCTURE SYSTEMS GROWTH..... 12

BASIC PARAMETERS: POPULATION..... 16
URBANIZED AREA..... 17
DWELLINGS..... 18

INFRASTRUCTURE SYSTEMS: ROAD SYSTEM..... 22
PUBLIC TRANSPORT SYSTEM..... 26
WATER SYSTEM..... 30
SEWER-DRAINAGE SYSTEM..... 34
ELECTRICITY SYSTEM..... 38
TELEPHONE SYSTEM..... 42
REFUSE SYSTEM..... 46

BIBLIOGRAPHY..... 50

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INTRODUCTION

The Objective:

To provide a better understanding of selected aspects of the city's physical growth to allow a more informed participation by the urban community in the control of their environment. Despite numerous studies of Bogota, a majority of the city's population is unaware of the magnitude and consequences of the uncontrolled urban growth.

The Method:

A field research in Bogota provided the background to the study. Utilizing personal contacts within the various Institutions and Agencies in charge of the elected systems: (a) Relevant aspects of each system were gradually established; (b) Population, Urbanized Area and Dwellings were selected as parameters of comparison; (c) This century was selected as the period of focus. (Data after 1970 is projected.)

The Scope:

The study is limited to the primary utility systems of the city. The study does not present new explanations or theoretical solutions for the city's development. It uses, mostly, already-developed information. It basically attempts to inform in relation to the implications of rapid growth.

Due to the necessity of simplification, the general quality of the included information is approximate.

CONTEXT
COLOMBIA. BASIC DATA

Brief History:

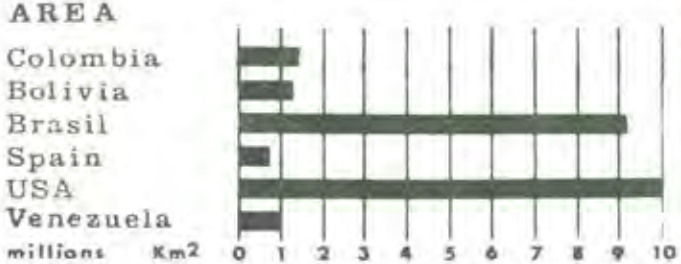
1502: Columbus arrives; Spain begins domination and exploitation of the native tribes.
1538: Bogota is founded.
1547: The territories of Panama, Colombia, and Venezuela are politically organized as the "Real Audiencia de Santa Fe," with the capital in Bogota.
1717: The territories of Panama, Colombia, Venezuela, and Ecuador are politically organized as the "Virreinato de Nueva Granada," with the capital in Bogota.
1781: Popular movements for independence begin with the "Revolution of Los Comuneros."
1810: Independence is declared.
1819: Independence is assured by the battle of Boyaca. The Nueva Granada becomes the New Republic of Gran Colombia.
1830: Venezuela and Ecuador declare their independence from Gran Colombia.
1903: Colombia loses Panama.

COLOMBIA
GEOGRAPHIC LOCATION

Source: 11.1
Information: Accurate

COLOMBIA
URBAN CENTERS DISTRIBUTION

Source: 11.1
Information: Accurate



COLOMBIA 1970

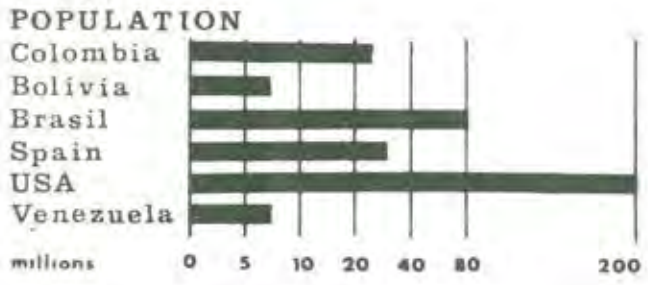
A country in continued under-development.

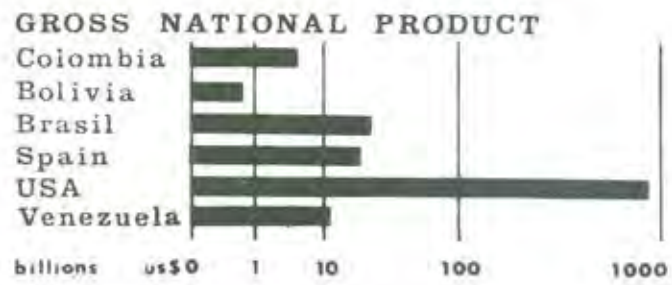
POPULATION: 25 million (est.)
LANGUAGE: Spanish
RELIGION: Catholic
ILLITERACY: 25% (17% of the urban population, 36% of the rural); only 0.6% has a University education.
ETHNIC DISTRIBUTION: 47% Mestizo, 23% Mulattoe, 20% White, 9% Black and 1% Indian.

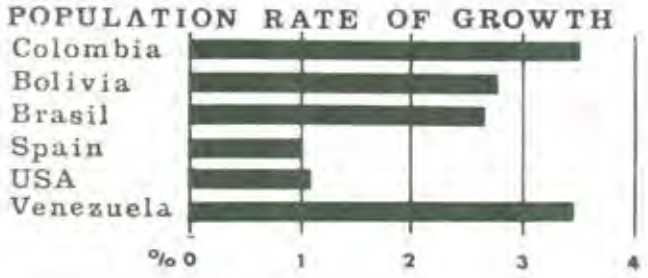
GOVERNMENT: democracy, with elections every four years.
ECONOMIC SYSTEM: capitalism
CURRENCY: Colombian peso = US $0.60 (1945), US$0.04 today.
MAJOR EXPORT: Coffee (64% of exportations)
MAJOR EXP./IMP. MARKET: USA
CULTIVATED LAND: 15.7% of total agricultural land.
UNEMPLOYMENT: 12.6% of total active population.

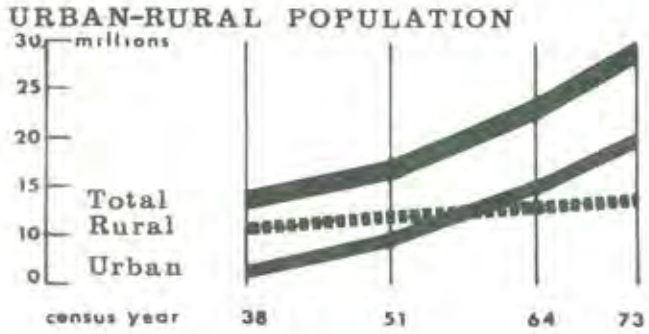
QUANTITATIVE URBAN HOUSING DEFICIT: 600,000 Units (22% of families)
QUALITATIVE URBAN HOUSING DEFICIT: 828,000 Units (45% of existing dwelling units)

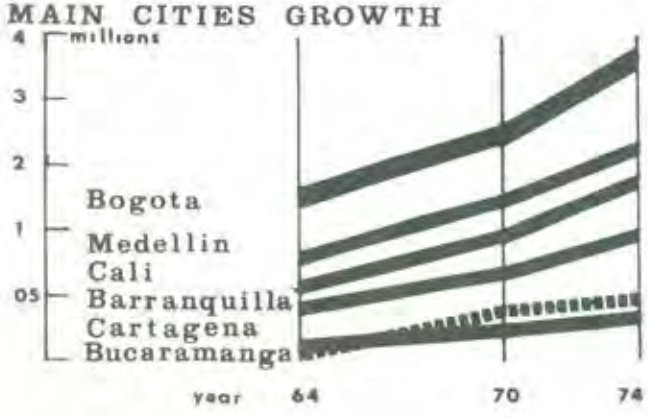
Sources: 2.1; 13; 15; 16
Information: Accurate

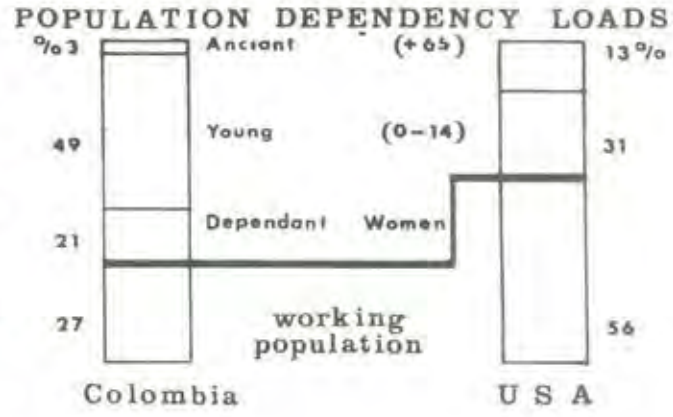












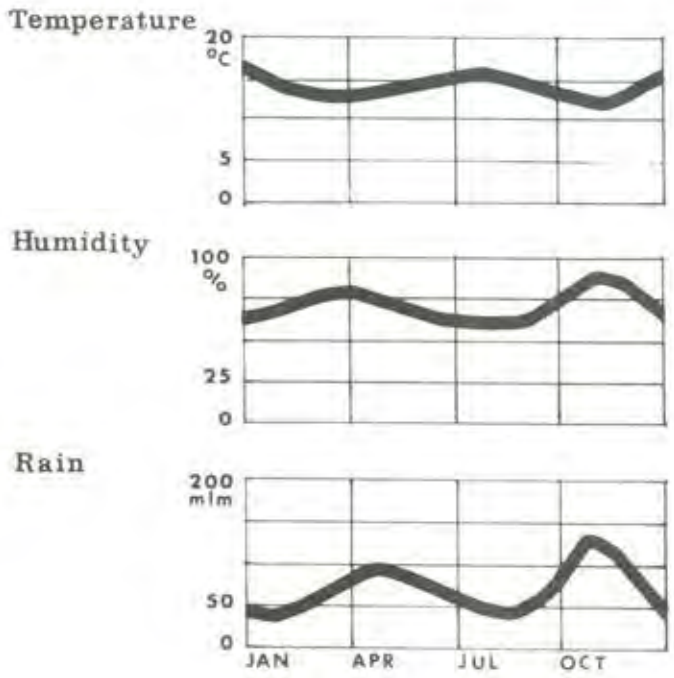
CONTEXT
BOGOTA. BASIC DATA

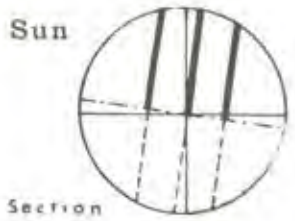
BRIEF HISTORY

	1538	1540-1850
POLITICAL:	Bacata, the Indian city, is the capital of the most important federation (100,000 inhab.) of the Chibcha nation.	Bogota, the Spanish city, becomes capital of a vast colonial empire, including Colombia, Ecuador, Panama, and Venezuela.
LEGAL, ADMINISTRATIVE:	It is ruled by the federation chief (the "Zipa") and by a council of representatives of the various social groups.	It is ruled by Spaniards, designated by the Spanish King, who follow the royal "Laws of Indians."
ECONOMIC:	The economy is principally based on agriculture and commerce. It is dynamic and progressive.	The economy depends entirely on Spanish handling of human and natural local resources. It is mercantilist and ruinous.
PHYSICAL:	The city is organized around a temple dedicated to the Sun, and around the Zipa's house. All structures are detached wooden shacks with single room, natural floor, and straw roof.	The city is harmonically organized around a Catholic cathedral and a central plaza; it grows within a "peatonal area" of 300 Ha. Most structures are masonry and wood, with mud and tile roofs, row, one or two floors, in traditional Spanish style. Transportation is by horse-car. Utilities and services are not provided.
SOCIAL:	Population: 20,000. Race: Pure Indian. Community is patriarchal with its own cultural values.	Population: 40,000. Spanish genetically mix with native Indians and black Africans. Community is feudal with Spanish values. Rigid social stratification with status defined by ownership of land and ethnic group.

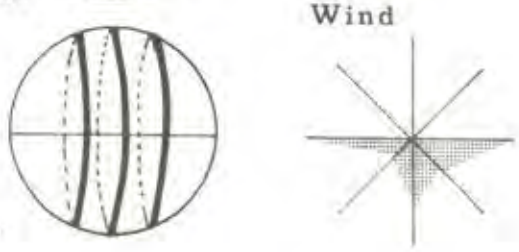
1850-1950	PRESENT
Bogota is the capital of Colombia and Department of Cundinamarca centralizing the political, administrative, and economic powers of the nation.	Bogota becomes the capital of a Special District of six municipalities. It confronts growing national influence of other urban centers.
It is ruled by a Mayor designated by the President and a council of representatives of the various political groups.	It is ruled by a Mayor, a politicalized council, and 16 minor mayors.
The economy progresses vigorously. Industrialization begins to be pursued.	Industrialization continues, with growing State intervention and great foreign dependency.
It changes from a colonial, isolated, backward city into a modern one. Urbanized area grows to 4000 Ha. Masonry-concrete houses and 4-5 floor houses become common. Modern European styles of architecture flourish. Automobiles and buses become daily means of transportation. Utilities and services gradually improve.	The city becomes chaotic and contemporary, its 13,500 Ha. of urbanization spreading over valuable agricultural land, and new buildings destroying the structures of 4 centuries. Luxurious buildings increasingly surrounded by shacks, caves, and tents. Population increase outstrips improvements of infrastructure.
Population: 620,000, the white-Indian racial mixture becoming the most numerous. Society gradually becomes capitalist, with a middle class emerging and status being more clearly defined by capacity to consume.	Population: 2,500,000, with wide following of foreign society's values. Immense disparity in socio-economic levels.

CLIMATE CONDITIONS



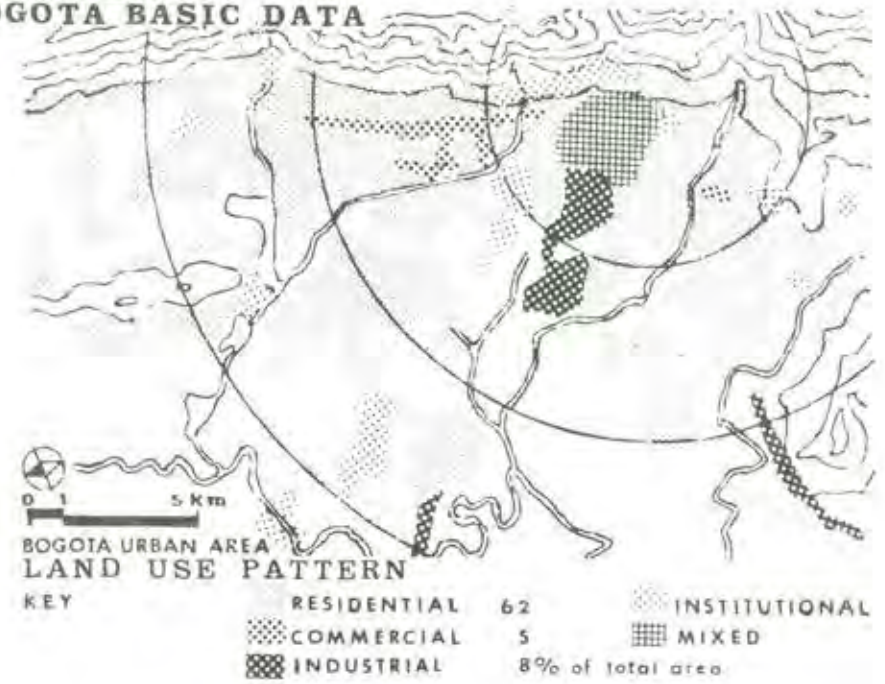


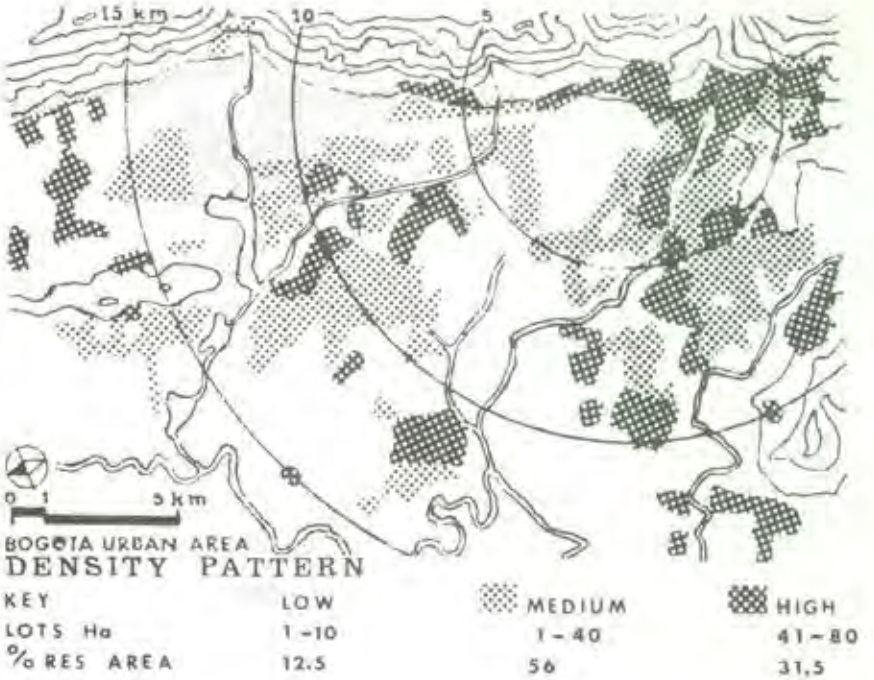
4° 35' Norte
2 630 m above sea level

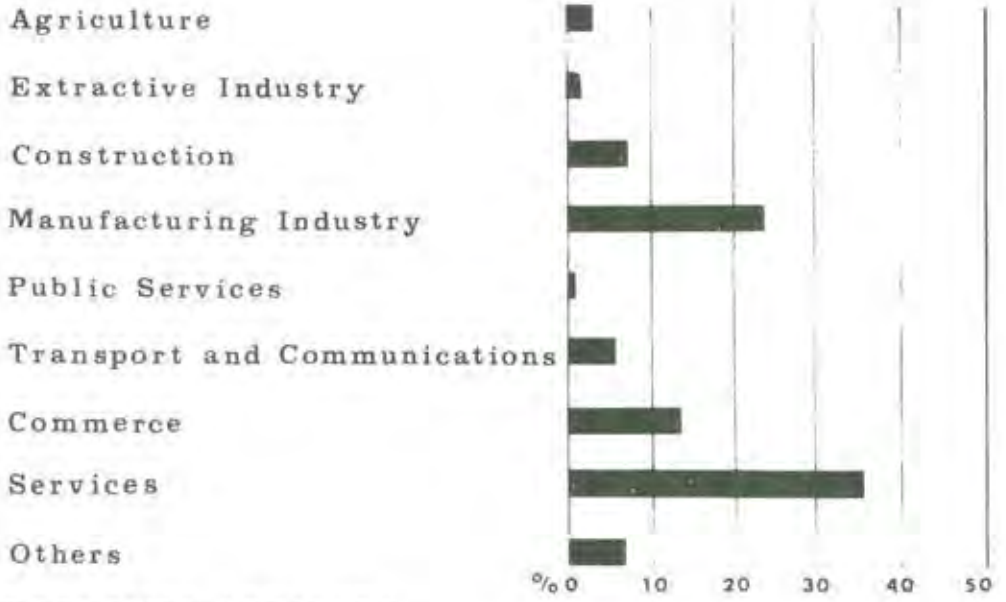


Sources: 2.1, 1967; 16.
Information: Accurate

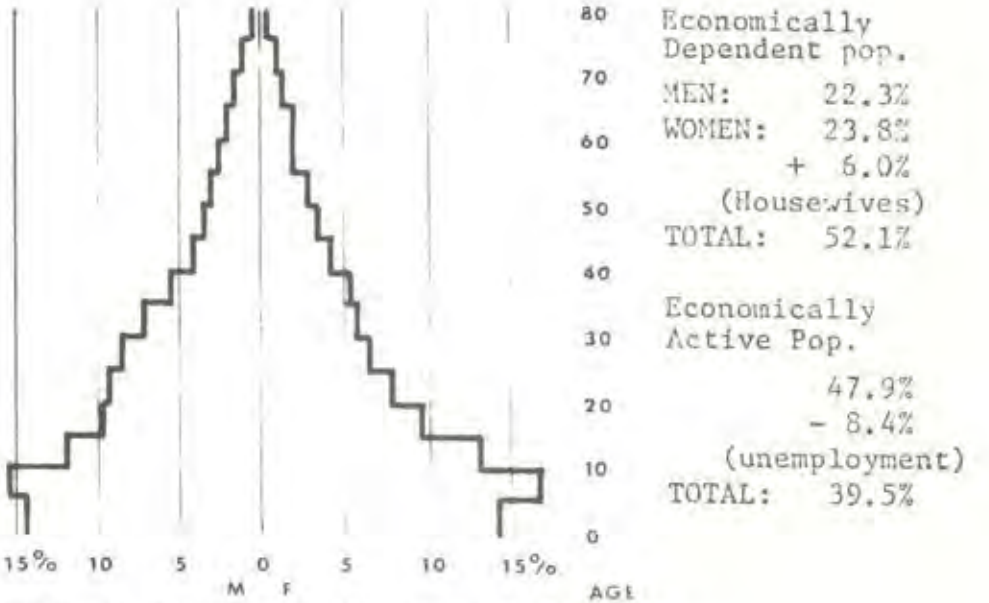
CONTEXT
BOGOTA BASIC DATA







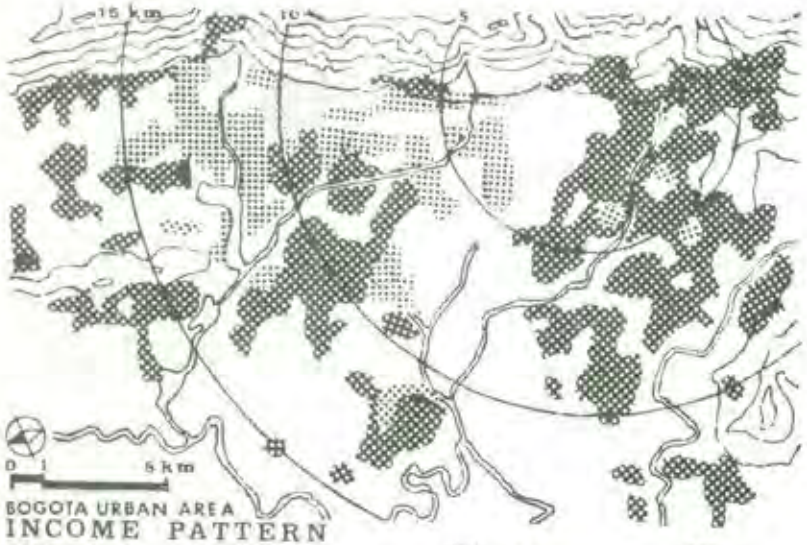
ECONOMIC ACTIVITY
Source: 4.3; 12. Information: Accurate



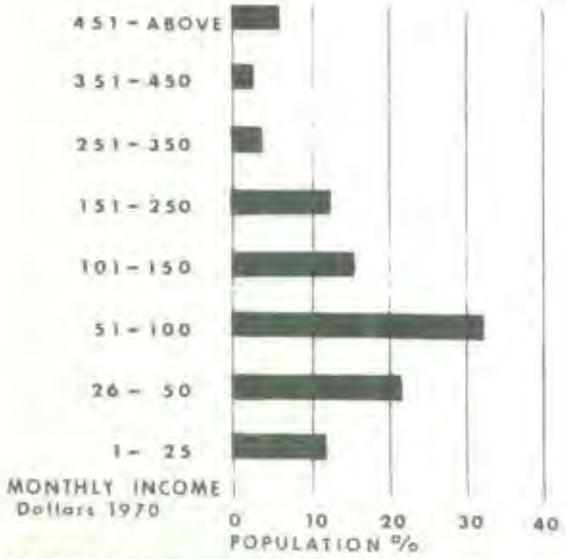
Economically Dependent pop.
MEN: 22.3%
WOMEN: 23.8%
+ 6.0%
(Housewives)
TOTAL: 52.1%

Economically Active Pop.
47.9%
- 8.4%
(unemployment)
TOTAL: 39.5%

URBAN POPULATION DISTRIBUTION
Source: 4.3; 12. Information: Accurate



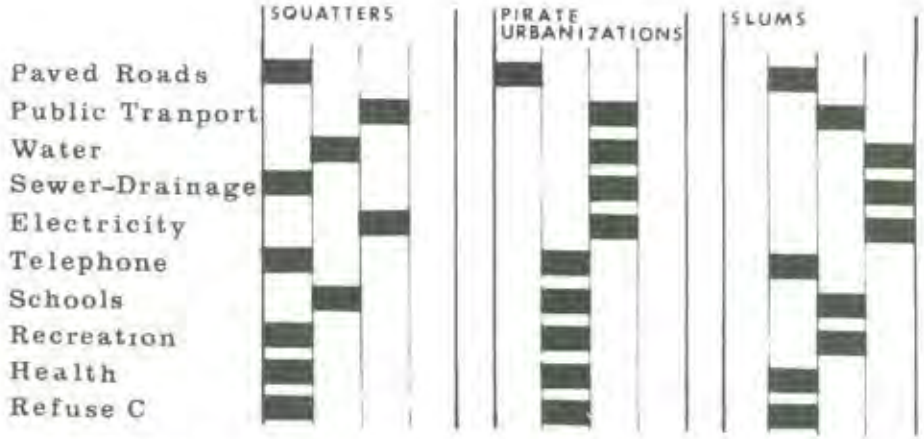
RESIDENTIAL SUBSTANDARD PATTERN
Substandard in terms of legal tennency and/or services available and/or occupation density and/or construction specifications.



Family monthly income of subsistency level: US $40.

Families with less than US $40 per month: 16% of total.

INCOME DISTRIBUTION
Sources: 4.3; 12; 16. Information: Accurate



Availability at four levels: no provision at all, very limited or occasional, available but inadequate and adequate or normal service. (See: Dwellings)

SERVICES AVAILABILITY
Sources: 1.1; 5, unpublished maps. Inf : Approximate.

CONTEXT
INFRASTRUCTURE. BASIC DATA

The cost of the Infrastructure considered in this study is affected by three aspects of the served development: (1) the Location; (2) the Scale/Size; (3) the Density. The Infrastructure can be divided into three types: (a) Supply (water and electricity); (b) Collection (sewer, drainage, refuse); (c) Communication (roads, public transport, telephone).

The Supply Infrastructure is tied to the location of a natural resource: If the distance source-area served increases, cost of trunk networks increase. In addition, location of the development affects water pressure available to it. If this pressure decreases, possibilities of water supply decrease and cost of this supply increase.

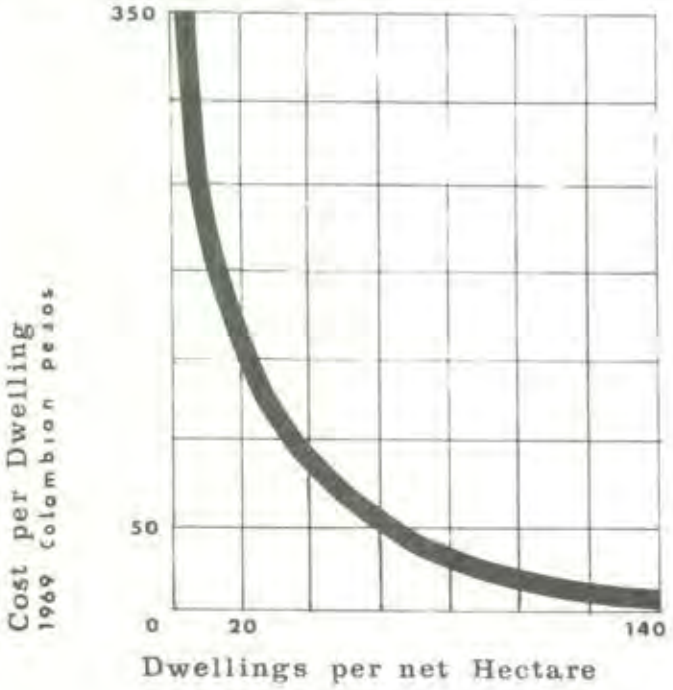
The Collection Infrastructure is tied to the location of a suitable point of discharge: If the distance area served's discharge increases, the cost of trunk networks increases. In addition, location of the development implies special soil and topographic conditions which affect strongly the cost of this system as follows: A soft soil forces expensive foundations and a very solid soil implies expensive excavations and, in addition, increased cost of this network. A steep terrain permits favorable network costs for slopes between 0% and 10%; negative and excessive slopes force extra engineering work and equipment, and network costs increase.

Roads, especially, and transportation costs are affected by soil and topographic conditions in a way similar to that of Collection Infrastructure systems. The telephone system is realtively independent of external restraints.

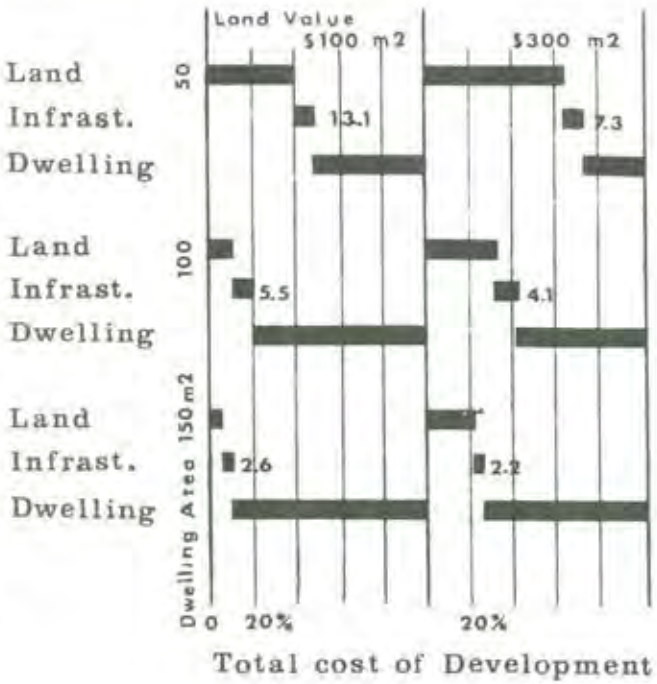
With the exception of storm drains, which are dependent solely on the area served and the rate of run-off, all Infrastructure depends on the population served. In general, increases of the population served and/or the demands of the population served and/or the area served, forces improvement and/or enlargement of the Infrastructure systems and cost of the systems increases.

Due to the fact that these systems have individual connections or installations to each user, the more concentrated the users are the less the given length of networks required is, and therefore a lower cost is possible.

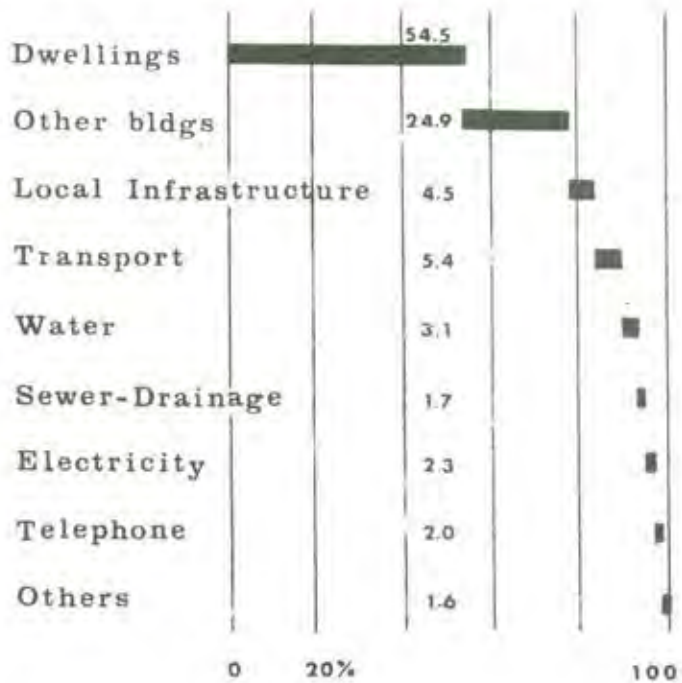
LOCAL NETWORKS COSTS



HOUSING DEVELOPMENT COSTS



URBAN-FABRIC TOTAL COSTS



For 1-2 story buildings, if higher the density of development (more dwellings per Ha) lower the cost per dwelling of provided local infrastructure networks.

Considering high costs of this provision and very limited economical potentiality of Bogota, this is a strong argument in favor of a dense city.

The presented six Bogota typical examples (Density: 80 dwellings per Hectare), permit one to compare the proportion(%) of total cost of development of a house corresponding to Land, Infrastructure and Dwelling; They show how this proportion change for different basic prices of land and different types of dwellings.

Although costs per building are small, the total amount of building activity accounts for 79.4% of the total urban fabric costs.

All Infrastructure costs are 21% (approx.) of the total. Sewer/D., Electricity and Telephone require similar investments.

5.4% transport (29% of total Infrastructure cost) is due to "the necessary Infrastructure to achieve acceptable speeds on the roads."

Source: 12.

SUMMARY
INFRASTRUCTURE SYSTEMS GROWTH

COMPARATIVE DIAGRAM

POPULATION
● 250,000 INHABITANTS

URBANIZED AREA
■ 10,000 HECTARES

DWELLINGS
● 25,000 UNITS

ROAD NETWORK
— 500 KILOMETERS

PUBLIC TRANSPORT VEHICLES
● 500 UNITS

WATER CONSUMPTION
■ 100 MILLIONS M3

WATER INSTALLATIONS
● 25,000 UNITS

WATER NETWORK
— 500 KILOMETERS

SEWER-DRAINAGE AREA SERVED
■ 10,000 HECTARES

SEWER-DRAINAGE NETWORK
— 500 KILOMETERS

ELECTRICITY GENERATION
■ 750 MILLIONS MWH

ELECTRICITY INSTALLATIONS
● 25,000 UNITS

ELECTRICITY NETWORK
— 500 KILOMETERS

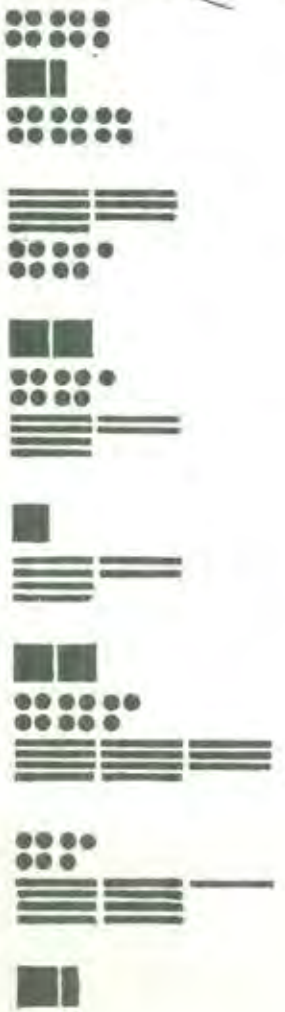
TELEPHONE INSTALLATIONS
● 25,000 UNITS

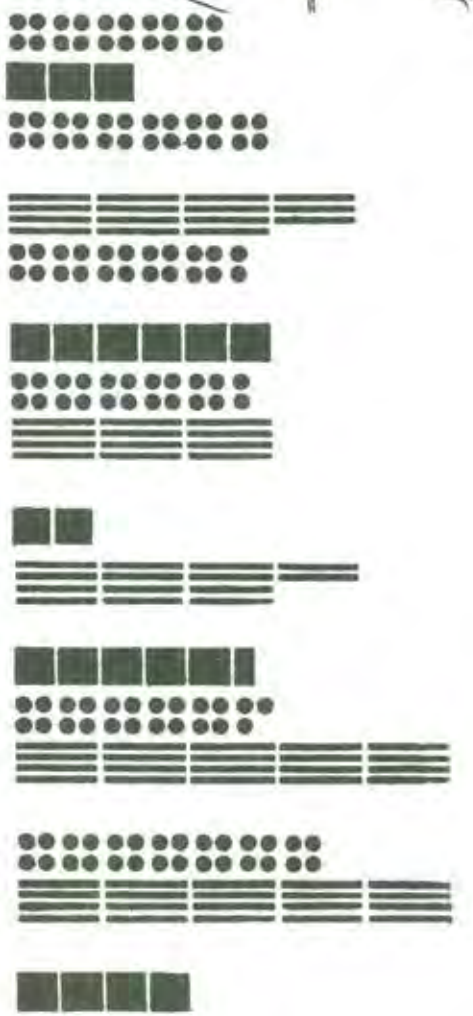
TELEPHONE NETWORK
— 100,000 PATH-KILOMETERS

REFUSE COLLECTED
■ 1 MILLIONS M3

BOGOTA URBAN AREA **1970**

BOGOTA URBAN AREA **1980**





SUMMARY
INFRASTRUCTURE SYSTEMS GROWTH

INSTALLATIONS GROWTH

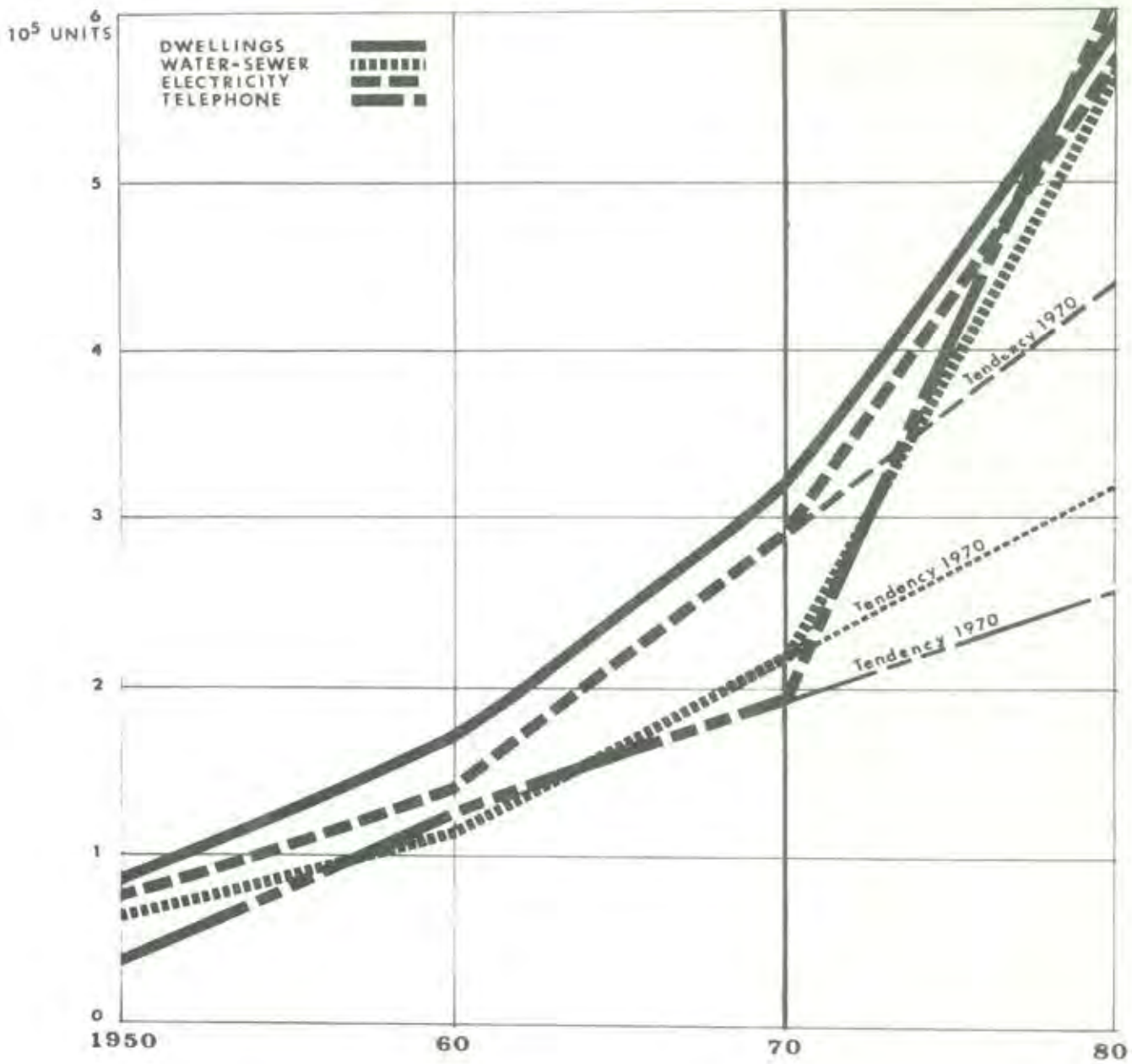
According to the authorities in charge, deficits between number of installations and number of dwellings are going to be greatly reduced during this decade.

Number of installations projected for 1980 is two and three times greater than existing installations in 1970.

This projection implies that during 10 years (1970-1980), it must be doing two and three times what it was doing during the previous century (1900-1970).

If this giant effort is not done (and there is no certainty that it is being done), deficits are going to be immense.

(Note that if commercial, industrial and institutional necessities are added to residential, deficits will be even larger than indicated)



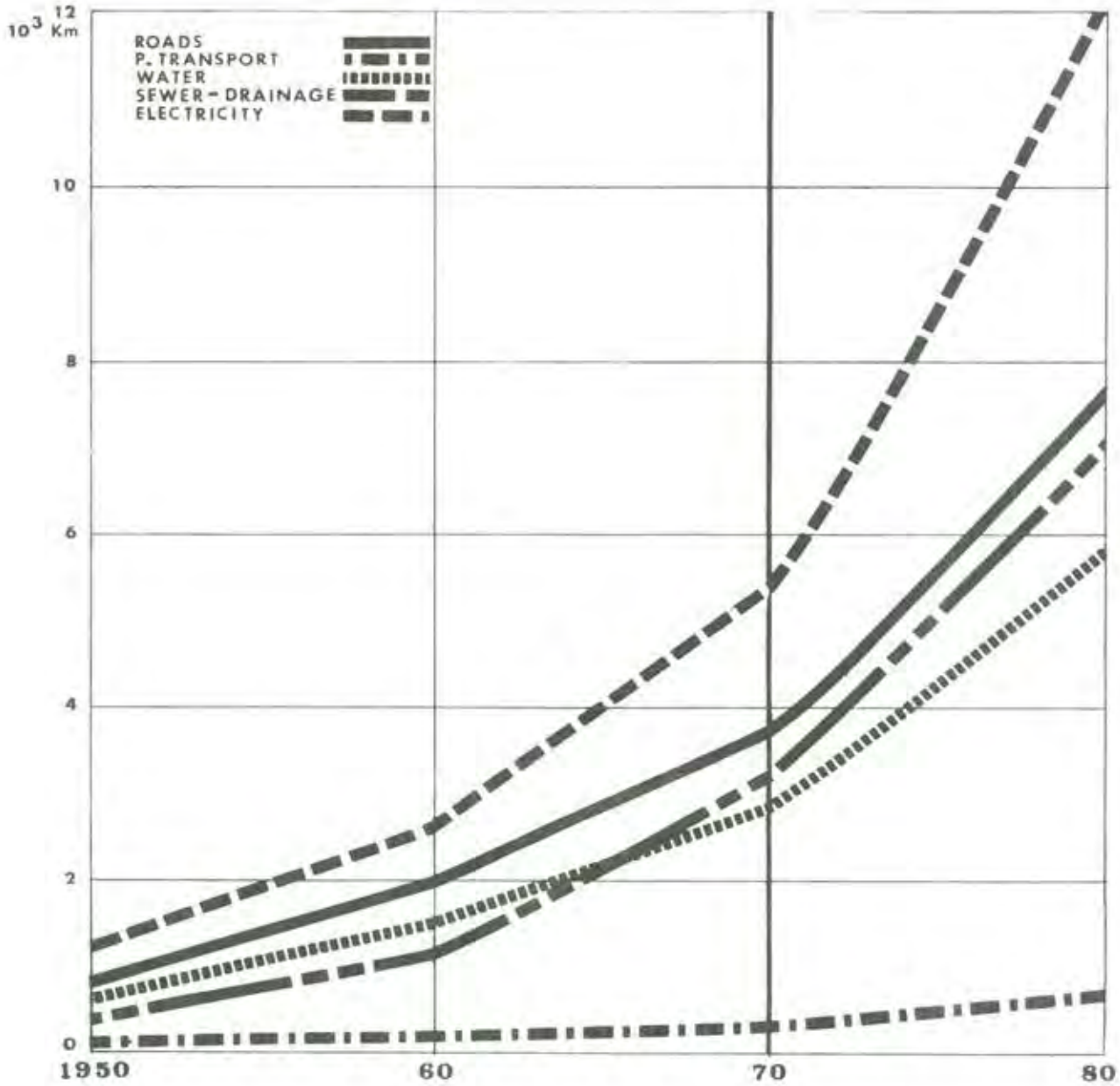
SUMMARY
INFRASTRUCTURE SYSTEMS GROWTH

NETWORKS LENGTH GROWTH

If it is considered that the road network normally serves the entire area of the city, a comparison of this network with the others in the diagram permit one to appreciate an increasing availability of the electricity network, a decreasing availability of water and public transport networks, and an improvement, by 1970, of the 1960's availability of sewer network.

As in the case of installations, the projected growth of the networks during 1970-80 imply that in 10 years it must be doing two and three times what it was doing during 70 (1900-1970).

From both diagrams (Installations and Networks length) it can be deduced that growth of the city is greater than growth of the provision of services.



POPULATION
250.000 INHABITANTS

URBANIZED AREA
10.000 HECTARES

BASIC PARAMETER
POPULATION

Population policies and demographic controls, primarily focused on the low income groups, began to be applied timidly by government agencies in the late '60's.

1. POPULATION. It was 200 years after Bogota's foundation in 1538 that the population reached 10,000. By 1900 it was 8.5 times larger; by 1950, 62 times larger; by 2000 it is projected to be 1,400 times larger.

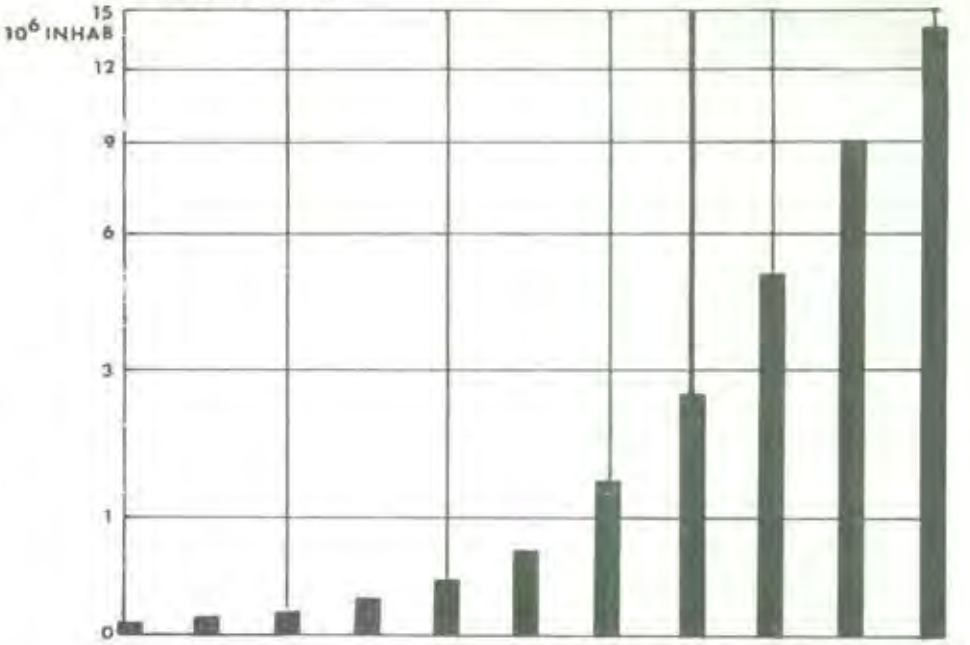
If the first group of 10,000 inhabitants needed 200 years to "arrive," there is a new group of the same size in the city each 53 days during the 1950's, each 31 days during the 1960's, each 14 days during the 1970's, each 9 days during the 1980's, and each 7 days during the 1990's.

Each day now there are approximately 690 new city residents (138 families), 62% of them immigrants from rural and less urbanized areas all around the country.

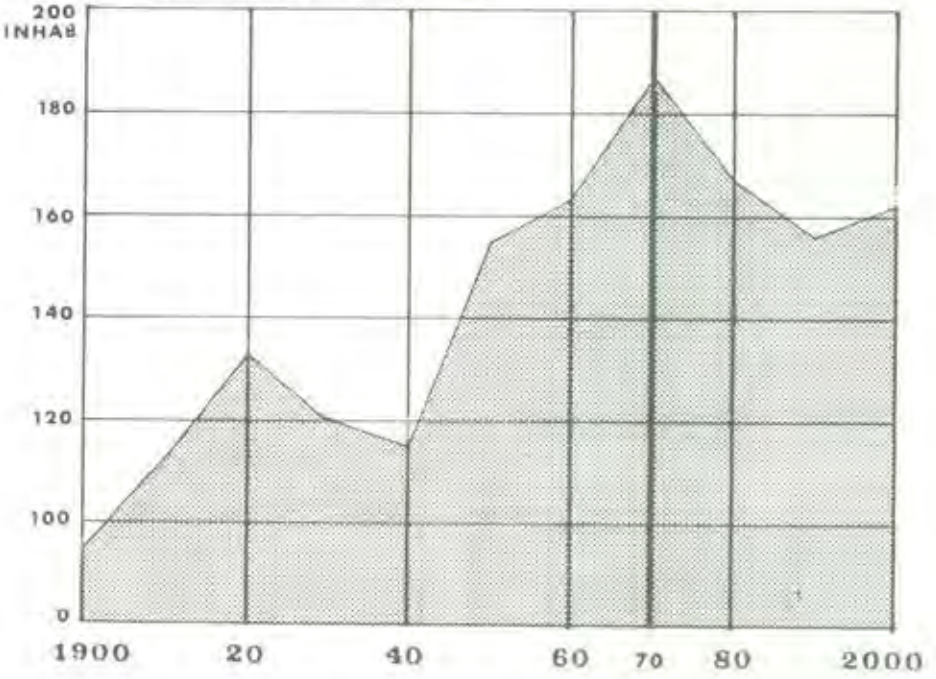
2. INHABITANTS PER HECTARE. When population growth is greater than urbanized area growth, concentration of people increases. As the diagram shows, the periods from 1900 to 1920 and 1940 to 1970 are of concentration and from 1920 to 1940 and 1970 to 1990 are periods of expansion (a less effective, intensive, and/or dense accomodation of population in the urbanized area).

Source: 2.1,3; 7.2,4; 10.1; 12.
Information: Approximate.

1 Population



2 Inhabitants per Hectare



BASIC PARAMETER
URBANIZED AREA

City planning and control of the city's physical growth began in the late 1930's.

1. URBANIZED AREA. Reflecting the population growth, increase of Bogota's urbanized area was very slow during the first 300 years (until around 1850).

By 1950, the urbanized area was 13 times larger than in 1350. A variety of factors causes the city of 1960 to be as large as two 1950 Bogota's, the city of 1970 as large as three 1950 Bogota's, the city of 1980 as large as seven 1950 Bogota's, and so forth.

Today, 60% of the residential area is occupied by low income family dwellings (1970 US$ 0-150 monthly income).

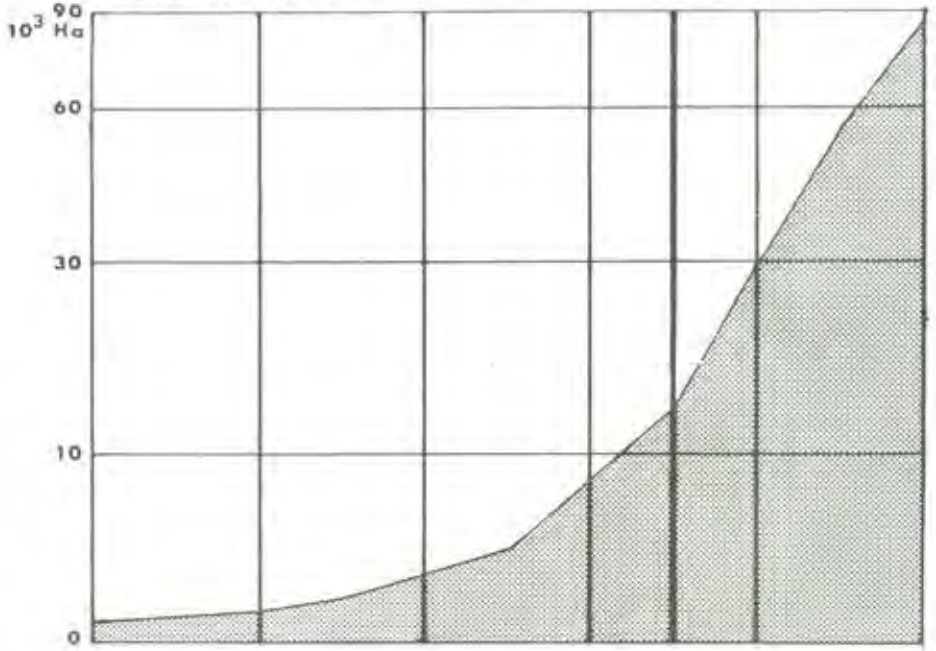
2. POPULATION-URBANIZED AREA: PERCENTAGE OF GROWTH With 1970 as 100%, the diagram directly relates growth of population and urbanized area.

It indicates that, to any increase of population, an equivalent increase of urbanized area has corresponded and apparently will continue to correspond.

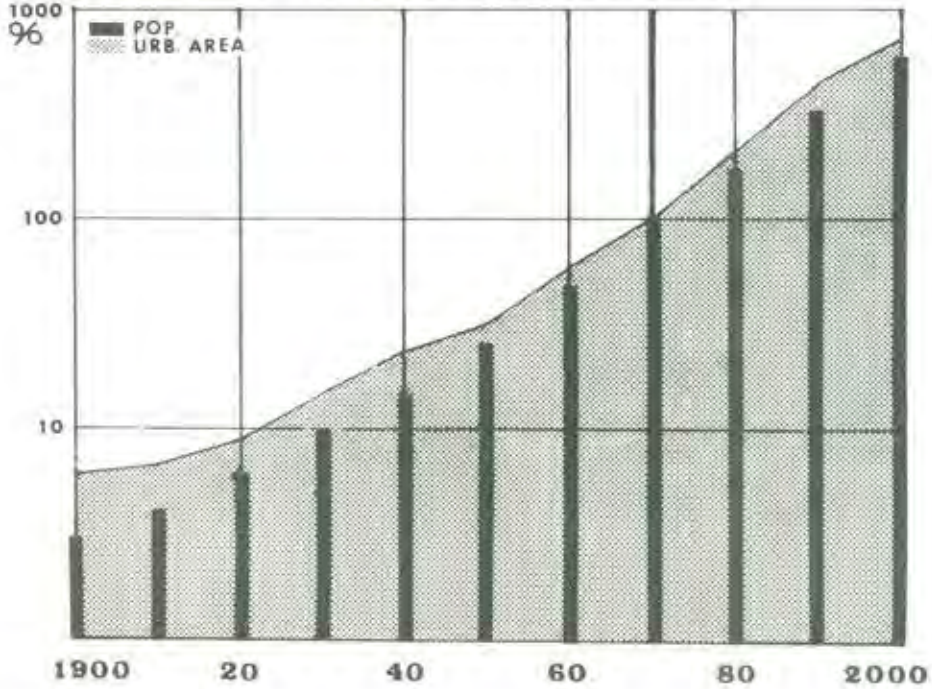
As a result of this, the pattern of urban sprawl is apparent in Bogota: relatively low density of occupation, permanent expansion over surrounding areas, large portion of area devoted to circulation (roads), expensive and difficult transportation, very expensive provision and maintenance of utilities and services...

Sources: 2.1,2; 7.1,2,4; 10.1; 12; 16.
Information: Approximate.

1 Urbanized Area



2 Population & Urbanized Area. % of Growth



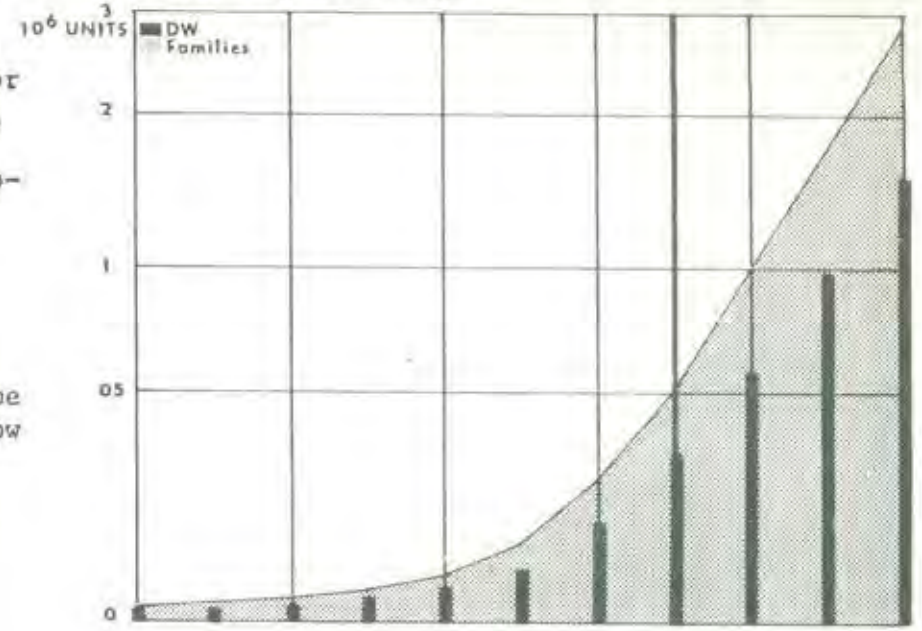
BASIC PARAMETER
DWELLINGS

In the late 1930's and early 1940's, government housing agencies were founded and large projects of dwellings for middle-income began to be developed. In the late '50's, private firms began to attend to middle-income housing necessities and government agencies began to develop projects and techniques to attend to low-income housing.

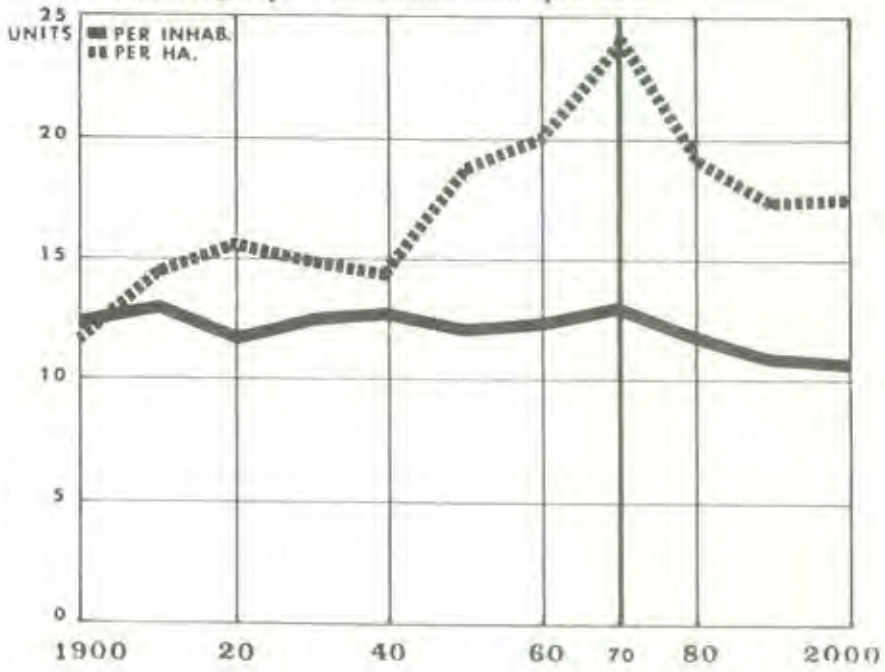
PRESENT CONDITION OF DWELLINGS: Administration: Housing policies exist at national and local levels. Regulations and Controls are a major government responsibility. Financing is generously provided by the government and private agencies to medium and high income families; it is available in a very reduced scale for low income families.

-Dwellings Developer/Builder: (a) the family/self help artisans (low income); (b) the family, private firms/ small, large contracters (middle, high income); (c) the government/small and large contractors (low and middle income).
-Low Income Dwellings Type: (a) Squatter Type, (illegal land tenure, improvised land subdivision): shacks, tents, caves of wastage materials; 1-2 families/unit; detached 1-2-3 floors; no utilities; north, south, east and west periphery location; (b) Pirate urbanization type, (legal land tenure, illegal land subdivision): masonry-concrete houses; 1-2 families/unit; row 1-2 floors; occasional and available but inadequate utilities; south and west inner ring and periphery location.
(c) Slum type (tenement): wastage masonry-wood houses; multi-family; Row 1-2-3 floors; available but not always adequate utilities; city center location.
(d) Government project type: masonry concrete houses; 1 family/unit; Row 1-2 floors; adequate utilities; periphery location.
-Middle Income Dwelling Type: (a) masonry-concrete houses; Row 1-2 floors; (b) concrete apt. buildings; Row walk-up. Adequate utilities.
-High Income Dwelling Type: (a) masonry-concrete houses; Row, semidetached and detached 1-2-3 floors; (b) concrete apt. buildings; detached high rise. Adequate utilities.

1 Existing Dwellings



2 Dwellings per 10^2 Inhab and per Ha



1. EXISTING DWELLINGS. Bogotá of 1950 had seven times the dwellings of 1900, and by 2000 could have as many as twenty 1950 Bogota's or one hundred and forty 1900 Bogota's. Nevertheless, because population has grown faster than dwelling production, the difference between number of families and number of dwellings has increased during the century. In 1980, the number of families without proper dwellings could be double that of 1970, eight times that of 1950, and sixty-four times that of 1900.

2. DWELLINGS PER 100 INHABITANTS AND PER HECTARE
- Per inhabitant: Variations are very small through the century; by 1970, the situation is similar to that of 1960.

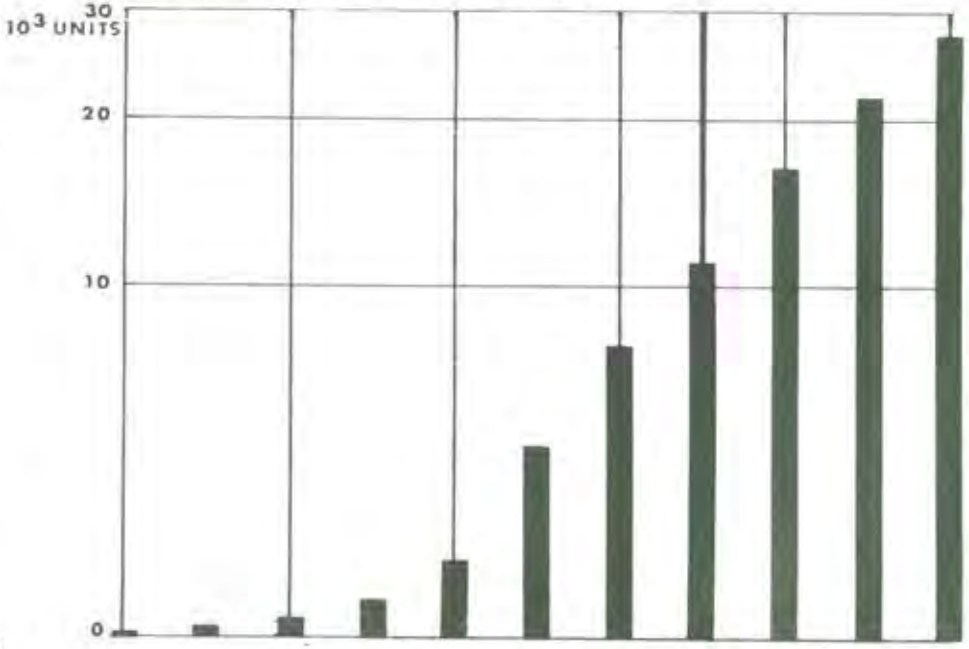
- Per Hectare: It indicates intensity of use of the urbanized area for dwelling accomodations purposes. Until 1970, the average number of dwellings per hectare increased; land was used more effectively. After 1970, this tendency may change; By 1980 the number is projected to be similar to that of 1950.

3. DWELLING PRODUCTION (not including production outside official control). Growth has been permanent. Today, the average production of one month equals the total production of 1940.

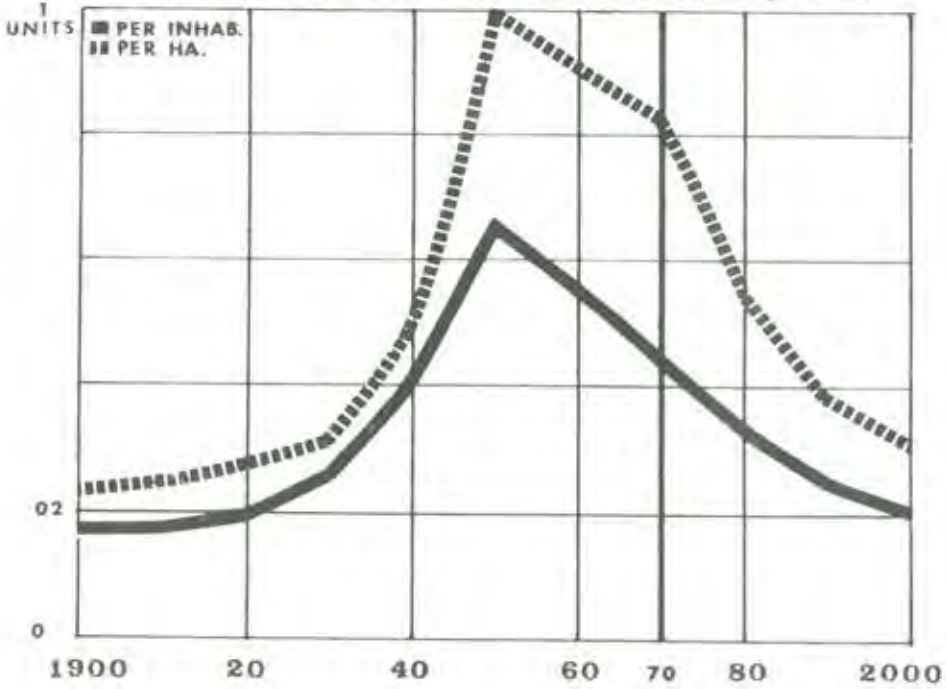
4. DWELLING PRODUCTION PER 100 INHABITANTS AND PER HECTARE. Indicate that by the end of the century the average production per Inhab. and per Ha. may be similar to that of the beginning of the century.

Sources: 2.1,2,4; 7.6; 12; 16
Information: Approximate

3 Dwelling Production (legal)



4 Dwellings Production per 100 Inhab and per Ha



INFRASTRUCTURE SYSTEMS

ROAD SYSTEM

PUBLIC TRANSPORT SYSTEM

WATER SYSTEM

SEWER DRAINAGE SYSTEM

ELECTRICITY SYSTEM

TELEPHONE SYSTEM

REFUSE SYSTEM

ROAD SYSTEM

The system has followed the pattern of physical organization provided by the Spanish: a rectangular subdivision of the land with streets every 80 meters.
Road width: Old streets, 9 m.; 1970 avenue, 60 m.
Traffic lanes: old streets, 1; 1970 avenue, 12.
Traffic speed: 1970 average, 45-50 km/h.

PRESENT CONDITION OF THE SYSTEM: Administration: Road Policies, Regulations and Controls are in charge of different local government branches. Foreign entities provide financing to major projects. Projects Developer/Builder are the government/private firms.

- Condition of roads: unpaved in low income areas; paved with deficient maintenance in the rest of the city.

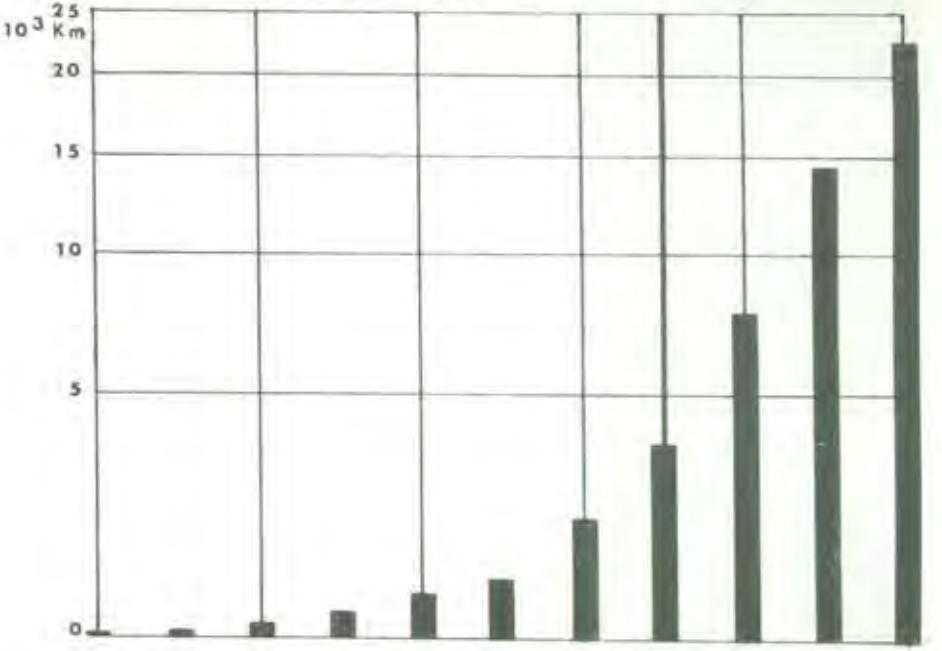
1. ROAD NETWORK LENGTH: In 1980 Bogota will have twice the road network of 1970, and eighty times that of 1900.

2. ROAD NETWORK LENGTH PER 100 INHABITANTS AND PER HECTARE:
A) The road network length per 100 inhab. is least in 1920 and greatest in 1940. If it is considered that the populations both of 1920 and 1940 had similar basic circulation needs, this could mean that the road network of 1920 is the most efficient of the century, and that of 1940 the least efficient. The other values may be compared with these two.

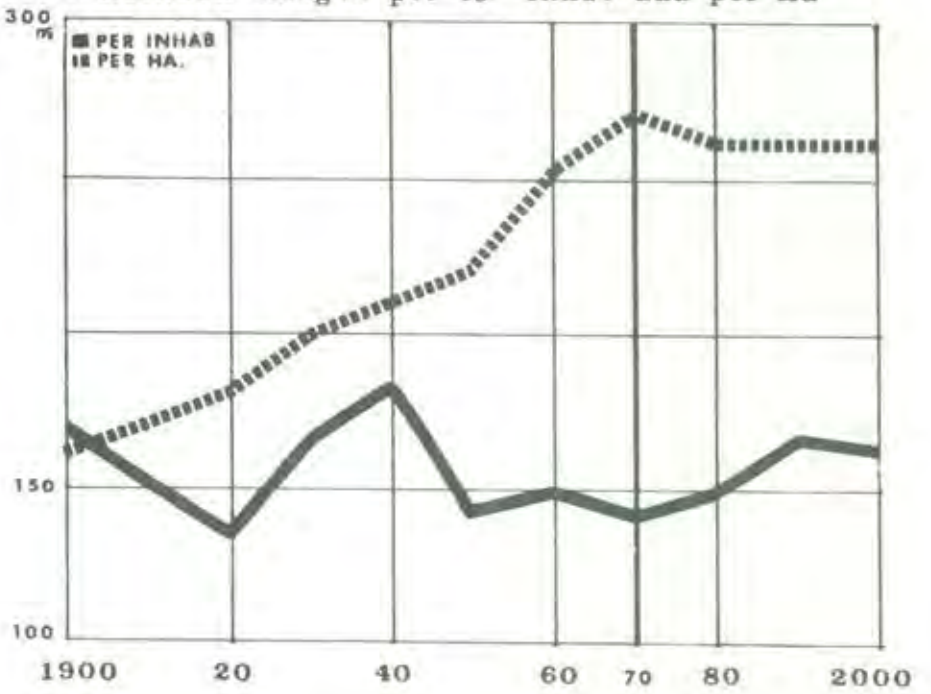
B) The road network length per hectare is a reasonable indicator of quality of land utilization for circulation purposes. An increase, as in Bogota during this century, indicates that greater portions of land are being devoted to circulation.

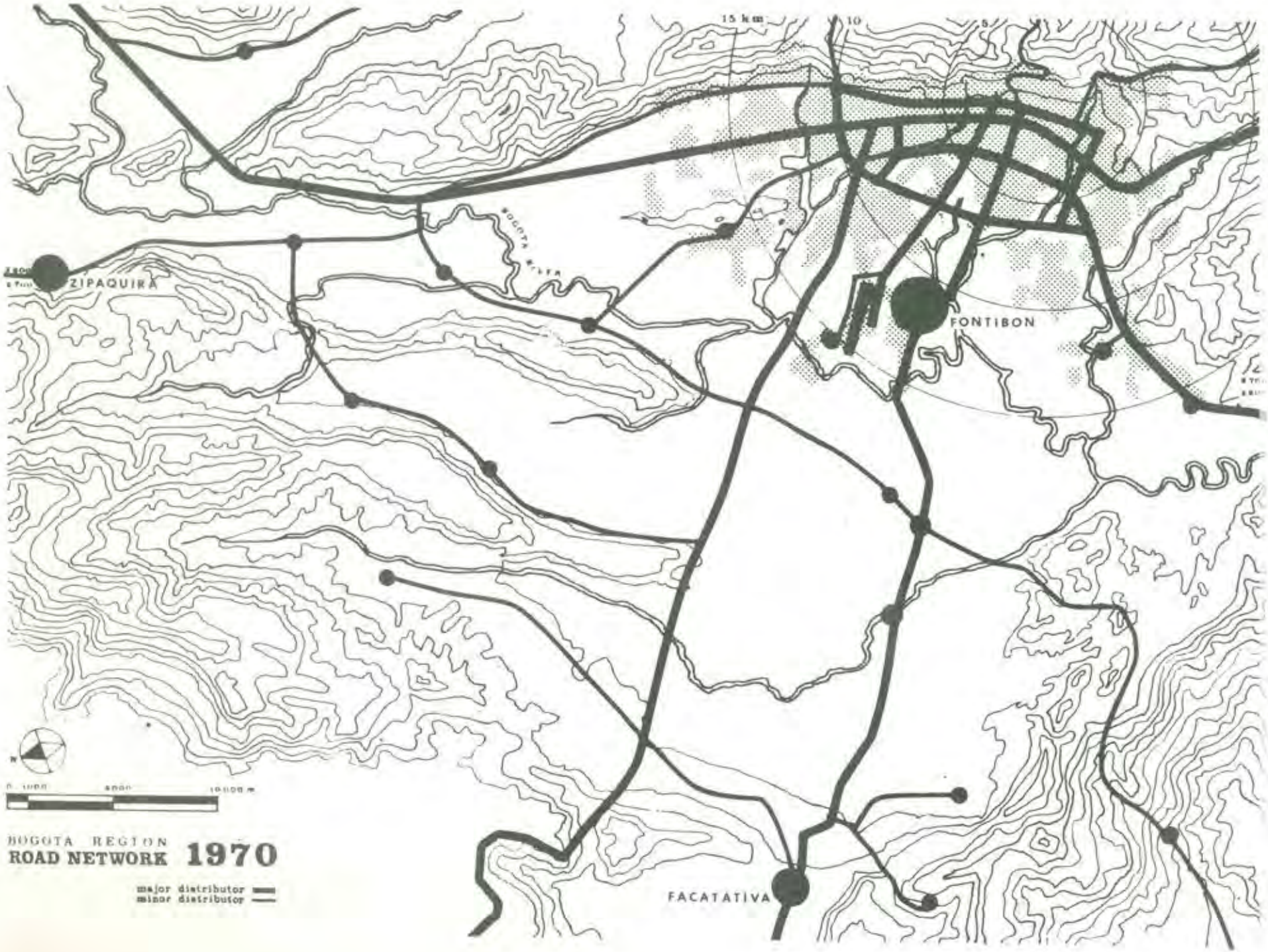
Sources: 4.2; 11, unpublished and published maps.
Information: Approximate.

1 Road Network Length



2 Network Length per 10^2 Inhab and per Ha



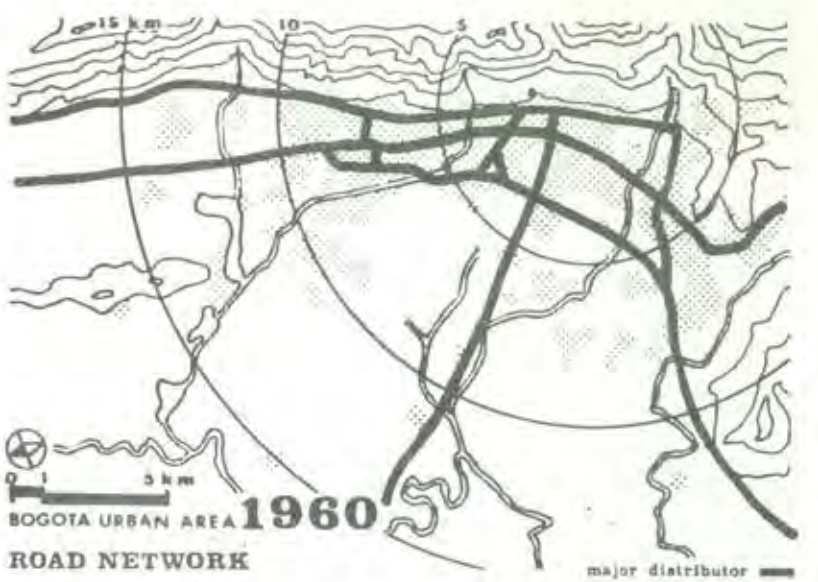


BOGOTA REGION
ROAD NETWORK 1970

major distributor
minor distributor

ROAD SYSTEM GROWTH

COMPARATIVE DIAGRAM



POPULATION
● 250 000 INHABITANTS

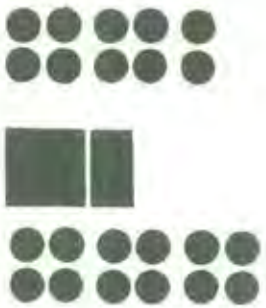
URBANIZED AREA
■ 10 000 HECTARES

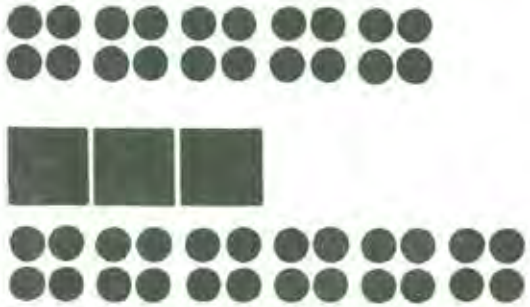
DWELLINGS
● 25 000 UNITS

ROAD NETWORK
▬ 500 KILOMETERS

15 km
10
5
0 1 5 km
BOGOTA URBAN AREA 1970
ROAD NETWORK
major distributor

15 km
10
5
0 1 5 km
BOGOTA URBAN AREA 1980
ROAD NETWORK
major distributor





PUBLIC TRANSPORT SYSTEM

Emphasis has been on north-south transport. The system has always been dependable only for vehicles of very limited capacity.
1900: mule streetcars, 16-26 passengers, 8-12 km/h.
1920: electric streetcars, 32-42 passengers, 20-30 km/h.
1930 to present: buses, 60-80 passengers, 40-60 km/h.

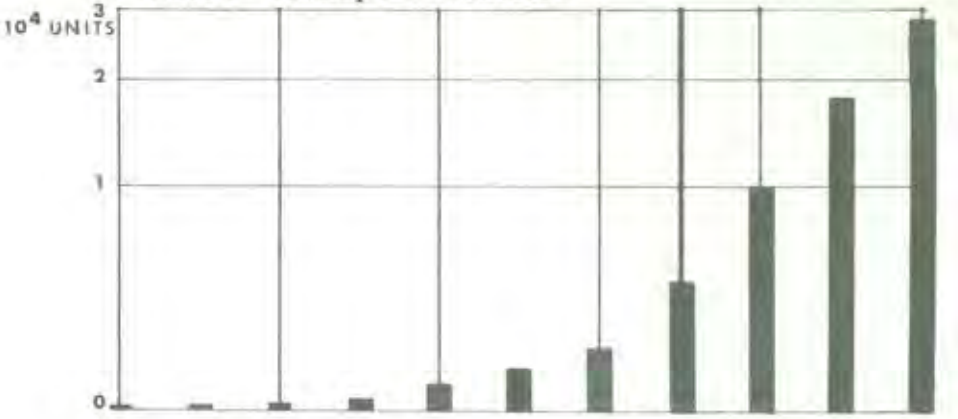
PRESENT CONDITION OF THE SYSTEM - Administration: Policies, Regulations and Controls are centralized in a national government institution. Foreign entities provide financing to major projects. Projects Developer/Builder are the government/foreign and Colombian private firms.
- Type of vehicles. Buses are the most numerous. Minibuses, vans and modified cars have appeared recently and their number has grown strongly; These provide a more expensive service than buses but not always a better one.
- Condition of vehicles. Most vehicles are privately owned and organized into private companies subsidized by the government. The service they provide is highly unorganized. Their physical condition is commonly bad; most vehicles are old and poorly maintained.
- Public Transport Availability: Usually available but not always adequate. The system is intensively used by a majority of the population.

1. PUBLIC TRANSPORT VEHICLES.

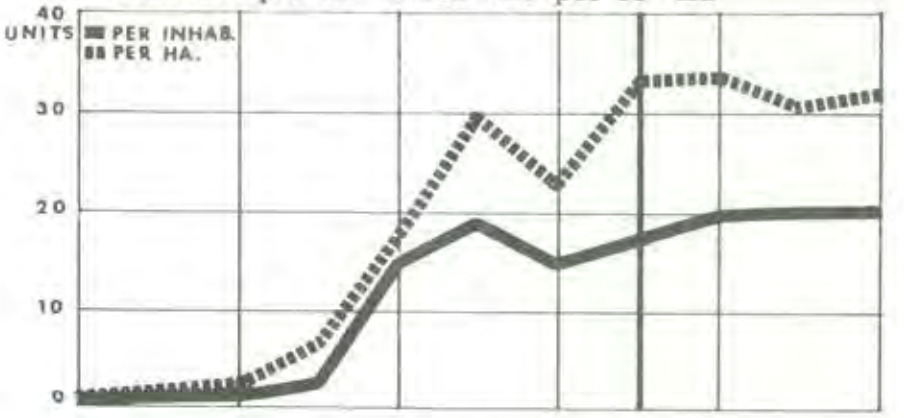
There were 2,500 more vehicles in 1970 than in 1960, and if no changes are introduced, 1980 will have 5,600 more than 1970.

2. VEHICLES PER 10,000 INHABITANTS AND PER 100 HECTARES. Except for period 1950-60, the number of vehicles per inhab. and per Ha. has increased almost constantly since 1900.

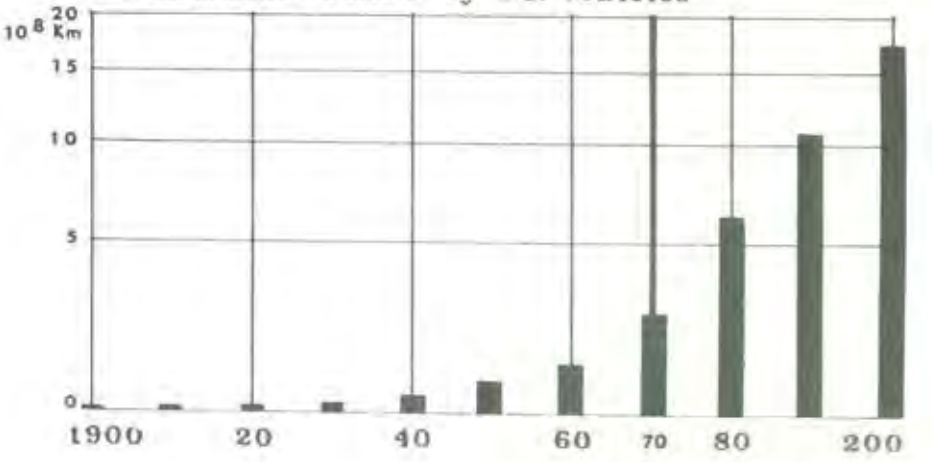
1 Public Transport Vehicles



2 Vehicles per 10^4 Inhab and per 10^2 Ha



3 Kilometers Runed by P.T. Vehicles



There are far more vehicles per inhabitant and Ha. in 1970 than in 1900, but this does not necessarily mean that the service is better today (see following information).

3. KILOMETERS RUNNING BY P.T. VEHICLES. Obviously, more vehicles, more people and greater distances to serve require more time, money and community effort in transportation. The distance covered by P.T. vehicles increased by 140 million km. from 1960 to 1970, and by 1980 may increase another 370 million km.

4. PUBLIC TRANSPORT PASSENGERS. (Equivalent to persons/trips per year.) The difference between 1960 and 1970 is 361 million, and if present trends continue, by 1980 the city system will transport 1484 million passengers more than in 1970. Is the system being prepared for that?

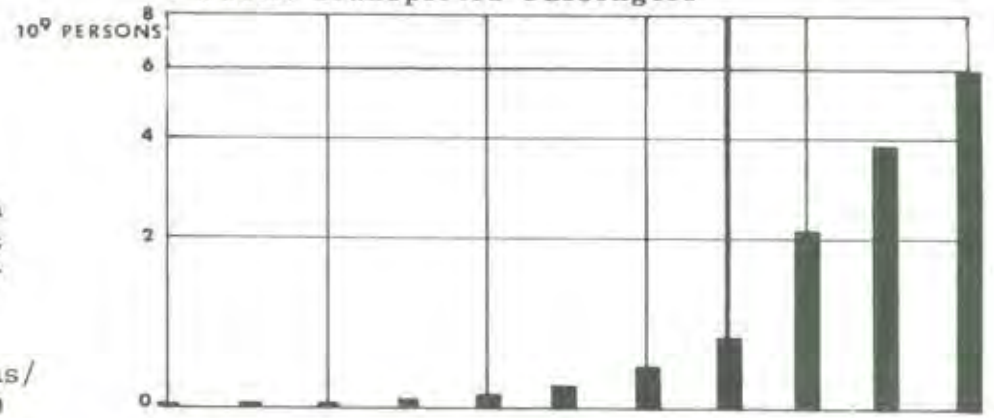
5. PASSENGERS PER 100 INHABITANTS AND PER HECTARE. The illustrated relation indicates:
A) Intensity of use of public transport. Intensity increases from 1900 to 1940, then decreases until 1960 (relatively fewer people used or had access to public transportation in 1960 than in 1940), increases again until 1980, and is considered stable in this study from then on.

B) Number of passengers "generating" the city in relation with its extension. Between 1900 and 1980, the average number of passengers "generated" per Hectare of urbanized area increases.

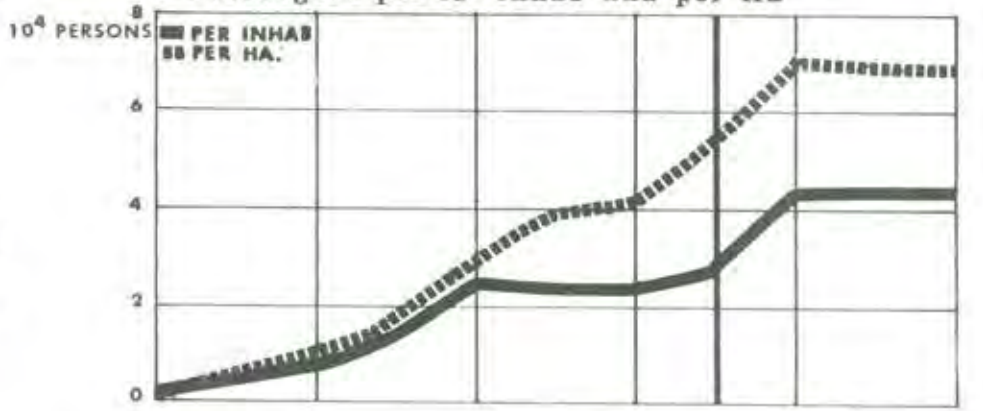
6. PUBLIC TRANSPORT NETWORK LENGTH. The city in 1980 will have twice the amount of roads for Public Transport as in 1970, and 67 times the amount of 1900.

Source: 2.1; 3.1; 3.2; 12.
Information: Approximate.

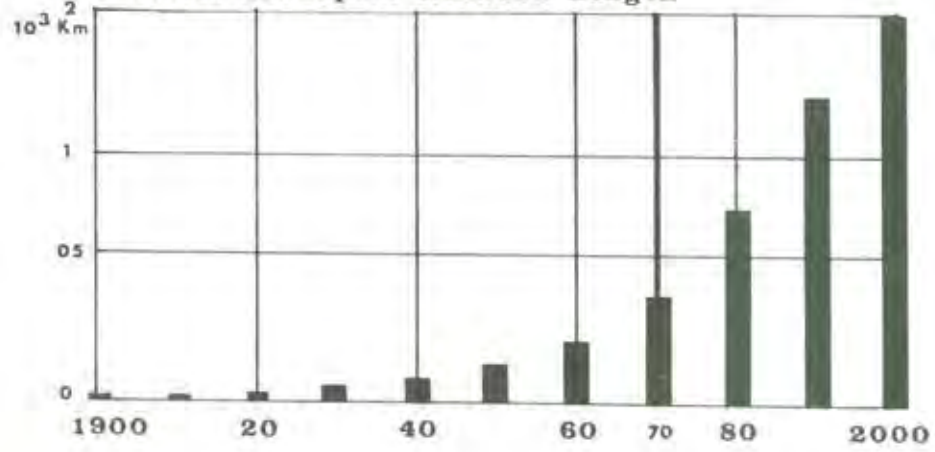
4 Public Transported Passengers



5 Passengers per 10^2 Inhab and per Ha

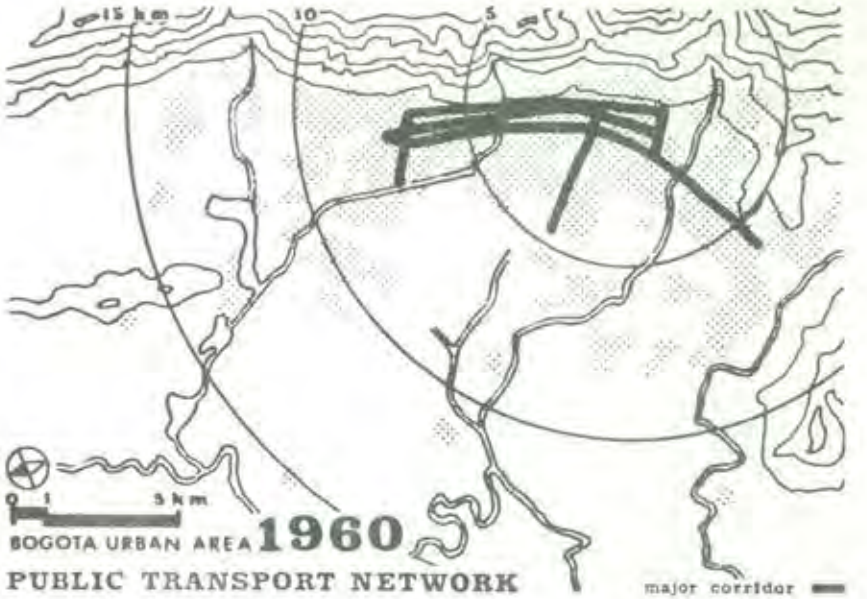


6 Public Transport Network Length



PUBLIC TRANSPORT SYSTEM GROWTH

COMPARATIVE DIAGRAM



POPULATION
● 250 000 INHABITANTS

URBANIZED AREA
■ 10 000 HECTARES

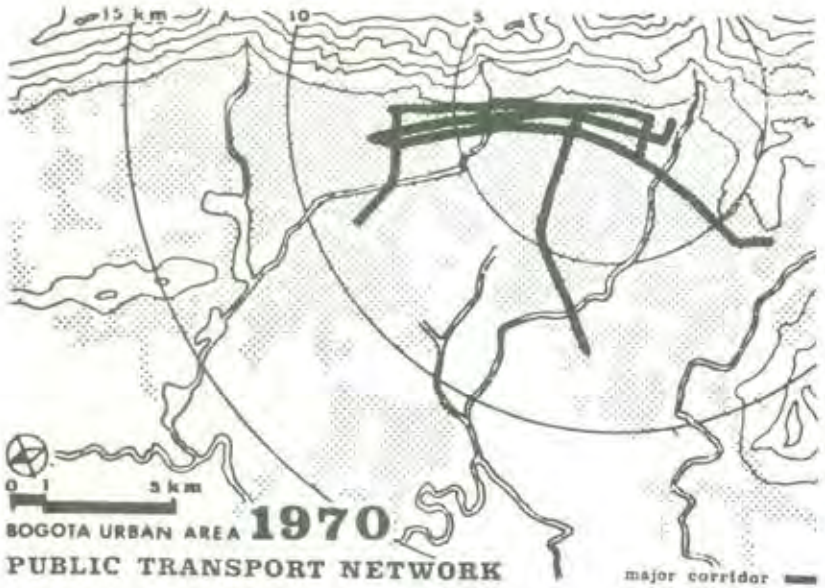
DWELLINGS
● 25 000 UNITS

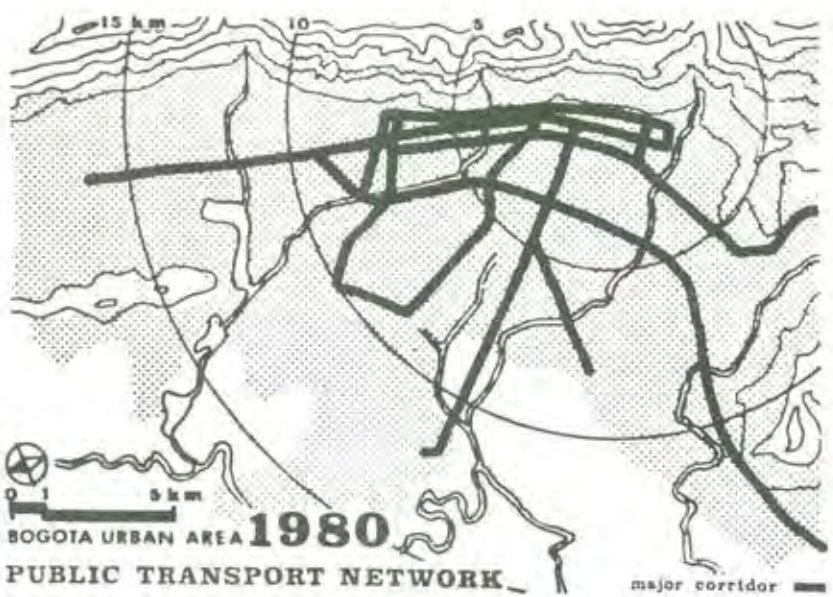
PUBLIC TRANPORT VEHICLES
● 500 UNITS

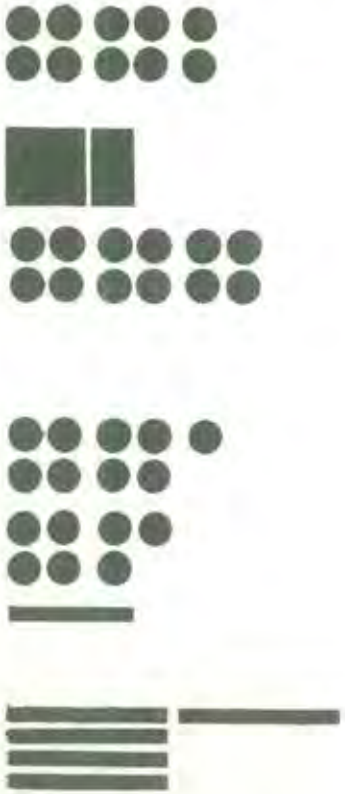
PASSENGERS
● 100 MILLIONS

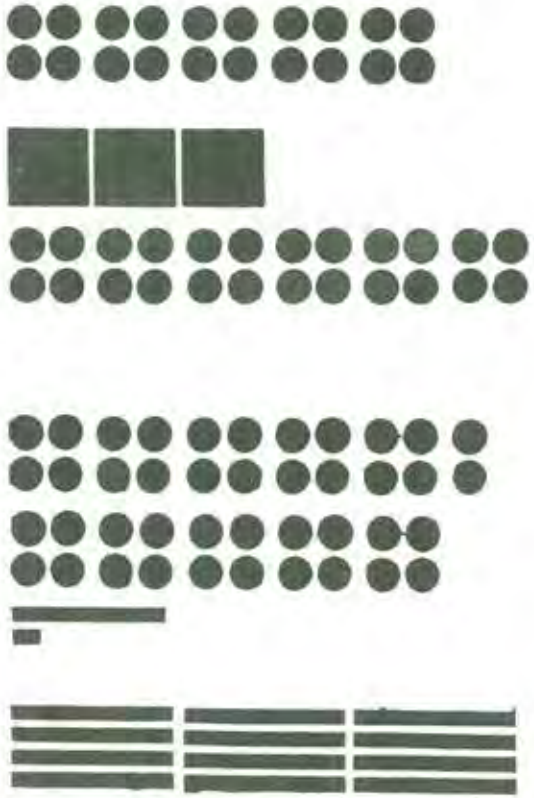
NETWORK
— 500 KILOMETERS

RUNNING KILOMETERS
— 50 MILLIONS KILOMETERS


15 km
10
5
0 1 5 km
BOGOTA URBAN AREA 1970
PUBLIC TRANSPORT NETWORK
major corridor


15 km
10
5
0 1 5 km
BOGOTA URBAN AREA 1980
PUBLIC TRANSPORT NETWORK
major corridor





WATER SYSTEM

Though very primitive in 1900, the system now has all the advantages of modern engineering.

In 1900, water was collected from streams flowing through the city and transported by crude open ditches. The water was untreated and stored in dwelling cans. It was distributed by means of stone ditches and public faucets, and by a primitive network of iron pipes.

PRESENT CONDITION OF THE SYSTEM - Administration: Policies, Regulations and Controls are in charge of a regional and a local government agency. Foreign entities provide financing to major projects. Projects Developer/Builder are the government/foreign and Colombian private firms.

-Water Collection: Watershed areas within 50 km. north and south of the city.

-Transmission: Underground pipes, up to 2m. in diameter.

-Treatment: It permits uninterrupted drinking

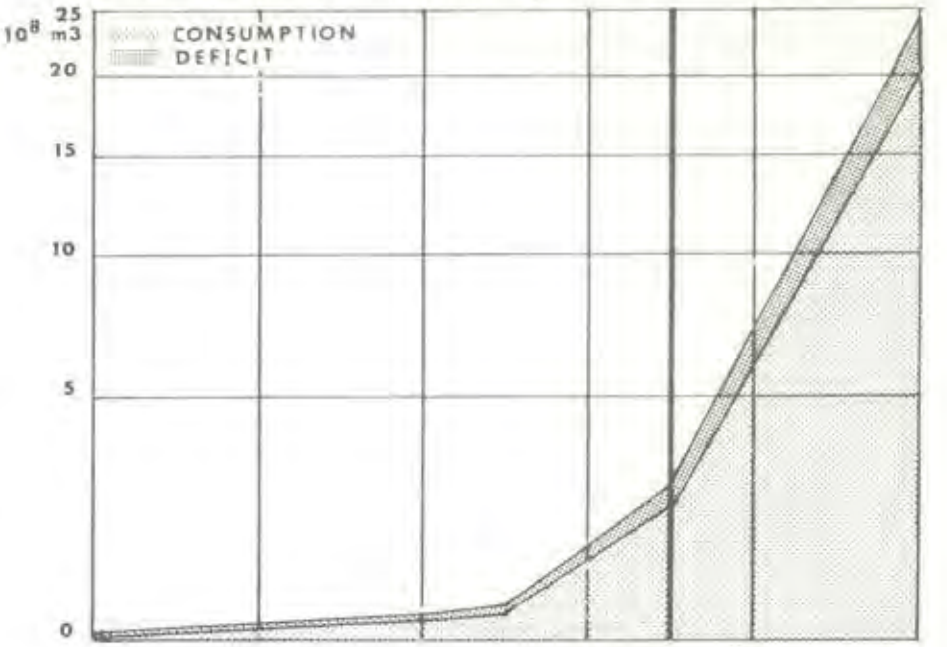
-Augmentation: Reservoirs of 4 to 460 million m3, 6 city tanks that contain 182,000 m3 (total) and user's tanks of 150-500 lbs.

-Distribution: An efficient underground network; capacity, 8m3/seg.

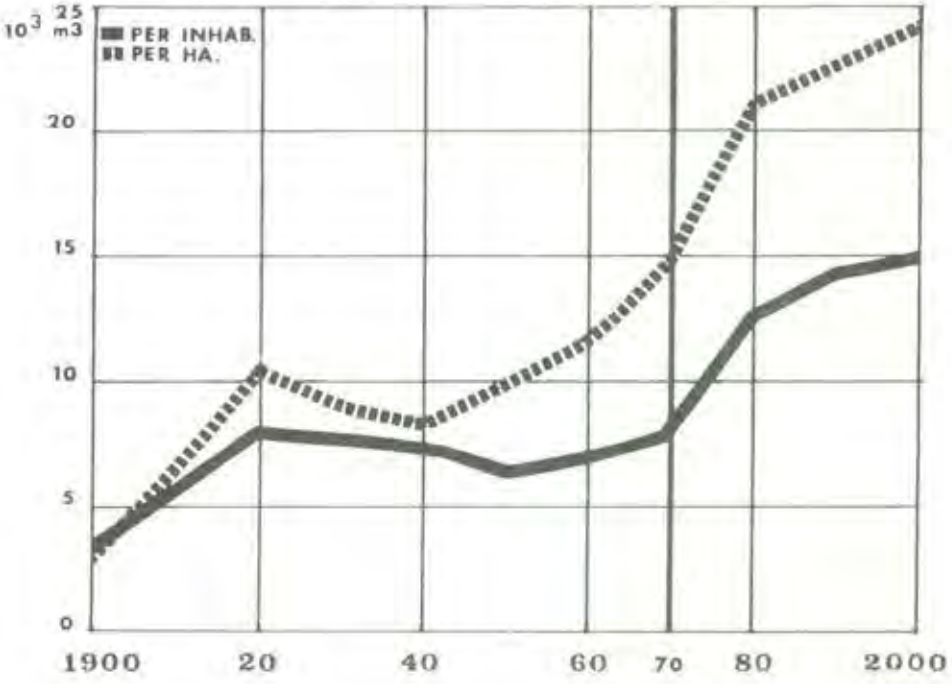
-Water Availability: Low income areas are initially served by public faucets of rationing service. The other areas have private installations and normal service.

1. WATER DEMAND AND CONSUMPTION. The city of 1970 required fifty times the water of 1900, and in 1980 will require more than twice the water of 1970. Needs were not satisfied in the past and will not be satisfied in the future. Consumption has always been smaller than demand and the difference has increased through the century.

1 Water Demand and Consumption



2 Consumption per 10^2 Inhab and per Ha.



This difference does not necessarily indicate a physical or real growing deficit of water; it is the difference between what the city could potentially consume and what it actually consumes given present water availability.

2. CONSUMPTION PER 100 INHABITANT AND PER HECTARE.
A) Per Inhabitant. This measure is a likely indicator of level of cultural-economic development, averaging 15 m3/inhab./year in primitive societies and over 400 m3/inhab./year in developed societies. As a whole, Bogota has surpassed the primitive stage. But due to uncontrolled population growth and to great technical and economic foreign dependency, consumption/inhab. in 1970 equalled that of 1920 and by 2000, levels of consumption will still correspond to those of underdeveloped societies.

B) Per Hectare. In general, the chart indicates growing availability of water per Hectare since 1940, but it does not indicate whether this availability has been equally increased through the entire urbanized area.

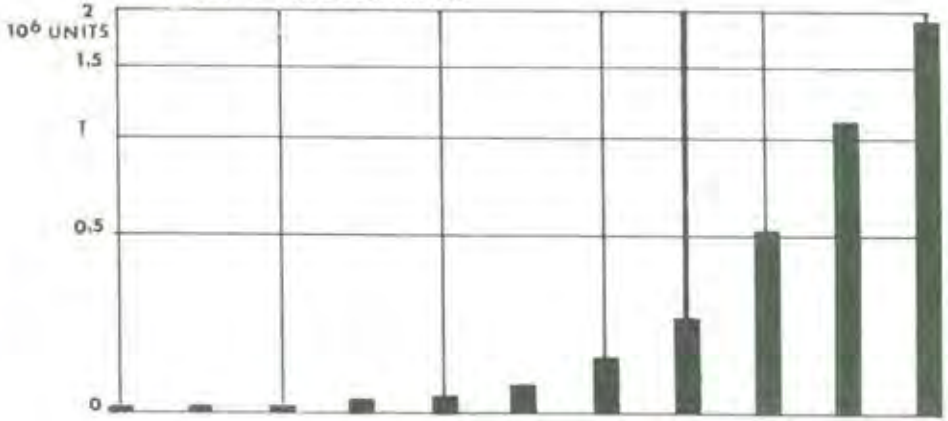
3. WATER INSTALLATIONS. Since 1900, 213,000 installations have been added, and by 1980 another 350,000 are projected to be added to meet the growing requirements.

4. INSTALLATIONS PER 100 INHABITANTS AND PER HECTARE. Despite these increases in installations, availability among the population and throughout the urbanized area has now shown a parallel increase through the century. In 1960, there were fewer installations per inhab. and per Ha. than in 1950. In 1970, the number per inhab. equalled that of 1950.

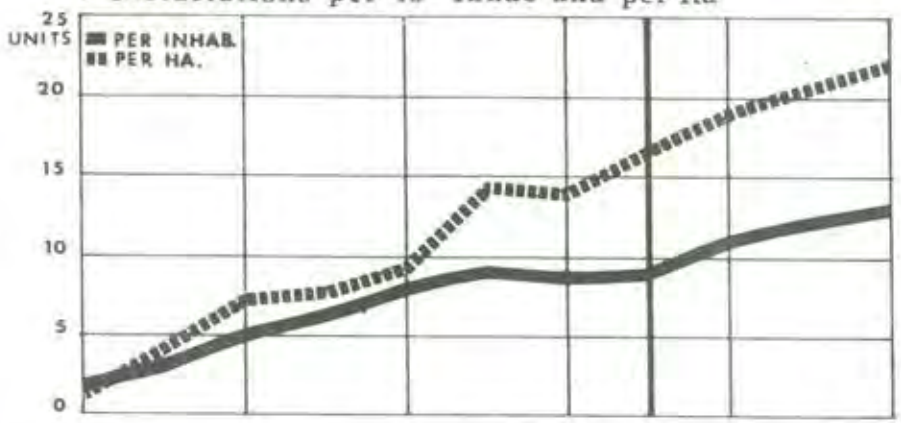
5. WATER NETWORK LENGTH. 1970 underground water pipe lines doubled that of 1960, and 1980 may double that of 1970.

Sources: 1.1; 2.1; 4.1; 7.2,4,6; 14.
Information: Approximate.

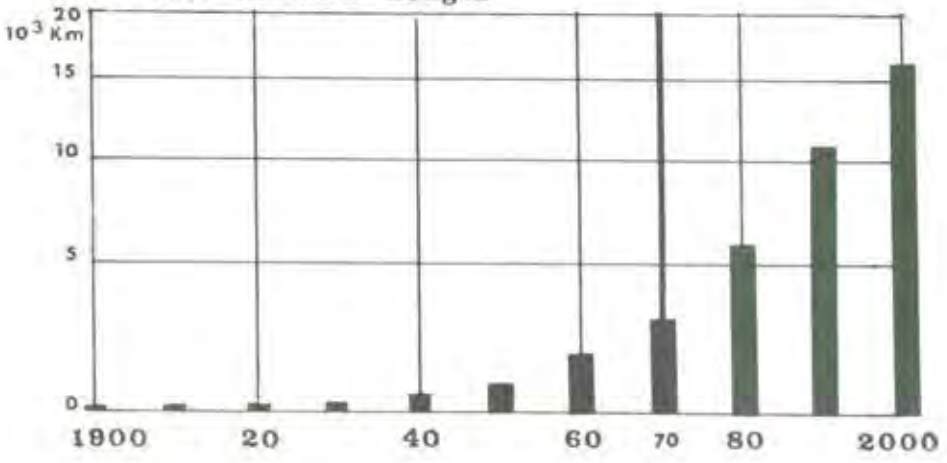
3 Water Installations



4 Installations per 10^2 Inhab and per Ha

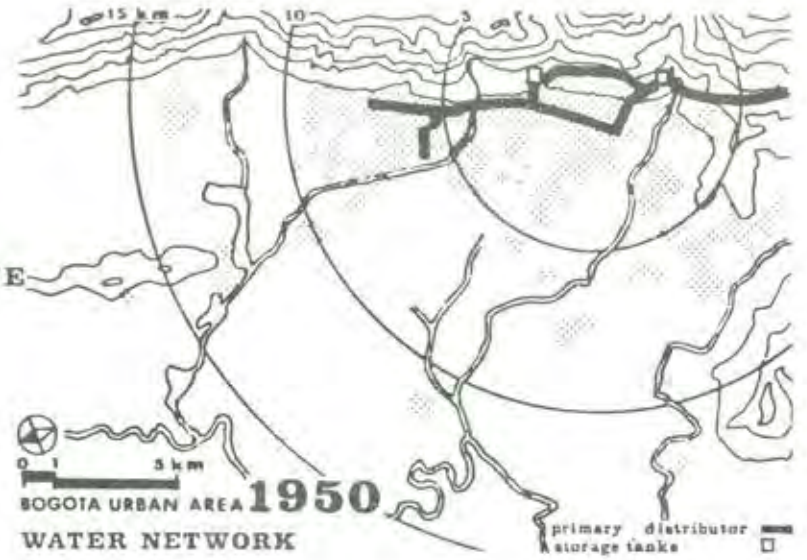


5 Water Network Length



WATER SYSTEM GROWTH

COMPARATIVE DIAGRAM



POPULATION
● 250 000 INHABITANTS

URBANIZED AREA
■ 10 000 HECTARES

DWELLINGS
● 25 000 UNITS

WATER DEMAND
■ 100 MILLIONS M3

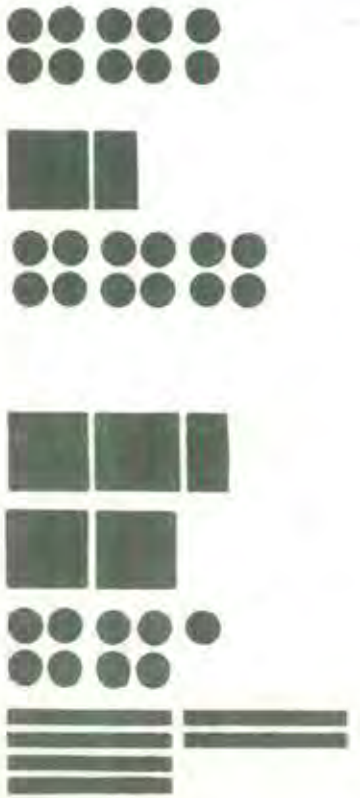
CONSUMPTION
■ 100 MILLIONS M3

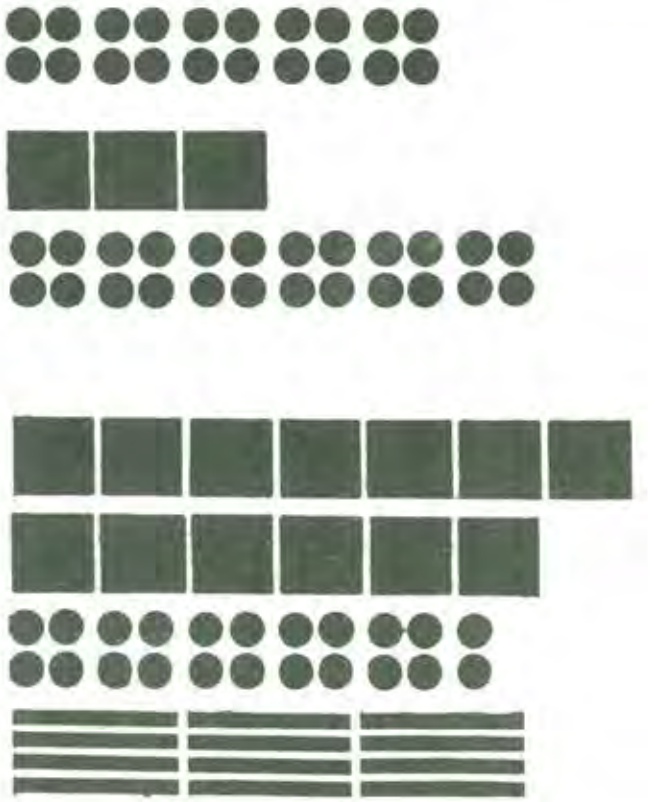
INSTALLATIONS
● 25 000 UNITS

NETWORK
— 500 KILOMETERS

15 km
10
5
0 1 5 km
BOGOTA URBAN AREA 1970
WATER NETWORK
primary distributor
storage tanks

15 km
10
5
0 1 5 km
BOGOTA URBAN AREA 1980
WATER NETWORK
primary distributor
storage tanks





SEWER-DRAINAGE SYSTEM

A combined, and for a long time unmodified, sewer-drainage system has provided acceptable city sanitation since 1900. Important technical improvements have come only recently.

PRESENT CONDITION OF THE SYSTEM

-Administration: Policies, Regulations and Controls are in charge of the same local government agency that manages the water system. Foreign entities provide financing to major projects. Projects Developer/Builders are the government agency/foreign and Colombian private firms.

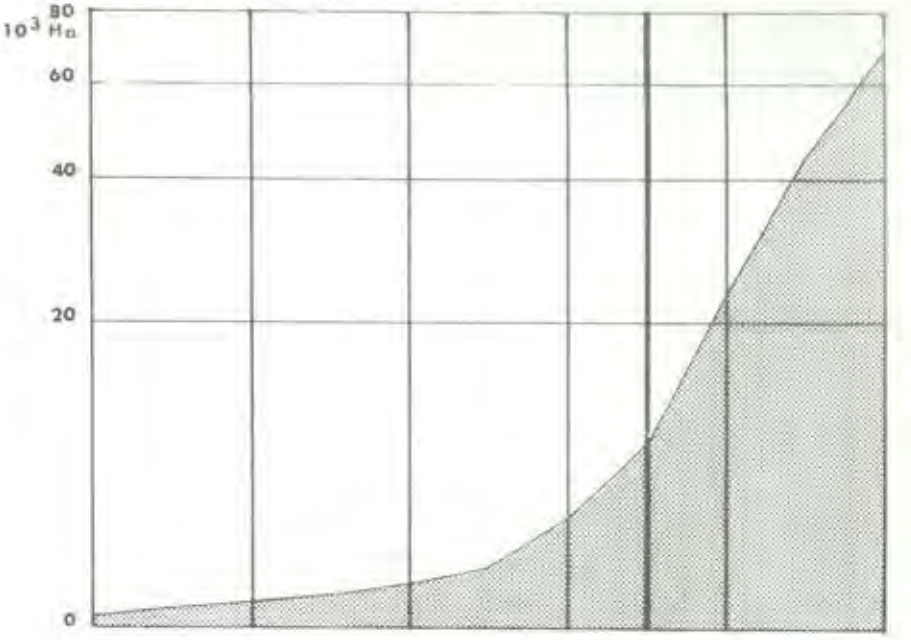
-Sewage Collection: Waste water and storm floods are combined in the same network of underground pipes and open channels.

-Treatment: There is none.

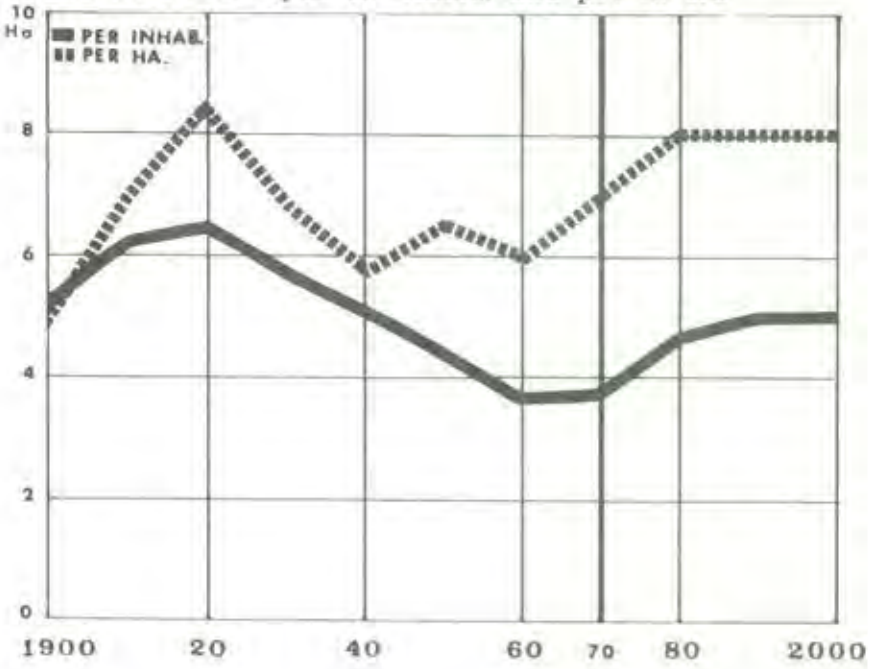
-Disposal: Sewage has always been dumped directly into neighboring streams which are now extremely polluted. A master plan will provide both separate systems and a treatment process by 1985.

-Sewer-Drainage Availability. Low income areas are usually not served, on initial stages of development, by the system. Other areas have generally available but not always adequate service; in raining seasons, damages caused by storm floods are common even in new urbanizations of high standards of construction.

1 Sewer-Drainage Area Served



2 Area Served per 10^3 Inhab. and per 10 Ha



1. SEWER-DRAINAGE AREA SERVED. Between 1900 and 1970, 8,720 Ha. were connected to the system, and in the short period from 1970 to 1980, another 14,750 new Ha. are projected to be serviced in an effort to meet the growing needs of the city.

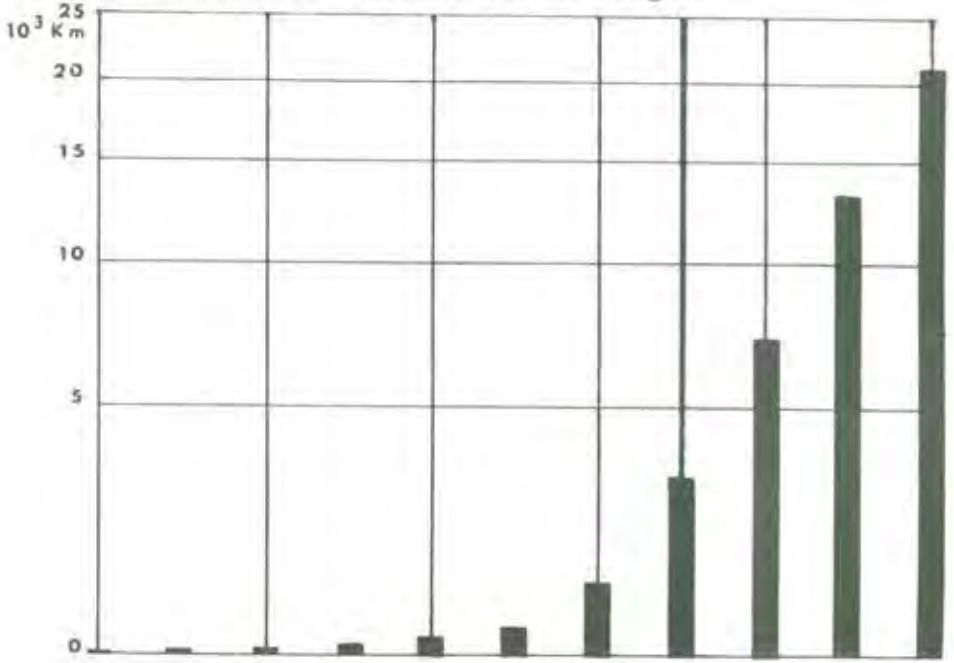
2. AREA SERVED PER 1000 INHABITANTS AND PER 10 HECTARES. The diagram indicates: (A) Amount of Hectares with sewer-drainage available per 1,000 inhabitants and (B) Proportion of urbanized area with sewer-drainage available. Despite continuous increase of the number of hectares served by the system, there has been no progress since 1920 in the amount of service per hectare and per inhabitant. Number of hectares served is larger in 1920 than in any other year of the century, both in relation to number of inhabitants and amount of urbanized area.

3. SEWER-DRAINAGE NETWORK LENGTH. In 1970 there were three times the length of open channels and underground pipes as in 1960. In 1980, there are projected to be 2½ times as much as in 1970.

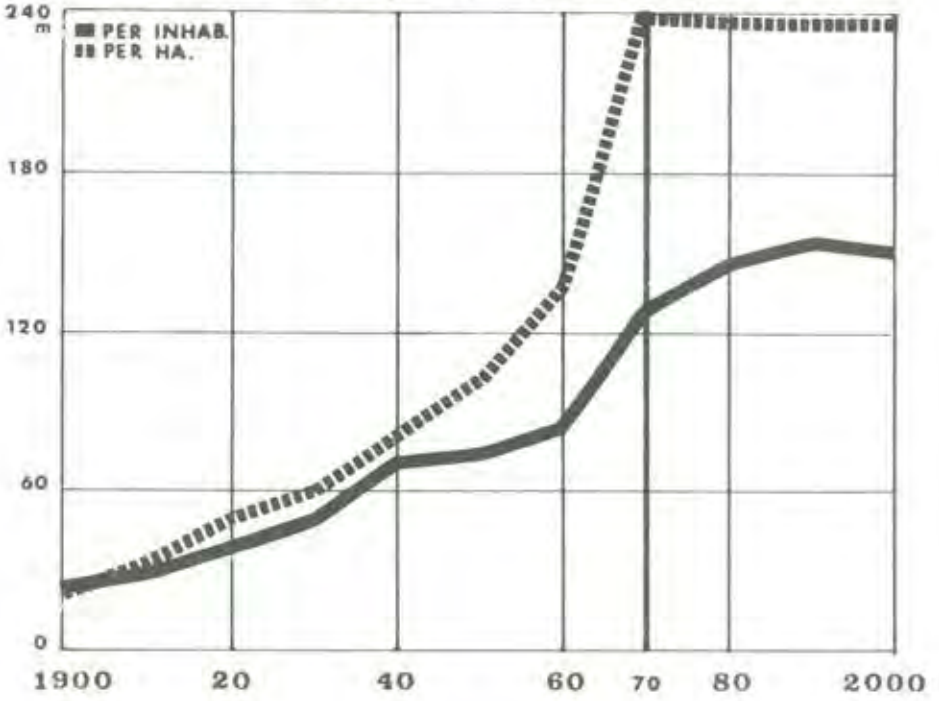
4. NETWORK LENGTH PER 100 INHABITANTS AND PER HECTARE. It increases continuously through the century which could mean continuous improvements of the availability of this utility. But a different thing is indicated by the diagram (2) and by the reality. The network is growing constantly in some areas and is leaving some areas of the city without service.

Sources: 1.1; 2.1; 7.1,2,3,4,5,6; 12.
Information: Approximate

1 Sewer-Drainage Network Length

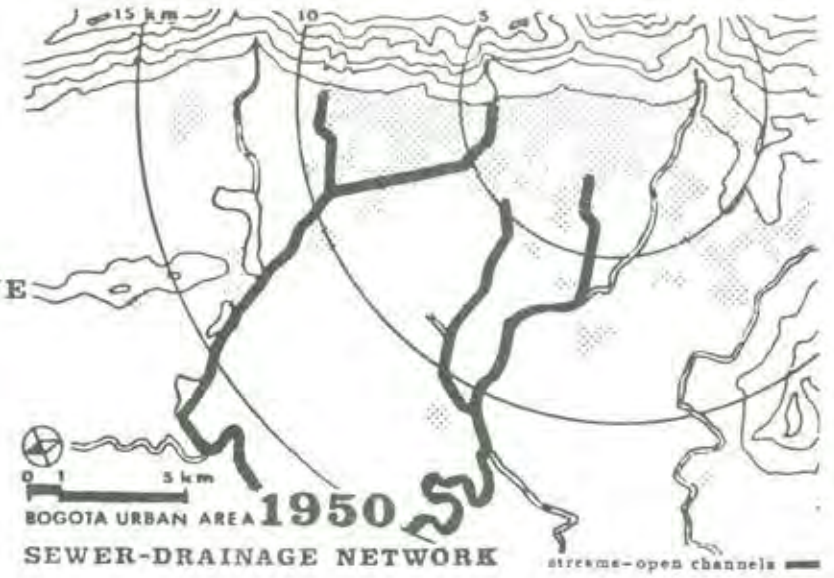


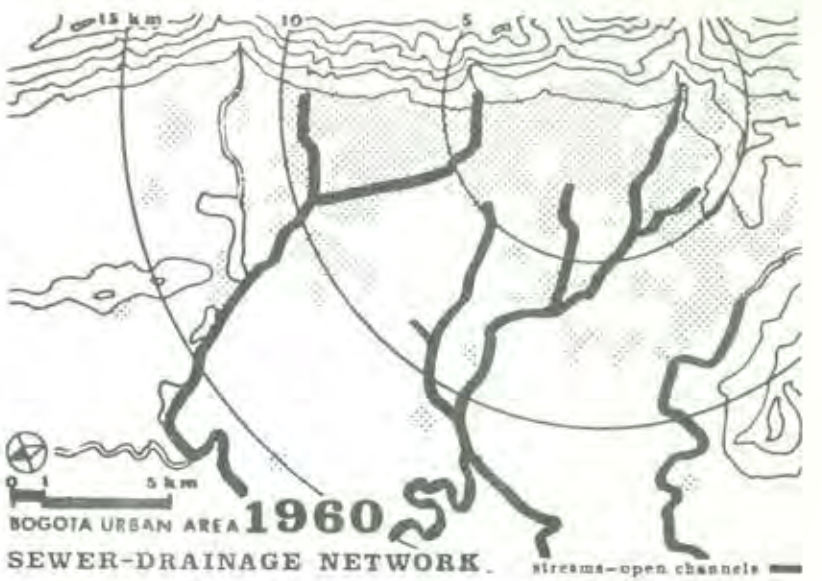
2 Network Length per 10^2 Inhab and per Ha



SEWER – DRAINAGE SYSTEM GROWTH

COMPARATIVE DIAGRAM





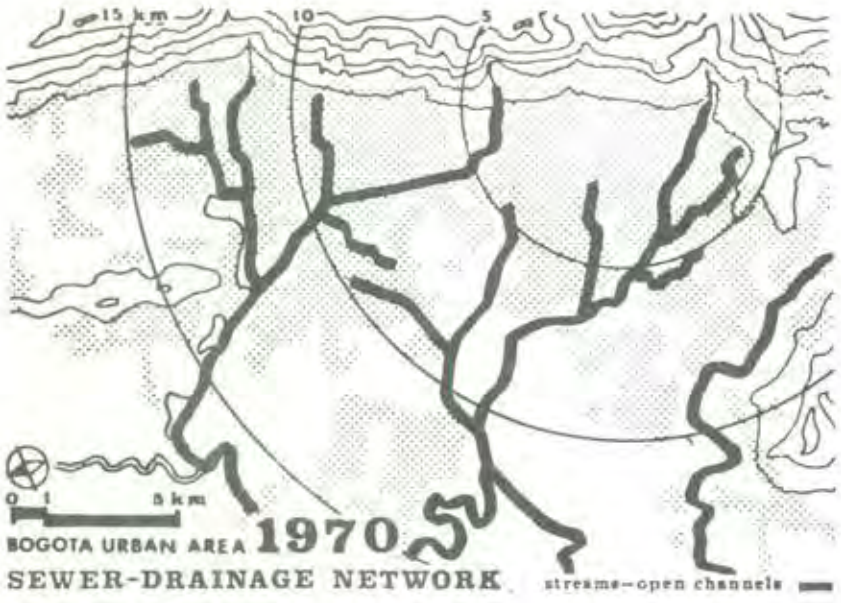
POPULATION
● 250 000 INHABITANTS

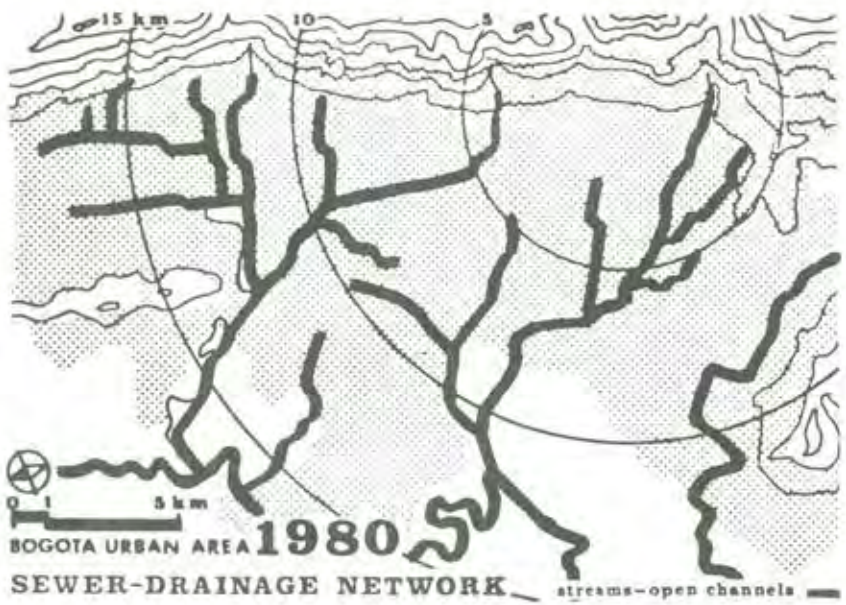
URBANIZED AREA
■ 10 000 HECTARES

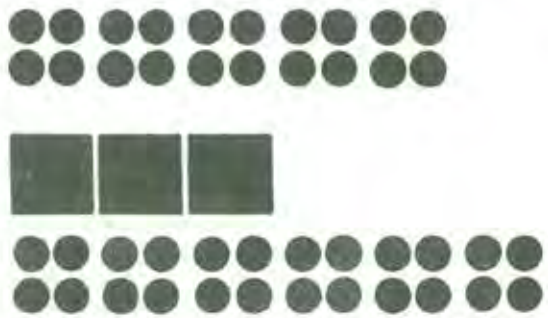
DWELLINGS
● 25 000 UNITS

SEWER AND DRAINAGE AREA SERVED
■ 10 000 HECTARES

NETWORK
—— 500 KILOMETERS


15 km
10
5
0 1 5 km
BOGOTA URBAN AREA 1970
SEWER-DRAINAGE NETWORK
streams-open channels


15 km
10
5
0 1 5 km
BOGOTA URBAN AREA 1980
SEWER-DRAINAGE NETWORK
streams-open channels



ELECTRICITY SYSTEM

Electricity has been available in Bogota since 1880. The present system began to be developed in 1900.

PRESENT CONDITION OF THE SYSTEM - Administration: Policies, Regulations and Controls are in charge of a regional government agency. Foreign entities provide financing of major projects. Project Developers/ Builders are the government agency/foreign and Colombian private firms.

-Electricity Generation: (a) One carbon thermic plant of 70 MW located 50 km. north of the city. (b) Four hydroelectric plants with a total capacity of 550 MW located in a chain on the Bogota River, 30 km. southwest of the city. (The river has a capacity of 22 m3/s. and it is controlled by four reservoirs which contain 1,000,000 m3; it falls 2,000 m. in less than 30 km.)

-Transmission: two old lines of 57.5 kv. and four new lines of 115 kv. (by 1975 there will be an additional line of 220 kv.).

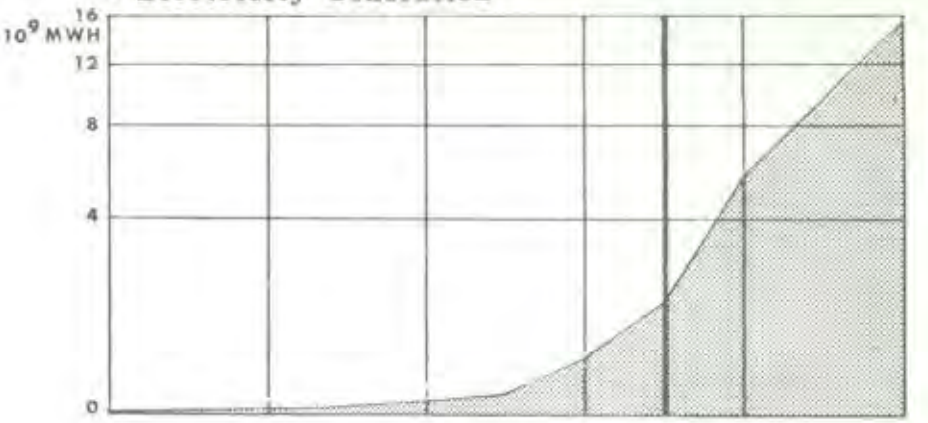
-Primary Distribution: lines of 11.4 kv. (they are being changed to lines of 13.2 kv.).

-Secondary Distribution: lines of 150 v. (now being changed to 120 v.). In recently developed low income areas, illegal private Distribution is common.

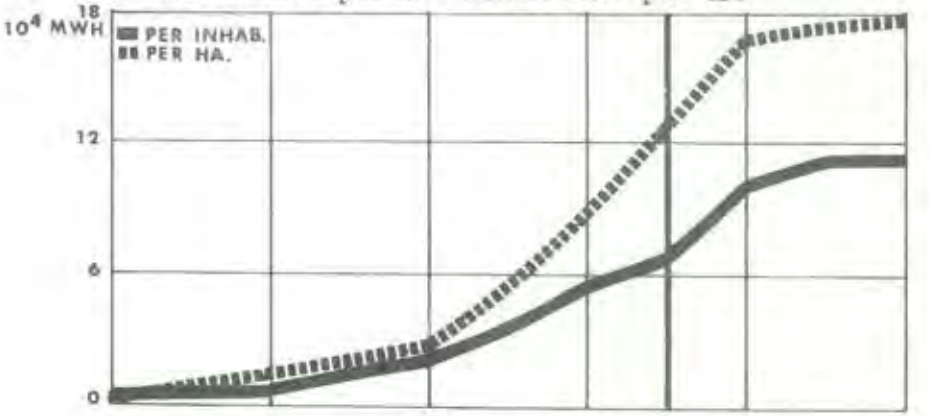
-Sub-stations of primary distribution: three of 115/57.5 kv.; fourteen of 57.5/11.4 kv.; one of 115/13.2 and 11.4 kv. (There is a current program to have only this kind of sub-station and also 220/13.2 sub-stations by 1980.) Total number of sub-stations, including secondary distribution sub-stations, is shown below.

-Electricity availability: low income neighborhoods usually obtain free service by making illegal connections to the network in initial stages of development. Most of the city has adequate and normal service.

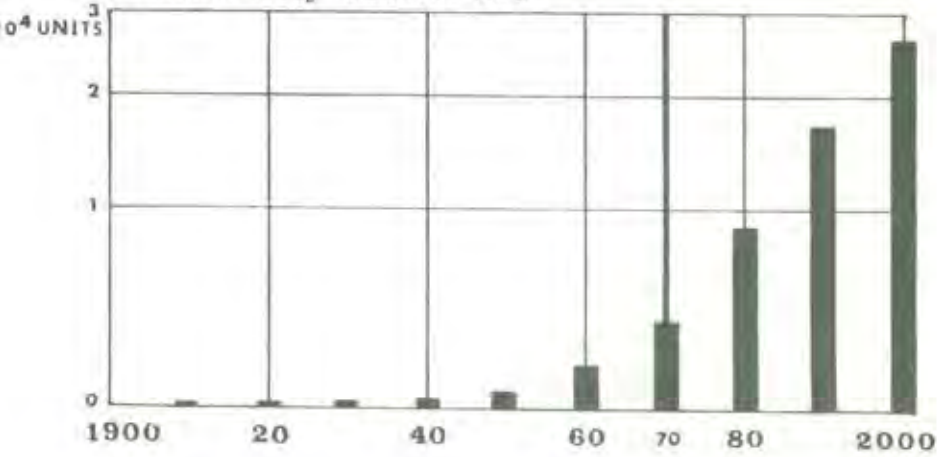
1 Electricity Generation



2 Generation per 10^2 Inhab and per Ha



3 Electricity Substations



1. ELECTRICITY GENERATION. Electricity generation in 1970 is twice that of 1960, and that of 1980 is projected to be three times that of 1970. By 1980, the city will require daily the amount required annually in the early 20's.

2. ELECTRICITY GENERATION PER 100 INHAB. AND PER HA. Except for the period from 1930 to 1940, electricity generated per inhabitant and per hectare has increased continuously throughout the century. Much more electricity per person and per hectare is available today than 10 or 20 years ago. This does not clarify if such availability is the same throughout the city, but it is a likely indicator of a generally improving standard of living.

3. ELECTRICITY SUB-STATIONS. Apparently there was only one at the beginning of the century. Then, 3,493 were added from 1900 to 1970, and another 5,476 are projected to be added by 1980 to meet rapidly-growing needs.

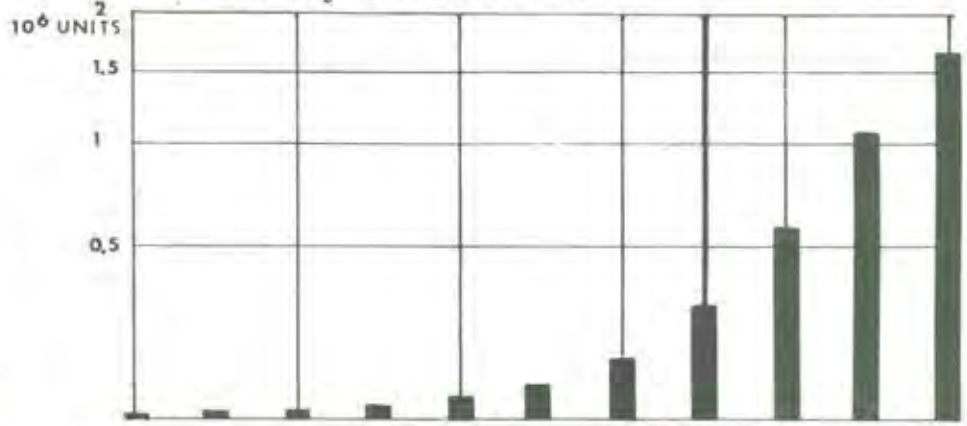
4. ELECTRICITY INSTALLATIONS. By 1900 there were 4,000. From 1900 to 1970, another 280,700 were added. Twice this amount must be added in only ten years to meet the needs of 1980.

5. ELECTRICITY INSTALLATIONS PER 100 INHAB. AND PER HA. Despite these increases of installations and due to the uncontrolled growth of the population and urbanized area, average availability of installations has not significantly improved since 1950. By 1980 the average number of installations available per 100 inhabitants could be similar to that of 1950.

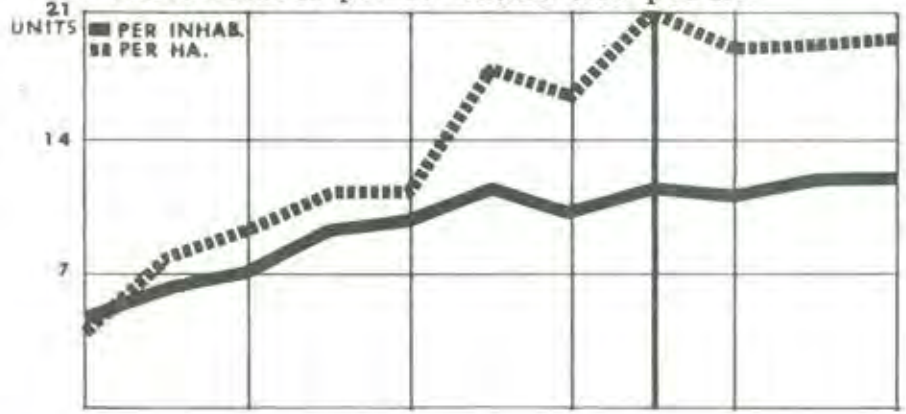
6. ELECTRICITY NETWORK LENGTH. In 1970 there were twice the electric lines and poles of 1960, and by 1980 there will be twice the amount of 1970.

Sources: 1.1; 2.1; 7.4,6; 8, unpublished data; 8.1,2.
Information: Approximate

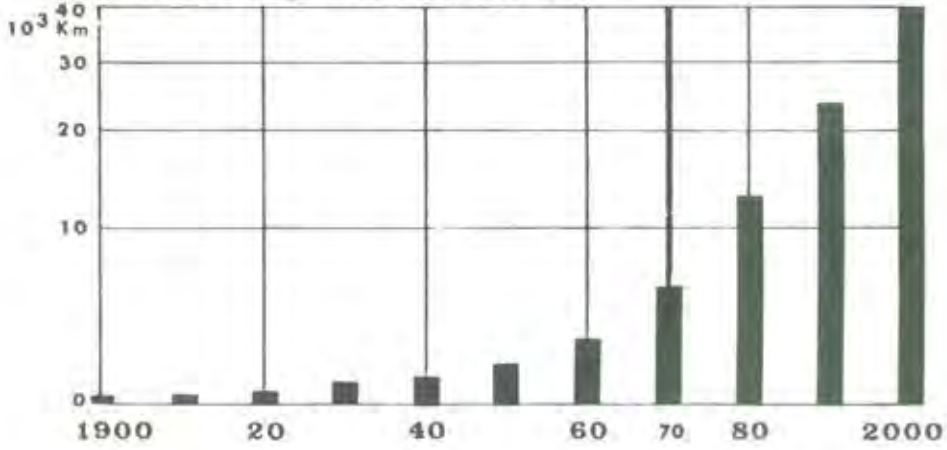
4 Electricity Installations



5 Installations per 10^2 Inhab and per Ha

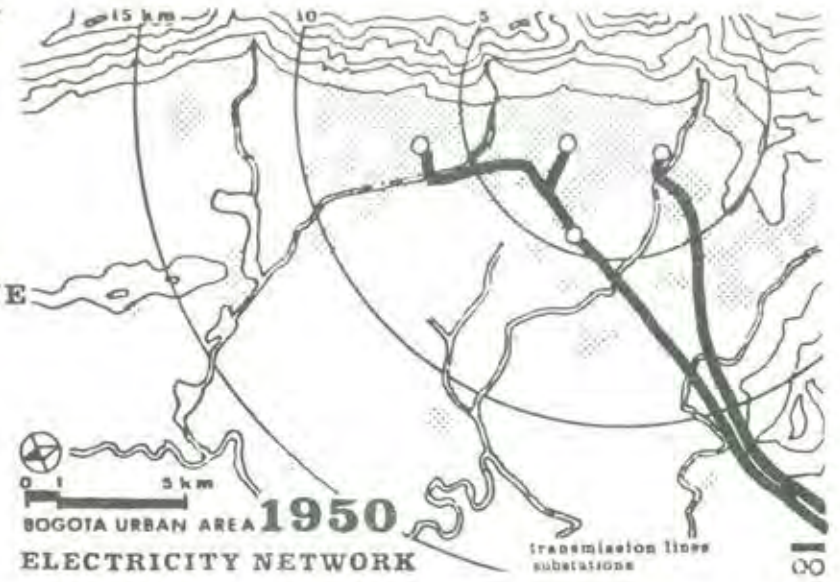


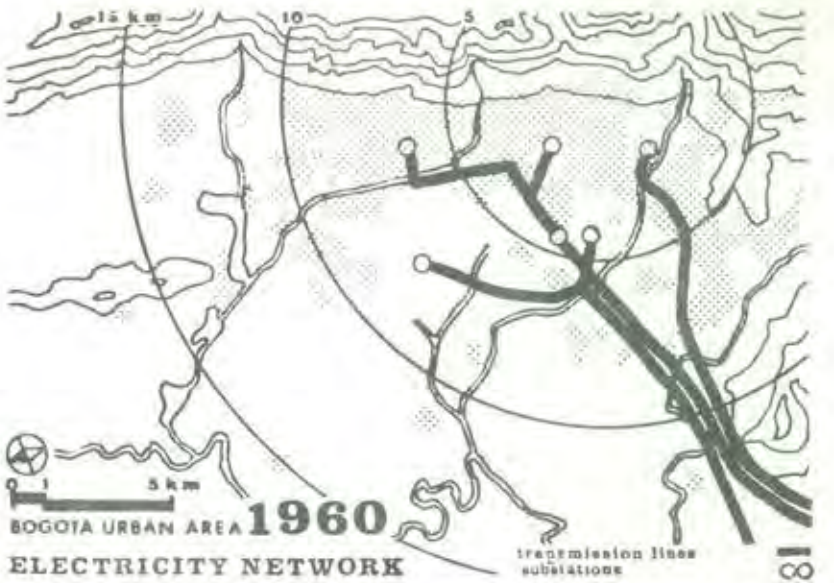
6 Electricity Network Length



ELECTRICITY SYSTEM GROWTH

COMPARATIVE DIAGRAM





POPULATION
● 250 000 INHABITANTS

URBANIZED AREA
■ 10 000 HECTARES

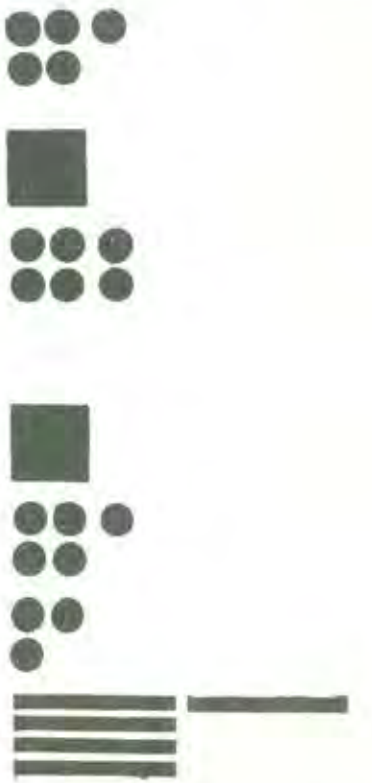
DWELLINGS
● 25 000 UNITS

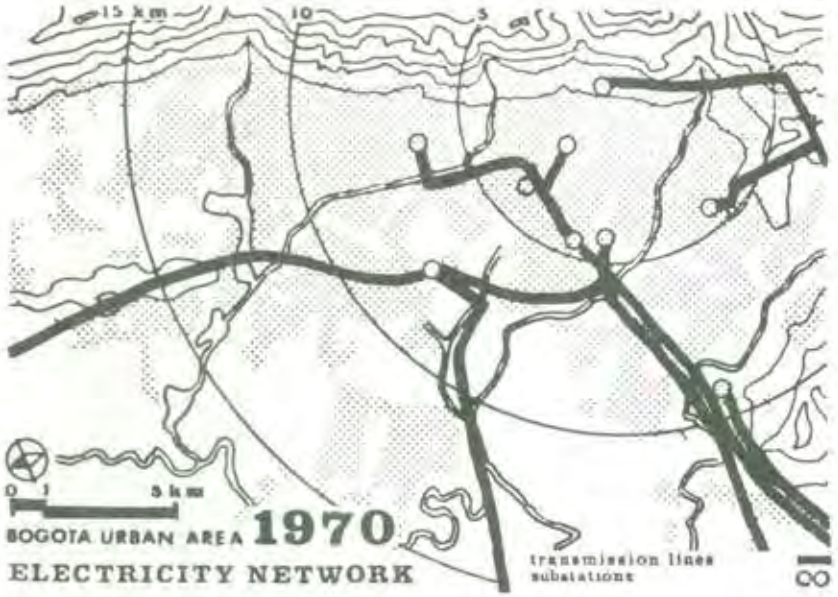
ELECTRICITY GENERATION
■ 750 MILLIONS KWH

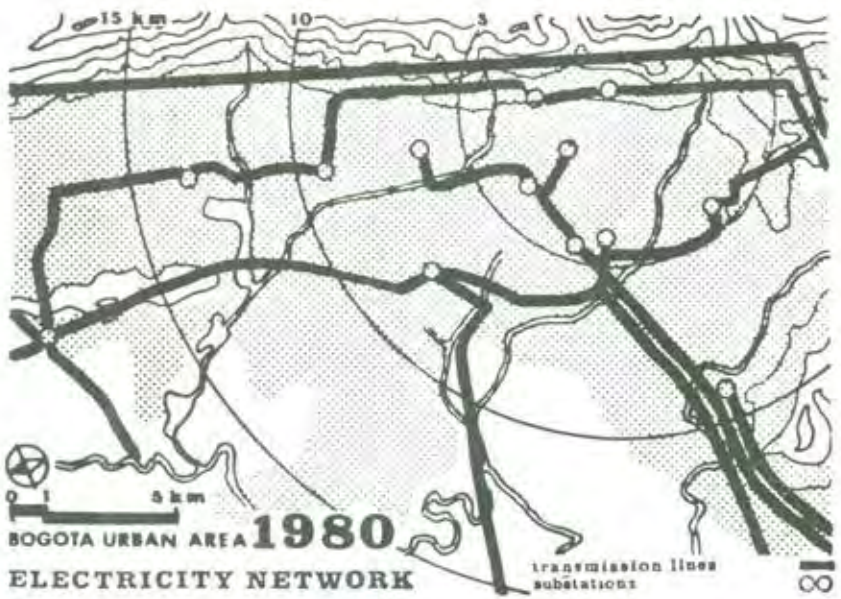
INSTALLATIONS
● 25 000 UNITS

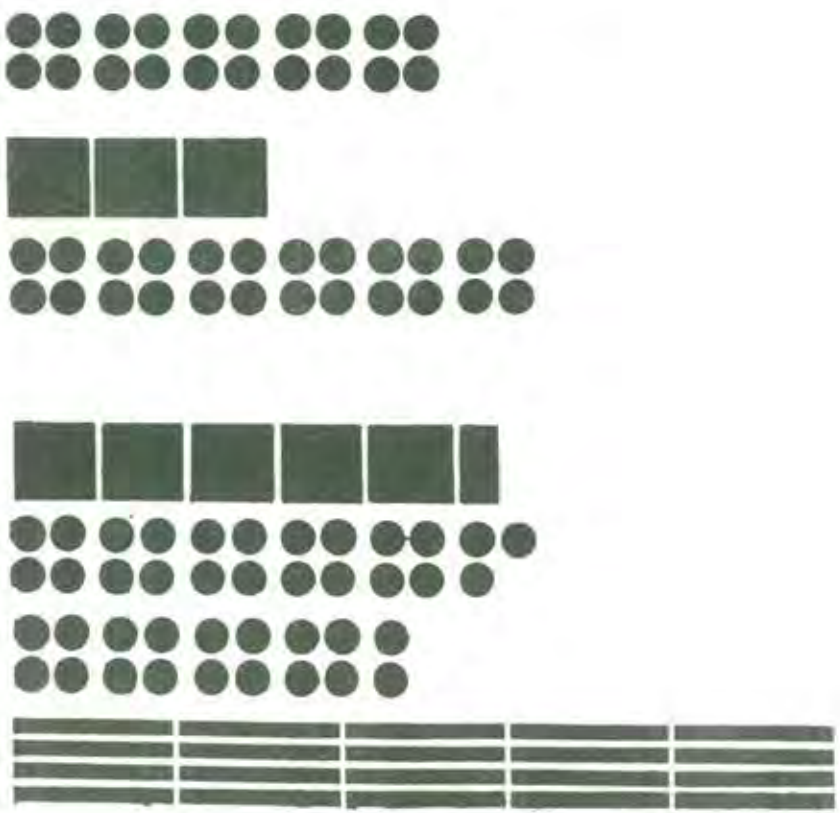
SUBSTATIONS
● 500 UNITS

NETWORK
— 500 KILOMETERS




15 km
10
5
0 1 5 km
BOGOTA URBAN AREA 1970
ELECTRICITY NETWORK
transmission lines
substations


15 km
10
5
0 1 5 km
BOGOTA URBAN AREA 1980
ELECTRICITY NETWORK
transmission lines
substations



TELEPHONE SYSTEM

Telephone service has been available since 1884. The present system began developing in 1906. It is a combination of the so-called Ericsson AGF and ADF-102 systems.

PRESENT CONDITION OF THE SYSTEM.

-Administration: Policies, Regulations and Controls are in charge of a local government agency. Foreign entities provide financing to major projects. Project Developers/ Builders are the government agency/foreign and Colombian private firms.

-The telephones: Four public phones located in central dense areas and in the airport, are connected to a long distance service; the others are for local service only. Private phones can be connected to a national automatic service for long distance calls.

-Transmission: Primarily by aerial cables supported by wood poles; underground trunk lines.

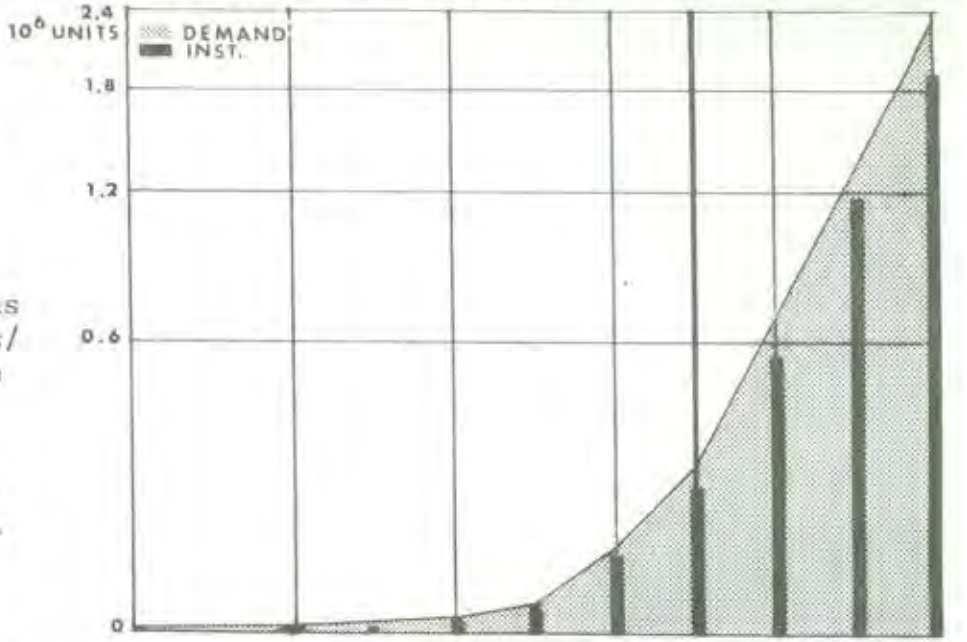
-First selection/distribution of calls: Occurs in cabinets located on the sidewalks. Its capacity: 300 installations.

-Trunk lines: Cables of 600 to 10,000 lines.

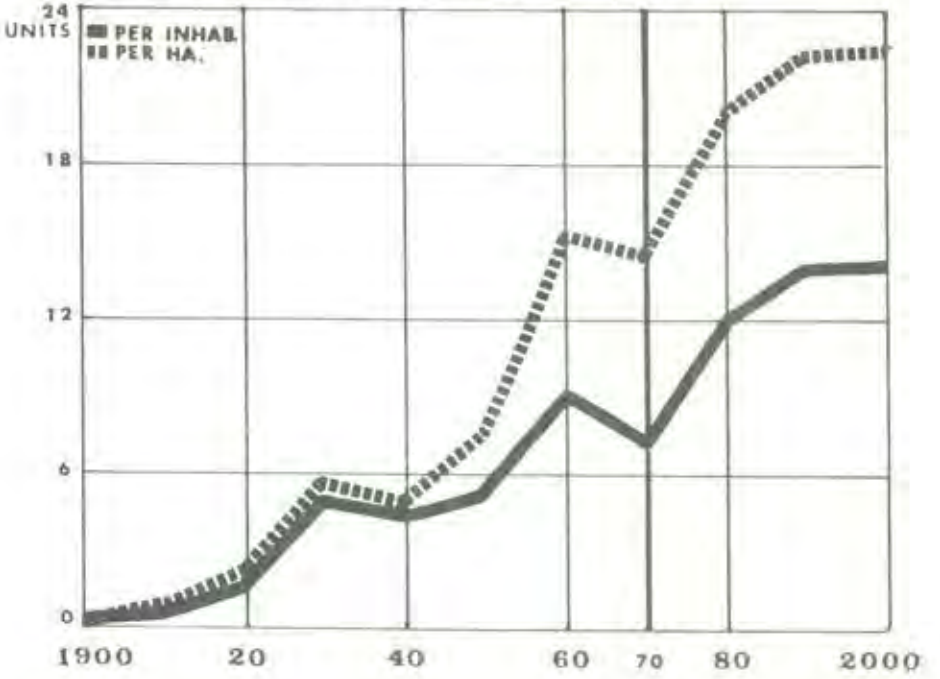
-Switching centers: The largest connects 50,000 installations; the smallest are mobil units of 800 installations.

-Telephone availability: The city is becoming well-served by public telephones that are available within average radius of 800 meters. Private telephones are mostly located in sectors other than low income.

1 Telephones Demand and Installations



2 Installations per 10^2 Inhab and per Ha



1. TELEPHONE DEMAND-INSTALLATIONS. In 1970, Bogota demanded 264,600 more phones than in 1900. By 1980, the city will demand another 555,000. The demand, as measured by the number of written applications for installations to the Telephone Company, has not been met in the past and will not be met in the future. The deficiency has been increasing throughout the century; the city is now attempting to eliminate it by a large scale plan of public telephone installations.

2. INSTALLATIONS PER 100 INHABITANTS AND PER HA. This measure has increased throughout the century, except for decreasing periods from 1930-40 and 1960-70. This indicates a growing average availability in the city, but it does not indicate whether this availability has been equally distributed.

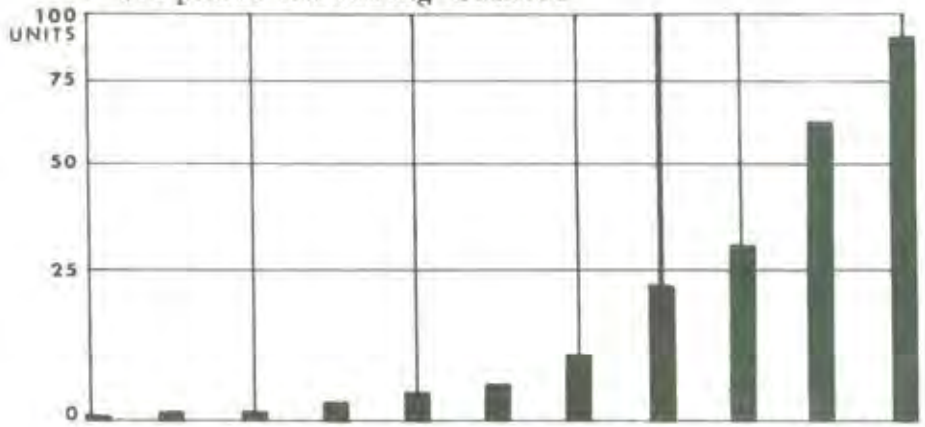
3. SWITCHING CENTERS. Apparently there was only one at the beginning of the century. Eight were added by 1960. 14 were added between 1960 and 1970, and 7 could be added by 1980.

4. SWITCHING CENTERS PER 100,000 INHABITANTS AND PER 1000 HA. The system has grown by adding new centers (diagram #3) and by enlarging the capacity of existing centers (diagrams #1 and #3). In general, new centers correspond to expansion of the telephone service over the urbanized area, and growth of existing centers corresponds to major concentration of the service in areas in which these centers are located. Accordingly, the diagram indicates periods of expansion (1920-30 and 1940-70) and periods of concentration of the service among population and urbanized area.

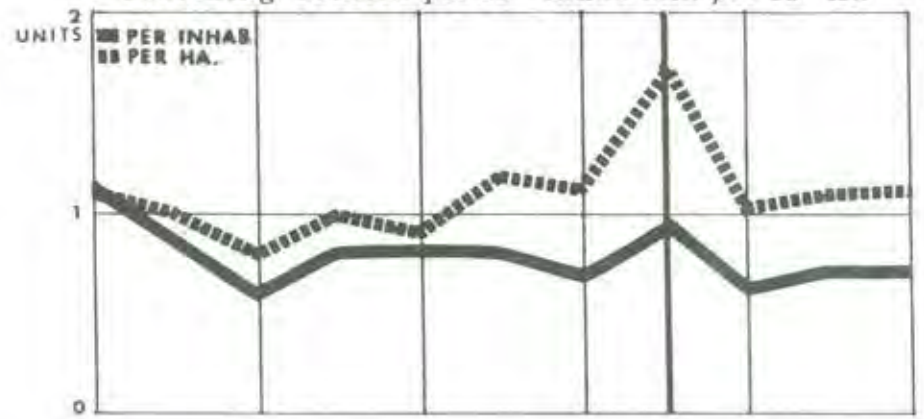
5. TELEPHONE NETWORK LENGTH. In 1970, there were three times the cables and poles of 1960. In 1980, there will be three times as much as in 1970.

Sources: 2.1; 7.4,6; 9, unpublished data; 9.1,2,3.
Information: Approximate.

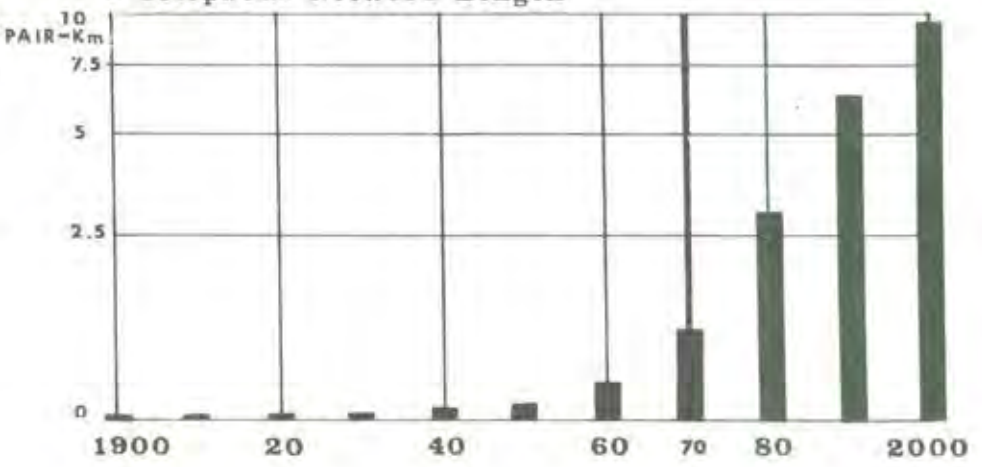
3 Telephone Switching Centers



4 Switching Centers per 10^5 Inhab and per 10^2 Ha

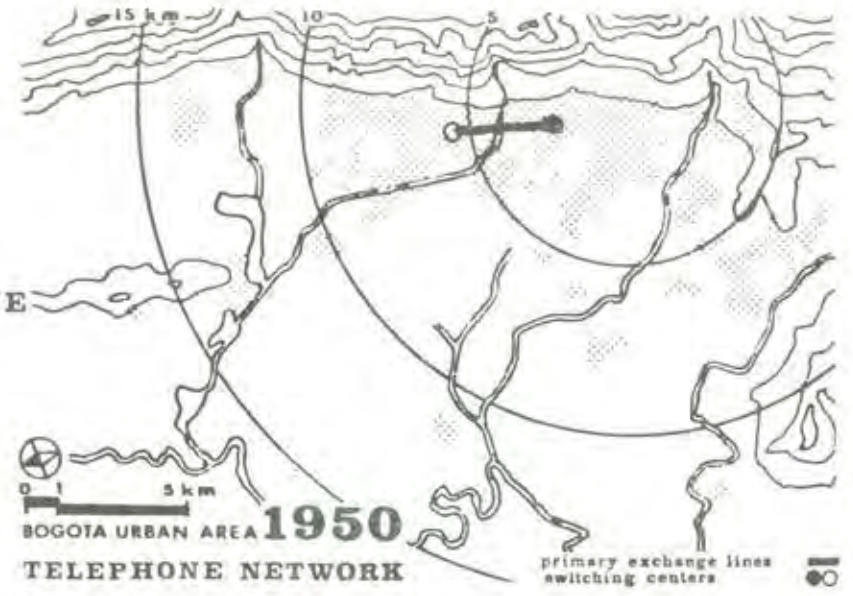


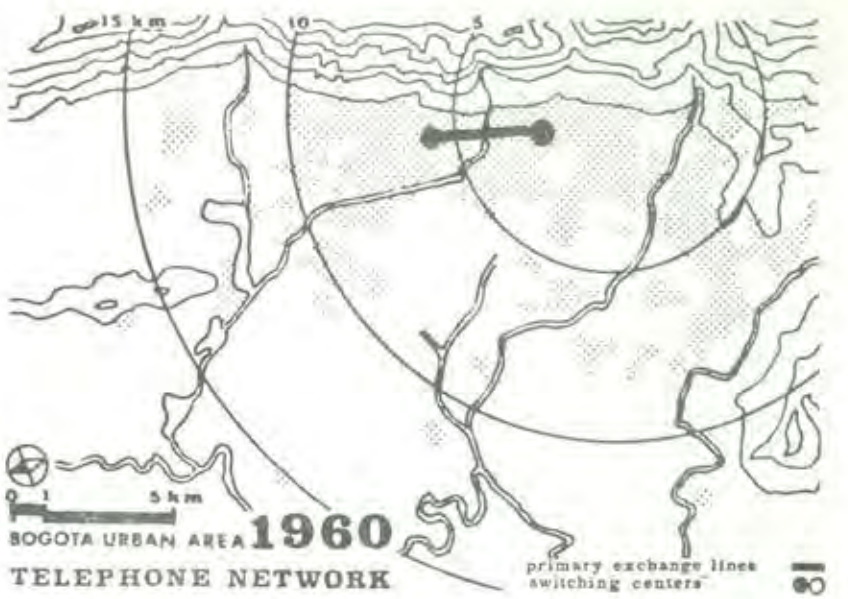
5 Telephone Network Length



TELEPHONE SYSTEM GROWTH

COMPARATIVE DIAGRAM





POPULATION
● 250 000 INHABITANTS

URBANIZED AREA
■ 10 000 HECTARES

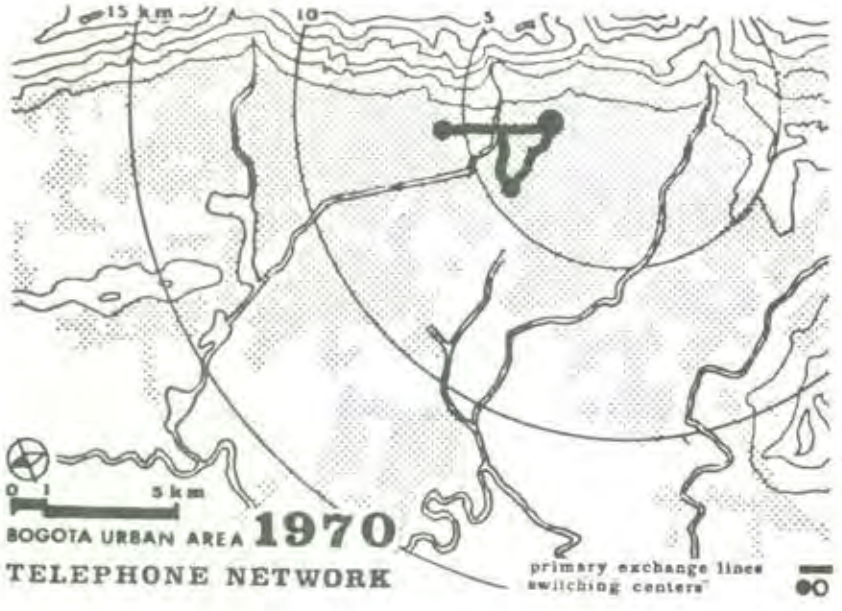
DWELLINGS
● 25 000 UNITS

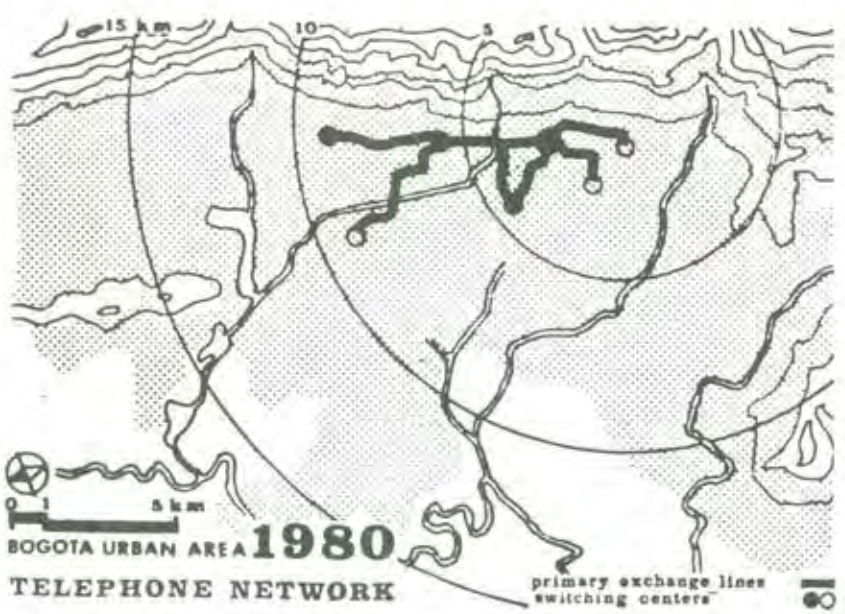
TELEPHONE DEMAND
● 25 000 UNITS

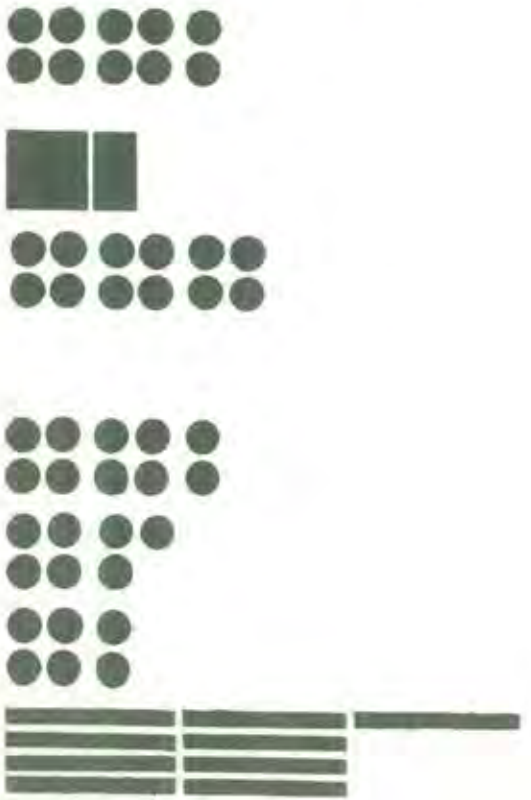
INSTALLATIONS
● 25 000 UNITS

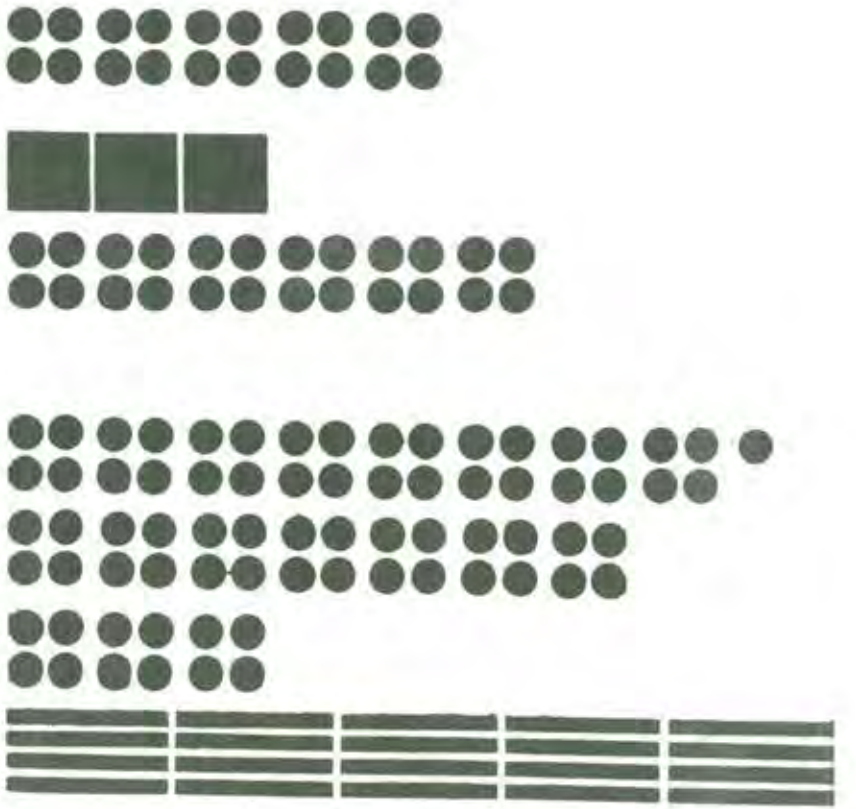
SWITCHING CENTERS
● 5 UNITS

NETWORK
— 100 000 PAIR-KILOMETERS


15 km
10
5
0
1
5 km
BOGOTA URBAN AREA 1970
TELEPHONE NETWORK
primary exchange lines
switching centers


15 km
10
5
0
1
5 km
BOGOTA URBAN AREA 1980
TELEPHONE NETWORK
primary exchange lines
switching centers





REFUSE SYSTEM

The Refuse System has not had a development parallel with the other systems studied here.

PRESENT CONDITION OF THE SYSTEM - Administration: Policies, Regulations and Controls are in charge of a government agency that also attends administration of slaughterhouses, cemeteries and popular markets. No major project has been attempted related to the refuse system.

-Refuse collection: Dwelling refuse (80% of total collected refuse) is collected once or twice a week from individual cans in front of each dwelling.

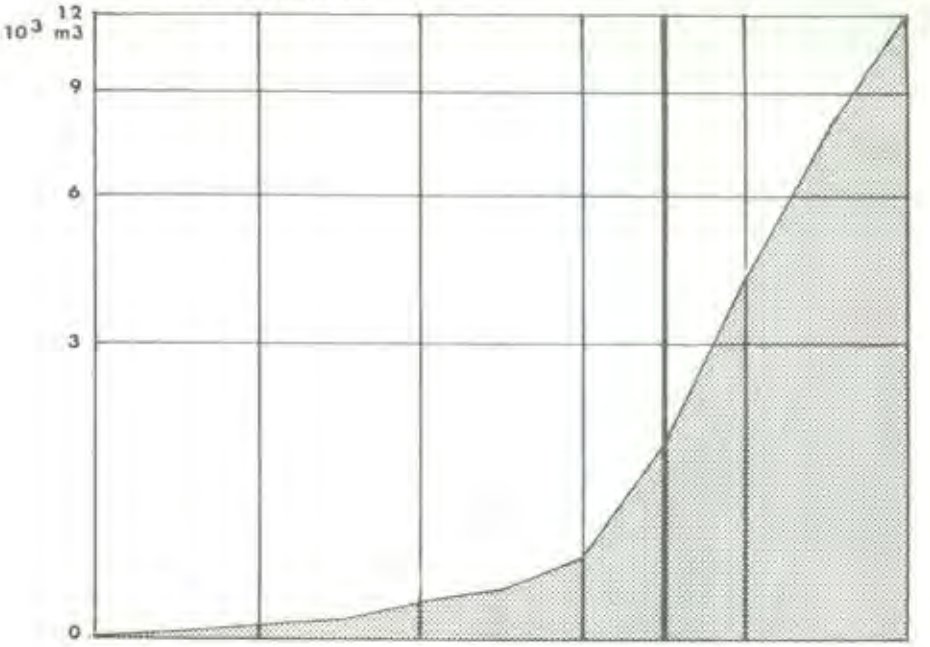
-Transportation: It is done by proper and improper trucks of 3 to 9 ton. capacity.

-Disposal: Refuse is dumped without treatment into open areas and streams in the suburbs.

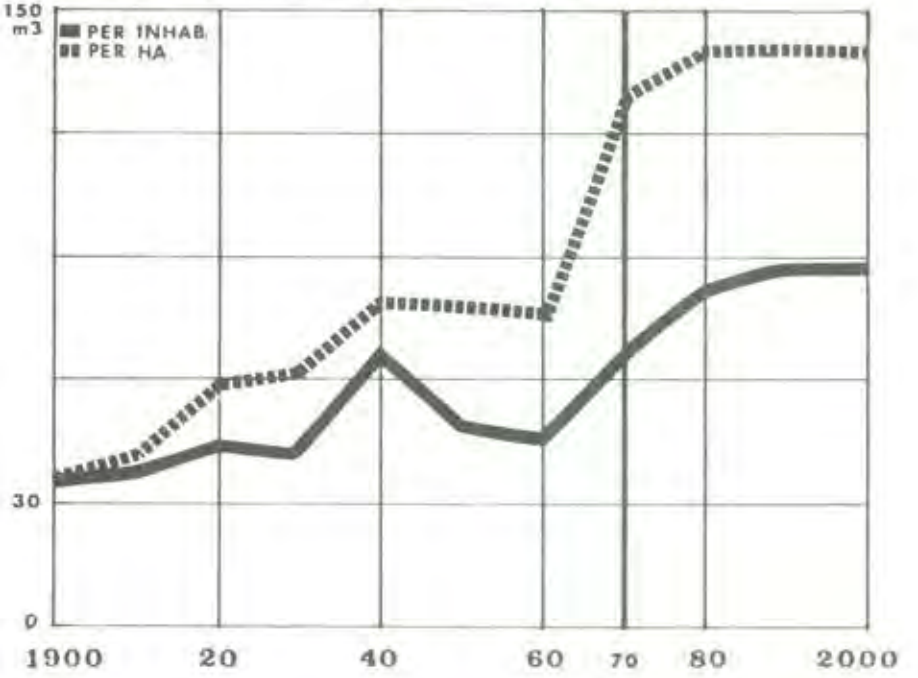
-Refuse Collection Availability: Low income sectors receive no service or an occasional irregular service of the system; individual and communal open dumps are common there. Other sectors have generally available but frequently inadequate service.

1. REFUSE COLLECTED. Refuse collected in 1970 was 55 times the amount collected in 1900. In 1980, it will be three times the 1970 amount; In 1980, as much refuse will be collected in four months as in all of 1970.

1 Refuse Collected



2 Refuse Collected per 10^2 Inhab and per Ha



2. REFUSE COLLECTED PER 100 INHABITANTS AND PER HA. Modern industrialized cities in consuming societies have increasing quantities of refuse collected per person and per hectare. In Bogota, the amount increased from 1900 to 1940, decreased from 1940-1960, and increased from then on. Periods when this amount increase apparently correspond with periods of improving standards of living, and periods when this amount decreases correspond to deficient provision of utilities and/or no significant improvement of standard of living of the city as a whole.

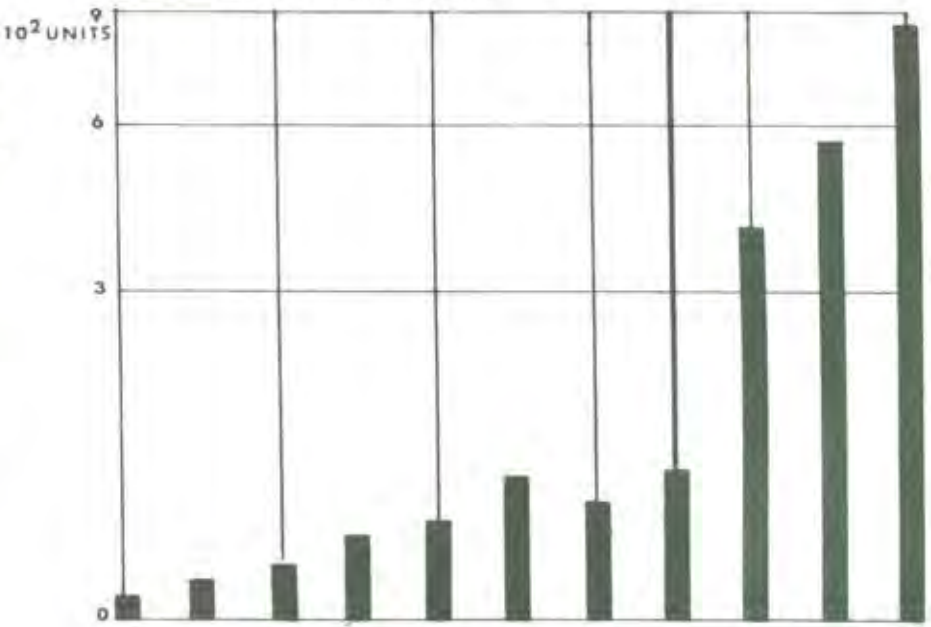
3. REFUSE COLLECTION VEHICLES (mechanical since 1920). The number increases from 10 in 1900 to 94 in 1950, decreases by 1960, and increases again to a probable 870 by 2000. In 1970 there were 90 vehicles more than 80 years before, and only ten years later (1980) it could be necessary to provide 300 more vehicles.

4. VEHICLES PER 10,000 INHABITANTS AND PER 100 HA. This relation partially indicates the availability of refuse collection vehicles among the population and through the urbanized area. This availability depends on the number of vehicles (shown in diagram #3) and on the efficiency of the vehicles, which can be analyzed by comparing diagrams #1 and #3 (refuse collected by vehicles).

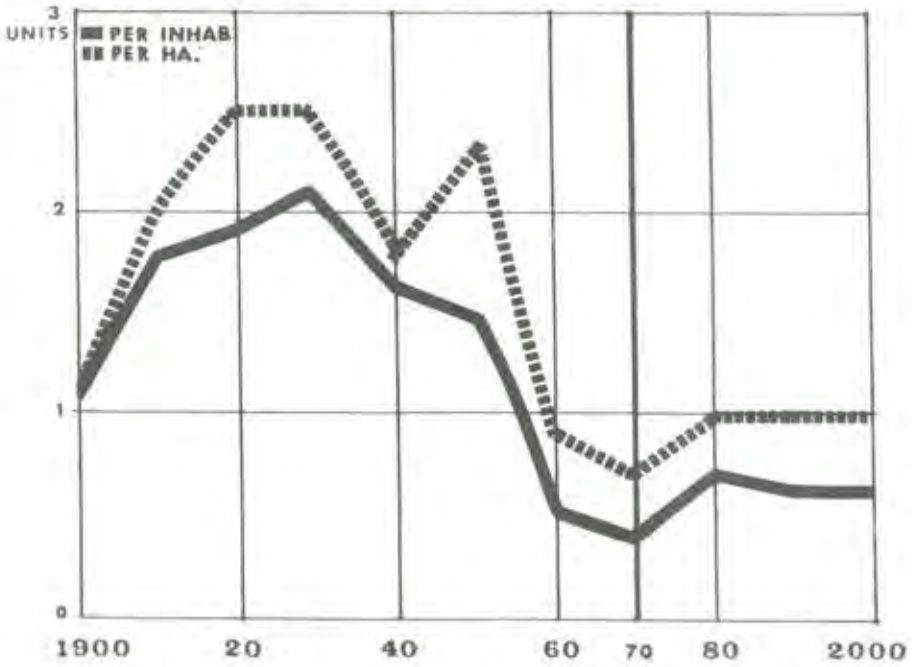
Today there are fewer vehicles per 10,000 inhabitants and per 100 Ha. than ever before. Today's vehicles are more efficient, but considering that they are not essentially different from older ones and that no basic change has been introduced in the system since 1920, it seems clear that Bogota has had a serious deficiency of refuse collection vehicles at least since 1930.

Sources: 2.1; 5.4; 6.1.
Information: Approximate.

3 Refuse Collection Vehicles

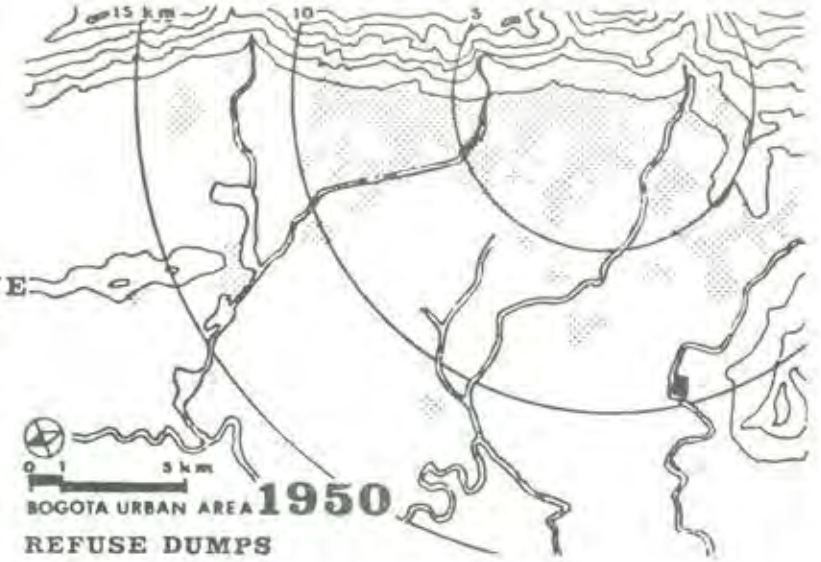


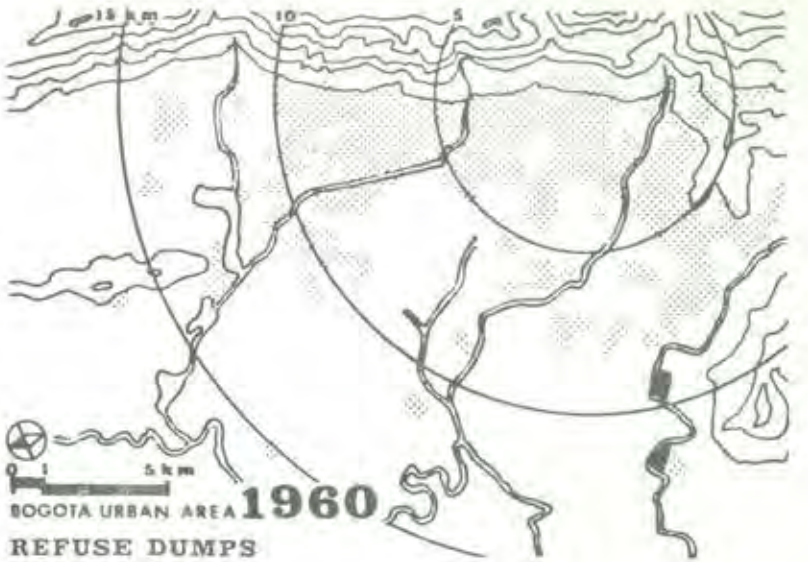
4 Vehicles per 10^4 Inhab and per 10^2 Ha



REFUSE SYSTEM GROWTH

COMPARATIVE DIAGRAM





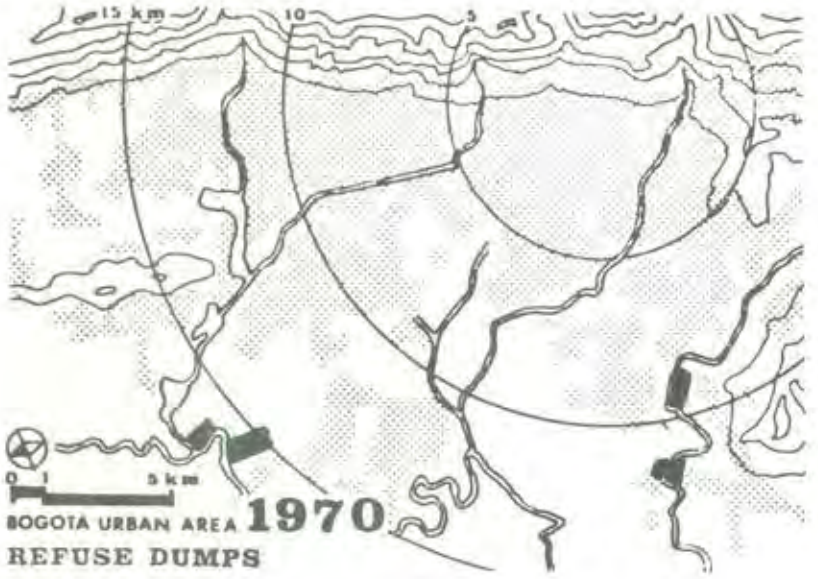
POPULATION
● 250 000 INHABITANTS

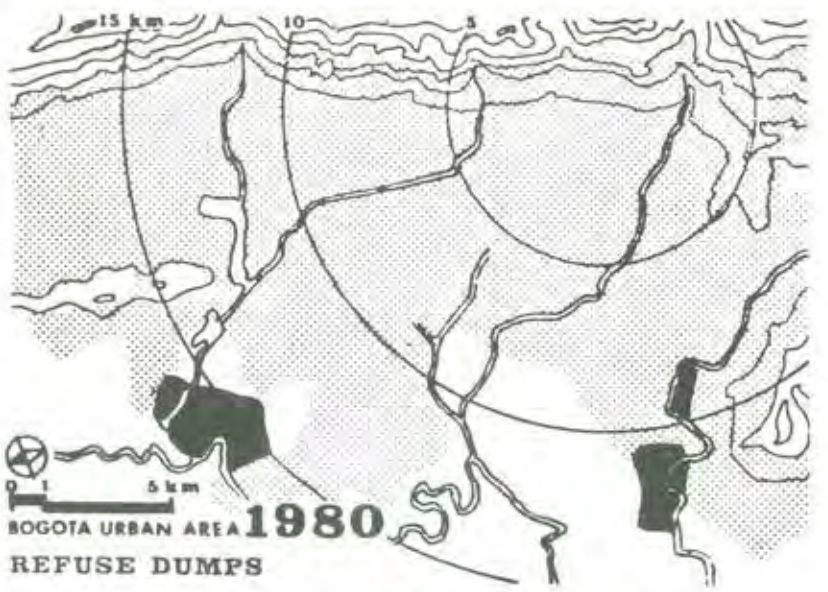
URBANIZED AREA
■ 10 000 HECTARES

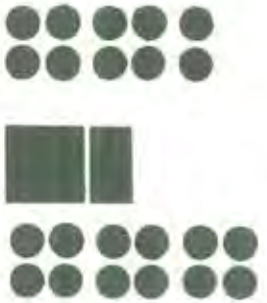
DWELLINGS
● 25 000 UNITS

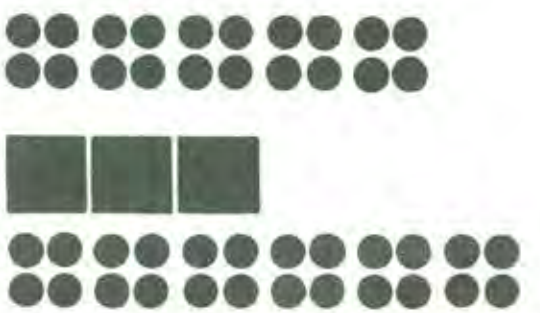
REFUSE COLLECTED
■ 1 MILLIONS M3

COLLECTION VEHICLES
● 25 UNITS


15 km
10
5
0 1 5 km
BOGOTA URBAN AREA 1970
REFUSE DUMPS


15 km
10
5
0 1 5 km
BOGOTA URBAN AREA 1980
REFUSE DUMPS





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