Chapter 2

Existing Situation

CHAPTER 2 EXISTING SITUATION

2.1 Natural Conditions

2.1.1 Topography

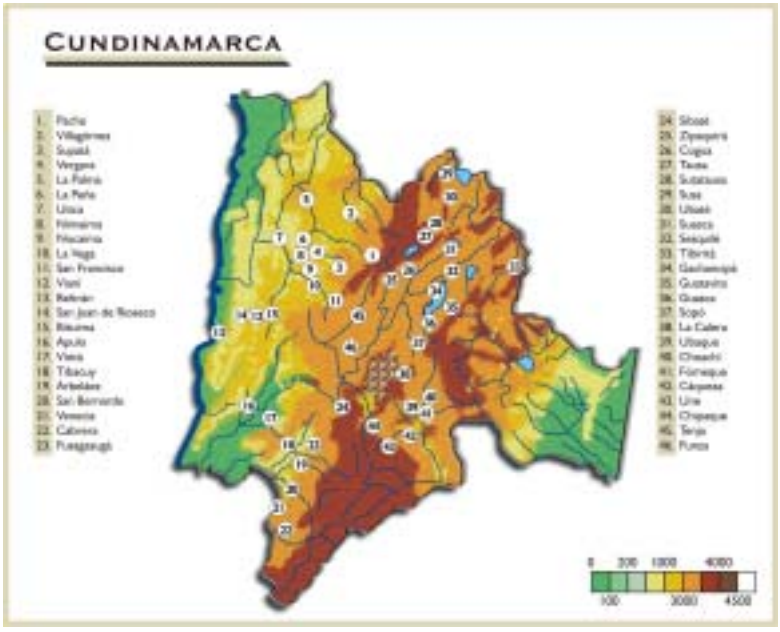
1) Topography in Colombia

The territorial area of the country is 1,141,747 km^2, ranging between latitude 4.2 degrees south and 12.4 degrees north, and between longitude 66.9 degrees west and 78.8 degrees west. From viewpoints of location, topography hydrology and climate, the territory is subdivided into five major regions, namely, Pacific region, Caribbean region, Andean region, Orinoco region and Amazon region. Among them, the Andean region has the largest share of the total population at 70%.

There are three distinct cordilleras, or ranges, - the Cordillera Occidental, the Cordillera Central, and the Cordillera Oriental - in Colombia running parallel in NNE-SSW directions, whose peaks are higher than 5,000m. Between the cordilleras, there are valleys or plateaus, in which major urban areas of Colombia are located. Separating the cordilleras are the deep valleys of the country's major rivers, the Magdalena and its tributary, the Cauca, flowing in a northerly direction into the Caribbean Sea.

2) Topography in Cundinamarca

Figure 2.1.1 shows the topography of the Prefecture of Cundinamarca, whose capital is Bogotá. The Cordillera Oriental runs in the midst of the Prefecture, and the western border has its limit with the Magdalena River.



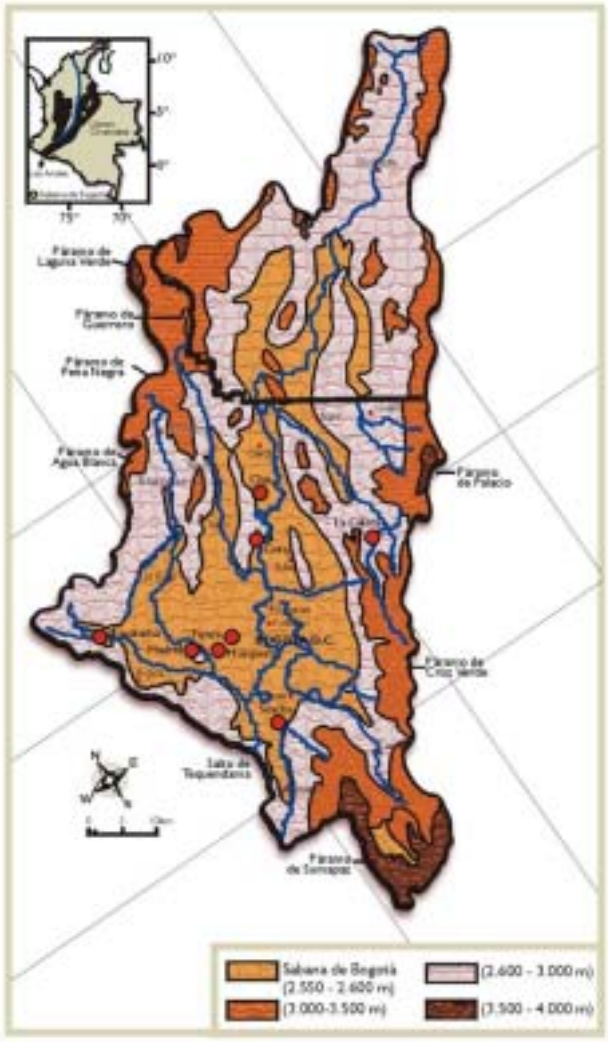
Source: Gobernacion de Cundinamarca

Figure 2.1.1 Topography of Cundinamarca

Sabana de Bogotá locates west of Cordillera Oriental and it is the largest plane within the Eastern Mountains ranges in Colombia.

3) Topography in the Study Area

The geographical location of the Study Area ranges between lat. 4.5 and 5.0 degrees north and between longitude 74 and 74.5 degrees west, with a total area of approximately 1,400km2. The average height of the Bogotá plane is 2,560m above mean sea level, and it reaches 3,000m high in the eastern mountain area. There are some hills of 3,000m high within the area such as Cerro Suba. Eastern hill locates 3,000m to 3,500m high, whereas the southern end of the plain reaches over 3,500m high as shown in Figure 2.1.2.



Source: Analysis Geograficos No. 24,
Plioceno y cuaternario del altiplano de Bogotá y alrededores IGAC, 1995

Figure 2.1.2 Topography of Sabana de Bogotá

Sabana de Bogotá is made of a lakebed, a lake formed in the western part of Cordillera Oriental. Due to its formation, the thickness of the lacustrine clay beneath the Sabana de Bogotá reaches more than 500m, whose thickness increases westward. The lake area has diminished as urbanization in Bogotá began to develop in the last century. As such, the groundwater level in Bogotá plain is still high in general, and differential settlement is seen elsewhere in Bogotá plain, though it is not observed qualitatively.

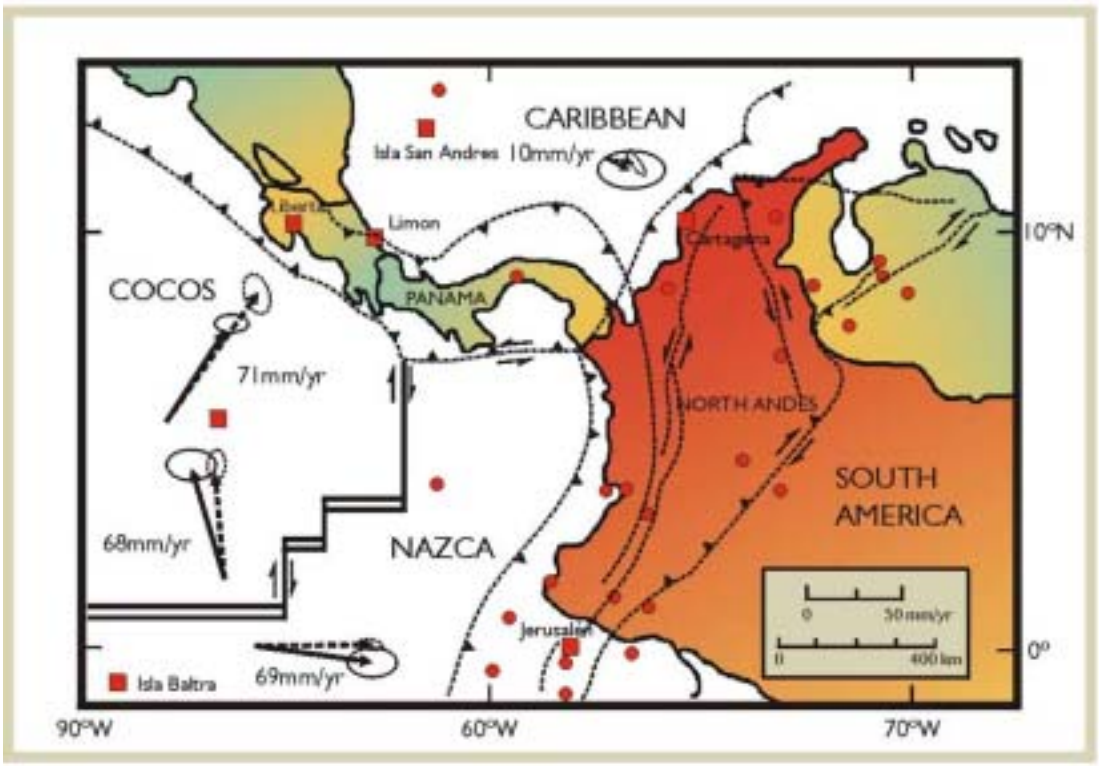
Most of Bogotá and surrounding municipalities for this study locates within Sabana de Bogotá, except La Calera and some part of Soacha. La Calera locates in a mountainous area and has its western boundary with Bogotá along Cordillera Oriental. Hilly area also extends in southeastern part of Soacha, where a vastly developed housing area exists.

2.1.2 Geology

1) Tectonics in Colombia

In the Colombian territory, the southeastern part is made of tectonically stable Guyana plateau. On the other hand, the northwestern part of the territory is the northern end of the Andean range, which is formed by collision of eastward subjecting Nazca plate with a rate of 69mm per year, and westward uplifting South American plate.

The schematic illustration of the plate movement is shown in Figure 2.1.3. This movement is part of the circum-pacific volcanic belt, where seismic and volcanic activity is very high.

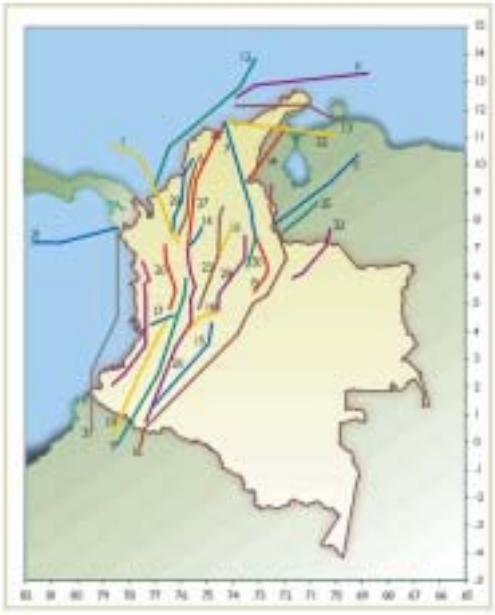


Source: Estudio General de Amenaza Sísmica de Colombia, AIS, 1996

Figure 2.1.3 Plates and Their Movement in South America

2) Fault Systems in Colombia

Due to the tectonic movement of the Nazca plate and South American plate, major fault systems such as Falla de la Cordillera Oriental or Falla Romeral are formed in the Colombian territory. Figure 2.1.4 shows the distribution of 32 major faults identified in Colombia. Using earthquake catalogue and regression analysis, the maximum magnitude of possible earthquake is calculated as shown in Table 2.1.1.



Source: Microzonificación sísmica de Bogotá city, INGEOMINAS, 1997

Figure 2.1.4 Distribution of Major Active Faults in Colombia

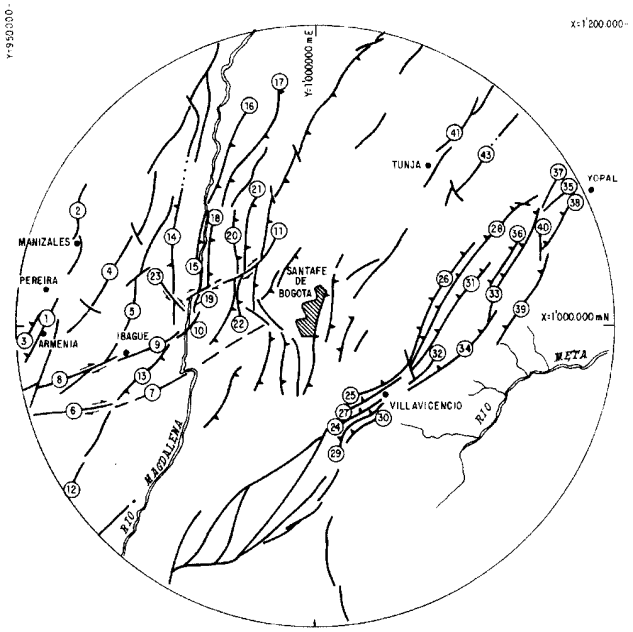
Table 2.1.1 Major Active Faults and Their Maximum Probable Magnitude[2-1-1]

No	Fault name	Maximum Probable Magnitude	No	Fault name	Maximum Probable Magnitude
1	Arco de Dabeiba	6.5	17	Garrapatas	6.5
2	Bahia Solano	7.5	18	Ibague	6.5
3	Benioff-Intermedia	8.0	19	Junin-Sanbiambi	7.0
4	Benioff-Profunda	7.5	20	Murindo Atrato	7.5
5	Bocono	8.0	21	Normal Panama Pacifico	7.0
6	Bolivar	6.0	22	OCA	7.4
7	Bucaramanga-Sta Marta North	6.5	23	Palestina	6.5
8	Bucaramanga-Sta Marta South	6.5	24	Perija	6.5
9	Cauca	7.0	25	Puerto Rondon	6.5
10	Cimitarra	6.5	26	Romeral	7.6
11	Compression South Caribe East	6.0	27	Romeral-Norte	6.5
12	Compression South Caribe West	6.0	28	Salinas	6.5
13	Cuiza	7.0	29	Sinu	6.0
14	Espiritu-Santo	6.5	30	Suarez	6.5
15	Faults of Magdalena	7.0	31	Subduccion	8.6
16	Frontal Cordillera Oriental	8.0	32	Uribante-Caparo	7.0

Source: Estudio General de Amenaza Sísmica de Colombia, AIS, 1996

[2-1-1] Maximum probable magnitude supposes that all segments within the fault are activated during one single event, and it gives superior number in the estimation of magnitude size of earthquake

Figure 2.1.5 shows the distribution of the active faults identified within a radius of 200km from Bogotá. In total, there are 40 active faults in the northwest and southeast direction of Bogotá. Characteristics of these faults such as fault length, activity rate, fault type direction and dip angle are studied for each faults, and most probable expected magnitude are estimated using empirical relationship based on fault characteristics. The most significant faults among them are listed in Table 2.1.2.



Source: Microzonificación sísmica de Bogotá city, INGEOMINAS, 1997

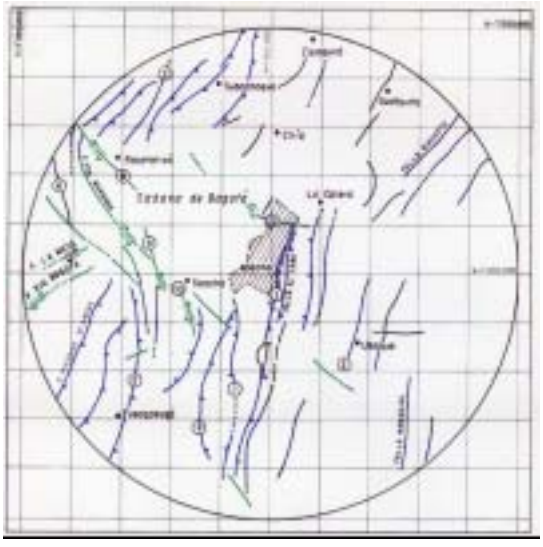
Figure 2.1.5 Map of Active Faults in Northwestern and Southeastern Region

Table 2.1.2 Characterization of Active Faults in Northwestern and Southeastern Regions

Fault system	No	Fault name	Length (km)	Activity rate	Fault type	Azimuth: dip	Maximum Probable Magnitude
Romeral	1	Armenia	60	High-Intermediate	Inversed dextral	30 W	6.8
Romeral	3	Montenegro	45	High-Intermediate	Inversed dextral	45 W	6.7
Ibague	8	Cocora	60	Intermediate	Dextral	65 V	6.9
Ibague	9	Ibague	45	High	Dextral	75 V	7.0
Ibague	10	Piedras	20	Intermediate	Dextral-Inverse	55 V	6.4
Samaria-La Colorada	13	Doima	35	High	Inversed dextral	30 E	6.7
Noroeste	23	El Palmar	20	Intermediate	Sinistral	150 V	6.2
Servia-Santa Maria	24	Colepato	40	Intermediate	Inversed	50 30W	6.7
Servia-Santa Maria	25	Servita	60	Intermediate-High	Inversed	45 40W	6.9
Servia-Santa Maria	27	Guayuriba	60	High	Inversed dextral	45 40W	7.0
Servia-Santa Maria	30	Acacias	30	Intermediate	Inversed	30 30W	6.6
Cuaicaramo	33	Guaicaramo Centro	80	High	Inversed dextral	35 35W	7.2
Cuaicaramo	34	Guaicaramo Sur	65	Intermediate	Inversed	35 35W	7.1
Cuaicaramo	37	Pajarito	60	Intermediate	Inversed dextral	30 50W	6.7
Yopal	38	Yopal	65	High	Inversed	40 40W	7.1
Yopal	39	San Pedro	80	High	Inversed	40 30W	7.2

Source: Microzonificación sísmica de Bogotá city, INGEOMINAS, 1997

Figure 2.1.6 shows the distribution of 10 active faults identified within a radius of 50km from Bogotá. These characteristics are studied and the most probable expected magnitudes from these faults are listed as shown in Table 2.1.3.



Source: Microzonificación sísmica de Bogotá city, INGEOMINAS, 1997

Figure 2.1.6 Maps of Active Faults in Central Region

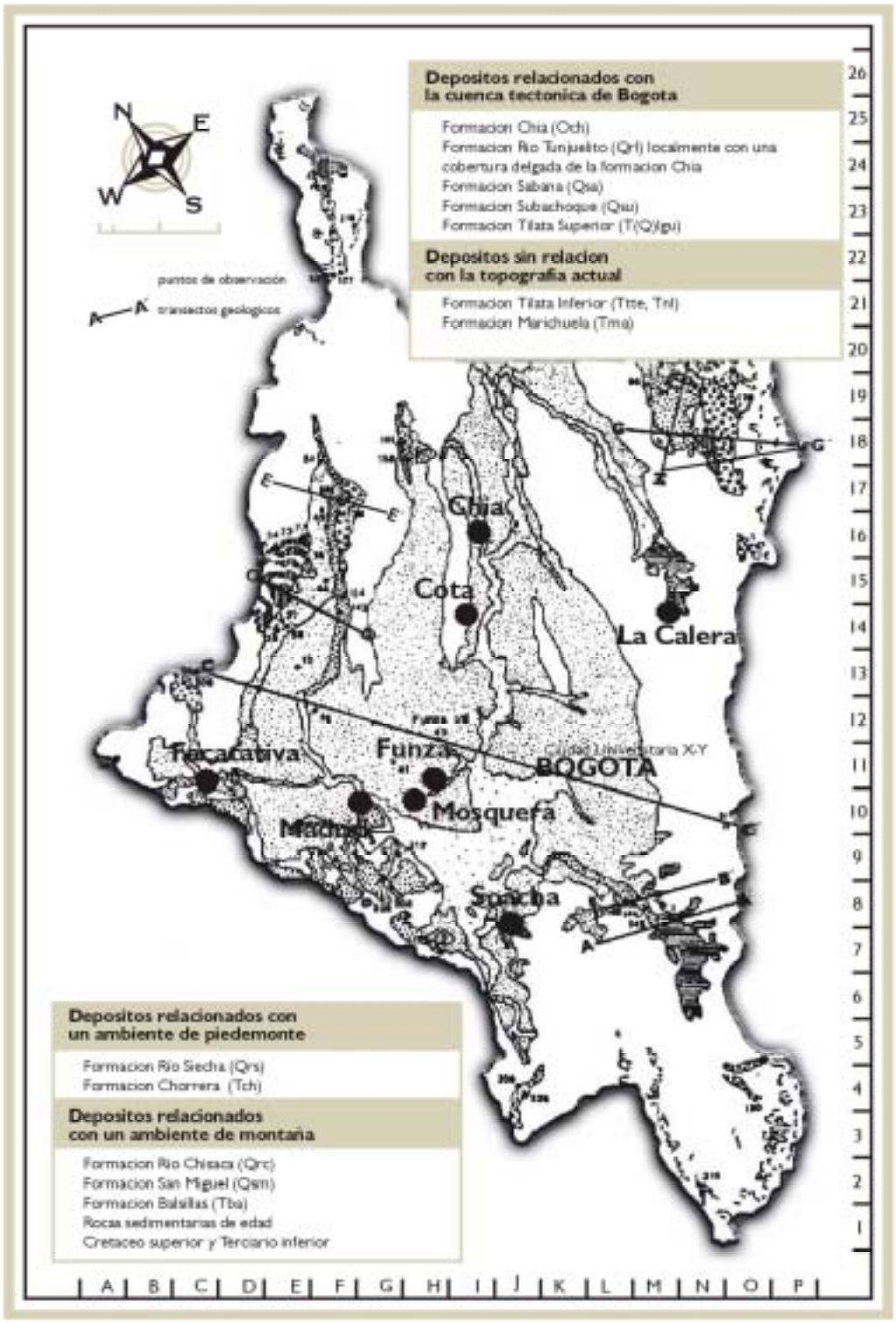
Table 2.1.3 Characterization of Active Faults in Central Region

Fault system	No	Fault name	Length (km)	Activity rate	Fault type	Azimuth: dip	Maximum Probable Magnitude	Distance to Bogota(km)
Oriente	1	Bogota	50	Low	Inverse	10 E	6.4	3
Sur	6	La Cajita	35	Intermediate	Inverse-Dextral	10 E	6.4	30
Sur	7	Rio Tunjelito	35	Intermediate	Inverse	5 W	6.4	25

Source: Microzonificación sísmica de Bogotá city, INGEOMINAS, 1997

3) Geology in the Study Area

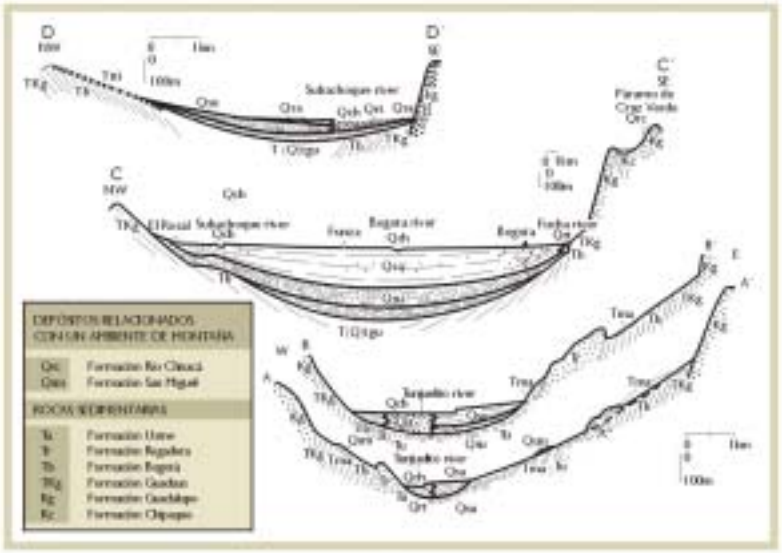
Figure 2.1.7 shows the distribution of distinct lithological units within Sabana de Bogotá. Quaternary sediment rock of marine and continent origin spreads in the central part, while the mountainous area in the east and south of Sabana de Bogotá is mostly composed of Cretaceous or Tertiary origin sediment rock. They have been excavated for construction materials for a long time, and abandoned old quarries exist elsewhere. They are made of mostly sandstone or siltstone; most of them are highly weathered and fractured, thus prone to collapse or landslide.



Source: Analysis Geograficos No. 24, Plioceno y cuaternario del altiplano de Bogotá y alrededores IGAC, 1995

Figure 2.1.7 Distribution of Distinguished Lithological Unit within Sabana de Bogotá

Figure 2.1.8 shows cross sections which correspond to the lines seen in Figure 2.1.7. Thickness of Quaternary sediment in the central part of the plain is over 500m deep above Tertiary silty clay stone.



Source: Analysis Geográficos No. 24, Plioceno y cuaternario del altiplano de Bogotá y alrededores IGAC, 1995

Figure 2.1.8 Geological Cross Section of Sabana de Bogotá

There are various geological classifications for the geology in the Study area, and Table 2.1.4 shows general stratigraphy in Sabana de Bogotá, as classified in the only one microzonation study in Bogotá.

Table 2.1.4 General Lithology in Bogotá

Age	Legend		Name
Upper Tertiary and Quaternary	Qb		Garbage fill
	Qr		Filled depost of excavation
	Qdp		Colluvion or erosion of slope
	Qrs		Residual soil
	Qlla		Innudation plane
	Qtb		Lower lacustrine deposit
	Qta		Upper lacustrine deposit
	Qcc		Complex of cones or fans
Tertiary	Tu		Usme formation
	Ter		La regadera sandstone
	Tpb		Bogota formation
	Tpc		Cacho formation
Cretatceous	Ktg		Guaduas formation
	Ksg		Guadarupe formation
		Ksglt	Labor-tierna formation
		Ksgp	Plaeners formation
		Ksgd	Hard sandstone
	Ksch		Chipaque formation

Source: Microzonificación Sísmica de Santafé de Bogotá, Estudio geológicos subproyecto No2., INGEOMINAS, 1995

4) Geotechnical Properties of Soils in the Study Area

In the former microzonation study, locations of existing boreholes were identified and 38 new ones were systematically made in Bogotá to make a geological classification.

In this study, identification of existing boreholes is focused mainly in satellite cities and some additional boreholes were made in Bogotá, which includes groundwater and geotechnical boring.

5) Geophysical Properties of Subsurface in the Study Area

Vertical electric sounding, gravity and seismic exploration studies are made in Bogotá plain in the former microzoning study to detect the distribution of basement depth. In addition, seismic refraction survey and down hole seismic survey were also made to study shear wave velocity distribution within surface geology.

In this study, however, no additional study was made due to the time limitation, thus the result of former study shall was used as a reference to extend the geophysical model to satellite cities.

2.1.3 Meteorology and Hydrology

1) Temperature

The portion of Bogotá located in the tropical zone has an average temperature of about 13 °C (low: 7 °C and high: 18°C) the year round, because Bogotá is 2,600 m above sea level in the eastern Andes Mountains. The average temperature is shown in Table 2.1.5.

Table 2.1.5 Temperature of Bogotá City

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ave
L (°C)	6	7	8	8	8	8	8	7	7	8	8	7	7
H (°C)	18	18	19	18	18	17	17	17	18	18	18	18	18
Ave. (°C)	12	13	13	13	13	13	12	12	13	13	13	12	13

Source: International Station Meteorological Climate Summary, Version 4.0

2) Rainfall

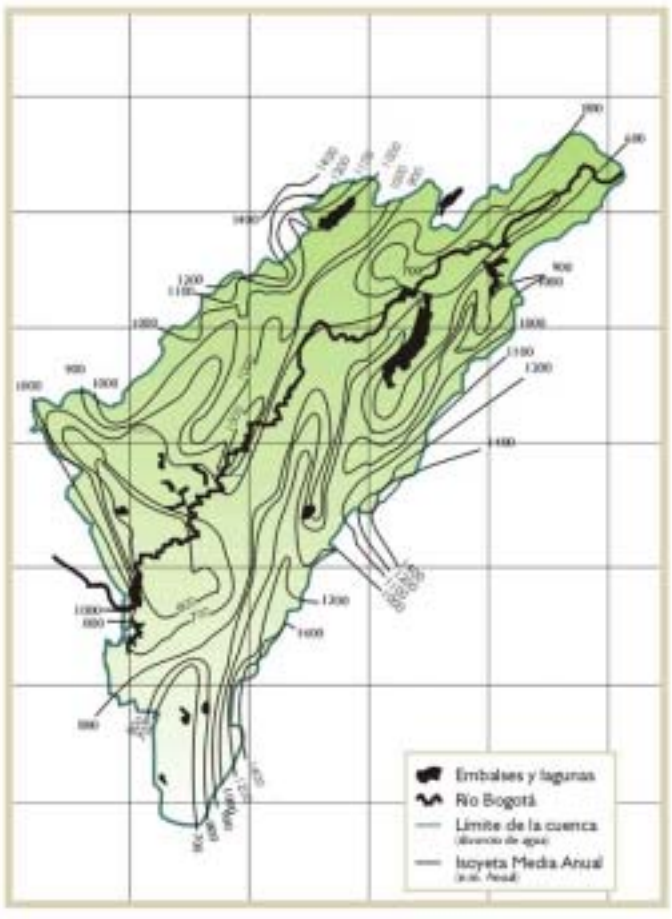
The area has two dry seasons and two rainy seasons per year. The main dry season is from December to March and the other is from July to August, which is shorter and less dry. The rainfall depth varies widely depending on elevation and location from less than 500 mm to over 1,500 mm. The average precipitation of Bogotá City is 960 mm as shown in Table 2.1.6.

Table 2.1.6. Precipitation of Bogotá City

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Precipitation (mm)	48	50	81	119	101	60	45	48	58	142	114	68	960

Source: International Station Meteorological Climate Summary, Version 4.0

There are two rainy seasons such as April to June and October to November in this area. Annual rainfall depth varies from less than 500 mm to more than 1,500 mm (see Figure 2.1.9).



Source: POT Rio Bogotá Upstream Basin

Figure 2.1.9 Isohyetal Map of Upper Rio Bogotá Basin

There are many rainfall stations in the Study Area. Among them, ten stations of EAAB having longer observation period were selected for analysis of rainfall. The one-day rainfall data for these stations was collected and analyzed. Maximum one-day rainfall among the analyzed stations is at San Luis for one day rainfall of 129.0 mm (Apr. 12, 2000). Results of analysis are shown in 3.1.3 in this report.

3) River Systems

The largest river in the Study Area is the Rio Bogotá and the area is mostly covered by this catchment. The catchment area of the river at the Alicachin Gate, which is at downstream of Soacha municipality, is approximately 4,400 km^2. The river flows with a mild slope of less than 1/5,000 near Bogotá city.

Three major tributaries, namely the Rio Juan Amarillo, the Rio Fucha and the Rio Tunjuelo, flow into the Rio Bogotá from the eastern side (Bogotá city area) of the Study area. All the tributaries have a steep slope near the mountainous area of the city and it changes to a very mild of less than 1/1,000 near the junction of the Rio Bogotá.

Other major tributaries, such as the Rio Furio, the Rio Chicu and the Balsillas flow into the Rio Bogotá from the western side.

4) River Flow

Average flow of the Rio Bogotá is approximately 35 m^3/s in normal situation. Almost all water is taken for hydropower generation at Alicachin Gate.

2.1.4 Study Area

According to the Bogotá and Cundinamarca Governments, the metropolitan Bogotá is composed of city of Bogotá and 17 municipalities. 17 municipalities are composed of Bojacá, Cajicá, Chía, Cota, Facatativá, Funza, Gachancipá, La Calera, Madrid, Mosquera, Sibaté, Soacha, Sopó, Tabio, Tenjo, Tocancipá, and Zipaquirá. Bogotá city is composed of 20 administrative units, called localities, as seen in Table 2.1.7.

The Study area for this project is composed of the 19 localities of Bogotá City and surrounding eight municipalities of Cundinamarca, and it is stated as the Bogotá metropolitan area within this study. The 20^{th} locality of Bogotá city, Sumapaz, is not included in this Study, because the population of the locality is less populas than other localities and categorized at a rural area.

Table 2.1.7 describes the area of each locality with urban and rural areas. The total area of Bogotá is 85,832 ha, of which the urban area comprises 42,115 ha and rural area comprises 43,718 ha. The proportion of urban area and rural area are approximately equal. Each area of municipality is shown in Table 2.1.8. Proportion of the urban area and the rural area is nearly one to seventeen. Total area of the study is calculated as 194,797 ha.

Table 2.1.7 Area of Localities in Bogotá City in 1990

Unit: Ha

	Localities	Urban	Rural	Total
1	Usaquén	4,277	2,257	6,534
2	Chapinero	1,349	2,497	3,846
3	Santa Fe	662	3,814	4,476
4	San Cristobal	1,677	3,176	4,853
5	Usme	2,220	9,684	11,904
6	Tunjuelito	1,062	-	1,062
7	Bosa	1,930	536	2,466
8	Kennedy	3,786	-	3,786
9	Fontibón	3,323	4	3,327
10	Engativá	3,612	-	3,612
11	Suba	9,140	915	10,055
12	Barrios Unidos	1,190	-	1,190
13	Teusaquillo	1,419	-	1,419
14	Mártires	651	-	651
15	Antonio Nariño	494	-	494
16	Puente Aranda	1,723	-	1,723
17	La Candelaria	164	17	181
18	Rafael Uribe	1,345	0	1,345
19	Ciudad Bolívar	2,089	20,819	22,908
	Sub-Total	42,115	43,718	85,832
20	Sumapaz	-	125,000	125,000
	Total	42,115	168,718	210,833

Source: Población, estratificación y aspectos, socioeconómicos de Santa Fe de Bogotá; Estadísticas Santa Fe de Bogotá, Departamento Administrativo de Planeación Distrital
Note: In case the data conflicts between the two sources, data of primary document was used.

Table 2.1.8 Area of Eight Municipalities

Unit: Ha

Municipalities	Urban	Rural	Total
Chía	722	7,292	8,014
Cota	138	5,231	5,368
Facatativá	698	15,085	15,783
Funza	542	6,483	7,024
La Calera	94	31,699	31,793
Madrid	593	11,346	11,939
Mosquera	1,074	9,508	10,582
Soacha	2,163	16,297	18,460
Total	**6,025**	**102,940**	**108,965**

Source: Digital data of the study team

2.2 Social and Economic Conditions

2.2.1 Administrative System

1) General

According to Article 286 of the constitution, the administrative system in Colombia is divided into four territorial entities: prefecture, district, municipality and territory inhabited by natives. Each territorial entity is autonomous as far as management of their interest along the by laws of the constitution. Article 298 stated that the prefectures would act as administration and perform coordination and complementary duties of municipal action and serve as intermediaries between the national government and municipalities.

The new constitution conceives the municipality as the "basic unit" of the state political and administrative division. The constitution grants the municipalities a priority position in the distribution of resources and competence (Articles 356 to 361).

2) Bogotá City

In 1945, Bogotá City became a special district in the municipal system. Bogotá is the capital city of the Republic of Colombia as well as the Cundinamarca prefecture. According to Article 322 of the constitution, the capital city of the Republic and of Cundinamarca prefecture is proclaimed as a capital district.

The central administrative sector of the city government of Bogotá is made up of secretariats and administrative departments. Secretariats consists of finance, government, health, transit and transportation (STT) and four others unit. Administrative departments are composed of planning (DAPD), environment (DAMA), communal action, and four other sections, as well as one administrative unit.

Bogotá has the following types of public corporations:

- Public Establishments: FOPAE, IDU, Fund of Popular Housing, Fund of Saving and Housing (FAVIDI), Institute of Recreation and Sports (IDRD), etc.
- Public Domestic Service Enterprises: EAAB, ETB, EEB.
- Industrial and Commercial Companies: Metrovivienda Company, Urban Renovation Company, etc.
- Public Societies: Transmilenio Company, etc.
- Mixed Economy Societies.
- Social Enterprises of the State: public hospitals, and other corporations.

Within Bogotá City there is a further division into 20 localities, and each locality forms a unit of administrative board, elected from the people, and the Local Mayor is selected by the Mayor of

Bogotá, with recommendation of the administrative board of the locality. A local mayor is responsible for the harmonious and integrated development of the locality.

3) Cundinamarca

Cundinamarca is divided into 15 provinces, which are administrative associations of municipalities. Each association has its head municipality that coordinates the member municipalities. The eight municipalities of the Study Area belong to four different provinces; Soacha, Sabana Occidental, Sabana Centro, and Guavio.

This Government is made up of the secretariat of government and 10 other secretariats, the administrative department of planning and other two departments, five special administrative units, and other public establishments and companies.

2.2.2 Population and Employment

1) Population Growth

(1) Population data

There have been several census-takings in Colombia in recent years: 1951, 1964, 1978, 1985 and 1993; however, all the estimation used for the present population is based on the Census 1993. The National Administrative Department of Statistics (DANE) was responsible for the Census 1993, and published the adjusted population after the Census to estimate the actual population. This was prepared by three forms, targeting the non-indigenous population, indigenous population, and special accommodating population. Through this operation, the census concluded the total number as 33,109,840. However, it was estimated that not all the population was covered by this census survey, thus, a supplemental survey was executed to achieve the direct estimate of people and houses. This survey was designed and selected according to the probability samplings throughout the nation. The houses in the targeted area were rigorously examined, and the result was compared with the numbers achieved by the former census. Comparing the two figures of the census and survey, the coefficient for the uncovered rate was obvious in the targeted area, making available the estimation of actual population in the prefecture, region, and nation. With the adjustment, DANE had publicized the population of 1993 in Colombia as 37,145,322. DANE concluded that the population of Bogotá City in 1993 was 5,355,979. In 1951, the population percentage to the national population was 5.9%, whereas in 1985, it increased to 14.8%, and 14.4% in 1993. This indicates that the population centralization to the large cities has progressed after then.

(2) Population growth in Colombia

A. Trend of population growth

Colombia's population has constant increase of approximately 2% to 3% annual growth rate since 1951, although, the rate of population growth has been slightly decreasing after 1985 as seen in Table 2.2.1. The table also indicates that although Colombia's national population increase has been constant, population growth in large cities are higher than that of nation. The population growth in the period of 1951 to 1985 was most rapid among all the cities, and among them, Bogotá City shows the largest population increase.

Table 2.2.1 Population Change in Colombia and Large Cities

	Population				Population Growth		
	1951	1985	1993 Adjusted Pop of '93	2000 Estimate	1951-1985	1985-1993	1993-2000
Colombia	11,454,760	30,062,207	37,145,322	42,209,299	2.88%	2.68%	1.84%
Santafe de Bogota DC	676,099	4,447,601	5,355,979	6,437,842	5.70%	2.35%	2.66%
Barranquilla	302,046	1,156,320	1,090,618	1,276,540	4.03%	-0.73%	2.27%
Cali	304,012	1,674,054	1,847,176	2,087,758	5.15%	1.24%	1.76%
Medellin	413,933	2,050,001	1,834,881	2,043,585	4.82%	-1.38%	1.55%

Source: Projection of Population by the area for Municipalities, Colombia 1995-2000, DANE

The population distribution for Colombia recently is indicated in Table 2.2.2. Population proportion of the four major cities of Bogotá City, Barranquilla, Cali, and Medellin as per the national population is approximately 30%, and Bogotá City comprises one half of the major city population.

Table 2.2.2 National Population Distribution of Colombia

	1993 Adjusted Pop of 93	2000 Estimate	1993-2000	Prefectural Population to Total Population(%) 2000
National				
Colombia	37,145,322	42,209,299	1.84%	
Capitals & Cities				28%
Santafe de Bogota DC	5,355,979	6,437,842	2.66%	15%
Barranquilla	1,090,618	1,276,540	2.27%	3%
Cali	1,847,176	2,087,758	1.76%	5%
Medellin	1,834,881	2,043,585	1.55%	5%
Prefectures				85%
Amazonas	55,689	70,489	3.42%	0%
Antioquia (Medellin)	4,856,519	5,377,854	1.47%	13%
Arauca	183,536	240,190	3.92%	1%
Atlantico (Barranquilla)	1,817,014	2,127,567	2.28%	5%
Bolivar	1,683,527	1,996,906	2.47%	5%
Boyaca	1,298,833	1,365,110	0.71%	3%
Caldas	1,017,038	1,017,627	0.01%	2%
Caqueta	363,256	418,998	2.06%	1%
Cesanare	208,670	285,416	4.58%	1%
Cauca	1,113,475	1,255,333	1.73%	3%
Cesar	864,053	961,535	1.54%	2%
Choco	401,086	407,255	0.22%	1%
Cordoba	1,220,114	1,322,852	1.16%	3%
Cundinamarca (Stfe Bogota)	1,851,566	2,142,260	2.11%	5%
Guainia	28,122	37,162	4.06%	0%
Guaviare	96,397	117,189	2.83%	0%
Huila	833,121	924,968	1.51%	2%
La Guajira	428,593	483,107	1.73%	1%
Magdalena	1,115,392	1,284,134	2.03%	3%
Meta	610,611	700,506	1.98%	2%
Narino	1,425,403	1,632,093	1.95%	4%
Norte de Santander	1,147,693	1,345,697	2.30%	3%
Putumayo	260,979	332,434	3.52%	1%
Quindio	488,942	562,154	2.01%	1%
Risaralda	833,438	944,298	1.80%	2%
San Andres y Providencia	60,365	73,465	2.85%	0%
Santander	1,788,609	1,964,361	1.35%	5%
Sucre	693,456	794,631	1.96%	2%
Tolima	1,269,909	1,296,942	0.30%	3%
Valle del Cauca (Cali)	3,688,277	4,175,515	1.79%	10%
Vaupes	24,362	29,942	2.99%	0%
Vichada	61,298	83,467	4.51%	0%

Source: Projection of Population by the area for Municipalities, Colombia 1995-2000, DANE

B. Population growth in the urban areas

Urban population growth in Colombia was in an aggressive manner for the past 50 years. The population in urban area compared to the total population was only 30% in 1938; in 1985, it had grown to 70%.

Table 2.2.3 gives the percentage change of population in major metropolitan areas in Colombia. Four major cities have more than 40% of the urban population. Among these four cities, Metropolitan Bogotá has the highest rate of urbanized population, since around 1973, at 20% or more.

Table 2.2.3 Percentage Change of Population in Major Metropolitan Areas in Colombia

	1951	1964	1973	1985	1993
Bogota Metropolitan *1	676,099	1,702,378	2,926,966	4,447,601	5,355,979
Ratio to total population	5.9%	9.8%	12.8%	14.8%	14.4%
Ratio to total urban population	15.2%	18.4%	21.4%	22.7%	20.3%
Medellin Metropolitan *2	413,933	983,283	1,524,051	2,050,001	2,355,676
Ratio to total population	3.6%	5.7%	6.7%	6.8%	6.3%
Ratio to total urban population	9.3%	10.6%	11.2%	10.4%	8.9%
Cali Metropolitan *3	304,012	751,097	1,169,502	1,674,054	1,943,301
Ratio to total population	2.7%	4.3%	5.1%	5.6%	5.2%
Ratio to total urban population	6.8%	8.1%	8.6%	8.5%	7.4%
Barranquilla Metropolitan *4	302,046	543,439	789,430	1,156,320	1,301,419
Ratio to total population	2.6%	3.1%	3.4%	3.8%	3.5%
Ratio to total urban population	6.8%	5.9%	5.8%	5.9%	4.9%
Other 5 Metropolitans *5	443,169	949,826	1,318,453	1,914,979	2,428,814
Ratio to total population	3.9%	5.5%	5.8%	6.4%	6.5%
Ratio to total urban population	9.9%	10.3%	9.7%	9.8%	9.2%
Total of four urbanized area	1,696,090	3,980,197	6,409,949	9,327,976	10,956,375
Ratio to total population	14.8%	23.0%	28.0%	31.0%	29.5%
Ratio to total urban population	38.0%	43.1%	46.9%	47.5%	41.5%
Total of nine metropolitan	2,139,259	4,930,023	7,728,402	11,242,955	13,385,189
Ratio to total population	18.7%	28.5%	33.8%	37.4%	36.0%
Ratio to total urban population	48.0%	53.4%	56.6%	57.3%	50.8%
Total Population	11,454,760	17,319,110	22,886,290	30,062,207	37,145,322
Total urban population	4,459,345	9,239,211	13,656,107	19,628,417	26,373,179
Ratio of urbanization	38.9%	53.3%	59.7%	65.3%	71.0%

*1 Santa Fe de Bogotá, Cajica, Chia, Funza, La Calera, Madrid, Sibate, and Soacha, *2: Medellin, Barbosa, Bello, Caldas, Copacabana, Envigado, Girardota, Itagui, LaCeja, La Estrella, Marinilla, Rionegro and Sabaneta, *3: Cali, Candelaria, Jamundi, Palmira, and Yumbo, *4: Barranquilla, Malambo, Puerto Colombia, Soledad, *5:Manizales, Cucuta, Armenia, Pereira, Bucaramanga.
Source: Urbanization and Community Organization of Latin America; Colombia Projecciones Municipales de Población por Area, 1995-2005, DANE

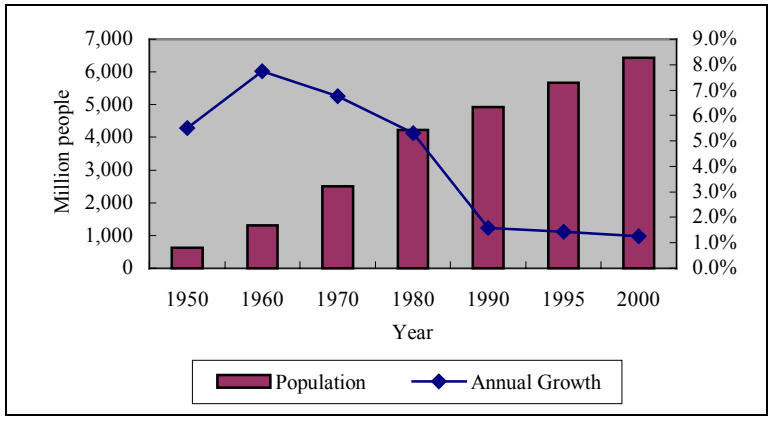
(3) Population growth in the study area

A. Population data

Several corrections have been applied to the adjusted population of Colombia within DANE, however, the District Planning of Administrative Department (DAPD) had concluded to use the total population of Bogotá City in 1993 was 5,440,401. With this figure, DAPD had projected the number of total population for year 2000 as 6,378,928.

B. Overall population growth

Figure 2.2.1 shows the changes of Bogotá City population and its annual growth for the past 50 years. Bogotá's population growth had shown the largest increase between 1950 and 1960, and after 1960, the annual growth had decreased. However, the annual growth was still high until the 1980s, but in the1990s, rate of increase had dropped to approximately 1.5%.



Source: DANE

Figure 2.2.1 Changes of Bogotá City Population and Its Annual Growth

The rapid population increase in the 1950s to the 60's can be attributed to two factors. One is the natural factor arising from the decreased percentile of infant mortality. The rate of mortality for infants had been decreased almost 80% during this era. The other is the social factor, with the effect of civil war called *La Violencia* between 1946 and 1964, which caused the domestic migration to Bogotá[2-2-1]

C. Population distribution of the study area

The population distribution and its growth rate within Bogotá City in the 1990 to 2000 are presented in Table 2.2.4.

[2-2-1] Referred to "Urbanization and Community Organization of Latin America, Noriko Hataya", page 142

Table 2.2.4 Population Change in Bogotá City

	Year	Population			Growth Rate	
	Locality	1993*	1997*	2000**	1993-1997	1997-2000
1	Usaquén	348,852	387,271	421,320	2.65%	2.85%
2	Chapinero	122,991	122,991	122,991	0.00%	0.00%
3	Santa Fe	107,044	107,044	107,044	0.00%	0.00%
4	San Cristobal	439,559	445,535	455,028	0.34%	0.71%
5	Usme	200,892	222,915	244,270	2.63%	3.10%
6	Tunjuelito	204,367	204,367	204,367	0.00%	0.00%
7	Bosa	215,816	311,698	410,099	9.63%	9.58%
8	Kennedy	758,870	840,036	912,781	2.57%	2.81%
9	Fontibón	201,610	241,372	278,746	4.60%	4.92%
10	Engativá	671,360	712,040	749,068	1.48%	1.70%
11	Suba	564,658	634,669	706,528	2.97%	3.64%
12	Barrios Unidos	176,552	176,552	176,552	0.00%	0.00%
13	Teusaquillo	126,125	126,125	126,125	0.00%	0.00%
14	Los Mártires	95,541	95,541	95,541	0.00%	0.00%
15	Antonio Nariño	98,355	98,355	98,355	0.00%	0.00%
16	Puente Aranda	282,491	282,491	282,491	0.00%	0.00%
17	Candelaria	27,450	27,450	27,450	0.00%	0.00%
18	Rafael Uribe	379,259	382,801	384,623	0.23%	0.16%
19	Ciudad Bolívar	418,609	498,177	575,549	4.45%	4.93%
	Total	**5,440,401**	**5,917,430**	**6,378,928**	**2.12%**	**2.53%**

Source: *DAPD Poblacion, estratificacion y aspectos socioeconomicos de Bogotá, **Informacion para el Plan Local 2001, Informacion social basica

The eight surrounding municipalities, which are Chia, Cota, Facatativa, Funza, La Calera, Madrid, Mosquera, and Soacha, comprising the Study Area, have their population distributions and growth rates shown in Table 2.2.5.

Table 2.2.5 Population Change in the Eight Municipalities

		Population						Growth Rate		
	Year	1993*			2000**			1993-2000		
	Cities	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total
1	Chia	41,632	4,064	45,696	56,522	5,261	61,783	4.46%	3.76%	4.40%
2	Cota	5,071	6,400	11,471	6,665	8,119	14,784	3.98%	3.46%	3.69%
3	Facatativa	63,237	6,315	69,552	82,409	7,857	90,266	3.86%	3.17%	3.79%
4	Funza	34,612	3,162	37,774	47,670	4,138	51,808	4.68%	3.92%	4.62%
5	La Calera	11,765	6,087	17,852	15,637	8,551	24,188	4.15%	4.98%	4.43%
6	Madrid	33,347	5,865	39,212	44,485	7,625	52,110	4.20%	3.82%	4.15%
7	Mosquera	17,774	2,666	20,440	24,227	3,526	27,753	4.52%	4.07%	4.47%
8	Soacha	222,565	7,770	230,335	278,665	5,224	283,889	3.26%	-5.51%	3.03%
	Total	**430,003**	**42,329**	**472,332**	**556,280**	**50,301**	**606,581**	**3.75%**	**2.50%**	**3.64%**

Source: * Censo 1993 Republica de Colombia, Cundinamarca, DANE; **Colombia Proyecciones Municipales de Poblacion por Area, 1995-2005, DANE

From these tables, it can be concluded that Bogotá City has population increase of 2.12% during 1993-1997 and 2.53% during 1997-2000. Bogotá City has increased approximately 2.5% annually for the past 10 years, while the surrounding municipalities have, on the average, approximately 3.6% annual increase as shown in Tables 2.2.5. In Bogotá City, the locality of

Bosa has an extreme population increase of approximately 10% annually, followed by Fontibón and Ciudad Bolivar. It shows that the localities in the southwestern to the western area of the city have a high rate of population increase. The eight surrounding municipalities have higher population growth rates comparing to the average of Bogotá City, however, most of the municipalities' population growth in the urban area are between 3 to 5 percent. Figure 2.2.2 shows the population growth from 1993 to 2000. It is easily noticeable in this figure that the population increased in the surrounding areas of the city center. Areas classified in the higher estrato are found and no population increase is registered. Also, localities adjoining the city center have only a slight increase in population. On the other hand, as localities and municipalities expand toward the outer side of the city, population growth becomes increasingly higher in the urban area.

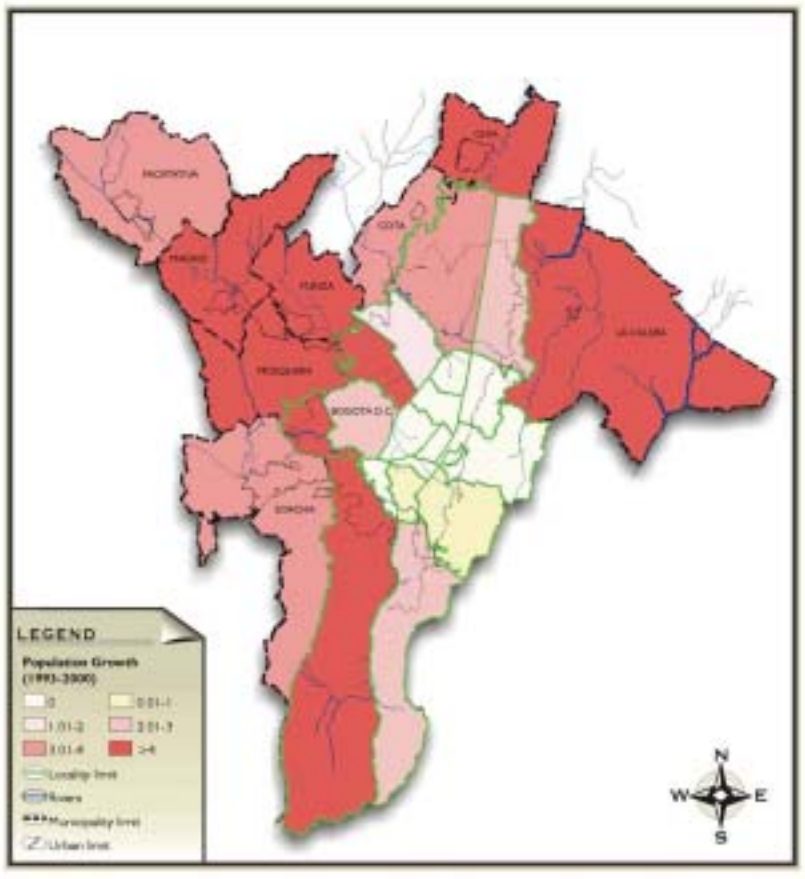


Figure 2.2.2 Population Growth of the Study Area, 1993 - 2000

Table 2.2.6 represents the population density of each locality in Bogotá City for 2000, with respect to the urban area. Localities with high number of population are Kennedy, Engativá, Suba, Ciudad Bolivar, and San Cristobal. High population density areas are Rafael Uribe, San Cristobal, Ciudad Bolívar, and

Kennedy, which are located in the southeastern part of the city, while the low density areas are Suba, Fontibón, and Teusaquillo, located in the northeastern part of the city.

Table 2.2.6 Population Density by Locality of Bogotá

No	Locality	2000 Population	Urban Area (ha)	Density (Population/ ha)
1	Usaquén	421,320	4,277.07	98.51
2	Chapinero	122,991	1,349.39	91.15
3	Santa Fe	107,044	662.05	161.69
4	San Cristobal	455,028	1,677.40	271.27
5	Usme	244,270	2,220.35	110.01
6	Tunjuelito	204,367	1,062.33	192.38
7	Bosa	410,099	1,930.11	212.47
8	Kennedy	912,781	3,786.16	241.08
9	Fontibón	278,746	3,323.03	83.88
10	Engativá	749,068	3,612.27	207.37
11	Suba	706,528	9,139.60	77.30
12	Barrios Unidos	176,552	1,190.35	148.32
13	Teusaquillo	126,125	1,419.32	88.86
14	Los Mártires	95,541	650.67	146.83
15	Antonio Nariño	98,355	493.74	199.20
16	Puente Aranda	282,491	1,723.13	163.94
17	Candelaria	27,450	164.14	167.24
18	Rafael Uribe	384,623	1,344.71	286.03
19	Ciudad Bolívar	575,549	2,088.78	275.54
	Total	**6,378,928**	**42,114.60**	**151.47**

Source: DAPD Poblacion, estratificacion y aspectos socioeconomicos de Bogotá

Table 2.2.7 shows the density of the population for the eight municipalities. According to this table, the high dense urbanized areas are La Calera, Soacha, and Facatativa. These municipalities in urban areas have the population density of more than 100 people per hectors.

Table 2.2.7 Density of Population for the Eight Surrounding Municipalities

	Municipality	Urban Population 2000	Urban Area (ha)	Density
1	Chia	56,522	722	78.29
2	Cota	6,665	138	48.30
3	Facatativa	82,409	698	118.06
4	Funza	47,670	542	87.95
5	La Calera	15,637	94	166.35
6	Madrid	44,485	593	75.02
7	Mosquera	24,227	1,074	22.56
8	Soacha	278,665	2,163	128.83

Source: Population by DANE Projection for Municipalities 1996-2005

Figure 2.2.3 shows the distribution of population density. Comparing this figure with population growth, it can be noted that Ciudad Bolivar and Kennedy already have high rates of population, and they are still growing.

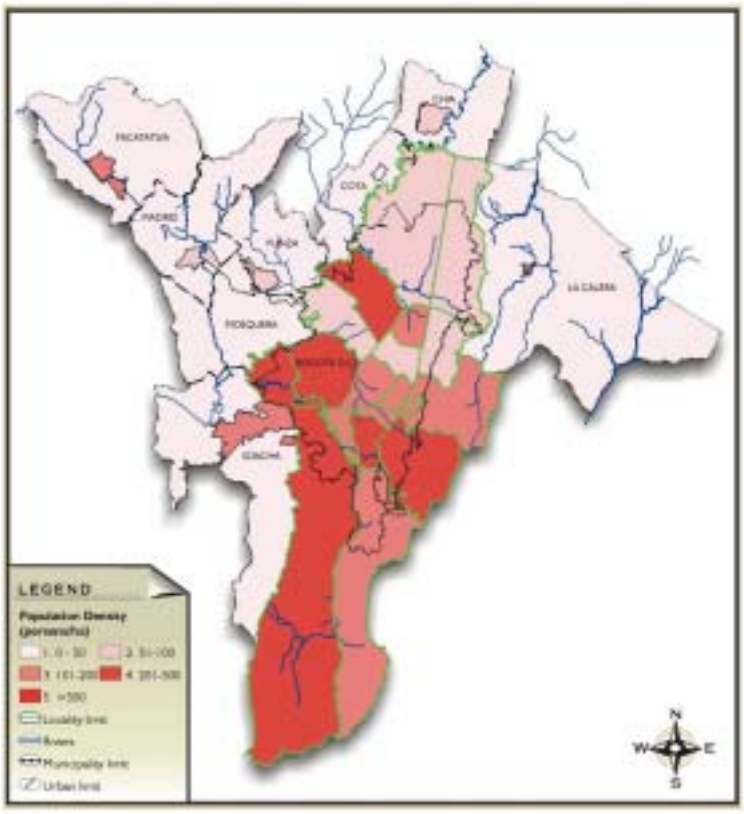


Figure 2.2.3 Population Density by Locality and Municipalities

2) Employment

(1) Employment data

According to DANE, the employment data are defined as follows.

- Total Population: Total population estimated through projections based on the population census of 1993.
- Working Population: All population including 12 years old or older for the urban areas, and 10 years old or older for the rural areas.
- Labor Force: Population contributing or able to contribute to the goods production or rendering services, which can be classified into employed and unemployed. For the term of employed, it is defined as the population contributing to the production or to the services, and as to the unemployed, it is defined as population looking work, or have not looked for the work in the last 4 weeks but have been looking for work for the last 12 months.
- Economically Inactive: Population that is within the working population, but does not participate for the goods production or rendering services. This category includes population whom do not need work, or can not or is not interested in working.

Data prepared by DANE is categorized by 5 geographical regions, which are Atlántica, Oriental, Bogotá D.C., Central, and Pacifica. Each region is classified with several departments as follows.

- Atlantica: Atlantico, Bolivar, Cesar, Cordoba, La Guajira, Magdalena, Sucre (7).
- Oriental: Boyaca, Cundinamarca, Meta, Norte de Santander, Santander (5).
- Bogotá D.C.: Bogotá D.C. (1).
- Central: Antioquia, Huila, Quindio, Risaralda, Tolima (5).
- Pacifica: Cauca, Choco, Narino, Valle (4).

(2) Employment condition

Transition of the labor force within the last five years is shown in Table 2.2.8. From the table, it can be said that the changes of labor force population is not constant, but the population growth for the last five year in each region is somewhat close, approximately 3.5%. Taking in the consideration of the urban and rural population growth, both shows the plus growth for the term of 5 years, but the growth in urban area is higher than that in rural. Five regions within Colombia do not show much of the difference regarding the labor force.

Table 2.2.8 Transition of the Labor Force

Unit: thousands

Region	Labor Force					Change of Labor Force (%)				
	1996	1997	1998	1999	2000	96-97	97-98	98-99	99-00	96-00
Atlantica	**3,162**	**3,299**	**3,430**	**3,587**	**3,842**	**4.3%**	**4.0%**	**4.6%**	**7.1%**	**4.0%**
Urban	2,200	2,313	2,430	2,538	2,758	5.1%	5.1%	4.4%	8.7%	4.6%
Rural	962	986	1,000	1,049	1,084	2.5%	1.4%	4.9%	3.3%	2.4%
Oriental	**3,068**	**3,084**	**3,310**	**3,303**	**3,636**	**0.5%**	**7.3%**	**-0.2%**	**10.1%**	**3.5%**
Urban	1,862	1,874	1,997	2,021	2,270	0.6%	6.6%	1.2%	12.3%	4.0%
Rural	1,206	1,210	1,313	1,282	1,366	0.3%	8.5%	-2.4%	6.6%	2.5%
Bogotá D.C.	**2,788**	**2,903**	**2,926**	**3,131**	**3,330**	**4.1%**	**0.8%**	**7.0%**	**6.4%**	**3.6%**
Central	**4,218**	**4,270**	**4,318**	**4,570**	**4,817**	**1.2%**	**1.1%**	**5.8%**	**5.4%**	**2.7%**
Urban	2,886	2,971	2,926	3,298	3,533	2.9%	-1.5%	12.7%	7.1%	4.1%
Rural	1,332	1,299	1,392	1,272	1,284	-2.5%	7.2%	-8.6%	0.9%	-0.7%
Pacifica	**3,056**	**3,275**	**3,480**	**3,631**	**3,774**	**7.2%**	**6.3%**	**4.3%**	**3.9%**	**4.3%**
Urban	1,988	2,169	2,301	2,442	2,550	9.1%	6.1%	6.1%	4.4%	5.1%
Rural	1,068	1,106	1,179	1,189	1,224	3.6%	6.6%	0.8%	2.9%	2.8%
National	**16,292**	**16,831**	**17,464**	**18,222**	**19,399**	**3.3%**	**3.8%**	**4.3%**	**6.5%**	**3.6%**

Source: DANE webpage

Table 2.2.9 shows the distribution of the labor force within the large cities in Colombia. From this figure, labor force in urban area for each region is approximately 15% and 7% in rural area, about.

Table 2.2.9 Distribution of Labor Force in year 2000

Unit: thousands

Region	Total Population	L.F.Pop of Year 00	Regional L.F./Total L.F.
Atlantica	**9,008**	**3,842**	**20%**
Urban	6,327	2,758	14%
Rural	2,681	1,084	6%
Oriental	**7,558**	**3,636**	**19%**
Urban	4,637	2,270	12%
Rural	2,921	1,366	7%
Bogotá D.C.	**6,450**	**3,330**	**17%**
Central	**10,242**	**4,817**	**25%**
Urban	7,372	3,533	18%
Rural	2,870	1,284	7%
Pacifica	**7,496**	**3,774**	**19%**
Urban	4,943	2,550	13%
Rural	2,553	1,224	6%
National	**40,754**	**19,399**	**100%**

Note: L.F. stands for Labor Force
Source: DANE webpage

Employment rate is described as number of employed personnel divided by working population. Table 2.2.10 represents the employment rate and the proportion of the employed population to the sectors of primary, secondary, and tertiary. Among five areas within Colombia, employment rate, which is a little bit more than 50%, is almost equal to each other weather if it is in the urban or rural area. Regarding the proportion of employed population to each sector, urban areas among the country has the most employment rate in the tertiary sector, with high percentage of more than 70%. Approximately 25% composes the secondary sector, and approximately 7% composes the primary sector. This proportion is applied to all the urban areas among Colombia, including Bogotá City. For the rural area, employment rate in the primary sector predominates by approximately 65 to 70%, tertiary sector next by approximately 25%, and then the secondary sector by approximately 8%.

Table 2.2.10 Employment Rate and its Proportion for Year 2000

Unit: thousands

Region	Working Population	Employed Population				Proportion			Unemployed Rate
		Total	Primary	Secondary	Tertiary	Primary*	Secondary	Tertiary*	
Atlantica	**6,842**	**3,288**	**830**	**431**	**2,027**	**25%**	**13%**	**62%**	**48%**
Urban	4,796	2,281	176	375	1,730	8%	16%	76%	48%
Rural	2,046	1,007	654	56	297	65%	6%	29%	49%
Oriental	**5,798**	**3,079**	**1,006**	**525**	**1,548**	**33%**	**17%**	**50%**	**53%**
Urban	3,526	1,843	135	428	1,280	7%	23%	69%	52%
Rural	2,272	1,236	871	97	268	70%	8%	22%	54%
Bogotá DC	**5,060**	**2,650**	**34**	**617**	**1,999**	**1%**	**23%**	**75%**	**52%**
Central	**7,965**	**4,189**	**1,155**	**792**	**2,242**	**28%**	**19%**	**54%**	**53%**
Urban	5,735	2,860	198	714	1,948	7%	25%	68%	50%
Rural	2,230	1,329	957	78	294	72%	6%	22%	60%
Pacifica	**5,722**	**3,103**	**779**	**595**	**1,729**	**25%**	**19%**	**56%**	**54%**
Urban	3,783	2,019	101	465	1,453	5%	23%	72%	53%
Rural	1,939	1,084	678	130	276	63%	12%	25%	56%
National	**31,387**	**16,308**	**3,804**	**2,959**	**9,545**	**23%**	**18%**	**59%**	**52%**

*Primary Sector: 1) Agriculture, farming and fisheries, 2) Mining, Secondary Sector: 1) Manufacturing industries, 2) Electricity, gas and water, 3) Construction, Tertiary sector: 1) Commercial, restaurants, and hotels, 2) Transportation and communication, 3) Financial services, 4) Social services, 5) Indirect Services
Source: DANE webpage

According to DANE, unemployment rate is defined as the number of unoccupied population divided by labor force. Table 2.2.11 describes the changes of unemployment rate between years 1996 to 2000. It shows that the unemployment rate has started to increase in 1998 in the urban area, and in 1999 for the rural area.

Table 2.2.11 Changes of Unemployment Rate

Unit: thousand

Region	Labor Force					Unemployed Population					Unemployment Rate				
	1996	1997	1998	1999	2000	1996	1997	1998	1999	2000	1996	1997	1998	1999	2000
Atlantica	**3,162**	**3,299**	**3,430**	**3,587**	**3,842**	**272**	**291**	**332**	**458**	**552**	**8.6%**	**8.8%**	**9.7%**	**12.8%**	**14.4%**
Urban	2,200	2,313	2,430	2,538	2,758	226	238	275	383	475	10.3%	10.3%	11.3%	15.1%	17.2%
Rural	962	986	1,000	1,049	1,084	46	53	57	75	77	4.8%	5.4%	5.7%	7.1%	7.1%
Oriental	**3,068**	**3,084**	**3,310**	**3,303**	**3,636**	**263**	**219**	**335**	**437**	**553**	**8.6%**	**7.1%**	**10.1%**	**13.2%**	**15.2%**
Urban	1,862	1,874	1,997	2,021	2,270	200	165	281	340	422	10.7%	8.8%	14.1%	16.8%	18.6%
Rural	1,206	1,210	1,313	1,282	1,366	63	54	54	97	131	5.2%	4.5%	4.1%	7.6%	9.6%
Bogota D.C.	**2,788**	**2,903**	**2,926**	**3,131**	**3,330**	**288**	**287**	**389**	**604**	**676**	**10.3%**	**9.9%**	**13.3%**	**19.3%**	**20.3%**
Central	**4,218**	**4,270**	**4,318**	**4,570**	**4,817**	**404**	**410**	**507**	**790**	**780**	**9.6%**	**9.6%**	**11.7%**	**17.3%**	**16.2%**
Urban	2,886	2,971	2,926	3,298	3,533	328	343	453	655	672	11.4%	11.5%	15.5%	19.9%	19.0%
Rural	1,332	1,299	1,392	1,272	1,284	76	67	54	135	108	5.7%	5.2%	3.9%	10.6%	8.4%
Pacifica	**3,056**	**3,275**	**3,480**	**3,631**	**3,774**	**340**	**450**	**592**	**678**	**670**	**11.1%**	**13.7%**	**17.0%**	**18.7%**	**17.8%**
Urban	1,988	2,169	2,301	2,442	2,550	268	350	466	528	532	13.5%	16.1%	20.3%	21.6%	20.9%
Rural	1,068	1,106	1,179	1,189	1,224	72	100	126	150	138	6.7%	9.0%	10.7%	12.6%	11.3%
National	**16,292**	**16,831**	**17,464**	**18,222**	**19,399**	**1567**	**1657**	**2155**	**2967**	**3231**	**9.6%**	**9.8%**	**12.3%**	**16.3%**	**16.7%**

Source: DANE webpage

In Bogotá, the unemployment rate has started to increase from 1998. For year 2000, Bogotá's unemployment rate is the highest than any other region in the nation. This trend might put the brakes on inflows of population, but can not be prospected because other social factors can affect the population increase.

2.2.3 Economic Conditions

1) Economic Growth

(1) Colombia

A. Position of Colombia in the world and Latin America

According to the data of the World Bank for year 2000, Colombia's GNP per capita is estimated as US$ 2,080. Out of 206 countries registered to World Bank, Colombia ranks 101st. With this figure, Colombia is classified to lower middle income country within their classification. Within the Latin America & Caribbean region, Colombia ranks 12th out of 20 countries.

B. National trends

Colombia has been in an economic progress since after the negative growth in the first quarter in the 1980s. Gross Domestic Product (GDP) per capita had showed the growth of more than 4% during the mid 1990's, though the situation turned adverse in 1998. One of the factors is the Armenian earthquake in 1999, which hit directly to the coffee industry worsening the economic situation of Colombia.

Table 2.2.12 shows the trend of GDP and GDP per capita of Colombia for the term of 30 years.

Table 2.2.12 Changes of GDP in Colombia

(Constant Price in 1994)

	Total GDP		GDP per Capita	
Year	Mil COP in 1994	Growth Rate	Mil COP in 1994	Growth Rate
1970	23,864,764	-	1,115,401	-
1973	29,057,029	6.78%	1,231,057	3.34%
1975	31,440,432	4.02%	1,254,283	0.94%
1978	37,201,189	5.77%	1,367,332	2.92%
1980	40,804,622	4.73%	1,427,609	2.18%
1983	42,792,602	1.60%	1,400,749	-0.63%
1985	45,600,609	3.23%	1,433,534	1.16%
1988	52,913,800	5.08%	1,571,152	3.10%
1990	57,063,451	3.85%	1,634,273	1.99%
1993	63,821,419	3.80%	1,734,761	2.01%
1995	71,046,217	5.51%	1,843,363	3.08%
1998	75,412,448	2.01%	1,847,130	0.07%
1999	72,357,004	1.84%	1,739,810	-5.62%

Source: Colombia Statistics 1993-1999 DANE and DANE website

C. Trends in Bogotá City

Table 2.2.13 shows the transition of the total GDP in Bogotá City. It shows that Bogotá City had experienced an average annual growth of GDP approximately 7% during the 1970s to 1980s, slowing down in the mid 1980s and then picking up again to register a growth of more than 5%. In 1995, Bogotá City's regional GDP reached approximately 16,665,172 million pesos. In the

same year, the national GDP was 71,046,217 million pesos, meaning that GDP of the city comprised approximately 25% of the national's.

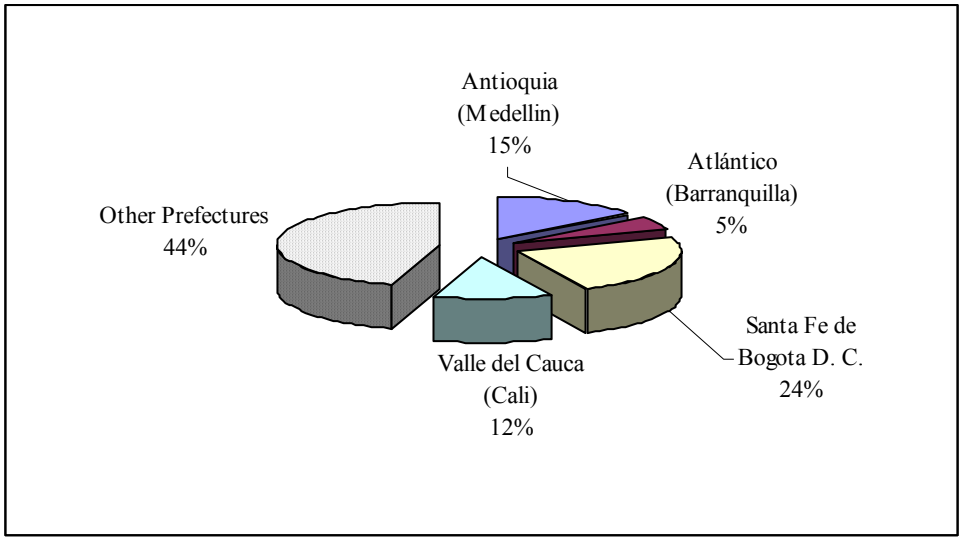
Table 2.2.13 GDP Growth in Bogotá City

Unit: Million Pesos as of 1994 fixed rate

Year	Total GDP	Avg Annual Growth Rate
1970	4,492,097	-
1975	6,349,231	7.17%
1980	8,445,638	5.87%
1985	9,496,560	2.37%
1990	11,971,082	4.74%
1995	16,665,172	6.84%

Source: Historic Statistics Bogotá City 1950-1999, Department of Planning

Figure 2.2.4 describes the proportion of the national GDP in 1998. With this figure, prefecture with major cities which are Antioquia (Medellín), Atlántico (Barranquilla), Santafé de Bogotá, and Valle del Cauca (Cali) composes 56% of the total Economy. Out of these prefectures, Bogotá City composes 24% of the total economy.



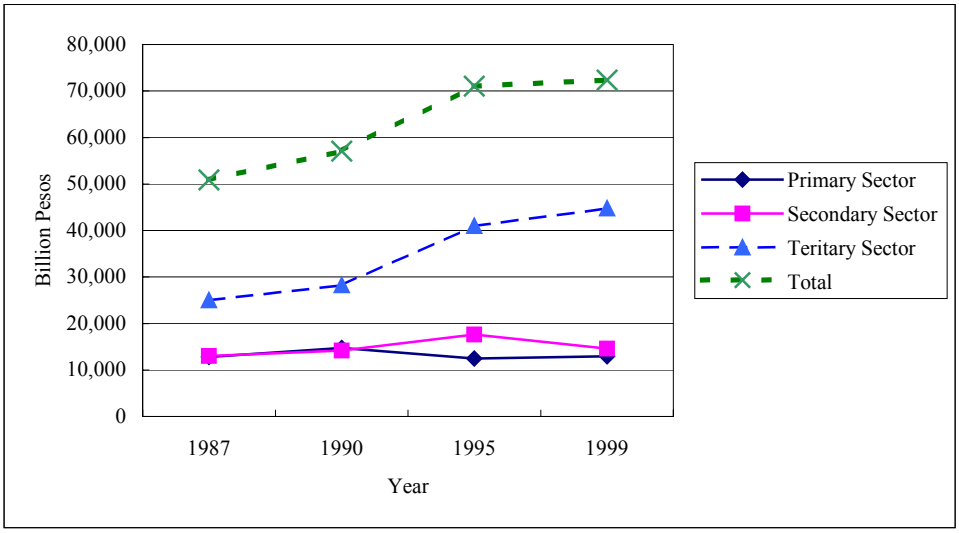
Source: DANE web page

Figure 2.2.4 Distribution of National GDP in 1998

(2) Economical development by the sectors

A. National trends

Figure 2.2.5 shows the transition of the amounts of GDP by the sectors. From the figure, it is obvious that the tertiary sector dominates GDP, and secondary sector comes next, competing with the primary sector. As total GDP has increased, the shared tertiary sector has increased to reach 62% of GDP in 1998. Also, the total GDP of primary sector has been dropped off around 18% of the total GDP in 1995.



Source: Colombia Statistics 1993-1999 DANE Website

Figure 2.2.5 Changes of National GDP

As Table 2.2.14 describes, agriculture, farming and fisheries sub sector has been dropped for the primary sector. In the secondary sector, the sub sector of manufacturing industries has dropped, while the other two sub sectors had grown. In the tertiary sector, major service sub-sectors has not changed much, while the social service and indirect service has been increasing.

Table 2.2.14 National Trend of GDP per Sector

Unit: Million COP as of Constant Price in 1994

Year	1987		1990		1995		1999	
Primary Sector	**12,816,426**	**25%**	**14,698,755**	**26%**	**12,447,587**	**18%**	**12,952,762**	**18%**
Agriculture, farming and fisheries	10,720,194	21%	12,116,826	21%	9,750,754	14%	9,102,251	13%
Minings	2,096,232	4%	2,581,929	5%	2,696,834	4%	3,850,511	5%
Secondary Sector	**13,012,360**	**26%**	**14,160,305**	**25%**	**17,634,361**	**25%**	**14,622,834**	**20%**
Manufacturing industries	10,641,199	21%	11,893,386	21%	10,267,878	14%	9,042,475	12%
Electricity, gas and water	535,441	1%	613,535	1%	2,161,286	3%	2,631,840	4%
Construction	1,835,720	4%	1,653,384	3%	5,205,197	7%	2,948,518	4%
Tertiary Sector	**25,018,492**	**49%**	**28,204,391**	**49%**	**40,964,268**	**58%**	**44,781,408**	**62%**
Commercial, restaurants, and hote	5,847,579	12%	6,407,638	11%	8,397,069	12%	7,699,574	11%
Transportation and communicatior	4,357,740	9%	4,808,848	8%	4,997,947	7%	5,741,726	8%
Financial Services	6,947,979	14%	8,112,591	14%	12,336,684	17%	11,221,211	16%
Social Services	6,597,317	13%	7,336,637	13%	11,434,264	16%	16,841,114	23%
Indirect Services	1,267,877	2%	1,538,677	3%	3,798,305	5%	3,277,783	5%
Total	**50,847,278**	**100%**	**57,063,451**	**100%**	**71,046,217**	**100%**	**72,357,004**	**100%**

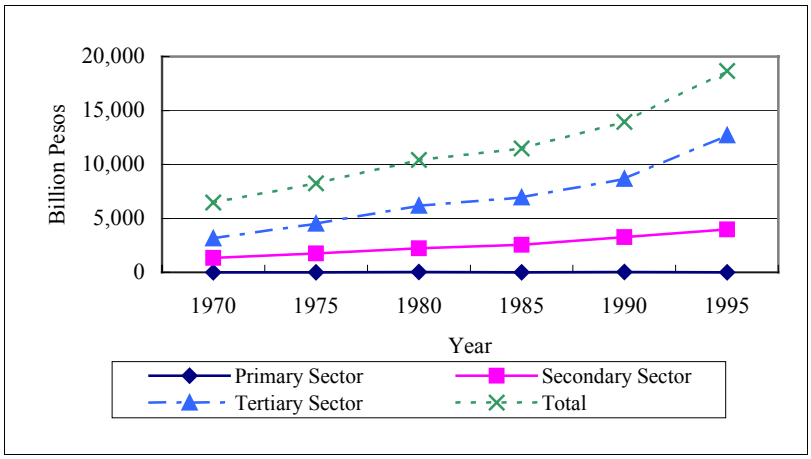
Source: Colombia Statistics 1993-1999 DANE and DANE website

It can be analyzed that GDP proportion of pure industries such as agriculture, farming and fisheries, as well as manufacturing industries have been decreasing. Among the tertiary sectors, social service and financial service has increased while other sectors has a little change.

B. Trends in Bogotá City

Characteristic of the economical proportion is similar to the national one, where tertiary sector dominates, secondary sector follows and then the primary sector comes as seen in Figure 2.2.6

However, the proportion is quite different from the nationals, that in 1995, tertiary sector composed 75%, secondary sector 24%, and primary sector less than 1%. This can lead to the idea that Bogotá City is an area where economically depended solely onto the tertiary sector.



Source: Historic Statistics Bogotá City DC 1950-1999, Department of Planning, Bogotá City

Figure 2.2.6 Growth of GDP in Bogotá City

With the Table 2.2.15, it is clear that primary and secondary sector has gradually decreased since 1970's, and the tertiary sector has been increasing since then.

Table 2.2.15 Trend of GDP by Sector in Bogotá City

Unit: Millon Pesos

	1970	%	1975	%	1980	%	1985	%	1990	%	1995	%
Primary Sector	8,356	0.2%	9,125	0.1%	35,507	0.4%	14,893	0.2%	36,938	0.3%	4,037	0.02%
Secondary Sector	1,331,347	29.6%	1,820,382	28.7%	2,236,039	26.5%	2,546,551	26.8%	3,273,319	27.3%	3,969,201	23.8%
Tertiary Sector	3,150,424	70.1%	4,517,750	71.2%	6,172,111	73.1%	6,933,130	73.0%	8,658,835	72.3%	12,689,939	76.1%
Total	4,492,097	100.0%	6,349,231	100.0%	8,445,638	100.0%	9,496,560	100.0%	11,971,082	100.0%	16,665,172	100.0%

Source: Historic Statistics Santa Fe de Bogotá 1950-1999, department of planning, Bogotá

2.2.4 Socio Economical Indicators

1) Basic Understanding of the Estrato

(1) General idea of Estrato

The *estrato* is the index of the urban residential variables that are classified into six, from class one (lowest) to class six (highest). This classification was first done in 1995 through the "Stratification program", planned and guided by the National Department of Planning (DNP), directly executed by DAPD and other related municipalities. After 1996, it has been obligated to each municipality of the administration to keep updating the data of the stratification project, and some revision has been made in Bogotá City.

Estrato is applied to all the urban area throughout Colombia, through the manzana census and its evaluation, based on the stratification model published by DNP. It is classified in to four, as shown below.

- Type Bogotá: Applied only to Bogotá City.
- Type 1: Applied to the city with population more than 200,000.
- Type 2: Applied to the city with population up to 200,000.
- Type 3: Applied to the city with population up to 5,000.

The difference between all these four types are the variety of evaluating variables, for example, type Bogotá does not include the variable of contamination while type 1 includes this index. Though small items vary between these models, the results between these models are not large.

(2) Process

Estrato classification is basically based on the criteria for present condition of the manzana and land use classification by the variables set by DNP. Variables used for evaluation of manzana are the 1) land use, 2) planning of the settling, 3) materials of the construction, 4) density pertaining to real estate, 5) quality of the public space, and 6) degree of deterioration of the housing. The other variables, land use classification, are described as Table 2.2.16 with the 20 zonings.

Table 2.2.16 Zoning Categories and Descriptions

New Zone	Description	Estrato
Zone 1	Poverty (-)	1
Zone 2	Poverty (+)	1
Zone 3	Social Deviation and Tolerance Zone	1-2
Zone 4	Progressive Development without Consolidation (-)	2
Zone 5	Progressive Development without Consolidation (+)	2
Zone 6	Urban Deteriorating	2
Zone 7	Industrial	2-3
Zone 8	Consolidated Progressive Development (-)	3
Zone 9	Consolidated Progressive Development (+)	3
Zone 10	Commercial Predominating (-)	3
Zone 11	Commercial Predominating (+)	3
Zone 12	Intermediate Residential Zone (-)	4
Zone 13	Intermediate Residential Zone (+)	4
Zone 14	Residential Zone with Special or Compatible Commerce	5
Zone 15	Exclusive Residential (-)	5
Zone 16	Exclusive Residential (+)	6
Zone 17	Low Residential Density	6
Zone 18	Institutional	-
Zone 19	Lots and others without housings	-
Zone 20	Green Zone	-

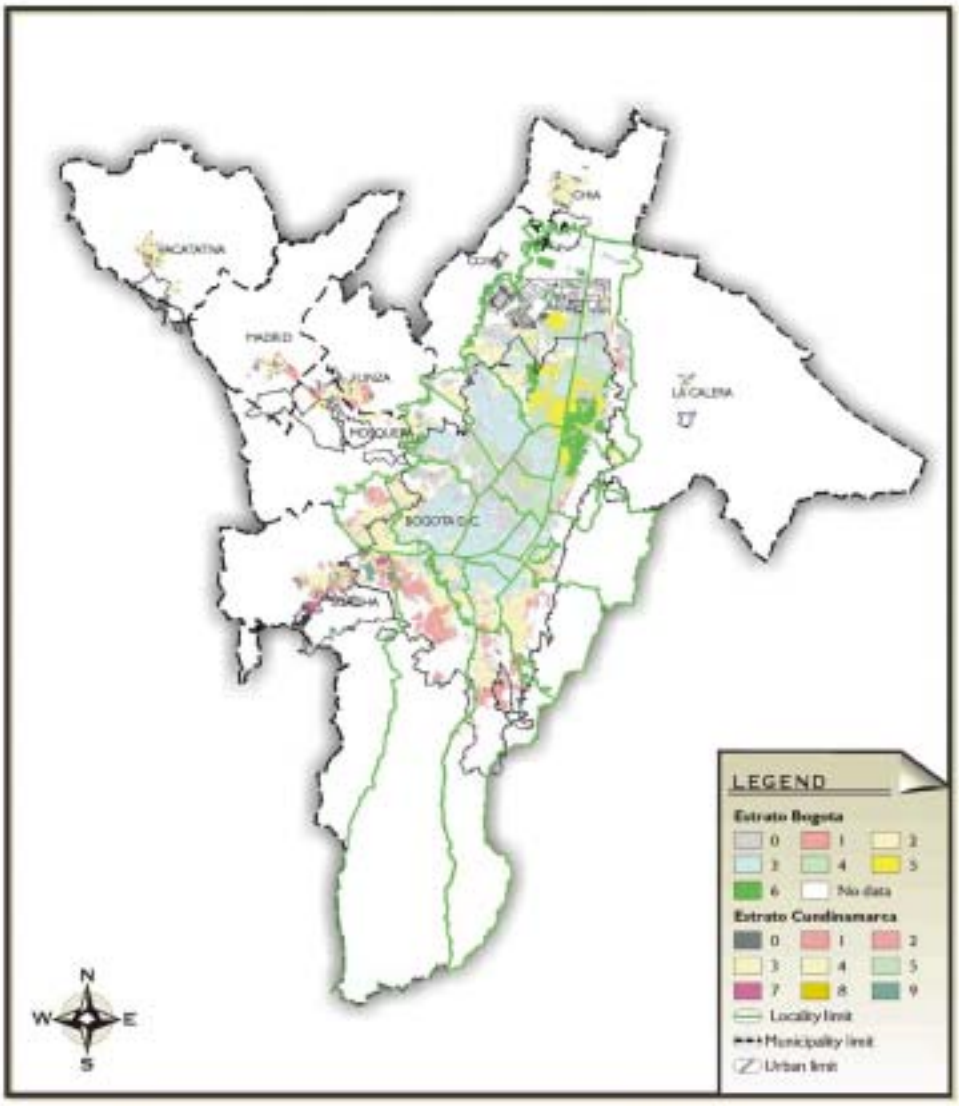
Note: + meaning more progressed, - meaning less progressed
Source: DAPD

For Bogotá City, first *estrato* process was done between June 1995 and December 1996, and passed by the district decree of 009 of January 1997. Then, the upgrade process was done by the decree 737 of October 1997, adding 1,600 manzana to the former one. There will be several upgrades in 2002, and new census is planned to be taken by year 2003.

2) Estrato in Bogotá City and Surrounding Cities

(1) General analysis of the Estrato distributions

Figure 2.2.7 shows the distribution of the *estrato* in the Study Area. From that figure, it is obvious that the highest *estrato* in the Study Area is set in the north-central part of Bogotá City, comprising the most of the part of Chapinero and a part of Suba for *estrato* 6. Surrounding the area of estrato 6, area of estrato 5 is distributed including Barrios Unidos. Semi circle in the center-north surrounding the estrato 6 and 5 is composed of estrato 4, and the rest in the northern part of Bogotá is mainly estrato 3. Central Bogotá to south is mainly composed of estrato 3 and 2, lower estrato as far as to the southern expansion. For the eight municipalities in Cundinamarca are mainly *estrato* 2, according to the classification set by the DNP.



Note: Estrato 0 is defined by DAPD, where the buildings exist, but no reside are found.

Figure 2.2.7 Distribution of the Estrato

The distribution of the estrato in 1996 is described as following table. It can be noted that in Bogotá City, the major estrato is estrato 2 and 3.

Table 2.2.17 Actual Situation of Estrato (by Manzana)

Estrato	Percentile of Manzana
1	9.3
2	42.7
3	30.2
4	9.1
5	3.7
6	1.7
No estrato classification	3.3

Source: Estadísticas Santa Fe de Bogotá D.C, Departamento Administrativo de Planeación Distrital

3) Basic Services Tariff and Estrato

Public service tariff to the residential area are established by the following committees.

- Regulation committee for energy and gas: CREG: Ministry of Mining.
- Regulation committee for water: CRA: Ministry of Development.
- Regulation committee for telecommunication: CRT: Ministry of Communication.

In these committees, the estrato is taken into consideration for determining the tariffs of public services, under the District Decree 347 of May 10, 1997. The main ideas for these tariff values are to cover the residents of estrato 1 and 2 by the residents of estrato 5 and 6.

The established amount of tariff is imposed directly by the public facility companies, of the energy (EEB), telecommunications (ETB), and aqueduct and sewage (EAAB).

2.3 Bogotá City Development

2.3.1 Development of Urbanized Area in the Study Area

There have been three different patterns of expansion in Bogotá's development history:

- Dwelling block-based development phase.
- Barrio-based development phase.
- Block-based development phase.

Each development phase is described below:

1) Dwelling Block-Based Development Era

The *Manzana*, which means a dwelling unit, is a basic unit of development in Bogotá City in the 16th century until the first decade of the 20th century. The *Manzana* forms the old city where events of historical significance took place, as well as the most important administrative and political institutions located. The area was constructed a grid type network without any road hierarchy system, and that defines the *Manzanas* with constant dimensions. This pattern was developed three hundred years before.

This pattern of development has progressed in the La Candelaria area. It is located in the center of Bogotá City.

2) Barrio-Based-Development Era (1910 – 1970)

During 1910 to 1970, the development of Bogotá City was based on the Barrio, which comprises several *Manzanas*. Each barrio became an autonomous unit.

Between 1910 to 1930, the population in Bogotá doubled in size and, between 1910 to the 1960s, some 4,427 hectares were added to the City's urbanized area where it composed mainly of residential neighborhoods. The construction and development of some barrios were planned, yet illegal development had progressed at the edge of the City.

The City was expanded along the road network. The urban center developed long the important road sections and formed a hierarchical road network. One of the characteristics of the development was that the urban area expanded to the North - South direction in a relatively narrow corridor that was limited by the topographical conditions of the City. Complementary to this axis, other important road corridors were constructed in the East - West direction because of limitation of the urban land.

Illegal housing developments continued in more distant and isolated places from the city in such a way that a marginal area of huge dimensions appeared in the peripheral zones of the City. The illegal development was carried out by organized action by the community members.

3) City Development from 1980s to Present

This stage is characterized by the expansion of high and high-medium *estrato* toward the periphery on the North, creating neighborhoods of low densities. For low and low-medium estrato, there was a settlement process in the high areas of the mountains and in the flood areas of the rivers. Roads connected these new developed areas to the city center

The present urban situation is the result of the superimposition of the already described ways of expansion, their interrelations and the common areas between each system. Additionally to these processes, an important change has happened because of the recent increasing density of residential areas which is represented in the demolition of old houses in order to construct tall buildings. This increase in density of about 10 to 20 times the original ones was not done together with the upgrading of lifelines, the addition of public spaces and the improvement of other urban aspects. Furthermore, new illegal settlements are established in places far form the city periphery, which represents a repetition of the colonization process of the first barrios. Figure 2.3.1 shows the urbanization process in Bogotá City.

Year: 1894-

Population: approx. 100,000 inhabitants (year 1900)
Developed Area: 570 ha
Density: 175 people/ha
Characteristics:

- Developed area was less than 2% of the current area of the city
- Urbanization toward Chapinero, northern part of Bogotá, progressed rapidly
- Railways, Avenida Caracas, and Carrerra 7 were constructed

Year: 1960-

Population: 1,697,311 inhabitants (year 1964)
Developed area: 7,915 ha (year 1964)
Density: 214.4 people/ha
Characteristics:

- Population increase between 1890 and 1964 was 4.52% annually
- Developed area increased 13 times more, compared with that in 1894
- Density increase was more than 120%, compared with that in the 1900s
- Social population growth was rapid due to the migration owing to the threat of guerrillas
- Basic plan of arterial road consolidation was introduced

Population: 4,315,309 inhabitants (year 1985)
Developed Area: 24,046 ha
Density: 179.5 people/ha
Characteristics:

- Population increase between 1973 and 1985 was 3.46% annually
- Developed area increased 1.7 times more, compared with that in 1973.
- Density increase was approximately 87.5% compared with that in 1973.
- Informal urbanization continued representing a very high proportion of the urban expansion.
- Population with higher estrato occupied the north and northeastern area, lower estrato occupied south and southeastern area of the city

Year 1980-

Population: 6,322,000 inhabitants
Developed area: 29,308 ha
Density: 199.9 people/ha
Characteristics:

- Population increase between 1985 and 1996 was 2.82% annually.
- Developed area increased 1.2 times more, compared with that in 1985
- Density increase was approximately 110%, compared with that in 1985
- Territory Ordering Plan was created for the appropriate use of land in 2000

Year 1990-

Source: Museo de Desarrollo Urbano, instante memoria espacio

Figure 2.3.1 Urbanization Process in Bogotá City

2.3.2 Urban Planning Aspects

1) Review of Existing Laws and Regulations for Urban Planning

The following table shows the important laws and regulations for the urban planning field in Bogotá City.

Table 2.3.1 Laws and Regulations in Urban Planning Aspects

Decree or Law	Summary
Ley 9 de 1989	The present law regulates aspects of social housing projects such as financial aids, construction licenses for social housing, etc. Furthermore, the law also regulates how to proceed in the acquisition of land or facilities in order to construct social housing projects.
Agreement VI of 1990	The agreement regulates the land use of the East border of Bogotá City and its influence area, as well as some areas in Suba, and Ciudad Bolivar localities; specifically it tries to control the land use in the mountainous areas. The plan settled in the document is referred to the conservation of the orographic system by means of the introduction of land uses that guarantees the preservation of the environment, and the balance between city development and natural resources.
Ley 3 de 1991	This regulation creates the National System for Socialized Housing , the subsidy for family houses, and the Institute for the Territorial Credit is reformed and acquires the new name of INURBE. The law explains how the organization of the National System must be performed, and the functions of each institution involved in the system. Additionally describes which kind of houses are to be the target of the system, and the procedures and general requisites to apply for a Family Subsidy. This law also regulates the objectives and responsibilities of the INURBE.
Ley 388 de 1997	This law promotes the territorial organization through the implementation of plans of land use. For doing so, the law gives the POT as an instrument to develop the municipal and district territorial ordering, which includes the guidelines or studies to follow in order to perform the following task: Disaster prevention, environmental protection, infrastructure and vital lines management. This law only gives guidelines about how to perform the POT.

Source: Summarized by JICA Study Team

With regard to the land use control, there is Ley 388 of 1997 as the main law to be considered. This Ley 388 is the basic and most important law for Colombia in terms of land use.

This law states that territorial ordering plans should be planned at the initiative of each city and municipality. The plans should contain the basic concept of whatever components each entity includes in the plan. It can be concluded that the land use in Bogotá metropolitan area is basically regulated by Ley 388, 1997 and specific land use is controlled by each entity.

2) Land use Classification of Bogotá

With the above-mentioned decree, it is defined that the Territorial Ordering Plan (POT) must classify the land of municipalities and the districts into three categories of urban, rural, and urban expansion. Also, under the rural land category, the classification for suburban and protection areas can be established. Each of the land could be described as follows.

Urban Land: This land has road infrastructures and primary energy networks, water supply and sewerage system. Also, the zones under urbanization process could belong to this category, if this was approved under the POT of the area. The urban land would include the populated centers for the suburban area, and it must be delimited by the perimeters. In any case, the urban perimeter is greater than the set perimeter of the public service.

Urban Expansion Land: This land is constituted by the municipal land designated to urban expansion, which will be set aside for urban use upon approval by the POT of the programs to be implemented. This land will be defined by the POT, with the provision of land development, and also with the possibility of public service expansion.

Rural Land: Land not intended for urban use falls under this category. This type of land is usually used for agricultural, livestock, forest, natural resources, and analogue activities. The possible categories of sub urban and environmental protection land can be defined as the mixed land use of country and city life forms, and possess characteristics environmentally not appropriate for living.

2.3.3 Urban Structure

1) Urban Transportation Development

Le Corbusier planned the basic arterial road network in 1951, and based on his plan, the government of Colombia reviewed its road network plan in 1958. As the results of revision, the road plan was formulated. The basic concepts of the roads are shown as follows:

- To define a ring road structure in order to organize the land use and the transport system.
- To correct the city expansion process through a homogeneous and nested road network.
- To establish an expansion tendency in the peripheral areas.

Since then, Bogotá City government has constructed a broad network along the development plan established in 1958.

The recent development in the field of urban transportation development is the introduction of Transmilenio in the center of Bogotá City.

Transmilenio company started with the Agreement 4 issued by the Bogotá Council, authorizing the Mayor of Bogotá to create the Empresa de Transporte del Tercer Milenio, Transmilenio. On October 13th of 1999 the statutes and norms to control the company such as mission, responsibilities, functions and actions were settled through the Public Scripture No. 1528. Since December 18th of 2000 the company has started rendering the transport service after a process of construction that took less than two years. At that time the corridors of Calle 80 and partially the Avenida Caracas were opened to traffic.

The system of corridors is developed gradually in order to cover the total demand of transport public service. The plan is to create 22 corridors with a total length of 388 Km to be developed in 15 years as follows:

Table 2.3.2 Development Plan for Transmilenio

Stage	Name of the Street or Avenue	Length (Km)	Remarks
1998 – 2001	Calle 80	8	Under operation
	Avenida Caracas	17	Under operation
	Autopista Norte	10	Under operation
2002 – 2005	Avenida Las Americas	17	Under preparation
	Avenida Suba	11	Under preparation
	Corredor Férreo del Sur	12	Under preparation
	Avenida Norte-Quito-Sur	35	Under preparation
2006 – 2010	Avenida Boyacá	35	Future plan
	Avenida Primero de Mayo	15	Future plan
	Viaducto Caracas	21	Future plan
	Avenida Longitudinal de Occidente	48	Future plan
	Avenida Villavicencio	10	Future plan
	Avenida 68	16	Future plan
	Calle 63	9	Future plan
	Calle 200	7	Future plan
	Carrera 10	13	Future plan
	Carrera 7	11	Future plan
	Calle 6	5	Future plan
	Calle 170	10	Future plan
	Calle 26	10	Future plan
	Avenida Ciudad de Cali	31	Future plan
	Viaducto del Norte	10	Future plan

Source: Transmilenio S.A.

The total estimated amount of money planned to be invested for the whole project is US$ 1,970 million.

Transmilenio has 411 buses at the present time, 56 of 62 stations in operation, 22 feeder routes form neighborhoods to the main corridors, and the average number of passengers in peak hour is 57,196, while the average per day is around 600,000 passengers.

2) Open Space

(1) Open space ratio in the study area

It is important to secure the open spaces in the Study Area for the safety of victims in a disaster.. The open spaces include parks, sport grounds, green space, vacant land, agricultural land, etc. The open spaces are made use of as an evacuation place, an emergency response center, and an emergency response location for the public service companies as well as a temporary housing location.

The study team analyzes open spaces for public parks and roads of the Study Area. The summary of the open space classification is shown as follows:

Table 2.3.3 Open Space for Bogotá City

Unit: Ha

	Bogotá City	Cundinamarca
Public Parks	2,220.3	57.8
Roads	4,845.8	-
Total	**7,066.1**	**57.8**
Open Space Ratio	8.2 percent	0.05 percent

Source. JICA Study Team

(2) Parks in the study area

The information of the open space is collected from the District Institute of Sports and Recreation (IDRD), which is responsible for the maintenance of the parks. The Department of District Planning has responsibility of the planning aspects of the park, while the construction is carried out by the other organization. The information includes only public parks in the Study Area. According to IDRD, the parks can be classified into six categories as shown follows:

Table 2.3.4 Classification of Parks

Category	Description
Regional Parks	These parks are natural spaces with relatively huge areas and located totally or partially outside the urbanized area of Bogotá City. They provide good environmental values.
Metropolitan Parks	The purposes of these parks are recreational and active uses to attract the people and they provide good environment and landscape. Infrastructure should be provided for these purposes.
Urban Parks	These parks are distributed at strategic locations of the Capital District area with an historical and symbolic value for the city. They are of intermediate scale.
Zonal Parks	Zonal parks have variable sizes. They provide opportunities for locality personnel of recreation and activities. They could have recreational infrastructure. The parks also have good landscape and management.
Barrio Parks	This park is for the neighborhood unit. The objectives of the parks are mainly public in nature–for recreation and integration of the community.
Pocket Parks	These are neighborhood parks with an area less than 1,000 square meters. The purpose of the parks is to provide opportunities for the community people for recreation and other activities.

Source: Inst Distrital de Recreccion y Deporte

The summary of the parks in the Study Area is shown in Table 2.3.5. There are more than 2,500 parks with an area of 2,600 ha in total in the Study Area. The Barrio Park shares more than 83% of the total number, while the total area is 1,085 ha, or 41.4%, of the total park area. The metropolitan park numbers only 16 in the Study Area, yet it shares 19% of the total park area.

The distribution of parks shows that open space per person is more than 10m^2 in Usaquén, Barrios Unidos and Teusaquillo localities. Three localities, Los Mártires, La Candelaria and Ciudad Bolivar, in Bogotá City show that the open area per person is approximately 1.0m^2. In the eight municipalities in Cundinamarca, open space in the urban area is relatively small at less than 0.7 m^2.

Table 2.3.5 Summary of Parks in the Study Area

Locality	*Population*	*Number of Parks*						*Area (Ha)*						*Open Space Per Person (m²)*
		Metropolitan	*Urban Park*	*Regional Park*	*Barrio Park*	*Zonal Park*	*Pocket Park*	*Metropolitan*	*Urban Park*	*Regional Park*	*Barrio Park*	*Zonal Park*	*Pocket Park*	
Bogota City														
1 - Usaquén	421,320	1		2	221	4	17	12.0		353.5	92.4	12.3	1.8	**11.2**
2 - Chapinero	122,991		1		116	2	13		17.7		32.9	1.5	1.6	**4.4**
3 - Santa Fé	107,044	1	1		54	2	7	14.1	4.4		18.4	1.5	0.7	**3.7**
4 - San Cristóbal	455,028		1		138	5	17		23.0		62.3	18.1	1.7	**2.3**
5 - Usme	244,270	1			102	5	18	20.5			30.0	11.4	1.3	**2.6**
6 - Tunjuelito	204,367	1			31	1	8	66.0			17.2	2.7	0.2	**4.2**
7 - Bosa	410,099	1			124	5	13	20.4			41.7	18.7	1.6	**2.0**
8 - Kennedy	912,781	1	3		257	5	31	49.2	35.2		163.2	11.9	2.3	**2.9**
9 - Fontibón	278,746		1		82	4	7		30.1		35.6	25.9	0.8	**3.3**
10 - Engativá	749,068	3		1	190	6	27	45.6		278.9	180.4	22.4	3.9	**7.1**
11 - Suba	706,528		2		183	4	15		13.8		124.9	8.3	1.1	**2.1**
12 - Barrios Unidos	176,552	4	1		52	2	13	146.1	4.7		21.9	2.7	2.6	**10.1**
13 - Teusaquillo	126,125	2			101	1	10	115.5			44.8	2.7	0.4	**13.0**
14 - Los Mártires	95,541		2		25	2	7		5.3		10.9	3.6	0.8	**2.1**
15 - Antonio Nariño	98,355	1			25	5	7	10.8			14.0	18.7	0.4	**4.5**
16 - Puente Aranda	282,491				97	5	15				81.8	24.9	1.3	**3.8**
17 - La Candelaria	27,450				10	2	1				1.8	0.9	0.7	**1.2**
18 - Rafael Uribe	384,623		2		125	5	16		33.4		47.0	9.7	1.9	**2.4**
19 - Ciudad Bolívar	575,549		2		144	4	17		0.9		64.2	6.1	2.4	**1.3**
Municipalities in Cundinamarca														
Chia	61,783		3		7		8		3.4		2.8		0.4	**1.1**
Cota	14,784													**0.0**
La Calera	24,188													**0.0**
Facatativá	90,266		1		10		7		7.5		3.3		0.4	**1.2**
Funza	51,808		3		4		13		2.9		0.8		0.5	**0.8**
Madrid	52,110		2		10		17		7.2		5.2		1.0	**2.6**
Mosquera	27,753		1		11		14		11.6		3.4		0.5	**5.6**
Soacha	283,889		2		7		3		1.1		5.8		0.2	**0.2**

Source: JICA Study Team

2.4 Existing Plan

2.4.1 National Development Plan

The National Development Plan is prepared by the president of Colombia in accordance with Article 340 of the Constitution. The plan becomes a Law after approval by the congress. The Department of National Planning (DNP) is responsible for the formulation of the plan.

The most recent national development plan covers 1998-2001, which is the term of office of President Pastrana. The objective of the plan is to change for peace. Moreover, the plan addresses for the first time disaster prevention in the country. The main focus is to reconstruct the coffee-growing region, which was hit by an earthquake in 1999. The development plan shows the direction of the rehabilitation of the affected area.

2.4.2 Disaster Management Plan

The disaster management plan is established in late 1980s and 1990s, when the Colombian government recognized the importance of the plan. The following section gives a summary of the disaster management plan at the national level.

1) National Level

The government of Colombia decided to address the disaster management of the country after the volcanic disaster in Ruiz in 1985, and established the National Office for the Attention of Disasters. The government also enacted several laws and regulations for disaster management from 1988 to 1992. In 1996, the National Office for the Attention of Disaster changed its name to the General Directive Office for Prevention and Attention of Disasters (DGPAD) and became an attached office to the Ministry of Interior.

The DGPAD prepared the national disaster management plan in 1998. The objective of the plan can be summarized as follows:

- Reduction of risks and prevention of disaster.
- Quick and effective response after disaster.
- Quick recovery of the affected area.

The national disaster plan shows the basic concepts to deal with the disaster management.

(1) Decentralization

According to the ordinance law 919 of 1989, the responsibility of the disaster management is decentralized to the municipalities and territories. The municipality should prepare its own disaster management plan. The DGPAD has prepared the model of contingency plan to support the municipality.

(2) Scope of the competition

The disaster management field shall keep an efficient and effective environment through competition of the related organizations.

(3) Coordination

The disaster management shall require close coordination with national, regional and local governments as well as the internal government sections. The plan urges to formulate a regional and a local level coordination body for the implementation of the disaster management system.

(4) Participation

The disaster management shall guarantee participation of the community personnel because of the nature of the project.

There are four strategies to achieve the objectives:

- To gain the knowledge of risks of natural disaster.
- To formulate prevention plan to reduce the risks.
- To promote institutional development; and
- To socialize disaster management.

The summary of the program recommended by the national disaster plan is shown as follows:

Table 2.4.1 Summary of the National Program on Disaster

Name of the Program	Sub-Program
Natural disaster risk mitigation program	Establishment of warning system Evaluation of the risks
Establishment of prevention and mitigation plan	Formulation of prevention plan in the development plans Human and infrastructure management plan Formulation of environmental management plan
Institutional development plan	The national level institutional development Regional and local level institutional development Implementation level organizational development Upgrade of the infrastructure Formulation of the emergency plan Plan of efficient infrastructure reconstruction Establishment of integrated information system
Community level disaster management activities	Community level disaster management education Disaster management and environmental protection Human development program for national level personnel Community level organizational development

2.4.3 Territorial Ordering Plan (POT)

1) Bogotá City

(1) General understandings

A. Background

Bogotá City had several urban plans and decrees as follows:

Pilot Plan of 1951 of Le Corbusier, Regulator Plan of 1954 of Wienner and Sert, Agreements 30 of 1961, 65 of 1967, 7 of 1979 and 6 of 1990, and Phase II of 1972-73. All these lacked the legal necessary instruments to guide the public investment in medium and long-term, searching for the territory ordering.

a) Legal frameworks

Law 152 of 1994 established two basic planning mechanisms for the cities: Municipality Development Plan and Territorial Ordering Plan (Art. 41 law 152 of 1994). Law 388 of 1997 of Territorial Development was issued, as the set of principles, instruments and arrangements about planning and territorial proceedings

The P.O.T for Bogotá was adopted with the signing of Decree No. 619 of 2000.

(2) Elements included in the POT

The Bogotá City's development presents four basic tendencies which were used as reference frame for the performance of the document: Bogotá's supremacy in the National order, the

persistence of a weak integration of the regional space, the need of achieving an environmental bearing, and finally, the growth tendencies of the size of the population.

(3) Existing estimations

- Great imbalance in the migration distribution, resulting in a segregated city. The territory reflects high levels of space inequality, because the areas occupied by the poorest groups of the city have grown without regulation or order and out of the parameters and principles of the planning.
- Absence of a massive transportation system and the lack of a road network hierarchy, which affects specially the access of the peripheral areas. Due to inefficiency reasons in the routes, roads and transportation type, a commuter from Bogotá spends approximately 4 hours per day to travel from their home to work.
- Weakening of the public amenities and the incapacity of defending and constructing the public space. This deterioration is due to the occupation and privatization of sidewalks, parks and cession areas, as well as the fact of ignoring the importance of the collective property, such as the urban patrimony.
- Lack of houses for the quantity of habitants in the city corresponding to the population growth.
- The city still presents incomplete coverage in the supply of the sanitation and potable water services. In addition, health equipment, educational facilities, jails, sport and community facilities are deficient.
- The urban development of Bogotá has neglected the construction of the zone scale. A zone scale is composed by a great city, in which basic needs such as housing, employment, commercial services, health, education and recreation are met.
- Most of the residential zones have been deteriorated by changes in uses, without any regulation or parameter, as consequence of the market laws of the land rent, without urban development considerations or coherence with the pre-existent services capacity.

(4) Territorial Ordering Model (Desirable Future Image of the Municipalities)

A. Urban area

The Model proposes a continuous, compact and dense urban area, ordered by a structure composed by urban pieces and hierarchical general systems from the metropolitan scale to the local one.

B. Rural area

The Territorial Model searches to consolidate the rural area as a new water, biotic, stage and productive reserve and as a proper habitat for the rural population of the District.

The water sources and the existent natural resources will be valued. The populated centres will be strengthened by means of the supply of public services and equipment that reinforce activities related to the rural productivity.

C. Others

The objective is to recognize and to consolidate the importance of the Capital at National Level.

(5) POT in practice

A. Projects

a) Main ecological structure projects

The projects regarding the Ecological Structure are referred to the district sanctuaries of fauna and flora, the forest urban and rural reserves, and the urban and rural recreational ecological parks.

In order to put in practice a valorization and preservation process of the elements that compose the Main Ecological Structure, a group of policies of regional integration and environmental sustainability were defined, as well as programs about the treatment plants and hills protection, in addition to the intervention of the Rio Bogotá and its affluent.

b) Projects regarding rural territory

These projects refer to the sanctuaries and rural ecological parks protection and valorization.

c) Projects regarding the urban structure

These projects are divided into those that refer to the urban pieces and those that affect the general systems.

- Projects for the urban pieces: They are intended to find an answer to the POT's objectives and consolidate an urban structure of high life quality, balance, and efficiency and that which makes easier coexistence with the citizens. To reach this, a group of complementary projects were defined in each one of the urban pieces.
- Projects in the general systems: In order to guarantee the construction of an integrated and equitable territory, the required projects in each one of the infrastructure systems or networks of the city are established.

B. Programs

The Urban Programs define the performances the District Administration must render or promote in four topics relevant to the city development and the starting of the Ordering Model. (These are the Patrimony Valorization and Protection, Housing (which includes New Housing, Integral Improvement, Human Resettling, and Neighborhoods Recovery), the Urban Renewal and the Eco-efficient Production.)

a) Patrimony valorization and protection

This program establishes incentives for the maintenance and preservation of the goods of cultural interests. Its objectives are the following:

- To design and perform urban development on the built patrimony that stimulates the private intervention, valorize the surrounding and revitalize the properties and surrounding sectors.
- To allow interventions in the protected properties, with the purpose of improving their housing conditions without losing any main patrimonial values.
- To reorganize the District institutional structure to allow patrimony recovery projects to proceed and be performed.

These objectives are concrete in the following situations:

- Special Plan for the Historic Downtown Protection.
- Valorization and Preservation of the Foundational Centre areas of the annexed municipalities (Usaquén, Suba, Engativá, Fontibón, Bosa and Usme).
- Performance in the patrimonial interest neighborhood.
- Compensations for the preservation of cultural interest goods.

b) Housing

This program has the objective of establishing the mechanisms to provide proper attention to the demand, both quantitative as qualitative, for houses of lower income families in the city. This is done by means of the promotion and provision of incentives to the urban land, programs and new housing solutions, the development of integral improvement programs in urban sectors with deficit, the performance of programs of resettling of families in non-mitigable high risk areas and the recovery of neighborhoods.

Its goal, during the validity of the Plan, is to generate urban land to address the lack of 400,000 housing units in *estrato* 1, 2 and 3.

c) Integral improvement

This program has as objective to guide the required actions in order to complete, reorder or adequately address both the urban space and the housing units that compose the illegal settlements located in the periphery of the city. Its purpose is correcting physical, environmental and legal deficiencies. The priority intervention in Zone Planning Units - UPZ- was defined, which present critical poverty and overcrowding situations.

Its goal, during the plan validity, is to attend to 600,000 people, of *estrato* 1 and 2, located in illegal developments in eight locations, in an urban area of 3,600 hectares.

d) Resettling of families in non-mitigable high risk areas

This program has as objective to transfer the families that are settled in zones declared as non-mitigable high risk areas of floods or landslides, in zones that are the object of intervention by public works or those that required any territorial re-ordering intervention. Its goal is to resettle at least 1,400 families per year.

e) Urban renewal

This program proposes the performance of direct actions of public management; it also promotes private performances in strategic zones of the city. For this effect, the interventions in the public services infrastructures will be coordinated, as well as the viability and pedestrian public space with the intervention of private lands. The program aims to identify the zones where to develop projects or undertake urban renewal and to give priority to public performances to propel their execution.

In these actions, the District will be attended to through the Urban Renewal Company and its objectives are:

- To define the zones propitious for being renewed.
- To start strategic renewal projects by means of the instruments established in the POT.

f) Eco-efficient production

This program has as objective to guarantee the transformation of the city into one that is sustainable, productive and with high environmental quality ecosystem, strengthening the industry settled in the District, with an eye to convert it into one of the elements that contributes to achieve a high urban competitiveness. Two classifications have been established:

- Eco-efficient Industrial Parks.
- Mining-Industrial Parks.

2) Eight Municipalities in Cundinamarca

The summary of POTs in surrounding municipalities is shown in Table 2.4.2. The POT for Facatativá has not been authorized yet.

Table 2.4.2 Summary of POT for Eight Municipalities (Cundinamarca)

Municipality	La Calera	Chía	Funza	Madrid	Mosquera	Soacha	Cota
POT or PBOT	P.O.T.	P.O.T.	P.B.O.T.	P.B.O.T.	P.B.O.T.	P.O.T	P.B.O.T.
Year of Adoption	Agreement No. 043 of 1999.	Agreement 17 of 2000.	Decree No. 000140 of September 13th of 2000.	Agreement 024 of 2000.	Agreement No. 001 of February 23rd of 2000	Agreement No. 046 of December 26th of 2000.	Agreement No 021 from October 20th of 2000
Dev't Direction	Land use and infrastructure.	Land division and infrastructure, but principal projects are addressed to health.	Infrastructure.	Land use and land division, but objectives oriented to infrastructure.	Environment and Urban Infrastructure	Infrastructure	Agricultural housing and environmental protection activities.
Back ground	The norm before the P.O.T. was the Agreement 024 of 1995.	The actual POT replaces the Agreement 03 of 1994, the Agreement 38 of 1998, and the chapter 4 of Agreement 011 of 1996.	The Agreement No. 002 of January 24th of 1997 determines the opening of industrial zones inside the urban and rural areas. Probably still in function.	The P.B.O.T. derogates the Agreement 044 of 1994; probably it was about land division and land use.	Before POT the regulation of land was dictated by the Agreement 038 of 1993, which includes land use and cession areas.	Without reference.	For industrial areas: Agreement No. 16 of December 4th 1991, agreement No. 9 of June 30th 1995. The industrial area was set there by the laws 99 of 1993, 388 of 1997 and the agreement No. 16 of 1998.
Future Direction	Improvement of Infrastructure in the municipality	Recover and maintain historical and cultural places Explore and protect land and natural resources Explore the tourist potential of the municipality.	Concentration of the urban development and to strengthen the agro industrial development of the municipality. .	Integration of urban area with the environment. Protection of the rural space with its conservation and development.	To organize the road network and transportation. To be a center of storing of agricultural products. To save the waters of Rio Bogotá and their tributaries. To define the land use in zones within the capital city.	To consolidate Soacha as the first industrial and mining city in the Department. To promote the balanced development of goods and environmental services.	To avoid the immigration of people from Bogotá to be established as a "dormitory city" To obtain the best strategy in accordance with an agricultural, natural and a well controlled urban development.
Area of imple-mentation	Environment Socialize housing Construction of new lifelines Basic Reparation of Environment Attention and prevention of disasters Public Space and Recreation To guarantee Transport Improvement of Rural Equipment	Health Transport and Roads Infrastructure Public Services Infrastructure Education Environment and livestock Culture Employment Security and civic protection Recreation and Sport Institutional Development	Urban infrastructure and equipment Traffic Ordering Public Services Administration, Creation of institutions Occupation by determining areas and their uses Environment, recuperation humid soils and river borders	Roads infrastructure Water resources Socialized Housing Public Services Urban Equipment	Environment Physical Infrastructure Roads Public Services Housing Health Education Land Use	Transit and Transport, by massive media Public Services Housing Equipment Public Space generation Environment Administrative reform	Housing improvement Land distribution Foment of agricultural activities

Note: POT is defined as the Territory Ordering Plan, which is performed and adopted by the authorities of the districts and municipalities with population larger than 100,000, PBOT, is defined as the Territory Ordering Basic Plan, which is performed and adopted by the authorities of the municipalities with population between 30,000 and 100, 000 inhabitants.

2.5 Laws and Regulations for Disaster Management

2.5.1 Disaster Management System

1) Disaster Legislation

According to Law 46, November 1988, the government of Colombia established a national system for prevention and attention of disaster. The important disaster legislation was enacted for the first time in Colombia in 1989. Decree No 919 of 1989 regulated the national disaster management system to define the responsibility for the public sector, private sector and community organizations in disaster situations. The Colombian government enacted several disaster related laws and regulations. Table 2.5.1 shows the important disaster related legislation since 1988.

Table 2.5.1 Summary of Important Disaster Management Legislation

Law and regulation	Descriptions
Decree 1547, 1984	Creates the National Fund for catastrophes as a special account of the nation. This account will provide money for the required attention of disasters, social assistance, control of secondary effects such as diseases, and to finance the installation and operation of equipment for prevention of disasters as well as to implement measures to prevent them.
Decree 919, 1989	The National System for Prevention and Attention of Disasters is created. This law defines the institutions that conform the system, the scope and actions of the plan, and the guidelines to be followed by regional and local committees.
Ley 99, 1993	This law creates the Ministry of Environment. In respect to disasters, one of the tasks of the Ministry is to perform studies and to follow up their advance, in order to prevent and to control disasters related to the environment such as erosion control and management of streams. These procedures must be performed in agreement with local administrations, municipal governments) in programs of land adaptation in zones of high risk.
Decree 969, 1995	The decree specifies that IDEAM will participate in the National System for Prevention and Attention of Disasters, and its role will be as a scientific and technical institution in charge of advisory. IDEAM must supply hydrological and meteorological information to regional and local institutions for planning and land use aspects.
Decree 322, 1996	This law creates the National System of Fire Brigades, which has the responsibility of prevention and attention of fires, explosions and related situations. The law regulates its functions and responsibilities, organizational aspects in the national, regional and local levels.
Ley 388, 1997	This regulation specifies the land use according to three principles: Social and ecological function, the prevailing of public interest over the private one, and the fair distribution of responsibilities and benefits. The law does not regulate aspects related to attention of disasters, but within the POTs there must be done maps of risks areas, where constructions are forbidden.
Ley 400, 1998	This law regulates the norms of design and construction of houses and buildings, materials used for construction, and procedures to follow for a seism resistant design, in order to reduce human life casualties and damages to buildings.

Source: Summarized by JICA Study Team

Since 1989, the Colombian government has applied the disaster management system from the central to the local governments. The establishment of the regional committee for the disaster management for the region will be the most important for the national system. Bogotá City and

Cundinamarca governments have developed a cooperation agreement for the disaster management area on May 22, 1999. The agreement has been limited to infrastructure and lifeline areas and is a big step toward regional cooperation between Cundinamarca and Bogotá D.C, because a disaster situation will not be limited to administrative boundaries.

According to Article 3 of Decree No 919, 1989, the National Office for the Prevention and Attention of Disasters was established within the Ministry of Interior. The National Office for the Prevention and Attention of Disasters prepared a National Plan for Prevention and Attention of Disasters, which was approved by the National Committee for Prevention and Attention of Disasters. In 1998, the plan became Decree No 93 of 1998, now it is called National Disaster Plan.

The regional level governments, Cundinamarca and Bogotá City governments have started disaster management regulations in the late 1990s. According to Law 919, 1989 as well as Agreement 11, 1987 issued by the Bogotá Council, the city government established a Fund and Coordination Office for Prevention and Attention of Emergencies, currently the Direction of Prevention and Attention of Emergencies (DPAE) of Government Secretary's Office.

According to Decree 919, 1989, the Cundinamarca government created a prefecture disaster management system by the prefecture assembly in Ordinance No 021 dated 1998 and it became a Prefecture Decree No. 3019 of 1998. The Decree stated that the prefecture disaster management system includes public sector, private sector, community organizations and non-governmental organizations. These four entities have become important in the area of disaster management.

The Cundinamarca and Bogotá City governments agreed to cooperate in the following activities: prevention, preparedness, mitigation, attention and control, recovery and rehabilitation of the areas of infrastructure affected by emergency and disasters. The fourth clause of the agreement stated that both governments agree to formulate an action program for the following aspects:

- Risk appraisal and reduction and disaster prevention on potential scenario and influenced area:
- Strengthening of implementation capacity and effective response in the case of emergency or disaster situations;
- Definition of technical, administrative and financial processes needed in order to recover and rehabilitate lifelines in a community;
- Formulation of projects and their study and implementation; and
- Development of contingency, emergency plans, establishment of an integrated information system and communication network with immediate benefit for each party.

2) Roles and Responsibilities of the Organizations

For the disaster management, the roles of the organizations are defined by Decree 919 of 1989, and are summarized in Appendix 2.5.1. The organizations, which are in charge of disaster management, can be categorized into the three administrative levels: national level, prefecture level, local level, and other governmental organizations level. In the disaster management, the other organizations such as television and radio stations, public transportation companies, medical associations, should be included in the list.

3) Fund for Disaster Management

(1) General

Budget for disaster management is regulated by the laws and regulations. There are separate funds that available for disaster and calamity or similar situations. As for the disaster prevention and mitigation, the government established funds for the national and district levels. In the study area, each government organization has established laws for the disaster management budgets. The usage of the funds is also defined at the laws and the usage of the funds are disaster prevention and mitigation. There is no permanent fund for disaster response and recovery.

The government was established a fund for disaster recovery just after the disaster has happened. It is true in case of Armenia earthquake rehabilitation. The government established *Fondo para la Reconstruccion y Desarrollo Social del Eje Cafetero*:FOREC on January 30th of 1999, just five days after the earthquake. The rehabilitation was carried out through the funds of the FOREC.

As for public services companies, the president of the republic has the responsibility to control, inspect and watch the public service entities by way of superintendent (Art.370, Constitution). Public Service Enterprises (*E.S.P. - Empresa de Servicio Público*, Art.19, Law142/1994) giving services such as drinking water, sewage, cleaning, electricity, combustible gas and telecommunication have obligation to operate continuous service with good quality regardless of their business form whether public or private (Art.136, Law142/1994). Public Service Enterprises are exempted from compensation for loss caused by interruption of service occurred by of an act of God like disasters (Art.137 Law 142/1994).

Regulation Commission of Drinking Water and Basic Sanitation (CRA), Regulation Commission of Energy and Combustible Gas (CREG) and Regulation Commission of Telecommunications watch, control and instruct the Public Service Enterprises in their tariff systems and other regulations (Art.69, Law142/1994). Superintendent of Domestic Public Services (SSPD) controls inspects and watches the Public Service Enterprises in their quality of service (Art.75, Law142/1994).

(2) Budget for the Emergency Response Organization

The budget for the emergency response organization is determined by the each organization. The amount of the disaster management related budget is limited because of the shortage of the budgets as well as low priority of the disaster management. The following shows the summary of budget for the disaster related organization.

Table 2.5.2 Summary of Budget for Disaster Prevention

(Unit: million pesos)

	2000		2001	
	Revenue	Expenditure	Revenue	Expenditure
Fund				
National Calamity Funds	9,734	9,734	6,407	6,407
FOPAE	9,972	9,972	11,888	11,888
Lifeline companies (Disaster prevention related budget)				
IDU	-	(757,899)	-	(588,517)
EAAB	1,715	1,709 (483,707)	-	1,947 (881,439)
Gas Natural	-	370	-	450
ETB	-	800	-	4,408
TELECOM	-	(346,014)		(360,888)

Note: () shows the investment budget.

Source: JICA Study Team, Data are provided by each organization

2.5.2 Review of National Disaster Management System

1) National Disaster Management Plan

The national disaster management plan includes and determines all policies, actions and programs in the disaster management in Colombia. The plan addresses the following aspects:

- Prevention, emergency response, reconstruction and development phase in connection with the different types of disasters and public calamity situations;
- Topics of economic, financial, community, juridical and institutional order;
- Education, training and community participation;
- Integrated systems of information and communication at national, regional and local levels;
- Inter-institutional and inter-sectorial coordination; and
- Necessary scientific investigation and technical studies.

The plan points out that the private sector should play an important role in disaster management and calls for the involvement of non-governmental organizations to participate in the implementation of the plan. The plan also urges prefecture and municipal governments to enact their own disaster management plans, taking into consideration the situation and development direction of the territories.

2) Organization

The national system for disaster management is composed of the following organizations:

- The National Committee for Prevention and Attention of Disasters;
- The Regional and Local Committee for Prevention and Attention of Disasters;
- The National Office for the Attention of Disasters;
- The National Technical Committee for Prevention and Attention of Disasters;
- The National Operative Committee for the Attention of Disasters;
- Ministry and Administrative Departments;
- Other governmental organizations;
- Local governments;
- The Colombian Red Cross National Society; and
- Private entities and persons who due to their purpose and functions are related to disaster management.

According to Article 52 of Decree 919, 1989, the local governments shall prepare their own disaster management systems on the basis of their situations. Each of Bogotá City and Cundinamarca governments has enacted a law for the disaster management system in each of their territories. The next section reviews the disaster management system in both territories.

3) Organizational Chart of Disaster Management System

On the basis of Decree 919, 1989, the disaster management system in Colombia can be stratified as three governmental levels: national, regional and local. The functional responsibility in disaster management can be classified as preparedness, response and recovery. The disaster management system and functional diagram in Colombia is shown as follows:

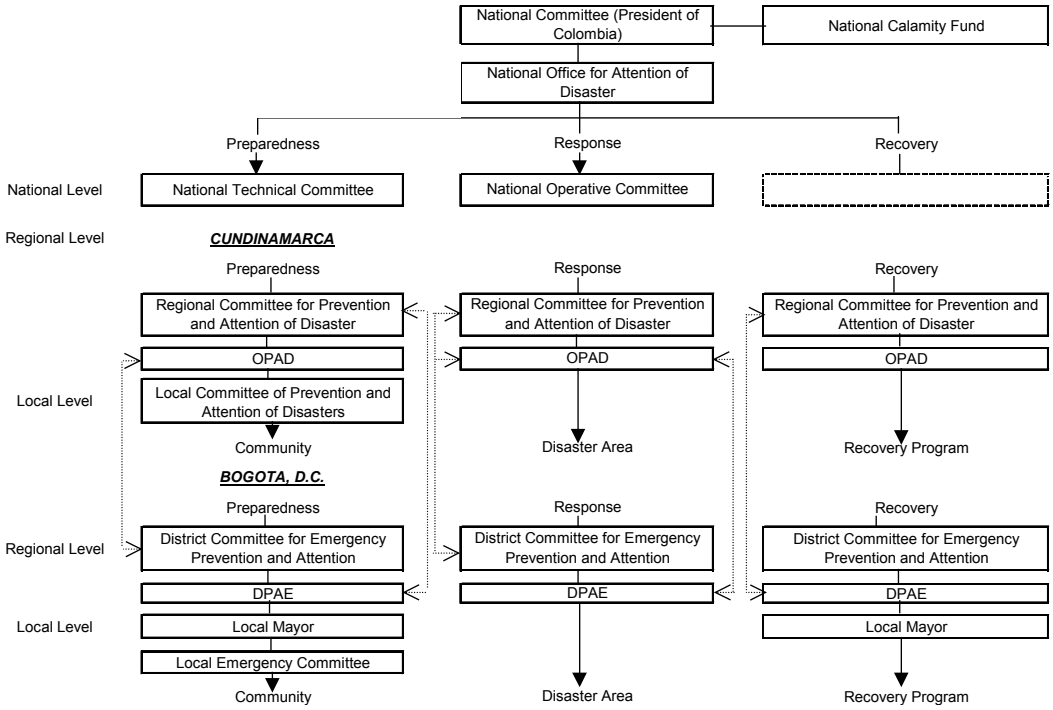


Figure 2.5.1 Disaster Management System

4) Funds for National Level

National Calamity Fund (FNC or *Fondo Nacional de Calamidades*) is an independent national budget account, with public interest and social assistance purposes, and devoted to the attention of disaster, calamity or similar situations (Art.1, Decree 1547/1884; Art.70, Decree-Law 919/1989).

Fund resources are destined to: 1) Offer economic support for the attention of declared disasters and calamities, 2) Control their effects, 3) Maintain environmental sanitation, 4) Finance the installation and operation of information systems, 5) Take the necessary steps in order to prevent disasters or mitigate its effects (Art.2, Decree 1547/1884; Art.70, Decree-Law 919/1989).

The FNC has as its sub-accounts Fond of Attention of the Displaced and National Fund of Fire Fighting, the latter of which has resources of 1 % of paid fire insurance fees (Art.2, 3, Decree 2211/1997).

2.5.3 Bogotá City Disaster Management System

1) Disaster Management Plan

There is no integrated disaster management plan in Bogotá D.C. until now, yet the Bogotá City government has enacted Decree No 723 of 1999 to regulate district disaster management system in Bogotá City.

2) Organization

Three committees compose the district disaster management system:

- District Committee for Prevention and Attention of Emergencies
- Operation, Technical and Educational Inter-institutional Committee
- Emergency Local Committee

DPAE shall play the role of coordinator and advisor of the district system.

(1) District committee for emergency prevention and attention

The district committee for the prevention and attention of Emergencies is constituted by at least 14 members from the Bogotá City government. The member list is shown in Appendix 2.5.2. The director of the District Planning of Administrative Department is the secretary of the district committee and the director of DPAE is the operation coordinator.

(2) Operation, Technical and Educational Inter-institutional Committee

A. Operation Committee

The purpose of the Operative Committee is developing a scheme of effective and coordinate response in front of an emergency arising in the Capital District, through the design and commissioning of plans, programs and projects that maximize the availability of technological, administrative, logistic, methodological and human resources. In order to raise the technical level of the respective bodies, unify the operative criteria and the procedures addressed to manage and attend the arising situations.

B. Technical Committee

Technical Committee's purpose is jointly promoting, arranging and developing projects and activities with the respective entities on the subject by increasing knowledge and treatment of threats and vulnerabilities, mitigation and monitoring of risk generating factors. It is the implementation of systems and procedures addressed to gathering, consulting and providing district information related to the issue to achieve its systematization and standardization.

C. Educational Committee

The Educational Committee's purpose is incorporating the issue of emergency prevention and attention to the culture of the inhabitants of the Capital District, through the design and put into practice of policies, strategies, plans and projects and methodologies, in coordination with district entities.

(3) Emergency Local Committee (CLE)

An emergency local committee is organized in each locality in the capital district. According to Article 26 of Decree 723 of 1999, the local mayor has the responsibility in emergency situations.

The emergency local committee is constituted by at least 12 members from local government, Bogotá City government and public service companies.

3) Emergency manual

Bogotá City government prepared the Unified System for Emergency Handling (*Sistema Unificado para Manejo de Emergencias*: SUME) in 1995. The objectives of the plan are to clarify technical and operational action criteria for the related institutions under emergency situations and to coordinate the institutional activities through institutional orders. An operational emergency committee (COE) is proposed to establish under the system and has a responsibility to provide support to the operation commander and logistical cooperation.

SUME divided the operational sections into five areas: health, security, operation, infrastructure and information. Each section in turn is divided into several sub-sections and shows a detailed procedure to follow during emergency situations.

4) Fund for the Bogotá City

The budget of FOPAE in 2001 is 11,500 million pesos for investment out of 11,888 million pesos in total. The 6,500 million pesos, 57 % of investment, are allocated to various prevention projects like relocation of housing in the menace of land slides, control of unstable slopes, and so on, under the Priority Items with slogans like "Let's be situated solidarity", "Let's make better the quarters and houses".

The 5,000 million pesos, 43 % of investment, are reserved specially for an urgent attention of disasters and emergencies, and maintained until the end of fiscal year (No.7240 project; Art.68, District Decree 1148/2000). FOPAE is only one organization that has reserve budget, though the 5,000 million pesos are just a little for 6 million inhabitants, 833 pesos per person.

However, if nothing happens and there is no utilization of this budget, the sum cannot be carried forward to the next fiscal year because of regulation (Art.13, District Decree 714/1996). It should be diverted to other investments, not always to disaster prevention programs, and again new budget will be compiled for the next year. 2,000 million pesos program the budget item for 2002, which is 60 % less than that for 2001. This budget item is not stable, depending on temporal policy for prevention and attention of disasters.

When a large disaster occurs diverting of budget will be needed. Diversion of budget without change of total sum can be done flexibly by the decision of Directive Board and approval of Secretariat of Finance. Additional budget needs accordance of Secretariat of Government, Department of Planning, Secretariat of Finance and CONFIS. The District Council for legislation as Accordance will approve the budget plan. Manifestation of Urgency case will be declared by the mayor (Art.42, Law 80/1993) and an extraordinary Council will be convoked.

2.5.4 Cundinamarca Disaster Management System

In accordance with Decree No 919, 1989, the Cundinamarca government enacted the disaster system for Cundinamarca prefecture as Prefecture Decree No. 3019, 1998. The prefecture system for the disaster management is composed of administrative, institutional and supply systems.

1) Administration

(1) Regional Committee for Prevention and Attention of Disaster of Cundinamarca Prefecture (CREPAD)

The CREPAD consists of 14 members from the government of Cundinamarca, the mayor of Bogotá City, representatives of Bogotá City government as well as of the national government. The director of OPAD is the committee's secretary. The responsibilities of the organization are disaster coordination, prevention, and operation and rehabilitation of the affected area. Under the CREPAD three commissions, namely, technical and planning, public education and information, operational and health commissions, are created to support these activities. For the technical and planning commission, the department of planning in Cundinamarca is responsible for the coordination, while public information is the responsibility of the department of education. The coordinator of the operation and health commission is in charge of the civil defense of the Cundinamarca branch.

(2) Office for Prevention and Attention of Emergencies and Disaster of Cundinamarca Prefecture (OPAD)

OPAD is under the Secretary of Government and acts as the professional resource group.

(3) Municipal Committee of Mutual Assistance for Prevention and Attention of Emergencies (CAM)

Through decree 3019 of December 11th of 1998, the Prefecture System for Prevention and Attention of Emergencies is created, as well as other issues. The third article specifies the composition and organization of the System, and makes reference to the Municipal Committee of Mutual Assistance for Prevention and Attention of Emergencies (CAM). So far, such committees have not been regulated and their objectives, mission, scope and organization have not been established.

(4) Local Committees for Prevention and Attention of Municipal Disasters (CLOPAD)

Other organizations in Cundinamarca government also take part in the prefecture disaster management system, such as the planning department in the prefecture and municipalities, commissions and the other organizations, which are related to disaster management.

2) Support organization

a) The funds allocated by the National Fund of Calamity.
b) A fund account for calamities and disasters.
c) A reserve center for emergency attention and immediate response.
d) A radio communication of prefecture network.
e) Territorial entity budgets addressed to disaster prevention and attention.
f) Emergency prefecture network.
g) Technical and material human resources addressed by the nation, the prefecture and the municipalities.

3) Emergency Response Plan

Cundinamarca government also prepared the emergency response plan with cooperation of the operational committee in CREPAD. The objective of the plan is to show the guideline and strategies under emergency situations. The plan provides guideline for procedure, institutional guideline, the resources and organization for emergency situations.

4) Fund for Cundinamarca

Calamity Fund of Cundinamarca is a special account of the prefecture government budget (Art.10, Prefecture Decree 3019/1998). Fund resources are destined to attend inherent tasks of prevention, preparation, mitigation, attention, recuperation and rehabilitation of affected areas or communities. Secretariat of Government manages the Fund, and OPAD directs, coordinates and controls the projects of the Fund. The budget of the Fund (2001) is 370 million pesos for investment out of 570 million pesos in total. There is no other project of prevention of disasters. There is no reserve budget defined to attend immediate response to disasters

2.5.5 Analysis on Key Organizations

1) National Organization

At the national level, the General Direction of National Office for the Attention of Disasters (DGPAD) is the key organization of the disaster management system. The role of the organization is to coordinate related organization at the national level. The national technical committee and the national operational committee are the most important organization for the coordination. At the regional level, the regional committee for the disaster prevention and attention is coordinated by the prefecture organization. The fund for calamity situation was created at the national level for DNPAD as well as rehabilitation of the affected area.

Since DGPAD is attached to the Ministry of Interior, approximately half of the staff comes from the ministry. The rest are working on contract bases and are paid from the national disaster fund. DGPAD intends to facilitate information networking in disaster situations and provide links

among the central government ministries and agencies, as regulated by Decree 919, 1989, but it is facing insufficient financial resource to complete the information system.

2) Direction of Prevention and Attention of Emergencies (DPAE)

(1) General

The Bogotá City government enacted disaster related law and regulation since 1987. The first step is to create fund for the disaster management system. The summary of the legal background is shown as follows:

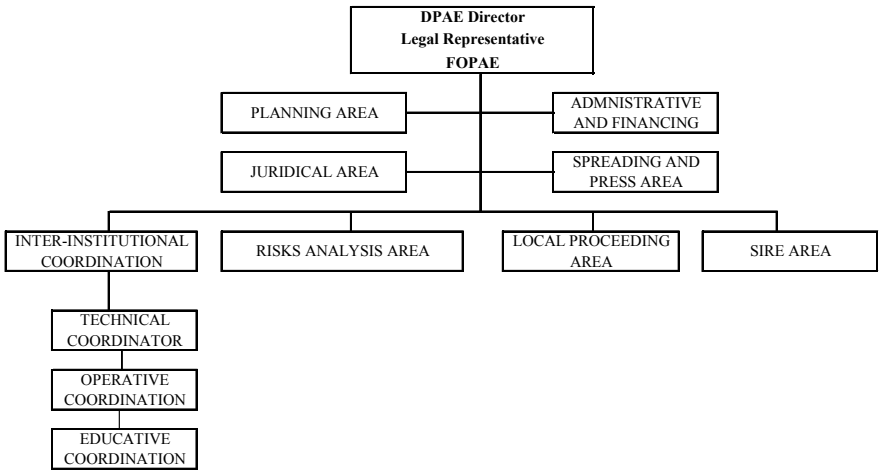
Table 2.5.3 Summary of Legal Background of DPAE

Law and regulation	Description
Agreement 11, 1987	The fund and the coordination office for the prevention and attention of emergencies were created in Bogotá City. The organization is attached to Mayor's office.
Agreement 13, 1990	According to the Agreement 11, 1987, the Agreement 13 puts into operation for the fund and organization.
Decree 652, 1990	This decree regulates the Fund of Prevention and Attention of emergencies in Bogotá.
Decree 657, 1994	This decree assigned the coordination office to carry out technical investigation of the existing risks in Bogotá City.
Decree 951, 1994	The coordination office is restructured to attach the general secretary.
Decree 382, 1995	The Unit of Prevention and Attention of Emergencies (UPES) is integrated into the government secretary's office.
Decree 485, 1996	The ownership is changed form the UPES to the government secretary.
Decree 069, 1999	By the Bogotá City's organizational change, the name is change to Direction of Prevention and Attention of Emergency (DPAE).

The objectives of both FOPAE and DPAE are summarized in Appendix 2.5.3.

(2) Organizational Chart

Since FOPAE does not have its own administrative staff, the director of DPAE is the same as the director of the FOPAE, as shown in the organizational chart of DPAE in Figure 2.5.2.



Source: Prevencion Y Atencion De Emergencias en Bogotá, D.C. 1998 – 2000, P.33 FOPAE

Figure 2.5.2 Organizational Structure of DPAE

DPAE is divided into four sections: technical sub-division, inter-institutional coordination, risk analysis, local community and SIRE, which is the disaster information network in DPAE. The inter-institutional coordination section is further divided into the technical coordination, operation and education. An organizational change is underway based on the new Bogotá City Development Plan, which is formulated in 2001.

(3) Budget and personnel

The budget allocation and spending of DPAE is shown below.

Table 2.5.4 Budget Allocation and Spending in DPAE

(Unit: Million Peso)

Descriptions	1997	1998	1999	2000
Allocation	12,359	19,165	20,099	10,013
Total expense	10,667	17,518	19,774	7,831
Operational expense	180	342	403	347
Investment	10,486	17,176	19,370	7,484
Items				
Improvement of quality of life		5,354	10,050	3,425
Safety and living together		8,553	5,673	1,613
Institutional reform		2,128	1,564	2,413

Source: DPAE

As of 2001, the personnel of DPAE are approximately 100 , yet the permanent staffs are only eight, while the others are on contract bases. The permanent staff is dispatched from the Government Secretary's Office of Bogotá. The personnel of DPAE are composed of several backgrounds (refer to Appendix 2.5.4). Approximately 30 percent of professional are a civil engineer followed by lawyer. The most predominant professional experience is five to ten years of 40 percent, followed by one to five years of 27 percent. More than 90 percent of staff is less than five years experience in DPAE.

3) Office for Prevention and Attention of Disasters (OPAD)

OPAD was established in 1995. The objective of the organization is to coordinate, plan and guide administrative requirements for the disaster prevention, mitigation, preparedness and rehabilitation phase. It also plays an important role during emergency response phase.

The functions of OPAD are regulated by Prefecture Decree No 2186, 1998, Article 12. They are as follows:

- To organize and coordinate the Prefecture system for disaster management.
- To design and advise the actions related to disaster management with reference to the national system.
- To elaborate and keep updated the information on the risk maps of the Prefecture for the contingency plan.
- To develop the knowledge and ability of the Cundinamarca officers for the disaster management; and
- To promote the activity participation and commitment for actions, programs and projects to mitigate the risks.

4) Organization

OPAD is composed of two experts and two technicians. The organizational chart of OPAD is shown below:

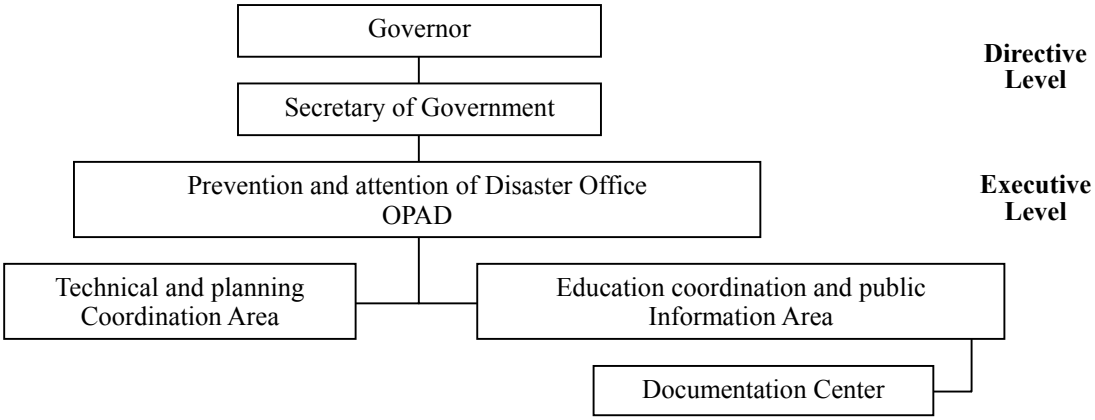


Figure 2.5.3 Organizational Chart of OPAD

The budget for disaster management is distributed among Cundinamarca government organizations.

2.5.6 Problems and Issues of the Disaster Management

1) Unclear Disaster Management Policy and Direction

According to the disaster management, Decree 919, 1989 Article 52, each territorial organization has to prepare its own disaster management plan. To cope with the national laws, the Bogotá City government established Decree 723 of 1999, regulating the disaster management system, and the Cundinamarca government established Decree No. 3019 of 1998. The establishment of laws, however, has not yet contributed in organizing the disaster management system.

DPAE has prepared the basic concepts to deal with disaster management in Bogotá City, but these have not been incorporated into the whole disaster management system. In Bogotá City a new development plan is formulated under the new mayor, and a disaster management plan should follow the concept of the City's development plan.

It is pointed out that a comprehensive disaster management plan is required to include all subjects of the disaster management system in Bogotá. It covers preparedness, emergency response, recovery and reconstruction of the disaster management and recommends program of disaster management. The general plan should prioritize policy alternative based on the disaster management plan as well as program and projects.

2) Improvement of Emergency Response Manual

The emergency response manual is only SUME in the Bogotá City government. The plan of Bogotá City, however, has not been updated since 1995, although the situations of the disaster management system in Colombia have changed recently.

Cundinamarca government also prepared the emergency response plan, which was established by OPAD. The plan is called "Regional Disaster Management System in Cundinamarca." The Regional Committee approves the plan for Disaster Management and Attention and Civil Defense of Cundinamarca.

The cooperation between Bogotá City and Cundinamarca government is little mentioned in the manual and plan. The emergency response system should be reviewed and prepared based on the seismic disaster responses, which are proposed in the Study. The new emergency response plan should consider the Bogotá Metropolitan Area.

3) Insufficient Coordination between Cundinamarca and Bogotá City

Although the Cundinamarca government and Bogotá City government reached an agreement on the disaster management treaty in 1999, the cooperation between the two governments has little progress. It is important for both of the governments, Bogotá City and Cundinamarca prefecture, to establish a coordination mechanism for the Bogotá Metropolitan Area.

2.6 Disaster

2.6.1 Earthquake

1) Existing Situation

(1) INGEOMINAS

Currently, INGEOMINAS has two seismic monitoring systems, national seismological network and national accelerograph network. The features are summarized in Table 2.6.1.

Table 2.6.1 Features of Seismic Monitoring Systems

	National Seismological Network	National Accelerograph Network	Bogota Accelerograph Network
No. of stations	20	120 (30 stations in RAB included)	30 (20 more to be installed in 2003)
No. of stations in study area	2	33 in Bogota	33 in Bogota
Initial operation	N/A	1987	1997
Data transfer	Sattelite, radio	Manually collected	Manually collected. To be connected by radio to DPAE in 2002
Instruments	Wide band 3 components, Short period vertical component	Digital 3+ components (Etna, K2, SSA-1, SSA-2)	Digital 3+ components (Etna, K2)
Object	Epicenter, Magnitude determination	Ground response, seismic design, seismic microzoning	Ground response, seismic design, seismic microzoning
Data publish	Web page, noticed to SNPAD, Red Cross, News agencies	Report, CD, partially on web page	Fully on web page
Owner	INGEOMINAS	INGEOMINAS	UPES
Data process	Automatic and manual processing at INGEOMINAS	INGEOMINAS	By contractor at DPAE
Maintenance	INGEOMINAS	INGEOMINAS, to be localized in the future	INGEOMINAS (untill 2002)

Source: INGEOMINAS, DPAE

A. National Seismological Network

a) Background

National Seismological Network of Colombia is realized by the cooperation by Canadian International Development Agency, United Nation Development Program, Colombian National Company of Telecommunications, and INGEOMINAS. It is operated by National System of Disaster Prevention and Attention to provide information to civil community as well as to scientific associations.

b) Object of Network

The objects of national seismological network are:

- To provide rapid and reliable information about Seismicity via National System of Disaster Prevention and Attention to investigator in earth science, engineers, and community in general.
- To investigate cause and process of earthquake, and to identify seismogenic zones and its potential hazard to the Colombian people.
- To study the propagation of seismic waves, its attenuation, and behavior of rocks and soils under seismic movement.
- To establish an adequate database to help the study of seismic hazard, the update of Colombian code for seismic resistant building and seismic microzonation of the cities.

c) Instrumentation and system

The network has 20 stations in total, one station of wide band three components, and 19 stations of vertical component with short period. The stations are distributed as shown in Figure 2.6.1 and listed as Table 2.6.2. The recording at each station is triggered independently.

The acquired data are transmitted to master station in Bogotá by satellite and radio telemetry in real time in digital form. Two computers, one in operative and one standing by, to secure the redundancy of a system, receive the transmitted data.

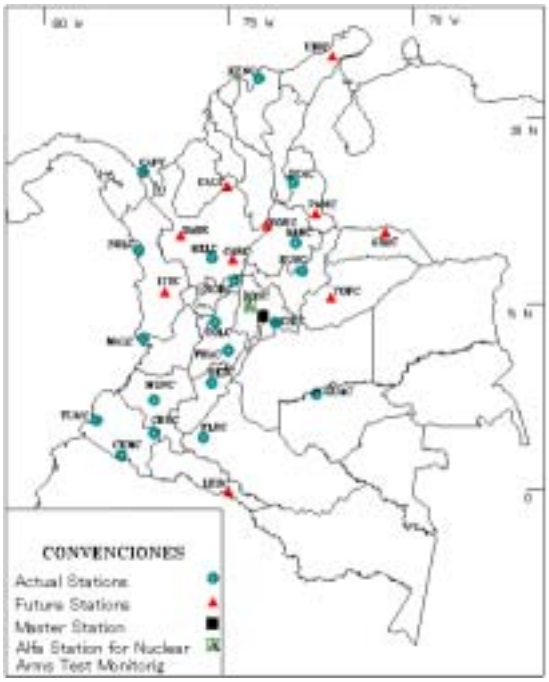
The data transmission system has a capacity of receiving 48 channels at a time. Epicenter is calculated automatically and manually. Determined earthquake locations are plotted by program HYPO71 and LOC.

The system has universal power system to prevent electricity interruption, and has power generator capable to run the system for six days by itself in case of emergency.

d) Data publishing

Determined earthquake parameters are catalogued, and then plotted epicenter distribution are published on INGEOMINAS website using web based mapping system, for a nation wide scale or department scale. Figure 2.6.2 shows an example of seismic activities in Cundinamarca during last nine years. Such information is useful to understand recent seismicity in a given region.

When a major earthquake happens, its parameters are also published on its website. Such report is also sent to related organizations such as National System of Disaster Prevention and Attention, Red Cross, and news agencies etc, to serve as basic information for disaster attention at the time of a major earthquake.



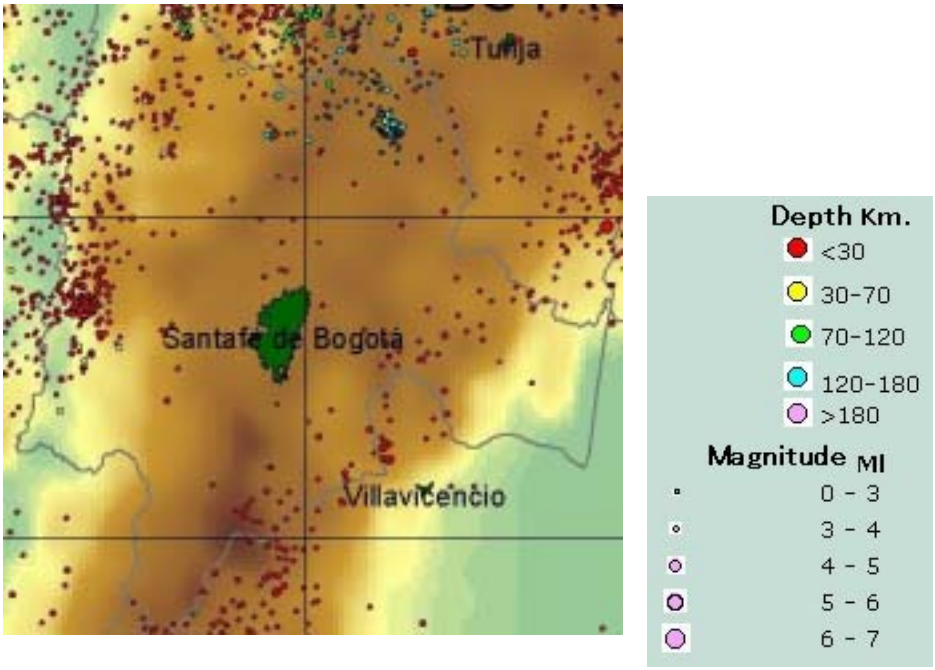
Source: INGEOMINAS

Figure 2.6.1 National Seismological Network Stations

Table 2.6.2 National Seismological Network Stations

Code	Name	Department	Lat. N	Lon. W	Height (m)
HELC	Santa Helena	Antioquia	6.23	75.55	2790
RUSC	La Rusia	Boyacá	5.93	73.08	3360
NORC	Norcasia	Caldas	5.60	74.89	510
FLOC	Florencia	Caquetá	1.51	75.63	360
MUNC	Munchique	Cauca	2.47	76.96	3010
SOLC	Bahía Solano	Chocó	6.37	77.46	50
CAPC	Capurganá	Chocó	8.30	77.20	50
ROSC	El Rosal	Cundinamarca	4.86	74.33	3020
CHIC	Chingaza	Cundinamarca	4.63	73.73	3100
GUAC	San José del Guaviare	Guaviare	2.60	72.68	200
BETC	Betania	Huila	2.68	75.44	540
KENC	Cerro Kennedy	Magdalena	11.11	74.05	2560
OCAC	Ocaña	N. Santander	8.20	73.40	1200
CUMC	Cumbal	Nariño	0.86	77.84	3420
CRUC	La Cruz	Nariño	1.50	76.95	2740
TUMC	Tumaco	Nariño	1.83	78.77	50
BARS	Barichara	Santander	6.64	73.18	1860
PRAC	Prado	Tolima	3.70	74.90	410
TOLC	Nev. Tolima	Tolima	4.59	75.34	2520
MALC	Bahía Málaga	Valle	4.10	77.35	50

Source: INGEOMINAS



Source: INGEOMINAS

Figure 2.6.2 Seismicity in Cundinamarca during June, 1993 to April, 2001

B. National Accelerograph Network

a) Development of network

Motivated by the tragedy by volcanic eruption of Nevado del Ruiz in 1985 that killed over 20,000 lives, members in INGEOMINAS proposed installations of seismological and accelerograph stations in 1987 in order to study, to prevent, and to mitigate natural disasters.

In 1987, INGEOMINAS took charge of maintenance of 18 out of 24 analogue existing accelerograph in Colombia. In 1993 the project of Colombian national accelerograph network had started under the support of National Foundation of Calamity via United Nations Development Program and INGEOMINAS.

In the beginning, INGEOMINAS, which is in charge of the project, purchased 35 digital accelerographs and installed 17 stations in lines of east west. In 1994, rest of 18 stations was installed in northeastern part of the country. During 1995, five more complementary stations were installed.

The network had recorded major earthquakes such as Tauramena earthquake (ML=6.5) in January 19 1995, and Calima earthquake in February 8, 1995 (ML=6.2). In 1996, 52 digital accelerographs (ETNA) were purchased.

b) Objects of network

The objects of national accelerograph network are the followings:

- To record intensive earthquakes in Colombian territory by operation and maintenance of national network and portable network.
- To offer processed earthquake information to serve as basis of seismic hazard study in national level
- To provide necessary information to maintain and update parameters for Colombian seismic resistant design code for construction
- To promote study of seismic microzonation in local level

c) Instrumentation of network

The national accelerograph network has currently 120 stations in total, among which 30 exists in Bogotá operated under conventions with DPAE. Besides, there are 22 accelerographs in Medellín and 5 in Pereira operated by another entities.

The instruments of National accelerograph are products of KINEMETRICS, such as SSA-1, SSA-2, and SSA-2MC with resolution of 12 bits, ETNA with resolution of 18 bits and K2 with resolution of 19 bits. ETNA and K2 has a PCMCIA memory card of 1 to 5 Mbytes capacity for recording.

The instrument at one station costs approximately 10,000 USD, and installation of housing costs about 1,000 USD.

Among them, at Tumaco station along the pacific coast, a piezo meter is included with the system so that it can record the change of pore water pressure during possible liquefaction phenomena.

d) Service of network

The national accelerograph network provides services as followings:

- To publish annual bulletins of strong motions with information of accelerogram and response spectra.
- To realize study of aftershock of intensive earthquake through operation of portable accelerograph network.
- To realize a study to evaluate the effect of ambient vibrations different from earthquake.
- To realize a study of microtremor to characterize dynamic properties of subsoil for the study of seismic microzoning.

- To satisfy consultation for scientific community, college students, universities, community in general.
- To install local networks.

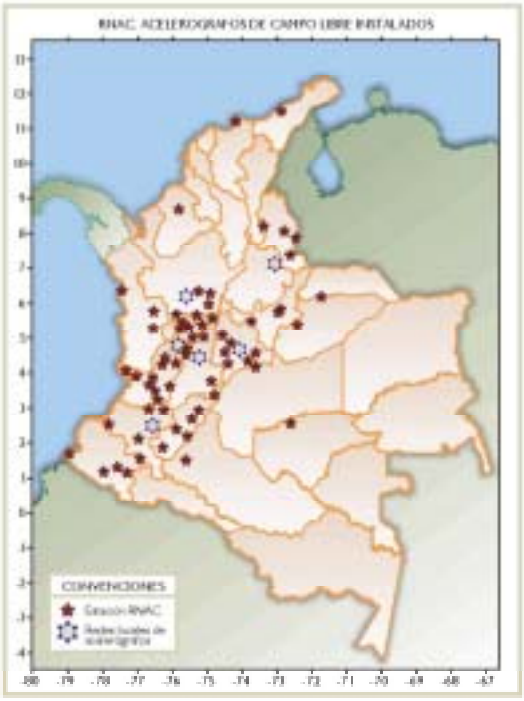
The national Accelerograph Network Stations are shown in Figure 2.6.3, and those in Cundinamarca are listed in Table 2.6.3.

e) Records of network

The observed records are processed and published in its printed report; "Bulletin of strong motion" Recorded data are also available in digital form. There are three volumes published since 1993. Major events are also published in its web site.

f) Maintenance of network

INGEOMINAS maintains all the stations by themselves in every four months, spending four hours per stations by specially assigned staffs.



Source: INGEOMINAS

Figure 2.6.3 National Accelerograph Network Stations

Table 2.6.3 National Accelerograph Network Stations in Cundinamarca Department

No	Stration name	Station code	Model	Lat. N	Lon. W	Geology	Topography	Owner
1	ANAPOIMA	CANAP	ETNA	4.586	-74.518	Rock	Waved	INGEOMINAS
2	ARBELAEZ	CARBE	ETNA	4.280	-74.430	Rock	Waved	INGEOMINAS
3	BOGOTA, INGEOMINAS	CBOG1	K - 2	4.642	-74.080	Rock and soil	Plane	INGEOMINAS
4	GAVIOTAS	CBOG2	ETNA	4.640	-74.080	Colluvion	Waved	INGEOMINAS
5	EMBALSE DE CHINGAZA (Galería)	CCHIN	ETNA	4.554	-73.631	Rock	Tunnel	INGEOMINAS
6	EMBALSE DE FÚQUENE	CFQNE	ETNA	5.472	-73.739	Rock	Waved	INGEOMINAS
7	GUADUAS	CGUAD	ETNA	5.065	-74.590	Rock	Waved	INGEOMINAS
8	QUETAME	CQUET	SSA - 2	4.328	-73.861	Rock	Waved	INGEOMINAS
9	EL ROSAL	CROSA	ETNA	4.848	-74.326	Rock	Waved	INGEOMINAS
10	EMBALSE SAN RAFAEL (Túnel)	CSRA1	SSA - 1	4.704	-73.986	Rock	Tunnel	EAAB
11	EMBALSE SAN RAFAEL (Cresta)	CSRA2	SSA - 2	4.737	-73.986	Soil	Plane	EAAB

Source: INGEOMINAS

(2) DPAE

Since 1997, DPAE began installation of accelerograph in Bogotá by convention with INGEOMINAS. DPAE's netowork is part of national accelerograph network.

A. Object of network

The objects of the network are followings:

- To register earthquakes felt near Bogotá.
- To process and analyze the recorded information
- To compare the result with the study of seismic microzoning in Bogotá
- To establish a database for the organization of recorded information

B. Instrumentation

The distribution of stations together with geotechnical zone is shown in Figure 2.6.4. The location and its characteristics of each station are listed in Table 2.6.4.

Two stations have simultaneous observation system at ground surface and borehole.

Among them, six stations have GPS clock system to assure the absolute timing in the record. Clock at other stations are calibrated at the time of maintenance.

C. Maintenance

Maintenance of the network is currently done once in every four months by INGEOMINAS through convention with DPAE. However, by the time the convention expires in 2002, DPAE will be likely to have its responsibility of maintenance.

D. Obtained records

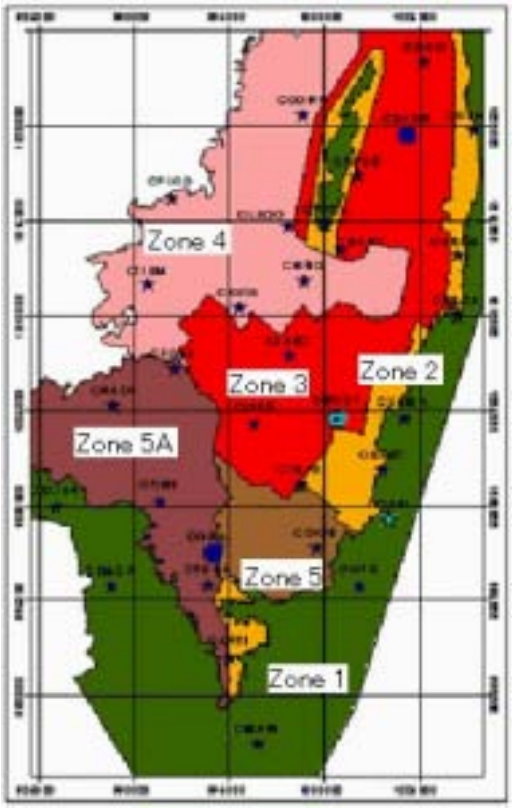
Since its installation in 1997, the network has recorded 66 records of 17 earthquakes as shown in Table 2.6.5. The magnitude of recorded events varies from 4.43 to 6.35, and epicenter distance varies from 45 to 499 km. There records are published in SIRE, a web site for DPAE.

E. Subsoil study at stations

Two stations have borehole study during the period of microzoning study of Bogotá in 1997, to study shear wave velocity of subsoil.

INGEOMINAS executed microtremor measurements at all the accelerograph sites in Bogotá. They then compared predominant period of microtremor with predominant period of the 20 sites obtained from 32 earthquake records during the period from 1994 to 2000.

The result of comparison is illustrated in Figure 2.6.4 according to the geotechnical zone defined in MZSB97. The predominant period varies from 0.2 second to 1.2 second, which reflects the thickness of subsurface soil. The predominant period of microtremor and that of earthquake has a good correlation in general, which shows the usefulness of microtremor measurement to evaluate the predominant period of ground.



Source: INGEOMINAS

Figure 2.6.4 Location of Accelerograph in Bogotá and Geotechnical Zone

Table 2.6.4 Location and Characteristics of Accelerograph Stations in Bogotá

No.	Station name	Code	Lat. N	Long. E	Geology	Geotechnical zone*	Topography	Model
1	Escuela de Ingeniería	CEING	4.7833	-74.0458	Soil	3	Plane	ETNA
2	Universidad La Salle	CUSAL	4.7559	-74.0264	Soil	2	Plane	ETNA
3	Colegio Fernando Mazuera	CBOSA	4.6066	-74.1920	Soil	1	Plane	ETNA
4	Universidad Corpas	CCORP	4.7617	-74.0940	Soil	4	Plane	ETNA
5	Universidad Agraria	CUAGR	4.7542	-74.0527	Soil/Rock	3	Plane	K-2
6	Academia de Policía	CPSUB	4.7379	-74.0726	Rock	2	Waved	ETNA
7	Colonia Escolar de Usaquén	CUSAQ	4.7064	-74.0332	Soil	2	Plane	ETNA (GPS)
8	Escuela de Caballería	CESCA	4.6822	-74.0332	Soil	1	Waved	ETNA
9	Banco de La República	CBANC	4.7085	-74.0791	Soil	3	Waved	ETNA
10	T.V. Cable	CTVCA	4.7181	-74.0848	Rock	1	Waved	ETNA (GPS)
11	Parque La Florida	CFLOD	4.7295	-74.1464	Soil	4	Plane	ETNA
12	Avianca	CAVIA	4.6858	-74.1190	Soil	4	Plane	ETNA
13	Fontibón	CFONT	4.6607	-74.1454	Soil	5A	Plane	ETNA
14	Centro de Estudios del Niño	CNIÑO	4.6962	-74.0932	Soil	4	Plane	ETNA
15	Jardín Botánico	CJABO	4.6665	-74.0993	Soil	3	Plane	ETNA
16	Colegio San Bartolomé	CBART	4.6205	-74.0620	Rock	1	Waved	ETNA
17	Universidad Manuela Beltrán	CUNMA	4.6415	-74.0563	Soil	1	Waved	ETNA
18	Hospital San Juan de Dios	CDIOS	4.5899	-74.0888	Soil	5	Plane	ETNA (GPS)
19	CITEC	CCITE	4.6395	-74.1131	Soil	3	Plane	ETNA (GPS)
20	Club El Tiempo	CTIEM	4.6943	-74.1558	Soil	4	Plane	ETNA
21	Parque Timiza	CTIMI	4.6084	-74.1511	Soil	5A	Plane	ETNA
22	Parque El Tunal	CTUNA	4.5753	-74.1313	Soil	5A	Plane	ETNA
23	Escuela de Artillería	CARTI	4.5468	-74.1234	Soil	2	Plane	ETNA
24	Bomberos La Marichuela	CMARI	4.5117	-74.1171	Soil	1	Plane	ETNA
25	Colegio Sierra Morena	CSMOR	4.5746	-74.1701	Rock	1	Waved	ETNA
26	Escuela de Tejedores	CTEJE	4.6149	-74.0951	Soil	5	Plane	ETNA (GPS)
27	Tanques de Vitelma	CVITE	4.5750	-74.0716	Soil	1	Waved	ETNA
28	Colegio Laureano Gómez	CLAGO	4.7180	-74.1003	Soil	4	Plane	ETNA (GPS)
29	Escuela General Santander	CGRAL	4.5881	-74.1301	Soil/Rock	5A	Plane	K-2
30	Radionet	CRADI	4.6465	-74.1694	Soil	5A	Plane	ETNA
National Network								
1	Bogotá, INGEOMINAS	CBOG1	4.6418	-74.0803	Soil/Rock	3	Plane	K-2 (GPS)
2	Gaviotas	CBOG2	4.6014	-74.0599	Coluvión	1	Waved	ETNA
3	Juan	CJUAN	4.7050	-74.1200	Soil	4	Plane	ETNA

* Geotechnical zone accroding to Seismic Microzoning in Bogota, 1997

Source: SIRE

Table 2.6.5 Recorded Earthquakes by Accelerograph Network of Bogotá

No.	Date	Time (GMT)	Earthquake	Magnitude (Ml)	Depth (km)	Lat. N	Lon. E	Hipocenter Distance (km)*	Epicentral Distance (km)*	No. of recorded stations
1	1999/1/25	18:19	Córdoba (Quindío)	6.2	0	4.44	-75.71	182.6	182.6	4
2	1999/1/25	22:04	Córdoba (Quindío)	5.4	0	4.41	-75.73	187.0	187.0	1
3	1999/4/14	7:26	Nido de Bucaramanga	6.13	170	6.82	-73.14	313.9	263.8	2
4	1999/5/15	10:20	Pulí (Cundinamarca)	4.82	18.74	4.67	-74.75	76.9	74.5	1
5	1999/6/1	21:42	Guayabetal (Cundinamarca)	5.21	0	4.29	-73.73	50.4	50.4	4
6	1999/6/10	3:22	Quetame (Cundinamarca)	4.67	2.04	4.31	-73.79	45.9	45.9	1
7	1999/7/17	12:23	Sativasur (Boyacá)	5.59	0	6.1	-72.74	206.2	206.2	7
8	1999/11/8	5:52	Betulia (Santander)	6.51	160	6.92	-73.18	302.2	256.4	21
9	2000/1/17	12:21	Fortul (Arauca)	5.87	1.06	6.64	-72.02	319.2	319.2	1
10	2000/2/5	21:53	Nido de Bucaramanga	6.02	160	6.77	-73.21	289.1	241.0	3
11	2000/5/24	1:05	Pulí (Cundinamarca)	4.43	0.64	4.76	-74.67	66.9	66.9	1
12	2000/9/12	10:55	Nido de Bucaramanga	5.92	160	6.76	-73.18	289.3	241.0	3
13	2000/11/8	7:01	Juradó (Chocó)	6.35	1.25	7.13	-77.94	499.2	499.2	3
14	2000/11/24	19:51	Nido de Bucaramanga	5.69	160	6.79	-73.02	297.9	251.3	2
15	2000/12/17	6:14	Nido de Bucaramanga	5.82	152.82	6.77	-72.97	294.1	251.2	9
16	2001/5/3	16:14	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1
17	2001/5/18	15:04	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2
	Total									66

* Minimum distance to stations

Source: SIRE

Source: "Period de vibracion fundamentales del suelo, en las estaciones de la Red de Accelerografos de Bogotá", 2001, Samuel Alexander et. al.., INGEOMINAS

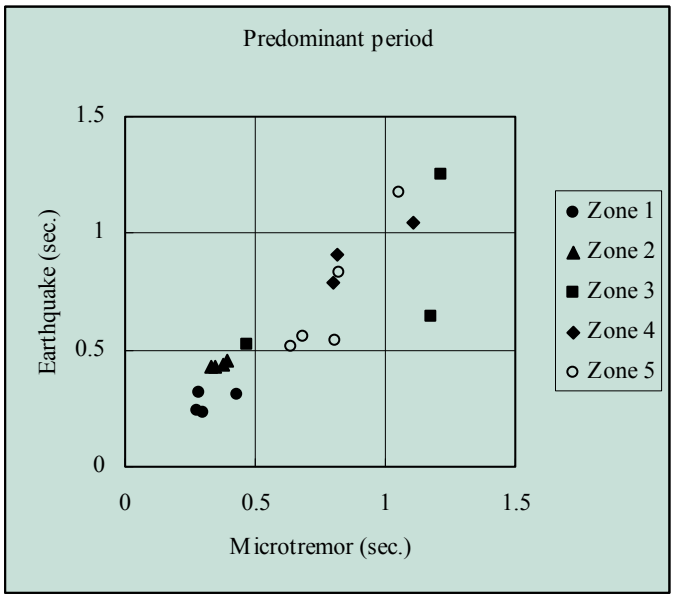
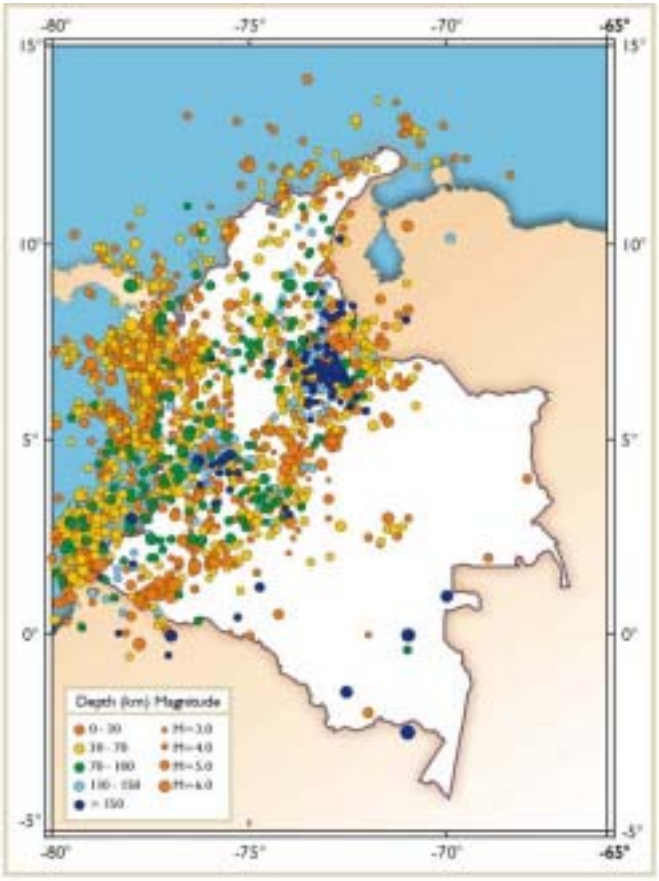


Figure 2.6.5 Comparison of Predominant Period of Microtremor and that of Earthquake

2) Seismicity in Colombia

Seism city in Colombia is high due to its tectonic environment. Figure 2.6.6 shows distribution of epicenters of the selected earthquakes that occurred between 1500-1994.



Source: Microzonificacion sismica de Bogotá City, INGEOMINAS, 1997

Figure 2.6.6 Distribution of Epicenters in Colombia from 1500-1994

In Colombia, two types of earthquakes should be taken into account. One is the inter-plate earthquake generated from subduction movement between the Nazca plate and the South American plate. This type of earthquake is expected to have a Magnitude around 8, thus it would affect an extensive area of Colombia. The focal depth of these events deepens from west to east, reflecting the subduction of the Nazca plate beneath the South American plate.

The other type is an intra-plate earthquake, which is generated from faults within the plate. Active or potential faults exist elsewhere in Colombia as a result of tectonic settings. Due to intra-plate seismic activities for the active faults along the Cordillera Oriental, the seism city in the eastern part of Colombia is as high as the coastal area. Even if the magnitude of event for this type is relatively small, it can be damaging due to the short distance from the fault to major urban area.

3) Seismcity in the Study Area

Figure 2.6.7 and Table 2.6.6 shows a list of major seismic events that have affected Bogotá since its foundation in the sixteenth century.

Bogotá has experienced ground shaking of MSK intensity[2-6-1] VIII three times and VII four times. In this sense, the recurrence period for Bogotá of event having intensity VIII is from 42 years to 90 years, whereas for the event with intensity VII is from 44 years to 97 years.

Source: Microzonificación sísmica de Bogotá City, INGEOMINAS, 1997

Figure 2.6.7 Epicenters of Major Earthquakes that have Affected Bogotá

[2-6-1] MSK intensity VII: 50 gal - 100 gal; MSK intensity VIII: 100 gal - 200 gal

Table 2.6.6 List of Major Earthquakes that have Affected Bogotá

Year	Month	Date	Latitude	Longitude	Maximum Intensity	Intensity in Bogotá	Epicentre
1616	2	--	5.00	74.00	VII		Cajicá
1644	1	16	7.40	72.70	IX	VI	Pamplona
1644	3	16	4.50	74.00	IX		Chipaque
1646	4	3	5.70	73.00	VIII		Sogamoso
1743	10	18	4.40	73.90	VIII	VII	Páramo de Chingaza
1785	7	12	4.70	73.80	IX	VIII	Páramo de Chingaza
1826	6	17	4.80	73.90	VIII	VII	Sopó
1827	11	16	1.90	75.90	X	VIII	Timaná
1917	8	31	4.26	74.15	IX	VIII	Páramo de Sumapaz
1923	12	22	4.40	73.20	VIII	VII	Paratebueno
1924	1	7	4.70	73.50	VIII		Gachala
1928	11	1	5.50	71.50	VII		El Milagro
1967	2	9	2.93	74.00	IX	VII	Los Cauchos
1967	7	29	6.84	74.09	VIII	VI	Chucurí

Source: Microzonificación sísmica de Bogotá City, INGEOMINAS, 1997

4) Mitigation measures currently done

As described in the next chapter, Bogotá municipality completed the first seismic microzoning study conducted in Colombia in 1996 including rough risk analysis. The result of the study has been published in various media such as booklet, video and web page for the purpose of educating the public. However, due to the limitation of finance, its circulation is rather limited.

Further, University of Los Andes has extended risk study for infrastructures such as gas pipelines, roads and hospitals for the emergency preparations.

Besides, DPAE will have a network of 30 strong motion observation stations in Bogotá within the next five years. The network will, once completed, greatly contribute to the knowledge of seismic response within Bogotá, and provide information for emergency response activities in the event of a major earthquake in the future.

2.6.2 Landslide

1) General

Landslide is a form of slope disasters. Generally, there are three forms of slope disasters as follows:

Landslide: Rotational and translational movement of soil and rock mass.

Flow: Movement of soil or weathered rock in surface, including rapid movement such as debris flow.

Fall: Fall or collapse of rock mass from steep slope.

Although these forms of slope disasters are called landslide in this Study, they, however, are usually distinguished in a narrow sense.

Damages common to landslides are the collapse or serious deformation of buildings, structures or facilities due to the external force caused by the landslide. Sometimes buildings, structures or facilities are buried underneath tons of earth or loses much of their function.

On the other hand, rock falls, debris flows and slope collapses tend to connect with human loss or casualties. Therefore, there is a need to consider some different characteristics of damage of slope disasters by their forms.

In this Study, a survey on landslide hazard areas has been conducted for the eight municipalities in Cundinamarca prefecture based on the existing survey results of Bogotá City that was carried out by 1998. A supplemental survey of landslide disasters occurred after 1998 and an assessment of the landslide hazard areas were carried out for Bogotá City in order to prepare basic materials for the preparation of disaster prevention plan for the Bogotá Metropolitan Area.

2) Existing Situation

Landslides in Bogotá are generally distributed at steep slopes in the eastern part of the Bogotá, which are generated due to the Bogotá fault, according to the material of *Prevencion y Atencion de Emergencias en Bogotá*, D.C./1998-2000 (FOPAE) (see Appendix 2.6.1).

Such material as mentioned above was not accumulated for the eight municipalities in Cundinamarca. Outlines of the slope hazard areas which have been surveyed, are summarized below.

(1) Bogotá

There is evidence of landslide on the slopes of the eastern and southern areas. Many of the landslide events are located at the wasted quarries, but not many on the natural slopes. The slopes are covered by residential buildings, but the main portions of the slopes causing landslides are natural slopes.

(2) Chía

Evidence of landslides distributes at the slopes of Majuy mountain located in the suburbs of Chia. The slopes are formed by fault and relatively steep but gradual at the foot of the slopes due to detritus. No slope and evidence of landslides are found in the urban area.

(3) Cota

Cota is the city next to Chia. No slope and evidence of landslide are found in the urban area. But evidence of landslide distributes at the east side slope of Majuy mountain. There are quarries in operation and wasted quarries at the foot of the slopes.

(4) Facatativá

Earth flows of small scale exist at a small hill located in the east of the urban area. Same scale of earth flows is identified at El Aserradero Hill in the south but there is no protective facility due to the presence of pasture area.

(5) Funza

There is no slope in the city.

(6) La Calera

There is evidence of earth flows on both the slopes along the Teusaca River, which flows northward in the urban area.

Landslide areas are scattered at both the slopes along the Blanco River located at the eastern part of the city. There are some wasted quarries, from which houses are located far.

(7) Madrid

There is no slope in the urban area. There is no prominent evidence of landslide at Majuy mountain because it becomes low at the northern part of the city.

(8) Mosquera

There is no slope in the urban area and no prominent evidence of landslide at the slopes of Las Lajas and Terreros mountain. However, there are slope hazard areas, where residential buildings are located at the wasted quarries in the southern part of the city.

(9) Soacha

The slope collapse hazard areas are found at the wasted quarries at Lajas Hill in the vicinity of the southern urban area. In January 2000 a landslide occurred at the north west end of Terros Hill, located near at the boundary of Bogotá City, and houses are gathered in the upper area close to the landslide hazard area.

There are large scale quarries along the Soacha River and there some houses exist.

3) Historical Record of Landslides

A historical record of environmental disasters in Cundinamarca in the past (1923-1997) shows that the highest events in number are of inundation and followed by that of landslide, according to "*Catalogo de desastres ambientales de Cundinamarca Gobernacion de Cundinamarca*, INGEOMINAS, 1997" (refer to Table 2.6.7).

Table 2.6.7 Human Damage due to Ambient Disaster in Cundinamarca (1923-1997)

		Human damage		
Event type	No. of event	Dead	Injured	Affected
Earthquake	68	40	107	915
Innudation	248	16	18	514,931
Flood	57	82	28	5,933
Fire	46	8	1	1,550
Contamination	11	0	0	0
Landslide	121	783	33	9,719
Hurricane	20	4	13	2,001
Dries	16	0	0	0
Tempest	60	13	7	795
Total	647	946	207	535,844

Source: Catálogo de desastres ambientales de Cundinamarca Gobernación de Cundinamarca, INGEOMINAS, 1997

However, the events of landslides claimed 82 % of the total casualties. The victims of landslides in the past (1923-1997) were mainly caused by slope collapses and falls at the wasted quarries. But only one victim is recorded due to the landslide in the last five years. Therefore, present disaster prevention manner is considered advanced with the improved communication and the systematic measures, unlike in the past where there was a shortage of them.

Landslides due to earthquake has not been an issue in the past five years including the 1999 Quindío earthquake, but it is to be considered that a landslide occurs in an earthquake, depending on the distance from the epicenter or the scale of the earthquake.

Due to the slope disasters currently observed in Bogotá, most of them were caused by landslides, secondary rock fall and flows (refer to Table 2.6.8). However, risk of disaster potential by rock fall and flows is higher than the other forms of slope disaster.

Table 2.6.8 Investigation of Disaster Activity in Bogotá

	Landslide	Fall	Flow
Disaster of potential	16	27	3
Historical disaster	267	55	36
total	283	82	39

Source: Result of the Study

The relation between precipitation and landslides is anticipated, but a quantified relation is not yet established due to insufficient observation data of precipitation. Precipitation gauges have been installed to cover the southern part of Bogotá City since October 2000. As a result of the investigation during the Study, it is found that 282 landslide events were considered to be caused by precipitation and 238 landslide events caused by human factors (refer to Table 2.6.9). The

most prominent human factor is infiltration of sewerage, which is considered to be responsible for 175 landslide events. It means groundwater to be related with the landslide events.

Table 2.6.9 Trigger of Disaster in Bogotá (1996-2001)

Trigger			Historical disaster	Disaster of potential
Natural factor			281	33
	Earthquacke		0	0
	Rain		282	33
		Erosion	64	22
		Saturation of groundwater	38	3
		unknown	189	10
Human factor			238	21
		Deforestation	49	5
		Discharge of water	176	11
		Excavtion	121	9
		Overload	28	0

Source: Result of the Study

Table 2.6.10 shows that San Cristobal has been suffered from many landslides and earth flows and Rafael Uribe has been suffered from many rock falls. Table 2.6.11 shows heavy human damages and structural damages in terms of high numbers of injured people and collapsed houses. About 70% to 80 % of the slope disasters are due to landslide and those due to rock fall follow (refer to Table 2.6.12).

Table 2.6.10 Disaster Events of Each Locality in Bogotá

Disaster type	Locality								total
	Usaquen	Chapinero	Santa fe	San Cristobal	Usme	Suba	Rafael Uribe Uribe	Ciudad Bolivar	
Landslide	22	16	47	64	35	8	47	44	283
Fall	15	6	8	7	7	0	28	11	82
Flow	3	1	4	20	6	0	5	0	39
total	40	23	59	91	48	8	80	55	404

Source: Result of the Study

Table 2.6.11 Damage or Protection Object in Bogotá

		Historical Disaster	Disaster of Potential
Damage of Life		98	2
	Death	1	0
	Injuring	97	2
Damage of Structures		225	3
	House	200	2
	Road	37	0
	Aquaduct	5	0
	Sewer System	7	0
	Bridge	0	0
	Energy	9	0
	Other	0	1

Source: Result of the Study

Table 2.6.12 Recent Change of Disaster Type in Bogotá

Year	Landslide	Fall	Flow	Total
1996	18	1	1	20
1997	19	18	1	54
1998	53	23	12	80
1999	110	25	15	139
2000	53	12	9	71
2001	8	2	1	8
Toal	261	81	39	372

Source: Result of the Study

4) Mitigation Measures

(1) Present status of the countermeasures against landslide disaster

In San Martin, houses were relocated from near and around the scarp and the concrete spraying has been done at the scarp in order to secure stability and to use the area as a park. Also, the houses at the foot of steep slopes along the upstream valley have been relocated. Table 2.6.13 shows the number of affected families in Bogotá City from 1998 to 2000. As shown in the table, it is understood that the relocation is the main portion of the prevention work. The prevention cost per family is 4.9 million pesos and the cost related with relocation is 8.8 million pesos, which includes the costs for detailed investigation, demolition, construction and other expenses.

Table 2.6.13 Recent Change of Relocation of Families in Bogotá

Year	site number	Landslide	Fall	Flow
1996	0	0	0	0
1997	5	5	0	0
1998	19	10	5	4
1999	54	42	8	4
2000	27	20	3	4
2001	1	1	0	0
Total	103	74	16	13

Source: Result of the Study

As mentioned above, DPAE conducted an investigation and evaluation of the present stability of the slopes in highly hazard areas where many people have already lived. DPAE also exerted effort to judge whether relocation is necessary or not by the evaluation result. It was somewhat easy for DPAE to obtain information on landslide in the initial stage from the inhabitants and the early information facilitated taking appropriate measures in the early stage.

Table 2.6.12 and 2.6.13 show the recent numbers of disasters and hazard areas as well as number of families necessary to be relocated respectively, which are tabulated by the JICA survey.

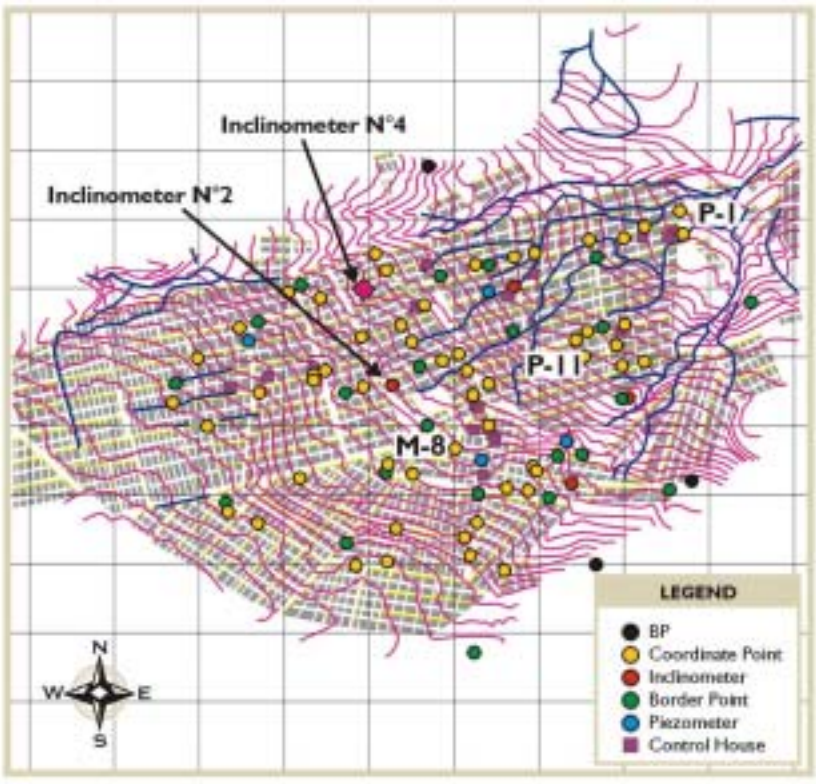
Also, it is considered that relocation of houses is more economical than implementing countermeasures at the hazardous sites. It is obtained by comparing Tables 2.6.12 and 2.6.13 that almost one-third of countermeasures pertain to relocation.

(2) Discussion of countermeasures for landslides

Although a monitoring system is not installed or operated, people near dangerous landslide areas could predict, to some extent, the occurrence of a landslide at an early stage. If the information were announced to the organization concerned, the proper countermeasures would be implemented. The recognition of hazard areas is the main activity taken in the present mitigation measures.

A landslide hazard map of Bogotá City prepared by DPAE shows three risk levels, shown in Appendix 2.6.1. During the Study landslide hazard area map has been prepared for the eight municipalities through the site survey, but a simple hazard map indicating the name or location instead of showing hazardous areas.

Measures and evacuation can be performed in Bogotá City before a landslide disaster, because the city has many experiences of landslide disasters and recognizing any unusual changes of slopes can be relatively done at an early stage due to the overlap of hazardous slopes and urban area (refer to Appendix 2.6.1 and Figure 2.6.8). But the main point is to raise the inhabitant's concern with landslide disasters, which prevails over installation of much monitoring equipment.



Fuente: Pagina inicial de DPAE

Figure 2.6.8 Landslide Monitoring Site Map (Ciudad Bolivar Carbonera)

(3) Present status of slope monitoring

In Bogotá City, monitoring equipment has already been installed at four landslide areas where accumulated movement was recognized and monitoring has been performed at around 15days interval. But the criteria for warning or evacuation are not yet made.

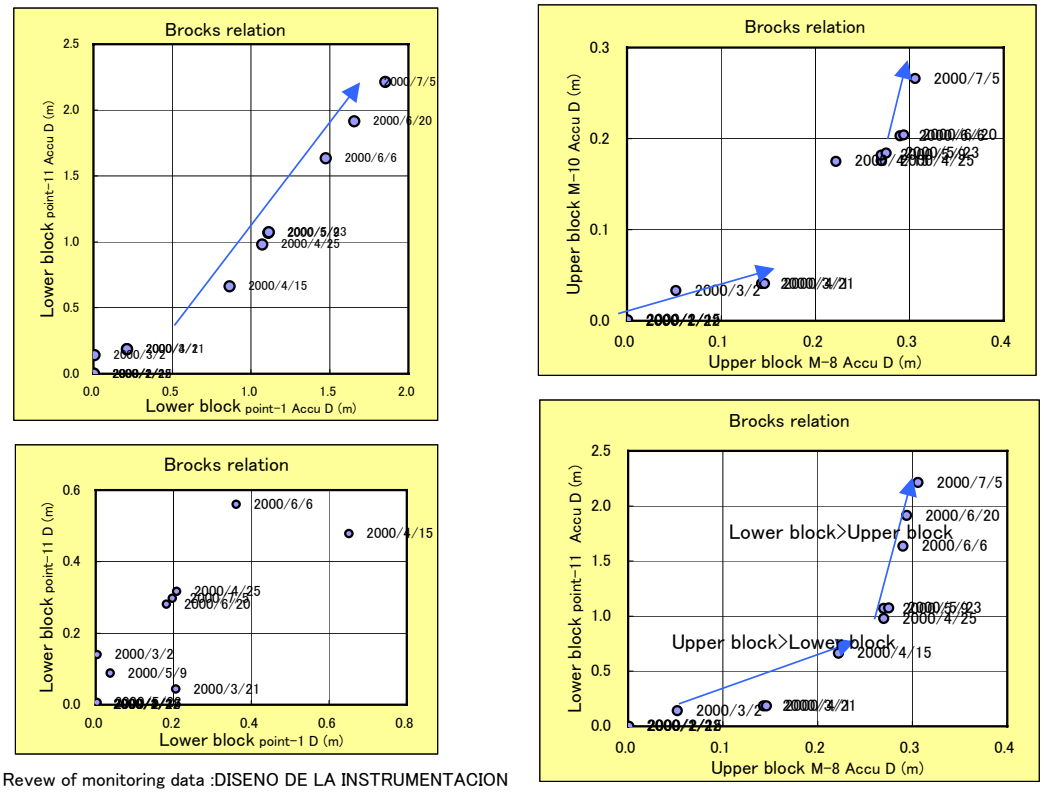
Movement of land began at Carbonera in Ciudad Bolivar in 1997 and houses were removed as the result of detailed investigation. Movement of 2m was confirmed at the monitoring in 2000. It is understood that movement of upper soil block stimulates that of lower soil block by analyzing the relative movement of both soil blocks in relation to time (refer to Figure 2.6.9 and Table 2.6.14) The behavior of landslide is evaluated well by proper analysis of monitoring data in such a manner as mentioned above.

Table 2.6.14 Review of Landslide Monitoring Data Analysis in Ciudad Bolivar Carbonera

	Lower block point-1 (m)			Lower block point-11 (m)			Upper block M-8 (m)			Upper block M-10 (m)		
Date	D	Accum D?	Accum D	D	Accum D?	Accum D	D	Accum D?	Accum D	D	Accum D?	Accum D
2000/1/22	0	0	0	0	0	0	0	0	0	0	0	0
2000/2/2	0	0	0	0	0	0	0	0	0	0	0	0
2000/2/15	0.003	0.002	0.003	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
2000/3/2	0.004	0.006	0.007	0.14	0.106	0.141	0.051	0.05	0.052	0.032	0.032	0.033
2000/3/21	0.206	0.141	0.213	0.044	0.138	0.185	0.091	0.053	0.143	0.008	0.024	0.041
2000/4/1	0.001	0.142	0.214	0	0.138	0.185	0.003	0.051	0.146	0	0.024	0.041
2000/4/15	0.651	0.384	0.865	0.478	0.433	0.663	0.076	0.028	0.222	0.134	0.154	0.175
2000/4/25	0.208	0.61	1.073	0.317	0.688	0.98	0.048	0.072	0.27	0.001	0.152	0.176
2000/5/9	0.037	0.642	1.11	0.088	0.776	1.068	0	0.072	0.27	0.006	0.148	0.182
2000/5/23	0.004	0.639	1.114	0.006	0.781	1.074	0.005	0.076	0.275	0.002	0.146	0.184
2000/6/6	0.361	1.074	1.475	0.56	1.235	1.634	0.015	0.063	0.29	0.019	0.152	0.203
2000/6/20	0.182	1.284	1.657	0.281	1.465	1.915	0.004	0.062	0.294	0.001	0.153	0.204
2000/7/5	0.197	1.521	1.854	0.298	1.714	2.213	0.012	0.059	0.306	0.062	0.107	0.266

D:differential deformation Accum D?:accumuration deformation? Accum D:accumuration deformation

Source: Revew of monitoring data : Diseño de la Instrumentación para el Monitoreo y Seguimiento del Deslizamiento en la Cuenca de la Quebrada la Carbonera ,UPES, Agosto, 2000.



Revew of monitoring data :DISENO DE LA INSTRUMENTACION PARA EL MONITOREO Y SEGUIMENTO DEL DESLIZAMIENTO EN LA CUENCA DE LA QUEBRADA LA CARBONERA ,UPES,Agosto,2

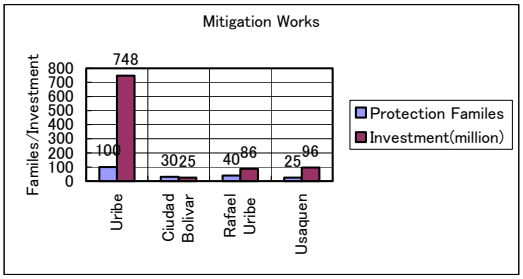
Compiled by JICA study team

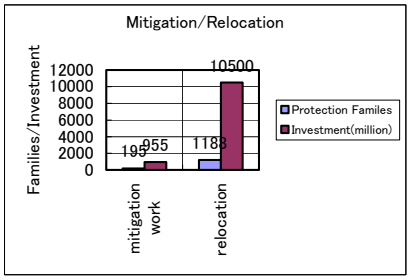
Figure 2.6.9 Upper and Lower Block Movement Traced from Landslide Monitoring Data in Ciudad Bolivar Carbonera

In other places, no criteria for alert and evacuation are established for slope monitoring. Monitoring places are very few in contrast to many dangerous places. Moreover monitoring system itself is considered to be at the testing stage and therefore is not introduced into proper disaster countermeasure system.

Table 2.6.15 Investment of Mitigation Works and Relocation in Bogotá (1998-2000)

	mitigation work(1998-2000)					relocation(1998-2000)
Locality	Urib	Ciudad Bolivar	Rafael Uribe	Usaquen	total	Bogota
Protection Familes	100	30	40	25	195	1188
Investment(million)	748	25	86	96	955	10500
I/F	7.5	0.8	2.2	3.8	4.9	8.8





Source: Prevencion & atencion de emergencias en Bogotá,D.C./1998-2000"Por la Bogotá que Queremos"

2.6.3 Flooding

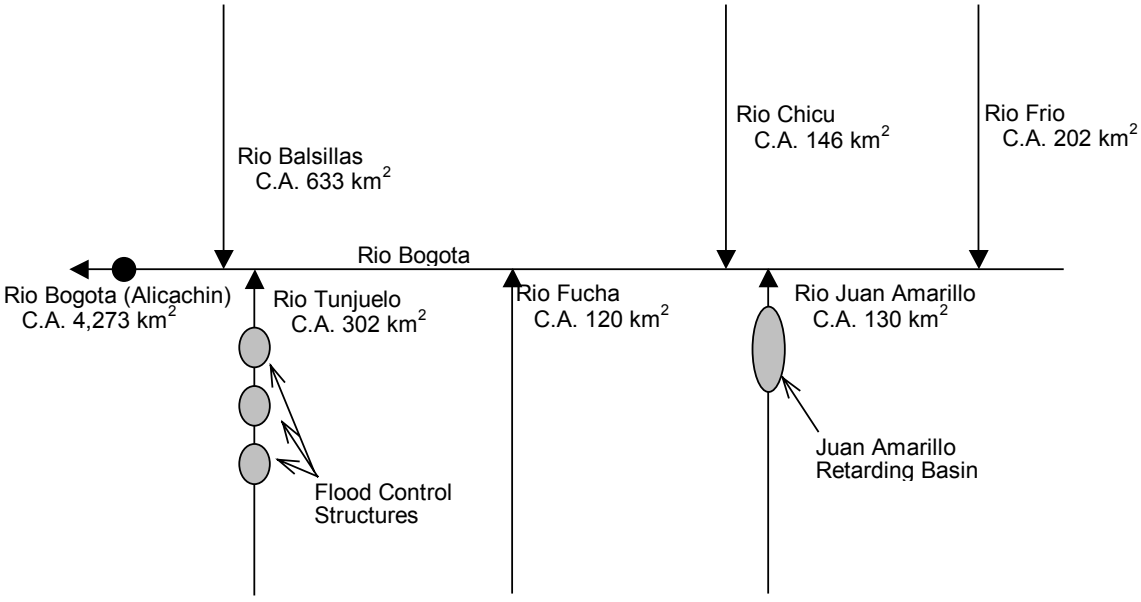
1) River Systems

The largest river in the Study Area is the Rio Bogotá and the area is mostly covered by this catchment. The catchment area of the river at the Alicachín Gate, which is at downstream of Soacha city, is approximately 4,273 km^2. The river flows with a mild slope of less than 1/5,000 near Bogotá City.

Three major tributaries, namely the Rio Juan Amarillo, the Rio Fucha and the Rio Tunjuelo, flow into the Rio Bogotá from the eastern side (Bogotá City area) of the Study Area. All the tributaries have a steep slope near the mountainous area of the city and it changes to a very mild of less than 1/1,000 near the junction of the Rio Bogotá.

Other major tributaries, such as the Rio Furio, the Rio Chicu and the Rio Balsillas are flows into the Rio Bogotá from the western side.

Figure 2.6.10 presents a schematic river system of the Rio Bogotá in the Study Area.



Source: Study Reports of DPAE and EAAB [2-6-2]

Figure 2.6.10 Schematic River System of Rio Bogotá in the Study Area

[2-6-2] Estudios Hidraulicos Geotecnicos y Topograficos para Definir el Nivel de Los Jarillones y Obras Requeridas para Mitigar el Riesgo de Inundacion del Rio Bogotá, en el Tramo Alicachin Humedal la Conejera, Hidroestudios, EAAB

Zonificacion de Riesgo por Inundacion del Rio Bogotá y Propuesta de Acciones para su Mitigacion en la Localidad de Bosa, Mayo 1999, Estudios y Asesorias

Estudio de Zonificacion de Amenaza por Inundacion del Rio Fucha en las Localidades de San Cristobal, Kennedy y Fontibon y Recomendaciones de Mididas de Mitigacion, Abril 2000, Hidroconsulta, FOPAE

Zonificacion de Riesgos por Inundacion del Rio Juan Amarillo, Marzo 1999, Hidrotec

For the management of the Rio Bogotá there are many entities related, but no entity managing it as a river basin. The left bank (East side or Bogotá city side) is under the management of the Bogotá city and EAAB, and the right bank (West side or Cundinamarca side) is under CAR, the municipalities related and Cundinamarca prefecture. It shall be important to arrange or establish an entity for managing water environment of the Rio Bogotá basin, considering the situation of water resources and water quality.

2) Present Flood Situation

The present flood situations of the cities to be studied are summarized in the following Table 2.6.16.

Table 2.6.16 Summary of Flood Situation

	Causes of Problem			Remarks
	by Rio Bogotá (or mainstream)	By tributaries	By poor drainage system	
Bogotá	Yes	Yes	Yes	No overflow from Rio Bogotá is reported since 1976.
Chía	Yes	No	Yes	Rio Frio had a problem before improvement.
Cota	No	No	-	
Facatativa	Yes (Rio Botello)	No	Yes	Less capacity of the river and building construction in low-lying area causes inundation problem.
Funza	No	No	Yes	Problem is a difficulty of drainage to Rio Bogotá.
La Calera	No	Yes (Qda. Toma)	No	The causes of the inundation by Qda. Toma is inappropriate treatment of stream course.
Madrid	No	No	-	
Mosquera	Yes	Yes	Yes	Illegal origin housing has been developed in low-lying area along Rio Bogotá.
Soacha	No	Yes	Yes	No overflow from Rio Bogotá is reported, however, dike of the river was damaged and inundated in 1998.

(1) Rio Bogotá

No severe flood damage along the Rio Bogotá has been reported since 1976. During the 1976 flood, the floodwater overflowed near the junction of the Rio Fucha.

Social and economic activities are mainly concentrated in the eastern side, Bogotá City side, and a small part of the western side (e.g. Porvenir) at present, while the land use is mainly pasture and/or agricultural land, so that the flood damage has a tendency to be concentrated to Bogotá City side.

(2) Tributaries flows through Bogotá City

A. Río Juan Amarillo

The downstream part of the river (Santa Cecilia) suffers from flood and inundation problems. The area suffered from floods from the overflowing of the Rio Juan Amarillo, however, even after construction of a dike, the drainage problems remained.

The water level at the downstream of the river is affected by the water level of the Rio Bogotá. Accordingly, dikes have been constructed along the river based on the floodwater level of Rio Bogotá. Some parts of the dikes have been damaged by illegal farming and informal settlements.

There is no flood problem in the upper reach from Cra.91, because the river has already been improved.

At the junction of the Rio Salitre and Rio Negro, where the riverbed slope changes from steep to gentle, periodic dredging is necessary to prevent the rising of riverbed by sedimentation, which might be a cause of inundation.

There are many tributaries, which flow into the urban area of Bogotá . Currently no record of flood or debris flows from those tributaries, but they should be studied because they have possibilities of flashfloods and debris from the geomorphologic conditions.

B. Rio Fucha

The upper reach from Ave. Boyacá of the Rio Fucha has been improved and has no flood problems.

In the downstream from Ave. Boyacá some areas suffer from floods from the river. The main cause is lack of the flow capacity at the bridge of Ave. Cali. The bridge is currently being improved, so that the problem would be solved in near future. The other cause of inundation is a lack of drainage capacity of the drainage system.

In the most downstream, near the junction to the Rio Bogotá, several development projects are on going. It is supposed that the area naturally retards the flow of water. With consideration of this situation, the EAAB instructed the developers to construct a drainage system as one of the conditions of permitting the development. Therefore, both wastewater and stormwater drainage system including the provision of pumping stations, discharging to the Rio Bogotá, have been constructed and the area has not been suffering from inundation so far.

Also in the this basin there are many tributaries, which flow into the urban area of Bogotá . They should be studied because they have possibilities of flashfloods and debris from the geomorphologic conditions.

C. Rio Tunjuelo

Among the three tributaries, the Rio Tunjuelo has the most severe flood problems. In 1996, the river overflowed at San Benito and flooding occurred widely. According to interviews with local residents at San Benito, the floodwater overtopped near the junction of the Rio Tunjuelo and the Rio Chiguaza, where the river had lower dikes. Average duration and depth of inundation were 8 days and more than 50 cm respectively.

(3) Other cities

According to the Government of Cundinamarca, the inundation problems have been reported in five cities, namely Facatativa, Mosquera, Chia, La Calera and Soacha at present.

Since the dike at the western side of the Rio Bogotá is mostly higher than that of the eastern side, Bogotá City side, and the areas are mostly used as farmland/pastures, there has been no severe flood damage.

A. Facatativá

The Rio Botello is mostly of natural stream and some reaches along the river have suffered from floods. Though there are no discharge data because no hydrological analysis has been carried out, the discharges of the river are not supposed to be a big amount at flood because of the following:

- The river is less than 10 m in width.
- A small bridge constructed in the 19th century still exists without any major damage.

According to interviews and field investigation, the main causes of the floods are the small conveyance capacity of the river channel and clogging at the small bridge by driftwood and garbage. The flood areas are limited at the area along the river, but flooding is of short duration.

B. Mosquera

Flood damages were reported at Porvenir, which is located along the Rio Bogotá. A dike was constructed along the Rio Bogotá, but the illegal farming and informal buildings on the bank have damaged and lowered the dike locally. The overtopping during floods occurred at the weak points of the dike, but there are no serious problems.

C. Chía

The Rio Frio flows through the city and usually caused flooding. However, flooding problem has not been reported since10 years ago when the river was improved.

There are some small flood areas reported in the low-lying areas along the Rio Bogotá, however, there are no serious problems because the area is not utilized much.

D. La Calera

The severe inundation problem has only been reported along the Qda. Toma. The area has been suffering from inundation almost every 5-years and the last one occurred in 1999.

Qda. Toma has no flow except when having heavy or continuous rainfall and has rather small flow area in the downstream. Many houses are located just beside the stream course and usually affected by flash flood during rainy season.

At the most downstream part, the stream goes into pipe culvert with the diameter of approximately 1 m, and discharged into Rio Teusacá.

The inundation problem usually occurred at the inlet of pipe culvert and at the bridge just upstream of the inlet. The bridge was improved after the 1999 flood and the pipe culvert also try to improve after the event of 1999. However, because of the uncontrolled housing development, the natural course of the downstream of Qda. Toma has been blocked and the stream could not be improved.

E. Soacha

The problems of the city are mainly due to the poor drainage system. However, the Rio Soacha, one of the small tributaries of the Rio Bogotá with smaller flood conveyance capacity, overflows usually during rainy season and causes inundation problem.

No overflowing from the Rio Bogotá is reported, however, the river water flowed into residential areas along the river from the weakened part of the dike in 1998.

3) Existing River Structures

(1) Flood mitigation structures

A. Río Bogotá

The Rio Bogotá has dikes on both sides in the major part of the Study Area. The dikes were constructed by CAR from 1980 to 1981 with a probable flood of once in 10-year to prevent floods from the river, as an urgent improvement project for the river after the 1976 flood.

After completion of the project, some parts of the dikes have been heightened by landowners along the river and also have been damaged locally by farming and informal settlements. That has caused the differences of dike crest elevation locally, which caused different safety levels along the river against floods.

B. Río Tunjuelo

The Rio Tunjuelo has dikes on both sides along most part of the channel. The river has three Flood Control Structures (FCS) with retarding basins to regulate the flood discharges at the

middle and lower reaches. The structure is like a small dam, having box culverts for ordinary discharges and a spillway for excess discharges. These structures are planned to regulate the maximum discharges. The outlines of the structures are shown in the following Table 2.6.17 and Figure 2.6.11.

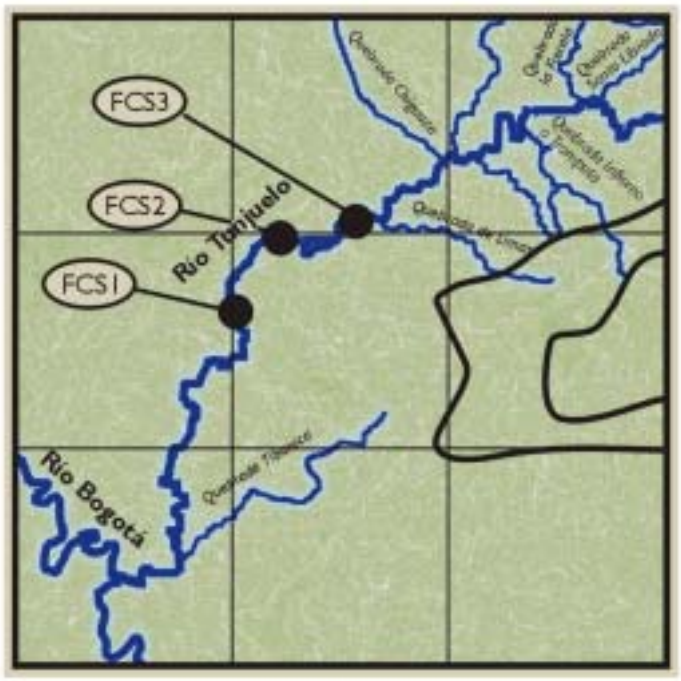


Figure 2.6.11 Location of Flood Control Structure

Table 2.6.17 Summary of Flood Control Structures in Rio Tunjuelo

	No. 1	No. 2	No. 3
Bottom Elevation (masl)	2,580.96	2,577.40	2,573.93
Crest Elevation (masl)	2,587.00*	2,583.00	2,582.00
Size and Nos. of Box Culvert	2.65 m x 2.65 m x 4 nos	2.80 m x 2.80 m x 4 nos	2.15 m x 2.15 m x 3 nos
Reservoir Capacity (m^3)	964,000	265,000	1,084,000

Source: DPAE study

* Estimated figure from the study report of DPAE

C. Río Fucha

The Rio Fucha has been improved with dikes and revetment along the mid-stream to upstream, however, in the lower part only poor earth dikes exist.

D. Río Juan Amarillo

Most part of the downstream of the river forms an earth channel with dikes, having a height of about 2 m, because the area is affected by floodwater of the Rio Bogotá.

The river has been improved in the upper part from Cra. 91. The channel downstream from the junction of the Rio Negro and the Rio Salitre has been improved as a compound cross section with dikes. Salitre box culvert system, which conveys the urban wastewater generated in the northern part of Bogotá City to Salitre Wastewater Treatment Plant, was also constructed under the riverbed, as shown in Figure 2.6.12.

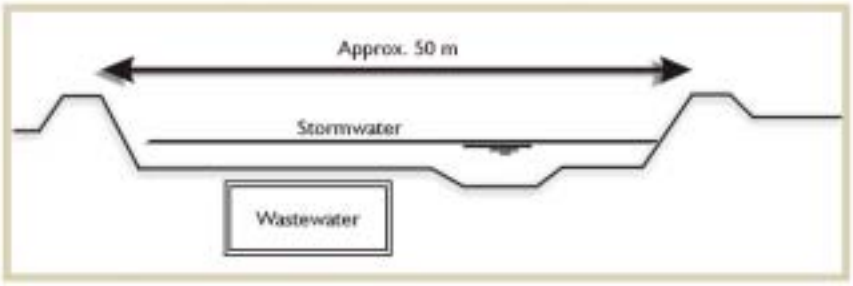


Figure 2.6.12 Cross Section of Rio Juan Amarillo/Salitre Box Culvert System

Embalse Salitre (Salitre Retarding Basin), which is located at the downstream of Cra.91 and planned to regulate the flood discharge to the Rio Bogotá, is now under construction. The retarding basin will regulate the probable flood discharge of once in 100-year.

(2) Other river structures

A. Alicachín hydropower intake

Two radial gates with a height of 10.88 m were installed in the mainstream of the Rio Bogotá at Alicachin hydropower intake, the downstream limit of the river for the Study, to take the river water for hydropower generation. In order to keep the pump efficiency (average pumping capacity: 43 m^3/s), the water level of the river is kept to an elevation of 2,539.24 m. The influence of these gates is estimated to reach approximately 15 km upstream of the river[2-6-3].

The gates are operated not to exceed the water level mentioned above to avoid drainage problems in the upper reach.

[2-6-3] Estudios Hidraulicos Geotecnicos y Topograficos para Definir el Nivel de Los Jarillones y Obras Requeridas para Mitigar el Riesgo de Inundacion del Rio Bogotá, en el Tramo Alicachin Hanedal La Conejera, Hidroestudios, EAAB

B. Salitre wastewater treatment plant

Salitre Wastewater Treatment Plant was constructed in 2000 at the junction of the Rio Juan Amarillo to the Rio Bogotá. The plant has a floodgate to avoid the floodwater of the Rio Bogotá into the Canal Salitre, which is constructed parallel to the Rio Juan Amarillo.

C. La Regadera dam

La Regadera Dam is located at the most upstream of the Rio Tunjuelo. The earth-fill dam was constructed in 1938 to supply water to Bogotá City and the reservoir capacity is 3,300,000 m^3. Since the dam was designed and constructed in the 1930s, it is said that an assessment of its seismic safety was recently conducted.

4) Existing Flood Mitigation Plans

(1) Bogotá City

A. Río Bogotá

EAAB carried out a study and has concluded that the most effective river improvement work for the Rio Bogotá is a combination of the widening (relocation of left dike from the existing position to 30 m behind the existing river bank, with excavation) and heightening of the dike by 3 m to have a conveyance capacity of the probable flood of a 100-year return period.

B. Tributaries

All major tributaries are planned to be improved to a scale of 100-year return period flood and some have already been improved.

(2) Eight municipalities

No active flood mitigation plans exist for the 8 municipalities.

2.6.4 Industrial Facilities

1) Existing Situation

Bogotá City and the eight municipalities in Cundinamarca have been investigated and reviewed as follows.

(1) Bogotá City

A. Potential technological threads

The survey and information gathering from companies that handle (producing, transforming, manipulating, storing and using) chemical substances, located in Bogotá City, was conducted by FOPAE-DPAE in 1999. Distribution of the potential technological thread in each locality of Bogotá City is shown in Table 2.6.18.

The selected systems were mainly found in the localities of Puente Aranda, Fontibón, Kennedy, Enqativá, Barrios Unidos and in lower rate in Usaquén, Los Mártires and Suba. These eight localities have 78% of the systems totally, since these localities count with identified industrial development zones.

Most of the selected systems are constituted by small companies (almost 80% are micro and small), according to the size classification criteria based on the gross assets reported by the Chamber of Commerce.

Table 2.6.18 Distribution of the Potential Technological Threat in Each Locality of Bogotá City

Locality	Total no. of entities		System with 4 types of hazard	System with 3 types of hazard			System with 2 types of hazard		System with 1 type of hazard		
	No	(%)	S,L,F,E	S,L,F	S,F,E	L,F,E	S,F	F,E	S	L	F
Usaquén	106	6.1	8	12	26		25	1		8	26
Chapinero	41	2.3	5	4	14		5			6	7
Santa Fe	20	1.1	5	4	9				1		1
San Cristobal	17	1.0	3	1	7		1				5
Usme	8	0.5			7						1
Tunjuelito	71	4.1	5	17	13		2	1	28	2	3
Bosa	37	2.1	8	7	11		3	1	1	4	2
Kennedy	161	9.2	15	14	42	1	29			15	45
Fontibón	205	11.7	46	15	51		31	4	1	14	43
Engativá	161	9.2	22	27	40		25			7	40
Suba	104	6.0	8	16	30		24			11	15
B. Unidos	132	7.6	13	21	34		28		1	16	19
Teusaquillo	79	4.5	14	15	23		20			3	4
Los Mártires	104	6.0	12	13	23		25			6	25
A. Nariño	58	3.3		5	14		16		2	1	20
Puente Aranda	390	22.3	39	41	78		71	6	1	34	120
La Candelaria	5	0.3			4		1				
R. Uribe	32	1.8	2	2	10		8			3	7
C. Bolívar	16	0.9	1		3		4		2		6
Total	1,747	100	206	203	439	1	318	13	35	130	389

Legend: S: Spill L: Leak F: Fire E: Explosion
Source: "Identificación, Evaluación y Análisis de Amenazas de Origen Tecnológico en el Distrito Capital" by FOPAE-DPAE

B. Accident investigation

The analysis was carried out about the accidents occurred in Bogotá City, related to spills, leaks, fires and explosions that had an impact on the community, the environment and properties. Distribution of the technological accidents from 1979 to 1998 in Bogotá is shown in Table 2.6.19.

- The activities or systems that registered a higher occurrence of events and magnitude were: the production and sale of gunpowder, transport, production of glues, restaurants, natural gas system, service stations, textile industry and a deposit of non identified chemical

residues. These activities are considered of high risk by the nature of the substance handled and the characteristics of the processes (Chemical industry).

- The most highlighted dangerous materials in the events by their frequency and impact were: gunpowder (including Christmas hot air balloons), propane, gasoline, ammonia, solvents, natural gas, chloride and hydrochloric acid.

  Firefighters, CISPROQUIM, industries and the police respectively are the entities that had greater participation in the response to these events.

Table 2.6.19 Distribution of the Technological Accidents from 1979 to 1998 in Bogotá City

Locality	Accident		Type of Accident						
	Number	(%)	L	S	F	E	F/E	F/S	L/S
Usaquén	14	7	1	0	9	3	1		
Chapinero	8	4	2	0	5	1			
Santa Fe	24	12	1	1	19	3			
San Cristobal	6	3	1	1	1	3			
Usme	0	0	0	0	0	0			
Tunjuelito	8	4	1	1	6	0			
Bosa	6	3	1	1	3	1			
Kennedy	22	11	1	2	13	2	2	1	1
Fontibón	11	5	0	2	6	1	2		
Engativá	9	4	2	1	6	0			
Suba	11	5	3	1	4	2	1		
Barrios Unidos	6	3	2	1	2	1			
Teusaquillo	9	4	2	1	5	1			
Los Mártires	8	4	2	1	5	0			
Antonio Nariño	3	1	0	0	1	2			
Puente Aranda	19	9	1	2	13	3			
La Candelaria	10	5	0	0	7	3			
Rafael Uribe	11	5	1	0	4	5	1		
Ciudad Bolivar	5	2	0	2	0	3			
Locality Not Identified	14	7							
Total	**204**	**100**	**21**	**17**	**109**	**34**	**7**	**1**	**1**

Legend: S: Spill L: Leak F: Fire E: Explosion
Source: "Identificación, Evaluación y Análisis de Amenazas de Origen Tecnológico en el Distrito Capital" by FOPAE-DPAE

(2) Eight municipalities

A. Potential technological threats

The information gathering from each company that handles chemical substances according to type of economic activity, chemical substances handled, processes and hazardous reactions involving heat, number of employees, prevention and emergency preparedness, seismic prevention measures, organization, training and generation of industrial residues, was carried out via the survey strategy using filled out forms. Distribution of the potential technological thread in each municipality is shown in Table 2.6.20. The characteristics of each municipality in terms of potential technological threat in summarized in Table 2.6.21.

Table 2.6.20 Distribution of the Potential Technological Threat in Eight Municipalities of Cundinamarca

Municipality	Total Number of Companies		System Type 4	System Type 3		System Type 2		System Type 1	
	No	(%)	S,L,F,E	S,F,E	L,F,E	S,F	F,E	S	F
Chia	46	12.7	3	1	0	37	0	4	1
Cota	28	7.7	2	0	1	18	0	7	0
Facatativa	29	8.0	3	1	5	15	0	3	2
Funza	70	19.3	9	3	9	28	0	11	10
La Calera	14	3.8	1	0	1	12	0	0	0
Madrid	44	12.1	9	3	2	26	1	2	1
Mosquera	15	4.1	5	4	1	4	0	1	0
Soacha	117	32.3	5	8	17	64	0	11	12
Total	**363**	**100**	**37**	**20**	**36**	**204**	**1**	**39**	**26**

Source: Study on the Prevention of Industrial Disasters in the Bogotá Metropolitan Area (2001) by JICA and CCS

Table 2.6.21 Potential Technological Threat in the 8 Municipalities

Municipality	Description
Chía	- The most representative systems in Chía, in terms of numbers, were construction materials (37%), service stations (24%), retail paint (13%) and agricultural chemicals (11%); the rest individually form 2% or less of the total, and most with only one establishment per system. - The Chía sample was mostly (over 90%) composed of micro-enterprises.
Cota	- The most representative systems of the Cota evaluated sample by number of establishments are the service stations (27.7%), the retail commerce of chemical products for farming use (20.7%), the manufacture of manure and inorganic compounds (10%), the flower-growing (percentage?) and the retail commerce of paints (7%); the remaining systems are dispersed and they do not even represent 4% of the sample on their own. Moreover, majority of them hardly has one establishment per system. - Small companies and micro-companies (86%) mainly constituted the evaluated sample in Cota.
Facatativa	- The systems with higher representation by the number of establishments in the evaluated sample correspond, in their order, to: flower cultivations (20%), wholesale commerce of propane gas (14%) and gasoline service stations (14%); the other systems (12) have one or two companies at most. - Small and micro-companies constituted most of the sample evaluated in Facatativá (more than 90%).
Funza	- The most representative systems by number of enterprises sampled were retail construction materials (13%), warehouses (8%), retail agricultural chemicals (6.7%) and manufacture of plastic products (6.7%). The rest individually did not account for more than 3% of the sample, and most only had one or two enterprises per system. - The Funza sample is mostly small and micro-enterprises (94%).
La Calera	- The most representative systems of the La Calera evaluated sample, due to the number of establishments, are the retail construction material businesses (50%) and retail agrochemical businesses (29%); the remaining systems are dispersed and most barely have 1 establishment per system. - The La Calera evaluated sample was totally made up by micro businesses.
Madrid	- Most representative systems for the number of stores of evaluated sample correspond to flower crops (15.6%), retail construction material businesses (11.2%), retail chemical products for farming and animal husbandry use businesses (11.2%), gasoline service station (9%) and retail paint businesses (6.8%); the remaining systems are dispersed and by themselves do not represent even 3% of the total sample. And most thereof barely have one establishment per system. - The Madrid evaluated sample was mainly constituted by small companies and micro-companies (78%).
Mosquera	- Most representative systems for the number of establishments of evaluated sample correspond to preparation of ready-to-eat food for animals (3 companies representing 20%) and wholesale business of raw material for the chemical industry (2 companies representing 13%); the remaining systems barely have one establishment. - The Mosquera evaluated sample was mainly constituted by small companies (40%) and micro-companies (33%). From samples evaluated from all municipalities, Mosquera had the greatest proportion of medium-sized and large-sized companies (27%), with the medium-sized (20%) having the greatest weight.
Soacha	- The most representative systems in terms of numbers within the sample were retail paints (21%), retail propane gas in bottles or cylinders for household distribution (10%), service stations (7.6%) and manufacture of plastics products (7%). The other 33 systems were represented by one or two enterprises only. - Over 90% of the Soacha sample is small or (particularly) micro-enterprises

B. Accident analysis

The analysis was carried out about the accidents related to spills, leaks, fires and explosions that have had an impact in the community, the environment and properties. Distribution of the technological accidents from 1989 to 2001 in the eight municipalities is shown in Table 2.6.22.

Table 2.6.22 Distribution of the Technological Accidents from 1989 to 2001 in Eight Municipalities of Cundinamarca

Municipality	Emergencies		Type Of Event					
	Quantity	%	L	S	F	E	S/F/E	E/F
Chía	2	8		1		1		
Cota	0	0						
Facatativá	2	8		2				
Funza	5	20	2	1		1	1	
La Calera	0	0						
Madrid	0	0						
Mosquera	2	8	1			1		
Soacha	11	44	8	1	1			1
Fontibón	2	8		2				
Sibate	1	4				1		
Total	**25**	**100**	**11**	**7**	**1**	**4**	**1**	**1**

Conventions: S: Spill L: Leak F: Fire E: Explosion
Source: Study on the Prevention of Industrial Disasters in the Bogotá Metropolitan Area (2001) by JICA and CCS

- There were not enough records available due to the poor recording system. So the preliminary diagnosis depending upon the statistics of accidents will be taken care of with a higher level of uncertainty.
- In the Bogotá Metropolitan Area, the most common emergency situation is the leak of chemical substances in the gaseous state, followed by spills of chemical substances mainly with inflammable characteristics. Nevertheless, the explosions and the fires are less frequent and have the same occurrence level.
- The municipality that has been affected in most occasions is Soacha, followed by Funza. Chía and Facatativá with the locality of Fontibón follow, sharing the same accident occurrence level.
- Soacha has suffered the highest number of high magnitude emergencies among all the eight municipalities. Funza has presented the highest number of medium-magnitude emergencies.
- The entities that have had the highest participation in the response to emergencies with chemical substances are, in order of participation: the fire brigade, CISPROQUIM®, the industries with their emergency brigades and the national police.