

IV-16

**An Analysis of Population Vulnerability to Natural Disaster
in the City of Buenos Aires**

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1. - Introduction

The city of Buenos Aires, the capital city of Argentina, is located in a plain area and is drained by subterranean channels directly into the La Plata and Matanza-Riachuelo rivers.

The total area of the city of Buenos Aires (200 Km²) lies in a privileged area insofar as the more common natural hazards are concerned. No volcanoes, earthquakes or hurricanes plague the region and its population. However, the city of Buenos Aires suffers only the effects of the occasional flooding.

Many authors¹ have described the floods as natural phenomena caused by:

a) Heavy rainfalls (sometimes over the monthly average) that surpass the capacity of the system to drain the rainwater and consequently produce the overflow of the streams².

B) The extraordinary flood tides of the La Plata river in coincidence with the blowing of the wind called "Sudestada".

c) The combination of both points. If in the same moment that a heavy rainfall precipitates the "Sudestada" wind is blowing, the La Plata river is transformed in a "hydraulic stopper". The "hydraulic stopper" functions as an impediment to the already difficult evacuation of the rain waters.

The floods, as a catastrophic event, cause abundance of damage and problems such as: the necessary evacuation of peoples, disruptions in transportation systems (bus, subway, train, plains), damages to properties (houses and commerce), and disruption of all the activities (cultural, educational, sportive) that normally take place in this area. Although, flooding is less significant cause of deaths and casualties than some others natural hazards, still many people are injured or killed³.

However, hazard identification (origins, recurrence interval, frequency, intensity and location) is not enough for a *Disaster or Risk Assessment*. The Risk Assessment combines information on physical hazard with information on vulnerability of the areas affected to determine the likely impacts of a hazardous event.

The population vulnerability analysis (the case of this study) includes the determination of the number, spatial distribution and growth of the population at risk in those endangered areas.

2. - Methodology

As is stated, an evaluation of the regional risk requires that the hazard maps are overlaid by socio economical information for the areas at risk (e.g., population, facilities).

Advances in computer technology such as *Geographical Information Systems (GIS)* can simplify the integration of hazard and vulnerability data. GIS allow the superimposition and analytical evaluations (using appropriate data banks) of different maps. This research is carried out using a GIS program - ARC/INFO⁴ version 5.01 for SUN Workstation.

In GIS, the reality is represented by *Geographical* (locational) data elements used to provide a reference for the *Attribute* (statical) data elements (Maguire, 1991). Two models have been adopted for achieving the linkage between the data elements within GIS: The *Geo-Relational* and the *Composite Map* Models (Shepherd, 1991).

¹ Barrionuevo, D., Bianchi, H., Jaime, P. and Secchi, A. (1988); Costa, L. and Albin, D. (1988); Di Pace, M., Federovisky, S. and Hardoy, J. (1991); Federovisky, S. (1990).

² Only the areas affected by this type (a) of flood are considered for this study.

³ Szlafsztein, C. F., 1995. Analysis of the Vulnerability to Natural Disasters using GIS - City of Buenos Aires. M. Env. Sc. thesis. Hokkaido University.

⁴ ARC/INFO is a product of Environmental Systems Research Institute, Inc. (ESRI)

3. - Population Vulnerability to Natural Disaster

3.1. - Total Population

In order to analyze some aspects of the population vulnerability to flooding in the city of Buenos Aires, the maps entitled "Total Population 1991" and "Density 1991" have been constructed based on the data extracted from the national census per scholar districts (INDEC, 1991) and after the application of the vulnerability criteria's table (table 1).

In areas where there is no human habitation there would not be any risk (katayama, 1993), whereas **the decision to locate people in hazard prone areas increases society's vulnerability** unless appropriate disasters' reduction measures are also made.

The map "Total Population - 1991" shows that the districts with the greatest number of inhabitants in the city of Buenos Aires are concentrated in the NE and N areas (Vulnerability 4 and 3, respectively). Those regions, crossed by the downstream areas, include half the surface of all the Buenos Aires' flood prone areas considered in this Study. Therefore, regarding only those regions about 126,600 inhabitants are affected, representing 49% of the total population that suffers the natural disasters (257,358 persons, 8.67% of the total population of the city of Buenos Aires).

In spite of the high number of people living in the N and NE areas of the city, the map "Density 1991" shows an intermediate value of density (vulnerability 2) for those sectors due to the extensive area of the scholar districts⁵ involved. However, the density (and the vulnerability) of those areas could be increased considering the **net density** (Schneider, J. et al., 1984) of the areas (the amount of land used for residential purposes). Many open spaces (parks) and buildings of public and private companies (closed Sunday when the census of population has been done) are located in the N, NE and E areas of the city.

Total Population (Inhabitants)	Vulnerability	Density (Inhab/Km ²)	Vulnerability
50,000-99,999	0	5,000-9,999	0
100,000-149,000	1	10,000-14,999	1
150,000-199,999	2	15,000-19,999	2
200,000-249,999	3	20,000-24,999	3
250,000-299,999	4	25,000-29,999	4
		30,000-34,999	5

Table 1. Vulnerability values assigned in relation to the number and density of population.

3.2. - Variation of Population

The total population of the city of Buenos Aires (currently 2,965,403 inhabitants) has registered few variations in the past 45 years. However, the population of each scholar district has changed in the last years (INDEC, 1991).

The map entitled "Variation of Population 1980-1991", based on the data extracted from the national census per scholar districts (INDEC, 1991) and after the application of the vulnerability criteria's table (table 2), shows districts that present a negative growth (vulnerability 0 and -1) and others that increase their population (vulnerability 2; 3; 4).

The district in the southern corner of the city has the highest increase of the population between 1980 and 1991 (vulnerability 4) due to recent municipal and national plans of resettlements of people of low economical resources.

However, despite the media (radio, television, newspaper) provide extensive information about the origins and consequences of the disasters moreover the location of the main flood areas, **it seems there is an internal migration of people principally to the North and NE areas of the city**. Consequently, the N and NE regions of the city, including their flood prone areas, are also sectors that hold a great increase of population between 1980 and 1991 (vulnerability 3 and 2).

⁵ Scholar district 1 (14.5 Km²); Scholar District 9 (17 Km²); Scholar District 10 (14.9 Km²)

The migration and settlement of population imply an accelerated urban development of those areas. Therefore, the map "Total Area Constructed (M²)⁶", shows that also in the N and NE district areas, the municipality of the city of Buenos Aires allows the biggest amount of square meters under construction (vulnerability 5; 4 and 3) in 1993.

Variation of Population (%)	Vulnerability	Area Constructed (M ²)	Vulnerability
-10 - -6	0	0-24,999	0
-5 - -1	1	25,000-49,999	1
0 - 4	2	50,000-74,999	2
5 - 9	3	75,000-99,999	3
10 - 14	4	100,000-124,999	4
		125,000-149,999	5

Table.2 Vulnerability values related to the variation of population 1980 -1991 and amount of m² constructed

Construction Surface 1993 Electoral Districts			
Elect. District	Total Area Enlargement (M ²)	Total Area New (M ²)	Total Area (M ²)
1	8,236	16,461	24,697
2	11,402	12,958	24,360
3	8,244	24,203	32,447
4	825	15,752	16,577
5	10,190	63,478	73,668
6	9,198	62,567	71,765
7	6,763	42,176	48,939
8	2,484	15,166	17,650
9	4,614	16,740	21,354
10	2,427	14,085	16,512
11	6,529	10,211	16,740
12	2,831	23,229	26,060
13	13,054	14,451	27,505
14	3,106	60,701	63,807
15	7,987	36,882	44,869
16	11,629	88,155	99,784
17	34,369	90,695	125,064
18	7,551	124,619	132,170
19	31,199	74,253	105,452
20	10,354	86,514	96,868
21	15,928	25,788	41,716
22	5,358	20,083	25,441
23	9,949	20,451	30,400
24	10,334	20,972	31,306
25	8,079	36,420	44,499
26	11,122	28,402	39,524
27	20,856	32,639	53,495
28	11,982	40,088	52,070

Source: *Dirección General de Estadística y Censos de la Municipalidad de la Ciudad de Buenos Aires.*

Table 3. Construction Surfaces (new and enlargement) in 1993 per electoral district.

4. - Conclusions

More than 60 years ago, the streams and their flood plains that cross the city of Buenos Aires were hidden through civil works and that together with a particular lack of urban hazards regulations have imposed on the inhabitants a

⁶ The map "Total Area Constructed" has been made based on the data of permissions to construct (new or enlarge) houses and commerce, expressed in M² (table 2) and after the application of the vulnerability criteria (table 3).

sensation of "security" concerning the flood problem. Therefore, those "forgotten" risk prone areas have started a slow process of settlement of population and urban development.

Then, currently, in spite of the settlement of many people and facilities in hazard prone areas increasing the vulnerability, the biggest population of the city of Buenos Aires lives near or inside the flood prone areas of the N and NE regions. Those areas also hold one of the highest densities of population of the city. It is important to consider that, unfortunately, data of daytime population are not available for this study.

However, the vulnerability situation in those areas will become worse in the future. Bad living conditions in the south area of the city and other socioeconomic reasons are causing an internal migration of people and facilities to the N and NE areas of the city of Buenos Aires. Seemingly oblivious to the hazard associated with those areas, most population growth and urban development (e.g., area constructed) of the city is taking place there in the recent years, transforming those areas into the most dynamic areas of the city, thereby increasing enormously their vulnerability to natural disasters.

If no measure is taken against the inundation (structural or non-structural), every time a flood occurs (no matter its magnitude) it will affect (mainly) the just analyzed N and NE areas of the city of Buenos Aires, causing a great impact in the population, disrupting their normal life and creating many negative social and economical consequences as until the Present.

5. - References

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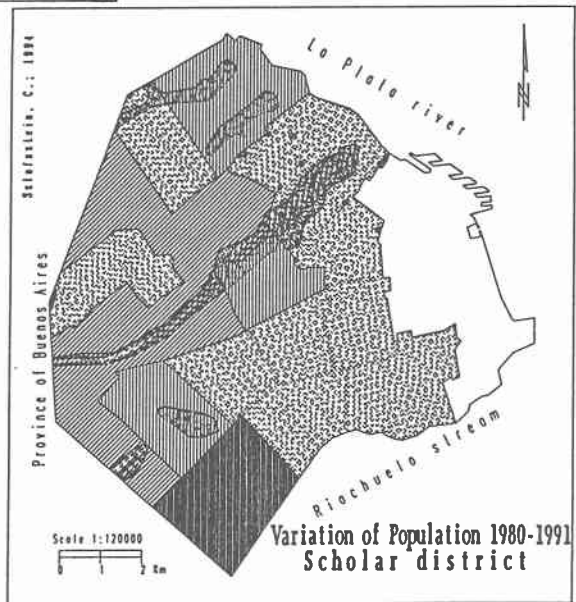
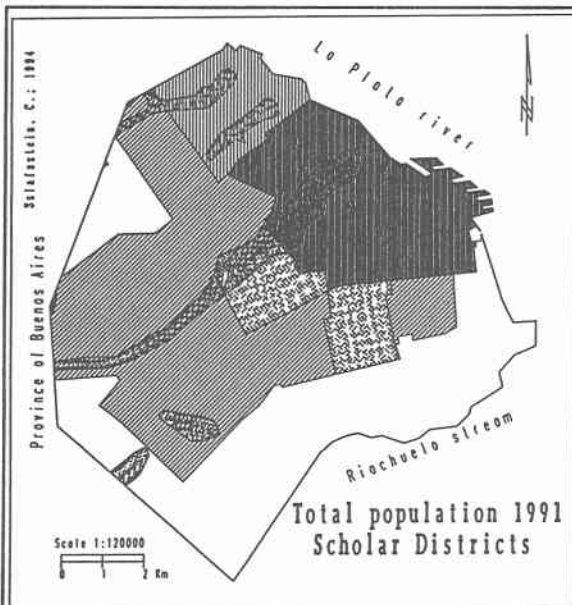
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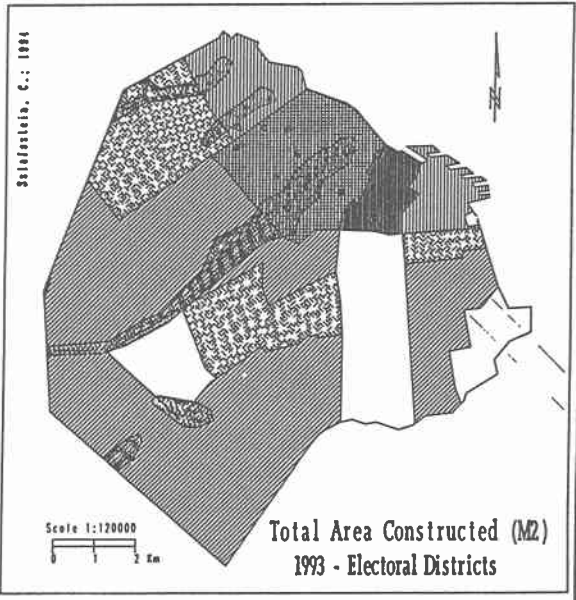
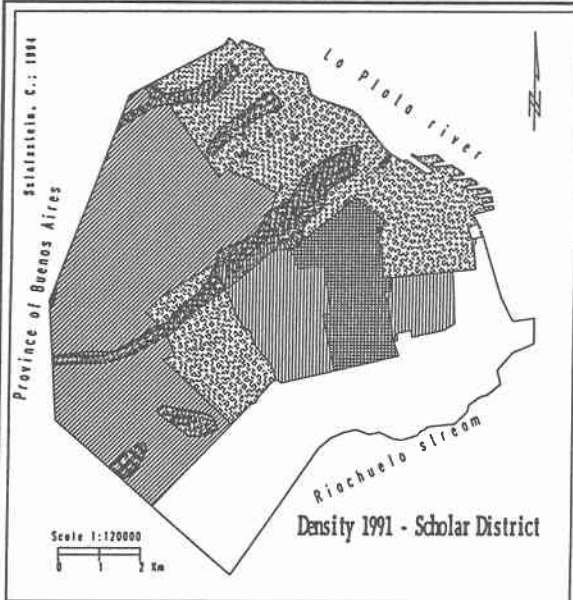
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References			
	Vulnerability 0		Vulnerability 5
	Vulnerability 1		Flood Area (Rainfall)
	Vulnerability 2		
	Vulnerability 3		
	Vulnerability 4		



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