CHAPTER 2 ANALYSIS OF MAJOR FLOOD

2.1 Analysis of May 19, 1994 Flood in Chiguaza Creek

2.1.1 Information of Literature

(1) Report in Colombia

A short report “Informe Geologico y Geotecnico "Cantera El Zuque" y Cause avalancha 19 Mayo 1994” introduces the occurrence of flash flood in Quebrada Zuque (one tributary of Chiguaza creek) in Thursday afternoon, May 19, 1994. The description about the phenomenon is as follows,

The day 19th of May at the afternoon, there was a heavy rain that originated an avalanche that began with a detachment at the medium zone that obstructed the creek at the elevation of 3.100 msnm. This detachment acquires weight and originates the mud and blocks flow to 4 or 5 meters of height above its flow, and erodes its margins and destroyed some houses that were above its flow.

At the points where there were obstacles, like the sector where the creek crosses the old highway to “Villavicencio”, was blocked and detour the flow to the barrio “Moralva”.

From this description, the flash flood did not go downward not so long and blocked the creek.

(2) Newspaper Articles of “El Tiempo”

<Damage>
The article dated on May 23, 1994 wrote that 4 people died, 15 people missing and 830 people were affected. The dead 4 people were 2 years old, 7 months baby, 22 years old pregnant ladies and 17 years old girl.

The article dated on May 20, 1994 wrote that the affected barrios were Belleza, Altamira, Nueva Deli, La Gloria, Diana Turbay, Puente Colorado, Villa del Cerro, Canada Guira, La Peninsula and Parque de Ibari.

<Phenomenon>
The article dated on May 20, 1994 wrote, at 4:30 PM the cloudburst began and 4:45 PM the overflow from the Belleza creek happened.

<Causes>
The article dated on June 24, 1994 said that the deforestation caused by the work in the Zuque quarry and the urban works promoted sedimentation in the creek bed.

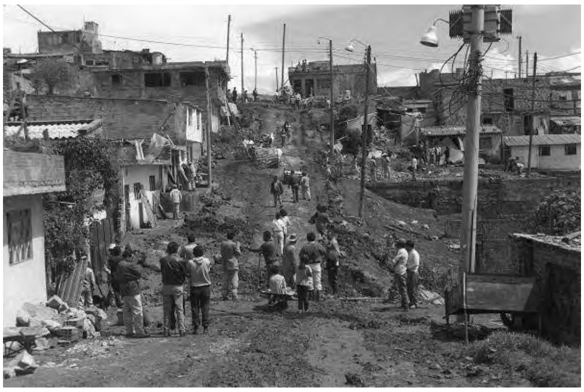
In an article, there is a description that people are afraid of the repeated dynamite in the Zuque quarry, which could loose the mountain.

2.1.2 Interview Survey

The study team conducted interview survey in Bogota and Soacha in September 2006, visiting community leaders as well as local people. In the Chiguaza creek basin, at an interview in Quindio (Barrio) it was said that a kind of flash flood happened in the past in the neighborhood. This said phenomenon is regarded as that in Qda. Zuque. According to the interview, the flash flood was 30 m width and lasted 3 hours.

In January 2007 the study team conducted the interview survey focusing on the 1994 flash flood in the Chiguaza creek in order to identify the affected area and its magnitude such as flood depth. Also to find some flood marks which were specified by the people who experienced the 1994 event, the elevations of those flood marks were surveyed by the study team.

The most significant phenomenon in the 1994 event was the diversion from the bridge on *old highway to "Villavicencio"*. The resultant flash flood went to barrios Altamira, running on the streets among the blocks.



after May 19, 1994 source El Tiempo

Feb. 2007 source Study Team

Photo S6-2-1 Affected Barrio Altamira

The area downstream of barrio Altamira suffered from the flash flood damage only in the creek and the limited riverine.

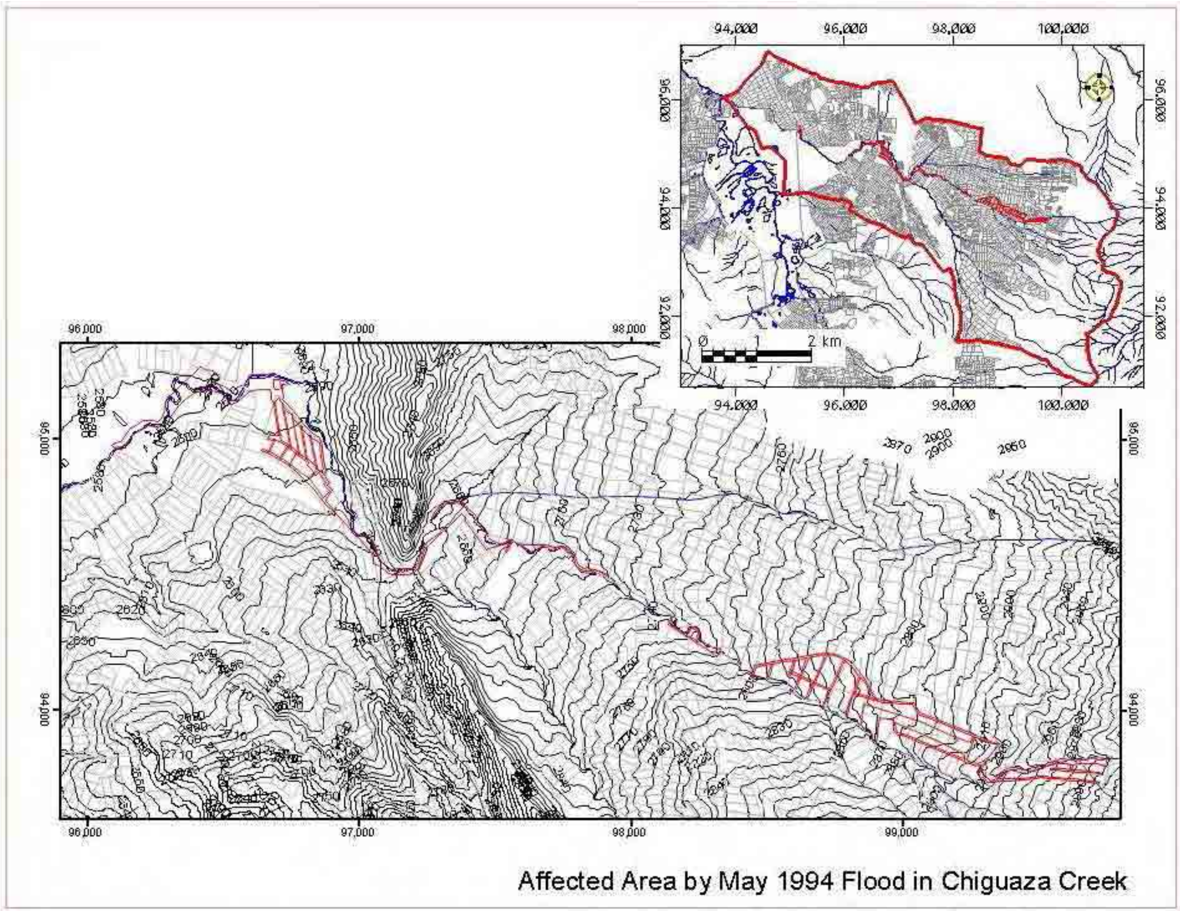


Figure S6-2-2 Affected Area by May 19, 1994 Flood in Chiguaza creek

2.1.3 Hydrological Conditions

According to the newspaper and the interview survey, the occurrence time of the flash flood is summarized as follows,

Description by source	source
At 4:30 PM the cloudburst began and 4:45 PM the overflow from the Belleza creek happened.	The article “El Tiempo “dated on May 20, 1994
At 4PM, there were three (3) times of flash flood.	People at 46A 33S (the house along the Zuque creek)
From 3:30PM to 9PM, the flow continued.	People at Tras 17 Este 47-44 Sur

Because they are people’s memories about 13 years ago and it is difficult to confirm the accuracy of the newspaper article at present, it can be regarded that about 4 PM the flash flood occurred.

The following figures show the daily rainfall on May 1994 of the stations near Qda. Zuque. In Juan Rey (EAAB) and Dona Juana (CAR), around 20 mm a day was observed on May 19, 2006. Especially Juan Rey station (EAAB) which is the nearest to the Qda. Zuque had 22.9 mm on May 19 after it experienced the almost same amount of rainfall on May 14.

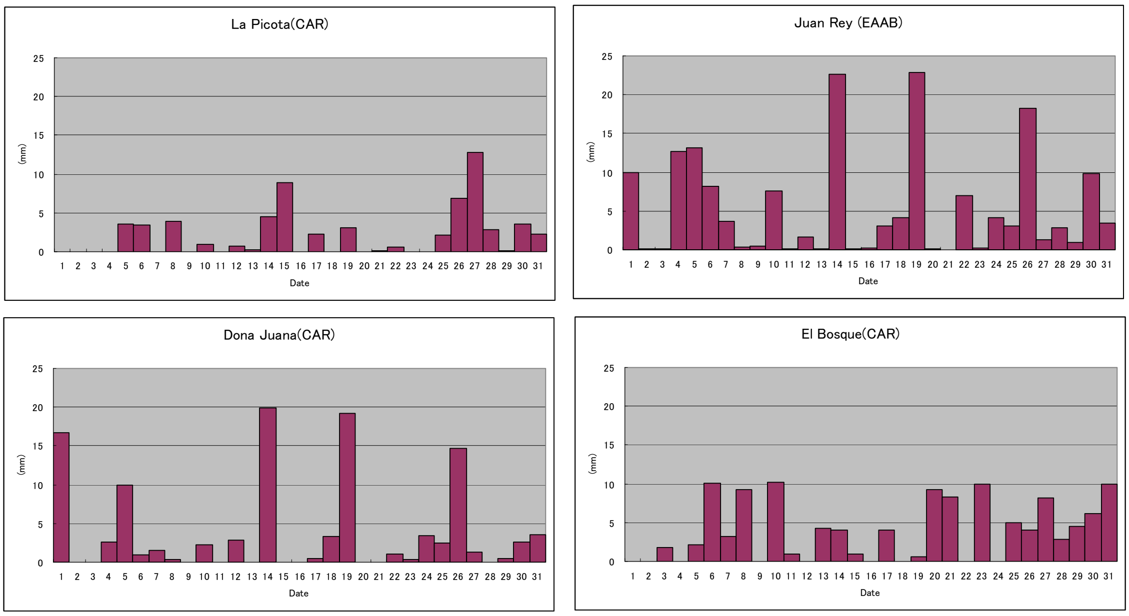


Figure S6-2-2 Daily Rainfall during 1 to 31 on May 1994

The hourly rainfall distribution of Juan Rey station (EAAB) was not available in EAAB database. Recommended by EAAB, the Study Team visited the Bogota Archives where the original recording sheets are stored and found the following.

Table S6-2-1 Hourly Rainfall Distribution at Juan Rey in May 19, 1994

Date	Time	Hourly Rainfall	
May 19	15:00-16:00	0 mm	
	16:00-17:00	5.1 mm	From 16:45 to 17:15, the amount was 9.5 mm.
	17:00-18:00	6.3 mm	
	18:00-19:00	1.8 mm	
	19:00-20:00	2.2 mm	
	20:00-21:00	0.1 mm	
	21:00-22:00	0.0 mm	
	22:00-23:00	0.9 mm	
	23:00-24:00	3.7 mm	
May 20	24:00-1:00	2.5 mm	
	1:00-2:00	0.0 mm	
	2:00-3:00	0.1 mm	
	3:00-4:00	0.2 mm	
	Total	22.9 mm	

It was found that 9.5 mm was observed during 16:45 to 17:15 PM, which corresponding to 19 mm per hour as intensity.

There is one thing not clear about the recording chart. According to the chart, the paper was just replaced May 18, 14:00, 1994, but the record started at 16:00 PM. The time is written on the top of the chart by pencil. The Study Team believed the time by pencil is correct.

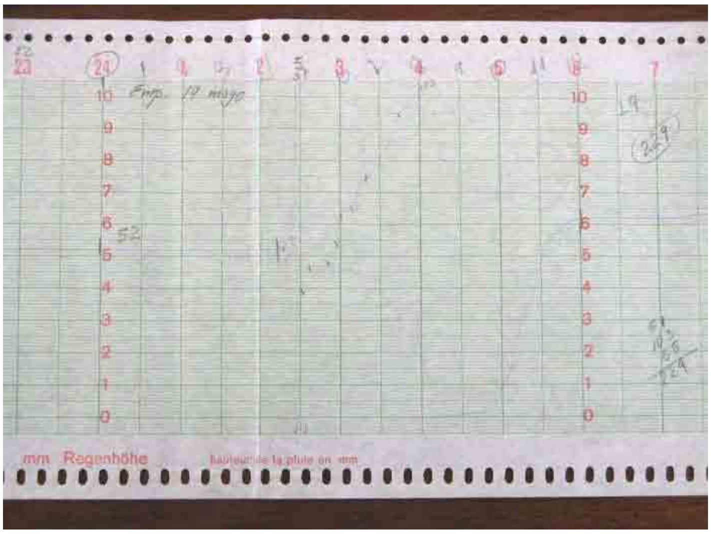


Photo S6-2-2 Recording Chart at May 19, 1994 of Juan Rey Station

If the description of El Tiempo saying that the overflow started at 4:45PM, The flash flood happened almost same time as the rainfall.

2.1.4. Analysis

(1) Sediment Deposit

The sediment deposited area is located at five (5) locations.

The most upstream location of Zuque creek was caused by the overflow from the culvert below Carrera Oriente.

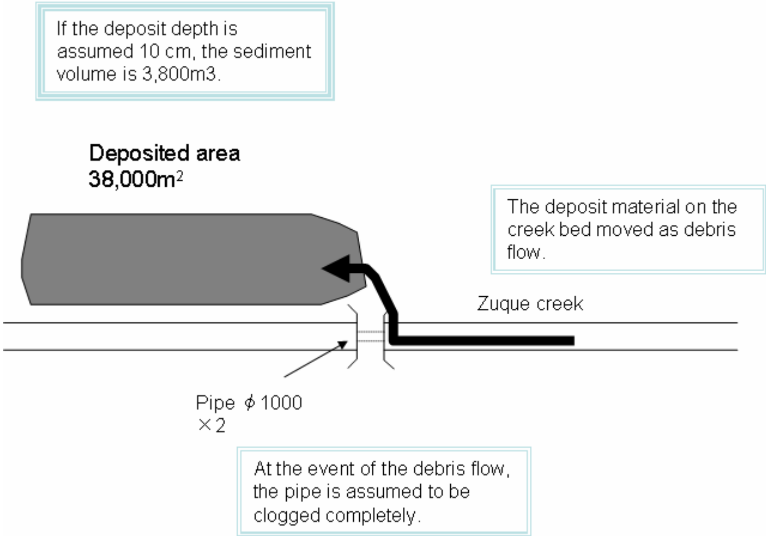


Figure S6-2-3 Schematic Image of Sediment Balance

Table S6-2-2 Area and Sediment Deposition Depth of Affected Area

Location	Cause of Deposit	Area	Depth
Zuque creek	Overflow	No available information	No available information
Downstream of Carrera Oriente (Barrio Altamira)	Overflow from Zuque creek due to clogging	38,000 m^2 (assumed from the interview survey)	10 cm (assumued from El Tiempo photos)
La Gloria	Overflow of Chiguaza creek due to clogging	-	No available information
Los Puentes	Overflow from Los Puentes due to clogging	-	No available information
Molinos	Overflow from creek	-	No available information

(2) Sediment Balance

The downstream of Carrera Oriente was the most seriously affected area. It is located upstream of the Zuque creek and it is very good to analyze the sediment balance. The analyze of sediment balance means here for given or estimated deposited sediment volume, considering the rainfall amount as trigger, the relation between generated sediment volume, deposited sediment volume on creek bed and the transported volume is explained. The analysis of the sediment balance shall clarify the mechanism of flash flood occurrence and its transported behavior.

However, the flood event was 14 years ago and the present condition does not reflect that of 1994. The most important information is the sediment deposit volume on the creek before the May 1994, but it is impossible to evaluate such figure.

Sediment Generation

According to the aerial photo observation for February 1998, in the area upstream of the Zuque creek any new slope failure can not be recognized. If in 1994 there was major slope failure which developed into the flash flood, the photo in 1998 should have some trace for the slope failure.

Another candidate location as sediment generation can be assumed to be the sediment deposited on creek cause.

Generally the relation between the flash flood generation and the stream bed slope is as follows,

Slope Category	General Description of Section
20° < θ	Generation
15° < θ <20°	Generation and Transport
10° < θ <15°	Transport
3° < θ <10°	Deposition

Zuque creek has bed slope of about 8.5 degree, which is corresponding to the deposition reach.

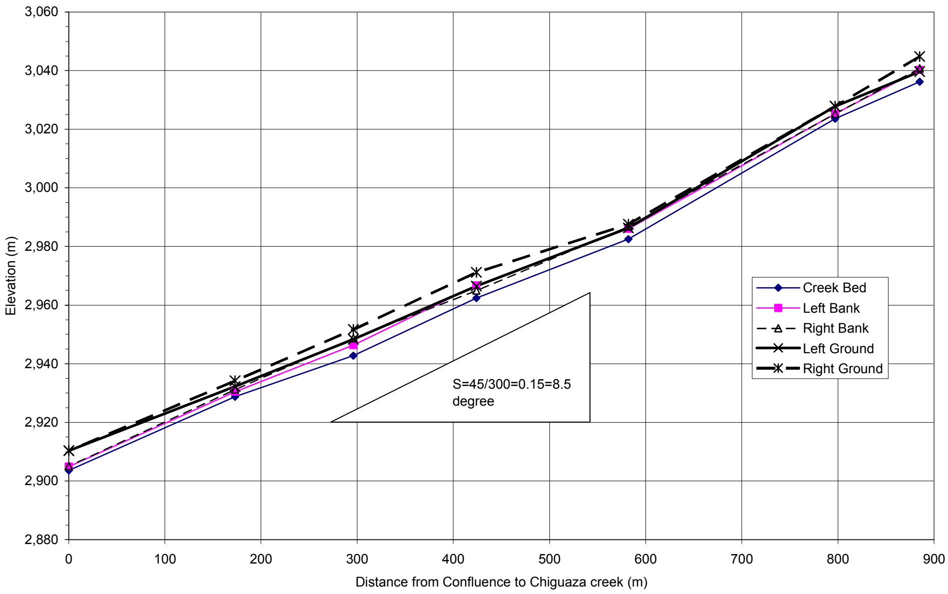


Figure S6-2-4 Longitudinal Profile of Zuque Creek

Here it is tried to check the possibility of sediment generation for the event of May 1994. The following formula is an experimental one in order to check the phenomena that unstable sediment deposit on creek bed could become flash flood. In this sense, this formula is already assuming the existence of unstable sediment on creek like the condition before May 1994 in Zuque.

$$A \geq \frac{3.6}{r_e}\left\{\frac{8g\cdot\sin\theta}{f_r}\right\}^{1/2}\times\left\{c_*(\sigma/\rho-1)\left(\frac{\tan\phi}{\tan\theta}\right)-1\right\}^{3/2}\cdot {d_m}^{3/2}\cdot B$$

A: catchment area (km^2), r: rainfall intensity during the concentration time (mm/h), fr: friction loss coefficient, g: gravity (9.8 m/s^2), θ : creek bed slope in degree, c*: volume density of deposit (=0.7), σ : density of gravel (g/cm^3), ρ : water density (g/cm^3), ϕ : internal friction in degree, dm: average diameter of gravel in meter, B: creek width in meter.

Also in order to cause flash flood, the following should be satisfied.

$$\tan\theta \geq \frac{c_*(\sigma-\rho)\tan\phi}{c_*(\sigma-\rho)+\rho(1+\dfrac{h_0}{d_m})}$$

h_0 : water depth (m)

The catchment area of the Zuque creek is 0.70 km^2. The following table shows the necessary parameters for the flash flood occurrence in the Zuque creek. The rainfall intensity is 40, 30 and 20 mm/h during the concentration time (in the case of Zuque creek Tc is 7.8 minutes). The corresponding gravel size is 10, 8 and 7 centimeter.

Parameter	Unit	Value			Remark
A	km2	0.74	0.71	0.78	
Re	mm/h	40	30	20	
fr	–	0.16	0.16	0.16	
θ	degree	8	8	8	
cb	–	0.7	0.7	0.7	
σ	g/cm3	2.65	2.65	2.65	
ρ	g/cm3	1	1	1	
φ	degree	35	35	35	
dm	m	0.10	0.08	0.07	
B	m	3	3	3	
h0	m	1	1	1	
tanθ	–	0.141	0.141	0.141	site
tanθ	–	0.067	0.055	0.046	calculated

In 1994 flood, the observed rainfall intensity such as hourly rainfall is 19 mm / hour, however, the above figure shows that if the high rainfall intensity such as 19 mm/h to 40 mm/h lasts 7.8 minutes, the flash flood could happen in the creek.

2.2 Analysis of May 31, 2002 Flood in Chiguaza Creek

2.2.1 General

The inundation in the Chiguaza creek in May 2002 can be regarded as one of the main flood disasters in recent years. The area near the Tunjuelo river confluence was seriously affected by flood water. As shown in Figure S6-2-5, it is reportedly said that the high water of the Tunjuelo river itself was the main cause of the inundation.

Figure S6-2-5 Presentation Material on May 2002 Flood by DPAE

The Study Team conducted interview survey in Chiguaza in September 2006 and identified the affected area by the May 2002 flood as shown in Figure S6-1-18 in Supporting Report S6 Chapter 1..

2.2.2 Hydrological Conditions

(1) Rainfall Condition in Juan Rey (EAAB)

In May 2002, the only available rainfall station in the Chiguaza upstream was Juan Rey (EAAB). The Study Team visited the Bogota Archive Center in order to check the rainfall of the end of May 2002. According to the recording chart, 15.4 m between 11 AM and 1 2AM (15.4 mm for only 15 minutes) was recorded on May 30, 2002. Generally the flooding date was said May 31, 2002, however, the maximum rainfall for hour was recorded in May 30,2002.

Table S6-2-3 Hourly Rainfall at Juan Rey on May 30, 2002

Date	Time	Hourly Rainfall (mm)	remarks
May 30	7:00	0	
	8:00	0	
	9:00	0	
	10:00	0	
	11:00	8.4	
	12:00	15.4	22.4mm for 15 min.
	13:00	0.2	
	14:00	0.9	
	15:00	7.2	
	16:00	3.4	
	17:00	1.5	
	18:00	0.5	
	19:00	0	
	20:00	0	

(2) Waterlevel Condition in Tunjuelo River Confluence near San Benito

EAAB had a waterlevel station at San Benito in May 2002. It was a staff gauge monitored by people. Figure S6-2-6 shows the reported waterlevel to EAAB at 6 AM and 6 PM from May 23 to June 6, 2002. This station is in the Tunjuelo river main course after the Chiguaza creek confluence. The waterlevel on May 30, 6 PM was increased 1 meter compared with May 29. This can be regarded as effect of the discharge from Chiguaza due to the rainfall at Juan Rey. The highest waterlevel was recorded in May 31, 18 PM, 2,562.9m.

Figure S6-2-7 shows the flood elevations along the Chiguaza and Tunjuelo River together with the longitudinal profile of the Chiguaza creek and the Tunjuelo River, according to the interview survey by the Study Team. The flood elevations were assumed as the ground elevation of the 2 m contour line plus interviewed inundation depth. The inundation depths are larger than 2 m in some points above ground elevation of the right bank.

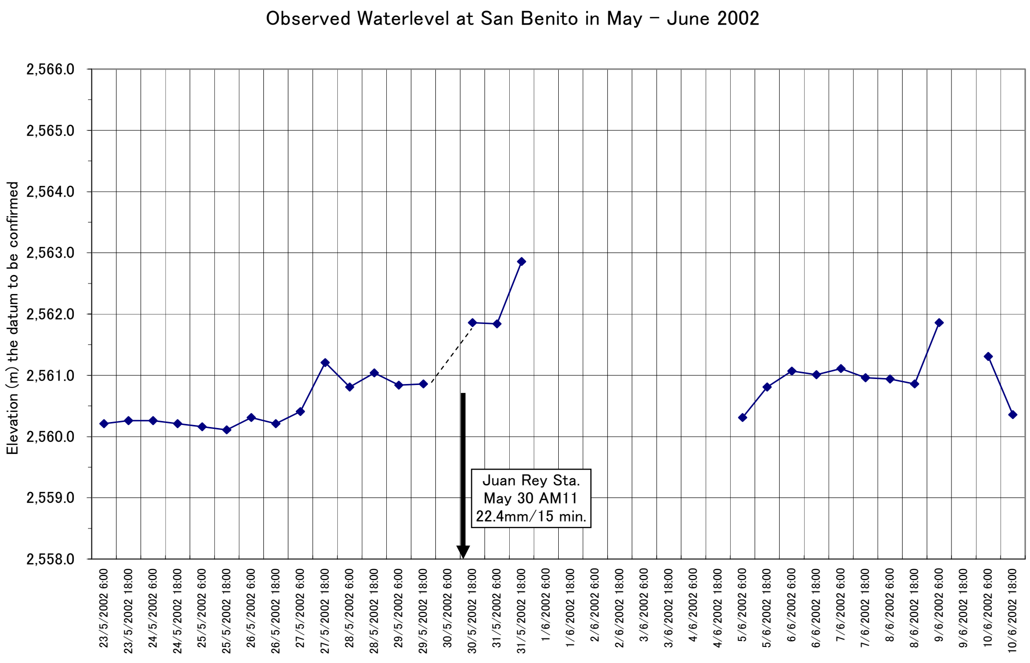


Figure S6-2-6 Observed Waterlevel from May 23 to June 6, 2002 at San Benito[1] (EAAB)

[1] The datum elevation of San Benito 2,559.809 m according to DPAE information dated on August 2, 2006.

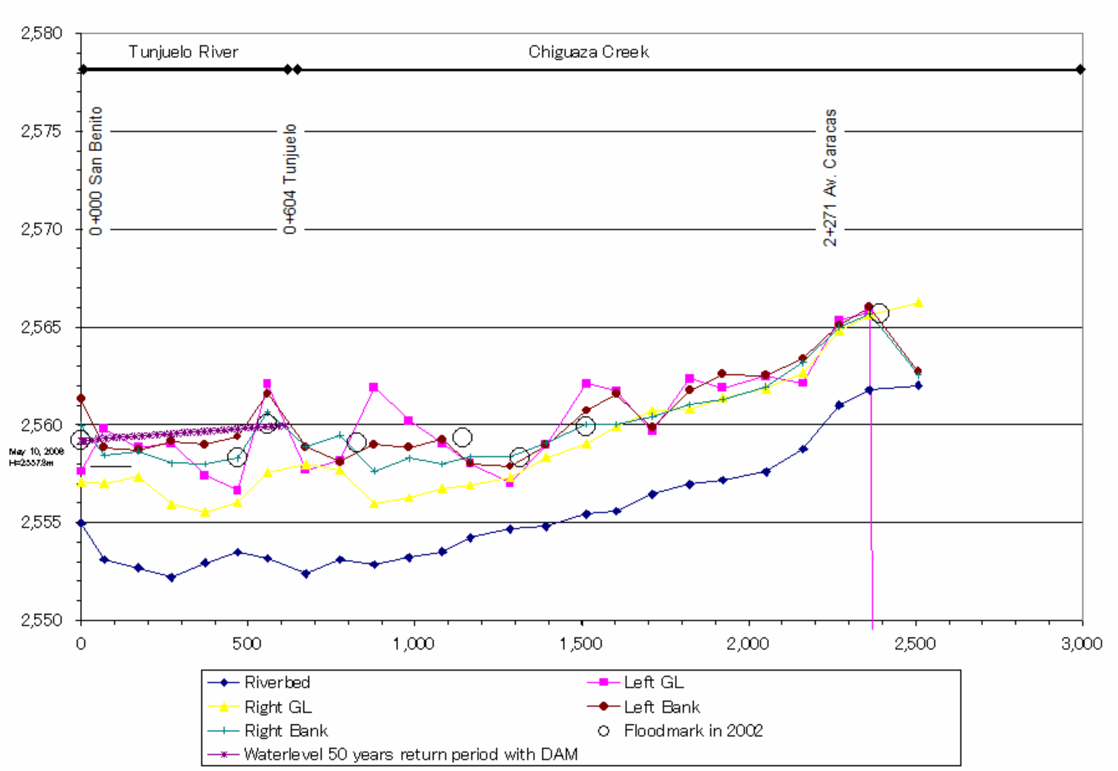


Figure S6-2-7 Flood Elevation in May 2002 Flood in Chiguaza and Tunjuelo river

(3) Effect of Cantaranna Dam

After the May 2002 flood, the Tunjuelo river's flood is controlled by the Cantarrana Dam. According to EAAB information, the Cantaranna Dam could cut 88 m^3/s for 100 years return period. The Study Team tried to explain the effect of the Dam at the point of San Benito.

Figure S6-2-8 shows the waterlevel and discharge curve at San Benito (0+068). The curve was made using uniform flow formula assuming the waterlevel slope 1/800 and Manning coefficient 0.04. According to the curve, the discharge of 88 m^3/s is corresponding to the waterlevel of 1.7 m reduction. The flood mark in May 2002 was 2,559.2m at San Benito. If at present the same flood occurs in the Tunjuelo river, the waterlevel at San Benito is 2,557.5 m, which is lower than existing right bank elevation.

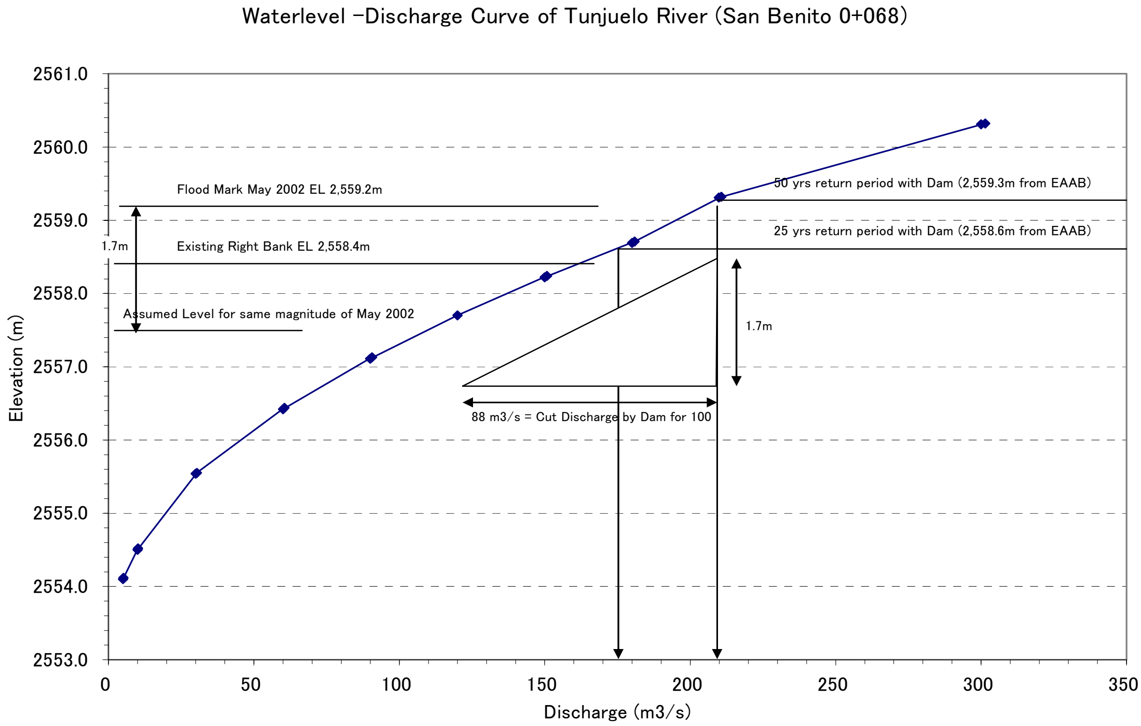


Figure S6-2-8 Waterlevel and Discharge Curve of Tunjuelo River (0+068)

2.3 Analysis of May 11, 2006 Flood in Soacha River

2.3.1 Hydrological Conditions

(1) Rainfall Condition in San Jorge (IDEAM)

In the Soacha river basin, IDEAM's San Jorge Station recorded rainfall during the May 11 flood. San Jorge station is located in the upper part of the basin.

The daily rainfall of May 11, 2006 at San Jorge was 20 mm according to IDEAM interpretation from the self-recording paper.

The figure below shows the daily rainfall at San Jorge since March 2006. In March 8 and March 18, the rainfalls over than 35 mm per day are registered. The Study Team collected the original self-recording paper of those days and checked the rainfall amount, however, the ink was not drawn on the paper clearly and it might be that actual rainfall amount were 10 mm less than the registered amount.

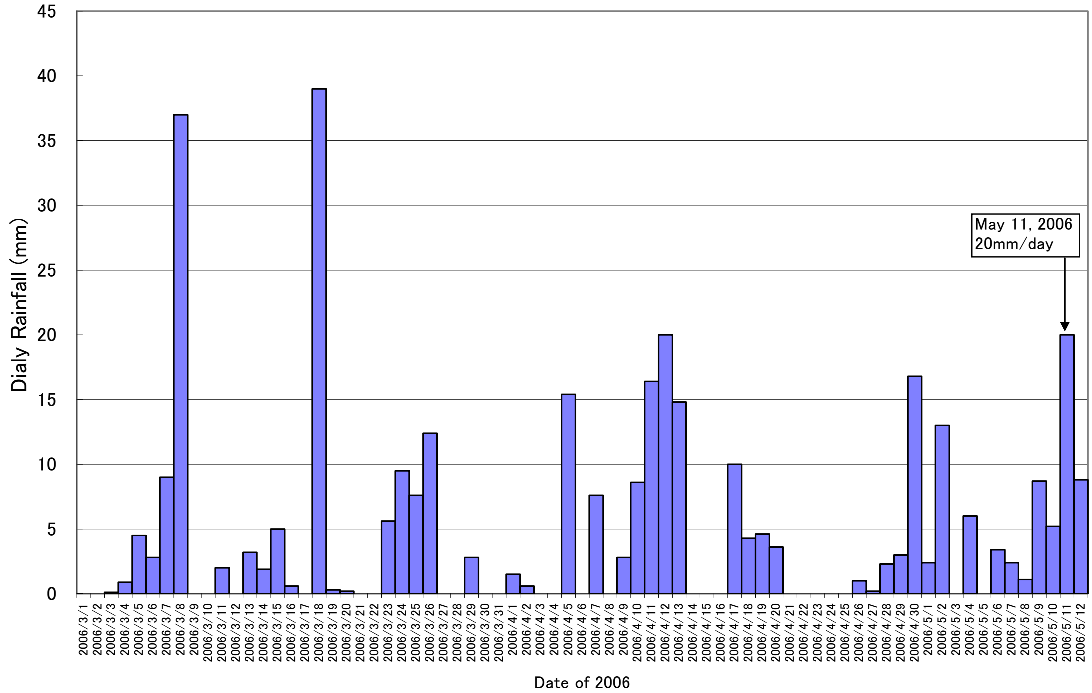


Figure S6-2-9 Daily Rainfall in San Jorge (IDEAM) in 2006

The maximum hourly rainfall in May 11, 2006 was 7.5 mm from 8:40 AM to 9:40 AM according to the self-recording paper.

Date	11-May-06	
Starting time	8:40	
	10 min. Rainfall	Accum. Rainfall
10min.	4.3	4.3
20min.	1.2	5.5
30min.	0.8	6.3
40min.	0.7	7.0
50min.	0.3	7.3
60min.	0.2	7.5
70min.	0.2	7.7
80min.	0.1	7.8
90min.	0.1	7.9
100min.	0.0	7.9
110min.	0.0	7.9
120min.	0.0	7.9
130min.	-	-
140min.	-	-
150min.	-	-
160min.	-	-
170min.	-	-
180min.	-	-
190min.	-	-
200min.	-	-
210min.	-	-
220min.	-	-
230min.	-	-
240min.	-	-

Figure S6-2-10 Rainfall Intensity in San Jorge (IDEAM) in May 11, 2006

(2) Flood Condition in Fusunga

The flood level at Fusunga was about 50 cm above the left side ground elevation. The peak water level took place at 11:45 AM in May 11, 2006 and lasted about 4 hours according to a resident living beside of the river. In the photo below, at 8:00 AM the water level was just 1 meter 40 cm on the staff gauge and the heavy rainfall happened at 10:30 AM in that day.

Photo S6-2-3 Photo of Fusunga Section

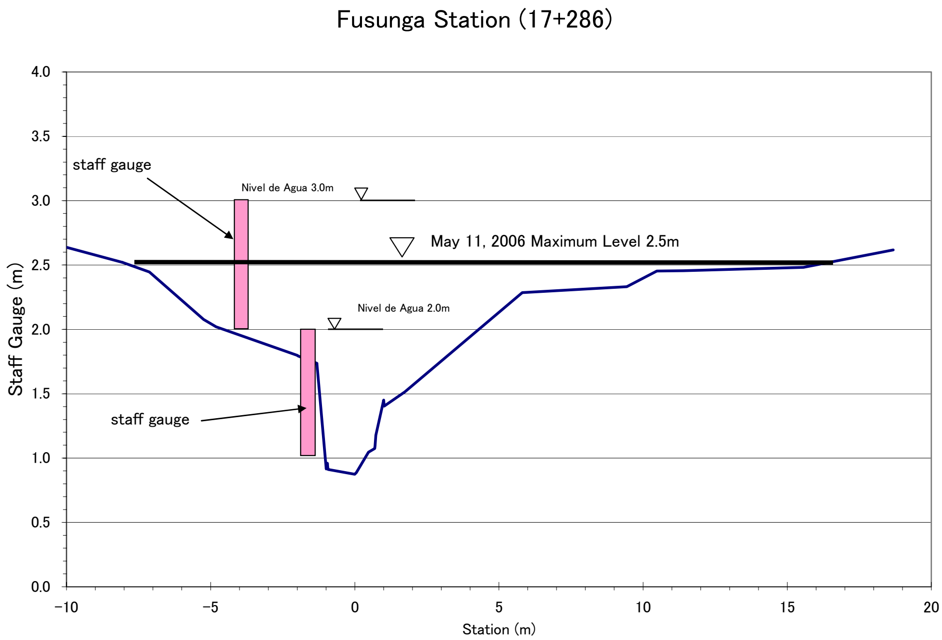


Figure S6-2-11 Flood Level and Cross Section at Fusunga

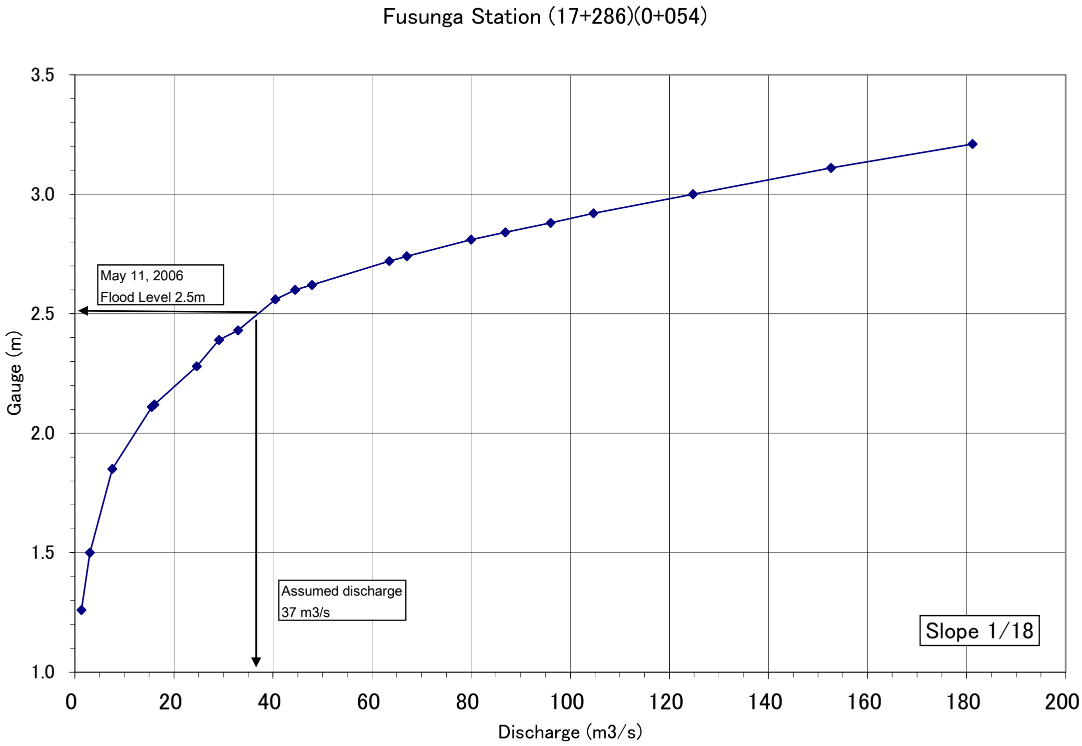


Figure S6-2-12 Waterlevel and Discharge Curve at Fusunga

(3) Flood Condition at Prison

Photo S6-2-4 Photo of Prison Section

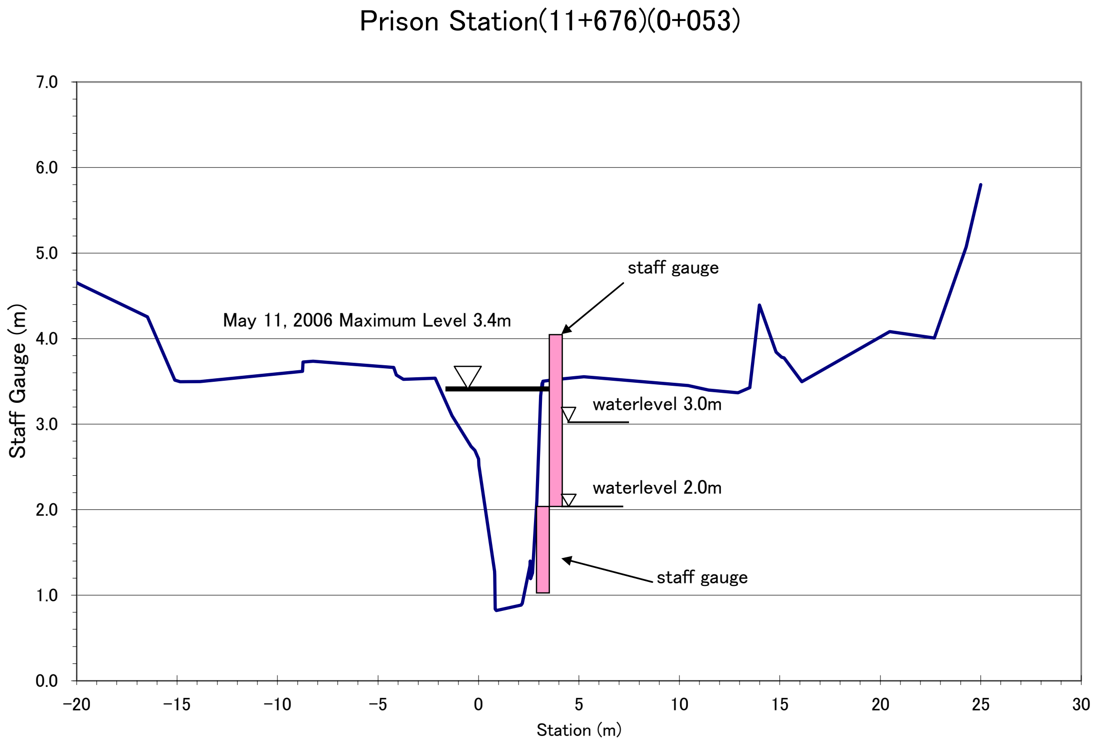


Figure S6-2-13 Flood Level and Cross Section at Prison

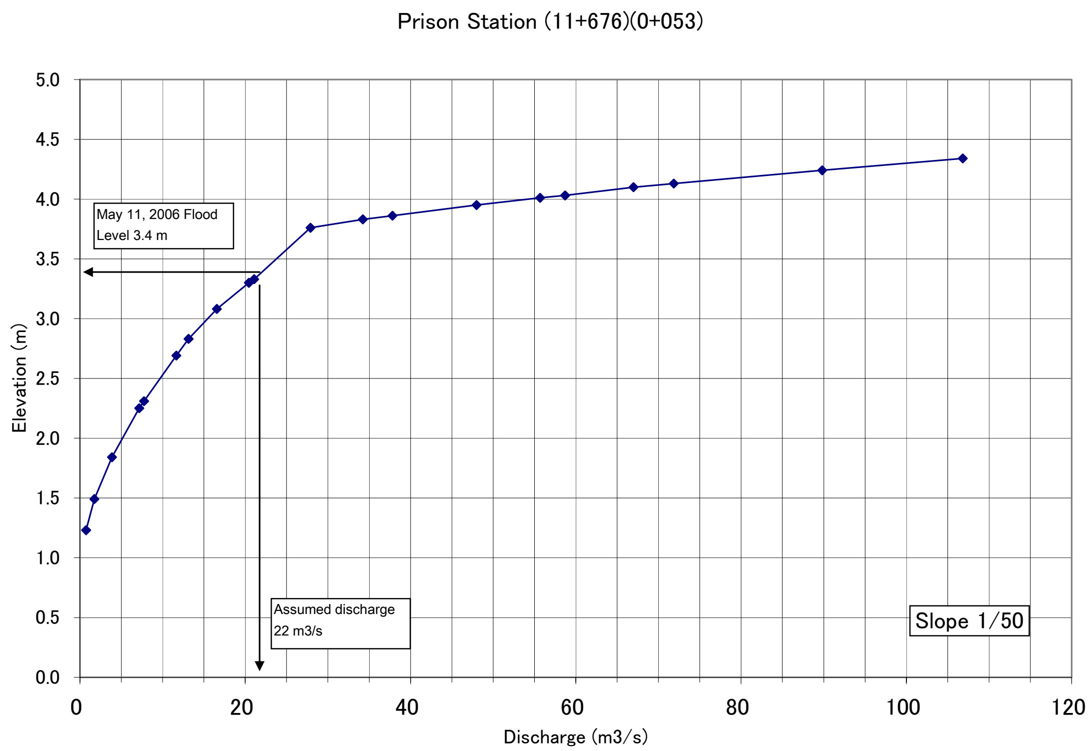


Figure S6-2-14 Waterlevel and Discharge Curve at Prison

(4) Flood Condition at Ladrillera Santa Fe

Photo S6-2-5 Photo of Ladrillera Santa Fe Section

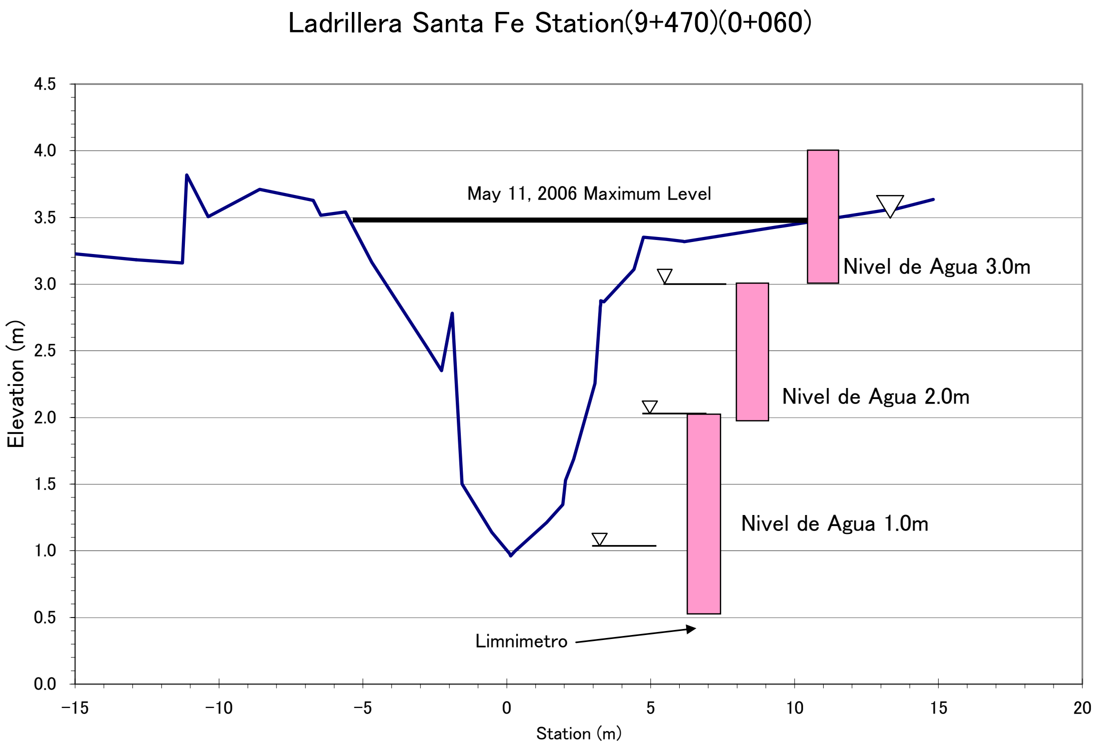


Figure S6-2-15 Flood Level and Cross Section at Ladrillera Santa Fe

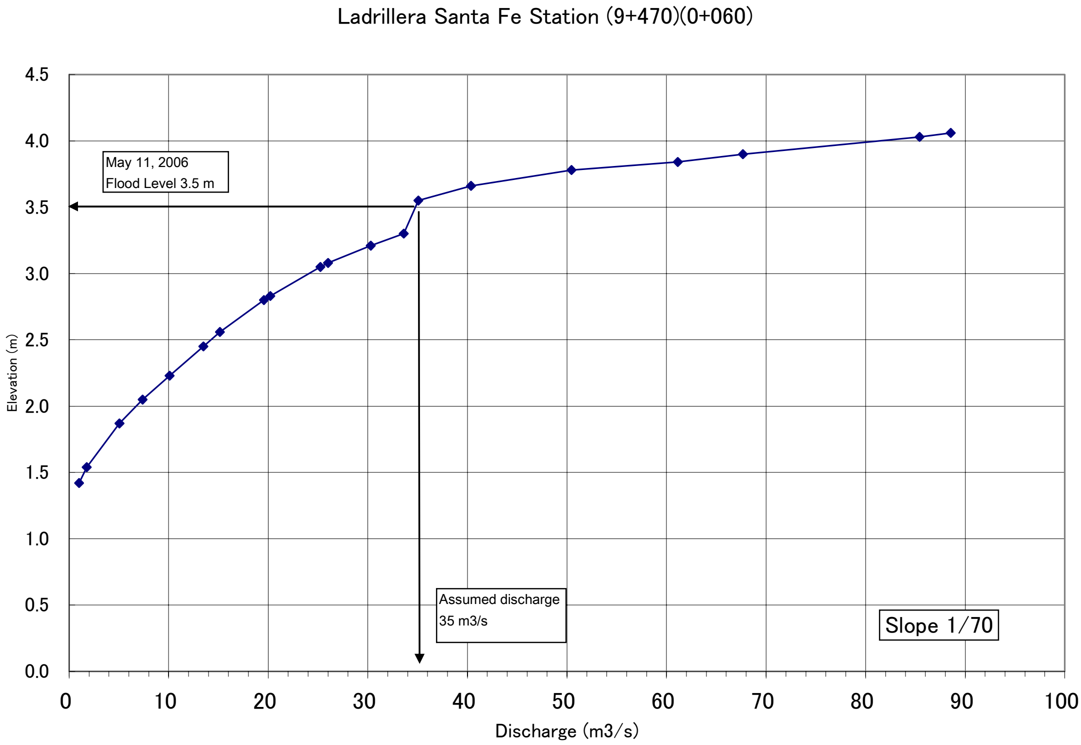


Figure S6-2-16 Waterlevel and Discharge Curve at Ladrillera Santa Fe

(5) Flood Condition at Llano Grande

Photo S6-2-6 Photo of Llano Grande Section

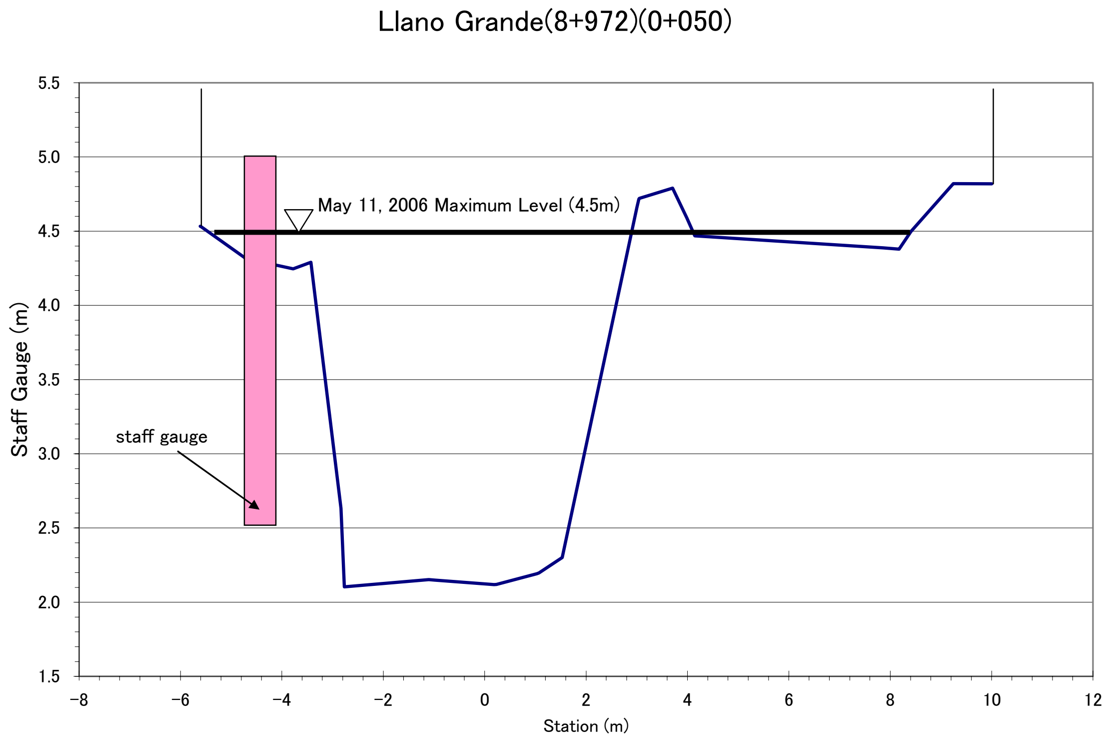


Figure S6-2-17 Flood Level and Cross Section at Llano Grande

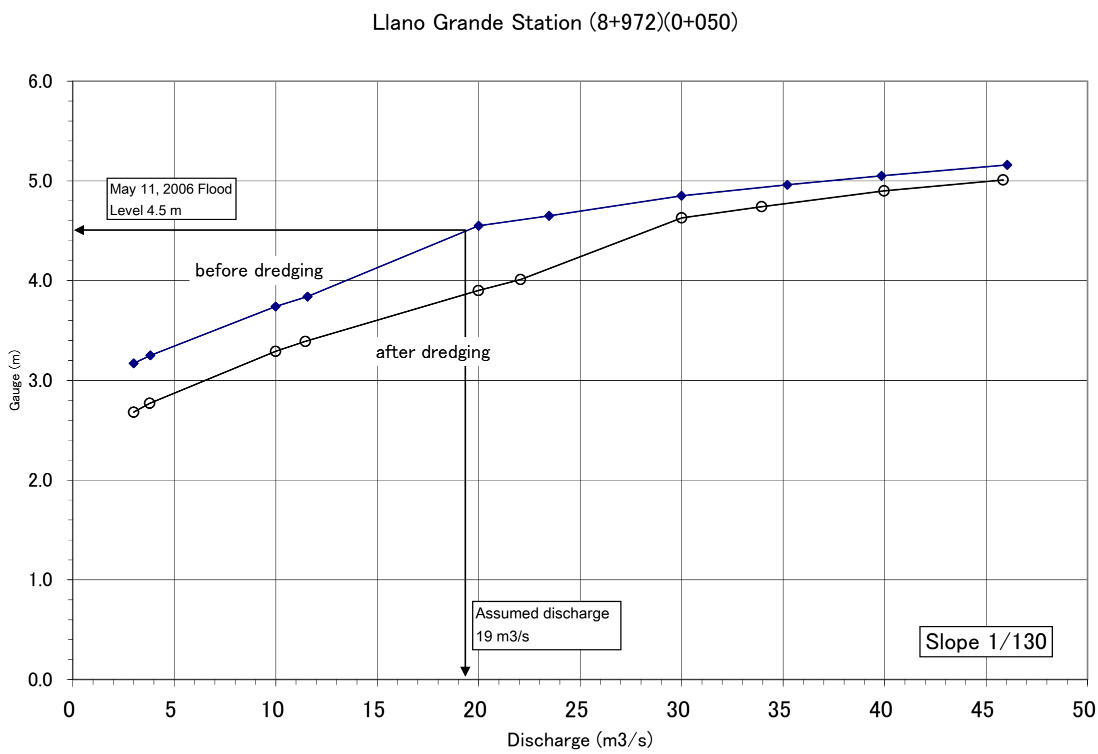


Figure S6-2-18 Waterlevel and Discharge Curve at Llano Grande

Figure S6-2-16 shows the curves before and after dredging. Since the dredging was done after the May 11, 2006 flood, the discharge was assumed as before dredging.

2.3.2 Hydrological Calculation

The entire Soacha river basin was delineated into thirteen (13) sub-catchments as shown in Figure S6-2-19.

In May 11, 2006 flood, the only measured rainfall data was that of IDEAM San Jorge. Using this rainfall, the peak discharge was estimated by rational method as shown in Table S6-2-4.

Table S6-2-5 is the comparison between flood mark discharge and rainfall assumed discharge. The flood mark discharge was indicated in Figure S6-2-12, Figure S6-2-14 and Figure S6-2-16. The Manning's roughness was 0.04. The flood mark discharges at Fusunga and Ladrillera Santa Fe are higher than those by rational method. It is regarded that more rainfall in the upper part and middle part had during the May 11, 2006. From this result, in the Soacha river basin, one rainfall station in the upper part and one rainfall station in the middle part are required in order to monitor the rainfall distribution in area.

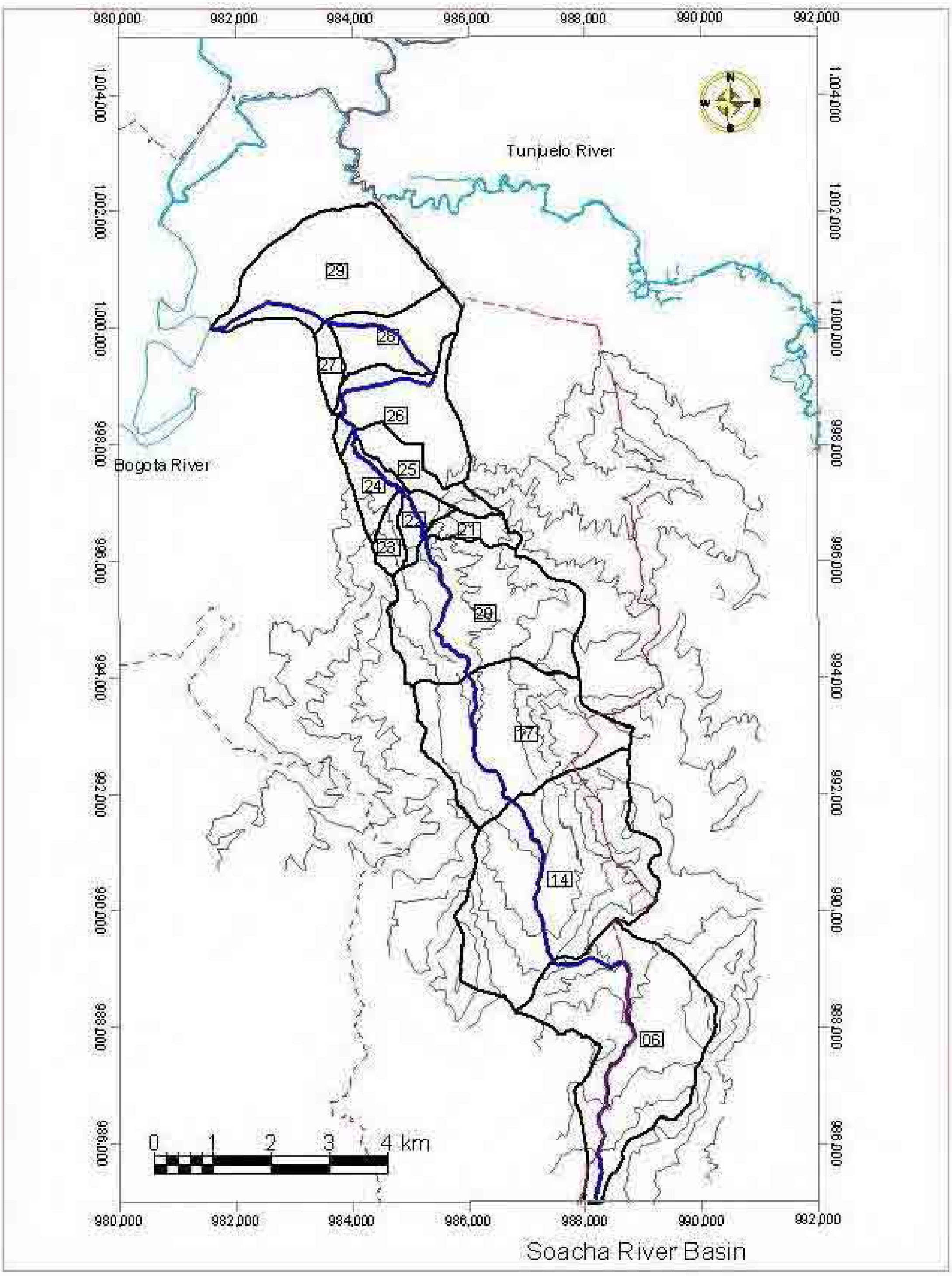


Figure S6-2-19 Sub-catchment of Soacha River Basin

Table S6-2-4 Assumed Peak Discharge by Rational Method

Location	Catchment Area (A)	Concentration Time	Rainfall Intensity (R)	Peak discharge (Q)
Fusunga	14.85 km^2 (No.1 to No.11)	0.72 hour (43 minutes)	7.0 mm /40 min. = 10.5 mm / hour	Q=1/3.6*0.5*10.5*14.85=21.7 m^3/s
Prison	25.43 km^2 (No.1 to No.18)	1.15 hour (69 minutes)	7.7 mm/70min.= 6.6 mm/hr	Q=1/3.6*0.5*6.6*25.43=23.3 m^3/s
Ladrillera Santa Fe	31.20 km^2 (No.1 to No.22)	1.33 hour (80 minutes)	7.8 mm / 80min.= 5.9 mm / hr	Q=1/3.6*0.5*5.9*31.2=25.6 m^3/s

Table S6-2-5Comparison of Flood Mark Discharge and Rainfall assumed Discharge

Location	Flood Mark Discharge	Rainfall assumed Discharge
Fusunga	37 m^3/s	21.7 m^3/s
Prison	22 m^3/s	23.3 m^3/s
Ladrillera Santa Fe	35 m^3/s	25.6 m^3/s

CHAPTER 3 HYDROLOGICAL MODELING

3.1 Methodology

3.1.1 Sub-catchment delineation

(1) Chiguaza Creek

There is a significant point in the catchment called “Los Puentes”, which is a kind of narrow, neck point resulted from the break of fault. The Los Puentes upstream area is an alluvial fan which has several tributaries of the Chiguaza. The main tributaries are Qda. Las Mercedes, Qda. Melo, Qda. Chorro Colorado, Qda. Seca, Qda. Nutria and Qda. Chiguaza as a tributary. These tributaries are joining until the Los Puentes to form the main Chiguaza stream toward to the Rio Tunjuelo.

The Chiguaza creek basin (18.87 km^2) was divided into 3 sub-areas such as downstream, middle stream and upstream. The boundary of the down stream and middle stream is Avenida Caracas. The boundary of the middle stream and the upstream is Los Puentes. The upstream basin is composed of Nutria creek system, Chiguaza creek system and Colorado creek system.

The boundary of the Chiguaza creek basin is basically same as the shape file which was provided by DPAE in the beginning of the JICA Study in 2006, however, partially it was corrected by the Study Team referring the 10 meter interval contour line. In the Study, the catchment was divided into forty four (44) sub-catchment (Figure S6-3-1).

(2) Santa Librada Creek

The sub-catchment delineation of the Santa Librada is shown in Figure S6-3-2. The most downstream end was defined at Caracas Avenue where the creek is crossing and entering the quarry site.

(3) Yomasa Creek

The sub-catchment delineation of the Yomasa creek is shown in Figure S6-3-3. The Alemana station (EAAB) is located at the downstream of sub-catchment 02.

(4) La Estrella and Trompeta

The sub-catchment delineation of the La Estrella-Trompeta creek is shown in Figure S6-3-4. Boyaca Avenue was defined as the most downstream edge of these two (2) creeks. The sub-catchment of La Estrella and Trompeta creek are given labels “E” and “T”, respectively.

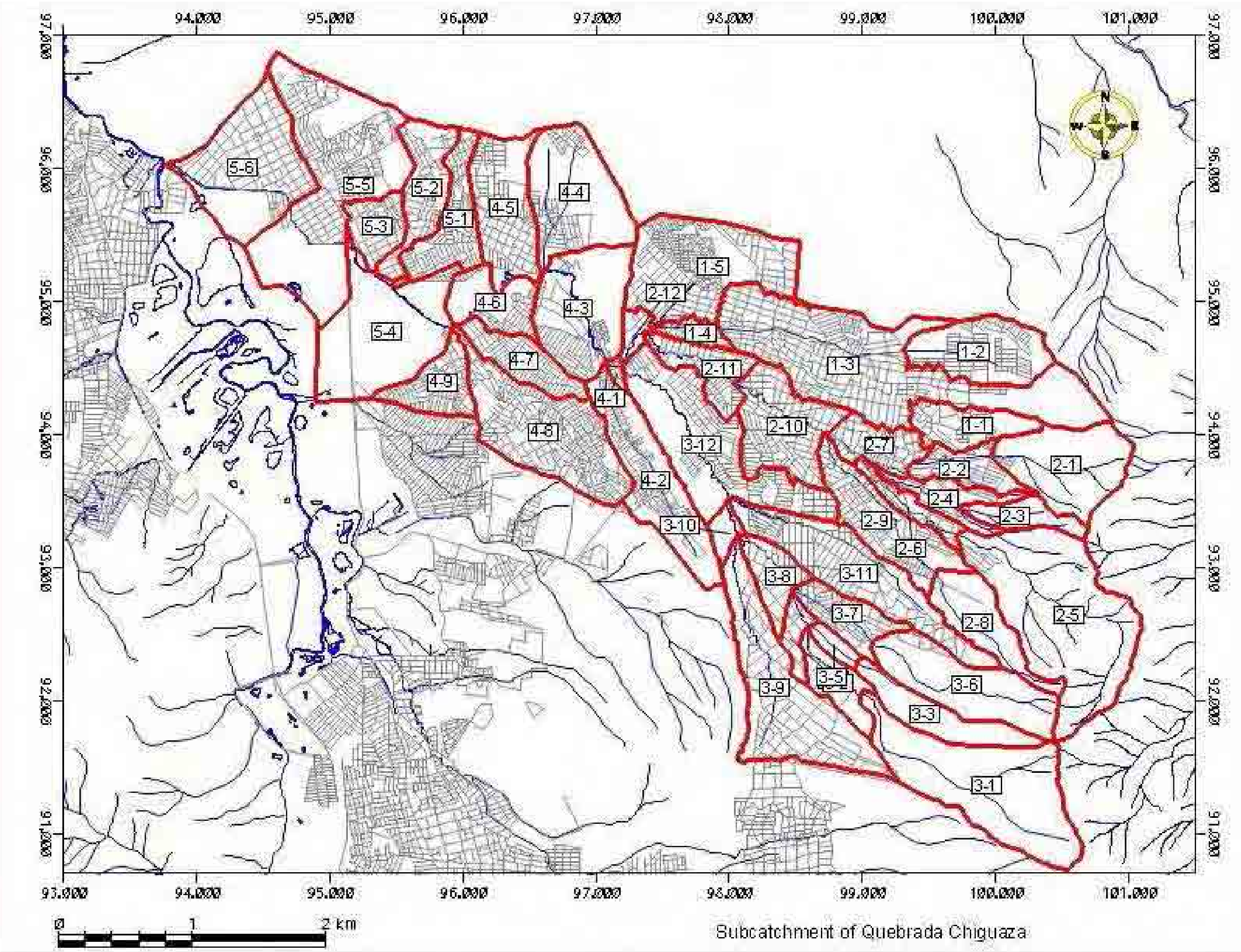


Figure S6-3-1 Subcatchment of Chiguaza Creek

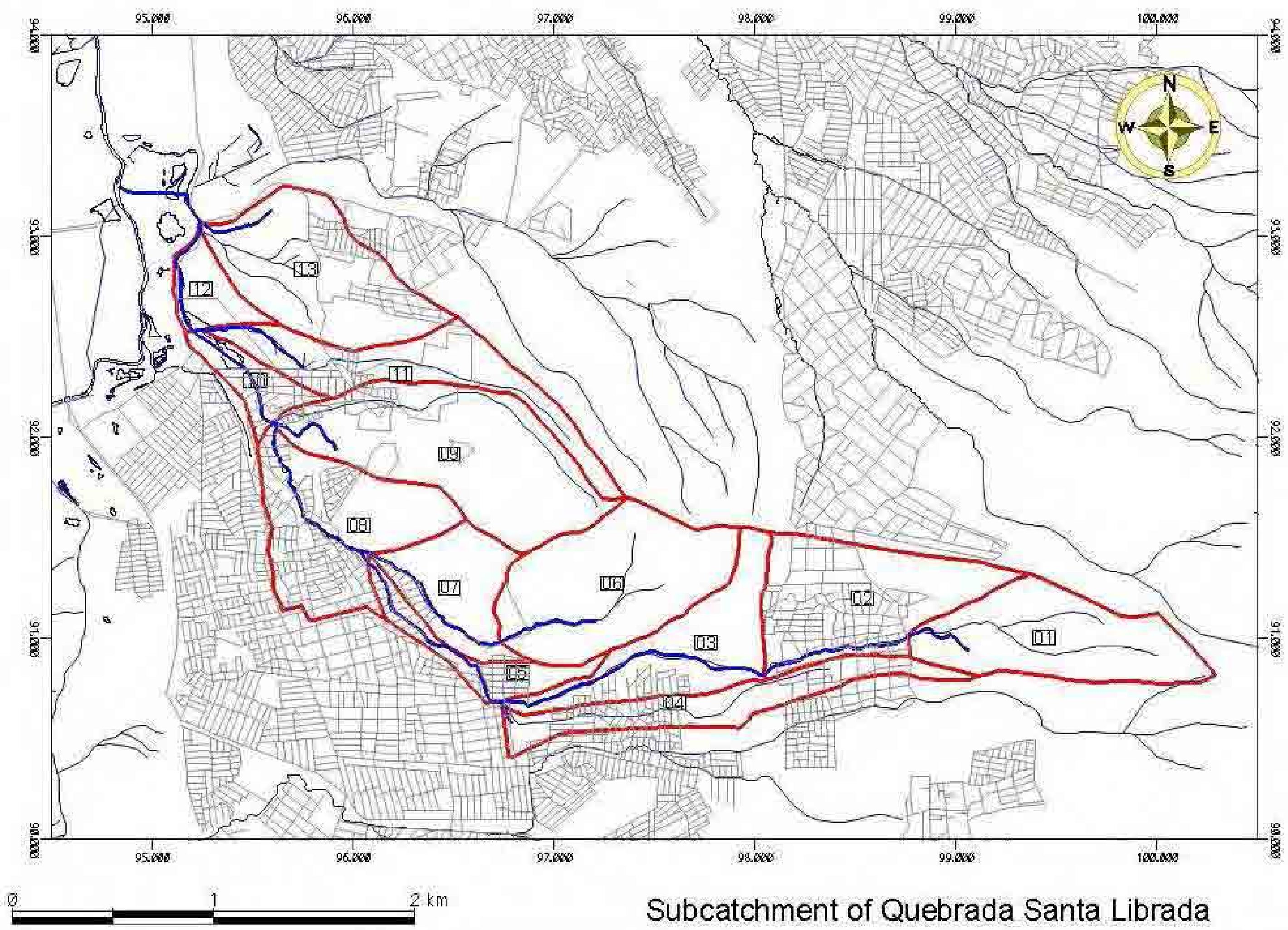


Figure S6-3-2 Subcatchment of Santa Librada Creek

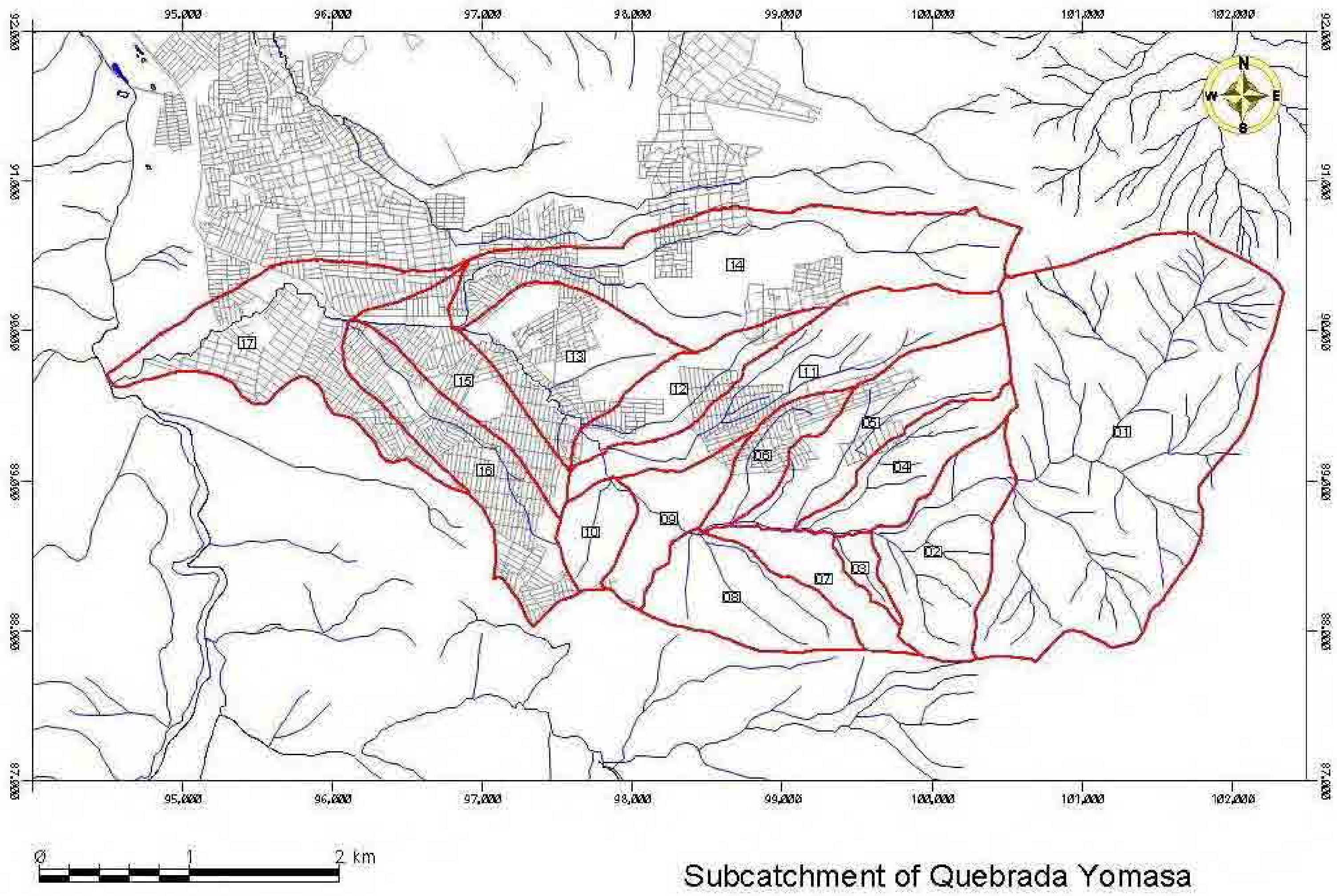


Figure S6-3-3 Subcatchment of Yomasa Creek

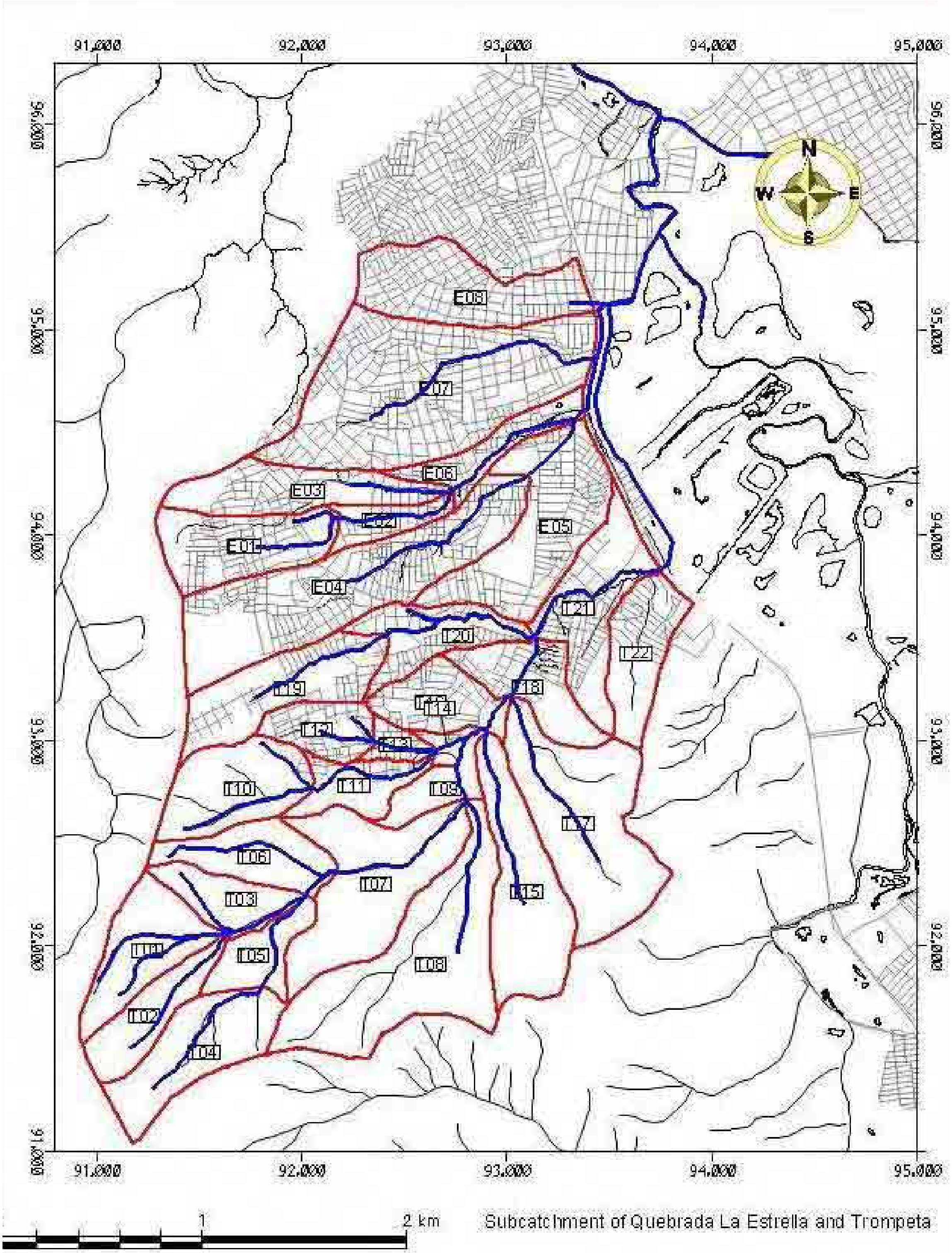


Figure S6-3-4 Subcatchment of La Estrella – Trompeta Creek

(5) Soacha River

Figure S6-3-5 also showed the subcatchment delineation for the Soacha River basin. The delineation was followed the Soacha Master Plan Study (EAAB). The total number of the subcatchment is twenty nine (29). In the Soacha river basin, the frequently flood- affected areas are located downstream and the available rainfall data is quite few, so that the small subcatchment in the upper and middle are to be combined. The target area for the early warning system is just downstream of the Subcatchment No.23. Thus the area for subcatchment No.1 to No.20 was simplified into four (4) main catchments.

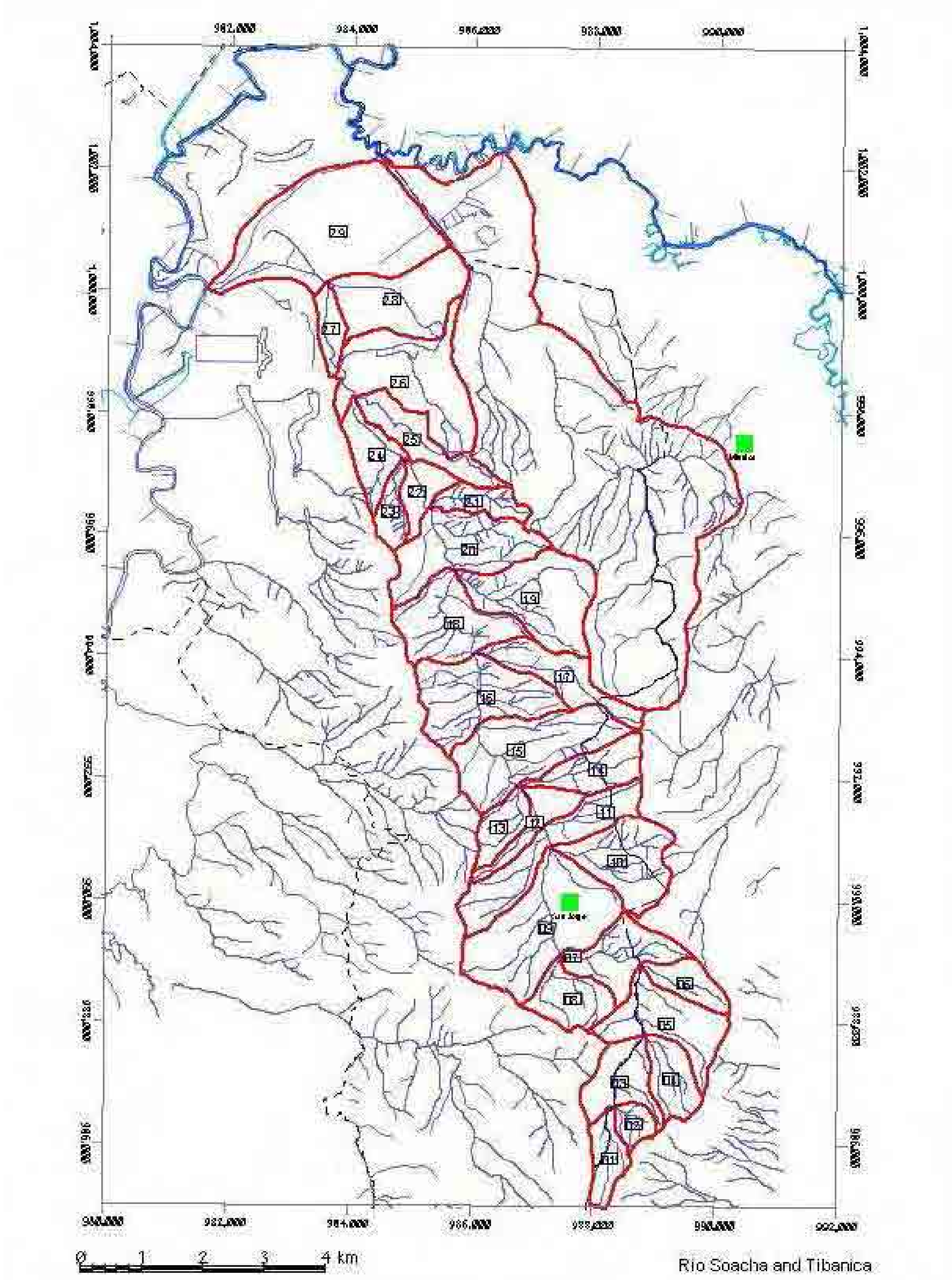


Figure S6-3-5 Subcatchment of Soacha River Basin (1)

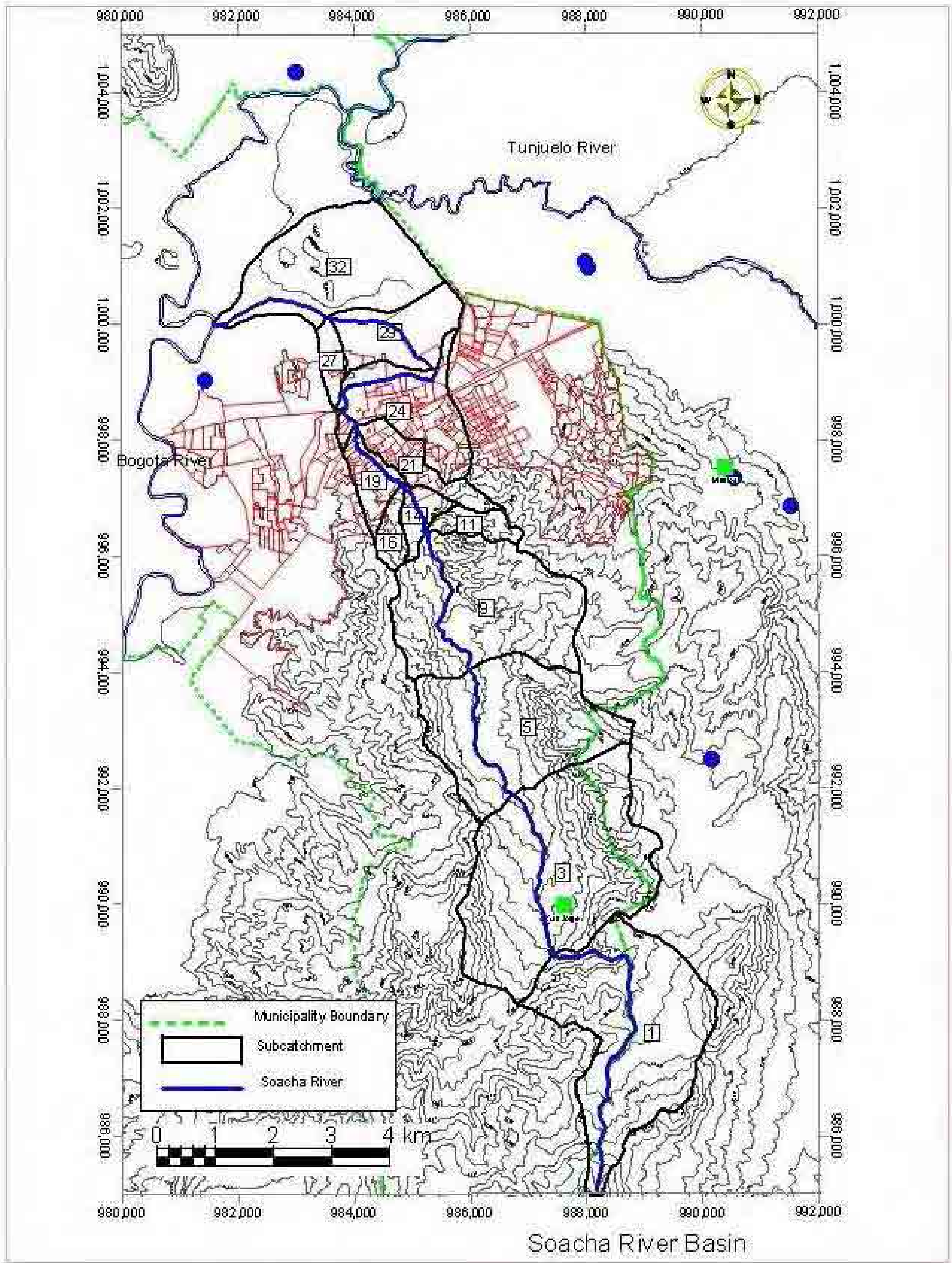


Figure S6-3-6 Subcatchment of Soacha River Basin (2)

(6) Tibanica River

Figure S6-3-7 shows the sub-catchment of the Tibanica River basin. Runoff from the upper area is controlled by the Terreros Dam. So at the dam site, the upper area was treated as single sub-catchment.

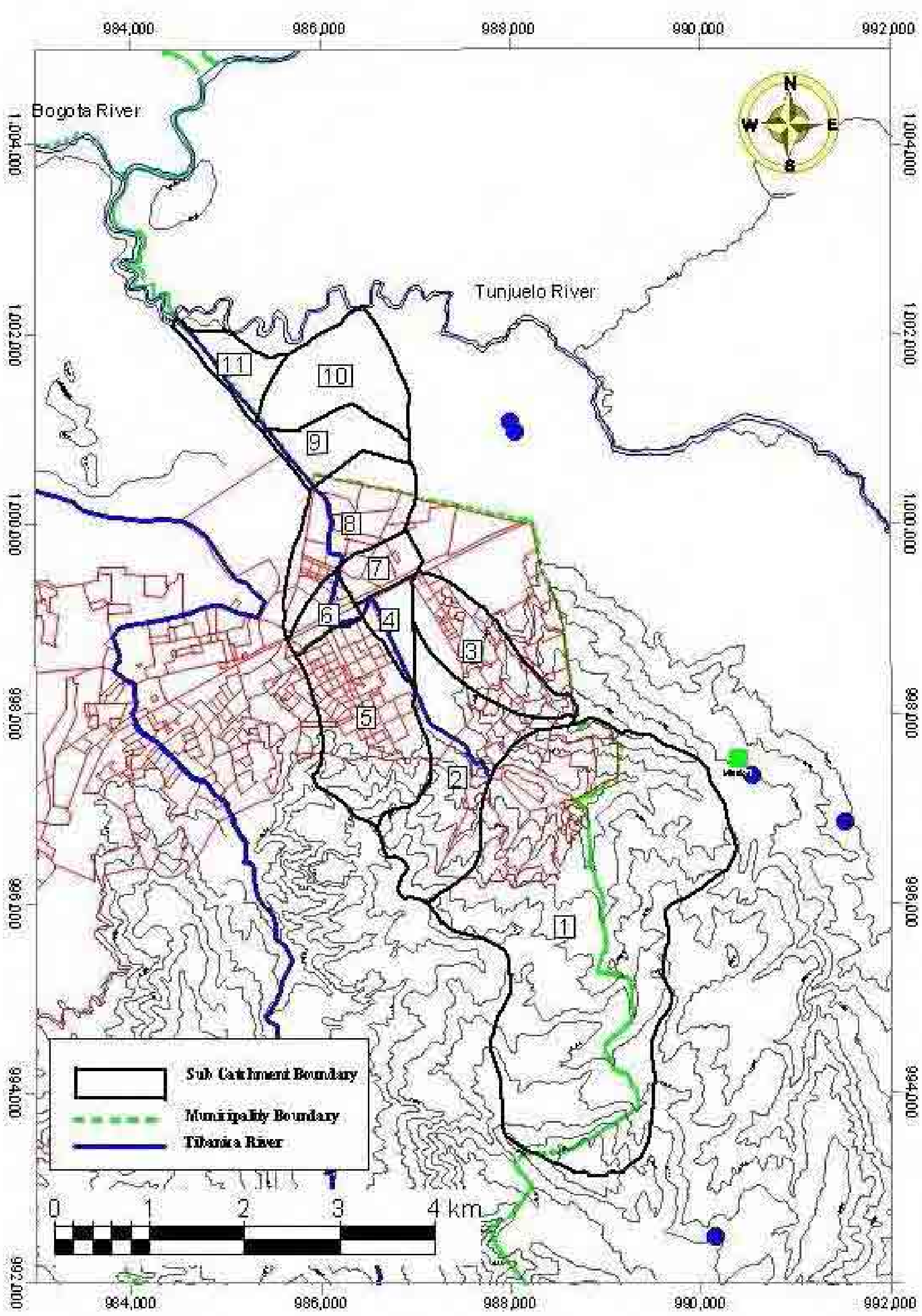


Figure S6-3-7 Subcatchment of Tibanica River Basin

3.1.2 Rainfall Runoff Model

(1) Rational Method for the Creeks in Bogota and Tibanica River

$$I = C_1 \times (d + X_0)^{C_2}$$

Where I: rainfall intensity (mm/h), d: duration (minutes).

Rational Method

$$Q = \frac{1}{3.6} C \times I \times A$$

Where Q: peak discharge (m^3/s), C: runoff coefficient, I: rainfall intensity (mm/hr) during the concentration time, A: catchment area (km^2).

(2) Storage Function Model for the Soacha River

The Soacha river basin is the largest among the Study Area catchment. The total catchment area is forty four (44) km^2. The upper part of the basin is covered by short vegetation, so that the rainwater storage should be considered in the hydrological model in the Study. The Study Team applied storage function model for the Soacha River.

The outline of the storage function model is as follows,

The model is composed of storage functions for catchment and channel (river course). The storage function for catchment is as follows,

$$s = KQ^p$$

$$\frac{\partial s}{\partial t} = r_{ave} - q(t + T_L)$$

K, p : *coefficient of storage function*

T_L : *time of flood retarding (hour)*

r_{ave} : rainfall subcatchment average (mm/h)

Q : runoff depth (mm/h)

s : storage depth (mm/h)

The storage function for channel is as follows,

$$S = KQ^p - T_L Q$$

$$\frac{\partial S}{\partial t} = Q_{in} - Q(t + T_{LZ})$$

K, p : coefficient of storage function

T_L, T_{LZ} : time of flood retarding in channel (hour)

Q_{in} : inflow to channel (m^3/s)

Q : outflow from channel (m^3/s)

s : storage depth (m^3)

The coefficient for catchment, K and p are calculated by the following formula.

$$K = 43.4 \times C \times I^{(-1/3)} \times L^{(-1/3)}$$
$$p = 1/3$$

L : length of river course (km)

I : Average of slope of catchment

C : roughness coefficient for catchment (natural catchment C = 0.12, urban area C = 0.012)

The T_L for catchment was set to be zero because of the small subcatchment.

The coefficient for channel, K and p were set to zero because of the small channel in the Soacha river. The time of flood retarding in channel was calculated using Kraven's criteria.

The parameters for channel and catchment of the Soacha river basin are shown in Table S6-3-3 and Table S6-3-4, respectively.

(3) Concentration time and travel time

For the most upstream subcatchment, Kirpich formula is used to calculate the concentration time.

$$t_c = 0.06628 \times L^{0.77} \times S^{-0.385}$$

where L : *km*, S : *slope*, t_c : Concentration time in hour

Travel time

When a basin is divided like Figure S6-3-8, the Kirpich way should be applied to only SB1. The Tc at "D" should be evaluated like below

Tc(D) = travel time (from D to A) + Tc (A)

The travel time from D to A can be evaluated by creek length and the slope. The Rziha formula was used to calculate the travel time.

$$T = \frac{L}{72\left(\frac{H}{L}\right)^{0.6}}$$

T : travel time in hour

H : height difference between the upstrema end and the downstream end of creek

L : length of creek

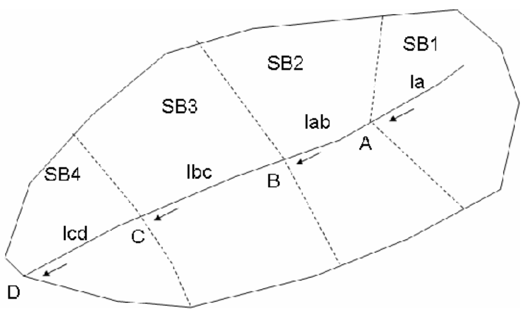
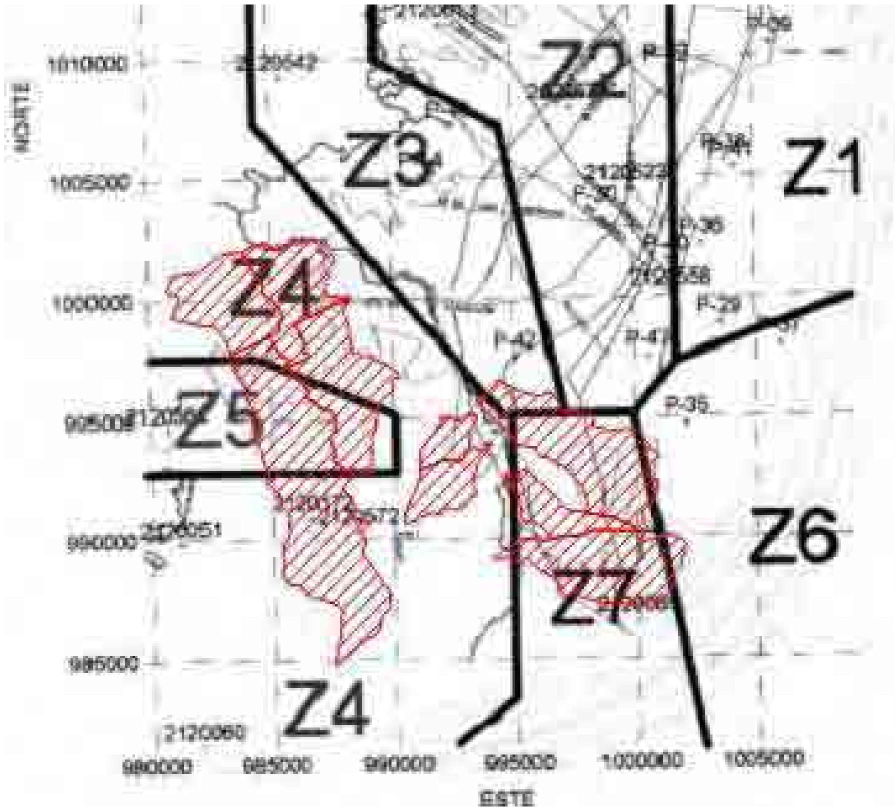


Figure S6-3-8 Concept of Travel time and Concentration Time

(4) Rainfall-Duration-Intensity (IDF) Curve

EAAB has defined a group of IDF curve in and around the Study Area. Figure S6-3-9 shows the zones by EAAB on which the Study Areas are overlapped. In Bogota, the Chiguaza, Santa Librada and Yomasa creek catchment belong to Zone 7, while the La Estrella and Tromepeta catchments belong to Zone 4.



(source: EAAB-IRH Ingenieria y Recursos Hidricos Ltda, Estudio para el analisis y caracterizacion de tormentas en la sabana de bogota volumen 1 Informe General,1995)

Figure S6-3-9 Defined Zones for IDF curve by EAAB

Figure S6-3-10 is the IDF curves of Zone 4 and Zone 7. The 60 minutes rainfall for 100 years return period of Zone 4 and Zone 7 are only 42.0 mm and 38.3 mm, respectively.

Zone 4 La Estrella, Trompeta

PERIODO DE RETORNO (AÑOS)	C1	Xo	C2
3	1413.4	19.0	-0.9539
5	1708.8	18.5	-0.9668
10	1716.3	15.5	-0.9424
25	1979.3	14.5	-0.94
50	2117.9	13.5	-0.9345
100	2301.0	13.0	-0.9331

Duration (minutes)							
5	10	15	30	60	120	180	240
68.2	56.9	48.9	34.5	21.9	12.8	9.1	7.1
80.8	67.0	57.3	40.1	25.2	14.5	10.3	7.9
99.6	81.1	68.5	47.0	29.2	16.8	11.9	9.2
121.3	97.9	82.2	55.9	34.4	19.7	14.0	10.8
138.6	110.8	92.5	62.3	38.2	21.9	15.5	12.0
155.1	123.4	102.7	68.8	42.0	24.0	17.0	13.2

Zone 7 Chiguaza, Yomasa, Santa Librada

PERIODO DE RETORNO (AÑOS)	C1	Xo	C2
3	259.2	0.0	-0.6586
5	320	0.0	-0.6639
10	343.7	-2.0	-0.6422
25	525.7	1.0	-0.6837
50	387.4	-5.0	-0.6054
100	435.4	-5.0	-0.6068

Duration (minutes)							
5	10	15	30	60	120	180	240
89.8	56.9	43.6	27.6	17.5	11.1	8.5	7.0
109.9	69.4	53.0	33.5	21.1	13.3	10.2	8.4
169.7	90.4	66.2	40.4	25.3	16.1	12.3	10.2
154.4	102.0	79.0	50.2	31.6	19.8	15.0	12.4
	146.2	96.1	55.2	34.2	21.9	17.0	14.2
	164.0	107.7	61.7	38.3	24.5	19.0	15.9

(source: EAAB-IRH Ingenieria y Recursos Hidricos Ltda, Estudio para el analisis y caracterizacion de tormentas en la sabana de bogota volumen 1 Informe General,1995)

Figure S6-3-10 EAAB IDF data in Study Area in Bogota

For Soacha and Tibanica river, the IDF curver Zone 4 was applied.

(5) Landuse (Runoff Coefficient) for Rational Method

Landuse of each sub-catchment was simply categorized as urban area, industrial and rural area based on GIS attribute. In order to calculate composite runoff coefficient, the runoff coefficient for urban area, industrial and rural area were assumed to be 0.8, 0.5 and 0.3, respectively.

Table S6-3-1 Landuse and Runoff Coefficient of Chiguaza and Santa Librada

Landuse of Chiguaza Creek Catchment

Main subcatchment	Subcatchment name	COMERCIO AGLOMERADO	EQUIPAMIENTOS COLECTIVOS	RECUPERACION MORFOLOGICA	SERVICIOS URBANOS BASICOS	INDUSTRIAL	MULTIPLE	RESIDENCIAL	RESIDENCIAL CON ACTIVIDAD ECONOMICA	RESIDENCIAL CON COMERCIO Y SERVICIOS	PARQUE MINERO INDUSTRIAL	ALTA CAPACIDAD (RURAL)	SUELO URBANO Y DE EXPANSION	MANEJO ESPECIAL	ALTA FRAGILIDAD	SISTEMA DE AREAS PROTEGIDAS (RURAL)	NO DATA	AREA TOTAL	AREA SUB CUENCA	DIFERENCIA	Urban Area C=0.8	Industrial Park C=0.5	Rural Area C=0.3	Composite Runoff Coeffcient
up	1-1								142,014	69,915						25,342		237,271	237,288	17	211,929	0	25,359	0.75
up	1-2							232,142								71,874		304,016	420,988	116,972	-	0	420,988	0.30
up	1-3	1,177	3,352					41,184	1,012,516	79,504						216,742	2,031	1,356,506	1,356,629	123	1,092,020	0	264,609	0.70
up	1-4								77,113								6,083	83,196	83,316	120	77,113	0	6,203	0.76
up	1-5	131,193	88,555						539,039								300	759,087	759,087	0	539,039	0	220,048	0.66
up	2-1									23,189						469,752		492,941	511,094	18,153	23,189	0	487,905	0.32
up	2-2								54,752	73,406						20,027		148,186	192,158	43,972	128,158	0	64,000	0.63
up	2-3								2,592	29,137						116,716		148,445	151,526	3,081	31,730	0	119,796	0.40
up	2-4								83,888	36,626						15,966	195	136,674	184,278	47,604	120,513	0	63,765	0.63
up	2-5							26,144		285						1,088,592		1,115,022	1,150,382	35,360	285	0	1,150,097	0.30
up	2-6							14,336	48,468	2,157							269	65,230	123,446	58,216	50,625	0	72,821	0.51
up	2-7								169,743									169,743	214,383	44,640	169,743	0	44,640	0.70
up	2-8							39,901								265,582		305,482	320,205	14,723	-	0	320,205	0.30
up	2-9							116,600	128,210	141,905						4,767	0	391,482	442,794	51,312	270,115	0	172,679	0.61
up	2-10								406,553	13,808							2	420,363	475,688	55,325	420,361	0	55,327	0.74
up	2-11								127,733	47,065							319	175,118	227,800	52,682	174,799	0	53,001	0.68
up	2-12								40,132									40,132	63,473	23,341	40,132	0	23,341	0.62
up	3-1							4,086								900,259	879	905,224	919,023	13,799	-	0	919,023	0.30
up	3-2							50,605	59,628							16,330		126,563	187,763	61,200	59,628	0	128,135	0.46
up	3-3															242,253	30,305	272,558	289,880	17,322	-	0	289,880	0.30
up	3-4							28,890	3,834								5,238	37,961	61,030	23,069	3,834	0	57,196	0.33
up	3-5								68,893									68,893	90,605	21,712	68,893	0	21,712	0.68
up	3-6								29,744							433,033	57,708	520,486	538,886	18,400	29,744	0	509,142	0.33
up	3-7								171,905								31,922	203,827	220,229	16,402	171,905	0	48,324	0.69
up	3-8								142,407								3	142,411	188,308	45,897	142,407	0	45,901	0.68
up	3-9							19,056	560,181							57,335	77,319	713,891	782,973	69,082	560,181	0	222,792	0.66
up	3-10								3,430								43,173	46,604	69,322	22,718	3,430	0	65,892	0.32
up	3-11							32,116	377,785	39,453						59,531	2,909	511,794	643,431	131,637	417,238	0	226,193	0.62
up	3-12								376,119	105,063								481,183	796,275	315,092	481,183	0	315,092	0.60
middle	4-1								10,256								3,656	13,911	23,469	9,558	10,256	0	13,213	0.52
middle	4-2							196,106	93,145								257,776	547,027	547,878	851	93,145	0	454,733	0.39
middle	4-3							1,092	189,823	106,735							177,467	475,117	577,820	102,703	296,558	0	281,262	0.56
middle	4-4						141,155	60,739	125,027	85,475							157,555	569,950	588,735	18,785	210,502	0	378,233	0.48
middle	4-5		3	16,462			18	6,722	281,046	142,766								447,016	464,472	17,456	440,273	0	24,199	0.77
middle	4-6			78,803					123,355	13,065								215,223	258,121	42,898	215,223	0	42,898	0.72
middle	4-7								234,944									234,944	238,589	3,645	234,944	0	3,645	0.79
middle	4-8							87,516	632,276								6,603	726,396	727,695	1,299	632,276	0	95,419	0.73
middle	4-9				1,768				232,528								405	234,702	234,850	148	232,528	0	2,322	0.80
down	5-1							2,332	109,935	202,648							2,348	317,263	318,103	840	312,583	0	5,520	0.79
down	5-2			29,030					153,043	131,440								313,512	315,327	1,815	313,512	0	1,815	0.80
down	5-3								79,944	99,510								179,454	182,678	3,224	179,454	0	3,224	0.79
down	5-4			70,249	577,762				9,625	25,582								683,217	779,198	95,981	105,455	0	673,743	0.37
down	5-5			111,533	199,479				676,003	23,269							2,765	1,013,049	1,199,234	186,185	810,805	0	388,429	0.64
down	5-6				16,764	5,931			463,999									486,694	714,887	228,193	463,999	0	250,888	0.62
																	TOTAL	16,837,766	18,873,316	2,035,550	9,839,709	0	9,033,607	

Landuse of Santa Librada Creek Catchment

Main subcatchment	Subcatchment name	COMERCIO AGLOMERADO	EQUIPAMIENTOS COLECTIVOS	RECUPERACION MORFOLOGICA	SERVICIOS URBANOS BASICOS	INDUSTRIAL	MULTIPLE	RESIDENCIAL	RESIDENCIAL CON ACTIVIDAD ECONOMICA	RESIDENCIAL CON COMERCIO Y SERVICIOS	PARQUE MINERO INDUSTRIAL	ALTA CAPACIDAD (RURAL)	SUELO URBANO Y DE EXPANSION	MANEJO ESPECIAL	ALTA FRAGILIDAD	SISTEMA DE AREAS PROTEGIDAS (RURAL)	NO DATA	AREA TOTAL	AREA SUB CUENCA	DIFERENCIA	Urban Area	Industrial Park	Rural Area	Runoff Coeffcient
	01								1,801							504,797		506,598	509,297	2,699	1,801	0	507,496	0.30
	02							15,779	352,062							163,358	18,020	549,219	550,086	867	352,062	0	198,023	0.62
	03							202,414	3,465								209,003	414,882	414,882	-0	3,465	0	411,417	0.30
	04							175,267	125,180							16,632		317,078	317,078	-0	125,180	0	191,899	0.50
	05			14				40,010	97,949								19,919	157,892	157,892	0	97,963	0	59,929	0.61
	06			124,033				67,297									450,120	641,450	641,450	-0	124,033	0	517,418	0.40
	07			201,899				10,514	54,005								26,556	292,975	292,975	-0	255,904	0	37,070	0.74
	08			214,229					313,540								6,693	534,462	534,462	0	527,769	0	6,693	0.79
	09			405,769					51,172								309,238	766,179	766,179	-0	456,941	0	309,238	0.60
	10			437			38,339		87,504									126,280	126,280	-0	87,941	0	38,339	0.65
	11			134,283			85,769		32,313								152,165	404,529	404,529	-0	166,595	0	237,934	0.51
	12			6,055			92,437											98,492	127,362	28,870	6,055	0	121,307	0.32
	13			135,600	11,380		263,450		135,938								2,310	548,679	553,307	4,628	271,539	0	281,768	0.55
																	TOTAL	5,358,715	5,395,778	37,064	2,477,249	-	2,918,530	

Table S6-3-2 Landuse and Runoff Coefficient of Yomasa and La Estrella Trompeta

Landuse of Yomasa Creek Catchment

Main subcatchment	Subcatchment name	COMERCIO AGLOMERADO	EQUIPAMIENTOS COLECTIVOS	RECUPERACION MORFOLOGICA	SERVICIOS URBANOS BASICOS	INDUSTRIAL	MULTIPLE	RESIDENCIAL	RESIDENCIAL CON ACTIVIDAD ECONOMICA	RESIDENCIAL CON COMERCIO Y SERVICIOS	PARQUE MINERO INDUSTRIAL	ALTA CAPACIDAD (RURAL)	SUELO URBANO Y DE EXPANSION	MANEJO ESPECIAL	ALTA FRAGILIDAD	SISTEMA DE AREAS PROTEGIDAS (RURAL)	NO DATA	AREA TOTAL	AREA SUB CUENCA	DIFERENCIA	Urban Area	Industrial Park	Rural Area	Runoff Coeffcient
	01															3,924,897		3,924,897	3,933,717	8,820	-	0	3,933,717	0.30
	02															847,675		847,675	847,675	-0	-	0	847,675	0.30
	03															97,765		97,765	104,285	6,520	-	0	104,285	0.30
	04								12,923							2,177	6	15,105	511,556	496,451	12,923	0	498,633	0.31
	05								143,936				6,380			472,080	20	622,415	787,301	164,886	143,936	0	643,365	0.39
	06								181,319				287			20,106	1	201,713	317,103	115,390	181,319	0	135,784	0.59
	07													2,854	72,724	252,686		328,264	355,020	26,756	-	0	355,020	0.30
	08											914		168,369	371,359	103,501		644,143	700,586	56,443	-	0	700,586	0.30
	09							186	25,400				11					25,596	414,929	389,333	25,400	0	389,529	0.33
	10							37,248	29,288									66,536	271,861	205,325	29,288	0	242,573	0.35
	11							65,359	221,632				13,167			606,700	606,700	1,513,557	1,067,486	-446,071	221,632	0	845,854	0.40
	12							210,858	210,858				141			23,660	181	445,699	514,139	68,440	210,858	0	303,281	0.51
	13						417	31,956	546,190								720	579,283	896,959	317,676	546,190	0	350,769	0.60
	14							484,389	550,068							866,208	0	1,900,665	2,014,165	113,500	550,068	0	1,464,097	0.44
	15						64,475	34,149	388,748	61,853								549,226	587,809	38,583	450,601	0	137,208	0.68
	16						13	39,497	695,206	144,592								879,309	882,706	3,397	839,799	0	42,907	0.78
	17			62,071	11,108				746,755	225,498								1,045,432	1,222,019	176,587	1,034,324	0	187,695	0.72
																	TOTAL	13,687,282	15,429,316	1,742,034	4,246,336	-	11,182,980	

Landuse of La Estrella Trompeta Creek Catchment

Main subcatchment	Subcatchment name	COMERCIO AGLOMERADO	EQUIPAMIENTOS COLECTIVOS	RECUPERACION MORFOLOGICA	SERVICIOS URBANOS BASICOS	INDUSTRIAL	MULTIPLE	RESIDENCIAL	RESIDENCIAL CON ACTIVIDAD ECONOMICA	RESIDENCIAL CON COMERCIO Y SERVICIOS	PARQUE MINERO INDUSTRIAL	ALTA CAPACIDAD (RURAL)	SUELO URBANO Y DE EXPANSION	MANEJO ESPECIAL	ALTA FRAGILIDAD	SISTEMA DE AREAS PROTEGIDAS (RURAL)	NO DATA	AREA TOTAL	AREA SUB CUENCA	DIFERENCIA	Urban Area	Industrial Park	Rural Area	Runoff Coeffcient
Estrella	E01							14,534	236,260								11,230	262,023	262,023	-0	236,260	0	25,763	0.75
Estrella	E02							17,126	43,924	1,710							26,949	89,709	89,709	-0	45,634	0	44,075	0.55
Estrella	E03							18,546	216,001								11,792	246,339	246,339	0	216,001	0	30,338	0.74
Estrella	E04							77,160	396,535	42,409	107,022						63	623,190	623,197	7	438,944	107,022	77,230	0.69
Estrella	E05							111,725	303,644								771	416,139	416,560	420	303,644	0	112,916	0.66
Estrella	E06							13,298	93,847	5,160							22,933	135,237	135,237	-0	99,007	0	36,231	0.67
Estrella	E07							28,122	807,972									836,094	836,095	0	807,972	0	28,122	0.78
Estrella	E08								337,624									337,624	337,624	-0	337,624	0	-0	0.80
Trompeta	T01										239,646							239,646	239,646	0	-	239,646	0	0.50
Trompeta	T02										166,422							166,422	166,422	0	-	166,422	0	0.50
Trompeta	T03										138,826							138,826	138,826	-0	-	138,826	-0	0.50
Trompeta	T04										286,632							286,632	286,632	0	-	286,632	0	0.50
Trompeta	T05										126,361							126,361	126,361	-0	-	126,361	-0	0.50
Trompeta	T06										196,553							196,553	196,553	-0	-	196,553	-0	0.50
Trompeta	T07										437,407							437,407	437,407	0	-	437,407	0	0.50
Trompeta	T08										579,952							579,952	579,952	0	-	579,952	0	0.50
Trompeta	T09										92,364							92,364	97,892	5,528	-	92,364	5,528	0.49
Trompeta	T10								15,123		250,886							266,009	266,297	288	15,123	250,886	288	0.52
Trompeta	T11								25,383		99,839							125,221	131,141	5,920	25,383	99,839	5,920	0.55
Trompeta	T12							2,518	2,518		13,834							18,870	127,538	108,668	2,518	13,834	111,186	0.33
Trompeta	T13								34,906		4,215							39,121	45,398	6,277	34,906	4,215	6,277	0.70
Trompeta	T14								2,155		8,719							10,874	30,226	19,352	2,155	8,719	19,352	0.39
Trompeta	T15										352,742							352,742	356,614	3,871	-	352,742	3,871	0.50
Trompeta	T16								131,936		1,577							133,513	169,462	35,949	131,936	1,577	35,949	0.69
Trompeta	T17										492,085							492,085	501,803	9,719	-	492,085	9,719	0.50
Trompeta	T18								92,124		61,170						436	153,731	195,345	41,613	92,124	61,170	42,050	0.60
Trompeta	T19							51,874	132,277		104,582						444	289,178	289,448	270	132,277	104,582	52,589	0.60
Trompeta	T20								147,444									147,444	188,794	41,349	147,444	0	41,349	0.69
Trompeta	T21							63,852	146,551		20,210							230,613	291,790	61,177	146,551	20,210	125,029	0.56
Trompeta	T22						9,268	70,335	104,578		14,397							198,577	201,160	2,583	104,578	14,397	82,185	0.57
																	TOTAL	7,668,497	8,011,488	342,991	3,320,081	3,795,441	895,966	

3.2 Hydrological Model

3.2.1 Chiguaza

Figure S6-3-11 shows the schematic tree of the hydrological model of the Chiguaza creek. In this figure, a triangle having a number such as 2-1 is a sub-catchment and its number. The number like [X] means a number of discharge points. They can be referred in Table S6-3-5.

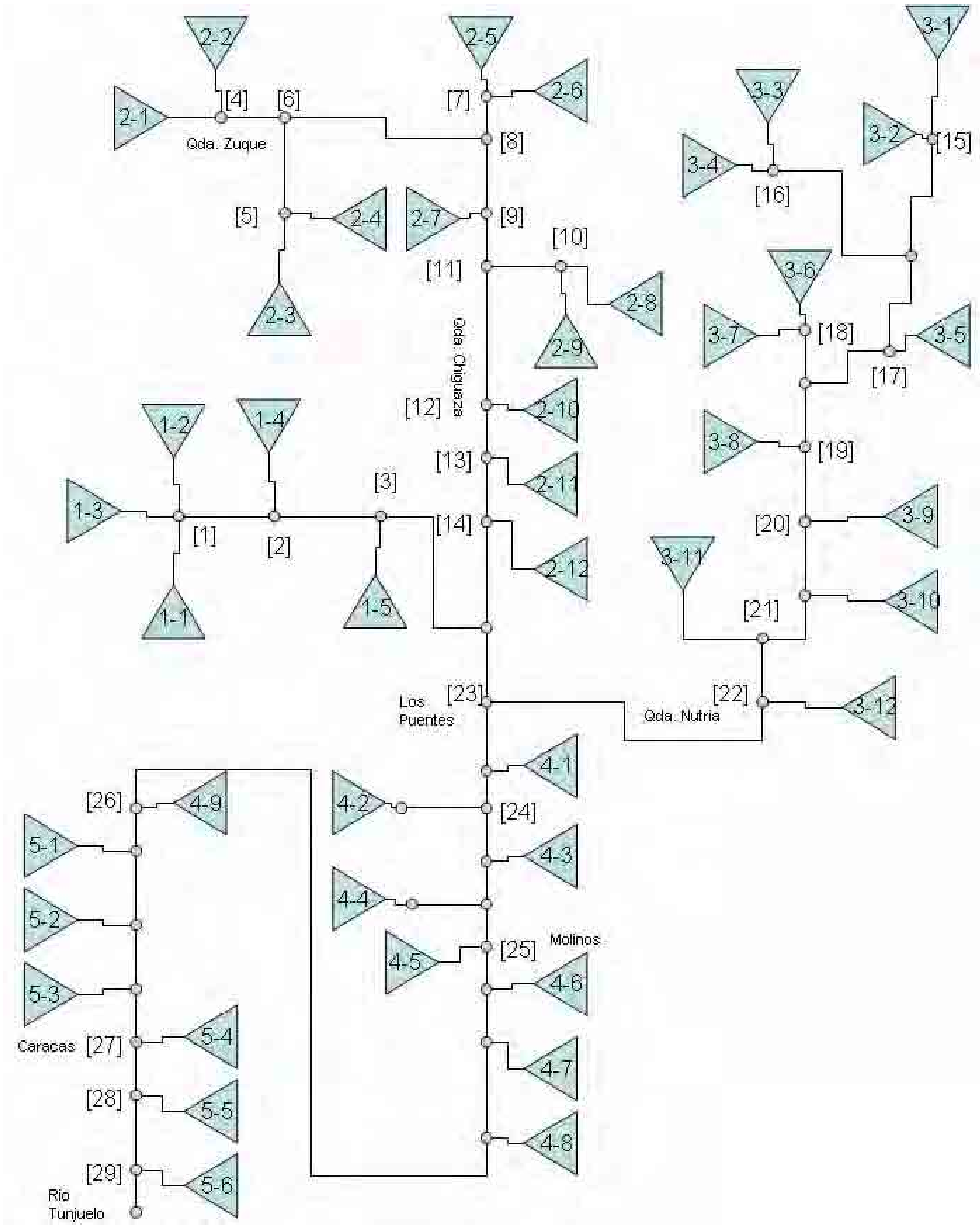


Figure S6-3-11 Hydrological Model Tree for Chiguaza Creek

3.2.2 Santa Librada

Figure S6-3-12 shows the schematic tree of the hydrological model of the Santa Librada creek. In this figure, a triangle having a number such as 2 is a sub-catchment and its number. The number like [X] means a number of discharge points. They can be referred in Table S6-3- 6.

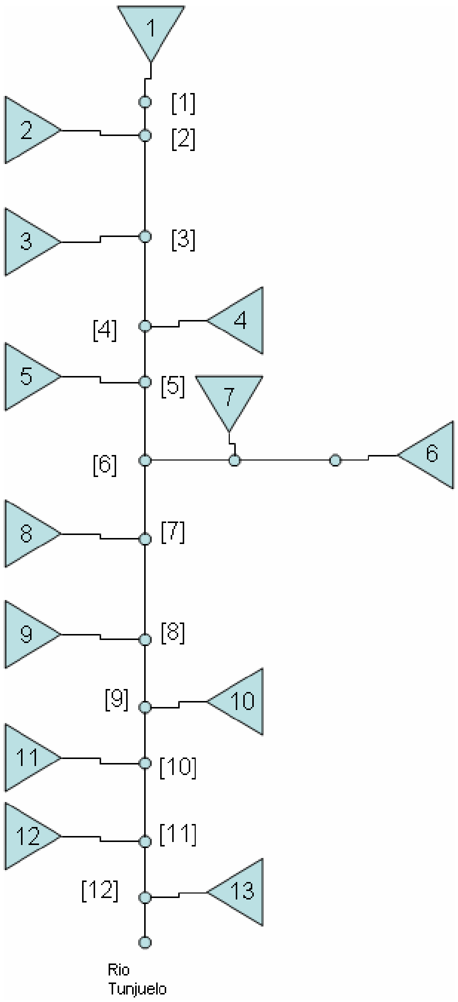


Figure S6-3-12 Hydrological Model Tree for Santa Librada Creek

3.2.3 Yomasa

Figure S6-3-13 shows the schematic tree of the hydrological model of the Yomasa creek. In this figure, a triangle having a number such as 2 is a sub-catchment and its number. The number like [X] means a number of discharge points. They can be referred in Table S6-3-7.

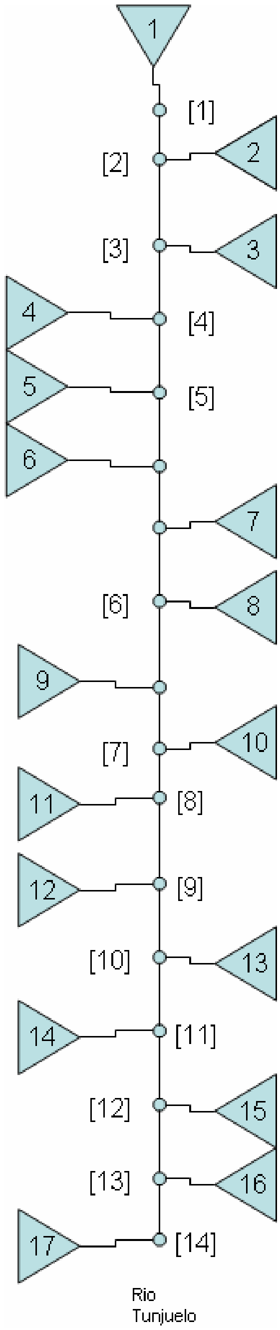


Figure S6-3-13 Hydrological Model Tree for Yomasa Creek

3.2.4 La Estrella and Trompeta

Figure S6-3-14 shows the schematic tree of the hydrological model of La Estrella Trompeta creek. In this figure, a triangle having a number such as E2 or T3 is a sub-catchment and its number. The number like [X] means a number of discharge points. They can be referred in Table S6-3-8.

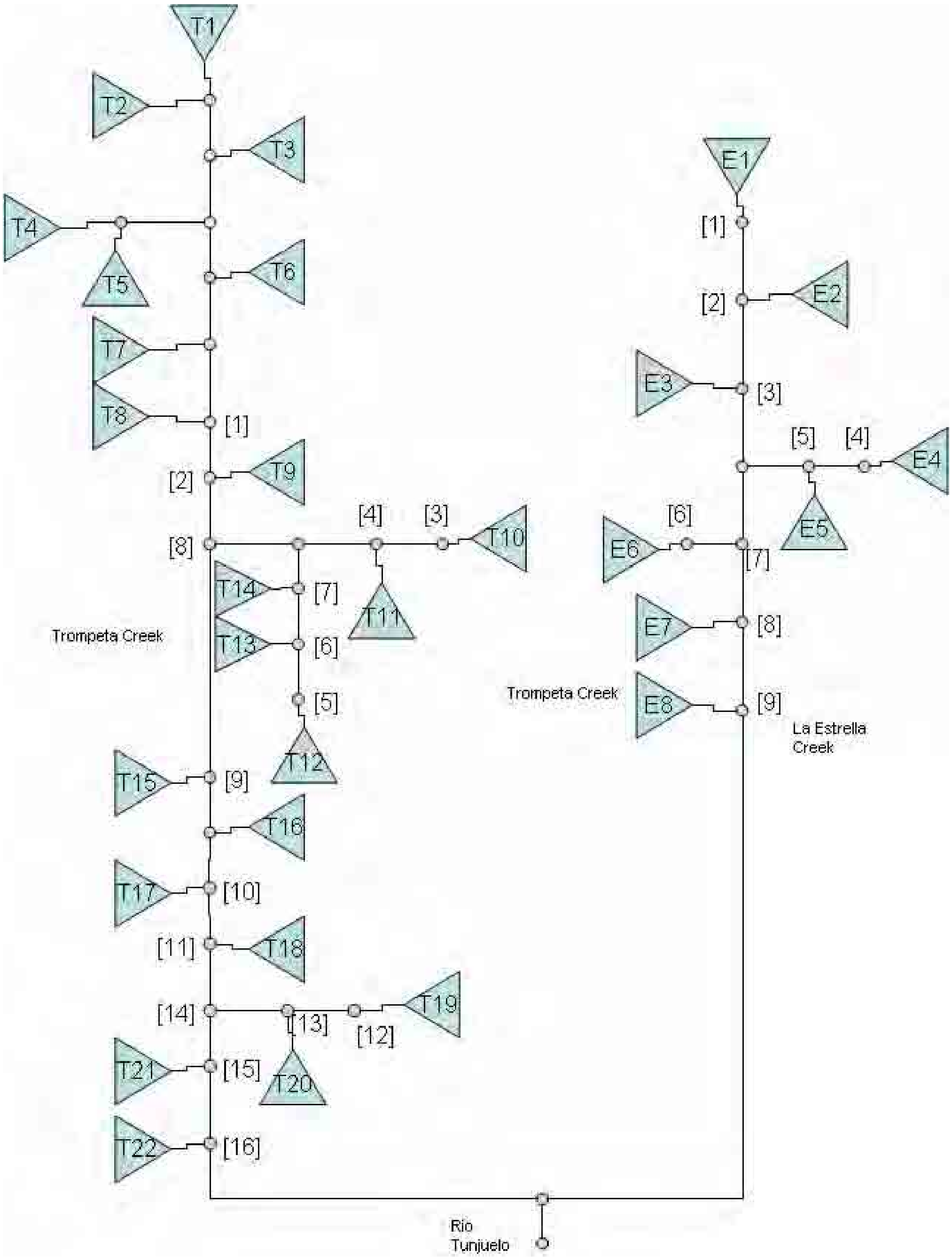


Figure S6-3-14 Hydrological Model Tree for La Estrella Trompeta Creek

3.2.5 Soacha River

Figure S6-3-15 shows the schematic tree of the hydrological model of the Soacha River.

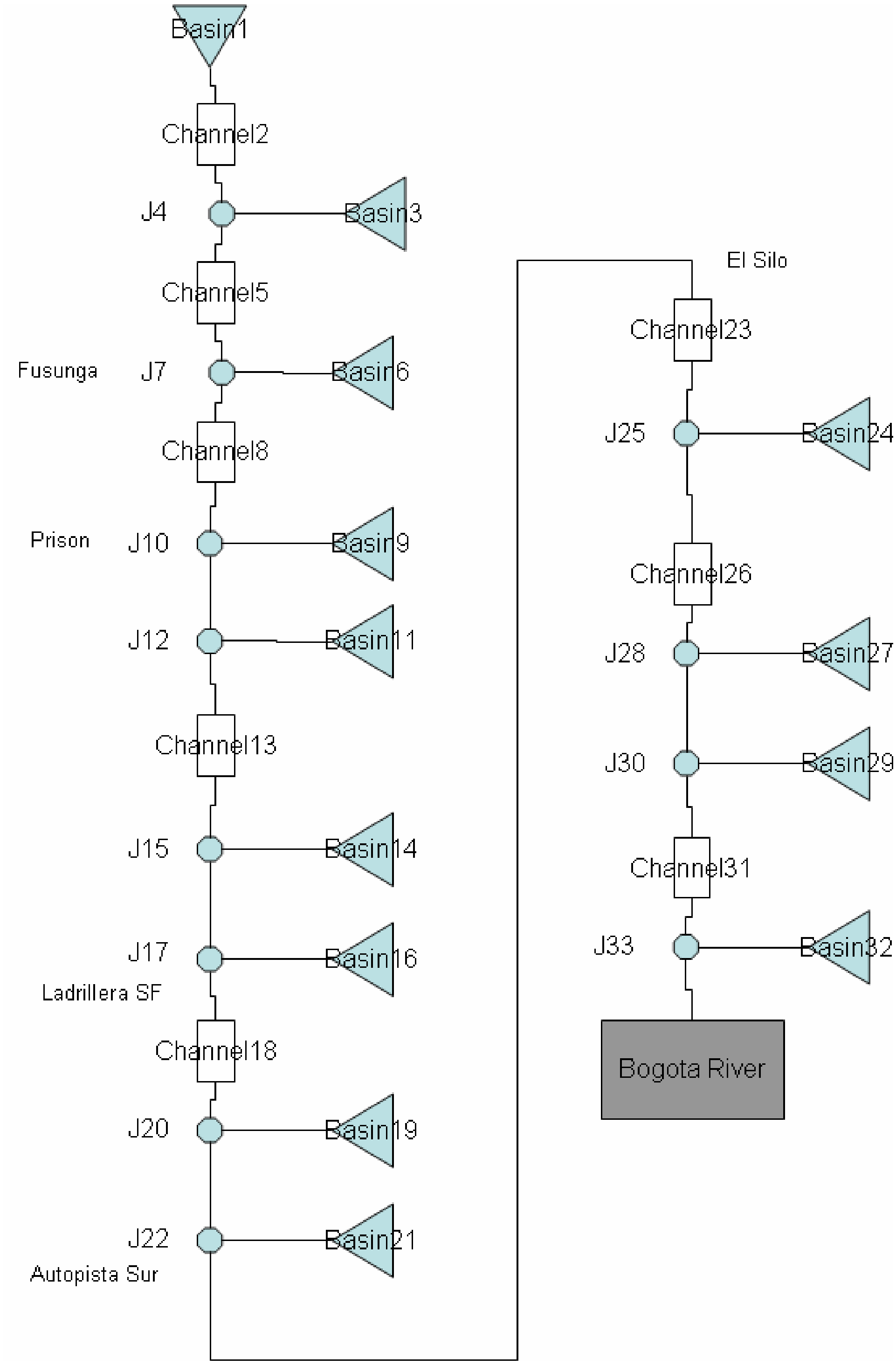


Figure S6-3-15 Hydrological Model Tree for Soacha River

Table S6-3-3 Model Parameter for Subcatchment in Soacha River Model

Main Catchment	Subcatchment	Area			C	I	L	p	EL. Max	EL. Min	K	Length	Length	EL. Max	EL. Min	Slope	V	Tc	
		(km2)		(km2)		(-)	(m)		(m)	(m)		(m)	(m)	(m)	(m)		(m/s)	(hr.)	(hr.)
1	B1	0.69	0.69	7.89	0.12	0.1040	6000	0.33	3573	2949	6.095	1800	1800	3573	3298	0.153	-	0.21	0.21
	B2	0.38	1.07									-							
	B3	1.14	2.21									1400	3200	3298	3244	0.039	3.5	0.11	0.32
	B4	0.89	3.10									-							
	B5	1.74	4.84									1200	4400	3244	3148	0.080	3.5	0.10	0.42
	B6	0.67	5.51									-							
	B7	1.34	6.85									1600	6000	3148	2949	0.124	3.5	0.13	0.54
	B8	1.04	7.89									-							
3	B9	3.33	11.22	9.38	0.12	0.1284	4285	0.33	3297	2747	6.356	1880	7880	2949	2798	0.080	3.5	0.15	0.69
	B10	1.75	12.97									-							
	B11	1.88	14.85									340	8220	2798	2783	0.044	3.5	0.03	0.72
	B12	0.73	15.58									820	9040	2783	2747	0.044	3.5	0.07	0.78
	B13	0.67	16.25									-							
	B14	1.02	17.27									-							
5	B15	2.63	19.90	6.24	0.12	0.1206	3208	0.33	3083	2696	7.147	1380	10420	2747	2714	0.024	3.5	0.11	0.89
	B16	2.31	22.21									1240	11660	2714	2696	0.015	3	0.11	1.01
	B17	1.30	23.51									-							
9	B18	1.92	25.43	6.42	0.12	0.0993	3837	0.33	2973	2592	7.184	1800	13460	2696	2638	0.032	3.5	0.14	1.15
	B19	2.32	27.75									-							
	B20	2.18	29.93									1140	14600	2638	2592	0.040	3.5	0.09	1.24
11	B21	0.65	30.58	0.65	0.012	0.1196	1864	0.33	2815	2592	0.859	-							
14	B22	0.62	31.20	0.62	0.012	0.1312	1044	0.33	2723	2586	1.010	1000	15600	2592	2586	0.006	3	0.09	1.33
16	B23	0.51	31.71	0.51	0.012	0.1186	1602	0.33	2776	2586	0.906	-							
19	B24	0.90	32.61	0.90	0.012	0.0586	2270	0.33	2698	2565	1.020	1420	17020	2586	2565	0.015	3	0.13	1.47
21	B25	1.15	33.76	1.15	0.012	0.0680	3280	0.33	2788	2565	0.859	-							
24	B26	2.87	36.63	2.87	0.012	0.0207	3386	0.33	2635	2565	1.264	2560	19580	2565	2565	0.000	2.1	0.34	1.80
27	B27	0.49	37.12	0.49	0.012	0.0200	1000	0.33	2565	2545	1.919	-							
29	B28	2.13	39.25	2.13	0.012	0.0014	2202	0.33	2548	2545	3.611	2240	21820	2565	2545	0.009	3	0.21	2.01
32	B29	5.07	44.32	5.07	0.120	0.0008	4000	0.33	2545	2542	36.110	2170	23990	2545	2550	-0.002	2.1	0.29	2.30

Table S6-3-4 Model Parameter for Channel in Soacha River Model

Channel	Catchment	Length	EL Max.	EL Min.	Average Slope
		(m)	(m)	(m)	(-)
Channel 1	9,11,12	3,040	2949	2747	0.0664
Channel 2	15,16	2,620	2747	2696	0.0195
Channel 3	18,20	2,940	2696	2592	0.0354
Channel 4	22	1,000	2592	2586	0.0060
Channel 5	24	1,420	2586	2565	0.0148
Channel 6	26	2,560	2565	2564	0.0004
Channel 7	27	2,240	2564	2545	0.0085
Channel 8	29	2,170	2545	2544	0.0005
		17,990			

3.2.6 Tibanica River

Figure S6-3-16 shows the schematic tree of the hydrological model of the Tibanica River. In the Tibanica river, there is the Tererros Dam which is regulating the runoff discharge from the upstream. Table S6-3-10 is the discharge calculation for the Tibanica river, in which the runoff from the Tererros Dam is not considered. The runoff to the Tibanica river downstream is caused by the local rainfall itself as an hydrological assumption.

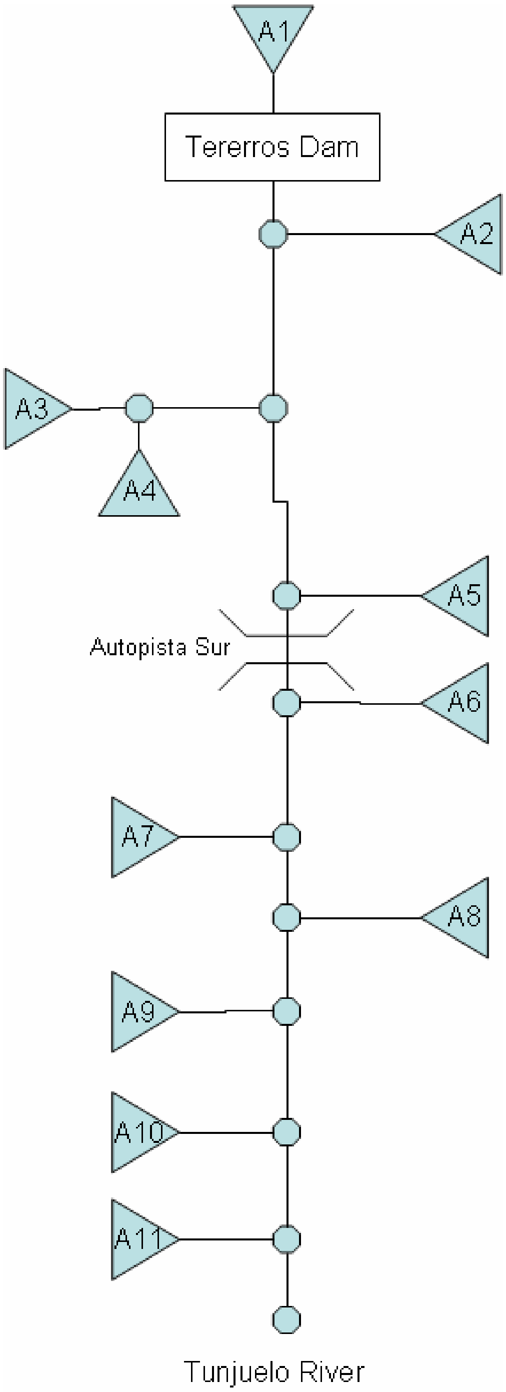


Figure S6-3-16 Hydrological Model Tree for Tibanica River

Table S6-3-5 Hydrological Parameter for Chiguaza Creek Basin

Subcatchment 1

Sub Area	Creek Name	Subcatchment	Area			Runoff Coef.		Subcatchment				Channel in Subcatchment				Tc	Travel Time		Accumulated	Location	Area	C	Tc	Intensity						Discharge					
		Number	(m2)	(km2)	(km2)			EL(Min)	EL(Max)	Length	Slope	EL(Min)	EL(Max)	Length	Slope	(min)	(min)	(min)	(min)	Name	(km2)	(-)	(min)	3	5	10	25	50	100	3	5	10	25	50	100
up	Chorro Colorado	1-1	237,288	0.24		0.75		2910	3130	1027	0.214					7.35																			
up	Los Toches	1-2	420,988	0.42		0.30		2875	3140	1170	0.226					7.95																			
up		1-3	1,356,629	1.36		0.70		2710	3440	3080	0.237					16.46																			
																				[1]	2.01	0.62	16.46	41.0	49.8	61.8	74.4	88.5	99.1	14.3	17.4	21.6	26.0	30.9	34.6
up		1-4	83,316	0.08		0.76		2650	2735	690	0.123	2650	2710	530	0.113	6.69	1.63		18.09																
																				[2]	2.10	0.63	18.09	38.5	46.8	57.7	70.0	81.6	91.4	14.1	17.2	21.2	25.7	29.9	33.5
up		1-5	759,087	0.76		0.66		2650	2760	1320	0.083					12.82																			
																				[3]	2.86	0.64	18.09	38.5	46.8	57.7	70.0	81.6	91.4	19.4	23.6	29.1	35.3	41.2	46.2

Subcatchment 2 (Chiguaza Main Creek)

Sub Area	Creek Name	Subcatchment	Area			Runoff Coef.		Subcatchment				Channel in Subcatchment				Tc	Travel Time		Accumulated	Location	Area	C	Tc	Intensity(mm/h)						Discharge(m3/s)					
		Number	(m2)	(km2)	(km2)			EL(Min)	EL(Max)	Length	Slope	EL(Min)	EL(Max)	Length	Slope	(min)	(min)	(min)	(min)	Name	(km2)	(-)	(min)	3	5	10	25	50	100	3	5	10	25	50	100
up	Zuque	2-1	511,094	0.51	4.06	0.32	0.48	3030	3450	1090	0.385					6.13																			
up	Zuque	2-2	192,158	0.19		0.63		2930	3150	1000	0.220	2930	3030	650	0.154	7.12	1.67																		
																				[4]	0.70	0.41	7.80	67.0	81.8	111.1	118.8	207.7	233.1	5.3	6.5	8.9	9.5	16.5	18.6
up	Chorro Silverio	2-3	151,526	0.15		0.40		3010	3440	980	0.439					5.38																			
up	Chorro Silverio	2-4	184,278	0.18		0.63		2890	3100	1250	0.168	2890	3010	710	0.169	9.38	1.72																		
																				[5]	0.34	0.53	7.10	71.3	87.1	120.8	125.8	247.5	277.9	3.5	4.3	5.9	6.2	12.2	13.7
																				[6]=[4]+[5]	1.04	0.45	7.80	67.0	81.8	111.1	118.8	207.7	233.1	8.6	10.5	14.3	15.3	26.7	30.0
up	Chiguaza	2-5	1,150,382	1.15		0.30		3010	3570	2560	0.219					14.72		14.72																	
up	Chiguaza	2-6	123,446	0.12		0.51		2870	3060	1120	0.170	2870	3010	980	0.143	8.59	2.62	2.62	17.35																
																				[7]	1.27	0.32	17.35	39.6	48.1	59.5	71.9	84.6	94.7	4.5	5.4	6.7	8.1	9.6	10.7
																				[8]=[6]+[7]	2.31	0.38	17.35	39.6	48.1	59.5	71.9	84.6	94.7	9.6	11.6	14.4	17.4	20.5	22.9
up	Chiguaza	2-7	214,383	0.21		0.70		2810	2950	830	0.169	2810	2920	740	0.149	6.84	1.94	1.94	19.28																
																				[9]	2.53	0.40	19.28	36.9	44.9	55.1	67.2	77.5	86.7	10.5	12.7	15.6	19.0	22.0	24.6
up	Seca	2-8	320,205	0.32		0.30		3000	3530	1400	0.379					7.49																			
up	Seca	2-9	442,794	0.44		0.61		2810	3100	1720	0.169	2810	3000	1400	0.136	11.98	3.87																		
																				[10]	0.76	0.48	11.36	52.3	63.8	81.8	94.2	126.4	141.7	5.3	6.4	8.3	9.5	12.8	14.3
																				[11]=[9]+[10]	3.29	0.42	19.28	36.9	44.9	55.1	67.2	77.5	86.7	14.2	17.3	21.2	25.8	29.8	33.3
up	Qda. Chiguaza	2-10	475,688	0.48		0.74		2730	2910	1080	0.167	2730	2810	855	0.094	8.41	2.95	2.95	22.24																
																				[12]	3.77	0.46	22.24	33.6	40.8	49.8	61.2	69.1	77.4	16.2	19.7	24.0	29.5	33.4	37.3
up	Qda. Chiguaza	2-11	227,800	0.23		0.68		2650	2755	1030	0.102	2650	2730	860	0.093	9.80	2.98	2.98	25.21																
																				[13]	3.99	0.47	25.21	30.9	37.5	45.6	56.3	62.8	70.2	16.3	19.7	24.0	29.6	33.0	36.9
up	Qda. Chiguaza	2-12	63,473	0.06		0.62		2635	2740	480	0.219	2635	2650	380	0.039	4.06	2.20	2.20	27.42																
																				[14]	4.06	0.48	27.42	29.3	35.5	43.0	53.3	59.0	66.0	15.7	19.1	23.1	28.6	31.6	35.4

Subcatchment 3 (Nutria Creek)

Sub Area	Creek Name	Subcatchment	Area			Runoff Coef.		Subcatchment				Channel in Subcatchment				Tc	Travel Time		Accumulated	Location	Area	C	Tc	Intensity(mm/h)						Discharge(m3/s)					
		Number	(m2)	(km2)	(km2)			EL(Min)	EL(Max)	Length	Slope	EL(Min)	EL(Max)	Length	Slope	(min)	(min)	(min)	(min)	Name	(km2)	(-)	(min)	3	5	10	25	50	100	3	5	10	25	50	100
up	Nutria	3-1	919,023	0.92	4.79	0.30	0.50	3040	3630	2180	0.271					11.99																			
up	Nutria	3-2	187,763	0.19		0.46		2940	3090	990	0.152	2940	3040	700	0.143	8.16	1.87																		
																				[15]	1.11	0.33	13.86	45.9	55.9	70.2	83.1	103.4	115.9	4.6	5.6	7.1	8.3	10.4	11.6
up	Nutria	3-3	289,880	0.29		0.30		3020	3570	1630	0.337					8.80																			
up	Nutria	3-4	61,030	0.06		0.33		2940	3020	460	0.174	2940	3020	460	0.174	4.29	1.09																		
																				[16]	0.35	0.31	9.90	57.3	69.9	91.2	102.7	148.1	166.1	1.7	2.1	2.7	3.1	4.4	4.9
up	Nutria	3-5	90,605	0.09		0.68		2900	2990	740	0.122	2900	2940	300	0.133	7.10	0.84																		
																				[17]	1.55	0.34	14.70	44.1	53.7	67.2	80.0	97.9	109.7	6.5	7.9	9.9	11.8	14.4	16.2
up	Nueva Delhi	3-6	538,886	0.54		0.33		3010	3580	1640	0.348					8.74																			
up	Nueva Delhi	3-7	220,229	0.22		0.69		2900	3060	950	0.168	2900	3010	730	0.151	7.59	1.89																		
																				[18]	0.76	0.43	10.64	54.6	66.6	86.1	98.2	136.0	152.5	5.0	6.1	7.9	9.0	12.4	13.9
up	Nutria	3-8	188,308	0.19		0.68		2810	2950	865	0.162	2810	2900	600	0.150	7.17	1.56																		
																				[19]	2.50	0.40	16.26	41.3	50.2	62.4	75.0	89.5	100.2	11.3	13.8	17.1	20.6	24.5	27.5
up	Nutria	3-9	782,973	0.78		0.66		2810	3170	2340	0.154					15.73																			
																				[20]	3.28	0.46	16.26	41.3	50.2	62.4	75.0	89.5	100.2	17.2	21.0	26.0	31.3	37.3	41.8
up	Nutria	3-10	69,322	0.07		0.32		2770	2915	520	0.279	2770	2810	300	0.133	3.93	0.84																		
up	Marales	3-11	643,431	0.64		0.62		2770	3260	2460	0.199					14.80																			
																				[21]	3.99	0.48	17.10	40.0	48.6	60.1	72.6	85.6	95.9	21.4	26.0	32.2	38.8	45.8	51.3
up	Verejones	3-12	796,275	0.80		0.60		2635	2935	2140	0.140	2635	2770	1380	0.098	15.22	4.64																		
																				[22]	4.79	0.50	21.74	34.1	41.4	50.6	62.1	70.4	78.8	22.8	27.7	33.8	41.5	47.0	52.6

Subcatchment 4 (Middle and Downstream)

Sub Area	Creek Name	Subcatchment	Area			Runoff Coef.		Subcatchment				Channel in Subcatchment				Tc	Travel Time		Accumulated	Location	Area	C	Tc	Intensity(mm/h)						Discharge(m3/s)					
		Number	(m2)	(km2)	(km2)			EL(Min)	EL(Max)	Length	Slope	EL(Min)	EL(Max)	Length	Slope	(min)	(min)	(min)	(min)	Name	(km2)	(-)	(min)	3	5	10	25	50	100	3	5	10	25	50	100
																				[23]	11.70	0.53	27.42	29.3	35.5	43.0	53.3	59.0	66.0	50.1	60.7	73.6	91.2	100.8	112.8
middle	Qda. Chiguaza	4-1	23,469	0.02	3.66	0.52	0.62	2620	2720	300	0.333	2620	2635	140	0.107	2.40	0.45	0.45	0.45	Los Puentes															
middle	Qda. Chiguaza	4-2	547,878	0.55		0.39		2620	2940	1910	0.168					13.02																			
																				[24]	12.27	0.52	27.86	29.0	35.1	42.6	52.8	58.3	65.2	51.3	62.3	75.4	93.5	103.2	115.5
middle	Qda. Chiguaza	4-3	577,820	0.58		0.56		2585	2780	750	0.260	2585	2620	990	0.035	5.35	6.13	6.13	6.57																
middle	Qda. Chiguaza	4-4	588,735	0.59		0.48		2585	2710	1160	0.108					10.51																			
middle	Qda. Chiguaza	4-5	464,472	0.46		0.77		2580	2670	1420	0.063	2580	2585	430	0.012	15.07	5.19	5.19	11.76																
																				[25]	13.90	0.53	39.18	23.1	28.0	33.7	42.1	45.7	51.1	47.2	57.1	68.7	85.8	93.1	104.1
middle	Qda. Chiguaza	4-6	258,121	0.26		0.72		2570	2620	800	0.063	2570	2580	440	0.023	9.74	3.55	3.55	15.31	Molinos															
middle	Qda. Chiguaza	4-7	238,589	0.24		0.79		2570	2670	1120	0.089					11.00																			
middle	Qda. Chiguaza	4-8	727,695	0.73		0.73		2570	2840	1930	0.140					14.07																			
middle	Qda. Chiguaza	4-9	234,850	0.23		0.80		2570	2650	800	0.100					8.13																			
																				[26]	15.36	0.55	42.73	21.9	26.5	31.8	39.7	43.0	48.1	51.2	62.0	74.5	93.1	100.8	112.7
down	Qda. Chiguaza	5-1	318,103	0.32	3.51	0.79	0.61	2570	2690	1380	0.087					13.05																			
down	Qda. Chiguaza	5-2	315,327	0.32		0.80		2568	2720	1280	0.119					10.92																			
down	Qda. Chiguaza	5-3	182,678	0.18		0.79		2566	2600	660	0.052					9.05																			
down	Qda. Chiguaza	5-4	779,198	0.78		0.37		2565	2580	1070	0.014	2565	2570	1070	0.005	21.66	22.31	22.31	37.62																
																				[27]	16.96	0.55	65.04	16.6	20.0	24.0	30.0	32.5	36.3	43.1	52.1	62.5	78.0	84.5	94.4
down	Qda. Chiguaza	5-5	1,199,234	1.20		0.64		2563	2700	1390	0.099	2563	2565	600	0.003	12.50	15.32	15.32	52.94																
																				[28]	18.16	0.56	80.36	14.4	17.4	20.9	26.0	28.3	31.6	40.6	49.0	58.8	73.1	79.7	89.0
down	Qda. Chiguaza	5-6	714,887	0.71		0.62		2560	2568	1550	0.005	2560	2563	1050	0.003	42.33	29.41	29.41	82.35	Rio Tunjuelo															
																				[29]	18.87	0.56	109.76	11.7	14.1	17.0	21.0	23.2	25.9	34.5	41.6	50.0	61.8	68.1	76.1

Table S6-3-6 Hydrological Parameter for Santa Librada Creek Basin

Sub Area	Creek Name	Subcatchment	Area			Runoff Coef.	Subcatchment				Channel in Subcatchment				Tc	Travel Time		Accumulate	Location	Area	C	Tc	Intensity						Discharge					
			(m2)	(km2)	(km2)		EL(Min)	EL(Max)	Length	Slope	EL(Min)	EL(Max)	Length	Slope	(min)	(min)	(min)	(min)	Name	(km2)	(-)	(min)	3	5	10	25	50	100	3	5	10	25	50	100
up	Santa Librada	1	509,297	0.51		0.30	3070	3500	1550	0.277					9.13			9.13																
																			[1]	0.51	0.30	9.13	60.4	73.7	97.3	107.9	164.2	184.1	2.6	3.1	4.2	4.6	7.0	7.9
up	Santa Librada	2	550,086	0.55		0.62	2960	3200	1420	0.169	2960	3070	755	0.146	10.33	2.00		11.13																
																			[2]	1.06	0.47	11.13	53.0	64.6	83.1	95.4	129.3	144.9	7.3	8.9	11.4	13.1	17.8	19.9
up	Santa Librada	3	414,882	0.41		0.30	2760	3090	1740	0.190	2760	2960	1390	0.144	11.55	3.71		14.84																
																			[3]	1.47	0.42	14.84	43.9	53.4	66.7	79.5	97.1	108.8	7.6	9.2	11.5	13.7	16.7	18.8
up	Santa Librada	4	317,078	0.32		0.50	2760	3115	2500	0.142					17.07																			
																			[4]	1.79	0.43	14.84	43.9	53.4	66.7	79.5	97.1	108.8	9.5	11.5	14.4	17.2	21.0	23.5
middle	Santa Librada	5	157,892	0.16		0.61	2675	2855	1520	0.118	2675	2750	1030	0.073	12.48	4.13		18.97																
																			[5]	1.95	0.45	18.97	37.3	45.4	55.8	67.9	78.5	87.9	9.1	11.0	13.6	16.5	19.1	21.4
middle	Santa Librada	6	641,450	0.64		0.40	2740	3070	1370	0.241					8.77																			
middle	Santa Librada	7	292,975	0.29		0.74	2675	2820	980	0.148	2675	2740	950	0.068	8.17	3.96																		
																			[6]	2.88	0.47	18.97	37.3	45.4	55.8	67.9	78.5	87.9	13.9	17.0	20.8	25.4	29.3	32.8
middle	Santa Librada	8	534,462	0.53		0.79	2610	2810	1140	0.175	2610	2675	870	0.075	8.60	3.44		22.41																
																			[7]	3.42	0.52	22.41	33.4	40.6	49.5	60.9	68.7	76.9	16.4	20.0	24.4	29.9	33.8	37.8
middle	Santa Librada	9	766,179	0.77		0.60	2610	2920	2020	0.153					14.06																			
																			[8]	4.18	0.53	22.41	33.4	40.6	49.5	60.9	68.7	76.9	20.7	25.1	30.7	37.7	42.5	47.6
down	Santa Librada	10	126,280	0.13		0.65	2590	2630	830	0.048	2590	2610	640	0.031	11.07	4.27		26.67																
																			[9]	4.31	0.54	26.67	29.8	36.2	43.9	54.3	60.2	67.3	19.1	23.2	28.1	34.8	38.6	43.2
down	Santa Librada	11	404,529	0.40		0.51	2590	2920	2410	0.137					16.83																			
																			[10]	4.72	0.53	26.67	29.8	36.2	43.9	54.3	60.2	67.3	20.8	25.3	30.6	37.9	42.0	47.0
down	Santa Librada	12	127,362	0.13		0.32	2575	2600	760	0.033	2575	2590	600	0.025	11.99	4.57		31.25																
																			[11]	4.84	0.53	31.25	26.9	32.6	39.3	48.9	53.6	60.0	19.1	23.1	27.9	34.7	38.0	42.6
down	Santa Librada	13	553,307	0.55		0.55	2575	2790	1390	0.155					10.51																			
																			[12]	5.40	0.53	31.25	26.9	32.6	39.3	48.9	53.6	60.0	21.3	25.8	31.2	38.8	42.5	47.6

Table S6-3-7 Hydrological Parameter for Yomasa Creek Basin

Sub Area	Creek Name	Subcatchment	Area			Runoff Coef.	Subcatchment				Channel in Subcatchment				Tc	Travel Time		Accumulate	Location	Area	C	Tc	Intensity(mm/hr)						Discharge(m3/s)					
			(m2)	(km2)	(km2)		EL(Min)	EL(Max)	Length	Slope	EL(Min)	EL(Max)	Length	Slope	(min)	(min)	(min)	(min)	Name	(km2)	(-)	(min)	3	5	10	25	50	100	3	5	10	25	50	100
up		1	3,933,717	3.93		0.30	3260	3460	2450	0.082					20.80			20.80																
																			[1]	3.93	0.30	20.80	35.1	42.7	52.2	63.9	72.9	81.6	11.5	14.0	17.1	21.0	23.9	26.7
up		2	847,675	0.85		0.30	3030	3550	1190	0.437	3030	3260	1110	0.207	6.25	2.38		23.18																
	Cra. Oriente																		[2]	4.78	0.30	23.18	32.7	39.7	48.4	59.5	66.9	74.9	13.0	15.8	19.3	23.7	26.7	29.8
middle		3	104,285	0.10		0.30	3010	3270	760	0.342	3010	3030	240	0.083	4.87	0.89		24.07																
																			[3]	4.89	0.30	24.07	31.9	38.7	47.1	58.1	65.0	72.8	13.0	15.8	19.2	23.7	26.5	29.6
middle		4	511,556	0.51		0.31	2970	3530	2000	0.138	2970	3010	290	0.138	14.54	0.79		24.86																
																			[4]	5.40	0.30	24.86	31.2	37.9	46.1	56.9	63.4	71.0	14.1	17.1	20.8	25.7	28.6	32.1
middle		5	787,301	0.79		0.39	2920	3580	2330	0.283	2920	2970	430	0.116	12.40	1.30		26.17																
																			[5]	6.18	0.31	26.17	30.2	36.6	44.5	55.0	61.0	68.3	16.2	19.7	23.9	29.5	32.8	36.7
middle		6	317,103	0.32		0.59	2890	3140	1610	0.155	2890	2920	240	0.125	11.75	0.70		26.86																
middle		7	355,020	0.36		0.30	2900	3340	1720	0.256					10.21																			
middle		8	700,586	0.70		0.30	2890	3240	1440	0.243					9.08																			
																			[6]	7.56	0.32	26.86	29.7	36.0	43.6	54.0	59.9	67.0	20.1	24.4	29.5	36.6	40.5	45.3
middle		9	414,929	0.41		0.33	2830	3060	960	0.240	2830	2890	720	0.083	6.68	2.66		29.53																
middle		10	271,861	0.27		0.35	2830	2990	800	0.200					6.22																			
																			[7]	8.24	0.32	29.53	27.9	33.8	40.9	50.8	55.8	62.5	20.7	25.1	30.3	37.7	41.4	46.3
middle		11	1,067,486	1.07		0.40	2820	3640	2970	0.276	2820	2830	160	0.063	15.09	0.70		30.23																
																			[8]	9.31	0.33	30.23	27.5	33.3	40.2	50.0	54.9	61.4	23.6	28.7	34.6	43.1	47.3	52.9
middle		12	514,139	0.51		0.51	2800	3170	1970	0.188	2800	2820	230	0.087	12.76	0.83		31.06																
																			[9]	9.83	0.34	31.06	27.0	32.7	39.5	49.1	53.8	60.2	25.2	30.5	36.9	45.8	50.2	56.2
Lower		13	896,959	0.90		0.60	2745	3030	1840	0.155	2745	2800	1180	0.047	13.04	6.19		37.25																
																			[10]	10.72	0.36	37.25	23.9	29.0	34.9	43.5	47.3	52.9	25.9	31.4	37.8	47.2	51.3	57.4
lower		14	2,014,165	2.01		0.44	2740	3640	4260	0.211					22.09																			
	Ave. Caracas																		[11]	12.74	0.38	37.25	23.9	29.0	34.9	43.5	47.3	52.9	31.8	38.5	46.3	57.8	62.8	70.3
lower		15	587,809	0.59		0.68	2710	2910	2020	0.099	2710	2745	700	0.050	16.65	3.52		40.77																
																			[12]	13.32	0.39	40.77	22.5	27.3	32.8	41.0	44.4	49.7	32.5	39.3	47.2	59.0	64.0	71.5
lower		16	882,706	0.88		0.78	2710	2990	2470	0.113					18.45																			
																			[13]	14.21	0.41	40.77	22.5	27.3	32.8	41.0	44.4	49.7	36.8	44.5	53.5	66.8	72.4	81.0
lower	Tunjuelo River	17	1,222,019	1.22		0.72	2620	2840	3050	0.072	2620	2710	2060	0.044	25.83	11.23		52.00																
																			[14]	15.43	0.44	52.00	19.2	23.2	27.9	34.8	37.7	42.1	36.0	43.6	52.3	65.3	70.6	79.0

Table S6-3-8 Hydrological Parameter for La Estrella Trompeta Creek Basin

Sub Area	Creek Name	Subcatchment	Area (m2)	Area (km2)	Area (km2)	Runoff Coef.		Subcatchment EL(Min)	Subcatchment EL(Max)	Subcatchment Length	Subcatchment Slope	Channel in Subcatchment EL(Min)	Channel in Subcatchment EL(Max)	Channel in Subcatchment Length	Channel in Subcatchment Slope	Tc (min)	Travel Time (min)	Travel Time (min)	Accumulated (min)	Location Name	Area (km2)	C (-)	Tc (min)	Intensity 3	Intensity 5	Intensity 10	Intensity 25	Intensity 50	Intensity 100	Discharge 3	Discharge 5	Discharge 10	Discharge 25	Discharge 50	Discharge 100
Estrella		E01	262,023	0.26		0.75		2690	2950	930	0.280					6.14			6.14																
																				[1]	0.26	0.75	6.14	65.2	77.1	94.7	115.0	131.0	146.4	3.6	4.2	5.2	6.3	7.2	8.0
Estrella		E02	89,709	0.09		0.55		2620	2730	790	0.139	2620	2690	620	0.113	7.09	1.91		8.06																
																				[2]	0.35	0.70	8.06	60.8	71.8	87.4	105.8	120.1	134.0	4.2	4.9	6.0	7.2	8.2	9.2
Estrella		E03	246,339	0.25		0.74		2620	2930	1440	0.215					9.51																			
																				[3]	0.60	0.72	9.51	57.9	68.1	82.6	99.7	113.0	125.9	6.9	8.1	9.8	11.9	13.4	15.0
Estrella		E04	623,197	0.62		0.69		2580	2980	2070	0.193					13.11																			
																				[4]	0.62	0.69	13.11	51.6	60.6	72.8	87.5	98.7	109.6	6.1	7.2	8.6	10.4	11.7	13.0
Estrella		E05	416,560	0.42		0.66		2570	2690	1350	0.089	2570	2580	370	0.027	12.72	2.69																		
																				[5]	1.04	0.68	15.80	47.8	56.0	66.9	80.2	90.2	100.0	9.4	11.0	13.1	15.7	17.6	19.6
Estrella		E06	135,237	0.14		0.67		2570	2670	1100	0.091	2570	2620	780	0.064	10.77	3.38		11.43																
																				[6]	0.73	0.71	12.89	52.0	61.0	73.3	88.1	99.4	110.5	7.5	8.8	10.6	12.7	14.3	15.9
																				[7]=[6]+[5]	1.77	0.69	15.80	47.8	56.0	66.9	80.2	90.2	100.0	16.3	19.0	22.7	27.2	30.6	34.0
Estrella		E07	836,095	0.84		0.78		2570	2750	1860	0.097					15.76																			
																				[8]	2.61	0.72	15.80	47.8	56.0	66.9	80.2	90.2	100.0	25.0	29.2	34.9	41.8	47.0	52.2
Estrella		E08	337,624	0.34		0.80		2565	2690	1190	0.105					10.83																			
																				[9]	2.95	0.73	15.80	47.8	56.0	66.9	80.2	90.2	100.0	28.5	33.4	39.9	47.8	53.8	59.7

Sub Area	Creek Name	Subcatchment	Area (m2)	Area (km2)	Area (km2)	Runoff Coef.		Subcatchment EL(Min)	Subcatchment EL(Max)	Subcatchment Length	Subcatchment Slope	Channel in Subcatchment EL(Min)	Channel in Subcatchment EL(Max)	Channel in Subcatchment Length	Channel in Subcatchment Slope	Tc (min)	Travel Time (min)	Travel Time (min)	Accumulated (min)	Location Name	Area (km2)	C (-)	Tc (min)	Intensity 3	Intensity 5	Intensity 10	Intensity 25	Intensity 50	Intensity 100	Discharge 3	Discharge 5	Discharge 10	Discharge 25	Discharge 50	Discharge 100
Trompeta		T01	239,646	0.24		0.50		2830	3090	1080	0.241					7.30			7.30																
Trompeta		T02	166,422	0.17		0.50		2830	3090	990	0.263					6.60																			
Trompeta		T03	138,826	0.14		0.50		2780	3030	950	0.263	2780	2830	410	0.122	6.39	1.21		8.51																
Trompeta		T04	286,632	0.29		0.50		2840	3070	1060	0.217					7.49																			
Trompeta		T05	126,361	0.13		0.50		2780	3030	720	0.347	2780	2840	550	0.109	4.64	1.73																		
Trompeta		T06	196,553	0.20		0.50		2760	3030	1000	0.270	2760	2780	190	0.105	6.58	0.61		9.12																
Trompeta		T07	437,407	0.44		0.50		2670	2900	1440	0.160	2670	2760	790	0.114	10.67	2.42		11.54																
Trompeta		T08	579,952	0.58		0.50		2670	2920	1750	0.143					12.94																			
																				[1]	2.17	0.50	12.94	51.9	60.9	73.2	88.0	99.3	110.3	15.7	18.4	22.1	26.5	29.9	33.3
Trompeta		T09	97,892	0.10		0.49		2640	2780	850	0.165	2640	2670	390	0.077	7.03	1.51		13.06																
																				[2]	2.27	0.50	14.46	49.7	58.2	69.7	83.6	94.2	104.6	15.6	18.3	21.9	26.3	29.7	32.9
Trompeta		T10	266,297	0.27		0.52		2790	3015	840	0.268					5.77																			
																				[3]	0.27	0.52	5.77	66.2	78.3	96.2	116.9	133.4	149.1	2.5	3.0	3.7	4.5	5.1	5.7
Trompeta		T11	131,141	0.13		0.55		2670	2850	890	0.202	2670	2790	680	0.176	6.73	1.60																		
																				[4]	0.40	0.53	7.38	62.3	73.6	89.8	108.9	123.8	138.1	3.6	4.3	5.2	6.3	7.2	8.0
Trompeta		T12	127,538	0.13		0.33		2740	2910	590	0.288					4.28																			
																				[5]	0.13	0.33	4.28	70.2	83.2	103.1	125.7	143.9	161.2	0.8	1.0	1.2	1.5	1.7	1.9
Trompeta		T13	45,398	0.05		0.70		2670	2755	400	0.213	2670	2740	290	0.241	3.57	0.57																		
																				[6]	0.17	0.43	4.84	68.6	81.3	100.4	122.2	139.7	156.4	1.4	1.7	2.1	2.5	2.9	3.2
Trompeta		T14	30,226	0.03		0.39		2640	2740	410	0.244	2640	2670	260	0.115	3.45	0.79		13.85																
																				[7]	0.20	0.42	5.64	66.5	78.7	96.8	117.7	134.3	150.2	1.6	1.9	2.3	2.8	3.2	3.6
																				[8]	2.87	0.50	13.85	50.5	59.3	71.0	85.3	96.2	106.8	20.1	23.5	28.2	33.9	38.2	42.4
Trompeta		T15	356,614	0.36		0.50		2640	2800	1350	0.119					11.39																			
																				[9]	3.23	0.50	13.85	50.5	59.3	71.0	85.3	96.2	106.8	22.6	26.5	31.7	38.1	42.9	47.7
Trompeta		T16	169,462	0.17		0.69		2630	2760	720	0.181	2630	2640	220	0.045	5.97	1.17		15.02																
Trompeta		T17	501,803	0.50		0.50		2630	2805	1410	0.124					11.57																			
																				[10]	3.90	0.51	15.02	48.9	57.3	68.5	82.1	92.5	102.6	26.8	31.4	37.5	45.0	50.7	56.2
Trompeta		T18	195,345	0.20		0.60		2615	2770	820	0.189	2615	2630	320	0.047	6.48	1.67		16.69																
																				[11]	4.09	0.51	16.69	46.7	54.6	65.1	78.0	87.7	97.2	27.1	31.7	37.8	45.3	50.9	56.4
Trompeta	El Infierno	T19	289,448	0.29		0.60		2700	3000	1270	0.236					8.33																			
																				[12]	0.29	0.60	8.33	60.2	71.0	86.4	104.6	118.7	132.4	2.9	3.4	4.2	5.1	5.7	6.4
Trompeta	El Infierno	T20	188,794	0.19		0.69		2620	2760	1080	0.130	2620	2700	780	0.103	9.27	2.55																		
																				[13]	0.48	0.64	10.88	55.3	65.1	78.6	94.7	107.1	119.1	4.7	5.5	6.6	8.0	9.0	10.1
																				[14]	4.57	0.52	16.69	46.7	54.6	65.1	78.0	87.7	97.2	31.1	36.3	43.3	51.9	58.3	64.7
Trompeta		T21	291,790	0.29		0.56		2580	2770	1090	0.174	2580	2620	770	0.052	8.33	3.78		20.48																
																				[15]	4.86	0.53	20.48	42.4	49.5	58.6	70.0	78.5	86.9	30.2	35.2	41.7	49.8	55.8	61.8
Trompeta		T22	201,160	0.20		0.57		2580	2770	920	0.207					6.85																			
																				[16]	5.06	0.53	20.48	42.4	49.5	58.6	70.0	78.5	86.9	31.5	36.8	43.6	52.0	58.3	64.6
				8.01																															

Table S6-3-9 Hydrological Parameter for Soacha River Basin

Main Catchment	Subcatchment	Area		Length		EL. Max	EL. Min	Slope	V	Tc		Runoff Coefficient		Rainfall Intensity						Peak Discharge					
														3 yr.	5 yr.	10 yr.	25 yr.	50 yr.	100 yr.	3 yr.	5 yr.	10 yr.	25 yr.	50 yr.	100 yr.
		(km2)		(m)	(m)	(m)	(m)		(m/s)	(hr.)	(hr.)			(mm/h)	(mm/h)	(mm/h)	(mm/h)	(mm/h)	(mm/h)	(m3/s)	(m3/s)	(m3/s)	(m3/s)	(m3/s)	(m3/s)
1	B1	0.69	0.69	1800	1800	3573	3298	0.153	–	0.21	0.21	0.3	0.3	52	62	74	89	100	112	3.0	3.5	4.3	5.1	5.8	6.4
	B2	0.38	1.07	–								0.3	0.3												
	B3	1.14	2.21	1400	3200	3298	3244	0.039	3.5	0.11	0.32	0.3	0.3	44	51	61	72	81	90	8.0	9.4	11.2	13.3	15.0	16.6
	B4	0.89	3.10	–								0.3	0.3												
	B5	1.74	4.84	1200	4400	3244	3148	0.080	3.5	0.10	0.42	0.3	0.3	38	45	52	63	70	77	15.4	18.0	21.2	25.2	28.2	31.2
	B6	0.67	5.51	–								0.3	0.3												
	B7	1.34	6.85	1600	6000	3148	2949	0.124	3.5	0.13	0.54	0.3	0.3	33	38	45	53	59	65	18.8	21.8	25.5	30.2	33.7	37.2
	B8	1.04	7.89	–								0.3	0.3												
3	B9	3.33	11.22	1880	7880	2949	2798	0.080	3.5	0.15	0.69	0.3	0.3	28	33	38	45	50	55	26.4	30.5	35.5	42.0	46.8	51.5
	B10	1.75	12.97	–								0.3	0.3												
	B11	1.88	14.85	340	8220	2798	2783	0.044	3.5	0.03	0.72	0.3	0.3	28	32	37	44	49	54	34.0	39.3	45.8	54.2	60.2	66.4
	B12	0.73	15.58	820	9040	2783	2747	0.044	3.5	0.07	0.78	0.3	0.3	26	30	35	41	46	50	33.7	38.9	45.2	53.4	59.4	65.4
	B13	0.67	16.25	–								0.3	0.3												
	B14	1.02	17.27	–								0.3	0.3												
5	B15	2.63	19.90	1380	10420	2747	2714	0.024	3.5	0.11	0.89	0.3	0.3	24	27	32	37	42	46	39.3	45.3	52.5	62.0	68.9	75.8
	B16	2.31	22.21	1240	11660	2714	2696	0.015	3.0	0.11	1.01	0.3	0.3	22	25	29	34	38	42	40.2	46.3	53.6	63.3	70.2	77.2
	B17	1.30	23.51	–								0.3	0.3												
9	B18	1.92	25.43	1800	13460	2696	2638	0.032	3.5	0.14	1.15	0.3	0.3	20	23	26	31	34	38	41.8	48.0	55.5	65.4	72.5	79.8
	B19	2.32	27.75	–								0.3	0.3												
	B20	2.18	29.93	1140	14600	2638	2592	0.040	3.5	0.09	1.24	0.3	0.3	19	21	25	29	32	35	46.5	53.3	61.6	72.6	80.5	88.4
11	B21	0.65	30.58	–								0.3	0.3												
14	B22	0.62	31.20	1000	15600	2592	2586	0.006	3.0	0.09	1.33	0.3	0.3	18	20	23	27	30	33	45.8	52.5	60.7	71.5	79.2	87.0
16	B23	0.51	31.71	–								0.3	0.3												
19	B24	0.90	32.61	1420	17020	2586	2565	0.015	3.0	0.13	1.47	0.3	0.3	16	19	22	25	28	31	44.5	50.9	58.9	69.3	76.8	84.3
21	B25	1.15	33.76	–								0.85	0.32												
24	B26	2.87	36.63	2560	19580	2565	2565	0.000	2.1	0.34	1.80	0.85	0.36	14	16	18	22	24	26	50.9	58.0	67.1	78.9	87.3	95.9
27	B27	0.49	37.12	–								0.85	0.37												
29	B28	2.13	39.25	2240	21820	2565	2545	0.009	3.0	0.21	2.01	0.85	0.39	13	14	17	20	22	24	54.4	62.0	71.6	84.2	93.2	102.3
32	B29	5.07	44.32	2170	23990	2545	2550	-0.002	2.1	0.29	2.30	0.3	0.38	11	13	15	18	19	21	53.5	60.8	70.4	82.6	91.5	100.4

Table S6-3-10 Hydrological Parameter for Tibanica River Basin

Main Catchment	Subcatchment	Area		Length		EL. Max	EL. Min	Slope	V	Tc		Landuse		Runoff Coefficient				Rainfall Intensity						Peak Discharge					
												Urban	%	sub-catchment				3 yr.	5 yr.	10 yr.	25 yr.	50 yr.	100 yr.	3 yr.	5 yr.	10 yr.	25 yr.	50 yr.	100 yr.
		(km2)		(m)	(m)	(m)	(m)		(m/s)	(hr.)	(hr.)	(m2)						(mm/h)	(mm/h)	(mm/h)	(mm/h)	(mm/h)	(mm/h)	(m3/s)	(m3/s)	(m3/s)	(m3/s)	(m3/s)	(m3/s)
Tererros Dam	A1	9.14	9.14	5440	5440	3100	2610	0.090	–			1,632,244	17.9	0.55	5.06	5.06	0.55												
	A2	2.08	2.08	1300	6740	2610	2558	0.040	3.5	0.10	0.10	638,492	30.7	0.59	1.232	1.23	0.59	65	77	94	115	131	146	22.3	26.3	32.3	39.3	44.7	50.0
	A3	1.15	3.23	–	–	–	–					946,318	82.0	0.75	0.861	2.09	0.65												
	A4	0.37	3.60	1240	7980	2558	2547	0.009	3.0	0.11	0.22	62,829	17.0	0.55	0.204	2.30	0.64	52	61	73	88	99	110	33.0	38.7	46.5	55.9	63.0	70.0
	A5	1.97	5.57	–	–	–	–					957,240	48.6	0.65	1.272	3.57	0.64												
	A6	0.32	5.89	950	8930	2547	2544	0.003	2.1	0.13	0.34	177,756	56.4	0.67	0.211	3.78	0.64	42	49	58	70	78	87	44.4	51.8	61.3	73.2	82.1	90.9
	A7	0.38	6.27	–	–	–	–					383,336	99.7	0.80	0.307	4.09	0.65												
	A8	1.28	7.55	1010	9940	2544	2542	0.002	2.1	0.13	0.48	843,124	66.1	0.70	0.891	4.98	0.66	35	41	48	58	64	71	49.0	57.0	66.9	79.5	88.8	98.1
	A9	0.68	8.23	770	10710	2542	2541	0.001	2.1	0.10	0.58	340,000	50.1	0.65	0.442	5.42	0.66	32	37	43	51	57	62	47.6	55.1	64.4	76.4	85.2	93.9
	A10	1.29	9.52	170	10880							1,290,000	99.7	0.80	1.034	6.45	0.68												
	A11	0.49	10.01	1340	12220	2541	2540	0.001	2.1	0.18	0.76	490,000	99.9	0.80	0.392	6.84	0.68	27	31	36	42	47	52	50.6	58.4	67.9	80.3	89.3	98.4

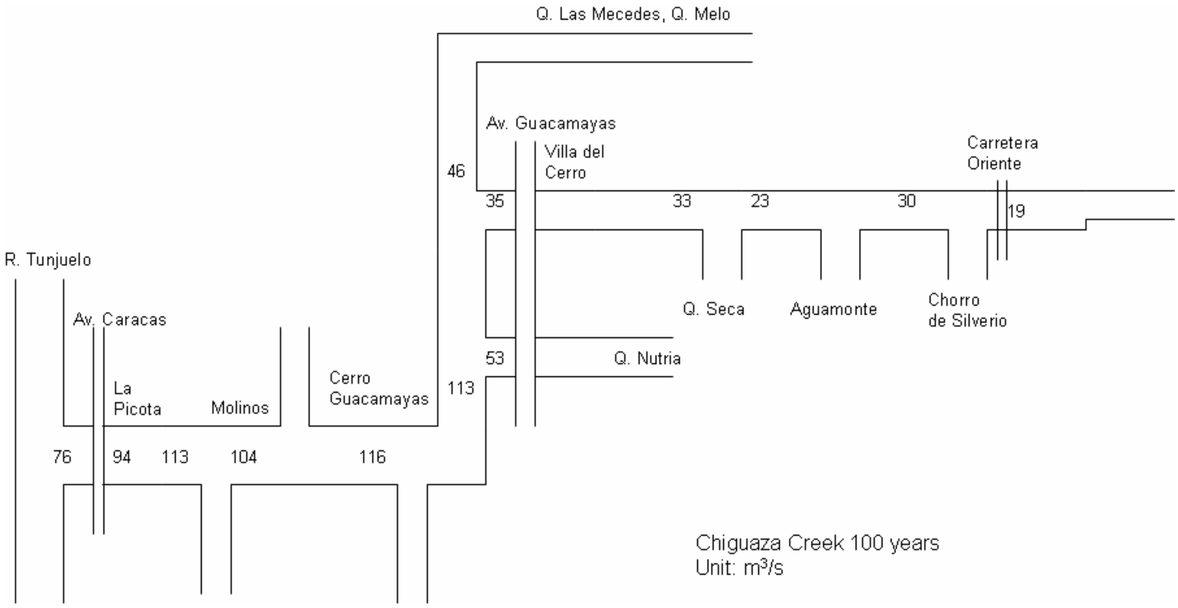


Figure S6-3-17 Discharge Distribution of Chiguaza Creek for 100 years Return period

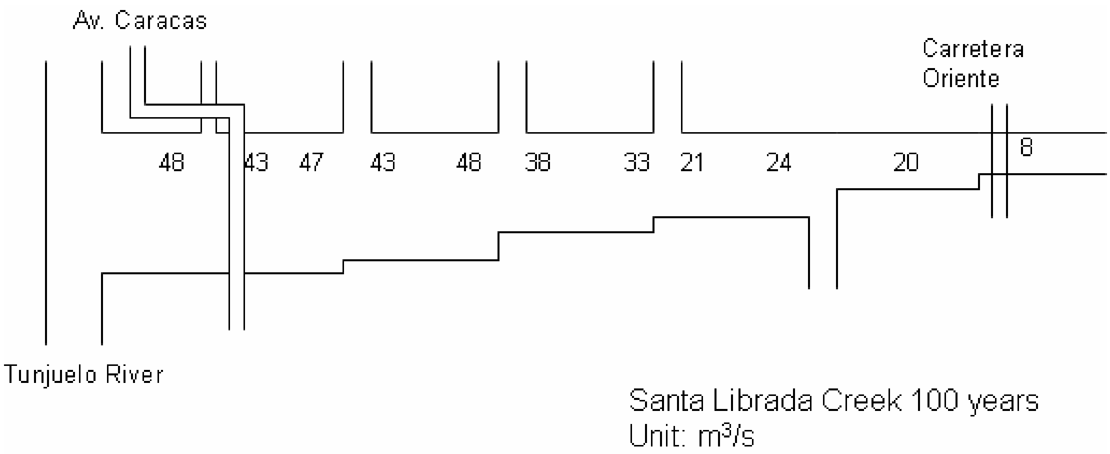


Figure S6-3-18 Discharge Distribution of Santa Librada Creek for 100 years Return period

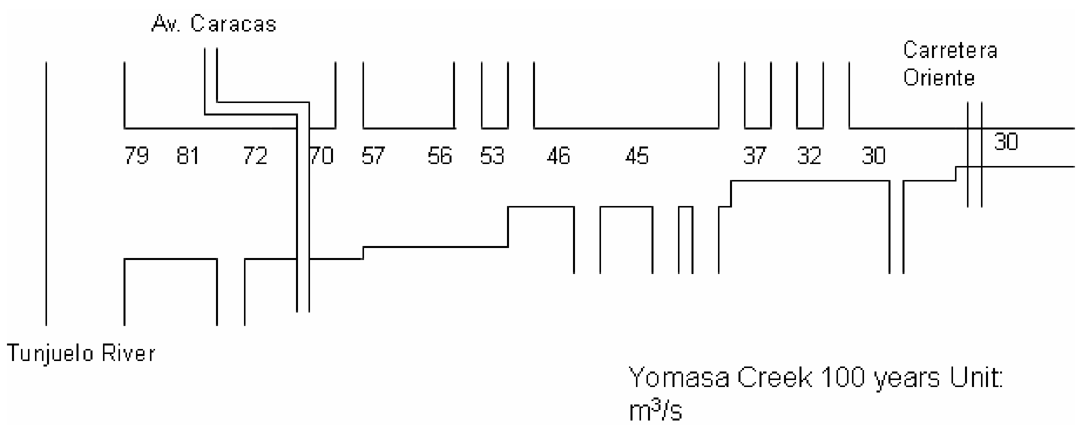


Figure S6-3-19 Discharge Distribution of Yomasa Creek for 100 years Return period

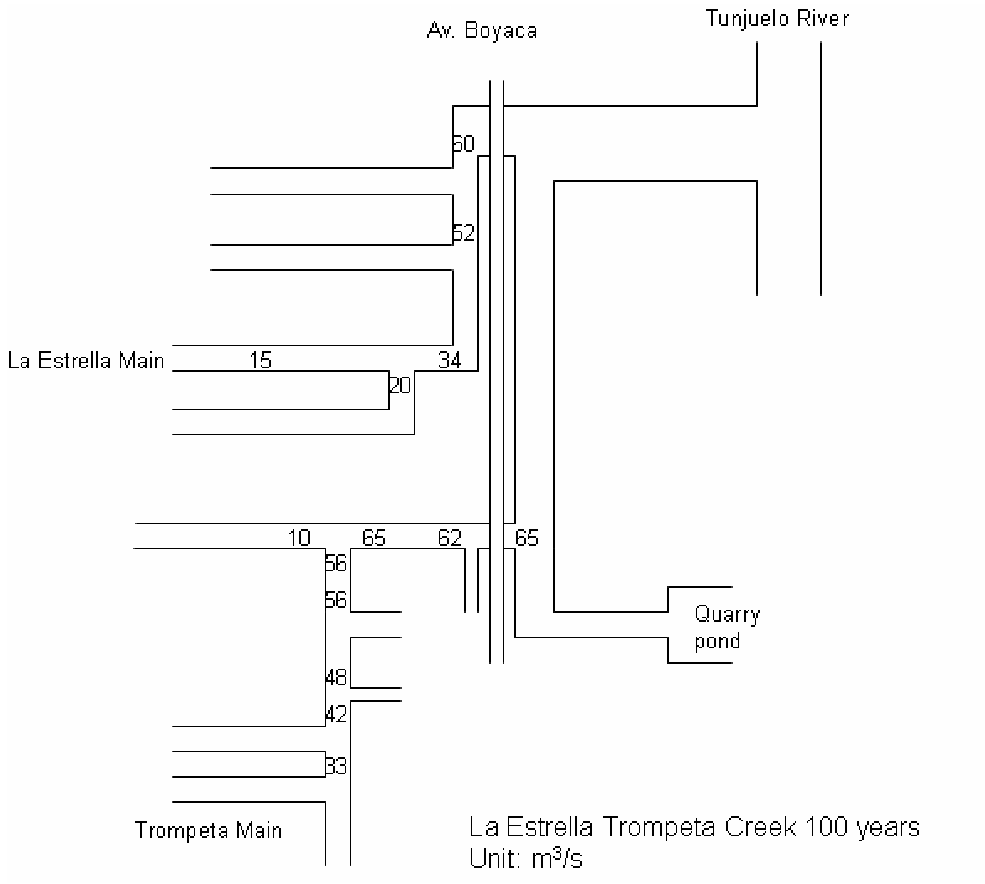


Figure S6-3-20 Discharge Distribution of La Estrella Trompeta Creek for 100 years Return period

CHAPTER 4 MAPPING ON FLOOD SUSCEPTIBILITY

4.1 General

As defined in Chapter 1.4 of the Main Report, the Study deals with flood, and flash flood containing sediment like debris flow.

Generally, the definition of flash flood is always controversial depending on countries and people. In this Study, considering the feature of the Study Area, the following clarification was made.

4.1.1 Types of Flash Flood

Nishimoto (2005)[1] reported the current situation of flash flood by searching a key word “flash flood” among technical papers in the world.

- Flash flood by slope failure (1) is a flood that collapsed sediment by heavy rainfall enters creek and transport downstream as debris flow.
- Flash flood by breach of natural dam (2) is a flood that the natural dam which was formed by collapsed sediment and drift woods is breached.
- Flash flood by runoff from semi-arid land (4) is a flood by runoff from poor vegetation in semi-arid land.
- Flash flood by rapid runoff from rain, snowmelt to valley (6) is a flood that the runoff concentrates on the small valley resulting into rapid rise of waterlevel.

It can be regarded that the type (1) and (2) are called debris flow. Here the term “debris flow” will be used as the phenomenon which includes the type (1) and type (2). The type (4) in the above is a kind of factor which would cause the phenomenon (1) and (2). It can also be said that the sediment laden flow which is caused by the type (4) is corresponding to the type (1) and (2).

4.1.2 Flash Flood in the Study Area

In general, the type (1) in the above is the most popular in the world and has large destructive energy as debris flow. This type is very popular in the Vargas Disaster in Venezuela December 1999. The type (2) is caused by the movement of deposited sediment on the creek by rainfall and is not always associated with simultaneously slope failure. Generally the latter case has less sediment volume and less destructive energy.

In the Study Area there is no record that the phenomenon like the type (1) clearly occurred. The disaster in May 1994 in the Zuque creek of the Chiguaza is regarded as the phenomenon close to the type (2).

In the Study Area the comparatively dominant phenomenon is the type (2) because since rainfall amount is not so big that the type (1) phenomenon is very rare. However in many years small scale collapse from the mountain slope entered into the creek and deposited on the creek. It is anticipated that such sediment deposition on the creek suddenly becomes flash flood (so called type (2)) when heavy rain.

In current expectation, there is a possibility that flash flood by breach of natural dam could happen in a catchment like Yomasa creek because there is a deposit reach (mild slope) in upper area.

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[1] Nishimoto, et.(2005), Current Situation and Future Research Tasks about Flash Flood in the world, Civil Engineering Report 47-7 (in Japanese).

Table S6-4-1 Number of Literature on Flash Flood (Nishimoto, 2005)

	Nepal	USA	Canada	Philippines	Iran	Venezuela	Indonesia	Taiwan	Korea	Guatemala	Costa Rica	Nicaragua	Brasil	Peru	Swiss	Austria	Total
1. by slope failure	3		3	2		2						1					11
2. by breach of natural dam	2							1	1								4
3. by runoff of fly ash				1			1			1	1						4
4. by runoff from semi-arid land					2									1			3
5. by runoff from devastated land (forest fire, air pollution)		2											1				3
6. by rapid runoff from rain , snowmelt to valley		3															3
7. by breach of glacial lake	2																2
8. by snow fall			1														1
9. not clear															1	1	2
Total	7	5	4	3	2	2	1	1	1	1	1	1	1	1	1	1	33

4.2 Flood Susceptibility

4.2.1 Methodology

(1) One (1) dimensional hydraulic calculation

In the target creeks in Bogota as well as the Study area in Soacha, the creek / river bed slope is quite steep and the topography is represented by V-shape contour lines, the flood flow is quite one dimensional. Since the energy slope is quite high, the uniform flow concept is appropriate. In the creek flow capacity evaluation (Supporting Report S6 Chapter 1), conveyance calculation was already applied based on Manning's equation.

For one (1) dimensional water surface profile calculation, HEC-RAS was used in the Study considering the usefulness, world-wide popularity, freeware and the existing studies related with the Study area.

Water surface profiles are computed from one cross section to the next by solving the energy equation with an iterative procedure called standard step method. The energy equation is written as follows;

$$Y_2 + Z_2 + \frac{\alpha_2 V_2^2}{2g} = Y_1 + Z_1 + \frac{\alpha_1 V_1^2}{2g} + h_e$$

Where; Y_1, Y_2 = depth of water at cross sections
Z_1, Z_2 = elevation of the main channel inverts
V_1, V_2 = average velocities (total discharge/total flow area)
Alpha$_1$, alpha$_2$ = velocity weighting coefficients
g = gravitational acceleration
H_e = energy head loss

The energy head loss (he) between two cross sections is comprised of friction losses and contraction or expansion losses. The equation for the energy head loss is as follows,

$$h_e = L\overline{S}_f + C\left|\frac{\alpha_2 V_2^2}{2g} - \frac{\alpha_1 V_1^2}{2g}\right|$$

Where; L = reach length
Sf = representative friction slope between two sections
C = expansion or contraction loss coefficient

(2) Two (2) dimensional hydraulic calculation

FLO-2D is a two-dimensional flood routing model that is a valuable tool for delineating flood hazards, regulating floodplain zoning and designing flood mitigation. FLO-2D routes a flood hydrograph using the full dynamic wave momentum equations and guaranteeing volume conservation to accurately predict the area of inundation. The fluid viscous and yield stress terms are accounted in the model. The channel and floodplain roughness play a role in the turbulent stresses in the full dynamic wave equation. The model is effective for analyzing river overbank flows, but it is also valuable for analyzing unconventional flooding problems such as unconfined flows over complex topography and roughness, spilt flows, mud / debris flows and urban flooding. The key to the model applicability is volume conservation that tracks the flood wave progression over an unconfined surface. Flood hazard delineation detail can be enhanced with FLO-2D by modeling rainfall and infiltration, applying bridge, culvert and levee components, simulating hyper-concentrated sediment flows or by modeling the effects of buildings or flow obstructions.

FLO-2D simulates overland flow using topographic data files that have been developed from a digitized base map. The FLO-2D software package includes a Grid Developer System (GDS) program that will overlay a grid system on a set of random digital terrain (DTM) points and interpolate and assign elevations to grid elements. A pre-processor program reformats the topographic data into a file that identifies contiguous grid elements. Other data files include those associated with various physical processes such as channel flow, rainfall and infiltration, and those files that control the simulation. The use has control over the creation of spatial and temporal output data files. The FLO-2D results include depth and velocity files that can be re-imported to the original CADD mapping to produce maximum depth and velocity contours. In addition, the MAPPER post-processor program will graphically display the output to assist in interpretation of the results. This process essentially automates the flood hazard delineation.

The governing equations for hydrodynamic computation is as follows,

$$\frac{\partial h}{\partial t} + \frac{\partial hV_x}{\partial x} + \frac{\partial hV_y}{\partial y} = i$$

$$S_{fx} = S_{ox} - \frac{\partial h}{\partial x} - \frac{V_x}{g}\frac{\partial V_x}{\partial x} - \frac{V_y}{g}\frac{\partial V_y}{\partial y} - \frac{1}{g}\frac{\partial V_x}{\partial t}$$

$$S_{fy} = S_{oy} - \frac{\partial h}{\partial y} - \frac{V_y}{g}\frac{\partial V_y}{\partial y} - \frac{V_x}{g}\frac{\partial V_y}{\partial x} - \frac{1}{g}\frac{\partial V_y}{\partial t}$$

Where h is the flow depth and Vx and Vy are the depth – averaged velocity components along the x- and y- coordinates. The I is excess rainfall intensity.

The differential form of the continuity and momentum equations in the FLO-2D model is solved with a central, finite difference scheme. The solution domain is discretized into uniform, square grid elements.

The friction slope components S_{fx} and S_{fy} are composed of yield slope component, viscous slope component and turbulent-dispersive slope component.

$$S_f = S_y + S_v + S_{td}$$
$$S_f : friction\,slope$$
$$S_y : yield\ slope$$
$$S_v : viscous\,slope$$
$$S_{td} : turbulent - dispersive\ \ slope$$

FLO-2D routes hyperconcentrated sediment flows (mud and debris flow) as a fluid continuum by predicting viscous fluid motion. For mudflows, the motion of the fluid matrix is governed by the sediment concentration. A quadratic rheologic model for predicting viscous and yield stresses as function of sediment concentration is employed and sediment volumes are tracked through the system. As sediment concentration changes for a given grid element, dilution effects, mudflow cessation and the remobilization of deposits are simulated.

4.2.2 Hydraulic Parameter

Manning's roughness coefficient is the most dominant parameter in one dimensional hydraulic calculation. Table S6-4-2 shows the range of Manning's roughness shown in Japanese Technical Standard on River and Sabo. Considering the steep slope (creek bed), gravel and boulder on the river bed and grass on banks, the Manning's roughness was set 0.040.

Table S6-4-2 Range of Manning's roughness

Condition of river/creek (natural)	Range of Manning's roughness
Small river/creek without grass in plain	0.025 to 0.033
Small river/creek with grass and bush in plain	0.030 to 0.040
Small river/creek with many grass, gravel river bed	0.040 to 0.055
River/creek in mountain, gravel and boulder river bed	0.030 to 0.050
River/creek in mountain, gravel and large boulder river bed	0.040 and more
Large river, clay, sand bed with small meandering	0.018 to 0.035
Large river, gravel bed	0.025 to 0.040

4.2.3 Chiguaza Creek

For Chiguaza creek, middle reach to downstream reach, one dimensional hydraulic calculation was made using HEC-RAS model in order to check the flood area.

The model outline is as follows,

Modeled Reach: San Benito to Los Puentes

Cross Section: River cross section survey (January 2007) supplemented by 2 m contour line of Bogota for floodplain

Discharge: Discharge by rational method at Los Puentes (10 and 25 years return period, refer to Supporting Report S6 Chapter 3).

The flood map by this calculation is shown in Data Book 1 GIS Map as Monitoring Plan Map.

According to the rational method discharge calculation, the peak discharge is decreasing from Los Puentes to the downstream reach because the flood concentration time is becoming longer while the catchment area is not increase so much. This kind of theoretical issue should be confirmed by monitoring data at Molinos and El Hoyo after the Study.

4.2.4 Soacha River

(1) One dimensional calculation

In order to reproduce the May 11, 2006 flood in the Soacha river, one dimensional hydraulic calculation was made using HEC-RAS model.

Modeled Reach: Bogota river confluence to Ladrillera Santa Fe

Cross Section: River cross section survey (January 2007) supplemented by SRTM3 Data

Discharge Case: May 11, 2006 Flood at Llano Grande

The flood map by this calculation is shown in Data Book 1 GIS Map as well as used in community hazard map.

(2) Two dimensional calculation

For the Soacha River and the Tibanica River, 2-dimensional flood simulation model was made in the 2nd field survey in Colombia. The flooding phenomenon in the Study Area in Soacha is quite 2-dimensional between the Tunjuelo River and the Bogota River. This kind of simulation model can show the inundation phenomenon quantitatively, for example, the inundation depth vs. duration time as well as potential flood area.

The model outline is as follows,

Model Area (see Figure S6-4-1)

Grid Size:	100 m * 100m
Grid Elevation:	SRTM3
Modeled Channel:	Soacha River, Tibanica River
Inflow Points:	Soacha River Llano Grande upstream, Tibanica River Terreros Dam outlet
Return Period:	25 years

The inflow hydrograph for 25 years return period was obtained from “Soacha Plan Maestro EAAB”.

The channel dimension of the Soacha River and the Tibanica River are that evaluated by the Study Team. The result is shown in Figure S6-4-1 (depth in channel and floodplain).Larger depth on floodplain can be seen in upstream of Autopista Sur of Soacha river and Tibanica river.

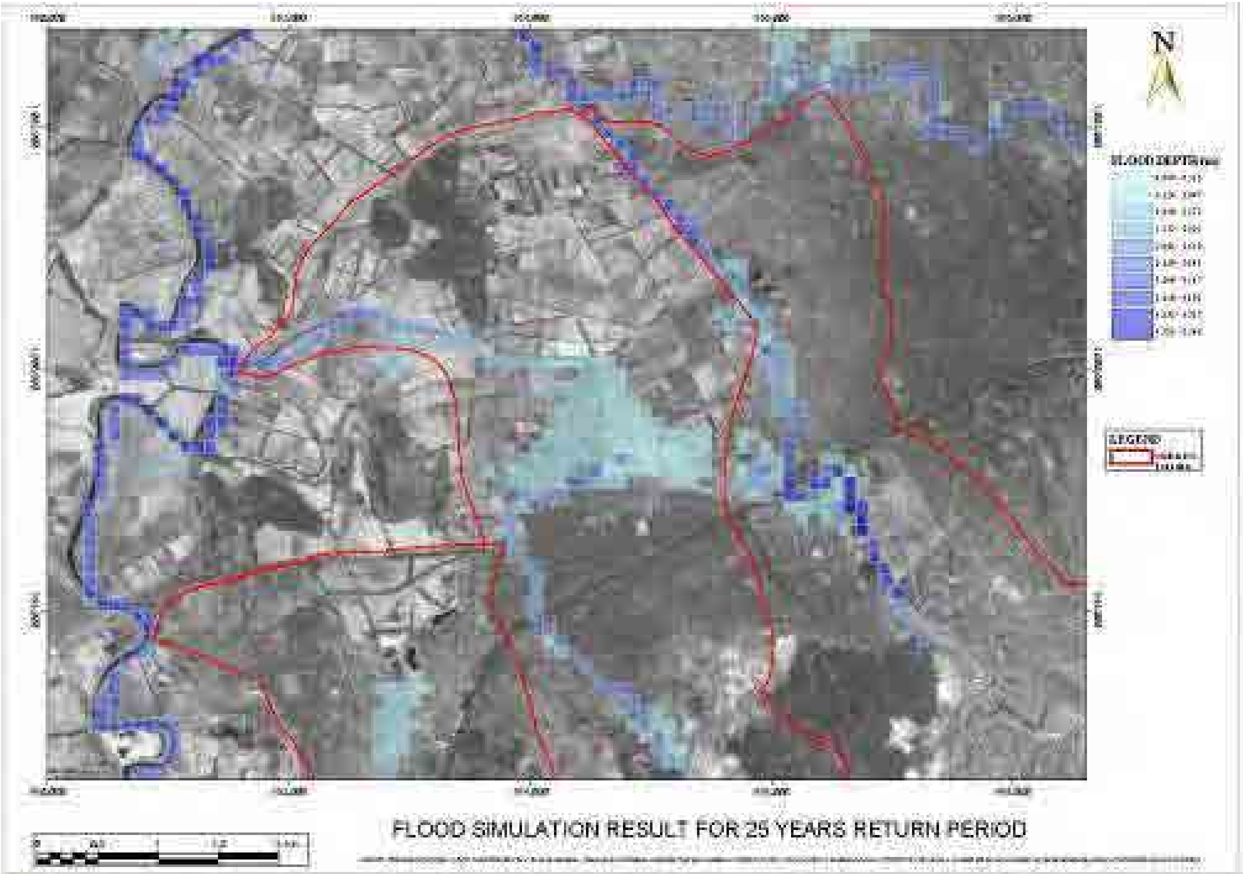


Figure S6-4-1 Flood Simulation Result by FLO-2D for Soacha

4.3 Flash Flood Susceptibility

4.3.1 General

In this sub-chapter the methodology of mapping of flash flood susceptibility is presented for the Study Area in Bogota. The methodology is basically based on that in Japan which has been applied in recent years. The application of the method in Japan is supported by laws in Japan for the sediment disaster prevention measure. The method is simple and supported by accumulated engineering experiences on sediment control field in Japan. The reason why the method is simple is to make the application easy in a lot of sediment disaster-prone areas in Japan using less time and less cost.

While the method is applied in Japan based on laws, considering the simplicity and the accumulated experiences in Japan, the Study Team regarded it is good reference in engineering sense to introduce the method in the Bogota target creeks.

Figure S6-4-2 shows the specific procedure for the Bogota target creeks as the result of this Study.

The first step is to select candidate catchment in which there is a possibility of flash flood occurrence and area supposed to be exposed to damage by flash flood from topography and social condition in general. The social condition means here that there should be property such as residential houses at the downstream of the candidate catchment in the case of Japan. However in this study, since it is an introduction of the methodology, natural conditions were emphasized for the selection.

The first step should be done comprehensively from three aspects. Other than the topography, recent slope failure by aerial photo interpretation and investigation of creek conditions are important aspects. As discussed in Supporting Report S3, among the target creeks, the Yomasa creek has only potential of flash flood (debris flow) because of the present sediment deposition on the creek.

Therefore the basic point was defined in the Yomasa creek in order to define the flash flood susceptibility mapping and to study the sediment volume for the consideration of sediment control measure in the future if it is decided to conduct.

The flash flood susceptibility map was prepared for the Yomasa creek although the area is not developed yet. In the future, if the mapped area starts to be developed, it is necessary to inform communities living there that the area is susceptible for flash flood as long as unstable sediment on the creek remains.

The sediment volume to be supposed generated from the upstream of the basic point was tentative calculated. However, in order to assure the sediment volume, the result should be supported by accumulated data of sediment balance studies based on the actual disaster events. In the study area, it is not possible because there are no recent events. Rather than such calculation, the more important activity is to accumulate the rainfall and waterlevel relation also in the Yomasa creek which will be necessary for the calculation of sediment volume.

At the end of this Chapter, the concept of sediment balance study was shown as reference.

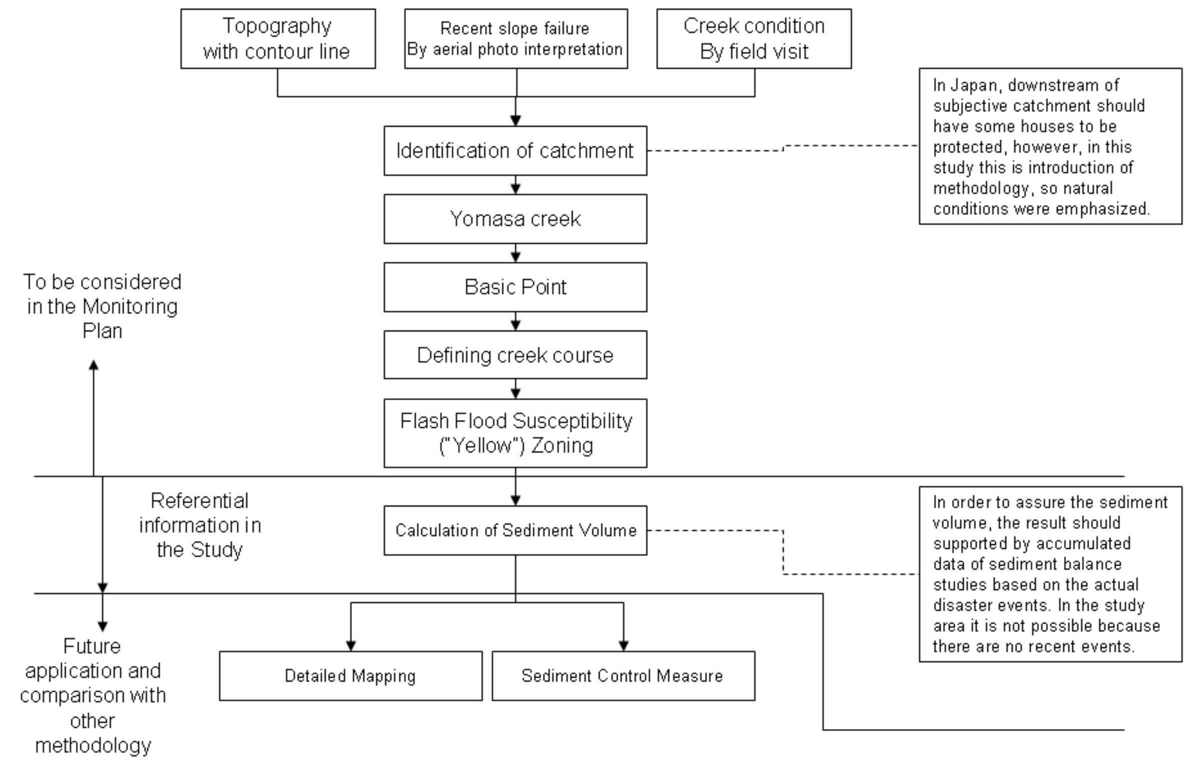


Figure S6-4-2 Specific Procedure of flash flood susceptibility mapping for the Study Area in Bogota

4.3.2 Identification of Catchment and Setting of Basic Point

Candidate catchment in which there is a possibility of flash flood occurrence and area supposed to be exposed to damage by flash flood are identified from viewpoint of topography. For the identification, topography and social condition are considered. Topography condition is whether a valley is formed or not on scale 1:25,000. Social condition is whether there are houses (residential or public, important facilities).

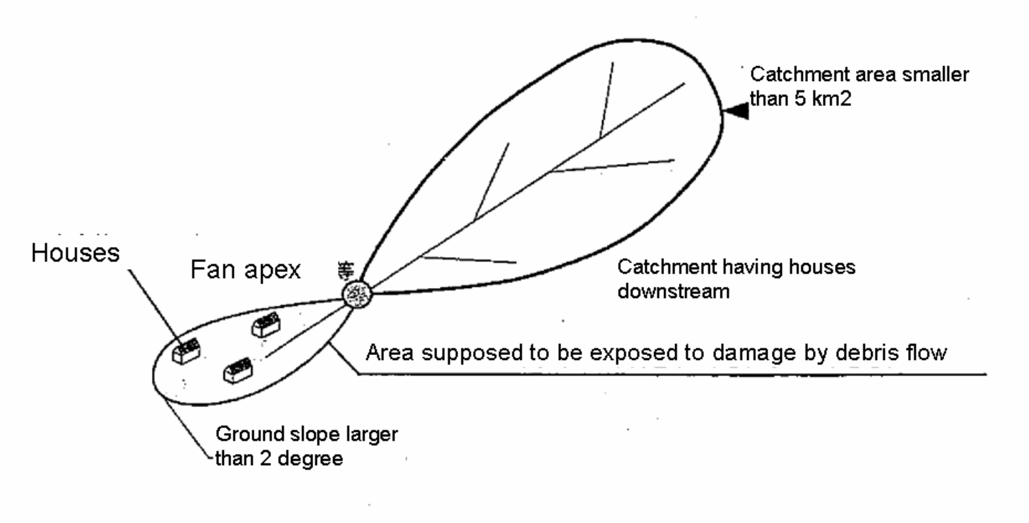


Figure S6-4-3 Schematic Image of Subjective Subcatchment

In Japan, the potential stream for flash flood is categorized based on the type and the number of target property to be protected. The type is for example residential house and public building, etc. The number of the property is more than five (5) or less.

The aerial photo of 1997-1998 interpretation was done by the Study Team. It was found that in Chiguaza, Yomasa and Trompeta there are new slope failures related to flash flood. Also the creek condition was examined by filed survey in this study in order to check the present creek condition and unstable sediment deposit to determine the subjective catchment.

(1) Basic Point

Basic point is defined as a point in order to calculate sediment volume (Ve') for hydraulic force estimation, to delineate the area supposed to be exposed to damage by flash flood, and to calculate the external force acting to houses for further zoning in Japan.

Generally the relation between the flash flood generation and the stream bed slope is as follows,

Table S6-4-3 Sediment Transport for Creek Bed Slope

Slope Category	General Description of Section
$20^\circ < \theta$	Generation
$15^\circ < \theta < 20^\circ$	Generation and Transport
$10^\circ < \theta < 15^\circ$	Transport
$3^\circ < \theta < 10^\circ$	Deposition

Usually the basic point is defined at a point whose bed slope is about 10 degree considering the beginning of flash flood deposition.

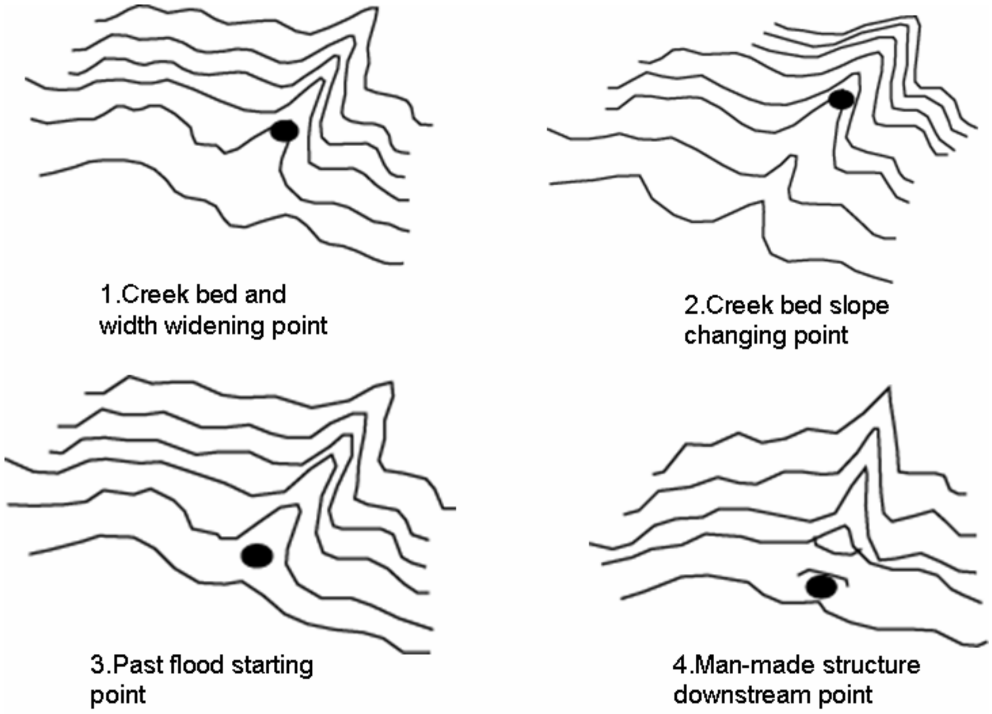


Figure S6-4-4 Example of Location of Basic Point

(2) Basic Point in the Study Area

The basic points in the study area were decided based on the following things.

- In the upstream of a basic point, there are the traces of comparatively new slope failure, which is located at the extended upstream creek.
- Creek bed and width widening point
- Creek bed slope changing point at ten (10) degrees
- Past flood starting point
- Man-made structure downstream point

Based on the above things, totally seven (7) basic points were selected as candidate points (Table S6-4-4). Figure S6-4-5 shows the location of new slope failures which were identified by aerial photo interpretation and the creek condition survey point.

Table S6-4-4 includes the evaluation results of each candidate basic point in terms of flash flood potential based on the aerial photo interpretation, creek condition survey and site visit. The candidate basic points were selected based on the existence of new slope failure identified by the aerial photo interpretation (refer to Figure S6-4-5 and Supporting Report S3). Also the creek condition as present condition were examined from a point of view of unstable sediment on creek bed, recent flash flood occurrence (experience of each creek) as well as vegetation of basic point upstream. It is concluded that the Yomasa basic point (downstream end of sub-catchment No.2) should be regarded as a basic point for the considering of flash flood susceptibility.

The upstream reach of the basic point of the Yomasa creek is assumed unstable sediment remains together with drift woods. Also in the upper catchment (sub-catchment No.1) many new slope failures are recognized.

Table S6-4-4 Candidate Basic Points in the Study Area

Creek	Upstream sub-catchment of basic point (candidate point)	Name of Creek (Basic Point Downstream)	New slope failure identified by aerial photo interpretation	Degree on unstable sediment deposit as present condition based on creek condition survey and field visit
Chiguaza	2-1	Zuque creek	Yes	It is assumed that because of the sediment runoff in 1994 and channel improvement work, at present little sediment on creek bed.
Chiguaza	2-3	Chorro Silverio	Yes	No recent flash flood and dense vegetation basic point upstream
Chiguaza	2-5	Chiguaza	Yes	No recent flash flood and dense vegetation basic point upstream
Chiguaza	2-8	Seca	Yes	No recent flash flood and dense vegetation basic point upstream
Chiguaza	3-1	Nutria	Yes	No recent flash flood and dense vegetation basic point upstream
Chiguaza	3-6	Nueva Delhi	Yes	No recent flash flood and dense vegetation basic point upstream
Yomasa	No.2	Yomasa Main creek	Yes	Unstable sediment and drift woods are recognized. High potential of sediment runoff from upper catchment (mild slope).

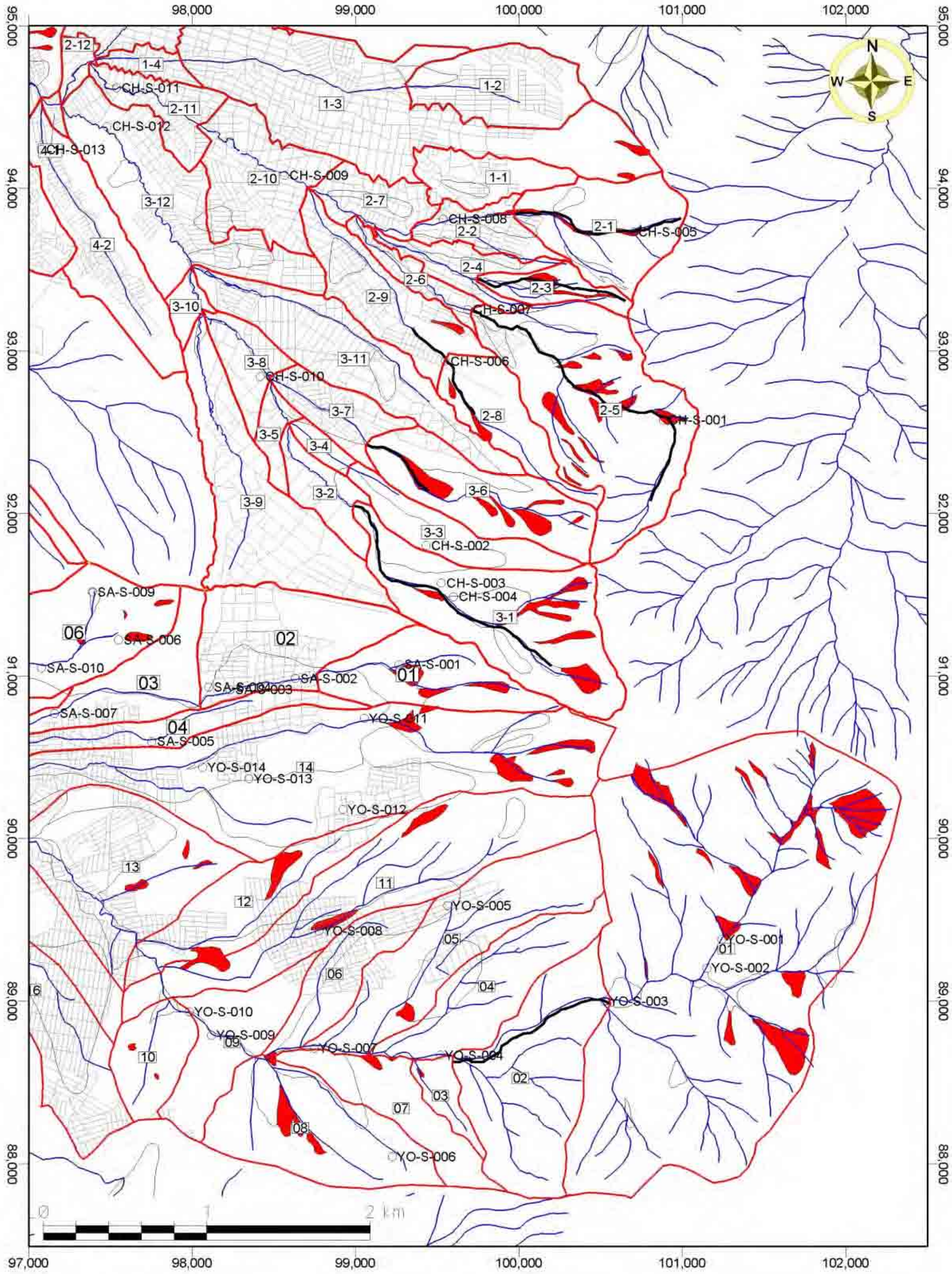


Figure S6-4-5 Location of New Slope Failure and Creek Condition Survey Point

4.3.3 Defining of Creek

The creek route is defined for the basic point downstream. In the Yomasa, if a basic point is defined, the downstream creek route is automatically decided because the existing drainage system is clear.

4.3.4 Definition of "Yellow Zone"

The normally affected area by flash flood so called "Yellow Zone" can be defined as the section in which the potentially flash flood could reach from the topographical viewpoint. The yellow zone is the basic point downstream and the slope three (3) degree upstream, in principle. The concept to delineate the yellow zone is illustrated in Figure S6-4-6.

The following is the methodology to define the yellow zone. The materials used here are that the Study Team could obtain in this study.

Step 1: Prepare the topographical map having 10 m interval contour line with scale 1:2,000.

Step 2: At the basic point, along the cross section line, the width which has the height of 5 m shall be defined. The 5 meter is recommended in Japan as a maximum flash flood height based on the field investigation in Japan.

Step 3: From the bank point, for example left bank, the steepest point which have 40 m distance shall be searched. This work can be done using a compass setting the interval 20 mm (scale is 1:2,000).

Step 4: From the steepest point, the vector shall be rotated outer side 30 degree and a new point 40 m distance from the left bank shall be defined. If the elevation of the new point is higher than 5 m compared the steepest point, the point just higher than 5 m from the steepest point shall be defined as a new point.

Step 5: Setting the new point as the next left bank point, the Steps 3 and 4 shall be repeated until the reach whose bed slope is milder than 3 degree.

Step 6: The area closed by the point decided in the Step 5 shall be defined as the yellow zone.

The yellow zone of the Yomasa creek is shown in Figure S6-4-7. The zone is not affected by houses or building in this case.

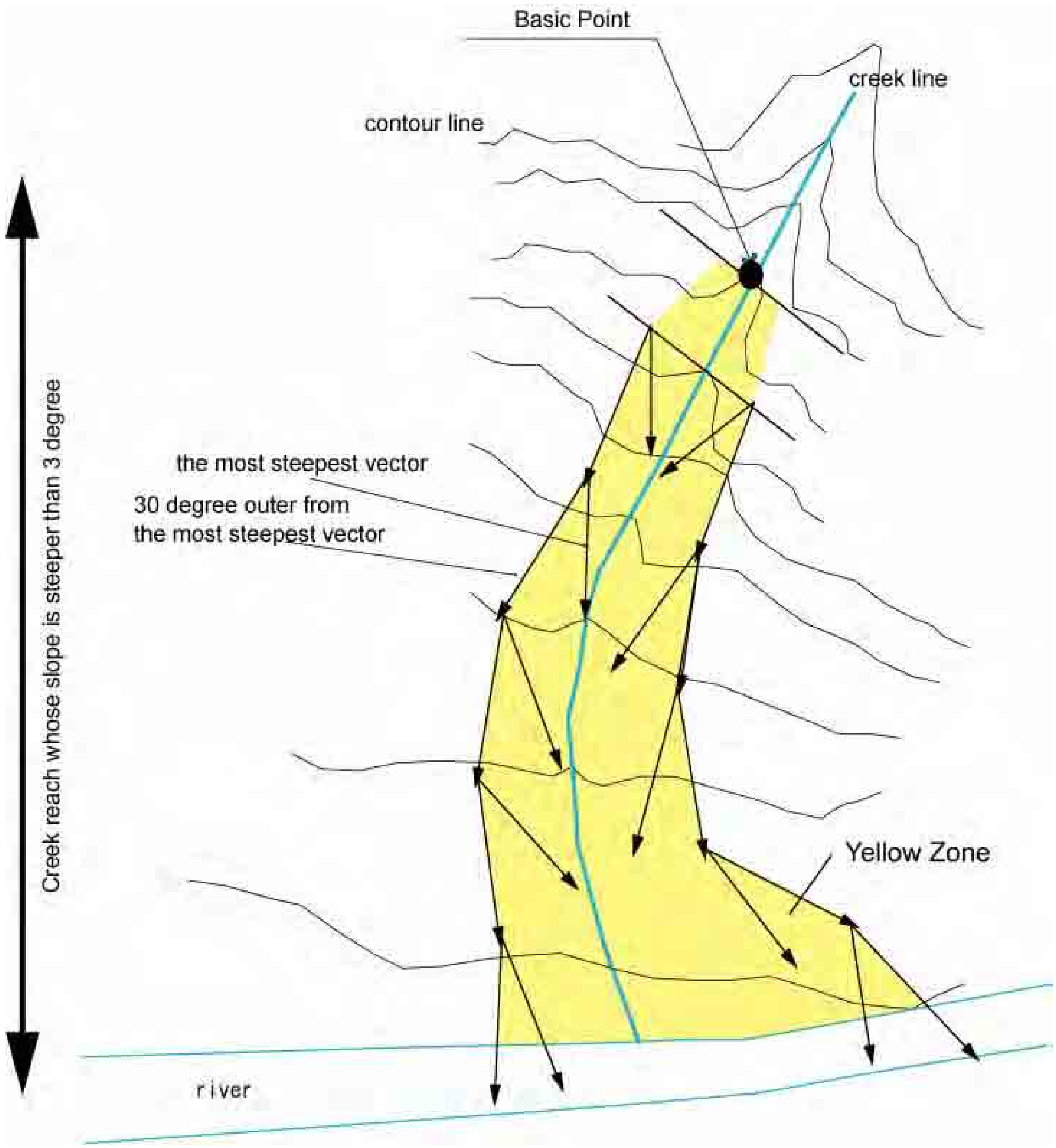


Figure S6-4-6 Concept to delineate the yellow zone

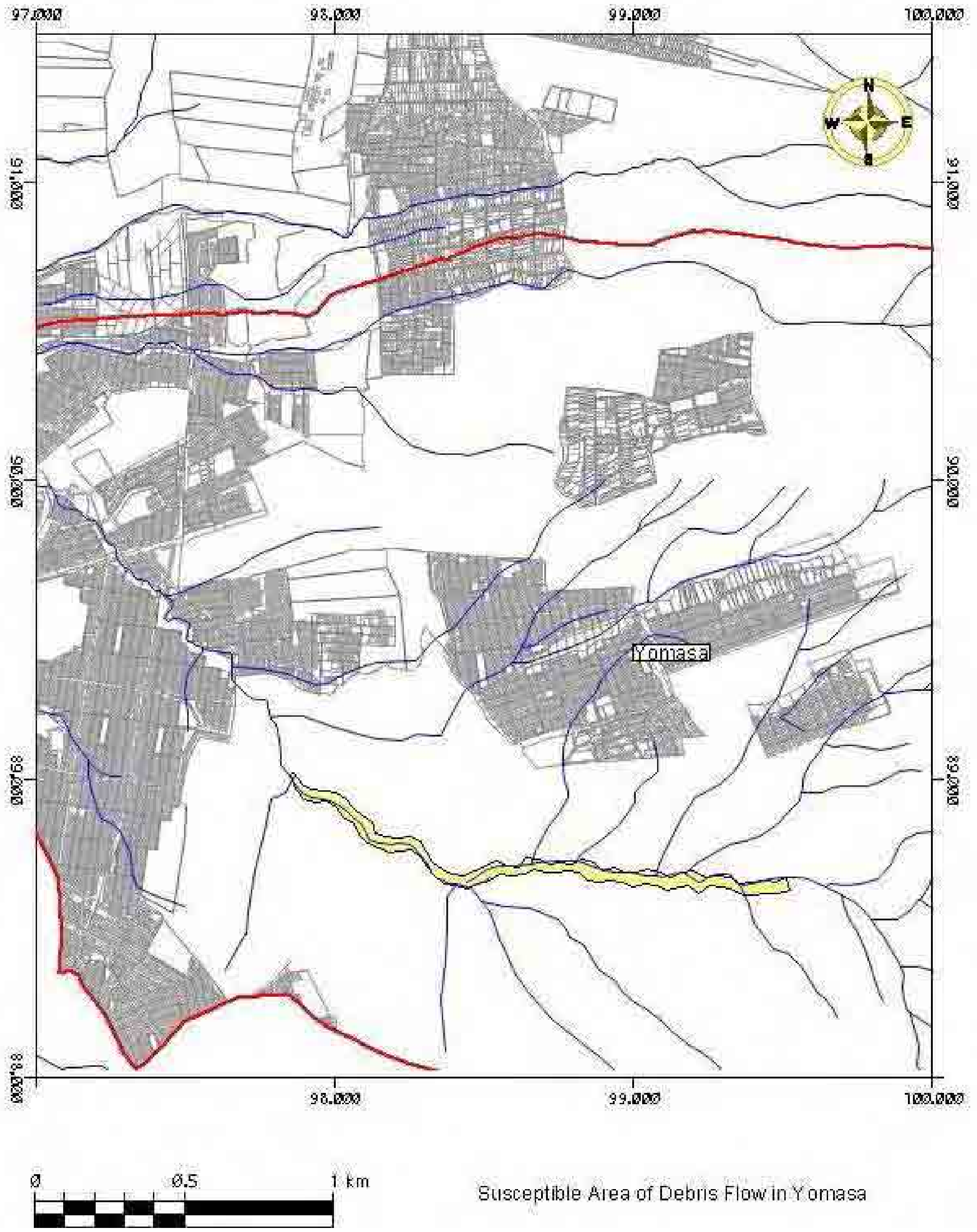


Figure S6-4-7 Susceptible Area of Flash flood (Yellow Zone) in Yomasa

4.3.5 Calculation of Sediment Volume

(1) Sediment volume (Ve') for detailed zoning and sediment control plan

The sediment volume for detailed zoning and sediment control plan (Ve') is calculated for each basic point. Ve' is a value smaller between "Erodable Sediment Volume (Ve)" and "Transportable Sediment Volume (Vec)".

Ve (Erodable Sediment Volume) can be calculated as follows,

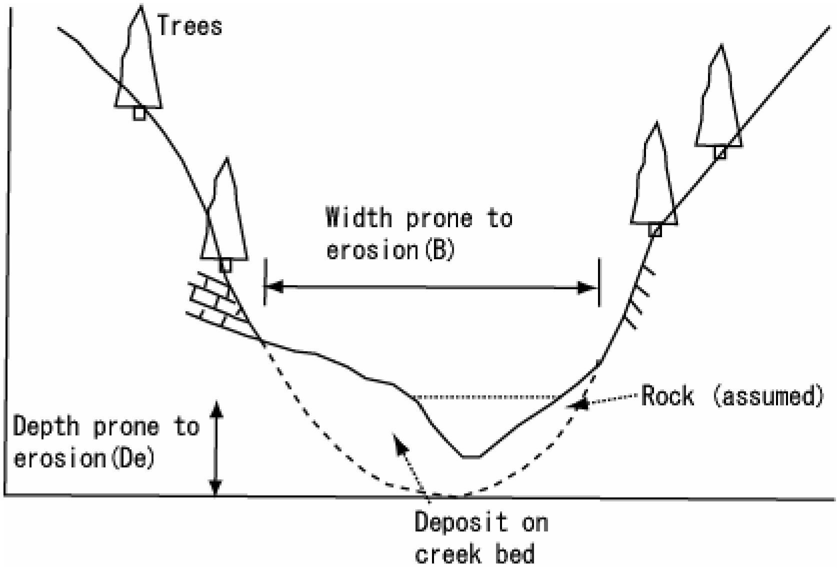


Figure S6-4-8 Schematic Image of Parameters “B” and “De”

$$V_e = \sum_{i=0}^{n} (A_e \times L_e)_i$$

where

$A_e = B \times D_e$ = sediment possible to be eroded per unit length (m3)

B = Width prone to erosion (m)

D_e = Depth prone to erosion (m)

L_e = Longitudinal Length to apply for $A_e (m)$

The creek condition survey for the estimation of the above “B” and “De” was conducted by the Study Team. The overall results of the survey are shown in Supporting Report S3.

In order to assume the amount of Ve (Erodable Sediment Volume), the upstream creek condition of each basic point was analyzed using the creek condition survey as follows,

Yomasa Creek

Basic Point	Creek Name	Creek Condition	Assumed “B” and “De”
2	Yomasa	There are four (4) cross sections to be referred for the basic point No.2 in the Yomasa creek. They are “YO-S-001”, “YO-S-002”, “YO-S-003” and “YO-S-004” from upstream. The upstream three (3) sections have no clear evidence on creek bed erosion by water because they are located on mild slope reach. The “YO-S-004” has sediment deposition of 2 meter depth and 10 m width. Also there are fallen trees on the sediment deposit.	B=10 m De=2 m

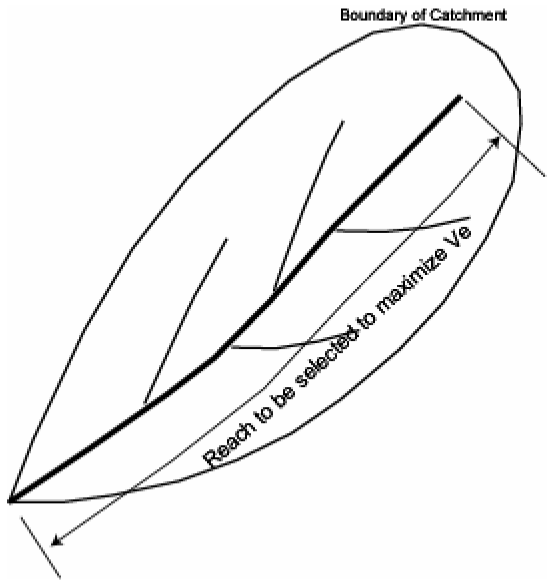


Figure S6-4-9 Selection of "Le"

"Vec" can be calculated as follows,

The runoff sediment volume below the control point is actually affected by the topographic condition around the control point and the hydrological condition. As it is widely done in Japan, the following sediment volume was calculated as the value possible through the control point.

$$Vec = \frac{10^3 \cdot Rt \cdot A}{1-\lambda}\left(\frac{Cd}{1-Cd}\right) \cdot fr$$

Where A: Catchment area in km^2, Rt: 24 hours rainfall in mm for the selected return period[2], λ : void ratio(=0.4) , fr: runoff adjustment ratio, Cd: sediment concentration as a function of stream bed slope.

The runoff adjustment ratio is

$$fr = 0.05(\log A - 2.0)^2 + 0.05$$
$$0.1 \le fr \le 0.5$$

$$Cd = \frac{\rho \cdot \tan\theta}{(\sigma - \rho)(\tan\phi - \tan\theta)}$$

Where Cd : concentration of flash flood after Takahashi, sigma : specific density of sediment (t/m^3), row : flow density (t/m^3), phi : internal friction angle (degree), theta : slope of stream bed (degree).

Table S6-4-5 Calculation of "Ve" and "Vec"

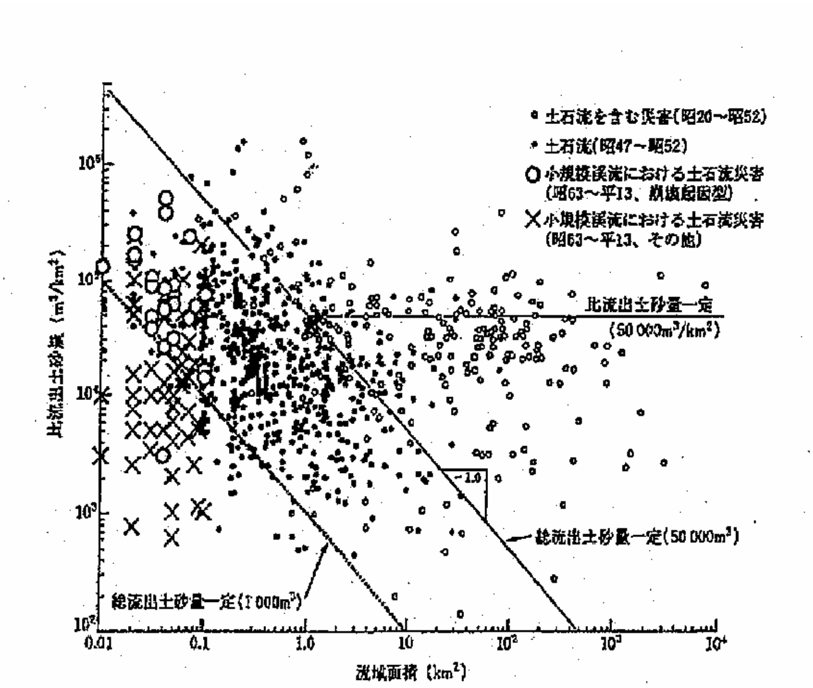
				Ve					Vec									
Creek	Upstream sub-catchment of basic point		Catchment Area	Le	B	De	Referenced Point	Ve	Rt		λ	fr	bed slope		Cd	Vec	Ve'	
			(km2)	(m)	(m)	(m)		(m3)	(mm)	Station Name			(m)	(degree)		(m3)	(m3)	(m3/km2)
Yomasa	No.2	Yomasa Main creek	4.78	1100	10.0	2.0		22,000	80.18	Juan Rey(EAAB)	0.4	0.14	65	18.0	0.74	252,627	22,000	4,603

[2] Considering the rareness of occurrence of debris flow in the study area, the return period is proposed 100 years.

(2) Checking of Calculated Sediment Volume

In Japan as a usual procedure, the calculated sediment volume should be compared with the past event or other examples in order to avoid overestimated and underestimated. In the Study area, the calculated sediment volume in 4.3.5 (1) should be supported by the accumulated data in Yomasa and/or in similar catchment before the calculated sediment volume is applied for some plans.

Figure S6-4-10 shows the relation between catchment area and specific sediment runoff volume in Japan at the events of flash flood. The x-axis is catchment area in km^2 and the y –axis is specific runoff sediment volume (m^3/km^2). The small dots are the events with comparatively large catchment between 1945 and 1972. The large circle and cross marks are the events with comparatively small catchment between 1988 and 2001. This figure is used to check and compare the calculated value with the historical actual values.



Source: Okamoto, Engineering Hydrology, Nikkan Kogyo Shinbunsha, 1982 (Japanese Book)

Figure S6-4-10 Relation between catchment area and specific sediment runoff volume in Japan

(3) Recommendation of Sediment Balance Study

In the Study area, it is not possible to assure the sediment volume from upstream of basic point of the Yomasa creek because flash flood associated with sediment runoff and deposition is rare. In order to set a reliable sediment volume in the Study area it is necessary to accumulate the result of sediment balance each time when the flash flood happens in the future.

Figure S6-4-11 shows the concept of sediment balance in the case of without slope failure. It is assumed that a flash flood took place in associated with the sediment deposit on the creek. The catchment area upstream of the basic point is “CA”. “V2B” means the sediment volume in the reach of upstream of the basic point. “V3” means the sediment deposition in the area of downstream of the basic point.

“V2B” can be evaluated as product of sectional area of unstable sediment and corresponding longitudinal creek length. The sectional area of unstable sediment should be confirmed in the site investigation, paying attention to sediment deposit layer and rock line.

“V3” can be evaluated as product of sediment deposit area (m^2) and the average depth of deposit.

These values also should be confirmed by field visit and interview survey to the affected people.

The important parameters are as follows,

1) V3/CA

In general, the "V3/CA" is called specific sediment runoff volume (per catchment area). It depends on the magnitude of the flash flood event such as rainfall amount as well as catchment conditions. However, if the value is accumulated for a lot of catchment in and around the study area, such data set will be an index of sediment runoff volume for a given catchment. Figure S6-4-10 is one example of the data set in Japan.

2) V3 / V2B

The "V3 / V2B" is a ratio of sediment runoff volume to sediment deposit on creek before flash flood. After accumulating of the "V3 / V2B" for each flash flood event, the average value will an index of sediment runoff volume for a given condition of creek bed.

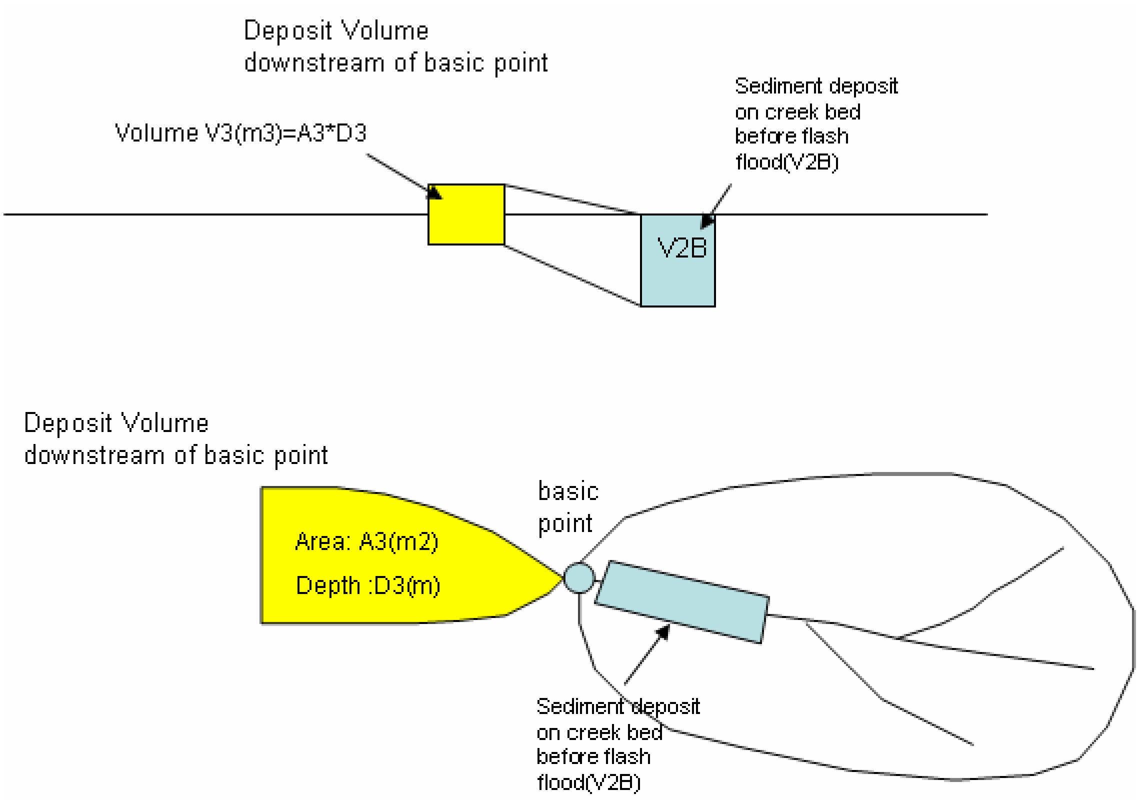


Figure S6-4-11 Concept of Sediment Balance (Flash Flood without Slope Failure)

Figure S6-4-12 shows the concept of sediment balance in the case of with slope failure. It is assumed that a flash flood took place in associated with the slope failure and sediment deposit on the creek. This case is regarded not possible in the target creeks of the Study, however, the Study Team presents this case for future comparison with other methodology by DPAE for reference. The catchment area upstream of the basic point is "CA".

"V1" means the sediment generation due to slope failure, which is a product of slope failure area and failure depth. These values should be evaluated by aerial photo interpretation and field visit after the flash flood event. In Chapter 3 of Supporting Report S3, the average weathering thickness of each creek is shown based on the field investigation in the Study. The actual depth of slope failure in the future can be compared with the Table S3-3-1. If this table is close to the actual depth of slope failure in the future, it can be used to forecast the sediment generation volume for future flash flood event in creeks.

"V2T" means the newly transported sediment volume from slope failure. Usually all the sediment generation volume ("V1") does not arrive at the downstream reach, so "V2T" is less than "V1". "V2B" means the sediment deposit on creek bed before the flash flood event. "V2B" can be evaluated by the field survey (Creek Condition Survey) shown in Chapter 3 of Supporting Report.

Usually the "V3" is less than the sum of "V2T" and "V2B" because some of "V2T" and "V2B" remain on the creek bed after the flash flood.

The relation between "V1" and sum of "V2T" and "V2B" and the relation between "V3" and sum of "V2T" and "V2B" are highly complicated and still research issue in Japan. However, as a prioritized parameter, the following index should be evaluated from a macro viewpoint.

3) (A1+A2) / CA

This parameter means that in one flash flood event caused by rainfall, the percentage of area in which slope failure happened to the catchment area ("CA") for one flash flood event. It varies by geology and magnitude of flash flood event, etc., however, if this value is accumulated and some tendency is clarified, it will be quite useful index because if slope failure depth is assumed, the sediment generation volume can be evaluated for given catchment area.

4) V3 / V1

Since the relation regarding the "V2T" and "V2B" is highly complicated, this parameter should be evaluated for each flash flood event.

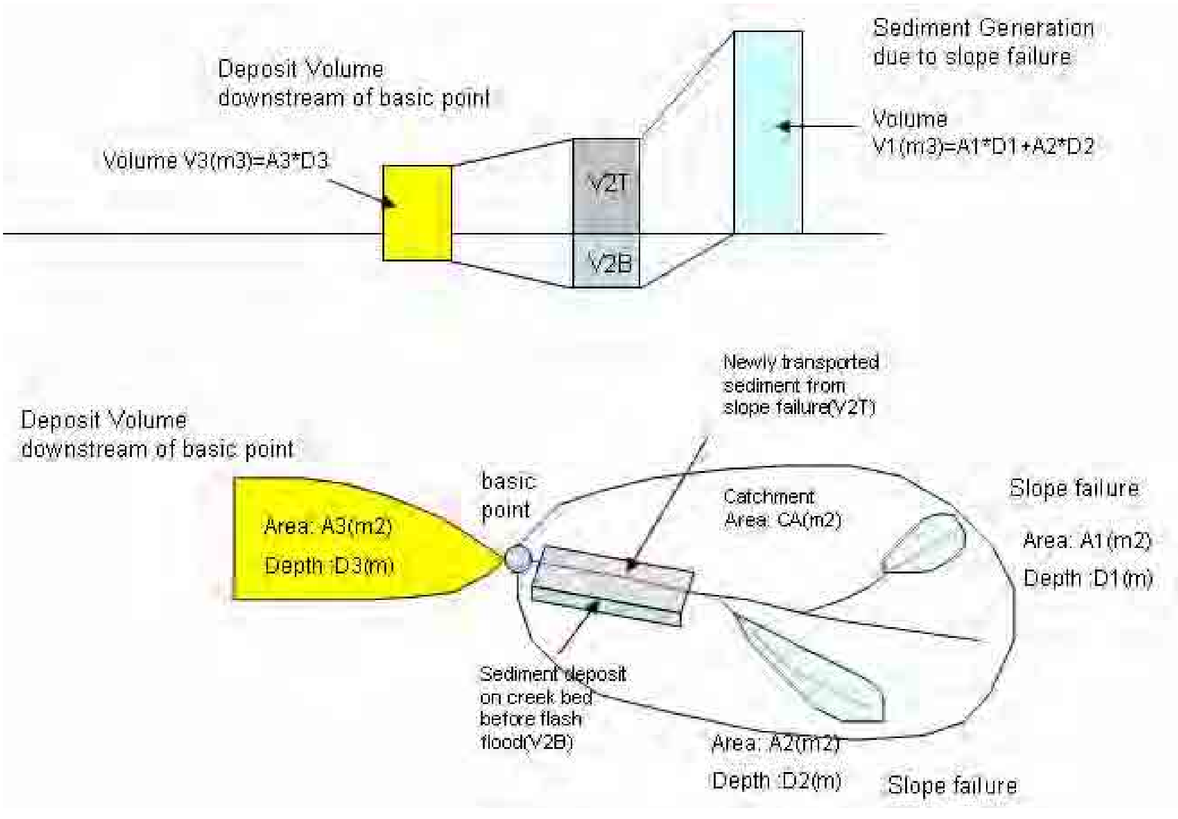


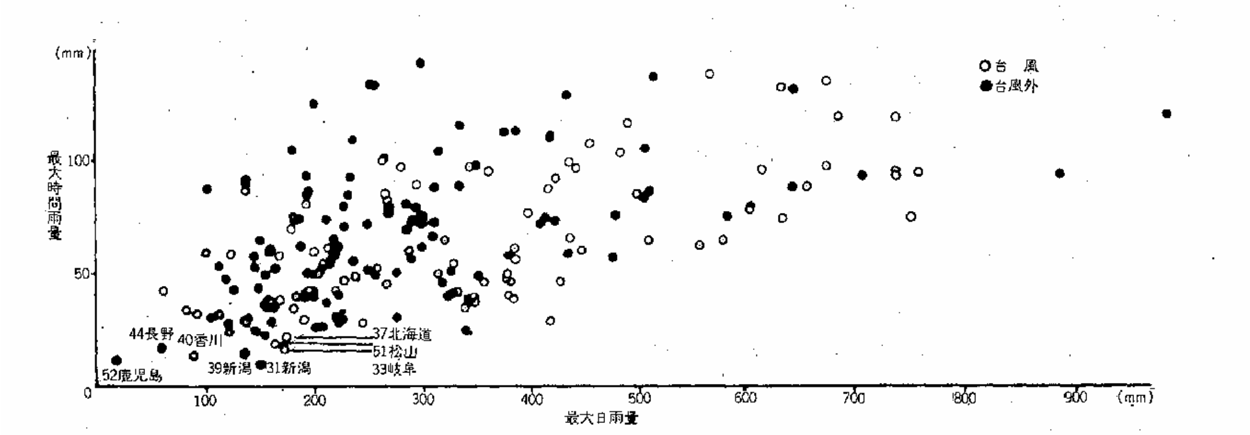
Figure S6-4-12 Concept of Sediment Balance (Flash Flood with Slope Failure)

(4) Example of Sediment Disaster Record in Japan

In Japan, an authority on sediment disaster prevention has been issuing annual report on sediment disaster throughout Japan.

In the case of the 1992 and 1993, totally 42 and 106 flash flood events were listed up in the annual report, respectively as shown in the form of Table S6-4-6. The characters such as CA, A1, A2, V1, V3, D3 and A3 in this table are corresponding to those in Figure S6-4-11 and Figure S6-4-12.

Figure S6-4-13 shows the rainfall amounts which caused flash flood in Japan. The x-axis is maximum daily rainfall during the flash flood in mm and the y –axis is maximum hourly rainfall during the flash flood in mm/h. The circle mark indicates the flash flood caused by typhoon and black circle indicates the flash flood caused by unstable weather other than typhoon (such as cold front). Most of the flash flood was caused by daily rainfall larger than 100 mm, however, one flash flood event was caused by less than 20 mm on daily rainfall and hourly rainfall.



(Source: Research on Debris Flow Occurrence, Ministry of Land, Infrastructure, Transport and Tourism, 1988.)

Figure S6-4-13 Rainfall which caused flash flood in Japan

Table S6-4-6 Contents of annual report on Sediment Disaster (Flash Flood)

No.	Name of creek	Type of geology	Relief index	Catchment Area	Slope Failure condition		Sediment Runoff Condition					Sediment -ation Area	Damage (Human and Physical)
					area	volume	Peak discharge	Maximum Boulder Size	Deposition Volume	Maximum deposition Depth	Average deposition depth		
				CA(km^2)	A1+A2 m^2)	V1(m^3)	(m^3/s)	(m)	V3(m^3)	(m)	D3(m)	A3(km^2)	
1	XX												
2	YY												

SUPPORTING REPORT

S7

COMMUNITY ACTIVITIES

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CHAPTER 1   COMMUNITY ACTIVITIES

1.1 Community Survey

The overall objective of this Survey was to understand the community conditions in the Study Area, unique in reflecting complex conditions in which social displacement, lack of infrastructure services, overuse of resources on fragile land conditions, over population, and high exposure of people living in these areas, lead to build risk creating highly prone areas to floods and landslide disasters.

By understanding the characteristics of local communities in the study area the likelihood to enhance the potential for disaster prevention for landslide and flooding is expected to increase. Six topics were addressed both in the questionnaires and the Focus Groups: hazard awareness, disaster experience, leadership characteristics, mutual support, specific community concerns and willingness for action.

The selection of the location of the surveyed communities mainly considered the affectations by emergencies in prone areas for landslide and flood disaster, representing different existing community organizations, whether neighborhood associations or JACs and other networks which involve women's leaderships, youth activities or informal networks.

The understanding of the different types of community organizing conditions is important in considering the selection of pilot projects, and installing the monitoring and early warning systems. The criteria for the selection will take into account age distribution, gender and disabilities, within the population diversity. In some cases communities lack of local groups other than JACs, but have temporal programs based in external NGOs agendas. Community leaders have expressed concern about the lack of options youngsters have with regards to community healthy activities and opportunities. Nevertheless there are initiatives in which youth population are being involved (for example AFRODES –Asociación Afrocolombianos- an ethnic based cultural program in Altos de Cazucá.[1]

With regards to gender, women specifically are known to participate voluntary community activities, set by external NGOs for strengthening their self esteem, and many times leadership skills –decreased during the migration and displacement processes- and establishing networks among social age groups (such as children, youth, elders) and in income generation activities, as well.[2] CLOPAD members have expressed concern about the existence of people with physical disabilities living in the barrios, which need to be surveyed and taken into account in the Municipal Prevention efforts and plans.

Community Survey included 363 persons distributed within both: Tibanica and Soacha watersheds; and Divino Niño and Altos de Cazuca landslide prone areas, was done according to the following criteria: above 15 years old, 25% adults, 25% youth below 26, people with physical disabilities, young leaders of both sexes, 50% women, living 100 mts from hazard (river or steep slope), Critical and Very Critical Zones for Landslide, according to Ingeminas Maps of 2006.[3]

In Comuna 4, the communities identified as Very Critical were: La Capilla, Casa Loma, Villa Mercedes, Villa Esperanza El Barreno, Terranova, Luis Carlos Galan 1,2,3, El Arroyo, Santo Domingo and El Mirador de Corinto. Critical Zones in Comuna 4 are: El Progreso, La Nueva Unión, Altos del Pino, El Mirador de Corinto, Santo Domingo, Villas de Casa Loma, Carlos Pizarro, Julio Rincón. In Comuna 6, declared as Very Critical are Divino Niño and Altos de La Florida. The survey sheets used in this survey are attached as Annex S7-1

Annex S7-2 shows a map of communities both sides of the Watershed of Soacha River.

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[1] Jensen, Kirstine Westh. Consejería en Proyectos. *La Juventud dentro del Conflicto Urbano. Violencia, control social e iniciativa cultural en los Altos de Cazucá*. 17 de mayo del 2005. www.pcslatin.org/noticias/2005/07-09.pdf

[2] Garzón, Clara Stella. *Diagnóstico de Género de la Población de Soacha, con énfasis en las Mujeres Desplazadas*. Fondo de Desarrollo de las Naciones Unidas para la Mujer. UNIFEM. Colombia. 2005. www.acnur.org/biblioteca/pdf/4088.pdf.

[3] INGEOMINAS. Zonificación de Amenaza por Movimientos en Masa de Tres Sectores del Municipio de Soacha. Fase I. Convenio Inter Administrativo No. 050. 2005, 2006.

Table S7-1-1 provides a methodological overview of the Community Survey. This study took place in eleven days, between September 19 and 29th 2006. The 363 surveys were administered in four Comunas -mostly Comunas 4 and 6- and in five Veredas -four upper stream Veredas-. Most of the areas choose appeared to present landslide and inundation hazards occurred during May 2006.

Table S7-1-1 Methodological Summary of the Community Survey

Días	Fecha	Zona	Barrios encuestados	Ctd/Barrio	Afectación Mayo 2006	ST Final	Encuestas/Encuestadores
	19-Sep	Com 4: A.Cazuca	Luis Carlos Galan 1	15	Deslizamiento		3 por cada encuestador + 2
	19-Sep	Com 4: A.Cazuca	Luis Carlos Galan 2	19	**Deslizamiento**		4 por cada encuestador + 3
1	19-Sep	Com 4: A.Cazuca	Luis Carlos Galan 3	8	Deslizamiento	42	2 por cada encuestador
	20-Sep	Com 4: A.Cazuca	Villa Esper. El Barreno	17	**Desliz., Caída Talud e Inund.**		4 por cada encuestador + 1
2	20-Sep	Com 4: A.Cazuca	Villa Sandra	16	Deslizamiento	33	4 por cada encuestador
	21-Sep	Comuna 6	Divino Niño	30	**Deslizamiento & Caída Talud**		7 por cada encuestador + 2
	21-Sep	Com 4: A.Cazuca	Bella Vista	8	Inundación		2 por cada encuestador
3	21-Sep	Comuna 5	Terra Grande	8	Inundación	46	2 por cada encuestador
4	22-Sep	Com 4: A.Cazuca	Loma Linda	17	Deslizamiento	17	4 por cada encuestador
5	23-Sep	Com 4: A.Cazuca	Villa Mercedes II	19	Deslizamiento		4 por cada encuestador
	23-Sep	Com 4: A.Cazuca	Santo Domingo	10	Deslizamiento		2 por cada encuestador + 3
6	24-Sep	Com 4: A.Cazuca	Villa Mercedes I	13	Deslizamiento	42	3 por cada encuestador + 1
	25-Sep	Comuna 6	Llano Grande	19	Inundacion		2 por cada encuestador + 3
	25-Sep	Comuna 6	El Cardal	19	Inundacion		2 por cada encuestador + 3
	25-Sep	Com 4: A.Cazuca	Casa Loma	14	Deslizamiento		7 por cada encuestador + 2
7	25-Sep	Com 4: A.Cazuca	Villas de Casa Loma	2	Deslizamiento	54	2 encuestas
	26-Sep	Com 4: A.Cazuca	La Capilla	16	**Deslizamiento e Inundación**		4 por cada encuestador
	26-Sep	Comuna 6	Cien Familias	4	Inundacion		1 por cada encuestador
8	26-Sep	Comuna 6	La Florida II	16	Inundacion	36	4 por cada encuestador
	27-Sep	Comuna 6	Parques del Sol II	16	**Inundacion y Hundimiento**		4 por cada encuestador
9	27-Sep	Comuna 2	Danubio	16	Inundación	32	4 por cada encuestador
	28-Sep	Comuna 2	El Rosal	10	Inundación		2 por cada encuestador + 2
	28-Sep	Comuna 2	Satelite	4	Inundación		1 por cada encuestador
	28-Sep	Comuna 2	El Silo	16	Inundación		4 por cada encuestador
10	28-Sep	Vereda, Correg. 1	Bosatama 1	6	Inundación	36	1 por cada encuestador + 2
	29-Sep	Vereda, Correg. 2	Panama	6	Inundación		1 por cada encuestador + 2
	29-Sep	Vereda, Correg. 2	Hungría	5	Sin afectación		1 por cada encuestador +1
	29-Sep	Vereda, Correg. 2	San Jorge	6	Sin afectación		1 por cada encuestador + 2
11	29-Sep	Vereda, Correg. 2	Fusungá	8	Sin afectación	25	2 por cada encuestador + 1
11	**DIAS**	**3 Comun, 2 Corr**	**24 Barrios, 5 Veredas**		**4 Tipos de Afectación**	**363**	

Results of Survey

The first segment of the Survey addressed the profile of the Informant and their surroundings. Seventy two percent of the respondents appeared to be women, predominantly in the age range of 29 to 64 years old. Only 22 respondents of the 363 were over 64 years old. Seventy percent of the respondents have lived twelve years or less in Soacha. The majority of household family members were composed of four people, but 53.2% of the respondents had between four to six members in each house. Sixty seven percent (a total of 244 counts) of the interviewed expressed that the person that stays the most time at home is the mother of the family, staying mostly during daytime (82.9%) rather than being at home in the mornings-only, afternoon-only, evening, or weekends.

Two hundred thirty six people (65%) were working as opposed to 35% claiming not to work. Contrarily, when asked about income generating, interestingly only 3.3% claimed not generate income. This might be explained by the commonly expression that household tasks, childcare and others, are yet not considered as “work”.

Concerning “Experience and Perception of Disasters” 283 persons, 78% claimed to have experienced a disaster. From those 283, 265 have experienced floods, 208 landslides, 21 people an epidemic and only 2 persons have lived a fire. Sixty eight percent of all 383 respondents, 249 people, claimed having lived the experience in May 2006.

Only seven people (1.9%) expressed unlikely they could experience a disaster in the place where they live, as opposed to 356 persons ensuring the likelihood of a disaster. When asked if they had received information and training on emergencies and disasters, 94.2% expressed negatively, only 21 persons responded with a yes. These 21 people expressed that the sources of information they received in disasters came mainly through the schools and by the JACs.

When asked if the respondent was trained in disaster topics, 170 people expressed they had some sort of training and 193 (53.2%) mentioned not to have training. When asked about the particular type of training people responded as shown in Table S7-1-2.

Regarding affectation during the last emergency due to rain in May, 211 persons marked the category of partial affectation or lost of house and house items. Thirty-six persons suffered some harm and 32 people were evacuated. The affectation was widely spread out in all the area where the Survey took place.

Table S7-1-2 People's Training

Trained in:	Persons	%
First Aid	32	17%
Home Evacuation	87	46%
Fire control	7	4%
Rescue	27	14%
Radio communication	2	1%
Food Preparation	33	17%
Administration of medicines, food, equipment	2	1%
Total	190	100%

Regarding the question "How did you react during the emergency?", most people (39% or 128) mentioned feeling paralyzed. Sixty tree persons from the 363 surveyed mentioned they helped coordinate emergency actions, and another 20% mentioned helping relatives during the emergency. It was also asked: in case of an emergency where would you go?. One hundred twenty one persons would not know where to go and 39 would not leave their home. These two categories add 44% of all surveyed people. Fifteen per cent would go to an open space and 22% would go to a relative's house.

Continuing with the Fourth Subtopic: Self Help and Community Organization in disaster prevention, it was asked if the surveyed person had, relatives close by. The answers showed that 59% (214) claimed not having relatives close-by, and 23% did have in this same barrio relatives. When asked who would be the ideal persons to observe the behavior of natural phenomena young male and female added up to 61%, but when specifically asked in terms of age range, the category of 29 to 64 years old was the one selected by 199 or 45% of the respondent. Therefore, adults appeared stronger as an age range than young population on disaster related activities.

The final segment: Active Participation and Involvement started out asking if the respondent would be willing to dedicate time to collaborate voluntarily in emergency prevention activities, where 66.9% (243 persons) answered affirmatively, being the most willing the range age of adult women (29 to 64 years old). - coincident with the largest segment of population surveyed.

The willingness to be involved was widespread manifested amongst all barrios, adding a total of 72 men and 171 women. The types of activities in which people were willing to work was also widespread as well. Specifically, 37% of the respondents were willing to be part of a community based committee on the topic of emergencies, adding a total of 119 persons. Next activity of interest was supporting involvement of youngsters in disaster monitoring activities (41 persons) and organizing, recollecting and administrating "centros de acopio" or collecting centers of goods for emergencies (38 persons). Other activities of interest were monitoring the behavior of the river (10%), helping with drills and evacuation (9%), organizing a disaster prevention plan and emergency attention (9%), and monitoring the steep slopes (7%). These last four activities added 35% of the surveyors, -112 people-, topics directly related with the Study Team topics.

Interestingly people said having more daily available time (151 persons or 41.6%), than weekly (51 persons or 14%), or monthly (39 people - 10.7%). At the same time 302 persons (82% of total respondents) mentioned not participating voluntarily in any other community project. Finally, it was asked if the respondent could think of someone likely to be involved in self-help community groups in disaster prevention, the answers were affirmative for 115 respondents: 32%. A list of names was collected in the case that the respondent was willing to suggest any name for this matter.

The entire database is available to make specific inquiries by gender, age group or barrio, to serve specific questions CLOPAD and Alcaldía of Soacha should have for disaster prevention organization's purposes.

1.2 Focus Groups

The focus groups were done as a complementary research technique to improve the understanding of the perceptions and vision of the community members that live in the high risk conditions. Invitations were delivered to a pre-determined number of participants. Below fifteen persons per session were invited. Key community leaders were helpful in helping to have a varied selection of attendees, in each one of the four locations selected. Gender balance, attempts to obtain adults and young, and different organizing background, -not only JAC leaders- were criteria used to select the participants. Each Focus Group was accomplished successfully with substantial attendance. Each event delayed less than two hours.

Each session was pre-formatted similarly. After reading the Rules of participation, these were agreed upon by the attendants:

- Many years of experience are behind each opinions
- Answers are all valid, there are not right or wrong answers
- Focus on the topic at hand
- Allow for one person speaking at the time
- Raise your hand to indicate the intention to speak
- Listen carefully to other opinions
- Self moderate your use of time while speaking
- Stimulate those that participate the less
- Write down your ideas
- Ask for clarification of concepts at any time

The Agenda for all four events used the following structure:

1. Brief presentation of attendees (name, which barrio, how many years living in the area)
2. Explanation of the session
   a. Background: The community approach of the Study
   b. What is a Focus Group ?
   c. How do we propose to work today:
      i. How to stimulate and balance participation?
      ii. Ice breaker dynamic: The glass of water: half empty or half full?
3. Discussion of Topics
   a. Topic 1: Which are the priority actions in community disaster prevention in this area?
   b. Topic 2: Who might be the ideal and appropriate persons to possibly interested in disaster prevention?
   c. Topic 3: Any topic emerging from the common interest of the participants (Called "emerging topic")

1.2.1 Results of the Four Focus Groups

Annex S7-3 the complete list of all forty-four (44) persons attending the four focus Groups. The results can be found in a Summary Table in Annex S7-4. The outputs of the discussions in each Focus Groups are summarized as follows.

Divino Niño

Ten people attended being all neighbors from Divino Niño. The meeting took place in the Escuela Panamericana. The responses for the first topic: "Which are the priority actions for community disaster prevention in this community", it was mentioned at first the need to establish good communication among the neighbors, to unite, and to raise awareness, as three subsets of one internal community task. The second action is to comprehend the outputs of the technical analysis, in other words to understand the technical criteria on the behavior of the hazard and the risk of the slope as well. The third is to execute a temporary relocation. The fourth action is to do the physical infrastructure works to "fix" the problem of the steep slope. The last activity is to resettle. It was strongly agreed that "evaluation-only" was not acceptable. The participants understood and claimed relocation as part of a resettlement plan. So both "relocation" and "resettlement" were the appropriate concepts.

Regarding the second topic: "who are the ideal persons to interest in disaster prevention" the debate arouse about how youth and adults were to communicate, particularly the adults improving their listening skills. Nevertheless it was stated that the adult involvement came first, being their task to keep permanently informed. As ways to involve youth, the social service program was mentioned as a possible way to involve youth in disaster prevention activities.

The third topic was a consensus about the need to form a local committee for the topic of improvement of the conditions of the barrio with respect to the hazard and risk that the slope poses to the inhabitants of Divino Niño.

They envisioned an Improvement Plan that included solving the runoff of sewerage waters in the high part of the slope, since this caused many problems and illnesses particularly to the children of the community. Also mentioned was the task of permanently staying very alert, paying attention to the hazard in high-risk sections. Finally, they expected their Committee to count with sound professional advice, by having contact and communication with technical advisors as a way to strengthen the work of this Committee.

Llano Grande

Ten people attended the Focus Group in Llano Grande Community Center, coming from Llano Grande, El Cardal, Cien Familias, La Florida and La Florida Sector II. In addition, two community leaders attended coming all the way from the upper stream of Río Soacha: the Veredas of San Jorge and from Fusungá.

The participants' comments started out by the community leader from Vereda Fusungá sharing her high concern about the management of the rivers, the effects of the rain over the ill- managed watershed, with tremendous consequences for the people living in the communities down stream. She explained how she suffered of not being able to sleep comfortably, worrying about those living next to the river in the lower part of the Soacha watershed.

With this spontaneous motivation, the three topics to be discussed started. Regarding the priority actions to be taken, the first action agreed upon was the construction of the "Colector Canoa", a longstanding project that has not been completed yet. The second action was the construction and improvement of the "alcantarillado" the sewerage infrastructure in the barrios. The third item was the dredging of Soacha River each six months at least, along with its maintenance, an activity the community leaders present agreed as a community responsibility. It was highlighted that the dredged material should not be left at the river side, after the dredging works were concluded, as it has been the case. Rather the removed material should be properly located and disposed. Along the riverside it can be easily seen the dredged material sitting at both sides of the river. Other actions to be taken were planning works, and specifically it was mentioned the channeling of the river finally.

Another set of subtopics were related to the environmental management of the watershed and the responsibility that companies using the soil resources have in this proper management. It was mentioned the need to exert control over the extraction activity and to request soil studies before allowing the construction of buildings.

Regarding the topic of who were the ideal persons to be involved in disaster prevention topics, it was agreed that among neighbors and leaders of each neighborhood this task was to be shared. In the upper section of the river, in Fusungá and San Jorge it was stated that the awareness was shared among adults and youth. In the lower part, the opinions reflected that the task was to be carried through by adults, because youth was not necessarily involved in this topic. Some limitation on the knowledge was mentioned, regarding how to successfully raise awareness on neighbors used to throw solid waste in the river. Again, the need was stated to watch the river level, and to sanction those that carelessly did not take proper disposal of the solid waste.

In the third topic, the "emerging topic" arisen was the inter-neighborhood communication. During the event the participants were quite active sharing phones and establishing links to keep in touch for the future. By the end of the Focus Group, the neighbors had already exchanged and started to create their own informal network. One initiative proposed among participants addressed finding proper locations and appropriate cans to have solid waste collectors, made by the communities themselves, to provide alternatives to river trashing the solid waste.

Finally, the greatest concern overstated was about the infrastructure works, being of quite high priority: putting in the commonly known as Colector Canoas, which meant having sewerage pipes built next but separately from the river, rather than sewerage being deposited *in* the river. Another critical issue was the control and enforcement of the land use in the upper watershed of Río Soacha.

La Capilla

Seventeen people attended the Community Center at La Capilla, in Altos de Cazuca, coming most of them from La Capilla, but also from the neighborhoods of Naciones Unidas, La Meseta, Casa Loma, Loma Linda and Villa Mercedes.

Out of the four focus groups, this event proved to be where more topics, concerns and reflection occurred, including expression of longstanding frustration, due to the complexity of the environmental, legal, disaster, and social issues in Altos de Cazuca.

With respect to the priority actions, the first item discussed was the need to obtain the soil studies to determine the high, middle and low risk conditions of Altos de Cazuca. Secondly mentioned was the channeling of the superficial flow of the sewerage. Third the demarcation of affected areas: to install visible and clear signs for incoming people to know that the areas are dangerous and not for urbanizing. Fourth action is to construct the retention walls and the terraces to prevent the landslides and rock falling. The need to shut down mining activities in Terreros area was also mentioned.

Below, illustrative photos of two of the four focus groups.

Above and below: Partial view of Divino Niño and Tibanica's Focus Groups.
Left: The most important actions were collectively prioritized according to the problem-solving rationale among attendants.

Photo S7-1-1 Focus Group Meeting

Other related topics discussed were the overarching need to have the sanitation infrastructure (sewerage) because this is one of the factors that causes risk. Nevertheless, the contradiction is that there is no permit to build infrastructure in Altos de Cazuca because being of high risk and because it has not been declared as a "legal human settlement" area, inside the urban boundary of Soacha Municipality.

It was mentioned that there were a number of studies, assessments, and also administrative decrees for Altos de Cazuca, mentioning studies from University of Los Andes, Ingeominas, Universidad Nacional, also document are found in the Library of Luis A: Arango and in Agustín Codazzi Geografical Institute. Finally, it was stated that there were two court statements, Number 1592 of 2003, and Number 1278 also from 2003, specifically for Altos de Cazuca in which the situation of legal tenure, high risk and dislocation condition of people was addressed.

Regarding the ideal people to be involved in the disaster prevention topic, Planeación Municipal from Soacha was the first one identified as a priority. Second, it was mentioned that the neighbors and leaders were to work together. It was mentioned the need to meet, discuss and train themselves about the sewerage issue and its proper management: "We need to take care of ourselves" and "broaden the awareness amongst us". The participants carefully mentioned that regrettably, many initiatives had been delayed, and even stopped by external entities, against the desires of the community.

As to the "emergent" topics, several were discussed: one is the lack of clarity about the consequences of determining the area of high risk, due to unclear intentions of continuing mining extraction in the area. Also, frustration was expressed about the difficulties of uniting themselves, due to the complexity of actors, interests and issues.

Villa Esperanza El Barreno (Río Tibanica)

Seven people attended the Focus Group, all but one neighbors of Villa Esperanza el Barreno, and one from La Isla sector, next to the Terreros area. The first activity attendants agreed upon was to raise awareness (concientizar) with the community members. Second action is the installation of sewerage infrastructure (sanitation pipes) in the high parts of the surrounding area. Third was to build retention walls and terraces. Fourth was mentioned to acquire the support of organizations. Fifth, channeling the Terreros dam sewerage deposit, out of the dam area, in order to dry up the antique and non-existent “lagoon’s area”. Currently there is no water emerging from the underneath up, as it used to be in the past. The idea is that the area is to be adapted for recreational use for youth and children of all the barrios around it.

Another set of actions were mentioned to resolve the issues on the legalization of the land where the communities lived, in order to allow for infrastructure improvement works such as sanitation services. People mentioned that the Alcaldía already was advancing paperwork for the sewerage infrastructure with an ONG called CHF and with World Vision. Other actions to be taken were geared to determine the areas considered at risk. It was evident that for the attendees the main risk was not the overflow of the dam, but the rocks falling and other landslide related hazards. A greater hazard considered was the sanitation issue rather than the rain runoff water affecting the “lagoon” area.

With respect to the second topic - the ideal persons to work on disaster prevention- the discussion focused on previous training that some attendees had received in the past. Some participants explained that two years ago a religious authority implemented some training activities on the topic of First Aid and Emergency Prevention. Some attendants expressed fear about handling new responsibilities without acquiring the proper training. For example, they mentioned the circumstance in which a leader from the upper part made a phone call in an improper manner, exaggerating the reality.

The inadequate message was about the imminent collapse of the walls of the Terreros dam and consequently spreading the idea that a disaster was inevitable, in a panic mode. The information, the tone of voice and the wording used by this leader made the listeners freeze and panic, nevertheless were calm enough to know that this message could not be spread out in the same way than generated. Instead, phone calls to known authorities and to other leaders to inspect the hazard condition took place.

Attendants also expressed that in any case, the logical reaction in an emergency should be taken into account, where a leader would first tend to think -and attend- the security of his/her own family, children and relatives. Only when knowing them safe the leader could focus on the community’s wellbeing and safety. Regarding who are the proper persons to address emergency topics, agreement came towards the conclusion that proper training could allow, themselves, to feel comfortable in emergency tasks, as long as the protocols were clear and safe. JAC leaders were mentioned, along with supporting community members as entitled to play a key role in an emergency process. Finally, it was suggested that a public announcement asking who wanted to receive training in emergency drill and prevention plan, could be a way to allow voluntary people to be involved.

Regarding the “emerging topic”, several issues came up: the mining activities once more were mentioned, the legalizing of land, the sewerage improvement works and the trainings requested. These could be done by community members as promoters, if they received the pedagogical tools to take on the task. Also another possibility mentioned was an external agent or NGO, since some times better listened than locals.

1.3 Community Based Disaster Management (CBDM) Activities

The following three sections: 1.3.1 (Workshops and Community Meetings), 1.4 Preparation and Evacuation Drill) and 1.5 (Communication Protocol and Full Stakeholder Drill)- are all CBDM activities accomplished between January and November 2007. Excepting a few workshops on Landslide Monitoring on Altos de Cazuca, the activities were devoted to the pilot area of Soacha Watershed, addressing the Early Warning System and Community Preparedness for Flood Emergency.

A number of response and aid agencies were involved supporting Soacha in the topic of disaster prevention. During 2006, a collaborative effort was structured among PAHO, OCHA, Red Cross, UN Volunteers and CLOPAD. The Study Team kept at all times communication with these groups of institutions. By mid 2007 Soacha municipality initiated a plan with UNDP, PAHO and Red Cross to execute an extensive preparedness program involving Emergency Trainings, Emergency Plans and Drills. The topics of the trainings included risk management, school, and household prevention plans. The activities directed to establishing a number of Emergency Plans in Schools, with communities and with kindergarten centers.

This agreement also included drills in hospitals with response groups and with the municipality. To avoid any duplication work on CBDM in Soacha River area, the Study Team held meetings. Collaboration took place among all response agencies during the time of implementation of the pilot project. The cooperation and voluntary organizations kept continued communication and exchange of information. Their presence during field activities helped leaders and community members gain self-confidence very beneficial for the sustainability of the plan.

The Study Team specifically coordinated with Red Cross trainers who helped facilitate a Course on Community First Respondent. Likewise, Civil Defense, Firefighters were keen to support as facilitators the community's efforts to accomplish their goal of setting a preparedness plan. These response volunteers accompanied the meetings set and held by leaders during the month of July. Red Cross volunteers offered useful information, supported in different ways such as providing key information on evacuation, preparedness. The attendance of these agencies validated and help guide the work of the JAC leaders.

1.3.1. Workshops and Community Meetings

During the third and fourth fieldwork of the Study, eight workshops were held. The Table S7-1-3 summarizes the community-based workshops held during this period. The following Table is by a descriptive detail of the contents of the workshops.

Table S7-1-3 Summary of Workshops held during January through June 2007

	Date	Location	Topic	Attendees
1	Jan. 26	Divino Niño	Monitoring Landslide Divino Niño (by Yokoo san)	100 community members and leaders
2	Feb. 15	Altos de Cazuca	Monitoring Landslide in Altos Cazuca (by Miyazaki san)	7 community members and leaders attended
3	Feb. 18	Soacha River	Past Floods in Soacha River and Community Map	36 persons from Institutions, CAR and community leaders and members
4	May 18	Soacha River	Soacha River Monitoring and Early Warning System	70 persons from Institutions, CAR and community leaders and members
5	June 2	Soacha River	Community Plan. Setting the preliminary responsible for the water level monitoring	25 community members from pilot project and institutional representatives
6	June 13	Soacha River	Community Prevention Plan Information transfer	41 community members from pilot project and institutional representatives2 Tibanica
7	June 23	Soacha River	Community Prevention Plan Evacuation Meeting points	62 community members from pilot project and institutional representatives, leaders from downstream affected communities by May 2006 flood.
8	June 27	Soacha River	Community Prevention Plan Time estimation of evacuation. Shelter conditions. Preparing community meetings for July	40 persons from Alcaldía, Bomberos, Ladrillera, Communities in the study area and neighboring areas affected by flood (El Silo & Tabacal)

1) Workshops in Landslide area

January 26th 2007 Landslide at Divino Niño

Mr Ivan Calderón explained about the problem at Divino Niño based on the history of the neighbors. Soacha Municipality has been struggling to address the problem of emergencies due to landslides in Soacha Municipality, particularly areas like Divino Niño. The main purpose of the workshop was to explain the condition at Divino Niño, to raise stress the need of awareness about the hazards in which communities of Divino Niño live. Listening to the perceptions and ideas of community members was key to understand their feelings, needs and ideas to solve the issues at stake.

Mr. Yokoo presented the technical explanation about the landslide and the dangers of the landslide at Divino Niño. First, he explained the general awareness and the explicit information about the landslides also, the types of landslides, examples of prevention measurements and early warning system in Japan. Secondly, he explained the level of exposure of Divino Niño to landslides. The community had the opportunity to clarify some of their doubts, by asking direct questions to Soacha Municipality and to JICA Study Team about the conditions and the schedule of the project works.

February 21st 2007 Landslides at Altos de Cazuca

The purpose of the workshop was to present the rainfall-monitoring plan with the purpose of supporting the prevention and mitigation tasks in face of landslide disasters, through a community-based monitoring system. Mr. Miyazaki as landslide expert of JICA Study Team explained and presented real data of disasters by landslides occurred in May 2006. The community expressed their interest in cooperating with the monitoring. Mr. Miyazaki recommended installing rain gauges in the community schools.

2) Workshops in the Flood Area

February 18th 2007: Past Floods in Soacha River

The topics addressed in the Workshop were the results on the Technical Study on Monitoring and Early Warning for flood in Soacha River, and a detailed group discussion about the flood emergency in May 2006. The attendants turned into four groups, and discussed three topics: 1) what happened? 2) How did we act? 3) What did are our lessons learned? The Barrios worked in four groups, according to geographical closeness. Close to the Autopista Sur: El Ciprés and Prado de las Flores. The second group included Florida II, Cohabitar and Cien Familias. The third group Florida I, Pradera I and II. The last group included Llano Grande and El Cardal.

The Study Team provided four maps with subsections of the pilot project area, and the participants gathered around each one of the maps and identified their main buildings, streets, and community centers. Then proceeded to fill out the questions through symbols that were located in the specific sites of the map where actions occurred.

The community people worked with the institutions representatives, who joined randomly each one of the four groups. The workshop was beneficial in setting communication across communities, institutions and amongst both.

May 18th 2007: Soacha River Monitoring and Early Warning System

This workshop was an introductory event followed by a series of workshops in Soacha, for the planning of community disaster prevention. Originally, CAR-Soacha was planning to hold a workshop in Soacha about the precaution for landslides and flood disaster on the starting of rainy season. The Study Team proposed to hold the introductory workshop jointly with CAR Soacha at Culture Center near the City Hall on May 18, 2007. In the workshop, the CAR Soacha director, Soacha City officials, Police, Firefighter, Civil Defense and communities leaders in and around the Soacha City. The total number of the participants was sixty (60).

The program was composed of two (2) sessions. The first one is the presentation by CAR officials about the general disaster precaution on landslides and floods in Colombia. The next one was the presentation by the JICA Study Team to introduce the community disaster prevention for flood in Soacha River as the pilot project. The Study Team presented to the public the six (6) components of the community disaster prevention's plan in the Soacha River and the draft plan on monitoring and early warning system in Soacha in the Study.

June 2nd 2007: Community Disaster Prevention Plan (1)

Four workshops were programmed to address in detail the components of the Community Disaster Prevention Plan. In this workshop, monitoring water rainfall and water levels, and information transferring were discussed.

The workshop was successful in gaining interest in the responsibility of monitoring the water gauges that will be installed in different points of the river. Particularly Llano Grande leaders accepted to monitor the water level gauge (limnímetro), as well as the Fusungá leader. For the use of the water level monitoring, the representative from IDEAM offered to train in the use of this device.

The community members and leaders also discussed the ideal location of the speaker system for information transfer as second topic. Three places were identified, covering all the barrios from Florida II to El Cardal, where the early warning is feasible to issue. Feasible in terms of being appropriate central locations, and because persons present were willing to accept the responsibility of disseminating the warning. These three places were in Florida II Sector, in the house of Carlos Varela, city council member; in Florida I sector in the Community Center; the third place is in the home of Dagoberto Silva, President of the JAC of El Cardal.

These places were located in the community map during the break down session. At a later moment, a fourth place was added in Llano Grande due to its high vulnerability. After discussions consensus was found at the home of Bernardo Sanchez.

June 13th 2007: Community Disaster Prevention Plan (2)

The topics addressed were the following: 1) who would be the persons taking the role of replacements, when the head responsible were to be absent, 2) speaker system for disseminating the information, 3) studying the flap gate as an anti flooding mechanism, to prevent backwater through the sewerage pipes into the homes, 4) evacuation routes considering the scenario of May 2006 flood, and 5) the necessity of community meetings in each barrio during the month of July, as initiatives that the JAC leaders would have to communicate with their neighbors about the prevention plan being prepared and the future evacuation drill.

Photo S7-1-2 Model of Flap gate
This flap gate model was used during one workshop as a visual example of how the barrios exposed to sewerage backwater events during floods, could mitigate their problem, as an option to discuss aments themselves.

One system was discussed. One central monitor with 10 speakers linked with one cable, which would distribute the information to all barrios at the same time. This required one single central point for disseminating the warning and activating all alarms or sirens. The conversation about the ideal place for this central point however did not arrive to a concluding point. Finding the optimal solution was a pending point. As a complementary topic during the workshop, the flooding mechanism due to back water through sewerage pipes was discussed, by presenting a model using a flap gate (right side photo). None of the participants were familiar with this type of device, and expressed interest in learning more about how it works.

This workshop and the following ones were useful in reinforcing concepts to the leaders, and explaining for first time to attendants about the condition of the flood plain where the barrios are located. The area which suffered the flooding in May 2006 is in a lower or same height than the natural flooding bed of the river, as evidenced in the 1940 year map of the area.

When the homes of the barrios next to the rivers were built, no terrain elevation or leveling works were done previous to the construction of the houses. Therefore year by year the constantly suffer of flooding. Unless the dredging works done by the municipality consider a substantial deepening, of the river bed, the natural topography of the area indicates the problem will continue. The community members continually expected Empresa de Acueducto de Bogotá to accomplish the infrastructure works called in their own wording "Colector Canoas", where both the sewerage and the runoff water would be properly channeled.

In the breakdown session, the groups discussed the best evacuation route, considering the scenario of May 2006, indicating in the maps the routes and meeting points, and the approximately number of families to evacuate. Florida II Sector would go to the Catholic Parish, Florida I would go to the Community Center. Llano Grande and El Cardal do not have a shelter, mentioning only they would go to open space higher grounds.

As one of the results of this workshop, "Activity log for May 2006 flood" was prepared (See in Annex S7-6). The Table summarized activity by barrio with time duration. This Table also contains the timetable which allows calculating roughly the time during each activity in emergency time.

June 23rd 2007: Community Disaster Prevention Plan (3)

This workshop was the one in which more people from different communities and institutions attended and actively participated. All representatives from the five monitoring points were present except firefighters: San Jorge Station, Fusungá, Carcel de Zaragoza, Ladrillera Santa Fe and Llano Grande. In addition, people from Panamá Vereda (close to Ladrillera) were present for the first time. Community leaders from downstream in the pilot project area and beyond, such as members from El Tabacal neighborhood participated to this workshop.

The breakdown session allowed the community groups to discuss more profoundly about the evacuation routes and the meeting points, explaining more clearly these in their sector map. For the families that did require evacuating, the time to be spent in the temporary shelter was discussed.

June 27th 2007: Community Disaster Prevention Plan (4)

Topic addressed during the last Workshop in this work period are, 1) river bed monitoring, 2) census street by street, and 3) responsibility and required time for evacuation process.

The five leaders that have been accomplishing the task of monitoring the river bed each fifteen days. They confirmed they were willing to continue to do the task, and also invited other members to join. As established the group would go the 2^{nd} and 16^{th} of each month to do the measurements. In case there were changes observed in the water level between one record and the following, they should right down this conditions on the column labeled as "observations". Best if any additional measurement could be done, particularly when weather conditions would happen, for example at times of persistent rain.

Almost all barrio leaders mentioned they would make a census street by street to write down the names of the families living in the vulnerable houses. The census information would be available by the end of July. The census should include information about their physical conditions such as disabilities (hearing or walking impaired) sickness status, elders, pregnant women and children. It became clear in this workshop that the assumption about one-story houses were the only ones required to evacuate or to climb to the second floor was incorrect. Leaders pointed out that many two or three story houses had more than one family inside living, which meant these already are overcrowded.

As the group work results, the leaders of each barrio confirmed the responsibility during the preparation and evacuation the meeting points and the final meeting point or shelter, and required time for evacuation. Regarding the conditions of these places, two barrios delivered to the Alcaldía a request of support for improving the shelters' infrastructure, since they suffered of severe deterioration during last disasters. The CLOPAD representative explained that under the Law, a community center administrated by a JAC is considered a private assess, and the regulations forbid the public administration to execute investments in this kind of buildings. Therefore, a study on the legal options in order to make possible an investment in this asset, since it would be used for disaster prevention purposes, to save lives in an eventual community emergency.

1.3.2 Community Based Monitoring Activity for Flood Emergency

Regarding the community based monitoring activities two field activities took place. One was a field training to learn how to measure the water level on March 2, 2007. The other activity took place on May 29th , 2007 consisting in a site recognition trip to the entire watershed points where the monitoring equipment would be installed and upgraded. This field visit involved community leaders to learn about which are the monitoring places and the type of equipment to install.

During the visit the upstream leaders and monitoring persons accepting the responsibility, exchanged names and phone numbers with downstream leaders, in order to keep in touch in the case of any abnormal observation of the river flow during the current season. (See photo below).

During the field visit recognition of the watershed, leaders from up and down stream exchanged names and phone numbers to keep in touch for any abnormal behavior of the river

Photo S7-1-3 Field Visit Recognition of the Soacha River basin (1/2)

June field trip.
The high part of Soacha river has relatively little polution – with forest, strawberry plantations and cattle use. Human activities increase by the middle section with heavy mining activiites and poor maintenance of the roads. The limited bridge design for water overflow was commented by the downstream visitors as reasons to keep an eye on the river.

Ivan Calderon, coordinator of CLOPAD, the Local Emergency Committee, at Fusungá testing the radio wave range during an upstream field visit to the monitoring stations installed by the Study Team.

Photo S7-1-4 Field Visit Recognition of the Soacha River basin (2/2)

1.3.3 Neighborhood Activities lead by JAC Leaders

During the month of July 2007, the JAC leaders agreed to organize meetings in each one of their neighborhoods by themselves. In these events, they explained all neighbors what they have learned on the preparatory process. The leaders raised awareness on the hazard by flood due to the rain and river behavior, the monitoring and early warning system, and the preparation works that were taking place. A total of 170 neighbors attended five meetings held in five barrios, between June 30th and July 29th 2007.

The leaders participating in the Workshops during June prepared the meetings contents and explained the disaster prevention plan, encouraging them to be part of activities for disaster preparation, particularly in light of the upcoming drill exercises. One particular topic was the compilation of the list of family names (by streets) in risk, i.e. determining families living in one floor house which needed to evacuate, elevate items from the floor or climb upstairs to second floor.

Table S7-1-4 summarizes the schedule of acquiring the list of families and holding the community meetings according to the JAC leaders. These events took place as initiatives taken in each neighborhood from each one of the community leaders. A total of one-hundred and seventy persons were informed about the emergency prevention activities, in five different locations of the pilot area. These activities proved the leader's willingness to be in command of the preparedness activities.

Table S7-1-4 Community Activities in each barrio during July 2007

Community Activities	Florida II- Cohabitar Cien Familias	Florida I	El Cardal	Llano Grande	Zona Rural
Community Meetings Schedule	July 29th. 9 am. Sports field in Cien Familias	July 8th 9 am. Community Center	June 30th. 1 pm. Next to the bridge	June 30th. 9 am. Community Center	July 1st 9 AM. in the Community Center of Vda. Fusungá
Number of people attending the meetings	40	36	32	51	11

1.4 Preparation and Evacuation Drills for Flood Emergency

During September 2007 activities were geared to produce specific outputs for the CBDM activities which concluded in an Evacuation Drill on September 22nd 2007. (See Table S7-1-5 Summary of September Events)

Meetings held on September 1st, 4th, 14th 15th,17th oriented the preparedness efforts in face of the Evacuation Drill that took place on September 22nd. First separately and later joined, both community leaders and CLOPAD response teams met to discuss their part of the action plan. The joint meeting took place on September 20th in a Simulation session, on one chosen site (Llano Grande community).

1.4.1 Meetings to prepare the Protocol

In all preparatory work, a group of no less than thirty community members was actively involved. The support of the head representatives of the Firefighters Department, Civil Defense and Soacha's Red Cross allowed for a consistent process characterized by good team work.

The preparation sessions were critical in defining the roles and tasks of the leaders. For example, the Street Coordinators were given specific tasks such as asking family members to move out of the dangerous area, guide them through the safe routes towards the Meeting Points or Shelters; provide special help to those in danger; avoid panic; keep an eye over the evacuated areas. Other tasks were "before leaving the area the Street or Block Coordinators must know how many people is under his/her responsibility". Also "keep in mind the responsibilities, the actions and prepare arguments to explain, motivate and convince people that they should evacuate the area"; "remember people about the escape route and the Meeting Point".

Table S7-1-5 Summary of September's CBDM events

Date	CBDM Activity	Attendants	Location	Description of activities
Sept 1st	Community meeting	10 Community leaders of seven barrios	Casa Cural Cien Familias	Set Schedule and responsibilities
Sept 4th	Preparatory session	4 CLOPAD entities Firefighters, Red Cross, Civil Defense and Alcaldía staff.	Firefighters Department	Setting the institutional scenario of the drill
Sept 10th	Training	24 leaders of seven barrios	Community Center at Florida I Sector	First Respondent Course by Red Cross Staff
Sept 14th	Training	35 persons of the communication system	Firefighters Station	Explanation about monitoring system and equipment
Sept 15th	Meeting with El Cardal leaders	7 involved leaders for street	El Cardal - JAC leader's home	Defining organizing strategies for preparedness and radio speaker communication
Sept 17th	Drill Preparation	42 leaders of seven barrios	Community Center at Florida I Sector	Meeting to plan ¿? Responsibility distribution during drill
Sept 20th	Drill Simulation	63 leaders of seven barrios, 8 firefighters, 4 Civil Defense, 8 red cross members	Community Center at Llano Grande	Rehearsal of Protocol for Drill in writing and in walking through each barrio, final comments back in Plenary Updating community lists of those who will evacuate
Sept 22nd	Evacuation Drill	100 attendants, leaders, coordinators, firefighters, red cross, civil defense, police and Alcaldía staff	Each Barrio had its own Meeting Point Unified Command Post (PMU) at Bo. El Paraíso, Sister's House.	Approx. 750 members from seven barrios evacuated Gathering for an evaluation of the Drill
Sept 26th	Second Evaluation of Drill results	14 Key leaders and CLOPAD response groups	Alcaldía of Soacha	Evaluate once more drill, Advance topics of community speakers for November's Seminar

During evacuation, the Street Coordinators should not allow people to take unsafe routes, support those that require help; refer to aid teams those in need of medical attention; communicate with the leaders of the Meeting Points. After the evacuation, leaders must verify all people reached the Meeting Points, or else notify the rescue teams any abnormal situation observed. The must report the tasks accomplished and supervise the arrival to the Meeting Points.

The person in charge at the Meeting Points had to collect the name and address of the family members arriving, add up the total number of people compiling a census and handle the information to the Firefighter's Department. Also, they were asked to manage keeping people at the Meeting Point, preventing them to return to the dangerous areas. Finally, the Neighborhood Leaders (Barrio or JAC leader) were responsible for receiving from the Firefighters the warnings, and transmitting an alert warning or an evacuation order through the speaker system to the community, while activating the sirens.

On the other hand, the CLOPAD members planned and discussed how to support best the first respondents -the community leaders- during the Flood Evacuation Drill. If the street leaders were to have difficulties in stimulating the neighbors to evacuate, the response team would role-model side-by-side the leaders, supporting with best arguments at hand the leader's communication effort towards possible reluctant neighbors. On September 4^{th} the CLOPAD members met to set the scenario of the evacuation. The photo below shows the sketch of the Drill's schedule. The September 22^{nd} Protocol of the Evacuation Drill can be found in Annex S7-7.

During the preparation sessions, one exercise was about what, when and how to communicate for an emergency evacuation. Leaders wrote down in their own wording the motivational language used when using the speaker system, or the street megaphone, to encourage neighbors to take quick and careful actions, putting their belongings in higher grounds, and taking care of their loved ones.

It was discussed iteratively how to avoid communicating panic through the speaker system. Issues such as: What if a neighbor -such as a pregnant women- listen to the message and this exacerbates the health condition? The explanation given by the Firefighter authorities with respect to the legal responsibility of affectation made the leaders consider the language and tone when building their messages

The below example was a one of the messages written by Florida II leaders, as a good example that other JAC leaders also found useful.


On September 17th 2007 the communities worked on their own to define their evacuation plan. Each group of neighborhood members discussed their specific ways to involve their neighbors and themselves, particularly those at higher risk. Firefighters were present to give the support needed during the session. Children and youngsters were part of the plan.


Photo S7-1-5 Community Workshop

Left: Alcaldía, Red Cross, Civil Defense and Firefighter's setting up their roles as CLOPAD – disaster prevention local committee. **Right:** CLOPAD's work, building the first draft of the Scenario for the September 22nd Flood Evacuation Drill.


On September 20th Red Cross staff held a Training event for the community leaders of all neighborhoods prone to affectation due to the river Soacha. The topic was First Community Responder. After the training, the leaders met in subgroups to discuss about how to address the response in each one of the streets.

Photo S7-1-6 CLOPAD preparation sessions

Table S7-1-6 Example of Warning Message

ANNOUNCEMENT DURING EMERGENCY
Atención, atención. Informamos a la comunidad de nuestro Barrio y en general a quien escuche este sonido y mensaje. En la parte alta esta lloviendo muy fuerte. El río se está creciendo y hay peligro de inundación para todos nosotros. Por lo tanto debemos estar prevenidos. Debemos: 1. Bajar los tacos de la luz. 2. Cerrar el Registro para cortar el paso del gas 3. Cerrar el Registro del Agua. Las personas que tienen casa de segundo piso suban niños, personas de la tercera edad, enfermos, electro-domésticos y enseres que al mojarse se pueden dañar. Las personas que tienen casa de un solo piso, colocar los enseres en las pares seguras donde no se mojen. Deben salir con sus familiares y dirigirse por la Ruta de Evacuación al Punto de Encuentro: *(Indicar claramente el sitio del Punto de Encuentro, por ejemplo Salón Comunal xxx, o parte alta, o antigua Ladrillera)* Quienes ya hayan puesto a salvo niños, personas de la tercera edad, enfermos, electrodomésticos y enseres, por favor miremos cuáles vecinos necesitan de su ayuda. Los coordinadores de cuadra por favor dirijan su ayuda a las casa donde hay personas vulnerables (enfermos). Donde la casa solo tiene un primer piso, los coordinadores deben llevar voluntarios para que ayuden y luego busquen más sitios donde se necesite ayuda. Las personas que ya hayan puesto a salvo sus enseres, dirigirse por las rutas seguras, que se indican con las flechas verdes, y seguir hacia el Punto de Encuentro (explicar claramente donde se ubica). Para cualquier mensaje acérquese hasta donde está el sonido, aquí lo ampliamos.

1.4.2 First Respondent's Course (September 10th, 2007)

In order to acquire First Respondent skills a training session was held for community leaders on September 10th. Twenty four leaders of the seven neighborhoods were present and actively involved during the training. The content of the Training is summarized on the following.

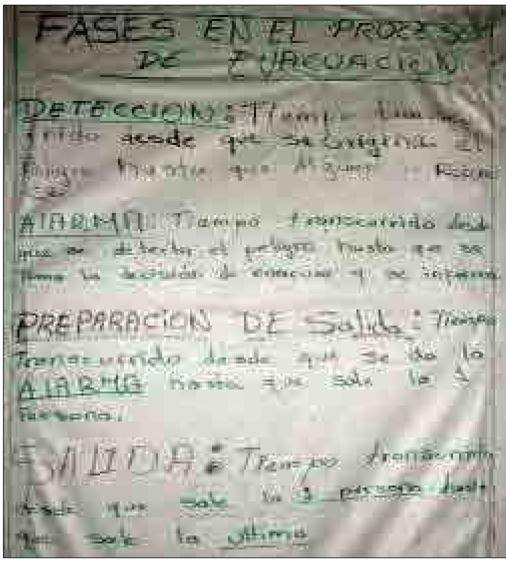
1. Execute the Action Plan
    i. All family members know what to do
    ii. Priority is saving lives
    iii. Do not put yourself in risk to save assets
    iv. Do not waste time trying to control the incident.
2. Take leadership
    i. Locate yourself in a safe place, observe the incident
    ii. Call the response teams
    iii. Organize a work team with people who already evacuated
    iv. Let them know your leading role
    v. Isolate the area
    vi. Do not take operative responsibilities
    vii. Wait the response entities
3. Report the current situation
    i. Collect the necessary information. Observe and ask.
    ii. Prepare the data: what, when, where, are there damages, is there access?
4. Isolate the zone
    i. Establish the following zones: first perimeter: 100 -300 mts.
    ii. Meeting point
    iii. Unified Command Post
    iv. Make sure there are in and out access points
5. Support the response teams
    i. Locate the higher rank of the response entities
    ii. Inform you were leading the actions
    iii. Inform about the data gathered
    iv. Take the name of who will take command and what time
    v. Keep available in case it is needed

After a motivational introduction, the Red Cross trainers went through the steps for a Community First Respondent.

1.4.3 Simulation Session (September 20th at Llano Grande Community Center)

On September 20th, at the Community Center of Llano Grande a general rehearsal took place. A wide representation of CLOPAD institutions attended (except the Police Department) along with the usual large number of leaders allowed for a quite productive session. The Evacuation Plan included summarily four phases of action: the detection (of the hazard), the warning and alarm, the preparation and the exit.

Time estimation was a key element of the exercise. Leaders were asked to check and refine their previous calculations on how much time did it took to inform about the warning, to achieve all preparation for evacuation steps, to gather and mobilize successfully to the established Meeting Points. The designated evaluation routes were confirmed. The meeting points were tested.



Llano Grande leaders defined in their own words the actions of each phase during an evacuation and recommendations for leaders and neighbors, such as carrying important documents, helping the neighbors keep calm and walk only through safe routes.

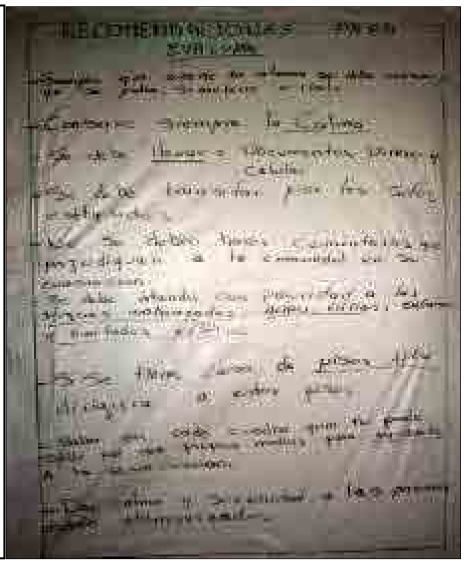


Photo S7-1-7 Community Preparation work

The high attendance from the Soacha's response teams created a stimulating effect on the neighbor, which gladly felt supported in their neighborhood team. One or two Firefighters and one or two Red Cross Volunteers supported each group. Some Civil Defense members joined randomly the community groups. The Alcaldía representatives joined one the most critical neighborhoods (Llano Grande).

Once again, the roles of the leaders in charge of distinct functions were rehearsed. Who would be at the meeting points and what kind of tasks were pertinent to those located in these positions? How would the JAC leader communicate with his/her team of street leaders, once he/she received from the Firefighter's Department the information about the warning? How would the people learn about the evacuation route? What kind of items have to be carried during the evacuation exercise, thinking in a real case?

The work session had three parts. The first section was a general going-through all the time protocol (as mentioned already and found in Annex S7-7) lead by the Commander Ivan Riobueno, Head of the Firefighter's Department. Secondly, all members broke down into the six neighborhood groups present for an on-site (walking) rehearsal. The third and last phase of the rehearsal took place back the Community Center of Llano Grande. All participants offered their feedback about the rehearsal exercise. (Illustrative photos below).

Left: Pradera II leaders joined the rehearsal session despite during May 2006 flood they were partially affected. Having their own communication system, they claimed the need to strengthen the system with alert sirens. ***Right:*** At a cross corner discussing the need of two Evacuation Routes and Meeting points, for each side of the river at El Cardal.

Left: The most enthusiastic group -Llano Grande leaders- implemented the strategy to increment the involvement of community members and leaders throughout the preparation sessions. At least 15 members of Llano Grande community were part of the Simulation session on September 20th. Engineer Sandra Vásquez, from Alcaldía joined this team (left end).

The commitment of the response teams was a stimulating ingredient to the rehearsal session. The community leaders expressed satisfaction and felt supported with the large presence of rescue teams at the Simulation session.

Photo S7-1-8 Illustrations on Simulation Session

1.4.4 Evacuation Drill (September 22nd, 2007)

The CLOPAD members selected to set the P.M.U. (Puesto de Mando Unificado, or Unified Command Emergency Center) at the neighborhood El Paraiso, located in a central and safe place at the opposite side and higher ground from the river. For this Drill, the location chosen was convenient because the access to accompany the drill was simple. The communication flow went as planed. The scenario plan for the drill was to be executed from the Firefighter's station to downstream communities.

Prior, the leaders were given large plastic sets of green arrows and "Meeting Point" signs which they located along the evacuation routes and corners. The arrows indicated the path towards the final place were neighbors were to congregate themselves during the Drill and during real emergencies as well.

Preliminary sets of lists of households to be evacuated were prepared by the JAC leaders. This lists, at this stage still incomplete, provided a baseline by which the neighborhood teams gained systematic knowledge about their neighbors and surroundings. The idea was to ask each street leader to fill out the household names and relevant data on the forms. Number of members, elder, children, and persons with physical disabilities were to be written down.

The response team actively involved during this exercise was composed by thirteen Civil Defense members, eight Firefighters and one emergency truck, nineteen Red Cross volunteers and one rescue medical vehicle, and four police officers. All added 44 response members and two vehicles.

The Drill exercise tested the effectiveness of the messages elaborated by the leaders, along with the volume of the speaker and siren systems.

After the exercise, the involved parts gathered at the set "P.M.U" place at El Paraiso, and proceeded to report back the actions. The leaders at the meeting points wrote down the names and members of families arriving. Table S7-1-7 shows a summary built with the aggregated data of all participating communities. About five hundred persons participated in the evacuation, a large portion (close to half) being children. Some neighborhood leaders decided to not participate (the case of Cohabitar). Other communities, like Florida II, did not write down the number of people at the meeting point, which they agreed to do from this point on.

Table S7-1-7 Summary of Evacuated Families on September 22nd, 2007

Resumen Familias Evacuadas durante Simulacro 22 de Setiembre, 2007							
Barrios	Total Adultos y Niños	Desgloce Integrantes Familia					
		Adultos			Niños		
		Total Adultos	Masc	Fem	Total Niños	Masc	Fem
La Pradera II	84	51	25	26	33	18	15
Cien Familias	40	22	7	15	18	10	8
Florida I	205	123	49	74	82	39	43
Florida II	n/d	n/d	n/d	n/d	n/d	n/d	n/d
El Cardal	147	77	34	43	70	34	36
Llano Grande	67	35	35	n/d	32	32	n/d
TODOS BARRIOS	**543**	**308**	**150**	**158**	**235**	**133**	**102**

1.4.5 Evaluation of the Drill (September 22nd and 26th)

Exercising an evaluation after the drill was an important step, and part of the preparedness plan, allowing improvements on the performance. Each neighborhood leader reported back to the crowd gathered in the P.M.U. about the way the activities in his/her area happened. This way, all could learn what went well and what needed to improve for the next time, but definitely if or when an emergency occurs.

During a second evaluation session – on September 26th- the leaders and response teams discussed again the outputs of the Drill exercise. The reflection brought up new elements. Among the reasons explaining why people did not leave their homes to join the evacuation exercise were the fear to leave unprotected their homes. Some people expected to have a strong presence of the Police Department, to safeguard the values of the homes. On September 26th a smaller group met to discuss the necessary actions to continue.

The shared reflection clarified some of the most important challenges, such as: How to convince with good arguments reluctant people about the urgency to evacuate? Which arguments does every leader need to know and use in addressing the different psychological profiles of reluctant people? How to avoid or minimize stress on emotionally sensitive, ill or elder people?

Firefighters and civil defense members stressed once more the fact that in real situations most likely the response entities would not be at the emergency site. The first responders are the community leaders, which through this process have increased their skills on how to protect themselves and how to conduct safely the members of their neighborhood.

Left : After the Drill, all key stakeholders gathered to evaluate the exercise. About one hundred participants between civil defense, firefighters, red cross took part of this drill and evaluation exercise. Recommendations stressed more stimulation and motivation towards household members. A general sense of satisfaction due to a good job performed, combined with the sense of a greater challenge that means the activity must improve to gain more involvement.

Right: Community leader Esperanza Sanín explains to the audience the response of the drill in her neighborhood Cien Familias Behind Firefighter Ivan Riobueno and Manuel Herrera from Civil Defense listen to her report. The neighborhood Cien Familias was having a street fair, which had two effects, in one hand it hindered the involvement of neighbors, and also the fair speaker was used by high school and Civil Defense authorities to raise awareness to the public about the Evacuation Drill activity and the need to be aware and prepared for such kind of eventualities.

Photo S7-1-9 Evaluation Session on September 22nd 2007

During the preparation sessions, the majority of the leaders had collectively come to an agreement about using the surprise factor for the September 22nd drill. They wanted to test if the community would really evacuate, not knowing that the warning corresponded to a Drill. The leaders shared some of the challenging aspects experienced during the exercise. As one leader explained, to face their neighbors that wanted to know the “real truth” about the warning, if the flood announcement was an exercise or a real situation.

Other issues -constant topics during all the preparation sessions- referred to the continued demands to the municipal authorities on maintenance of the river dredging works. The constant passage of heavy trucks full with sands and clay materials for construction causes sedimentation and clogging of the sewerage pipes. The community has increased awareness on the multiple factors that create risks. Preparedness is not only a factor of preparation FOR an emergency, but also avoiding, controlling or mitigating the factors which creates risk.

1.5 Communication Protocol and Full Stakeholders Evacuation Drill (November 2007 activities)

November was the last phase where closure activities took place. A second and full stakeholder Evacuation Drill took place on November 8th 2007. Four preparatory meetings were prepared and executed. Table S7-1-8 shows an overview of the activities, dates, topics and attendees during this period.

Table S7-1-8 Summary of events during November 2007

Date	CBDM Activity	Attendants	Location	Description of activities
Nov 1st	Organizing the protocol for Drill	About 20 p. from community& CLOPAD	Civil Defense's office in Soacha	Set Schedule and responsibilities
Nov 4th	Neighborhood Assembly	Open town meeting	Florida I Sector Community Center	Short explanation about the upcoming Drill
Nov 6th	Drill preparation	15 p. from stations & and speaker's system	Alcaldía of Soacha	Set protocol for Drill Evacuation on Nov 8
Nov 7th	Drill Preparation	45 leaders of seven barrios	Civil Defense's office in Soacha	Present communication system
Nov 8th	Evacuation Drill	About 90 leaders and response team members carried on the evacuation exercise	All Soacha watershed, up and down stream	Evacuation of approx. 1600 community members from seven barrios
Nov 13th	Dissemination Seminar: Community Based Disaster Management Activities	90 attendees, between communities and institutions from Soacha and Bogotá surroundings	Hotel Tequendama, Bogotá	Community presenters explained the CDBD activities in Soacha River and Altos de Cazuca

1.5.1 Preparatory Activities

On November 1st, 2007 the activities initiated again. In the offices of Civil Defense of Soacha, the leaders and response members discussed the new scenario, date and time of a new Evacuation Drill, which took place on November 8th. This time the drill included all the monitoring stations: the use of all equipment installed (direct observation of the rain gauge, digital readers, reading the staff gauge data), and the use of the radio communication system (up stream observers communicating three times a day to Bomberos). The Firefighter's would collect the data from upstream. Making their best judgment they would decide on the level of danger, inform the CLOPAD coordinator (the Alcaldía is the legal entity to issue a warning) and wait for the warning and/or the evacuation order. Once CLOPAD emits this order, the Firefighters, using the radios communicated to the four leaders of Florida I, Florida II, Llano Grande and El Cardal. These leaders held in their homes the speaker and siren systems. Immediately after receiving from the Firefighters the warning and/or evacuation order, they would set their known protocol: turn on the speaker system and announce the general standby alert warning, and/or the evacuation order. Also call the Street Coordinators and the Meeting Points leaders, and remind them their tasks. Remind people to stay in calm, taking care of their safety, ensuring no secondary hazard could appear, taking ill and children to second floor if applicable and evacuating through the designated routes to the Meeting Points.

Table S7-1-9 shows a model of Neighborhood Protocol, the one used by the Neighborhood of Florida II.

Table S7-1-9 Example of Communication Messages for Barrio Florida II.

Barrio Florida II	Warning about river rising	Warning about river to overflow
In charge of radio and communication system: Carlos Varela	1. Turn un the communication system and tell community about current situation 2. Call the Coordinators of each block and remind them their tasks (see list below) 3. Decide which tasks can be done in advance, in order to gain time. For example to disconnect electricity and gas connections. 4. Message to the community: Please be alert and remain calm. Remind the procedures in case of river overflow (read next column) remembering this is only to refresh the procedure.	1. Communicate situation to community: 2. Houses with a second floor, please take children, elders and valuable objects to second floor. 3. Turn off the electricity, water and gas pipes. 4. Keep handy first aid kit, flashlights, celular phones, water, non perishable food, blankets and cotas. 5. Go towards 7th street and then to the Ladrillera of the Dr. Murcia. One store homes: put bricks Ander the legs of your beds. Then, put values untop of beds. 7. If you need help in evacuating, please contact the street leader.

Monitoring station observers and JAC leaders in charge of the radio and speaker systems, met on November 6th, 2007 to discuss the Protocol of Communication for the Drill. The illustrations in below show some of the preparation activities.

The Coordinators had all their own specific tasks. Defined and agreed during the preparation sessions. Below for example is the checklist for a Street Coordinator.

1. Stay calm at all times
2. Identify the homes with children, elders, people with physical disabilities and ill.
3. Take with you the family street lists. Go door to door. Warn them according to the particular situation. which need to evacuate and which have to go to second floor, who have people in most vulnerable condition.
4. Ask household members which are readily prepared to search and help neighbors that need or request help.
5. Explain and direct them to the evacuation route
6. Explain and direct them to the Meeting Point

The response entities, once more rehearsed their roles, the communication tree flowchart, according to those

Attendants at November 6th 2007 meeting. Discussing the radio communication procedure. Uppers stream leaders agreed to report to Firefighter's, which in turn would communicate with downstream leaders.

Left: November 7th 2007. Amparo Pacheco and Mariela Beltran from El Cardal, write down the names of Street Coordinators. Right: Carlos Varela explains the evacuation plan details in Florida I to the other neighborhood.

Above Left: Blanca Barboza from Pradera II writes the steps to take once the alarm and evacuation warning is announced, with the support of Firefighter Ivan Riobueno. ***Above Right*:** Ivan Calderón, CLOPAD Coordinator explains the rationale of the Early Warning System, motivating to all the parts to maintain and improve it.

Photo S7-1-10 November 2007 Drill Preparation Sessions

1.5.2 Full Stakeholder Evacuation Drill (November 8th 2007)

November 8th was the date chosen for the final Evacuation Exercise for Flood Emergency. The activity took place as planned. The upstream trigger started at 10:00 am. The activity ended at 11:15 am. All barrios participated: Florida II, Cohabitar, Cien Familias, Pradera II, Florida I, Llano Grande and El Cardal. All monitoring stations were involved: San Jorge, Fusungá, Carcel de Zaragosa, Ladrillera Santa Fe and Llano Grande.

The evacuation drill took place in a weekday during morning hours. That implied the involvement of school in the area. The school authorities were eager to join, gave instructions to the students and lead the evacuation of the two schools present in Cien Familias: Eduardo Santos Sede C and Nuevo Milenio. A small Kindergarten School also participated in the evacuation. The photos below illustrate the activities as they happened.

Above: Toddlers at the Meeting Point. Mothers, teachers and leaders from Cien Familias exercised the role of keeping children and school students safe and well entertained.

Eduardo Santos High School students participated in the evacuation. They exercised chair-carrying among peers with walking - limitations climbing up hill.

Florida II Sector leader Miguel Aguilera as responsible of the Meeting Point, made a census of neighbors arriving to the safe place.

Photo S7-1-11 Full Stakeholders Evacuation Drill for Flood Emergency

1.5.3 Results of the Evacuation Drill on November 8th, 2007

The summary of the number of people reaching the Meeting Points is expressed in Table S7-1-10. The Table suggests that not all leaders wrote down in a disaggregated manner the composition of the special needs people arriving to the site. While there might be duplicative data (double counts in Meeting Points shared by more than one community) the Table reveals almost two thirds of greater attendance of adult population with respect to children.

Table S7-1-10 Summary of Evacuated Families on November 8th, 2007

Resumen Familias Evacuadas durante Simulacro 8 de Noviembre, 2007											
Barrios Comuna 6	Integrantes por familia de acuerdo a Reportes por Puntos de Encuentro										
	Sumatoria Columnas Total Adultos y Total Niños	Adultos			Niños			Población con Necesidades Especiales			
		Total Adultos	Masc	Fem	**Total Niños**	Masc	Fem	**Total Necesidades Especiales**	Discapaci-tados	Embaraza-das	Enfermos
Cohabitar	**56**	**36**	36	0	**20**	20	0	**0**	0	0	0
Florida II	**143**	**77**	29	48	**65**	34	31	**1**	1	0	0
Cien Familias	**170**	**145**	132	13	**25**	19	6	**0**	0	0	0
La Pradera II	**264**	**164**	80	84	**96**	45	51	**4**	4	0	0
Florida I	**491**	**262**	122	140	**229**	130	99	**0**	0	0	0
Llano Grande	**487**	**317**	129	188	**166**	81	85	**4**	0	0	4
El Cardal	**134**	**71**	39	32	**55**	23	32	**8**	4	4	0
TODOS BARRIOS	**1745**	**1072**	**567**	**505**	**656**	**352**	**304**	**17**	**9**	**4**	**4**

An increase in the attendance was a clear evidence the leaders did use their previous experience to improve their performance in practically all aspects: communication equipment, team building, practicing the delivery of warning messages, self confidence and self motivation, collaboration and team work inside and across neighborhoods.

After the drill, once all parts reunited at the Firefighters' Station, an Evaluation sheet was delivered to thirty persons actively involved in the activity. People filled the evaluation form. The thirty sheets were processes and the results are discussed in this section. (The Evaluation Form in found in Annex S7-7)

From those participants that filled out the form, the roles they played during the exercise are shown in Figure S7-1-1 "What was your role during the Drill". Ignoring the 40% of people that did not respond the question, 33% of the respondents were leaders and 17% considered they were members of the CLOPAD.

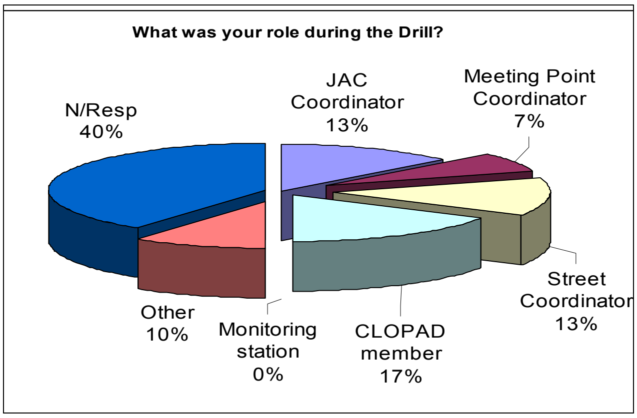


Figure S7-1-1 Roles the respondents played during the November 8th Drill

The general grading of the drill was "Good" and "Very Good"- Thirty eight percent graded "good" (7 and 8) and forty nine percent graded very good-excellent (grades 9 or 10) according to Table S7-1-11 below.

Table S7-1-11 Grading of the Drill by stakeholders

Grading of the Drill by stakeholders											
1	2	3	4	5	6	7	8	9	10	N/R	Total
0	0	0	1	0	1	2	10	7	8	2	31
0%	0%	0%	3%	0%	3%	6%	32%	23%	26%	6%	100%

There was agreement in the open-ended questions that the community's response to the evacuation was the aspect of the drill that worked the best. (36% of responses) followed by the communication and data transmission system (20%), the different types of coordination and collaboration (16%), and the role played by the CLOPAD members (16%). At the same, time the Figure S7-1-12 below reveals the aspects that need to improve being the community's response the aspect graded under "poor" and "to improve" categories. The apparent contradictory findings must be interpreted as appreciation put towards a job well done, and the need to stress that still improvement has to happen. The Figure also shows high perception of Firefighters, CLOPAD and JAC leaders' performance.

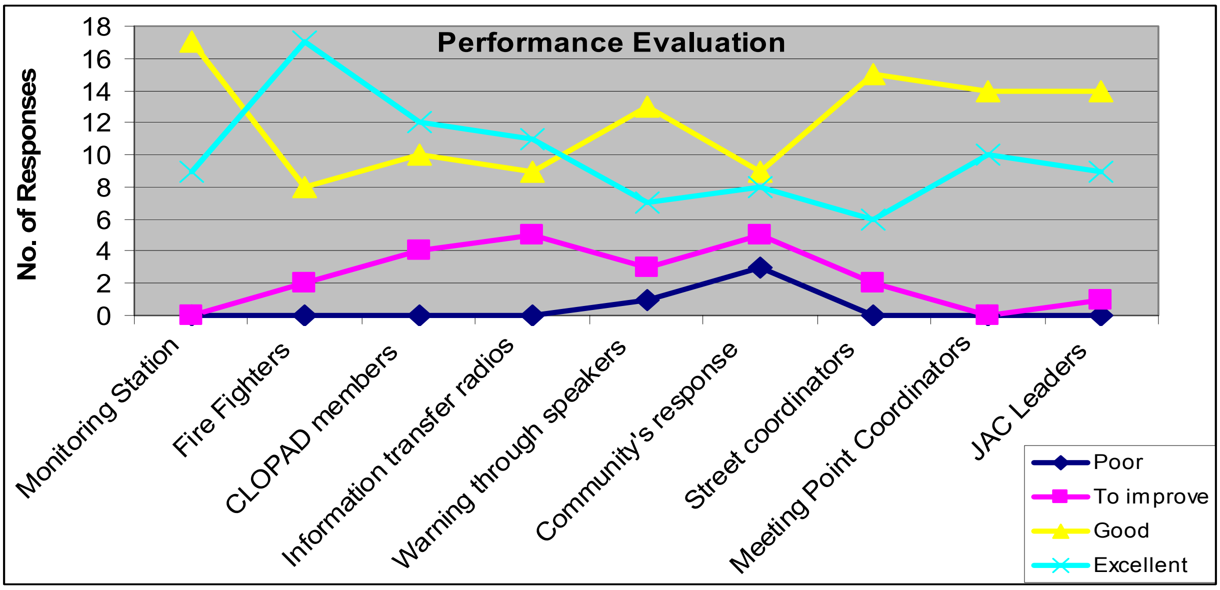


Figure S7-1-2 Stakeholder Performance Evaluation

People claimed to learn from the experience that "previous planning, organization and willingness can avoid adverse consequences". "Disasters can be prevented by paying attention when situations like this happen, with quicker evacuations".

A set of lessons learned were related to the social aspects of preparedness: "Good results can be obtained with the support and availability of community people". "We need to know better and improve our understanding of our communities". Some expressed great satisfaction in being able to help gather the communities towards the meeting point.

Another subset of conclusions were aimed towards collaboration: "We need to collaborate among each other in order to all benefit." "Team work is possible". "Coordination during the emergency, amongst leaders, towards the meeting points and amongst institutions are all key factors". "We need to help each other, to be prepared for a good evacuation performance, in order to increase effectiveness". Finally mentioned was the need to make adequate the evacuation system for specific population groups: particularly for schools and kindergartens. Some of the childcare places only have one adult attending groups of children. Emergency aid must specially direct their attention towards this fragile subgroup. School contingency plans were pointed out as highly needed. The CLOPAD and Red Cross should give priority to trainings on this topic.

With respect to the question "What needs to improve in this Early Warning System ?" there were several sets of topics. One subset was the communication system. It was clear some leaders were not accustomed to use the communication equipment (radio / speaker). Therefore, more training is needed in order to gain familiarity on its use.

Another subset was the community motivation aspect. The awareness raising trainings need to not stop if improved response is the goal. One suggestion mentioned as necessary to increase explanations and motivation towards community people *before* an evacuation for a better response.

Improving the information flow, regarding the message delivery protocol, the sequence of steps on the information flow, the (lack or unclear) answers to questions; and avoiding skipping or assuming steps of the protocol. One aspect to regulate is to set a priority use of the Radio Frequency according to emergency needs. In other words, when someone has urgent information, the communication equipment should allow for interruption at that time.

Finally, one key aspect to improve can be only gained through time, with a *careful data collection and data understanding from all the Monitoring Stations*. In other words, after months of collecting data -particularly during rainy season- the pattern of behavior, and the relation between rain and river flow, will reveal the real meaning of the values in the staff gauges and the rain gauges. The water levels marked in the equipment will help improve the understanding about which type of action must be taken whether observation warning, standby, preparing or acting for evacuation.

1.6 Visual CD Rom

Since February 18th 2007 the Study Team members started to record in a Video Camera the most important events taking place during the year. A set of thirteen cassettes were collected containing Workshops, Meetings, Drills some Field Activities, and the final Dissemination Seminar.

In coordination with Soacha Red Cross members, the Study Team gave the cassettes to a Red Cross member, Richard Ballen, who kindly selected representative sets of images and built a video clip about the community activities. Titles and explanatory sentences were added creating a fifteen-minute Video Clip, a visual testimony of the activities performed through out the year.

The Study team reproduced thirty copies and distributed to community members, response members. Copies were delivered to other CLOPAD and DPAE authorities as a motivational resource, and as dissemination material to stimulate community-based disaster management activities in other locations of Cundinamarca.

The original set of cassettes is kept under Soacha's CLOPAD care, available for any new initiative to produce a more in depth methodological video production in the future.

1.7 Seminar on Community Activities (November 13th, 2007)

On November 13, 2007, a seminar on Community Activities in Soacha was held in Hotel Tequendama, Bogotá by the Study Team. The sub title of the seminar was “Sustaining Disaster Prevention in Soacha Municipality: Lessons from Community Experiences and Challenges for Continuity over time”

Partial view of the attendants of the Seminar on Nov 13th, 2007

Left: Lecturer Flor María Ramírez, a committed upstream leader, designed a hand made scale model of the River Soacha with different kinds of seeds and colors. She is in charge of the Monitoring Station of Fusungá.

Right:
The scale model represents the stages that the Soacha River walks through.
From the upper stream -clean and protected with vegetation- through the grasslands (yellow), the subsoil extracting activities (black) and the urban pollution downstream until becoming dark grey, due to accumulated effects of the existing management practices.

Above:
JAC leaders from Llano Grande and Florida I Sector signed the inter-institutional and inter-communitarian agreement.
Commitment to keep monitoring the river, to taking care of Soacha River watershed and to improve their surroundings, are part of the tasks they agreed to sign and commit to continue.

The signing of the Inter Institutional and Inter communitarian Commitment for Soacha River on November 13th at Hotel Tequendama, 2007.

Above: Monitoring Station's observers, Community leaders and CLOPAD institutions agreed to continue the collaboration in the Monitoring and Early Warning System, and to improve the environmental sanitation of the River Soacha. The signing of the agreement was done symbolically in front of the scale model of the River Soacha.

1.8 Seminar on Community Activities (February 1, 2008)

On February 1, 2008, a seminar on the Study Recommendation and Panel Discussion was held in Hotel Tequendama, Bogotá by the Study Team. The Study Team made presentation briefly the main contents of the recommendation, after that, a panel discussion was held to discuss the sustainability of monitoring system after the Study. The panel discussion was facilitated by a Study Team member (Community activity expert) and the panelist was DPAE, IDEAM, Soacha city and Study Team. All the panelist and community people who attended the seminar confirmed the significance of the collaboration of the government and communities in order to keep the monitoring system and early warning system.

Annex S7-1 Survey Sheet (1/4)

ESTUDIO SOBRE MONITOREO Y SISTEMA DE ALERTA TEMPRANA DE DESLIZAMIENTOS E INUNDACIONES

C1

No FICHA: [ ][ ][ ]

A B C D E F G H I J K L M N Ñ O P Q R S T U V W X Y Z

1 2 3 4 5 6 7 8 9 0

- Utilice este tipo de letra y número
- Utilice únicamente el lápiz y el borrador que le entregaron
- NO tache / borre completamente
- No abrevie nombres
- No desprenda ninguna hoja
- Los textos son en MAYÚSCULAS

Marque así: 1.
- No marque así: 1.
- No marque así: 2.
- No marque así: 3.

1. FECHA DE ENCUESTA (COMPLETA): DD [ ][ ] MM [ ][ ] AA [ ][ ][ ][ ]

2. CÓDIGO DEPTO: 2 5

3. CÓDIGO MUNICIPIO: 7 5 4

4. NUMERO C/TRAL:

5. ÁREA: 1-Cabecera; 2-Centro Poblado; 3-Rural disperso

6. COMUNA:

I. DATOS DE LA VIVIENDA

7. SECCIÓN:

8. SECTOR:

9. CÓD. BARRIO:

10. BARRIO:

11. CL:

12. KR:

13. MZ:

14. LT:

15. OTRAS N/TURAS:

16. OTRAS N/TURAS:

17. TEL:

18. DIRECCIÓN:

II. DATOS DEL INFORMANTE Y CARACTERÍSTICAS DE LA VIVIENDA

19. Nombre del informante:

20. Sexo: 1. M; 2. F

21. Escolaridad:
   1. Analfabeta
   2. Ninguno, lee y escribe
   3. Primaria completa
   4. Primaria incompleta
   5. Bachillerato completo
   6. Bachillerato incompleto
   7. Técnico
   8. Universitario

22. Edad:

23. NUMERO DE PERSONAS QUE HABITAN EN LA VIVIENDA ACTUALMENTE:

24. HACE CUANTOS AÑOS VIVE EN SOACHA:

25. Labores que desarrolla en el hogar:
   - 1 ○ 1.Cocina
   - 1 ○ 2.Lava
   - 1 ○ 3.Limpieza
   - 1 ○ 4.Mandados
   - 1 ○ 5.Reparaciones
   - 1 ○ 6.Cuidado de menores
   - 1 ○ 7.Cuidado de adulto mayor
   - 2 ○ 8.Ninguno

26. ALGUNA PERSONA DE SU HOGAR SUFRE DE DISCAPACIDAD: 1. Si sufre; 2. No sufre

Si la respuesta es no pase a la pregunta 28

27. CUAL:
   - 0. ninguno
   - 1. enfermedad (sistema nervioso, cardiorrespirat, la piel, metabolismo)
   - 2. Discapacidad motriz
   - 3. Discapacidad mental
   - 4. Discapacidad visual
   - 5. Discapacidad auditiva
   - 6. Discapacidad visual y auditiva
   - 7. Discapacidad visual, habla y voz
   - 8. Discapacidad habla y la voz
   - 9. Discapacidad mental y motriz
   - 10. Discapacidad auditiva y habla
   - 11. Discapacidad motriz y auditiva
   - 12. Perdida de algún miembro

C2 **No FICHA:** ☐☐☐

28. Permanece alguien la mayoría del tiempo en la casa:
(Si la respuesta es 9 pase a la pregunta 28)
☐ 1. Padre 2. Madre 3. Abuelos 4. Hermanos 5. Hijos 6. Otros parientes 7. Vecinos 8. Otros 9. Nadie

29. En que tiempo:
☐ 0. Ninguno 1. Mañana 2. Tarde 3. Noche 4. Fines de semana 5. Todo el día

2.1 A que se dedica

30. Estudia:
☐ 1. Si 2. No

31. En que jornada:
☐ 0. No estudia 1. Diurno 2. Nocturno

32. Trabaja:
☐ 1. Si 2. No

33. Horario:
☐ 0. Ninguno 1. Diurno 2. Nocturno

34. Periodos:
☐ 0. Ninguno 1. Turnos 2. Por días 3. Ambulante

35. Cual de estas limitaciones o afecciones no le permite desarrollar algún tipo de trabajo:
☐
0. Ninguna
1. enfermedad (sistema nervioso, cardiorrespiratorio, la piel, metabolismo, digestivo
2. Discapacidad motriz
3. Discapacidad mental
4. Discapacidad visual
5. Discapacidad auditiva
6. Discapacidad visual y auditiva
7. Discapacidad visual, habla y voz
8. Discapacidad habla y la voz
9. Discapacidad mental y motriz
10. Discapacidad auditiva y habla
11. Discapacidad motriz y auditiva
12. Perdida de algún miembro

36. No genero ingresos, no realizo ningún oficio, estoy desempleado
☐ 0. Negación 1. Afirmación

2.2 Características del terren

37. Su casa se encuentra en superficie:
☐ 1. Pendiente 2. Plana

38. Tiene proximidad con:
☐
1. Humedal
2. Río
3. Ladera de montaña
4. Ladera a montaña y ladera de río
5. Humedal y ladera a montaña
6. Humedal y río
7. Humedal, río y ladera de montaña
8. Ninguno

39. Uso de la edificación:
(Si la respuesta es 2 pase a la pregunta 39)
☐ 1. Habitacional 2. Uso mixto

40. Usos complementarios de la vivienda:
☐ 1. Ninguno 2. Oficina 3. Hogar infantil 4. Hogar tercera edad 5. Comedor comunitario 6. Negocio 7. Templos Religiosos 8. Otros

41. En su sector se hallan señales de alerta para:
☐ 1. Ninguno 2. Incendio 3. Deslizamiento 4. Inundaciones 5. Seguridad comunal 6. Vendavales

42. Dispone su sector de un lugar especifico donde botar las basuras:
☐ 1. Si 2. No

43. Donde:
☐ 0. Ninguno 1. Botadero dispuesto por la comunidad 2. A la calle 3. Al río

44. Su barrio cuenta con vias de acceso:
☐ 1. Si 2. No

45. Cuenta con alguno de estos elementos en caso de una emergencia:
☐ 1. Ninguno 2. Botiquín o caja de primeros auxilios 3. Extintor 4. Linterna 5. Pito 6. Planta eléctrica 7. Herramientas

III. EXPERIENCIA EN DESASTRES Y PERCEPCIÓN DE RIESGOS

46. Le ha tocado vivir una emergencia en desastres:
☐ 1. Si 2. No
(Si la respuesta es no pase a la pregunta 48)

47. Fecha:
Mes ☐☐ Año ☐☐☐☐

48. Cual (es):
2 ○ 1. Ninguna
1 ○ 2. Temblor
1 ○ 3. Inundación
1 ○ 4. Derrumbe
1 ○ 5. Epidemia
1 ○ 6. Incendio
1 ○ 7. Derrame Químico
1 ○ 8. Explosión
1 ○ 9. Vendaval

49. Frecuencia del evento:
☐ 0. Ninguna 1. Semanas 2. Meses 3. Años 4. Más de dos años

50. Usted podria verse afectado por desastres en donde vive:
(Si la respuesta es no pase a la pregunta 51)
☐ 1. Si 2. No

C3 **No FICHA:** ☐☐☐

51. Que tipo de desastre

- 2 ⬭ 1. Ninguno
- 1 ⬭ 2. Temblor
- 1 ⬭ 3. Inundación
- 1 ⬭ 4. Derrumbe
- 1 ⬭ 5. Epidemia
- 1 ⬭ 6. Incendio
- 1 ⬭ 7. Derrame químico
- 1 ⬭ 8. Explosión
- 1 ⬭ 9. Vendaval

52. Ha recibido información o capacitación en temas como emergencias y / o desastres:

☐ 1. Si
2. No

Si la respuesta es no pase a la pregunta 54

53. Con que frecuencia:

☐ 0. Ninguno
1. Diaria
2. Semanal
3. Esporádica

54. Fuente de la que recibió la información

☐ 0. Ninguno
1. TV - Radio
2. Escuelas y colegios
3. Defensa civil o cuerpo de bomberos
4. Prensa
5. Ad/mon Municipal
6. JAC

55. Tipo de información que recibió

- 2 ⬭ 1. Ninguna
- 1 ⬭ 2. Temblor
- 1 ⬭ 3. Inundación
- 1 ⬭ 4. Derrumbe
- 1 ⬭ 5. Epidemia
- 1 ⬭ 6. Incendio
- 1 ⬭ 7. Derrame químico
- 1 ⬭ 8. Explosión
- 1 ⬭ 9. Zonas de riesgo en su comunidad
- 1 ⬭ 10. Normas de prevención ante incendios
- 1 ⬭ 11. Como organizarse ante un desastre
- 1 ⬭ 12. Atención a damnificados
- 1 ⬭ 13. Todas las anteriores

56. En caso de desastre quien seria para usted el responsable:

☐ 1. Gobierno
2. Municipio
3. Las juntas de acción comunal
4. El destino
5. Dios
6. La naturaleza
7. Yo mismo
8. Los vecinos

57. En caso de desastres, usted esta capacitado en:

- 1 ⬭ 1. Ninguna de las anteriores
- 1 ⬭ 2. Primeros auxilios
- 1 ⬭ 3. Desalojo de viviendas
- 1 ⬭ 4. Control de incendios
- 1 ⬭ 5. Labores de rescate
- 1 ⬭ 6. Manejo de radiocomunicaciones
- 1 ⬭ 7. Preparación de alimentos
- 2 ⬭ 8. Administración de alimentos, medicinas y / o equipos

58. Existen organizaciones que actúen en su comunidad en caso de desastre:

☐ 1. Junta de acción comunal
2. Defensa civil
3. Cruz roja
4. Bomberos
5. Grupos voluntarios
6. Departamento de atención y prevención de desastres
7. ONG
8. Ninguno

59. Cómo reaccionó?

☐ 1. No pudo reaccionar, me paralicé
2. Recibí orientación para salir de la emergencia
3. Ayudó a otros familiares
4. Coordiné acciones de socorro / evacuación

60. Cómo le afectó la ultima emergencia invernal en el mes de mayo aquí en Soacha?

☐ 1. Fui evacuado, huí del lugar, me fui donde un familiar
2. Perdí vivienda, vivienda afectada parcialmente, un familiar cercano perdió vivienda, perdí enseres
3. Sufrí lesión, otro sufrió lesión
4. No me paso nada, no me afectó directamente

61. Si ocurriera una emergencia y tuviera que evacuar su casa, adónde se dirigiría?

☐ 1. Área abierta (calle, loma, polideportivo, parque, lote baldío)
2. Sitio de reunión comunal (salón, escuela, iglesia, sede de ong)
3. No saldría de mi casa
4. Donde un familiar
5. No tendría donde ir
6. Centros de salud
7. Hospitales
8. Otros / Cual (anotar en observaciones)

IV. AYUDA MUTUA Y ORGANIZACIÓN COMUNAL EN PREVENCIÓN DE DESASTRES

62. Tiene familiares cercanos: ☐

1. En este barrio
2. En esta comuna
3. En otra comuna
4. No tengo nadie cerca

63. En esta comunidad, conoce usted jóvenes (14-26) que participan en proyectos comunitarios?

Temas comunitarios	Jóvenes Hombres	Jóvenes Mujeres
1. Salud (nutrición, estilos de vida saludables)	☐ 1. SI 2. NO	☐ 1. SI 2. NO
2. Educación (alfabetización, círculos lectura)	☐ 1. SI 2. NO	☐ 1. SI 2. NO
3. Mejoramiento infraestructural (vías, drenajes)	☐ 1. SI 2. NO	☐ 1. SI 2. NO
4. Seguridad comunitaria (derechos humanos, convivencia pacífica)	☐ 1. SI 2. NO	☐ 1. SI 2. NO
5. Recreación para niñez y juventud	☐ 1. SI 2. NO	☐ 1. SI 2. NO
6. Mejoramiento ambiental (desechos sólidos, reciclaje, reforestación, agricultura urbana, acueducto, alcantarillado)	☐ 1. SI 2. NO	☐ 1. SI 2. NO
7. Prevención/preparación de emergencias/desastres	☐ 1. SI 2. NO	☐ 1. SI 2. NO
8. Generación de ingresos	☐ 1. SI 2. NO	☐ 1. SI 2. NO

C4 **No FICHA:** ☐☐☐

64. Quienes serian las personas ideales para ayudar en la observación del comportamiento de los fenómenos naturales

☐
1. Hombres jóvenes,
2. Mujeres jóvenes
3. Hombres adultos,
4. Mujeres adultas,
5. Adultos mayores hombres

65. En edades de:

☐
1. Jóvenes 14 a 26 años
2. Adultos 27 a 59
3. Adulto mayor

66. En que sitios se debe aplicar la observación donde se pueda presentar una catástrofe ambiental:

☐
1. Las quebradas y ríos en esta comunidad (intensas lluvias, inundaciones)
2. Caída de rocas, movimiento de taludes o deslizamiento de tierra
3. Prevención de emergencias y desastres

V. INVOLUCRAMIENTO Y PARTICIPACIÓN ACTIVA

67. Podria usted dedicar tiempo para colaborar voluntariamente con actividades de prevención de emergencias:

☐
1. Si
2. No

Si la respuesta es no pase a la pregunta 68

68. En cuales:

2 ◯ 1. Ninguno

1 ◯ 2. Monitorear (observar/anotar/avisar) el comportamiento del caudal del río

1 ◯ 3. Monitorear (observar/anotar/avisar) el comportamiento de los taludes

1 ◯ 4. Organizar, recolectar y administrar centros de acopio en la comunidad

1 ◯ 5. Formar parte de un comité barrial de emergencia

1 ◯ 6. Ayudar a organizar un plan de prevención y atención de emergencias y desastres

1 ◯ 7. Apoyar acciones de organización de simulacros y evacuación en esta comunidad

1 ◯ 8. Apoyar el mejoramiento de vías de acceso para evacuaciones durante emergencias

1 ◯ 9. Ayudar a involucrar a jóvenes/niños en las actividades de monitoreo

69. En que tiempos:

☐
1. Por día
2. Por semana
3. Por mes
4. Ya participo en otras actividades comunitarias
5. No me interesa

70. Participa voluntariamente o en proyectos:

☐
1. Ninguno
2. Productivos (enseñanza y capacitación)
3. Comunitarias (comedores, JAC, Gestores sociales)
4. Educativos
5. Salud
6. Vivienda

71. Conoce a alguien que le gustaría involucrarse en grupos de ayuda comunitaria para la prevención de desastres:

☐
1. Si ➔ Si la respuesta es si, diligenciar numeral 70 y 71
2. No

72. Nombre del voluntario:

73. Teléfono :

74. COD. ENCUESTADOR: ☐

75. COD. ASESOR: ☐

76. COD. COORDINADOR: ☐

77. COD. DIGITADOR: ☐

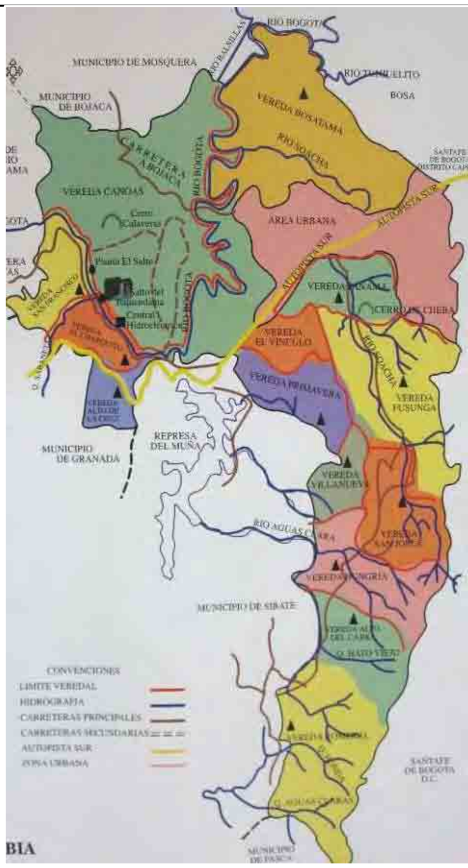
78. OBSERVACIONES

FIRMA DEL INFORMANTE

DOC I. ____________

Annex S7-2 Soacha River Watershed Map and Downstream List of Communities
contiguous to the river for the Community Survey

Corregimiento 2	Vereda Bosatama
	MARGEN IZQUIERDA
Comuna 2	El Carmen
Comuna 2	Las Huertas (finca 1 hda)
Comuna 2	El Silo
Comuna 2	La Fragua
Comuna 2	Cobec
Comuna 2	Villas de Santa Rosa
Comuna 2	Ciudad Salitre
Comuna 6	Parque de las Flores
Comuna 6	El Altico
Comuna 6	El Cipres
Comuna 6	Rincón de San Alejo
Comuna 6	Cohabitar
Comuna 6	Florida II
Comuna 6	Cien Familias
Comuna 6	La Pradera 2
Comuna 6	La Pradera 1
Comuna 6	La Florida 1
Comuna 6	Llano Grande
Comuna 6	Barrio El Cardal
Total Barrios	19
Zona Rural	V. Panamá
Corregimiento 1	V. Fusungá
	V. San Jorge
	V. Hungria



MARGEN DERECHA	
Hogar del Sol	Comuna 2
El Nogal	Comuna 2
La Amistad	Comuna 2
Bochica	Comuna 2
Altos Porto Alegre	Comuna 2
Porto Alegre Real	Comuna 2
El Sol de Porto Alegre	Comuna 2
Nueva Porto Alegre	Comuna 2
Porto Alegre	Comuna 2
Eugenio Díaz Castro	Comuna 2
La Unión	Comuna 2
Santa Cecilia	Comuna 2
Colmena II	Comuna 6
Ubate	Comuna 6
San Marcos	Comuna 6
EL Paraiso	Comuna 6
Parques del Sol II	Comuna 6
17	36
V. Panamá	Zona Rural
V. Fusungá	Corregimiento 1
V. San Jorge	
V. Hungria	

Annex S7-3 Focus Group List of Attendees

	GRUPO FOCAL BARRIO DIVINO NINO		
	NOMBRE	**APELLIDOS**	**ROL QUE OCUPA**
1	TERESA	CABRERA	HOGAR
2	JORGE	AMAYA	PRESIDENTE JAC DIVINO NINO
3	MONICA	ROMO ARANGO	HOGAR
4	DORIS M.	HERNANDEZ	HOGAR
5	ANA MARIA	LOPEZ TINJACA	HOGAR
6	ESPERANZA	NUMPAQUE L.	VECINO
7	PEDRO	BELLO PENALOSA	VECINO
8	BETY	VALENCIA	HOGAR
9	ilegible	CADAMID	HOGAR
10	ilegible	ilegible	n/d

	GRUPO FOCAL VILLA ESPERANZA EL BARRENO		
	NOMBRE	**APELLIDOS**	**ROL QUE OCUPA**
1	JOHANA	CARRILLO RODRIGUEZ	LIDER PROGR. FAMILIAS EN ACCION
2	MIRIAN	RAMIREZ	COMITE CONCILIADOR
3	DARIO	GRISALES	PRESIDENTE JAC
4	PASTOR	ROA G.	DELEGADA DE LA JAC
5	FABIOLA	ALCALA	VECINA
6	FANY	CORTEZ	VECINA
7	FABIOLA	MOLANOIZ	PRESIDENTE JAC

	GRUPO FOCAL, LLANO GRANDE, FLORIDA I Y II, EL CARDAL, CIEN FAMILIAS		
	NOMBRE	**APELLIDOS**	**ROL QUE OCUPA**
1	BENJAMIN	OSPINA	PRESIDENTE JAC LA FLORIDA
2	ELOIN	BENAVIDES	PRESIDENTE JAC LA FLORIDA II
3	LILIA	BELTRAN	COMITE DE SALUD VDA SAN JORGE
4	FLOR MARIA	RAMIREZ C.	PRESIDENTE JAC VDA FUSUNGA
5	YOLANDA	TORRES C.	VECINA LLANO GRANDE
6	BELARMINA	TRIANA	DELEGADA DE JAC EL CARDAL
7	ANA ISABEL	MOLANO PINZON	HABITANTE LLANO GRANDE
8	IDALID	PINZON	HABITANTE LLANO GRANDE
9	EULALIA	GUTIERREZ B.	PRESID. ASOC. HOGARES BIENESTAR FAMIL. CIEN FAM.
10	LUZ ESPER.	SANIN	TESORERA JAC CIEN FAMILIAS

	GRUPO FOCAL BARRIO LA CAPILLA		
	NOMBRE	**APELLIDOS**	**ROL QUE OCUPA**
1	LEONOR	AVENDANO	LIDER NACIONES UNIDAS
2	LUZ MERY	ENCISO GARCIA	PRESIDENTE JAC CAPILLA
3	HENRY	ACERO	SECRETARIO JAC LA CAPILLA
4	PEDRO ALFONSO	GALINDO D.	COMITE CONCILIADOR LA CAPILLA
5	MARIA LEONOR	CASALLAS	HABITANTE LA CAPILLA
6	BERTULFO	RODRIGUEZ	LA CAPILLA
7	MIGUEL	GONZALEZ	LA CAPILLA
8	ROSANA	RINCON	LA CAPILLA
9	RIGOBERTO	SULVARA	VISITANTE
10	AURA	DURAN	PRESIDENTE JAC LA MESETA
11	JOSE JOAQUIN	GARCIA	VOCAL CONTROL SOCIAL LA CAPILLA
12	NUBIA	FUQUENE	VECINO LA CAPILLA
13	HECTOR	MURILLO	JAC LA CAPILLA
14	LUIS	HERRERA	PRESIDENTE JAC LOMA LINDA
15	JOSE ORLANDO	AYA	COMITE CONCILIADOR CASA LOMA
16	ALFREDO	RICAURTE	PRESIDENTE JAC CASALOMA
17	n/d	n/d	VILLA MERCEDES

Annex S7-4 Summary of Focus Groups Outputs

Focus Groups October 7 & 8, 2006 Summary Sheet

Barrios represented	Hazard Type	Number of Attendees	Perception of Risk	Self help & Involvement	Priority Actions	Key Topics of Community Interest
Divino Niño (Divino Niño) *Saturday* *October 7, 2006*	Landslide/ Rock Fall	10	High	- Willing to form a Committee for general improvement and risk issues	- Works on slope - Temporary relocation - Proper resettlement	- Affordable relocation strongly pursued versus "evacuation-only" approach in high risk areas.
Altos Cazuca (Villa Mercedes II, La Capilla, Casaloma) *Sunday* *October 8, 2006*	Landslide	17	High	- Informed about agencies infrastructure projects	Sanitary infrastructure works, Soil studies Terraces, delimitation of risk area	- High/middle/low risk studies highly expected - Property rights vs. Aqueduct investment administrative/legal conflict. - Unclear mining exploitation in future
Llano Grande (Llano Grande, La Florida, San Jorge, Fusungá) *Saturday* *October 7, 2006*	Inundation	10	High	- Strong awareness already in place in upper stream - JACS and Current leaders willing to collaborate	- Colector Canoa - Sanitary infrastructure, - Proper watershed management activities - Observation of river flow	- Environment management during and post mining activities - Dredging the River Soacha twice a year - Construction of Collector Canoa sewerage canal - Dredged sediment must have proper location - Proper techniques to raise awareness among neighbors regarding waste disposal
Tibanica (V. Esperanza El Barreno, La Isla) *Sunday* *October 8, 2006*	Inundation /Landslide /Rockfall	7	High for landslide Low for inundation	- Women received training two yrs. ago on first aid and emergency topics	- Sewerage & rain runoff requested to be channeled. (1) - Worried about mining activities	- Dredging work of Terreros needed to turn area into a recreational open space for children and youth. - The dam (40 years old) has leaks. - Monitoring responsibility accepted if accompanied of proper training.
General issues	-	44 persons	High perception of risks	Mainly JACS and individual volunteers	Studies and infrastructure works highly expected Willingness to establish neighborhood collaborative work	- Urgent infrastructure works for sewerage, rain run off and grey waters - Lack of clarity on tenure and property rights perpetuate risky conditions - Actions need to follow the "awareness raising-only" approach of disaster prevention

Annex S7-5 Activity Log During the Flood Emergency May 11, 2006. (Data provided by community leaders of the barrios. June 2007)

May 11 flood emergency Step by step	Rincón de La Florida Florida II Sector Cien Familias	Florida I La Pradera II	Ladrillera Santa Fe, El Cardal y Llano Grande
1. Received information about the hazard of Soacha River	La Florida II, 11:45 a.m., Cien familias : warning issued. La Florida II, no warning, we ourselves noticed. Cien familias: we saw the situation through one of the bridged.	La Pradera II, 11:30 to 1:45. Florida I, 11:30 a.m. La Pradera II, warning through alarms and neighbors. Florida I, only noticed when river overflowed.	Llano Grande, no warning. El Cardal, 11:30 - 3:30 flood took four hours.No warning. For both: only noticed when overflowed.
2. Noticed the river increasing its level or flooding	11:30 am May 11 2006 La Florida II, water level increased very rapidly. Cien Fmilias, the river grew fast and started to overflow beyond its own boundaries	11:30 am May 11 2006 La Pradera II, the river level increased to a maximum level, un topo f the bridges. Florida I, river started to overflow by 11: 00 a.m.,	11:30 am May 11 2006 Llano Grande, in two minutes the river increased impresively until it overflowed. El Cardal, the river seemed low, but the inundation happened in few minutes.
4. Began actions to protect your home	La Florida II, 12:00 m. La Florida II, lift furniture quickly and started to push the water outside. Cien Familias, help neighbors by controlling the sand and sediment overflow.	La Pradera II, 8:00 p.m. Florida I, 11:40 a.m. La Pradera II, lift furniture to the second flor, and avoid children to go to the lower levels. Florida I, no protection actions was possible because the homes flooded through the sewerage pipes, and then the river overflowed in no time at all.	Llano Grande, 11:45 a.m. to 6:30 p.m. El Cardal, 3:30 p.m. Llano Grande, lift items to second floor and pull out the water in pails as much as possible. El Cardal, called firefighters and helped neighbors
5. Began actions to protect your family and relatives	La Florida II, 12:00 m. La Florida II, lead them to second floor if any, or send them to other homes with second floors. Cien familias, take children to second floor.	La Pradera II, 11:30 a.m. Florida I, 12:00 .m. La Pradera II, every possible action so children and elders were in a safe place. Florida I, not possible because the flood happened in no time.	Llano Grande, 11:45 a.m. El Cardal, 3:30 p.m. Llano Grande, permanently observing the river, go to the second floor. El Cardal, lead relatives to the second floor.
6. Decided to move -out or up- appliances and furniture	La Florida II, 12:00 m. La Florida II, lead them to second floor if any, or send them to other homes with second floors. Cien familias, lift mattresses and blankets to second floor.	La Pradera II, 11:30 a.m. Florida I, 12:00 .m. La Pradera II, left items at home taking all possible precautions. Florida I, homes with second floor lifted items, homes with one floor took items to the Comm. center.	Llano Grande, 11:45 a.m. to 6:30 p.m. El Cardal, 3:30 p.m. to 6:00 p.m. Llano Grande & El Cardal lift to second floor home items.
7. Decided to move people out or up	La Florida II, 12:00 m. Cien familias, not neccesary.	La Pradera II, 11:30 a.m. Florida I, 12:00 .m. La Pradera II, not neccesary. Florida I, all persons affected were taken to Comm. Center.	Llano Grande, 6:30 p.m. to 3:00 a.m. El Cardal, 3:30 p.m. to 6:00 p.m. Llano Grande, to several floor homes or to shelters. El Cardal, communicated to people to stay with their relatives and neighbor.

8. Decided to look for support from neighbors or institutions.	La Florida II, 12:00 La Florida II, Serví Generales & Ladrillera Santa Fe businesses, the parish, firefighters, police. Cien familias, the parish provided support.	La Pradera II, 11:30 a.m. Florida I, 12:00 .m. La Pradera II, Firefighters & Civil Defense. Florida I, support requested to neighbors, Red Cross, Alcaldía, World Vision.	Llano Grande, 11:15 a.m. El Cardal, 4:00 p.m. Llano Grande, firefighters, police. El Cardal, Alcaldías public services, the presence of Civil Defense.
9. Decided to provide support to neighbors or institutions.	La Florida II, 11:45 a.m. a 4:00 p. m. La Florida II, sandbags located in the left bank of the river. Cien familias, the parish provided food packages, blankets, and spiritual support.	La Pradera II, 4:00 p.m. Florida I, 5:00 p.m. La Pradera II, IJAC & the community organized brigades for the people affected. Florida I, JAC offered help. World Vision willingness to provide support	Llano Grande, 6:30 p.m. a 300 p.m. El Cardal, 11:00 a.m. a 6:30 p.m. Llano Grande, only some very affected received water and hot beverages, helped to take out the water from homes. El Cardal, help received collecting blankets and food packages
10. Atended the emergency	La Florida II, 12 m. a 6:00 p. m. La Florida II, take water out; clean items; request help to relative; make channels for water to get back into the river. Cien familias, asking for help, clearing the river side.	La Pradera II, 11:30 to 10:00 p.m. Florida I, 11:00 a.m. to 11:00 p.m. La Pradera II, sweeping the water level back to the river level. Florida I, formed brigadas to take water out of homes, electric motors to suck back the sewarage.	Llano Grande, 11:15 a.m. del 11-05-06 to eight days later. El Cardal, 11:00 a.m. to 7:00 p.m. Llano Grande, waited Hill river level decreased, then made cleaning work. El Cardal, request sanitation work for the sewerage, make census for families in need of help.
II. Executed the evacuation	La Florida II, 12 m. to 6:00 p. m. La Florida II, second floor and neighbor homes.	La Pradera II, 11:30 to 2:30 p.m. Florida I, 11:00 a.m. to 11:00 p.m. La Pradera II, second floor. Florida I, to the Community Center for one and a half month.	Llano Grande, 12:00m. El Cardal, 11:00 a.m. to 6:00 p.m. Llano Grande, moved to homes of relatives in Bogotá and Bosa. El Cardal, about 10 persons to second floor.
12. Wha Actions were taken during the time in the shelter	La Florida II, until 8 days. La Florida II, cleaned and organized homes and furniture.	La Pradera II, 11:30 to 2:30 p.m. Florida I, 19-05-06 9:00 a.m. to 1:00 p.m. One and a half month. La Pradera II, no flood, only furniture moved. Florida I, shelter organized for one day, some cooked others tried to wash everything.	Llano Grande, 12:00 m. El Cardal, 2:00 p.m. to eight days. Llano Grande, only slept in the shelter, every day went to homes. El Cardal, eight days while clearing and drying the homes.
13. Received a return back warning?	La Florida II, 12 m. 8 days later. La Florida II, no warning.	La Pradera II, 11:30 to 2:30 p.m. Florida I, 1 and a half month. La Pradera II, not necessary. Florida I, president of JAC, Benjamín advised to return to homes.	Llano Grande, 8 day later. El Cardal, 8 days later. Llano Grande, presidente of JAC advised to return to homes.. El Cardal, two youngsters advised the safe time to go back home.
14. How did the return back process happened?	La Florida II, 12 m. month and a half La Florida II, no return back advise.	La Pradera II, 11:30 to 2:30 p.m. Florida I, 8 days later. La Pradera II, not necessary Florida I, CAR gave disinfectants to for returning to the homes.	Llano Grande, 7:00 a.m. 8 days later. El Cardal, 9:00 a.m. eight days later. Llano Grande, clearing brigades. El Cardal, each neighbor cleaned their home, and received help as these arrived.

15. How did the home resettling process go?	La Florida II, 3 or 4 days La Florida II, Only alter everything was washed and organized.	La Pradera II, 10:00 p.m. Florida I, 1:00 p.m. to 7:00 p.m. . La Pradera II, a clearing brigade was made to lift the sewerage pipes and clean it well and put everything right. Florida I, washed all the mud, floors and walls disinfected and fumigated.	Llano Grande, 7:00 a.m. to 8:00 p.m. El Cardal, 9:00 a.m. three days later. Llano Grande, alter cleaning, washing homes and collecting damaged items. El Cardal, the paint fell off, the floors poped up, and in this condition we are living now.
16. How /when did the full recovery finalize, for both home and neighborhood ?	La Florida II, 25 to 30 días. La Florida II, economically difficult for most people.	La Pradera II, same day. Florida I, 1:00 p.m. to 9:00 p.m. . La Pradera II, same day families were accomodated back. Florida I, in the Community Center, since some families lost it all.	Llano Grande, Mayo 20 at 7:00 a.m. El Cardal, June 15 at 12:00 m. Llano Grande, One affected neighbor helped with a bulldozer removing and cleaning the streets. El Cardal, some families have been able to recover, others not, due to scarce resources.

Annex S7-6 Time Action Protocol for the Evacuation Drill of September 22nd 2007

SECUENCIA DE EJECUCION. SIMULACRO DE EVACUACION por INUNDACION
Barrios El Cardal, Llano Grande, Florida I, Pradera II, Cien Familias, Florida II, Cohabitar
SABADO 22 DE SETIEMBRE, 2007 *(borrador Jueves 20 set)*

Hora	Lugar	Actividad	Responsable	Suministros
12:00 md	Bo. Paraíso, Casa Hermanas Adelaida	Llegada de Organismos a P.M.U. Instalación de Mesa de Trabajo. Distribución de en cada barrio.	Coordinador: Ivan Riobueno, Bomberos Defensa Civil: Manuel Herrera Cruz Roja: Giovanny Orjuela	Papel, cinta, marcadores, radios. Directorios. Mapas con rutas y Puntos
12:00 md	Cada barrio. Donde se tiene el equipo de sonida.	Reportarse al encargado de barrio	Cada encargado de calle y de seguridad se reune con el Coordinador de Barrio	
12: 15 md	En cada calle	Instalar flechas orientando rutas de evacuación. Instalar rótulos con punto de encuentro Verificar listas de familias. Tener a mano cintas perimetrales. Verificar estado de equipo y radios.	Encargados de cuadra Coordinadores de puntos de encuentro. Coordinador de Barrio	Listas de nombres de encargados.
12:30 pm	Bomberos Soacha Vivienda de encargados de activar sirenas	Bomberos Soacha decide activar alarma. Envía mensajes por radio a encargados de activar sirenas	Bomberos: quien esté turno Florida II: Carlos Varela Florida I: Benjamín Ospina Llano Grande: Bernardo Sánchez El Cardal: Dagoberto Silva	Radios
12:35 pm	Viviendas donde se ubican los equipos.	Encargados de sirenas en los barrios, anuncian y activan sirenas. Cada uno anota la hora en que anunció y activó sirena.	mismos	Radios, consola, micrófonos switch.
12:35 pm	Cada vivienda y cada calle	Evacuación inicia. Familias toman medidas de seguridad en sus viviendas, congregan a familiares y evacuan por las rutas establecidas. Encargados de seguridad por calle inician vigilancia y acordonamiento por calle.	Coordinadores de Barrio Coordinadores por calle Encargados de seguridad por Barrio. Familias	Listas de familias por evacuar. Cinta perimetral. Megáfonos, uno por barrio.
12:50 pm	Cada barrio	A los 15 minutos de haber activado la sirena, se hace el primer conteo de personas en cada Punto de Encuentro	Coordinador de Punto de Encuentro Encargados de seguridad por calle.	Listas de familias esferos
1:10 pm	Puntos de Encuentro	Verificar que todas las familias de la lista hayan evacuado, o subido al 2do piso.	Coordinadores de Barrio con Encargados por Calle	Megáfono.
1:20-1:30 pm	Puntos de Encuentro	Pase de reporte de cada Calle a Barrio, y de éste a PMU.	Coordinador de Calle informa a Coordinador de Barrio y Coordinador de Punto de Encuentro a PMU.	Radios, celulares.

1:45 pm	Puntos de Encuentro	Segundo Conteo en cada Punto de Encuentro. Informar sobre personas que no llegaron Pase de reporte a PMU.	Coordinador de Punto de Encuentro	Listas de familias, esferos.
1:45 pm	Punto de Encuentro	Organización de Mesas de Trabajo: - Conteo detallado de familias - Inspección de viviendas, del nivel de inundación, seguridad del sitio. - Organización del Albergue. Administración de agua, organización de alimentación, medicamentos. - Brindar orientaciones a las familias: (permanecer unidas, darse apoyo emocional, acordar las medidas y pasos para una próxima emergencia)	Coordinador de Punto de Encuentro. Cuerpos de Socorro asignados en cada Punto de Encuentro.	Guía para orientar a familias a realizar actividades específicas. Contestar dudas e inquietudes de vecinas.
2:15	Salida de Puntos de Encuentro hacia Punto de Evaluación	Salida de cada punto de encuentro hacia el Punto de Evaluación en Casa Hermanas Instruir a familias que ya pueden regresar. Verificar que ocurra con normalidad. Encargados de seguridad recogen cintas, flechas y rótulos. Cierre de salones comunales.	Todos	
2:25	Cancha Multiple Cien Familias	Llegada a Punto de Evaluación. Inicio.	Todos Encargados por calle, barrio y P.M.U.	Megáfono Papel, esfero
3:00	Cancha Multiple Cien Familias	Fin de Actividad en Cancha Múltiple. Agradecimientos		

Annex S7-7 November 8th Drill Evaluation Form

Cuál fue su rol en este simulacro? *Marque con una "x"* Coordinador de barrio____ Encargado de Punto de Encuentro____ Encargado de calle____ Organismo del CLOPAD____ Encargado de monitoreo del río/lluvia ____ Otro______

*Favor escriba sus opiniones sobre **su experiencia** del Simulacro de Evacuación ante Inundación en el Río Soacha del día Jueves 8 de noviembre.*

1. Cómo le pareció que funcionó: *Si no tiene información deje en blanco, o coloque una raya ----*	Deficiente	Regular	Bien	Excelente
a. Los encargados de cada estación				
b. La Estación Central de Bomberos				
c. CLOPAD (Alcaldía, Cruz Roja, Def. Civil, Policía)				
d. La transferencia de información vía radios				
e. El aviso dado a las comunidades a sistemas de sonido				
f. La respuesta de los y las vecinas en su comunidad				
g. El desempeño de los Encargados por cada carrera y calle				
h. El desempeño de Encargados de Puntos de Encuentro				
i. El desempeño de los Coordinadores de Barrio				

2. Qué fue que lo funcionó mejor del simulacro?

3. Qué aprendizajes obtuvo usted de esta experiencia?

4. Qué se debe mejorar del Sistema de Alerta Temprana hacia el futuro?

5. Considera usted que este Sistema de Alerta Temprana se va a sostener en el tiempo? Explique.

6. Califique de 1 a 10 su opinión general sobre el resultado de este Simulacro

(dibuje un circulo alrededor de 1 si es muy deficiente, y 10 si es excelente)

1 2 3 4 5 6 7 8 9 10

7. Algo más que quisiera añadir?