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ZONING FOR THE MANAGEMENT OF URBAN FLOOD RISK AND RIPARIAN IN CANTON SAMBORONDON BY EFFECT OF SEDIMENTATION IN BABAHOYO RIVER AND EXTRAORDINARY WEATHER EVENTS

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ABSTRACT: Samborondón has a very high population growth rate; causing an increased urban development, pavement works and the reduction of the green areas, regarding the construction areas, producing a remarkable increase of the stormwater drainage, wich is conducted through hydraulics structures up to its final discharge in channels, estuaries or simply dumping it into the Babahoyo or Daule rivers.

Babahoyo river geomorphology has provided information about islets due to the sediments buildup on its cause, because of the basin contribution, erosion and because of the tides entering the gulf. The present of this sediments inside the river cause, influences on the storm sewer system discharge levels; many times, causing its collapse and small floods, wich like the channels discharging directly into the river, have a backwater effect at the exact moment of discharge.

This investigation, aims to zoning urban and riverside areas, which are more likely to be flooded, control and discipline urban occupation through a compatible densification according to the flood risks; in order to avoid urban areas hydrograph increment and to suggest possible theoretical solutions using hydraulic modeling samples.

Key Words: Geomorphology, Urban Flooding, Riverside Flooding

1. INTRODUCTION

Characteristics Of Babahoyo River Basin

Guayas river has one of the biggest hydrographic basins from the pacific coast of South America. It has an extension of 40000 Km2, it´s level depends mainly of the tide flow since leads into the Guayaquil gulf forming an estuary, thereafter Guayas river leads into the ocean.

Guayas river primary tributaries rivers are: Daule and Babahoyo rivers; Babahoyo river basin extends from the western cordillera heights (top of North Illiniza , 5248 km above sea level), to coastal plains (where Babahoyo river and Pueblo Viejo, 4 meters above sea level). Varied topography is also seen, with slopes between 10 and 80%. In the lower basin area, we can observe large floodplains and river valleys. This characteristic makes the sub basin to bear several floods, during winter. (See figure 1)

We have the first evidences around areas near Babahoyo river outlet, where canton Samborondón and canton Daule storm sewer systems, tend to collapse with high tides, since discharge levels match river level.

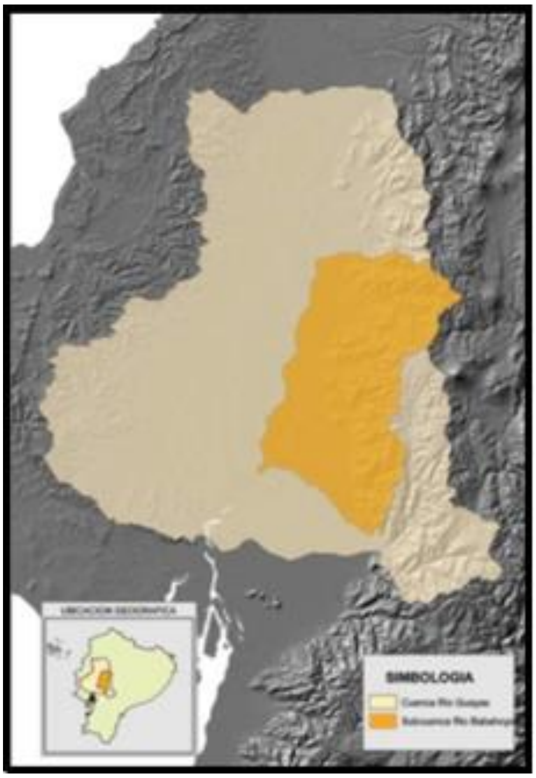

Figure 1. Guayas River basin and Babahoyo River subbasin.

We can also encounter this issues upstream, in front Ciudad Celeste community; the formation of an islet near the river's margin has caused an increment of the channel bottom level, prompting river level to match high tide level, causing river flow enter by main rainwater drainage collectors, of near communities. (See figure 2)

Figure 2. Islet location front of Ciudad Celeste community, we can also notice the storm drain chamber at it´s full capacity due to the river flow; whereby, the Water Company services are hired, in order to use the hydrocleaner so the proper maintenance can be done.

At Babahoyo river basin, a floods threats study was conducted by the Ministry of Environment, showing that the 38.3% of the basin territory is exposed to mid, high and maximum floods, which are characterized by their long duration. Lower cantons zone of the basin are: Babahoyo, Baba, Montalvo, Pueblo Viejo and Ventanas.

Immediately affected cantons by future floods, caused by extreme meteorological phenomena, from its outlet at Guayas River to upstream waters are: Samborondón, Duran and Yaguachi. These cantons will be mostly affected by islets formation due to Babahoyo River sedimentation so that channel area is reduced; choosing to take the floodplains.

2. SAMBORONDÓN CANTON FLOOD ISSUES

Canton Samborondón has a 6.38% population growth rate according to INEC. (See figure 3)

The disproportionate increase of communities, waterproofing soil , runoff acceleration, the construction of obstacles to runoff; the creation of unnatural ditches, rivers and creek on urban areas; has a big impact on the increase of floods in these areas.

With increasing of gray areas, green areas will be reduced, causing canton increment of runoffs. In addition to this, the storm sewer limitation due to design issues also represents difficulties.

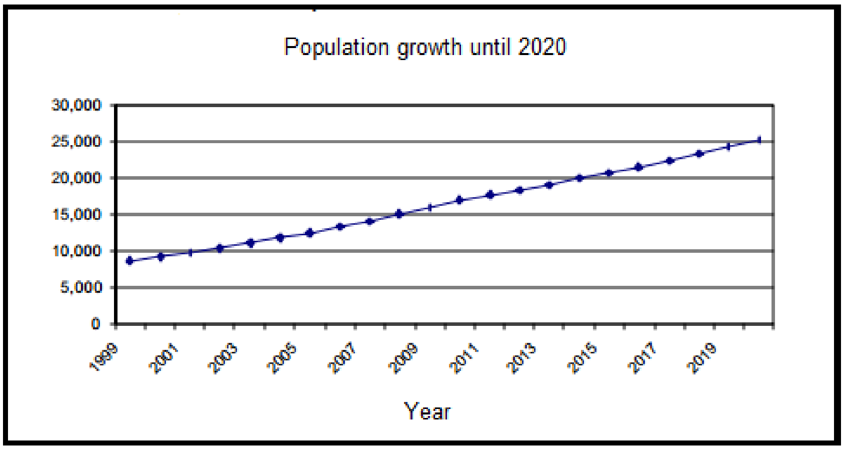

Figure 3. Canton Samborondón population growth until 2020.

a) Urban flooding

Urban flooding occurs, at the same time, because of 2 different situations:

- Due to heavy rains (storm water flooding).
- Due to the increment of ground water.

b) Riverside flooding

Riverside flooding occurs, at the same time, because of 2 different situations:

- For swollen rivers that drain he basin.
- For sedimentation, river damming effect by raising river level.

A fifth case result from the combination of some of the effect previously mentioned. In this case, the future risk is associated with the combination of: tides, meteorological and fluvial events that may cause critical situations.

Floods affect not only the water but also the sediment in rivers. Banks may erode during floods with the risk of undermining flood defences. On the riverbed larges dunes may develop that push up flood levels by increasing the hydraulic resistance. Erosion and sedimentation may change the distribution of discharges at river bifurcations in deltas, giving some branches higher flood discharges that accounted for. Moreover, flood management strategies based on giving more space to a river induce sedimentation reduces the navigability of the main channel and gradually negates the flood level reduction gained by the strategies. River morphology this affect both flooding risks and the sustainability of flood management strategies.

3. ZONIFICATION OF AREAS MOST PRONE TO FLOODING URBAN AND RIPARIANS

3.1. Convergence Between Babahoyo And Daule Rivers

The communities in Samborondón canton located near the convergence of both rivers are among of the first to be affected when the tide is at its maximum y match the raining season. (See figure 4). As a result of this, sewage system collapses; causing widespread flooding.

Figure 4. Significantly affected communities because of storm sewer system collapse.

3.2. Mocoli Island

We can observe at the western edge of the Mocoli Island, near the bridge which connects Samborondón canton with the island, a sediment accumulation, even entering the stormwater discharge system collectors. (See figure 5)

Figure 5. Sedimentation issues at the Mocoli Island western edge. How the sediments enter the main collectors can be seen as well, leaving remnants when the river levels decrease.

Front of the eastern edge of the island and limiting with Duran canton, when the river levels decrease, an islets formation can be noticed, due to erosion issues at the eastern edge of the island. (See figure 6)

Figure 6. Islets in front of Mocoli Island eastern edge.

3.3. Ciudad Celeste Community And Buijo Historico Sector

Front of Ciudad Celeste community and Buijo Historico sector, an islet called Penitencia, appears. The sedimentation which is accumulating on the separation fringe between community edge and the island, is shortening even the river bottom level is increasing because of sediment accumulation. (See Figure 7). When the river is at low tide, a distance of 10 meters can be observed between the islet and the edge. This is causing the storm water system collapsing and when the river level goes up, the discharge collector are totally covered.

Figure 7. We can observe the minimum distance between Penitencia Island and Ciudad Celeste community, causing the accumulated sediments level, increases.

Main channels or estuaries that borders Buijo Historico sector and Ciudad Celeste community, discharge a substantial amount of sediments, we can verify this in the zone where river channel leads, we have to consider the fact that this are hydraulic forces collision points; producing small dams, that would delay the water evacuation when river levels increase, is causing small flooding inside and outside the communities and all the sectors that borders this channels or estuaries. (See Figure 8)

Figure 8. The amount of sediments at the discharge of the two channels can be seen; both in the Buijo Historico and Ciudad Celeste community.

3.4. Tarifa Parish

We can appreciate Los Tintos river outlet into the Babahoyo River and next to the bridge that connects Tarifa parish.

Most of the rainwater discharge collectors are close to their maximum capacity, many areas that can be used for community development, are found inside flooding plains limits. (See Figure 9)

Figure 9. We can see how the river level partially covers the collectors, prompting their collapse.

The affected flooding plains due to river level increment at high tides, exemplified using Hec-Ras software, are clearly shown. On the site, we can observe the flow line marks at their maximum, which match with a small proportion of the parish boardwalk. (See Figure 10).

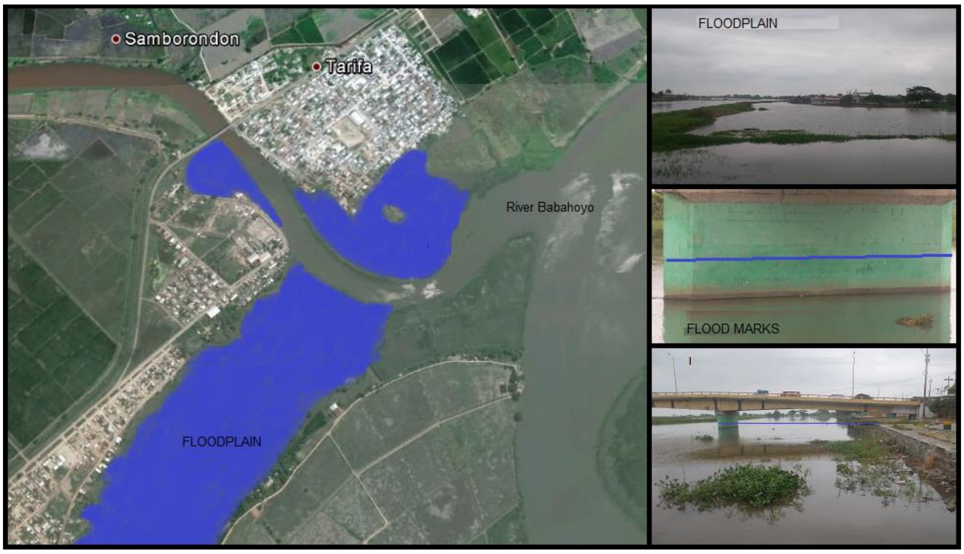

Figure 10. In the box at the left, we can appreciate which are the collectors covered by water in the lowlands or flood plains, modeled with the Hec-Ras software. In the boxes at the right, we can observe the river level at high tide.

3.5. Samborondón City

In here, we have 2 main channels that lead into the Babahoyo River. (See Figure 11).

We can observe the way the sector borders with the channels, having an important issue when this two channels overflow, causing a bigger affected area.

On the boardwalk sector, the discharge collectors are located that will collapse on high tides; in such way that many times the water flow exits from the sinkholes to the streets.

Figure 11. We have two main channels In Canton Samborondón, channel A and channel B. We can see them at the lower right boxes. In the upper left box, we can see the collapse of the discharge collectors toward the river, at high tides.

4. MANAGEMENT PLANS

A widely used frame for flood risk management is the disaster management cycle (See Figure 12). This figure distinguishes three distinct phases in flood risk management: prevention, flood event management and post-flood measures. It clearly shows that flood risks management encompasses a wide range of activities and measures, ranging from the traditional flood defence measures, such as dikes and dams, to spatial planning, early warning, evacuation and reconstruction.

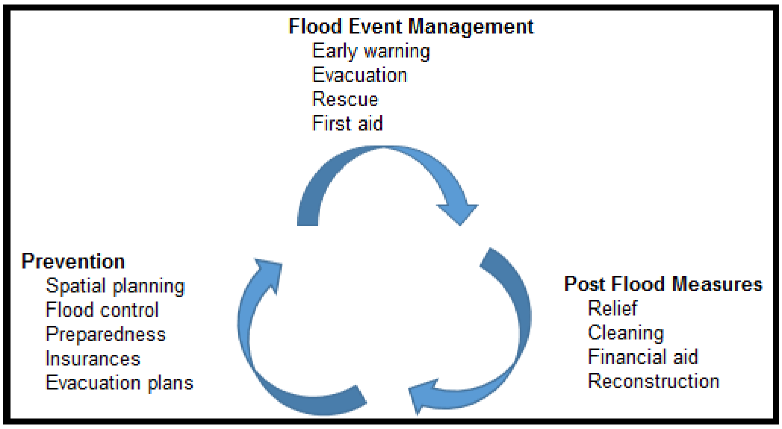

Figure 12. Disaster management cycle.

Typically, many cities and towns are situated in locations that are prone to flooding, especially deltas and flood plains. Climate changes may increase this risk, not only through rising sea water levels, but also because of more extreme weather conditions. Therefore there is a need for climate adaptation and mitigation measures, to make these urban areas more climate-robust flood-proofing of buildings is a well know measure in this respect.

We have to consider urban and Riverside flooding monitoring types.

The 2 Riverside control measures can be:

a) Structural: They modify the fluvial system through construction plans inside the watershed or on the river in order to avoid overflows into the mayor bed runoff. (See Figure 13).

b) Non-structural: Damage is reduced because of the improved population coexistence regarding to flooding, through preventive measures and flood control alerts.

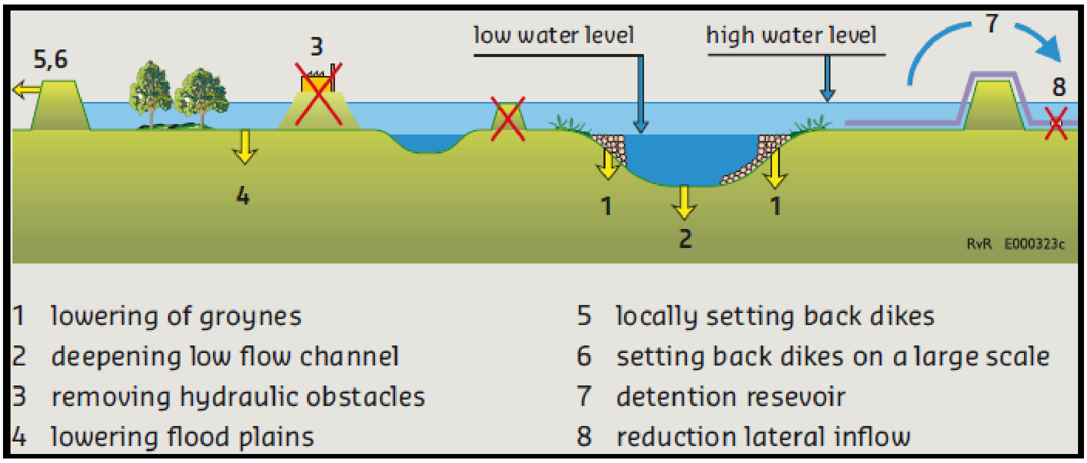

Figure 13. Overview of possible measures in the ´Room for the River´ project, supported by the planning kit.

Runoff control measures can be classified according to their influence on the hydrographic basin, follows:

a) Distributed on the source: Kind of management control that influences public places.

b) On the micro drainage: Kind of management control that has an impact on the final hydrograph Fromm one or some communities.

c) On the macro drainage: Kind of management control that Works on the main urban water flows.

5. CONCLUSIONS

The increased physical, economic and vulnerability (See Table 1); is one of the characteristic of the large urban areas. A truly awareness and education about the big hydrologic impact that is generated every time cities population grows, how this is mirrored on this problems and how we can reduce all of this risks; is needed.

	Monetised	Not Monetised
Direct Effects	Direct material damage:	Casualties (deaths, injured, evacuess)
	-houses and assets	Damages to landscape, nature, environment and cultural heritage
	-vehicles	
	-agricultural crops and livestock	
	Cost of rescue, evacuation and relief	
Indirect Effects	Damage suppliers and customers	Cut-offd of infraestructure, telecom and power lines (lifelines)
	Substution by production outside the flood area	
	Demand impulse through repair and reconstruction	
	Permanent impact on productivity and competitiveness	

Table 1. Economic effects of a flood disaster.

The presence of some islets on the Babahoyo river, is starting to reflect consequences, as much as, on the urban planning industry and the socioeconomic industry, at the time flooding occur because the river flow area is reduced due to the cumulative sediments and this flow tends to occupy the flooding plains; affecting communities, towns, crops; even affecting the economy of an entire country.

The affected scenarios and those who will be affected will be studied. Based on this, the reasons of these consequences are going to be identified, with the help of hydraulic fluvial modeling software and geographic information, the most affected areas will be zoned, the main problem will be recognized and from here we are going to perform the corresponding field tests so we can find the best solution, so that it is feasible technically and economically.

With this pre study, targeting the threaded zones that are subjected with the abovementioned problems and finding some possible solutions so future flooding can be avoid, that can not only affect one sector particularly but the economy of a whole country, due to the costs of public works and infrastructure in order to protect the communities and the losses on the farming industry; is intended

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