A METHODOLOGY FOR THE IDENTIFICATION OF SPILLWAY FAILURES DUE TO SPILLOVER OF THE HYDRAULIC HEAD. A PURPOSE FROM THE ACADEMY.

Diego Escobar Ocampo
Lecturer of Antonio Nariño University
Environmental and Sanitary Engineer
Geographic Information System Specialist

Oscar Lopez Espitia
Lecturer of Antonio Nariño University
Msc Water Engineer

Presentation Made for
ESRI Education User Conference
San Diego, California
October, 2009

Abstract

The Faculty of Environmental Engineering of Antonio Nariño University has been implementing pedagogical strategies in order to integrate the students' acquired knowledge from the lecture rooms of different subjects with the resolution of locally-generated environmental problems. The final objective is to create interdisciplinary student groups that can apply their theoretical knowledge to a real problem.

Particularly for this project, it was created a work methodology that involves students from both Water Supply System and Geographic Information System classes. The project itself, attempts to apply a methodology for the identification of spillways which fail due to an spillover of their hydraulic head.

As a context, these failures cause direct pollution without a previous treatment of the dumps from the sewerage systems to the artificial water sources of Bogota, thus causing a decreasing of the water quality in the district.

1. Introduction

The public sewerage network is designed with the purpose of collecting and conveying the sewage and rainwater to some discharge points that, according to Colombian law, must be wastewater treatment/purification points that aim to reduce the pollution load of waters, so they can be disposed to an artificial body of water.

The construction of both systems (sewerage and rainwater) has complementary structures such as spillways, drop chambers, drains, etc., that are intended to guarantee the effectiveness of the system and cost reduction throughout the useful life of the project.

Taking into consideration the aforementioned, the spillways are structures designed for improving the effectiveness of the system and, at the same time, for reducing the

conveying costs. It is true, since they allow to divert a part of the rainwater and sewage flow to superficial bodies of water without having to convey it throughout the system until the treatment points, causing, thus, savings on the design and construction of the system. The building of these structures must be based on that the mixture of sewage and the rainwater ought to guarantee a polluting load that the recipient body of water can assimilate according to the hydrological characteristics and the normative conditions of the place.

Nevertheless, it has been observed that several spillways of the sewerage system of Bogota are discharging sewage even in summertime, impeding its previous appropriate dilution, affecting directly the superficial bodies of water this way. For this reason, it is fundamental to identify the kind of causes that can generate the malfunctioning of the spillways to determine the following up and control strategies in order to avoid the negative impact of that resource. The lack of maintenance, the structural failure and the excess of the hydraulic head are three of the main possible reasons that can be generating this problem.

The present study will be focused on the latter of the causes above, making possible, from the academy, a methodology for the identification of spillways where an excess of the hydraulic head is presented and the reasons why it happened by means of the application of Geographic Information Systems.

Problem

One of the environmental problems of Bogota is the pollution of the river by the same name, and its tributaries. Among the pollution sources that cause this problem it is found the discharge of water --done by spillways, in the sewerage system that do not mix appropriately the rainwater and the sewage into the dumping they deliver to the rivers of the city, causing a direct impact on river's self-purification capacity.

The faults that make the spillway's hydraulic system to fail are due, in part to its spillover on the hydraulic head, produced by a rise in the flow that it conveys, and this raise at the same time is generated by the rise of the population that is favored without some technical studies of zoning plan previously made for locating them.

2. Considerations of the design

In order to generate a methodology that allows to provide evidence of the spillway's failures by the spillover its hydraulic head, is necessary taking into account some design guidelines that will allow hence to involve all the aspects for the identification of these spillways and the reasons for the rise of the hydraulic head.

Projection considerations[1]1: The flow diverted through the spillway is a fraction of the flow made up of sewage and rainwater, where sanitary and rainwater wastes are mixed, so that it is diluted the average concentration level of wastewater.

[1 1] Reglamento Técnico Del Sector De Agua Potable y Saneamiento Básico RAS – 2000.

Relief sewer flow: It corresponds to a daily average flow of wastewater that comes into the structure multiplied by the dilution factor that has to be more than 1. The lower values of this factor correspond to secondary manifolds that lessen watercourses with little water level; whereas, higher values correspond to interceptor sewers or final sewage pipes that discharge to a bed with a great water level.

Sewer Relief Frequency: It is necessary to characterize the frequency of events of rainfall that can generate a runoff that can, equally, produce spillovers of sewer. In this manner, it can be established the expected number of times per year that the sewer could operate.

Expected Volume of sewer reliefs: they are determined according the characteristics of the rainfall events analysis that can generate a rain runoff in the zone. The generated runoff is a function of the dampness previous to the rainfall event and the use of the land.

3. Methodology

The idea of the Project was set aiming at the students from Water Supply System and Sewerage with the students of Geographic Information Systems from the Faculty of Environmental Engineering could develop an interdisciplinary project, with a field work that allowed creating a proposal of solution to an environmental problem happening in Bogota.

The development of the stages of the project establish: 1) identifying the spillways that show failures, 2) choosing from the previous spillways the primary points, and 3) apply in the primary points the analysis for determining if the spillway failures are caused by an excess in the hydraulic head of the sewerage of Bogota.

5. Failures. Identification of the spillways that show a failure.

The identification of these spillways will be done in three stages that will be in charge by an interdisciplinary group conformed by students from Water Supply System and students from Geographic Information Systems. These stages consist on: 1) Analysis of existing previous the information, 2) Location of the discharge points by means of using the tool Google Earth and, 3) field work.

Initially, the information from the Water Supply and Sewerage System of Bogota (Empresa de acueducto y Alcantarillado de Bogotá - EAAB) will be analyzed. This information will be obtained from the System of Geographic Information located on the EAAB's site. The application posses the general information of the Sanitary network, the rainfall network, hydrology and hydrography from the district.

With this application it will be generated a database from all the spillways the sewerage system of Bogotá has. The database will be feed for the code of the spillway, the river basin which it belongs to, and the river which discharge its sewage to.

After the identification of all the spillways, it will be done a selection of all the possible spillways that have failures by means of the observation of changes in tone of the river in the places in which the spillways should discharge. It is hoped to get a darker tone in the places where spillways discharge the wastewater without the right dilution. This stage will be done by means of the observation of satellite images within the Program Google Earth.

The objective of this phase is to identify the spillways that students will be tracking in field work, which will consist on georeferencing the points by means of the use of GPS, that will be essential to the stage of prioritization of points.

The identification stage will culminate with the georeferencing of all data found: relief sewer points, sanitation basin of the prioritized spillway, sewerage drainage network, housing and industries belonging to the basin, etc.

This last step will be done by a students team who will be using the ArcGis 9.2 program.

Selection of prioritized points

The selection of the spillways where the methodology is going to be implemented will depend on the analysis of several factors such as: accessibility to do field work, sanitary basin area, hydraulic data from the sewerage system, etc.

At this point in time, it will be chosen one or several spillways depending on the existing working groups.

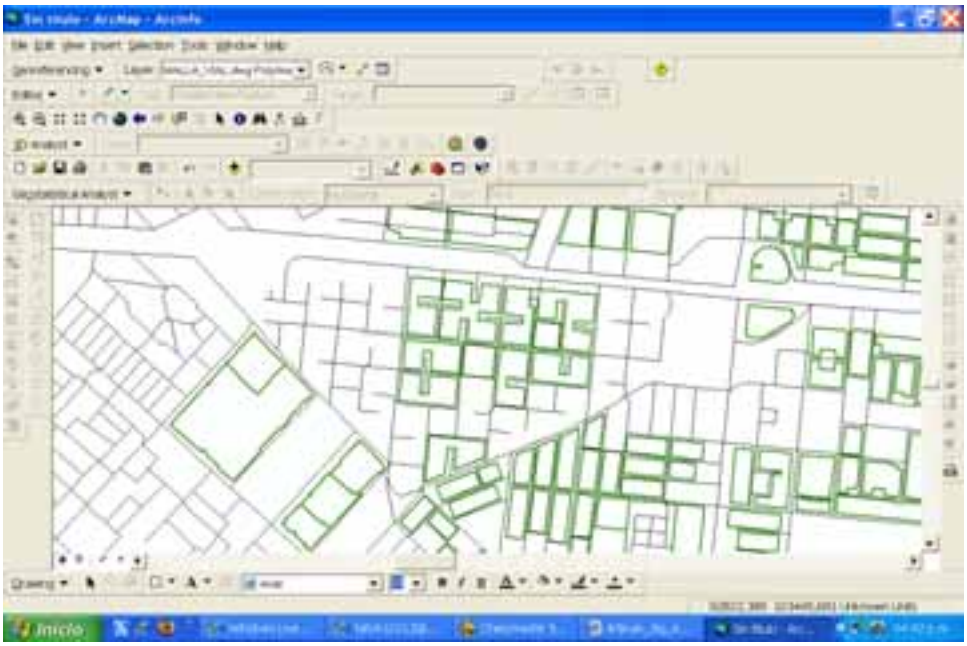
6. Data anylisis

According to the obtained information on previous stages, the next step will be analising the collected data, which will involve these steps: 1) Estimation of design flow of the stretch that covers the spillway 2). Estimation of the currently conveyed flow. And 3) Determining whether the current flow exceed the design flow or not.

the gradient of the section, pipe diameter, the sewer relief frequency, the expected volumes of sewer relief, etc. This will determine the flow which the spillway was made for, taking into account the concentrations of dilution that are expected to release in the water source.

Subsequently, another field work will be done to evaluate the current flow having into consideration the number of industries, companies and housing that are discharging their sewage to the spillway section. This information will be georeferenced and it will be coded for each section of the sewerage system.

It will be generated a data base -- the same as with previous information, which covers the neighborhood, the districts within the city, the diameter and material of the the pipe, length of the section, etc.



The current flow will be estimated with the distribution capacity of backflow per inhabitant and with the average number of inhabitants -in the housing case, and it will be given a distribution capacity of backflow for industries and companies according to the bibliography.

The sum of each flow will be done in every section, so that, when estimating the flow that will be discharged into the spillway , the result will only belong to the flow of sewage, that in case of being higher than or near the spillway's design flow it will allow to deduct that the system has spillover its hydraulic head and thus, it will be discharging sewage into the superficial body of water without the expecting diluting.

7. conclusions

This methodology will allow to strengthen the academic work for the Environmental Engineering classes, since it is expected to be carried out an interdisciplinary work between students from Water Supply System and Geographic Information System classes. This work ill prepare them to provide solutions to real problems that are happening in their environment.

The development of this kind of projects, done by students, involves the association of acquired knowledge in lecture rooms for providing solutions to the problem of diagnosing the failures of a spillway that can be discharging non-diluted or no enough diluted sewage to the bodies of water. This problem, is a real fact happening in Bogotá and in the most cities of Colombia.

The use of tools of the Geographic Information System, will permit making an appropriate management of information , achieving the possibility of continuity to this work in other subjects of the degree, such as Lend-use Planning class, because a good planning of the city will avoid new problems of this type in the future.

8. Works Cited

Reglamento Técnico Del Sector De Agua Potable y Saneamiento Básico RAS – 2000 Sección II Titulo, Ministerio de desarrollo económico. Bogotá D.C Noviembre, 2000.

MITCHELL ANDY, 1999. The ESRI guide to Gis analysis. Vol 1 geographic patterns and Relationships. ESRI.