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Sanitary Sewer Detection Using Android Based 3D GIS

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Abstract. Abstract of this paper is to show how geographic technology can enhance the detection and management of Inflow and Infiltration (I/I) into sanitary sewer systems. Inflow and Infiltration into sanitary sewers can mean unnecessary and expensive wastewater treatment costs. Detecting source of I/I and prioritizing their repairs can be most efficiently done using android based 3D GIS. By capturing a spatial attribute and a digital picture for each sanitary sewer defect, one can then streamline defects reports and analyze defects in the system in a way to prioritize those repairs that would have the most impact on reduction of I/I.

Keywords: Inflow, Infiltration, GIS, GPS.

1. Introduction

GIS stands for geographic information system. Geographic information science is new interdisciplinary field. It is built upon knowledge from geography, cartography, computer science, mathematics etc.

GIS can be defined as ' ***A system for capturing , storing, checking, integrating, manipulating, analyzing and displaying data which are spatially referenced to the Earth'***.

In a 2D GIS, a feature or phenomenon is represented as an area of grid cells or as an area within polygon boundary.

A 3D GIS, on the other hand, deals with volumes. Consider a cube. Instead of looking at just its faces, there must also be information about what lies inside the cube.

Sewerage system delivers raw sewage to treatment plants. The plants provide treatment so that either the effluent can be re-used, or disposed of if re-use is not a practical option.

2. Brief Literature Survey

Urban sanitation is a priority issue for cities everywhere. Major deficiencies in the provision of the basic service contribute to environment health problems and the degradation of scarce water resource. The rapid growth of cities and the accompanying concentration of population lead to increasing amount of human wastes that need to managed safely. As population densities in cities increases, the volumes of wastewater generated per household exceed the infiltration capacity of local soils and require greater drainage capacity and the introduction of sewer systems. The mix of problems and the capacity to deal with these sanitation problems varies amongst cities and countries. Below table provides a simple typology of the problems according to the national economic development levels [1].

This urban sanitation problem can be solved by proper sewerage system. The sewerage system delivers raw sewage to treatment plant. The plants provide treatment so that sewage can be re-used, or disposed it. Apart from advantages of sewerage system there is disadvantages also. The sewage overflow is the major one. An overflow causes or has the potential to cause environment or human health harm. There are several reasons which causes sewer overflows --

- Sewer Blockages

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- Pumping Station factors
- Infiltration/Inflow
- System Growth
- System Conditions
- Major Industrial Discharge

Table 1. Problem According to the Natioanl Economic Development Levels

Urban sanitation problems	Lower-income countries (<US$650 per capita)	Lower middle-income countries (US$ 650-2500 per capita)	Upper-middle-income countries (US$ 2500-6500 per capita)	Upper – income countries (> US$ 6500 per capita)
Water pollution issues	Health problems from inadequate sanitation and raw domestic sewage in the streets	Severe health problems from untreated municipal discharge	Severe pollution problems from poorly treated municipal and mixed industrial discharge	Primarily concerned with amenity value and toxic substances.
Wastewater treatment	Virtually no treatment	Few treatment facility; poorly operated	Increasing treatment capacity; operational deficiencies	Generally high treatment levels

The above six problems can be solved by open-channel flow monitors, to monitor and report overflow. Overflow monitors may be connected to telemetry or supervisory control and data acquisition (SCADA) systems to provide alarms back to system operator if required. If the hydraulic behavior of the system is studied over time it may be possible to provide an alarm before an overflow occurs [2].

3. Problem Formulation

Major problem which occur in sewerage system is overflow. Sewage overflows exert physical, chemical and biological effects on the receiving environment. This may result in human health, environmental and aesthetic impacts, which can be both acute and cumulative. Such impacts are dependent on the characteristics of the discharge and receiving environment.

3.1. Potential Human Health Impacts

As sewer overflows may contain raw sewage, they can carry pathogens (disease causing organisms). These include bacteria, viruses, protozoa (parasitic organisms), helminthes (intestinal worms), and inhaled moulds and fungi. Human can be exposed to pathogens through:

- Overflows into drinking water sources,
- Inhalation and skin absorption,
- Direct contact with overflows in public areas such as parks, street, or to swimming waters.

3.2. Potential Environment Impacts – sewer overflows can contain a range of pollutants including:

- Sediment and turbidity
- Nutrients, particularly nitrogen and phosphorus
- Toxicants, including metals, pesticides and other chemicals
- Substances creating a biochemical oxygen demand.

The above two problems can be caused due to inflow of waste water into sanitary sewer system and infiltration of ground water into sanitary sewer system [3].

To solve this above two problems, I have proposed with new system through which we can detect this inflow/infiltration (I/I) problem by using the android based 3D GIS technology. Detecting source of (I/I) and

prioritizing their repairs can be most efficiently done using 3D GIS. By capturing spatial attribute and a digital picture for each sanitary sewer defect, one can then streamline defect reports and analyze defects in the system in a way to prioritize those repairs that would have the most impact on reduction (I/I).

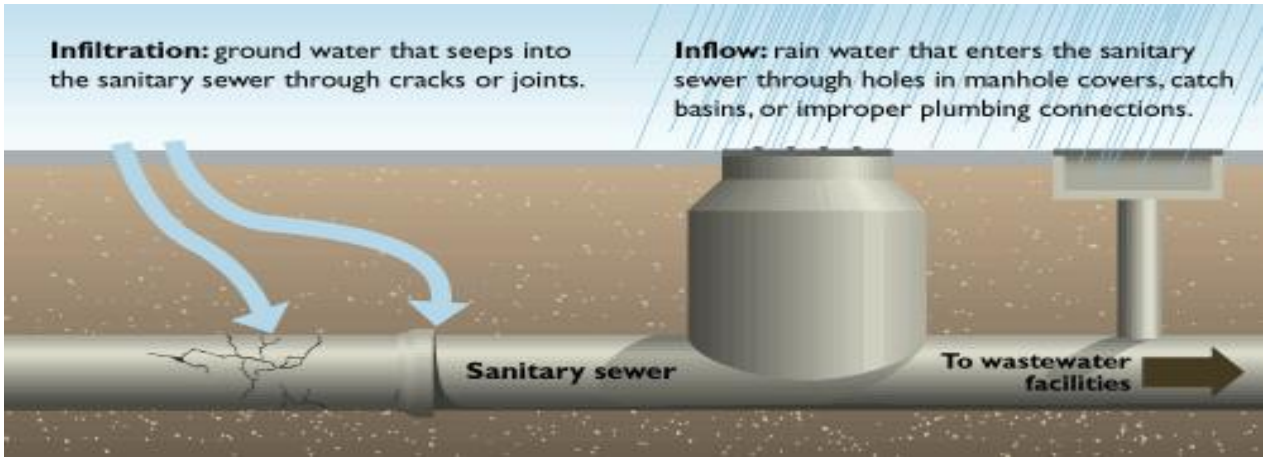

Fig. 1: Inflow and Infiltration

4. Proposed Methodology

For this research, several datasets were required. Data themes including zoning, sewer lines, utility lines, and roads were obtained from city. Sewer pipeline systems can be obtained from city municipal co-operation. After getting the sewer pipelines systems maps, we will combine the 3D GIS and GPS into the system for detecting and evaluating sanitary sewer defects, one may efficiently collect and analyze I/I problems. The technology consists of a 3D GIS application running on an android based tablet or smart phones connected to GPS [4].

Geographic Information Systems are extremely useful for digitally mapping sanitary sewer defects. By locating defects that are spatially referenced to other GIS layers, one make inferences about the cause of the defect, the type of repair, and an assessment of its repair priority and whether it is hazardous to public safety or the environment.

Real-Time mapping using GPS can accurately locate defects and sanitary sewer structures. By using, GPS, field crews may locate defects more accurately to better relate them to a sanitary sewer layer or other layers. It is important that defects be located with relatively high accuracy in order to be able to relate the defects to other features. When locating a clean-out plug that has a leak, it is important to locate it at least within the correct parcel in order for repair crews to easily find it.

5. Expected Outcome Of The Proposed Work

The expected outcome of the proposed work has not yet been fully realized. However, one advantage is the ability to use automated spatial process to analyze defects and one can also visualize more accurately for better repairing the sewerage system. By looking at the 3d map which is obtained from the 3D GIS one can prioritize repairs for a given drainage area. Also, by generating statistics across all drainage areas, one can prioritize drainage areas according the estimate amount of infiltration and inflow into the system.

6. Conclusion

Android based 3D GIS and GPS technology can help to reduce unnecessary flow to wastewater treatment plants and thus reduce cost for operating these facilities or reduce cost of fees for discharging to the facility. Also, by approaching the method of prioritizing analysis using 3D GIS, one can assign repair crews to those leaks that most impact the reduction of infiltration and inflow into the system. One may collect and analyze defects in sanitary sewer systems more efficiently and in ways lead to better solutions for repair and maintenance of these systems. I have also concluded that as it will be made in smart phone and tablet it will be very portable to use [5].

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