Optimal Design of Sanitary and Storm Sewer Networks Using Evolutionary Algorithms

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Introduction

Biggest cities around the world are equiped with sanitary and storm sewer systems and according to *Samba Bousso et al.* (2013) Those systems are built to rapidely drain storm water and to avoid inundations to cities, some of those systems have been built since years. One of the problems faced by some cities of developped countries and developping countries is the one of inundations.

To fight effectively against flooding, it is imperative to design optimal sanitary and storm sewer networks that adapt to changes that may occur and also provide the rehabilitation of old and defective systems.

Evolutionary Algorithms will be use in this work to reduce the costs of constructions of sanitary or storm sewer networks and minimize inundations.

State of Art

To optimize the design of the hydraulic parameters of sanitary and storm sewer networks (the diameters of different pipes and slopes, Speeds and reverse elevations), there are differents optimization methods that have been employed in previous interesting studies :

The first study in the literature according to *Diogo Freire et al.* (2000) was realised by *Argaman et al.* (1973), they used Dynamic Programming for Layout generation and hydraulic design of storm sewer network, *Li and Matthew* (1990) have developed a method combining directional search for layout genaration and Discrete Differential Dynamic Programming (DDDP) to optimize the design of the hydraulic characteristics of each pipe.

Dorigo et al. (1996) proposed the Ant Algorithm as a new evolutionary optimization method for the solution of discrete combinatorial optimization problems.

A Genetic Algorithm combined with a Quadratic Programming (GA-QP) which is an hybrid method has been developed by *Tze-Chin Pan and Jehng-Jung Kao* (2009) to optimize a sewer design.*Y. F. Guo et al* (2007) introduced an innovative sewer design approach base on Cellular Automata principle, *Joaquín Izquierdo et al.* (2008) used a Particle Swarm Optimization (PSO) technique for the optimal design of wastewater collection of network, their algorithm has been adapted to work similtaneously with continuous variables and discrete variable as requiered by the problem considered.

Methods

In this work, we are going to use evolutionary algorithms to optimize the design of sanitary or storm sewer networks. The main objective of the study is to reduce construction costs and minimize inudations :

- The first step is to build a Genetic Algorithm to optimize a benchmark problem.
- In the second step, we have planned to use a Particle Swarm Optimization (PSO) algorithm to optimize a benchmark problem.
- During the third step a Simulated Anealing algorithm will be implement to optimize the design of a benchmark storm sewer network.
- The last step will consist in choose a benchmark network, generate some usuals problems that occur in sanitary or storm sewer network with time, and try to rehabilitate the network with the 3 previous methods and compare the obtained results.

The Flow Chart Global of an Evolutive Algorithm applied to sanitary or storm sewer network is presented on the Figure 1.

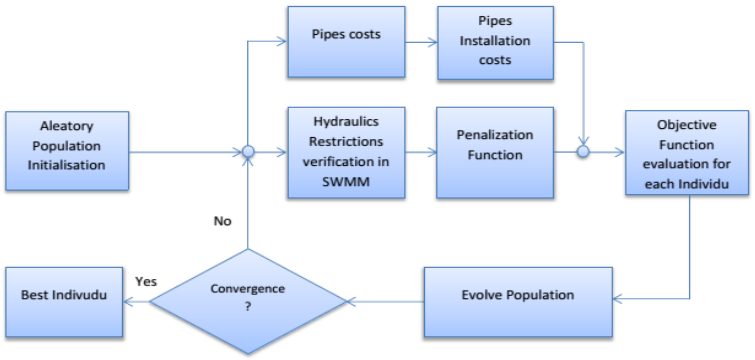

Figure 1: Global Evolutionary Algorithm for sanitary and storm sewer Networks

Conclusion

To optimize the design of sanitary and storm sewer networks, various optimization methods have been used. Genetic Algorithms have shown good results. We have obtained minimized costs for the construction of some storm sewer networks under a set of constraints allowing us to minimize inundations.

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