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Multi-criteria Global Evolutionary Optimisation Approach to Rehabilitation of Urban Drainage Systems

Z. Vojinovic and D.P. Solomatine

(1) UNESCO-IHE, Institute for Water Education, P.O.Box 3015, 2601 DA Delft, The Netherlands ({z.vojinovic, d.solomatine}@unesco-ihe.org / Phone: +31-15-2151715)

Urban drainage systems constitute a very significant portion of all assets in urban areas. Their structural integrity and functional efficiency represent key parameters for the safe transfer and disposal of surface run-off and domestic/trade discharges. The failure of these assets, which could be caused by various factors such as ageing, structural collapses, inflow/infiltration, exfiltration (leaking) and insufficient capacity due to increased urbanisation, may easily result in uncontrollable discharges and surface flooding, pollution of receiving waters, pollution of ground water and soil, treatment plant impacts and increasing maintenance costs. Therefore, the sustainability of such assets, which frequently, if not continuously, interact with other components of urban water cycle (i.e., water supply, groundwater and receiving waters), is therefore an important issue for urban drainage system managers. Furthermore, the frequency of high intensity rainfall seems to increase in many regions and climatologists predict climate changes that will increase the problem even further. The lack of an appropriate methodology for remedial works identification may result in expenditure programmes not achieving their given objectives, and therefore, the optimisation of rehabilitation works is of utmost importance. With the reference to the work published to date, the practitioner's attention to the use of full-fledge multi-criteria global evolutionary optimisation techniques in the dynamic context of urban drainage systems is found to be very limited.

A platform that links the hydrodynamic model of a drainage system with the multi-criteria global evolutionary optimisation engine that takes into account the performance indicators relevant for rehabilitation decisions (including various constraints such as, treatment plant capacity, environmental impacts, socio-economic and environmental risks, etc.) related to the system's operation is being developed. The following

steps are used in finding the optimal alternative of rehabilitation works requirements:

1. Initial simulation of the existing drainage network.
2. Performance evaluation against given standards (constraints).
3. Penalty cost calculation for each violated constraint.
4. Calculation of the total rehabilitation cost.
5. Identification of the new drainage network set up.
6. Simulation of the new drainage network; *Goto Step 2*.

The above steps are applied within the loop where the most optimal alternative is sought among a large number of alternatives. Such procedure can be formulated in a multi-criteria context as well. The advantage of this approach over the standard industry applied approaches (which are often limited to the use of a linear optimization scheme or a non-hydrodynamic computation) is that it solves the problem within the entire catchment with the use of sophisticated optimisation techniques and takes into account the dynamic nature of drainage systems during the process of identifying the least cost rehabilitation option.