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Statistically based sustainable re-design of stormwater overflow control systems in urban catchments

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Control and reduction of pollution from stormwater overflow is a major concern for municipalities to manage the quality of the receiving water bodies according to the Framework Water Directive 2000/60/CE. In this regard, assessment studies of the potential pollution load from sewer networks recognize the need for adaptation and upgrade of existing drainage systems, which can be achieved with either traditional water works (detention tanks, increase of wastewater treatment plant capacity, etc.) or even Nature-based solutions (constructed wetlands, restored floodplains, etc.) sometimes used in combination. Nature-based solutions are recently receiving consistent attentions as they are able to enhance urban and degraded environments being, in the same time, more resilient and adaptable to climatic and anthropic changes than most traditional engineering works. On the other hand, restoration of the urban environment using natural absorbing surfaces requires diffuse interventions, high costs and a considerable amount of time.
In this work we investigate how simple, economically-sustainable and quick solutions to the problem at hand can be addressed by changes in the management rules when pumping stations play a role in sewer systems. In particular, we provide a statistically-based framework to be used in the calibration of the management rules, facing improved quality of overflows from sewer systems.
Typical pumping rules favor a massive delivery of stormwater volumes to the wastewater treatment plans, requiring large storage tanks in the sewer network, heavy pumping power and reducing the efficiency of the treatment plant due to pollutant dilution. In this study we show that it is possible to optimize the pumping rule in order to reduce pumped volumes to the plant (thus saving energy), while simultaneously keeping high pollutant concentration. On the other hand, larger low-concentration overflow volumes are released outside the sewer network with respect to the standard pumping rules. Such released volumes could be efficiently processed by nature-based solutions, like for instance constructed wetlands, to reduce the final pollutant impact on the environment.
The proposed procedure is based on the previous knowledge of the precipitation forcing and of a quantity/quality model of the sewer network. The method provides marginal and joint probability distributions of water volumes and pollutant concentration (or mass) delivered toward the wastewater treatment plant and the Nature-based system, with the aim of supporting a more efficient design of the whole sewer system. A practical example of application is provided for illustrative purposes.