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Stormwater tanks and shock probability in receiving bodies

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Stormwater tanks are still an increasing need for urban drainage systems. In fact it is has been well recognized from literature and - with years - through the practical applications, that they are essential to control both floods and pollution.

In particular about the environmental protection of the receiving bodies, it has been demonstrated that most of the pollutant mass discharged by both combined and separated sewer overflows during a year are very often concentrated within a few dozen days, due especially to short and heavy rainfalls (Paoletti and Sanfilippo, 2004). This happens, in few words, because such rainfalls wash off, without a relevant dilution, the pollutants built up on the catchment surfaces in the antecedent dry weather periods. Moreover, a scarce dilution of the urban waste waters affects the receiving bodies downstream combined sewer overflows especially during right the same kind of rainfall events.

Indeed, many stormwater tanks are designed specifically just to control pollution (Mourad et al., 2005; Zukovs and Marsalek, 2005), and capacities of 25œ75 m^3 per contributing hectare are, by now, an acknowledged optimal range to this aim (Artina et al., 2002).

In general, a probabilistic approach can be used to design stormwater tanks, relating the required capacity to the expected probability (or, that is the same, to the corresponding return period) of their failure in terms of volume threshold exceeding. Exponential probability functions are usually adopted to implement such kind of approach (Adams and Papa, 2000; Bacchi et al., 2005).

Nevertheless, the proposed paper remarks that a second and a third quite different

topics are very important and must be analysed over a long period of time (namely, a year). They are the total number of spills and the total cumulative volume of polluted urban waters temporarily stored in first flush stormwater tanks and then delivered to a treatment plan instead of directly to the receiving body. Both of them are random variable too, as they depend not only on the given storage capacity but also on the random patterns of the series of the rainfall events. According to the modern concept of intermitent standard (Foundation for Water Research, 1994; Artina and Maglionico, 2001), the proposed paper shows how to take into account also a fourth aspect, that is the risk of environmental shock in the receiving body. The basic idea is that such a risk can be estimated as the probability of exceeding a given threshold for the antecedent dry weather period multiplied by the probability of exceeding a given threshold for the mean intensity of the rainfall event and multiplied also by the probability of exceeding a given threshold for duration of the rainfall event.

But other authors (Ciaponi et al., 2005) have already remarked that it is not correct to develop any statistical analysis just considering each event as standing alone, because of the relevance of the operational procedures adopted to empty the storage tanks.

Therefore the paper investigates also how the above mentioned probability functions can be influenced by both the definition of minimum inter-event-time and the choice of emptying or not emptying a first flush stormwater tank when not completely filled at the end of an event.

Just for example, those analyses have been carried out on a real rainfall series of 21 years recorded in Milan, considering a single tank with a fully impervious catchment upstream.

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