tion IV and V of the channel. Therefore, the system can be simultaneously designed to pursue flood risk reduction (abatement of flow peak) and improvement of receiving water quality objective; iii) the use of already existing grey, green and blue infrastructures allowed to reduce the space needed for CSOs storages from 1 ha in the current status to about 0.3 ha (sum of CW and FFT areas, the latter supposing a tank of 2 m height); iv) the overall cost for the construction of the integrated system is estimated to range from about 30 to 50% less than the traditional alternative solution of constructing of a larger CSO detention tank only. Nevertheless, further economic analysis need to be performed in order to evaluate the maintenance costs of each component.

Each component of the proposed system has some peculiarities. For example, CW performs a dual function, *i.e.* on one hand it cuts the peak of flow thanks to its storage capacity, while on the other hand it reduces the volume thanks to its infiltration capacity. These features are most important especially in the context of *hydraulic-hydrologic* invariance measures (that are becoming more and more present at local scale in Italy and elsewhere) (Masi *et al.*, 2017) where the reduction of peak discharge has necessarily to be accompanied by a reduction of volumes. Further improvements can be obtained through the control of flow in the RWB aimed to maintaining a correct ratio between upstream accumulation and downstream flow according to: i) the variability of flow in input to the RWB; and ii) the downstream channel hydraulic capacity. Improved flow control could be achieved by installing smart gates that operate automatically based on flow sensors and software-based actuators. Finally, the additional ecosystem services that can be provided by the green components of the system combined with the relatively low-cost of the interventions make the approach particularly attractive for small municipalities where large investments are seldom possible.

Therefore, results show the potential of exploiting natural systems and their self-depuration capacities in CSOs management, controlling both water and pollution loads by combining flow controls and storage mechanisms. Moreover, the adoption of a simplified mathematical model supported by LiDAR data analysis appears very useful in the design phase of the integrated system, allowing the exploration of the performances of each component in terms of remediation and flow control.

References

Ahiablame L.M., Engel B.A., Chaubey I. 2012. Effectiveness of low impact development practices: literature review and suggestions for future research. Water Air Soil Pollut. 223:4253-73.

Barco J., Papiri S., Stenstrom M.K. 2008. First flush in a combined sewer system. Chemosphere 71:827-33.

Becciu G., Paoletti A. 2009. Fondamenti di costruzioni idrauliche. UTET, Milano, Italy.

Brzezińska A., Zawilski M., Sakson G. 2016. Assessment of pollutant load emission from combined sewer overflows based on the online monitoring. Environ. Monitor. Assess. 188:502.

Carbone M., Garofalo G., Piro P. 2014. Decentralized real time control in combined sewer system by using smart objects. Procedia Engine. 89:473-8.

Cazorzi F., Fontana G.D., Luca A.D., Sofia G., Tarolli P. 2013. Drainage network detection and assessment of network storage capacity in agrarian landscape. Hydrol. Process. 27:541-53.

Dietz M.E. 2007. Low impact development practices: A review of current research and recommendations for future directions. Water Air Soil Pollut. 186:351-63.

Fletcher T.D., Shuster W., Hunt W.F., Ashley R., Butler D., Arthur S., Trowsdale S., Barraud S., Semadeni-Davies A., Bertrand-Krajewski J.-L., Mikkelsen P.S., Rivard G., Uhl M., Dagenais D., Viklander M. 2014. SUDS, LID, BMPs, WSUD and more - The evolution and application of terminology surrounding urban drainage. Urban Water J. 12:525-42.

Freni G., Maglionico M., Mannina G., Viviani G. 2008. Comparison between a detailed and a simplified integrated model for the assessment of urban drainage environmental impact on an ephemeral river. Urban Water J. 5:87-96.

Fry T.J., Maxwell R. 2017. Evaluation of distributed BMPs in an urban watershed-high resolution modelling for stormwater management. Hydrol. Process. [In press].

Huber W.C., Dickinson R.E., 1988. Storm water management model user's manual, version 4, EPA/600/3-88/001a (NTIS PB88- 236641/AS). Environmental Protection Agency, Athens, GA, USA.

Lavrnić S., Bregoli I., Anconelli S., Blasioli S., Solimando D., Mannina G., Toscano A. 2018. Long-term monitoring of a surface flow constructed wetland treating agricultural drainage water in Northern Italy. Water 10:644.

Lapointe J.V., Noe G.B., Jarnagin S.T., Hogan D.M., 2014. Effects of distributed and centralised stormwater best management practices and land cover on urban stream hydrology at the catchment scale. J. Hydrol. 519:2584-95.

Masi F., Rizzo A., Bresciani R., Conte G. 2017. Constructed wetlands for combined sewer overflow treatment: ecosystem services at Gorla Maggiore, Italy. Ecol. Engine. 98:427-38.

Piro P., Carbone M., Garofalo G., Sansalone J.J. 2010. Management of combined sewer overflows based on observations from the urbanised Liguori catchment of Cosenza, Italy. Water Sci. Technol. 61:135-43.

Suarez J., Puertas J. 2005. Determination of COD, BOD, and suspended solids loads during combined sewer overflow (CSO) events in some combined catchments in Spain. Ecol. Engine. 24:199-217.

Todeschini S. 2012. Trends in long daily rainfall series of Lombardia (northern Italy) affecting urban stormwater control. Int. J. Climatol. 32:900-19.

Toscano A., Marzo A., Milani M., Cirelli G.L., Barbagallo S. 2015. Comparison of removal efficiencies in Mediterranean pilot constructed wetlands vegetated with different plant species. Ecol. Engine. 75:155-60.

U.S. EPA. 2008. Combined sewer overflows: demographics (5.7.14.). Available from: http://cfpub.epa.gov /npdes/ cso/demo.cfm

Utilitalia. 2017. Blue Book. I dati sul servizio idrico integrato in Italia. Fondazione Utilitatis, Roma, Italy. Available from: https://www.utilitatis.org/my-product/blue-book/

Weyand M. 2002. Real-time control in combined sewer systems in Germany - some case studies. Urban Water 4:347-54.