Bulletin UASVM Horticulture, 69(2)/2012
Print ISSN 1843-5254; Electronic ISSN 1843-5394

Outdoor Experimental Mesocosm Construction for the Evaluation of Bioretention in Cluj-Napoca Condition

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Abstract. This paper presents field experimental setting represented by three mesocosms for bioretention cells performance research in pedoclimatic conditions offered by the urban environment of Cluj-Napoca. A mesocosm is an experimental tool, which allows investigation of a small part of the natural environment, under controlled conditions. In this way mesocosms provide a link between observational field studies that take place in natural environments and controlled laboratory experiments that may take place under somewhat unnatural conditions. To obtain effective bioretention mesocosms in early stages of setting up were used software designs, numerical and hydrological modelling. Mesocosm model was built on schemes obtained from modeling and design. The results purpose is to familiarize the different social groups in Romania with these sustainable drainage systems with environmental low impact.

Keywords: bioretention, experimental, low impact, mesocosm, model

Introduction. A mesocosm is an experimental tool, which allows investigation of a small part of the natural environment, in controlled conditions. Bioretention systems are designed to facilitate physical, chemical and biological processes that occur, usually in natural terrestrial ecosystems. Sedimentation, adsorption, filtration, volatilization, ion exchange, decomposition, phytoremediation and bioremediation, represents a part of the natural processes that contribute to water quality improvement in an bio retention system (Davis *et al.,* 2001; Prince George's County, 2007). Roy *et al.* (2008) have identified impediments in large scale implementation of sustainable practices in different watersheds. These impediments including: uncertainties related to performance and cost, insufficient standards and technical regulations; institutional and legislative gaps; insufficient funding and effective market incentives (Roy *et al*. 2008). Roy-Poirier *et al*. (2010) revealed some additional challenges in large scale implementation of bioretention systems: difficulties in obtaining permit from regulatory bodies, promoting public appropriation and educating owners regarding the bioretention system maintenance. Solutions to these challenges related to implementation would help facilitate the use of bioretention systems as self-governing rainwater management practices (Roy-Poirier *et al.* 2010).

Aims and objectives. In order to determine construction solutions, to streamline the management processes of runoff, implementation etc. the experiments conducted by various scientists, included the construction of mesocosms intended to provide concrete answers and relevant resolutions of the impediments arising from implementation of bioretention systems in different parts of the world. This paper presents field experimental setting represented by a small scale bioretention systems, referred as mesocosms (Henderson *et al.* 2007; Lucas and Greenway, 2008; Lucas and Greenway, 2010; Randall, 2011) or microcosm (Hunt, III, 2003) in previous investigations. This experimental field is intended for bioretention cells performance research in climatic conditions offered by the urban environment of Cluj-Napoca. The objectives of this work are: obtain effective bioretention mesocosms for hydraulic efficiency, retention and purification of rainwater study.

Materials and methods. To obtain the mesocosms were used (in early stages of setting up) design, numerical and hydrological modeling software. Election of construction materials has been carried after specialized scientific literature study. In previous studies that have used mesocosms in the carried experiments, for their construction were used various materials: plastic barrels (Randall, 2011); metal garbage dumpsters (Ming-Han Li *et al*., 2010); PVC (Hunt, III, 2003); plastic boxes (Muthanna, 2007) or wood, together with other auxiliary materials (waterproof foils, plastic or metal pipes, etc.).

Results and Discussion. Mesocosm model has been built based on schemes derived from modeling and design process. The outdoor experimental mesocosms are preferred in bioretention systems water quality and hydraulic performance assessment due to the low cost systems and space necessary for setting up the experiment (compared to a pilot bioretention system, scale 1:1). Experiments carried with these experimental bioretention cells focuses on the bioretention efficiency evaluation in terms of hydraulic effectiveness, retention and purification of rainwater runoff. Results are intended, in particular, to familiarize various social categories from Romania with these sustainable drainage systems.

Conclusion. The scientific literature study and use of preliminary steps (design, hydrological and numerical modeling) in the mesocosm construction allows the establishment of an experimental field suitable to pursue investigations intended to outlining bioretention system effective implementation regulations and patterns in Cluj-Napoca.

REFERENCES

1. Davis, A.P., M. Shokouhian, H. Sharma and C. Minami (2001). Laboratory study of biological retention for urban stormwater management. Water Environ. Res. 73:5-14.
2. Henderson, C., M. Greenway and I. Phillips (2007). Removal of dissolved nitrogen, phosphorous and carbon from stormwater by biofiltration mesocosms. Water Sci. Technol. 55(4):183-191.
3. Hunt, W.F. III (2003). Pollutant Removal Evaluation and Hydraulic Characterization for Bioretention Stormwater Treatment Devices. The Pennsylvania State University, PhD Abstr.
4. Lucas, W.C. and M. Greenway (2008). Nutrient retention in vegetated and nonvegetated bioretention mesocosms. J. Irrig. Drain. Eng. 134(5):613-623.
5. Lucas, W.C. and M. Greenway (2010). Phosphorus Retention by Bioretention Mesocosms Using Media Formulated for Phosphorus Sorption: Response to Accelerated Loads. J. Irrig. Drain. Eng.
6. Li MH., CY. Sung, MH. Kim and KH. Chu (2010). Bioretention for Stormwater Quality. Improvement in Texas: Pilot Experiments, Technical Report.
7. Muthanna, T.M. (2007). Bioretention as a Sustainable Stormwater Management Option in Cold Climates. Norwegian University of Science and Technology Faculty of Engineering Science and Technology Department of Hydraulic and Environmental Engineering, PhD Abstr.
8. Prince George's County (2007). The Bioretention Manual. Dept. of Environmental Resources, Prince George's County, MD, USA.
9. Randall, M. (2011). Bioretention Gardens for the Removal of Nitrogen and Phosphorous from Urban Runoff. Master of Applied Science Thesis. The Faculty of Graduate Studies of The University of Guelph.
10. Roy, A.H., S.J. Wenger, T.D. Fletcher, C.J. Walsh, A.R. Ladson, W.D. Shuster, H.W. Thurston and R.R. Brown (2008). Impediments and solutions to sustainable, watershed-scale urban stormwater management: lessons from Australia and the United States. Environ. Manage. 42(2):344-359.
11. Roy-Poirier, A., P. Champagne and Y. Filion (2010). Review of Bioretention System Research and Design: Past, Present, and Future. J. Environ. Eng. Asce. 136(9):878-889.