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STORMWATER MANAGEMENT BASED ON RESILIENT URBAN DRAINAGE STRATEGIES

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Urban stormwater has adverse impacts on the performance of urban infrastructures and the life of residents (Karamouz et al. 2011) causing extreme damages and disorder in the serviceability of urban infrastructures as well as transportation. Therefore, it is necessary to provide efficient management practices that can be resilient in stormwater events. Strategies applied for mitigating the impact of urbanization comprise the use of LID–BMPs for urban stormwater runoff quality and quantity control (Jia et al. 2011).

Many investigators have applied LID- BMPs in their case studies to mitigate stormwater adverse impacts. The most applied objectives considered have been the volume and the peak flow rate reductions as well as pollutant loads (Jia et al. 2011; etc). However, BMP selection and placement on site or watershed are still challenging for urban managers and planners; Therefore, some research have been conducted to facilitate BMP selection. Martin et al. (2006) performed an institutional analysis in France using Multi Criteria Analysis (MCA) approach to rank BMPs. Young etal. (2011) developed an Analytical Hierarchy Process (AHP) based algorithm to rank BMPs on a given site and introduced a tool (VT BMP DSS) for selecting BMPs.

Although these investigations are adequate for decision making at preliminary stormwater planning stages where stakeholders' preferences in a subjective manner are important, it seems that use of qualitative decision making alone cannot be enough in terms of efficient urban drainage systems. The reasons may be attributed to implementation problems and dependency of adopted criteria on local situations. To handle these problems, a comprehensive MCDM tool, "Definite Software", has been used in this research with an ability to use both qualitative and quantitative criteria to prioritize BMPs scenarios.

Furthermore, in spite of striking developments in urban drainage facilities, frequent urban flood events occur throughout the world where urban drainage systems cannot cope with rainfalls greater than the urban drainage system design rainfall implying no absolute protection against uncertainties such as extreme rainfalls or even land use developments are warranted. It has therefore been the aim of this research to introduce the concept of "resilience" for stormwater management systems. A resilience index has been introduced as the "Recovery Capacity" (Yazdandoost and Bozorgy 2008) and has been applied for BMPs scenarios prioritization. This index depends on physical, social and economical factors determined by a local survey. In this research, the physical/technical characteristics of the system have been considered.

Abovementioned concepts have been applied for the 22nd municipal district of Tehran (Iran). To realize preliminary BMP Selection, prioritization has been performed using VT BMP DSS based on predefined criteria utilized in this software (Table 1). Closer examination of the results

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indicated that the higher ranking BMP obtained by VT BMP DSS cannot be used in this case due to implementation problems such as space restriction, land price criteria, urban flood management standards and criteria, discrepancies in regional climate and so on. Therefore, another methodology should be used by which user can add supplementary criteria depending on specific case study situations. Definite Software has been selected for ranking BMP scenarios and BMPs have been re-ranked using the same criteria defined in VT BMP DSS and new criteria and weights. As illustrated in Table 1, when Definite is used, some of BMPs ranks have changed due to changing criteria weights. The effect of the introduced index, "Recovery Capacity" has been further investigated alongside other criteria.

In conclusion, the need for resilient approaches in dealing with urban stormwater management to compromise for uncertainties has been illustrated. Selection of appropriate criteria is instrumental in adaptation of integrity of the system. Definite Software has shown suitability of performance in BMP scenarios ranking in that it facilitates weighting and provides a flexible situation to add as many desirable quantitative and qualitative criteria such as technical, socioeconomical, environmental as well as resilience criteria.

Table 1 Comparison of BMP prioritization between "VT BMP DSS" and "Definite"

tools	BMP/ Rank*													
	RH	VR	RB	SF	BB	IB	PP	DDBE	MPB	CW	IT	DDB	VS	VFS
BMPDSS	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Definite	1	2	5	3	4	7	6	9	8	10	11	13	14	12

* RH: Rainwater Harvesting; VR: Vegetated Roof; RB: Retention Basin; SF: Sand Filter; BB: Bioretention Basin; IB: Infiltration Basin; PP: Porous Pavement; DDBE: Dry Detention Basin Enhanced; MPB: Manufactured/Proprietary BMP; CW: Constructed Wetland; IT: Infiltration Trench; DDB: Dry Detention Basin; VS: Vegetated water quality Swale; VFS: Vegetated Filter Strips

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