Comprehensive Review on Various Smart Methods for Stormwater Management System

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ABSTRACT

In India, currently the smart city projects become a most important part of the growth for the nation, and many cities are participating in it. In smart cities, the smartness of urban infrastructures also plays an important role. For that, the smart management of Stormwater drainage system is also essential. Thus it becomes necessary for the planner to give smart proposals and tools for that and give their great views to their city for becoming smart. Here literature carried out to understand the creative ideas for the Stormwater drainage system and its management.

KEY WORDS: ***Smart City; Stormwater Drainage System; StormCAD; Surface runoff; Low Impact Development; Best Management Practices.***

INTRODUCTION

Water which originates throughout precipitation events and snow/ice melts is known as Stormwater. Stormwater can soak into the soil (infiltrate), be held on the surface and evaporate, or runoff and end up in nearby streams, rivers, or other water bodies (surface water). Stormwater runoff is water from rain or melting snow that "runs off" across the land instead of seeping into the ground. This runoff is the nation's number one source of water pollution. Polluted runoff happens anywhere. For example, in developed areas, none of the water that falls on hard surfaces like roofs, parking lots or roads can bleed into the ground soil. These impervious surfaces create large amounts of runoff which carries out specks of dirt and makes the water polluted. The runoff flows from storm drains to streams. Runoff not only pollutes but erodes stream banks. This type of runoff and eroded dirt muddies the water and causes problems in the downstream.

Many countries are adopting and exploring smart growth strategies to reach environmental, community, and economic goals. The environmental goals consider the benefits of water that accrue when development plans use compact development forms, a mix of uses, proper use of existing infrastructure, and preservation of critical environmental areas. While the quality of water and benefits of Stormwater for smart growth is broadly recognized, there has been clear-cut regulatory recognition of these benefits to date.

In India, currently the smart city projects become a most important part of the growth for the nation, and many cities are participating in it. Smart Stormwater drainage system and its management are one of the most important aspects of the smart cities, which means to manage the surface runoff and other problems related to storm drainage network by using smart components, tools, and ideas in a system. By using smart technological tools, i.e. StormCAD,

CivilCAD, SewerGEMS, the existing Stormwater management system can be examined quickly, and problems are also resolved easily. These tools are also very convenient, accurate and less time consuming for the design of the network. Thus by applying such smart ideas and techniques, one can make the city smart in the way of urban infrastructure.

CRITICAL LITERATURE REVIEW

A literature review is a judgmental report of studies found in the literature related to the selected area. Here the reviews of the literature of books, research papers, reports and websites which related to the Stormwater drainage network and management are critically explained.

Romnée, Ambroise, Arnaud Evrard, and Sophie Trachte (2016) prepared the methodology for the design of urban watershed. They adopted the five steps in practice: 1.Indicator Analysis 2.Stakes and Strategies 3.Spatial typologies 4.Scenarios of decentralized management 5. Projects of decentralized management and gave the result that the application of the methodology to an entire watershed may lead the enhancement of the urban planning regulations and conventions for a decentralized approach to Stormwater management. (Romnée, 2016).

Gould, Stephanie et. al. (2016) developed used the StormCAD model in Fairbanks Alaska. They observed the correlation between the different types of metals present in Stormwater which were chosen for the detailed study i.e. lead, copper and zinc. (Gould, 2016).

Salvan, Leslie et. al. (2016) presented a detailed modeling approach at district scale and also an optimized Mediterranean city (France) scale runoff modeling and management. The study showed that the surface features were included in the topography and therefore hundred percent impermeable which was not an entirely satisfying statement. (Salvan, 2016)

Sun, Yu, Susanna Tong, and Y Jeffrey Yang (2016), with the helped of SUSTAIN: GIS-based modeling & decision support system they resolved the utility of Best Management Practices in justifying Stormwater runoff by the Duck Creek watershed at the Las Vegas Valley. They studied that an addition of one detention BMP and one infiltration BMP to the existing BMPs seemed to be the most appropriate choice to mitigate the hydrologic impacts induced by future climate and land-use changes. (Sun, 2016).

Bhadiyadra, Kishan J et. al. (2015) examined the performance of current Stormwater drainage system & the conditions that lead flooding problem at some low lying critical areas of Surat city. For that, they conducted Simple quantitative approach and some questionnaire survey and gave some appropriate solutions of current problem i.e. underground pipe network as temporary storage, Groundwater recharge well and hydraulic ram pump. (Bhadiyadra, 2015).

Gouri, R.l., & V.v.srinivas (2015) evaluated the performance of an existing Stormwater drain network in Bangalore, through reliability analysis by Advance First Order Second Moment (AFOSM) method and concluded three failure modes by AFOSM method. Failure mode 1: related to discharge carrying capacity of a conduit, the other two failure modes: related to permissible maximum flow velocity and desirable minimum flow velocity. The reliability values were low under the three failure modes and here was a necessity to redesign some of the conduits to improve their consistency. (Gouri, 2015).

De Paola, Francesco et al. (2015) minimized the total cost while preserving the system performance against the modification in the hydrological regime assessed through the disaggregation methodology. They used Harmony Search for optimal design of sewer systems and Disaggregation method for rainfall data and climate change prediction.

Needhidasan, S., and Manoj Nallanathel (2013) Designed the new Stormwater drains by the rational method and made some changes in the sections of the drains in the existing network in Calicut City (Kerala). They found out all the elements of the balanced formula.
(Needhidasan, 2013).

Welker, an L et. al. (2013) tried to give some monitoring plan for Stormwater control measures in Philadelphia region. They examined the efficiency of structural, nonproprietary Stormwater Control Measures and gave three tire monitoring plans in the system. (Welker, 2013).

Chahar, Bhagu R, Didier Graillot, and Shishir managed Stormwater through infiltration trenches by modified rational method and MATLAB programming. They concluded that Infiltration controls the quality and quantity of Stormwater from small catchments and proper shape of the infiltration trench is essential for its estimation and maintenance problems. (Chahar, 2012).

Young, Kevin D et. al. (2011) discussed a mathematically based approach to BMP selection, which applies the analytic hierarchy process (AHP) decision. They examined that there was a need instantaneously satisfy potentially clashing criteria may yield results that do not fully content each test individually. So, the BMP rankings managed by hiring the AHP must be critically analyzed. (Young, 2011).

Pazwash, Hormoz, and Inc Ebrary (2011) reviewed that as one study the past flows one can prepare for the future inundations by applying prior techniques to manage the runoff (Pazwash H. a., 2011).

Bentley (2011) studied the problem of flooding in heavy rain season and also ensured proper drainage of the Dronagiri area (Navi Mumbai) by building a Stormwater network model in Dronagiri with the help of CivilStorm and Dutch method. (Bentley, Analyzing complex StormWater systems with holding ponds below high tide levels in an archipelago of Navi Mumbai, 2011).

Freni, G Mannina, and G Viviani (2010) presented the comparison of different mitigation measures on modeling investigations and used modeling to assess the effects of the different urban drainage techniques in the Parco d'Orleans urban catchment; Italy. They used urban drainage model,

Infiltration BMP model, and Centralized storage tank model in their study. (Freni, 2010).

LeFevre, Nancy-Jeanne Bachmann et. al. (2010) studied that study site required to establish the long-term stability of sensors and to observe runoff trends suggested by the data over a wide range of storm events in Gainesville, VA., to circumscribing building Ghana. They also designed and tested an interconnected system of undertrained LID component. (LeFevre, 2010).

Balascio, Carmine C., and William C. Lucas (2009) carried out the survey and provided an overview and analysis of the current water quality regulations in four Mid-Atlantic States (Delaware, Maryland, New Jersey, and Pennsylvania).They concluded that the New Jersey & Pennsylvania's law: precise verification of removal rates, Maryland: not require accurate verification, Delaware: capacity to calculate TSS removal but verification is not needed. (Balascio, 2009).

James P. Heaney and John J. Sansalone (2009) illustrated what the Urban Stormwater field could look like in the year 2050. They studied Stormwater management tools and techniques and different type of literature related future Stormwater systems. Concluded that the key expected drivers cost of providing water and energy and technological advances. (Sansalone, 2009).

***Faust, Kasey M, and Dulcy M Abraham (2009*)** evaluated the impact of the generated runoff due to decommissioning impervious surfaces, transitioning land uses and incorporating bio-retention cells at the neighborhood level in vacant lots in Sahel, Africa. They did it with Stormwater management models and examined that an approach for quantifying the impact of retooling alternatives on the generated runoff. (Faust, 2009).

Bentley (2009) Provided Proper sizing of six infiltration basins without impacting the race track in New Jersey with the help of different types of Stormwater models, i.e., StormCAD, Pond pack, HEC-RAS, Flow master. In this study, Bentley products were chosen for the design of this project because of their ability to perform repetitions of a multitude of controls with greater ease and speed than entrants' software. (Bentley, Bentley's Stormwater Modeling Helps Paulus, Sokolowski, & Sartor, LLC Design Thunderbolt Raceway Motorsports Park's Stormwater Systems, 2009).

Schreier, Hans, and Jiri Marsalek (2008) Suggested Innovative ideas in the different stage of Stormwater Management System in Canada and examined what advances have been made in all aspect of Stormwater management with an Experimental anthropological approach. (Schreier, 2008).

***Franti and D P Shelton* (*2006*)** developed a runoff simulator water output control device with a simple, cost-efficient and adaptable design to produce repeatable hydrographs with different shapes. They used HEC2 & MUSLE: to establish realistic design constraints for simulator and concluded that Device was built based on the gravity controlled flow design. (Franti, 2006).

Bentley (2006) gave the brief introduction about StormCAD and its Features. (Bentley, Storm sewer design, and modeling, 2006).

Orlins, J. et. al. (2005) prepared a Regional Stormwater management plan for Managing Watersheds for Human and Natural Impacts in New Jersey. They observed that, RSWP: significant tool for managing quality & quantity of water in watershed.-RSWPPs required diversion team of experts.-RSWMPs can provide solutions& management strategies ideally suited to the issues of a particular watershed. (Orlins, 2005).

Pazwash, H, and S T Boswell (2013) presented an overviewed of design parameter for urban SWMS. Regulations governing developments in New Jersey and also gave Suggestions for the unification of directives statewide. (Pazwash H. a., 2004).

Villarreal, E et. al. (2002) analyzed the functions of the system by SWMM. They instead of connecting two Stormwater system the provision of retention storage for leading water is much appropriate in Östra Torn, Lund, Sweden. (Villarreal, 2002).

Thomas E. Barnard, Thomas M. Walski, S. Rocky Durans, Steve Lowry, Micheal E. Meadows, Brian E. Whitman (2013) presents the brief overview on inlets, gravity pipe systems, and storm sewer design. In which small introduction about StormCAD was also conducted which consist some topic like how we can use StormCAD? , Analysis and design and also its profile. StormCAD can be used for: Design multiple storm sewer systems with constraint-based design, Analyze inlets based on HEC-22 methodology;Use AASHTO, HEC-22 energy, standards, absolute or user-specified methods to compute losses;Analyze various design scenario for storm sewer system;Import and export AutoCAD and MicroStation DXF files;Predict rainfall runoff rates;Generate professional-looking reports for clients and review agencies;Generate plan and profile plots of the network (Thomas M. Walski, 2013).

CONCLUSION

The paper shows the different review of literature related to Stormwater drainage system and its management. The main purpose of this study is to get ideas about smart Stormwater drainage system, as the smart city provided with basic infrastructure to give a better, clean and livable environment and quality of life to live smarter. Smart infrastructure is also the key point of the smart city. For that, the smart management of Stormwater drainage system is also essential. Thus it becomes necessary for the planner to give smart proposals and tools for that.

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