International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 02 Issue: 01 | Apr-2015 www.irjet.net p-ISSN: 2395-0072

Simulation of Best Management Practices using SWMM

Harshal Pathak[1], Pravin Chaudhari[2]

[1]*Student, Department of civil Engineering,V.J.T.I Mumbai, Maharashtra, India*
[2]*Professor, Department of civil Engineering,V.J.T.I Mumbai, Maharashtra, India*

Abstract- Urban flooding is significantly different from rural flooding as urbanisation leads to developed catchments which increases the flood peaks from 1.8 to 8 times and flood volumes by up to 6 times. Consequently, flooding occurs very quickly due to faster flow times, sometimes in a matter of minutes The urban areas within India are increasing rapidly and resulting into a major land use change. This gives rise to changed runoff patterns which are high in peak flows and can result into flash floods. Flooding is considered as the most costly type of natural disaster in terms of human casualties and damages. An attempt has been made to study the various aspects of the flooding in complex urban environment. Conventional flood mitigation strategies were studied along with the sustainable ways of dealing with runoff in urban areas. Resilient measures have also been studied. A case study in the City of Mumbai Mithi river sub catchment is considered for this thesis. The catchment is divided into number of basin and it is modelled by using SWMM based on different land use in the catchment. A number of features within the catchment were studied and their suitability with respect to Best Management Practices management is checked. Impact of the proposed systems was checked on the peak flow and runoff volume at various locations within the catchment. It was found that the conventional solutions work out to ***be very costly. Amongst the BMP'S solutions, rain*** *garden system implementation appeared promising with reuse benefit along with runoff control. To achieve a better level of service and also deal with extreme events, a new way of design would need to be considered, which would involve assessing risks and use of sustainable and resilient measures.*

Key words- Urbanization, Flood, Mithi river, SWMM, Best management practices.

I. INTRODUCTION

Flooding is considered as the world's most costly type of natural disaster in terms of both human casualties and damages. Statistics show that over 45% of water – related disaster fatalities and 90% of affected people since 1980 – 2006 are from Asia. There has been an increasing trend of urban flood disasters in India over the past several years whereby major cities in India have been severely affected. The most notable amongst them are Hyderabad in 2000,The physical and chemical characteristics of storm water runoff change as urbanization occurs .Over the years, the trend in India has been toward increased urbanization Indian census 2001 figured 285 million people stay in 35 metro cities, and is estimated to cross 600 million with 100 metro cities in 2021. The runoff from built up areas within cities is generally collected with conventional drainage systems and finally discharged into a water body. In most urban areas, conventional stormwater management has led to increasing environmental and economical problems. The conventional system is designed for a particular rainfall and is inadequate to cater to higher rainfall intensities. Hence the conventional system fails and cause flooding results in tangible and intangible losses. The term "stormwater best management practices" implies a comprehensive approach to the planning, design, implementation, and operation of stormwater drainage improvements. The purpose of the best management approach is to develop effective drainage systems that balance the objectives of maximizing drainage efficiency
Urbanization results in elevated stormwater runoff, greater and more intense streamflow. Stormwater Best Management Practices (BMPs) are used to mitigate these effects of urban land use by retaining large volumes of stormwater runoff (water quantity). Best management practices are use for controlling runoff by using different BMP's techniques. such as rain water harvesting, inlet control, detention basin, rain garden, permeable pavement system.

© 2015, IRJET.NET- All Rights Reserved

II. CASE STUDY

The Mithi river upper reach from origin Vihar lake to L&T company area selected as study catchment area.Mumbai city receives seasonal rainfall for four months, from June to September. Average rainfall is 2500 mm, out of which 70 per cent is during July and August only. Mumbai is lined on the west by Arabian sea and is intercepted by number of creeks (Mahim, Mahul and Thane creeks), rivers (Mithi, Dahisar, Poisar and Oshiwara rivers, and their tributaries) and a complex nallah (drain) system. The catchment considered in this study is Mithi River catchment which is located between north latitudes of 19°1'36"and 19°10'9" and east longitudes of 72°49'59" and 72°56'33".The location of the Mithi River has been shown in Fig 1.

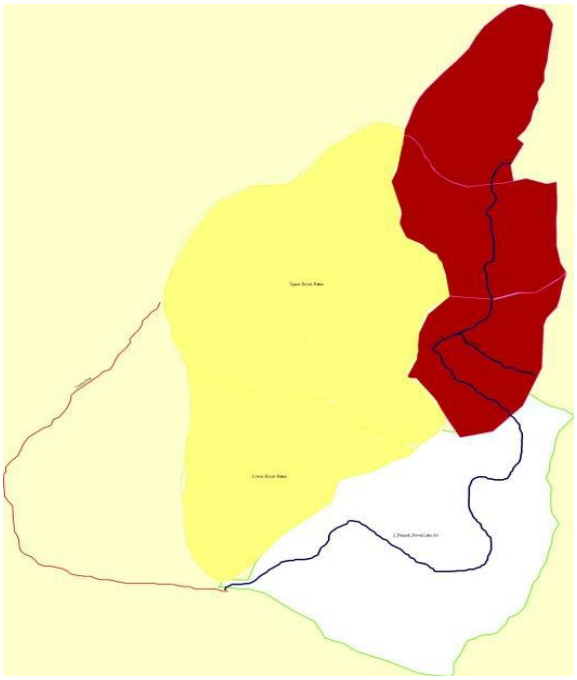

Figure 1: Mithi river sub-catchment

The river originates from the overflow of Vihar Lake and also receives the overflows from the Powai Lake about 2 km later. It flows for a total of 15 km before it meets the Arabian Sea at Mahim Creek flowing through residential and industrial complexes of Powai, Saki Naka, Kurla, Kalina, Vakola, Bandra-Kurla complex, Dharavi and Mahim.

III. METHODOLOGY

The EPA Storm Water Management Model (SWMM) is a dynamic rainfall-runoff simulation model used for single event or long-term (continuous) simulation of runoff quantity and quality from primarily urban areas. Rainfall runoff plays important role in surface urban flooding. The runoff data describes the characteristics of the ground surfaces in the system, and the rainfall-runoff model which is used for each. This defines how much of the rainfall falling on the catchment becomes runoff and how quickly it enters the drainage system. The rainfall-runoff models comprise a set of models enabling engineers to represent the transformation of rainfall into runoff for both urban and rural catchment areas contributing to piped or channelled drainage systems. . For this purpose rainfall runoff computation is important to know how much discharge carry by river channel due to rainfall occurring. Due to this rainfall runoff modeling required.

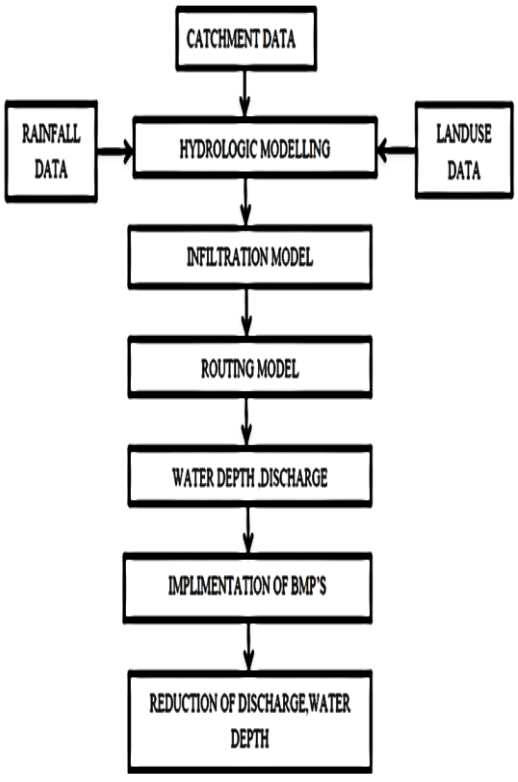

Figure 2: Conceptual framework by using SWMM

3.1 Preparation of the land use map.

Mithi river subcatchment is divided into number of different landuses such as urbanised area, grassy area

© 2015, IRJET.NET- All Rights Reserved

open ground, roads, forest area.To identify discharge from each landuses.

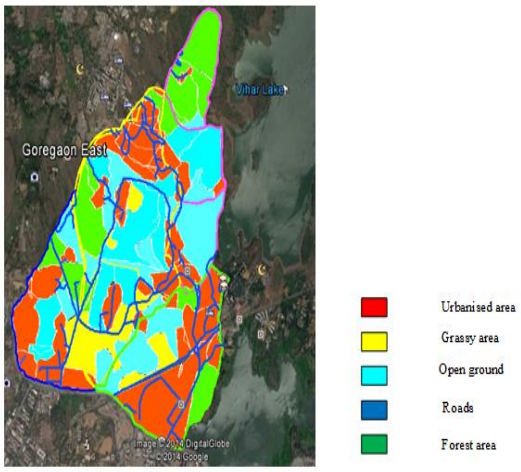

Figure 3: Landuse pattern for Mithi subcatchment.

IV. MODELLING BY USING SWMM

The mithi river sub-catchment was modelled for the rainfall event of 13th July 2009 to 15th July 2009 by using SWMM.From that water depth of the river can be simulated. It was observed that the peak water depth at powai site is about 0.8m.

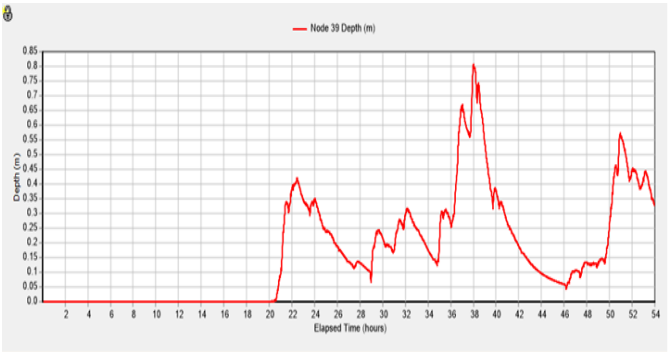

Figure 4: Depth simulation by using SWMM.

V. CALIBRATION AND VALIDATION OF THE MODEL

The Mithi River model has been calibrated at Powai site for the rainfall event of 13th July 2009 to 15th July 2009. The figure shows the comparison between observed depth and simulated depth. The co-relation coefficient for the event 1 was found to be 0.68 and for the event 2 is 0.60 so it is validated. The results obtained shows that the simulated water surface depth closely matches with observed depth. This SWMM model can be used as an effective tool for flood estimation in the Mithi River.

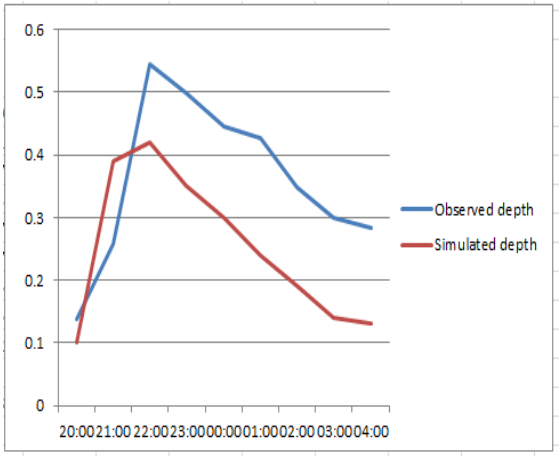

Chart 1: Calibration and validation of Mithi River model at Powai site (event 1)

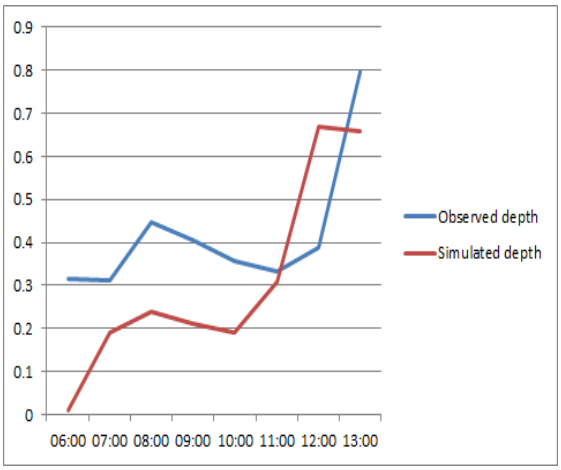

Chart 2: Calibration and validation of Mithi River model at Powai site (event 2)

VI. SENSITIVITY ANALYSIS

Sensitivity analysis of the model has been carried out for the different land uses such as Urban area, Forest area, Grassy area by varying Mannings roughness factor. So the effect of Mannings constant on Discharge and water depth can be determined for each sub-catchment. The following table shows the water depth and inflow at the powai site.

© 2015, IRJET.NET- All Rights Reserved

Manning's Coefficient **"n"**	Time of peak	Peak Water depth	Peak Inflow
n+10%	14:15	0.73	0.09
n+5%	14:00	0.76	0.10
N	14:30	0.8	0.11
n-5%	14:00	0.81	0.11
n+10%	14:00	0.83	0.12

Table shows that the simulated discharge and water depth increases when mannings coefficient decreases and simulated discharge and water depth decreases when mannings coefficient increases. Thus the above results shows that the mannings coefficient affects discharge and water depth. Table shows the variation ofin mannings roughness factor for each sub-catchment from -10 to +10 percent.

VII. RESULTS AND DISCUSSION

The flow and water surface depth have been simulated for the rainfall event of 13th July 2009 to 15th July 2009 using the model SWMM so by applying the rain garden LID (LOW IMPACT DEVELOPMENT) on open area in each basin concept in that model there is reduction in the water depth at the powai site and results were obtained. The following Figure shows the reduction of water depth at Powai site. The water depth from peak 0.8m is reduced to 0.34m.

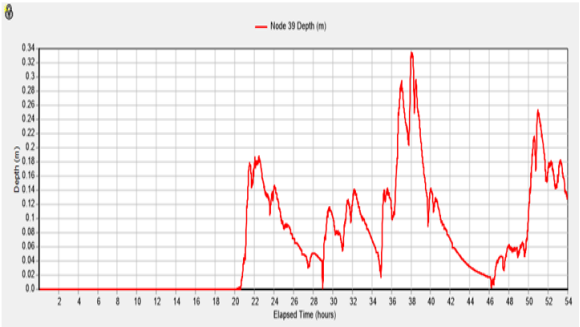

Figure 5: Implimentation of BMP reducing surface water depth.

VIII. CONCLUSION

The SWMM models have been used to demonstrate the simulation of flow and water surface depth at Mithi River sub-catchment. The water depth has been obtained at Powai site with and without considering the effect of BMP. The simulation result shows maximum peak reduction of 0.8m to 0.34m by using rain garden as a BMP techniques at Mithi river sub-catchment.

ACKNOWLEDGEMENT

The authors would like to appreciate the editor and potential reviewers very much for their valuable comments and suggestions.

REFERENCES

[1] Elizabeth A. Fassman, and Samuel Blackbourn,"Urban Runoff Mitigation by Permeable Pavement System over Impermeable Soils", ASCE, 473, 2010

[2] Michael E. Barber, Steven G. King, David R. Yonge and Wade E. Hathhorn ,"Ecology Ditch: A Best Management Practice for Storm Water Mitigation" ASCE, 111, 2003

[3] K.Gupta," Urban flood resilience planning and management and lessons for the future: a case study of Mumbai, India, Urban Water Journal, Vol. 4 No. 3, 183-194, 2007.

[4] D. Sharma," Sustainable Drainage System (SuDs) for Stormwater Management: A Technological and Policy Intervention to Combat Diffuse Pollution", 11th International Conference on Urban Drainage, Scotland, 54, 2008.

[5] Chaudhari Pravin and Gupta Kapil,"Hydrological and Hydraulic Modelling of Mithi River flow Using HEC-HMS and HEC- RAS",Hydro National conference proceeding M.M.University, Ambala,India,2010.

BIOGRAPHIES

Harshal Pathak

Mtech in Environmental Engineering from V.J.T.I. , Mumbai.

© 2015, IRJET.NET- All Rights Reserved