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Evaluation of Best Management Practices by using Hydrologic and Hydraulic Modeling

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Abstract- 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.

Keywords- Urbanization, Flood, Mithiriver, SWMM, Best management practices

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I. INTRODUCTION

The physical and chemical characteristics of stormwater 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.

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.

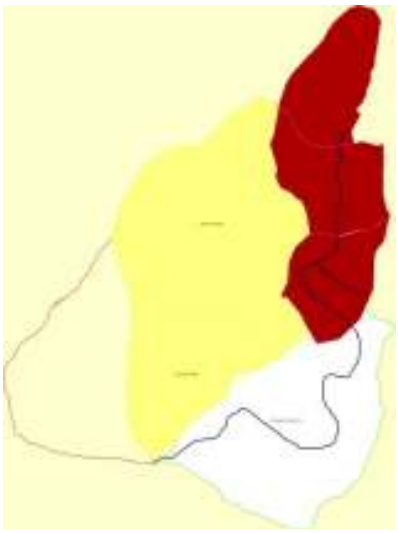

Figure 1.Mithi river sub-catchment

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 Mahi 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 therainfall-runoff model which is used for each. This defines how much of the rainfallfalling 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 thetransformation of rainfall into runoff for both urban and rural catchment areascontributing to piped or channelled drainage systems. . For this purpose rainfall runoffcomputation is important to know how much discharge carry by river channel due to rainfalloccurring. Due to this rainfall runoff modelling required.

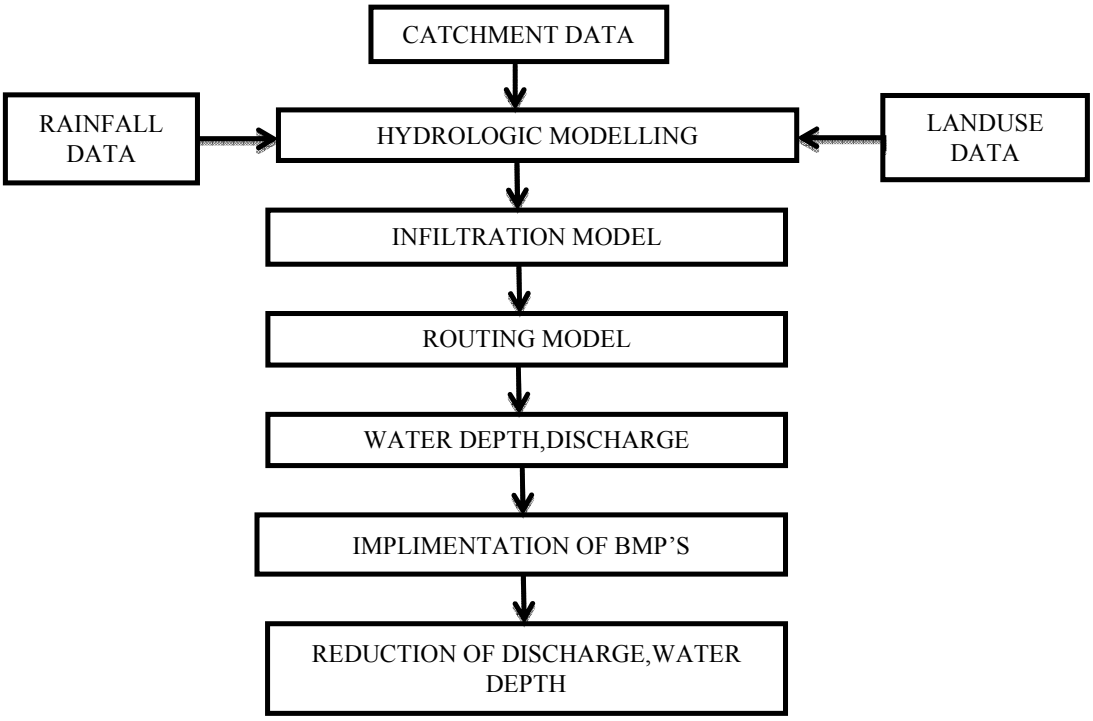

Figure 2. Conceptual framework by using SWMM

3.1 Preparation of the land use map.

Mithi river sub-catchment is divided into number of different landuses such as urbanised area, grassy area open ground, roads, forest area.To identify discharge from each landuses.

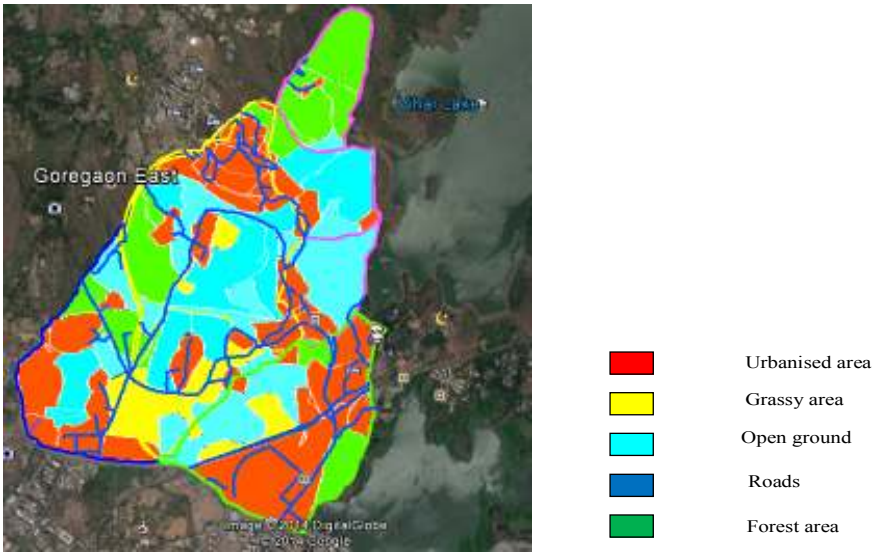

Figure 3.Landuse pattern for mithi sub-catchment.

IV. MODELLING BY USING SWMM

The mithi river sub-catchment was modelledfor 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.

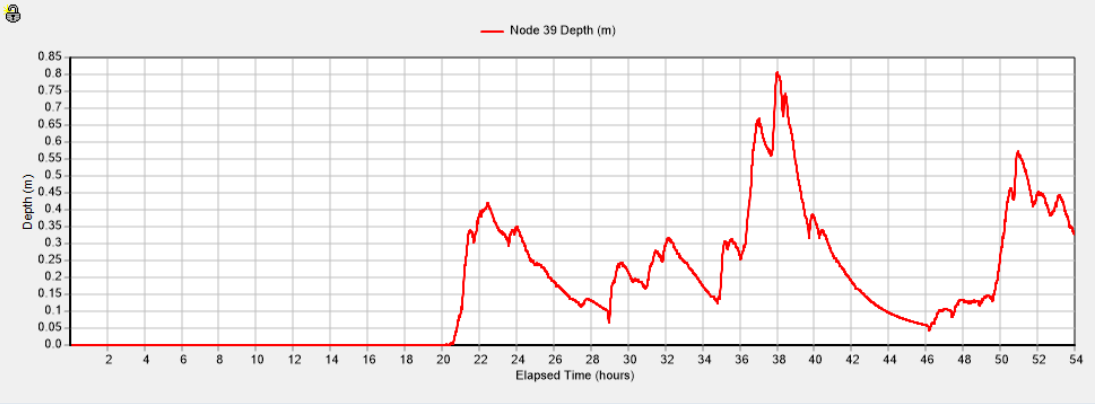

Figure 4.Depth simulation by using SWMM.

V. CALIBRATION AND VALIDATION OF THE MODEL

The Mithi River model has been calibrated at Powaisite 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.

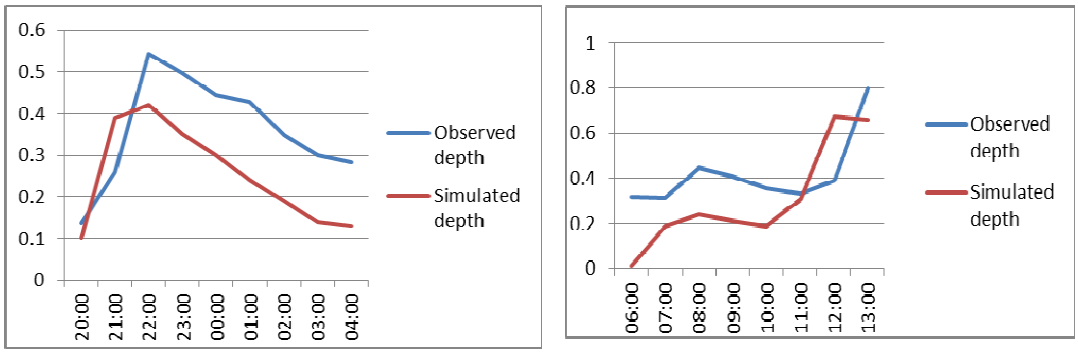

Figure 5. Calibration and validation of Mithi River model at Powai site.

VI. 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.

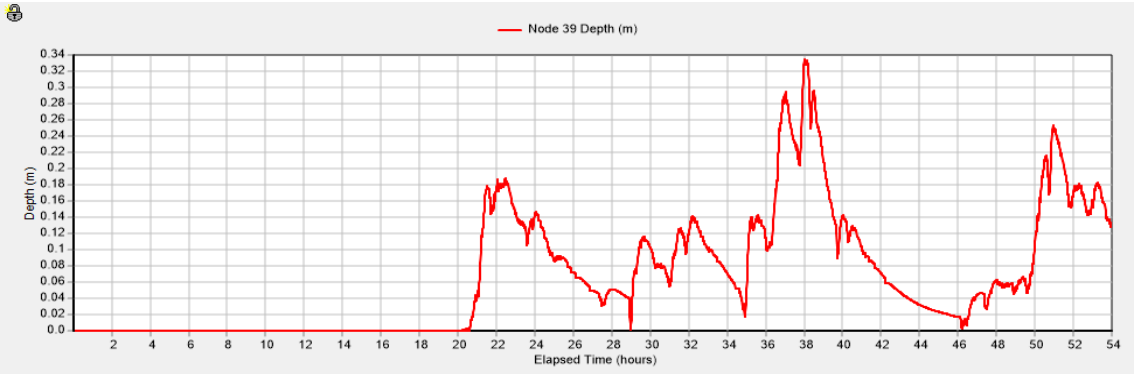

Figure 5.Implimentation of BMP reducing surface water depth.

VII. 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.

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