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Hydrological Modelling and Analysis of Water Logging Areas for Panvel Region: An Innovative Approach

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Abstract - *Flood disasters in the last decade have confirmed that, the risk from flooding has increased significantly worldwide. Flood is a natural disaster which is caused due to heavy rainfall, melting of snow area, increased water level in natural bodies, etc. which causes negative impact on environment. Due to urbanization, catchment areas are formed which increases flood peak and volume in less time. Flooding leads to loss of life, loss of economy, structural and non structural losses. Panvel region is considered as the catchment area in this study. It is segregated into a number of land use pattern such as open area, road area, and grassy area which is modeled by using Storm Water Management Modelling (SWMM) software based on different land use in the catchment. Various Best Management Practices (BMP) has been introduced to reduce runoff depth for water logging areas in Panvel region. By treating this runoff water, small water requirement can be fulfilled and can be supplied to the villages, cities or industries.*

Key Words: Waterlogging Areas, Panvel, SWMM, DEM, Google Earth, BMP; Rain barrels, Holding pond, Detention tank,.

1. INTRODUCTION

Stormwater runoff can be defined as "the water that flows over the land from rainfall during or after a storm event or as a result of snowmelt" 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. Low Impact Development (LID) 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 LID techniques. such as rain water harvesting, inlet control, detention basin.

2. NEED FOR STUDY

Maximum Flood losses are caused due to the stormwater; It means when the rainfall takes place. Due to heavy rainfall, runoff is increased on the ground surface this creates a problem like economic losses, tangible losses, intangible losses. To avoid this loss it is necessary to mitigate such runoff which causing a flood. By using traditional methods floods should be mitigated but it can be found that it is not applicable for the urban areas.In most cities in India, the runoff from roads, buildings and other urban areas, is directed to conventional drains/ conveyance systems. During the rainy season, it can be found that these drainage systems are exceeded hence that causes floods.This thesis aims to study flood problems in complex urban areas. A case study of a Kalundre river catchment in the region of Panvel has been chosen as it covered wider aspects and complexities related to urban flooding in the Indian environment. The study targets to integrate the flood management aspects with innovative methods and their application in the Indian scenario. In India from the last 10 years the major problem of the flood is arising in Mumbai, Uttarakhand, Bihar.so it is necessary to find sustainable solutions to mitigate the flood.

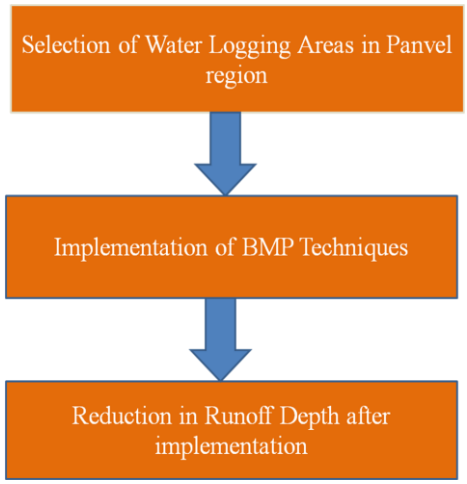
3. METHODOLOGY

In this study we have taken rainfall event from 10th July 2019 to 10th August 2019 which has cross highest peak during that period. SWMM software is the hydrological modelling software which can calculate rainfall to runoff process.

Assessment of flood disclosure had been done by combining existing methodologies and some innovative techniques. This section provides introduction to the methods used in the study and the discussion on analysis of non-structural and structural flood management measures. This section briefly describes the methods SWMM uses to

model storm water runoff quantity and quality through the following physical processes:

1. Start new project
2. Create Time series
3. Enter basin model data
4. Create rain gauge for each area
5. Apply time series for rain gage
6. Create and execute a run simulation
7. View the result



3.1 Land Use Pattern

Land use patterns are categories of development activities or land surface characteristics assigned to each sub catchment. Examples of land use activities in this case study of Panvel area is segregated into a number of land use patterns such as urban area, open area, road area and grassy area which is useful to identify discharge from each land uses.

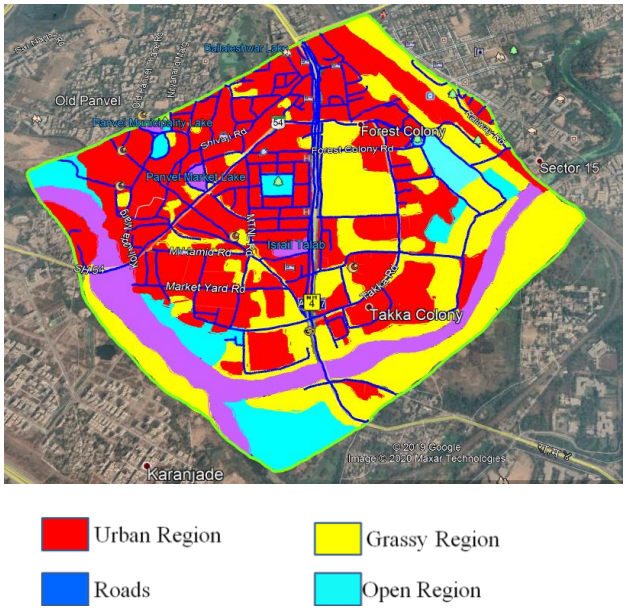


Fig -1: Land use pattern

3.2 MODELING BY USING SWMM

The sub-catchment, Kalundre river was modelled for the rainfall event from 10th July 2019 to 10th August 2019 by using SWMM. From that water depth of the waterlogging areas can be simulated. It was observed that the peak water depth was 0.82m.

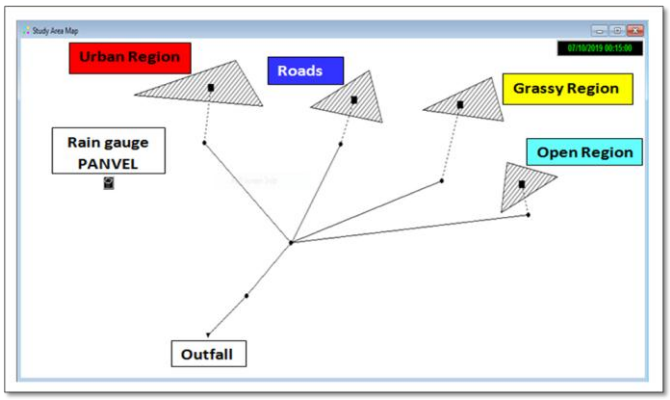


Fig -2 Panvel region modeling using SWMM

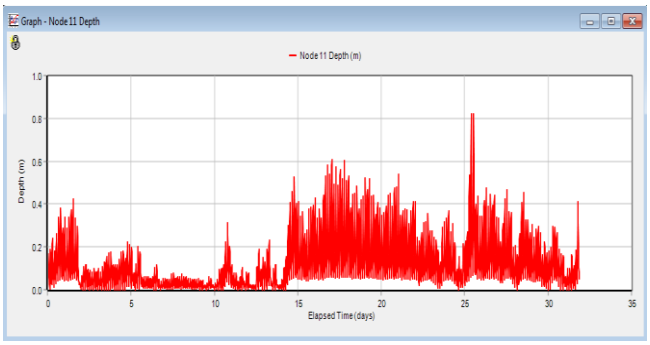


Fig -3 Runoff Depth Modelling using SWMM

4. RESULTS AND DISCUSSION

The Kalundre river sub-catchment was modelled for the rainfall event of 10th July 2019 to 10th August 2019 13th July 2017 to 15th July 2017 by using SWMM. From that runoff depth of the channel can be simulated. It requires some of the major parameters like area of each basin, Mannings roughness coefficient for the conduits, Slopes etc.

4.1 Implementation of LID by using SWMM

The main aim to prepare the land use is to calculate area of each land use of a particular basin. With the help of the land uses the implementation of the different LID'S techniques can be done. SWMM tracks the quantity and quality of runoff made within each sub catchment. It tracks the flow rate, flow depth, and quality of water in each pipe and channel during a simulation period made up of multiple time steps. SWMM 5 has recently been extended to model the hydrologic

performance of specific types of LID controls. The LID controls that can be choose include the following green infrastructure practices:

Case 1: Implementation of Permeable Pavement System on road area

The Permeable pavement system is designed to reduce water logged road areas. Following table shows the effect of permeable pavement system as a LID on water depths including total percentage reduction.

Table 1. Implementation of Permeable Pavement system as a LID on water depths

Sub-catchments	Peak Water depth without LID	Peak water depth with Permeable Pavement system on Road area	% Reduction
Panvel region	0.82	0.64	21.95

Case 2: Implementation of Rain Barrels on Urban area

The Rain barrel system is designed for storage of water for different houses in urban area. Following table shows the effect of rain barrel system as a LID on water depths including total percentage reduction.

Table 2. Implementation of Rain Barrel system as a LID on water depths

Sub-catchments	Peak Water depth without LID	Peak water depth with Rain Barrel system on Urban area	% Reduction
Panvel region	0.82	0.44	46.34

4.2 Implementation of Detention tank as a controlled structure by using SWMM

Detention tank is a structure which is used to reduce the peak of flood. The main aim of providing Detention tank it detains the water level up to the height of the river. It is used to detain the runoff coming from upper catchment and to release it during the time of low peak. In this study at the outfall of the basin detention tank of 5m is provided and simuation can be done for rainfall intensity 25mm/hr and checked for lagging time.

Table 3. Effect of detention tank on Rainfall intensity

Sub-catchments	Height of Detention tank(m)	Lagging Time (hrs)
Panvel region	5	20

5. CONCLUSIONS

- Water logging problems can be solved by using this sustainable drainage solution system for Storm water.
- By using this BMP techniques, runoff water can be reuse for Industrial uses, Irrigation, AC Plants, Gardening, Domestic purpose, Boiler plants and Construction purposes.
- Rain barrels, Holding pond, Detention tank, Permeable pavement, Underground storage tank these are all the low cost Best Management Practices which are helpful to reduce water logging areas in Flood prone region.
- This treated water can be used to replace the water supplied by Municipal Corporation to meet the various water demands. Hence it can be helpful for saving more water.

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