



Sponge City In Vasai-Virar: Opportunities And Challenges

Akshay Potdar¹, Shubham Patil², Jignesh Patil³, Dhiraj Patil⁴

¹(Civil, VIVA Institute of Technology/ Mumbai University , India)

²(Civil, VIVA Institute of Technology/ Mumbai University , India)

³(Civil, VIVA Institute of Technology/ Mumbai University , India)

⁴(Civil, VIVA Institute of Technology/ Mumbai University , India)

Abstract: *The frequency of flooding in urban areas has increased drastically over the years. Urban flooding also results in various other negative effects such as deterioration of quality of water, economical losses and loss of life. Similar conditions were noticed in the regions of Vasai-Virar. Tons of rainwater has to be allowed to flow to the bottom of the ground and to avoid calamity. This idea is analogous to the strategies and developments already adopted within the Western world. During this paper, new constraints on the interactions between the sponge facilities, the landscape and therefore the subsoil are identified for a hilly, sub-tropic terrain. Urban storm water runoff generates a volume of water of the identical order of magnitude because the domestic wastewater volume. However, the impact of wastewater use on crop production, crop change, human health and also the environment must be fully considered. Although, Sponge City may be a Chinese concept. It is a new urban construction model for managing floods The research will also highlight how the Sponge City concept can be implemented indigenously. This paper constitutes the various challenges and opportunities for the flood mitigation in the Vasai-Virar region. This paper presents the collective overview of research done in this domain which will be useful for those who are willing to do some further research. At the end of the paper some future research areas may also be discussed.*

Keywords – Low Impact Development, Sponge City, Green Infrastructure, Urban Waterlogging, SWMM

I. INTRODUCTION

Fast development of economy and urban development in most of the underdeveloped and developing countries have created a number of environmental and development issues. In India many cities are exposed to frequent flooding, which has a huge impact on society, economy and environment. As waterlogging is considered as one of the major underlying causes of these impacts, the management of urban drainage is a big challenge for both researchers and government authorities. Rising Sea-level, Developing economy, and increasing frequencies and intensities of storms will require that we constantly have to invest in adjusting our flood risk management (FRM) systems, including flood protection structures such as levees, dams and urban drainage systems. Water pollution in developed coastal regions due to the higher industrial development and quick urbanization has become a very critical environmental problem and require proper scientific measures to solve this problem.

1.1 Sponge City

The idea of “Sponge city” emphasizes the utilization of natural resources like soil and vegetation as a part of the urban runoff management strategy, that is analogous to the low impact development (LID) and green infrastructure (GI) practices being promoted in several elements of the globe. The sponge town construction goals not solely have an effect on urban control however additionally fresh water gathering, water quality.improvement, natural water discharge and ecological restoration.

1.2 Aim of Study

To absorb excessive water due to waterlogging in Vasai-Virar region in a more natural way to avoid floods and to naturally filter out the water which falls upon it, and allowed it to reach urban aquifers. And to study the various opportunities and challenges concerning the flooding problems in Vasai Virar area.

1.3 Classification

- To study the existing water supply network of Vasai-Virar.
- To study the various measures which are being taken by the government to mitigate the problems.
- To make an attempt to store rainwater and reuse it in a sustainable way.
- To design for reduction in the chance of flooding.

1.3 Scope of study

This paper gives the information about the analysis of sponge city in Vasai-Virar region area. For analysis the data for the drainage network was acquired from the Municipal Corporation of Vasai-Virar Region. The Google Earth Image of the area was downloaded and the flow of water was noted. These data were used for project analysis. This paper deals with the study of the waterlogging taking place in Vasai-Virar region and the ways to mitigate the rising issue of flooding and to cope up with it in a sustainable way. Through this paper we are trying to highlight the various opportunities and challenges that can be applied to tackle the issue of urban flooding.

II. METHODOLOGY

2.1 Study Area

A Vasai Virar which is part of district Thane and is located at the northern side of greater Mumbai. Vasai- Virar Sub-Region is located in the north-western point of the Mumbai Metropolitan Region and spreads across 380 square kilometres. The Vasai-Virar Sub-region (VVSR) is covered on the northern side by the River Vaitarna and on the southern side by the creek of Vasai and on the western side is the Arabian Sea. The eastern border is situated by the hill ranges of Tungar filled of forest that extends from village Sasunavghar to the village Chandip. A number of hills and peaks cover the region in the eastern part. The region on the whole is low-lying mainly in the south on both sides of the Western Railway station.

2.2 Data Analysis

2.2.1 Time of Concentration

Time of Concentration is the amount of time required for the rainwater to flow above the ground surface from the extreme point of the drainage basin and reach the watershed outlet. Meandering stream of waters exist in the central region of the corporation area before vacating into the Vasai Creek and River Vaitarna. These have a major role in naturally draining the region. However, the rapid development of the region has not only increased the quantity of storm water but also increased the amount of runoff.

2.2.2 Estimation of Storm water Runoff

By using Rational Method: Rational Method: For any hydraulic design it is necessary to calculate maximum Discharge and peak value discharge. Rational method is one of the finest methods to determine small watershed area runoff.

2.2.3 Water accumulation Calculations

Vasai Nallasopara Salt Pan Area and the Virar East area are the ones which face maximum and severe water logging problems in Vasai Virar. So in order to drain off the water that is getting collected in these areas, calculations of the amount of the amount of water getting collected in this area during rainfall of highest intensity. For this the area is divided into four regions and the water of logged in these regions are calculated in the following table:

Table 1
Time of Concentration and Rainfall Intensity Calculations

Sr. No.	Particular	Gass Tarkhad Road	Chulne	Khartan	Gokhivare-Vasant Nagari
1	Time of surface flow (min)	44.04	41.43	24.87	12.98
2	Weightage (C)	0.30			
3	Time of Travel (min)	41.31	32.13	21.3	47.84
4	Time of Concentration (min)	85.36	73.56	46.17	60.83
5	Intensity of Rainfall (mm/hr)	52.77	55.88	66.86	60.13

2.3 Sponge City in Vasai-Virar Opportunities

2.3.1 Drains:

New drains of larger widths are suggested at various location in Vasai Virar. First location where new drains are proposed is Vasai-Nallasopara Salt Pan. This area faces maximum water logging during monsoon season and the back flowing water gets accumulated here. To drain out all the collected water two drains are proposed in this area along with micro tunnelling (if required). Both these drains converse at a point and there onwards the width of the nallah increases as per design and then the nalla further meets with the main creek below them. The nalla further carries water to Vasai Creek. The length of the drains on right side is 5.68 km and the approximately width of the drains is 12-15 m which should be further analysed.

In Vasai Nallasopara Salt Pan Area, a bowl like area is formed near Vasai East Road where all the water gets logged. This logged water has to be diverted towards the well of micro tunnelling so that water can be discharged. So, for diverting water towards the well existing drain needs to be widened as per requirement and design standards.

Development Plan of Vasai Virar, 2007 has given proposals, one of constructing a new nalla proposed in Development Plan is 900 m in length and 35 m in width acts as a connection between two points of same nalla passinv, from Vasai East Salt Pan and leads to tapping of water. Since the river flows from the Peihar dam as well as it collecting ample amount of water from nearby catchments and Tunareshwar mountain range. Therefore, due to the high velocity of water which comes from high altitude converse with drain flows from gogte salta pan area and it blocks the flowing water of other drain due to high velocity and result of this water cannot flow from proper channel and het flooded nearby area tapping of water from another stream (which is the shortest distance) allows fast and easy discharge.

2.3.2 Holding Ponds

The velocity of the water flowing in the nallas near Gokhivare Talao is very high and does not allow discharge of water from the neighbouring nallas. This results in the backflow of water from neighbouring nallas and leads to water accumulation in the area. In order to avoid this, holding ponds should be constructed which will reduce the velocity of water and lead to equal discharge of water from all the nallas

Two holding ponds are present very close to each other near Gokhivare Talao and they have a depth of 4 m. These ponds have a holding capacity of 0.22 million litres and 0.28 million litres. The reason for suggesting two holding ponds in same area is the water logging in this area which is very high and as there is no holding space for water, it enters residential area. Hence two holding ponds will hold huge amount of water and restrict it from entering residential areas. This holding ponds were already advised in Development Plan of Vasai-Virar, 2007.

2.3.4 Culverts

Based on our site visit during the initial phases, it was observed that there were box and pipe culverts with gates which are not in operational condition. Since the area provided by box culvert is more as compared to pipe culverts the amount of water discharged is also high and that in case of pipe culverts it is less. As the result, water gets logged near the pipe culverts as the rate of discharge is less. To avoid this it is proposed that the pipe culverts present in this area will be demolished and box culverts will be built at those locations. This will allow the discharge of water at the rate as that of other box culverts and hence water logging will not take place. There is a need to provide automated gates at culvert's location along the Salt pan land side. These culverts must be effectively functional condition and should be cleaned periodically especially before the onset of monsoon.

2.3.5 Clearance and Restoration of Natural Water Courses

The water courses needs to be restored to the original shape and even the natural obstructions which have occurred due to habitation like flow of untreated sewage, which brings nutrients to the natural water courses. Thus, the phenomenon of artificial deltas and growth of mangroves and other vegetation occurs. The water courses have been reduced due to exponential growth of vegetation, where there is sewerage joining the natural water courses. This is an unnatural growth and this needs removal.

2.3.6 Management of Lake Water

There are approximately 80 lakes present in Vasai Virar and out of that 7 lakes are important. These tanks/lakes act as natural holding ponds if the level is below low tide. However, it is not possible to keep the level below low tide due to geographical and topographical condition. Hence these tanks/lakes are floods upstream side and surrounding areas because during monsoon season the water level of these lakes is already high. It is proposed to have an outlet at upper location and interconnect all these tanks/lakes with the gravity line. However long-term plan has to be prepared for design and development of the systems at the considering level for discharging the overflow water at nearest outlet.

2.3.7 Permeable Pavement

The road near the Vasant Nagari - Evershine City cross is suggested to be permeable. During monsoon in Vasai-Virar, water gets logged to such an extent that major roads get submerged under water and affect the accessibility to the area. Also, the height of road should be increased the level of road near the Gokhivare region should be 1 meter higher than the high flood level. The footpath on both the sides of the road near The Old Viva College which is located on both the sides could be made of permeable blocks and the excessive rainwater flow during the monsoon season will increase.

2.3.8 Vertical Gardening and Underground Tanks

The housing societies near the Vasai East region namely Madhuban Township should be allowed to carry out vertical Gardening respectively, this will not only help the society to have an aesthetic ambience but also help in reducing the excessive rainwater flowing. Also underground tanks should be permitted to societies where it is possible to construct such structures.

2.4 Sponge City in Vasai-Virar Challenges:

2.4.1 Natural Challenges

The major nallas are not scientifically constructed and steep topography results in the flood situation. The nallas ultimately discharge into the creeks so during high tide period, back water causes flooding. Most of drains and nallahs are open and direct disposal of solid waste into the drains obstruct the flow and also reduces the carrying capacity of drains. Various services are passing through nalla and crosses near culverts which also obstructs the flow. At many places the culverts are of inadequate capacity. The unnatural growth of mangroves and other vegetation has created a big mishap and a large amount of time and money has to be spent to tackle this conditions.

2.4.2 Governance Challenges

The Sponge city for urban flood management is a multi-stakeholder process and requires a number of strategies and processes to effectively tackle the issue, although the local municipal government is trying hard by itself to tackle the problem the rapid growth of urbanization in this region is making it impossible to tackle the problem. Lack of cooperation and communication between intergovernmental data leads to this kind of issues. The various government agencies should be more responsive to tackle the problem and should issue the necessary demands.

2.4.3 Construction Challenges

The various designs of Sponge City program cannot be totally incorporated with the recent infrastructure of this region. The projects like permeable pavement and bioswales on the sidewalks requires a proper roadway and footway planning. The Vertical Gardening system as well as Green roof system should be legally authorized.

2.4.4 Economical Challenges

Although the suggestions sound quite convenient it in return demands a lot of economic investment, which can be a major challenge for the local Municipal Corporation, and it was the main reason why the necessary measures were not taken according to the CIDCO town planning development plan in the year 2007. Various agencies should be contacted and asked for economic support as well as Public Private Partnership could be possible.

III. CONCLUSION

The main objective of this project is to analyse the recent flow of storm water and to study the distribution of waterlogging zones throughout the selected Area and check how the waterlogging issues of this region can be resolved using sustainable methods and to design a plan that can control the problem of floods in the selected region and how the water can be sustainably be stored and reused using various techniques. This study would help in finding methods for curbing the increasing waterlogging and flood like issues. The ground water level will be increased and the harvested water will be reused. And the quality of life will be improved.

Acknowledgements

We are using this opportunity to express our gratitude to everyone who has supported us throughout the completion of this project. We are thankful for their guidance, constructive criticism and friendly advice, during the project work. We express our gratitude to Prof. Vishal Urade for giving us an opportunity to carry out project on Sponge City in Vasai-Virar Opportunities and Challenges. We would also like to thank Prof. Lissy Jose, Head of Civil Department and Dr. Arun Kumar, the Principal for their whole hearted support. The authors are also thankful to the institute for their support.

REFERENCES

- [1] Zhou Xuwen. Current Hydraulic Construction, Problem and Approach, Vol. 01, pg. 03-23, 2011.
- [2] Dietz M E. Low impact development practices: A review of current research and recommendations for future directions, pp. 351-363, 2007.
- [3] Fabos J. Greenway planning in the United States: its origins and recent case studies, *Landscape and Urban Planning*, Vol. 68, pp. 321-342, 2004
- [4] CHE Wu, LU Fangfang, LI Junqi, et al. Typical storm water and flood management systems in developed countries and their inspiration. *China Water & Wastewater*, Vol. 20, pg. 12-17, 2009.
- [5] Yang Xiaodong. The impact of urban non-construction land on storm water management. *Shanxi Construction Journal*, Vol.10, pg. 12-13, 2013.
- [6] QIU Baoxing. The connotation, ways and prospects of sponge city (LID). *Construction Science and Technology*, Vol.1, pg. 11-18, 2015.
- [7] YU Kongjian, LI Dihua, YUAN Hong, "Sponge city": Theory and Practice, *City Planning Review*, Vol. 01, pg. 26-36, 2010.
- [8] Yu Kongjian. Hydro-Ecological Infrastructure: the Way to Beautiful China [N]. *Modern Water Conservancy Weekly of China Water Resources News*, Vol.5, pp. 01-15, 2015.
- [9] Yu Kongjian. Aquatic Ecological Infrastructure of Wild China : The Theory and Practice. *Journal of Poyang Lake*, Vol. 10, page. 5-18, 2015.
- [10] Wang Lijuan. Building the "Sponge City", Avoiding Storm Water Problem'. *China Revolution Daily*, Vol.05, pg. 76-80, 2014.
- [11] Su Yijing, Wang Sisi, Che Wu, Optimization Design of Sunken Greenbelt Based on the Concept of "Sponge City", *South Architecture Journal*, Vol.03, pg.39-43, 2014.
- [12] Che Wu, The construction of sponge city to avoid a few misunderstandings [J]. *China Construction Journal*, Vol. 7, pg. 1-21, 2015.

VIVA Institute of Technology
10th National Conference on Role of Engineers in Nation Building – 2022 (NCRENB-2022)

- [13] Wu Danjie, Jian San Ze, Li Youhua, et al. The new trend and practice of Chinese characteristic sponge city , *China Soft Science*, Vol. 01, pg. 79-97, 2016.
- [14] L. Hao, "Based on the Technology of Sponge City in Urban Design Study," *International Conference on Smart City and Systems Engineering (ICSCSE)*, Vol. 01 , pp. 27-29, 2016.
- [15] Li Q, Wang F, Huang Z. Comprehensive performance evaluation of LID practices for the sponge city construction: A case study in Guangxi, China, *Journal of Environmental Management*, Vol. 01, pg. 10-20, 2018.
- [16] JYang Xiaodong. The impact of urban non-construction land on storm water management. *Shanxi Construction Journal*, Vol.10, pg. 12-13, 2013.
- [17] QIU Baoxing. The connotation, ways and prospects of sponge city (LID). *Construction Science and Technology*, Vol.1, pg. 11-18, 2015.
- [18] YU Kongjian, LI Dihua, YUAN Hong, "Sponge city": Theory and Practice, *City Planning Review*, Vol. 01, pg. 26-36, 2010.
- [19] Yu Kongjian. Hydro-Ecological Infrastructure: the Way to Beautiful China [N]. *Modern Water Conservancy Weekly of China Water Resources News*, Vol.5, pp. 01-15, 2015.