

Storm Water Analysis and Solution of Waterlogging in Kothrud Region, Pune.

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Abstract

Stormwater is the water flow generated from rainfall. Rainfall that flows over the ground surface is created when rain falls on paved surfaces like road, parking lot, rooftop and other concrete surface that do not allow water to soak into the ground.

This research focuses on high intensity storm rainfall and runoff in the Kothrud region of Pune city and the problems due to lack of proper drainage system and insufficient management. It also includes water logging problem, its cause and its effect and living style of the city. The major issue because of this problem is traffic and loss of income potential for road dwellers. The storm water becomes polluted as it is mixes with various solid waste, domestic waste and other human wastes. Such lack of cleanliness can result in epidemic and health disorders.

KEYWORDS: Runoff, water logging, paved surfaces, land use, urban flooding.

1. INTRODUCTION

Pune is a major city located in the state of Maharashtra, India. Pune city central is the district headquarters of the district. The district population was 9,429,408 census 2011. It is the 4th most populous city of India. The Urban population is 58.08% of the total which nearly is 5.5 lakh. The population projection of Pune is 8.59 million in the year 2041. It is one of the most industrialised cities of India.

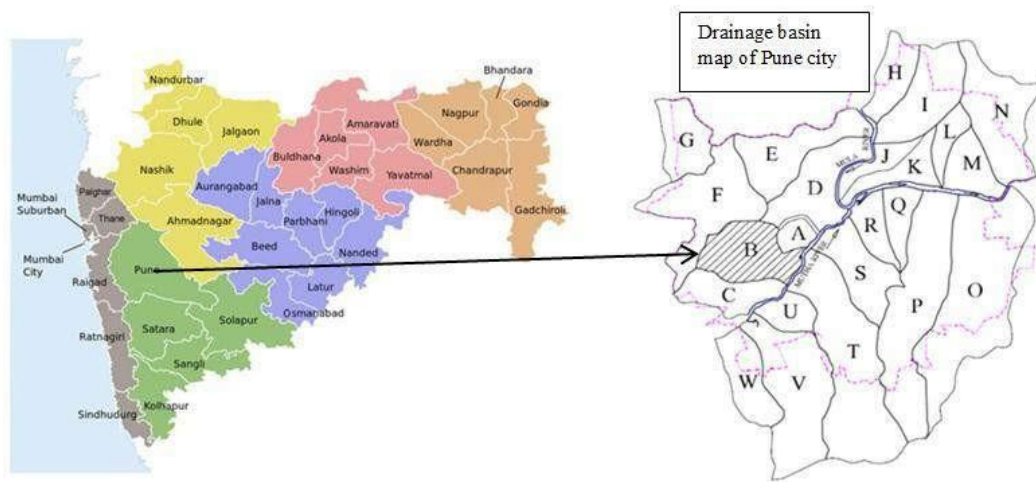


FIG 1

In the past we used to study only the river flood but as the population goes on increasing day by day the paved area increased which increases runoff and decreases the infiltration capacity of soil. Urbanisation creates lots of pressure on land use which may result in urban flooding. An urban flood is a situation that occurs when water overflows the sewer and takes the direction to the road and into the building parking. Due to torrential or sudden rainfalls nowadays water overflow condition in storm water drainage system occurs quite frequently. It clearly shows the need to increase the size and maintenance of not only the provided drainage system but also think of an innovative way to dispose off the sudden water. In this paper we shall find out the proper need of such a method.

2. NEED OF STUDY

2.1. To manage stormwater runoff in Kothrud Region.

Kothrud region is one of the most developed parts of the city. Due to this the area is mostly paved by footpaths roads and buildings. There is hardly any green vegetation to infiltrate the rainfall water into the ground. This creates a lot of pressure over the drainage system that has been provided for disposing domestic and industrial sewerage.

2.2 Unfavourable Topography of Kothrud region.

Kothrud is surrounded from hill on three sides. The water falling on the hilly region also come into the city due to slope. Due to this combined water the area repeatedly faces water runoff on the roads. This creates problem for traffic and pedestrian movement as well as presses over the existing systems of disposal.

2.3. Rapid urbanisation and paved surface covering.

Due to rapid industrialisation and tremendous growth opportunity for the city an influx of population has grown the population rapidly. To accommodate so many people it is construction works have covered a lot of area with pavements of roads buildings and houses.

3. OBJECTIVE

1. To provide a good drainage network.
2. To store and use Stormwater for plants and recycling after filtration.
3. To prevent impact like water logging and Drainage network problem.
4. To find an alternative way to dispose water due to runoff.

4. STUDY AREA

Kothrud is an area in the city of Pune experience Rapid growth and development residential and building real estate. it was one of the fastest developing areas in Pune, Maharashtra. It is geographically located at 18.53° N, 73.5° E.

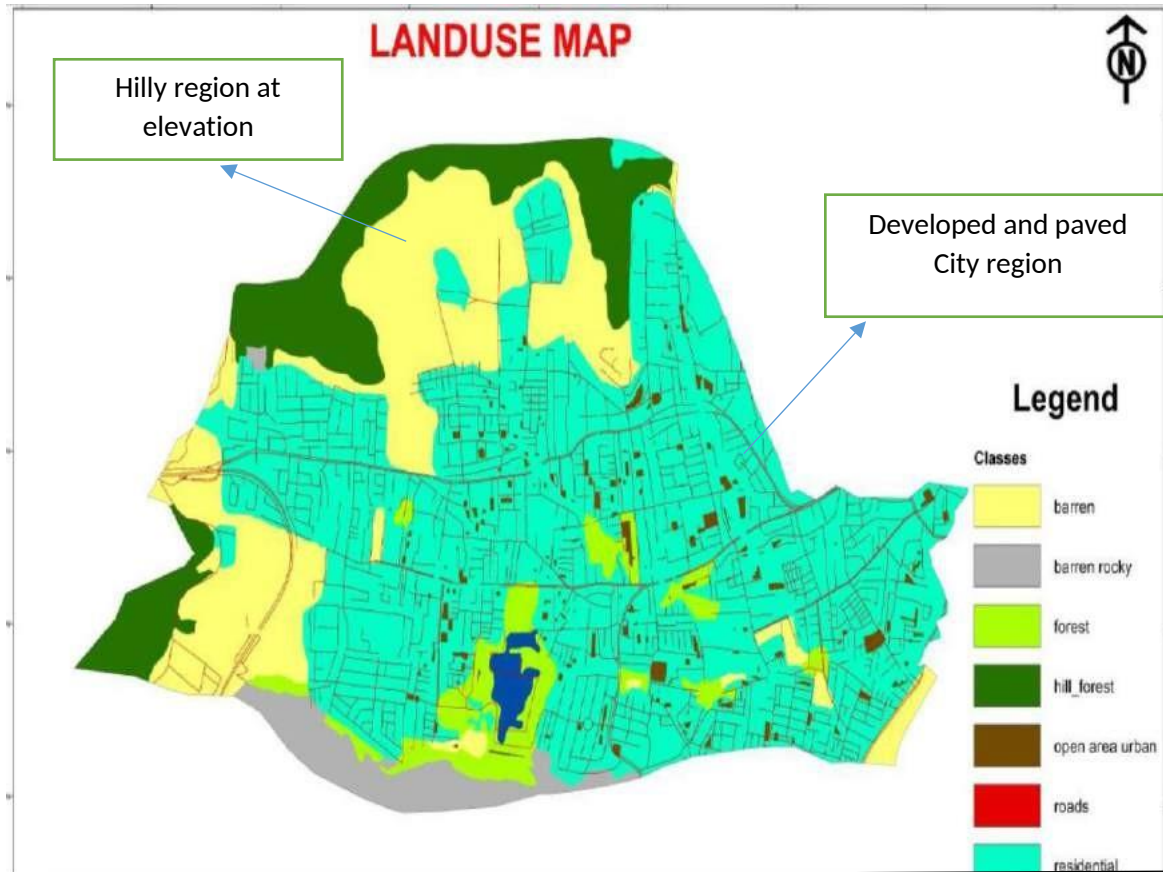
The region consist of areas around Paud Road and Karve Road. The population is estimated to be around 2.5 lakh in this area. Due to urbanization unpaved areas are altered with paved areas like Footpath and roads. The paved areas increase the runoff to some extent by not allowing water to seep in the ground. It requires proper drainage facility to dispose the water running on roads and hard surfaces like Footpaths.



VIEW IN YEAR 2008

VIEW IN YEAR 2018

FIG 2



Land-use Map of Selected Catchment (Source: PMC)

FIG 3

The land use map of the Kothrud region shows clearly that there has been a tremendous increase in Footpath pavement and due to which the overall runoff has increased in the past few years. Added to that the water coming from the elevated region of the nearby area is a significant problem.

5. DATA COLLECTION

Various types of data are needed to calculate the storm water calculation. it includes rainfall data land use data drainage lines maps, soil map, topographical map, Road network map, satellite images etc. The sources of data are Indian meteorological department (IMD) for rainfall data, Pune Municipal Corporation population data and Drainage lines maps, BHUVAN Maps for satellite maps, Transportation Dept. for Road network. Pune is surrounded by Panshet Dam, Tenmgarha Dam, Khadakwasla Dam and Varasgaon dam.

5.1 Drainage data

Drainage System at present is not up to the mark. In the last monsoon season we noticed that due to Rapid from water rainfall in short duration the water flows from upside Hilly region to the downwards direction which increases the water level tremendously. This results in water logging problem traffic problem and drains overflow. As per the report compiled by PMC to create sanitation plan in 2011, the watershed of the city is divided into 23 subwatersheds, each of which has one or more primary drains in the form of natural channels discharging into the river.

The PMC drainage network has limited area coverage under the ground which is insufficient to cover up the condition so development of new drainage is proposed.

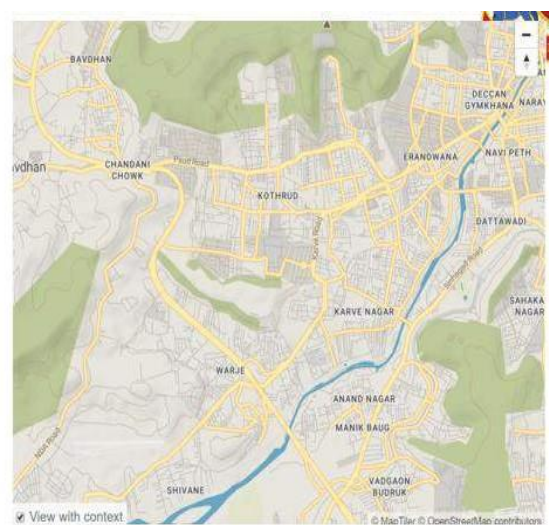
The total number of closed drainage 62-8, open drainage is 13- 5, and no drainage is 23-7. The total existing network coverage of storm water drainage in the city is 55% as against 100% requirement in service level benchmarking criteria specified by Ministry of Urban Development. The incidence of flooding areas is as high as 52% as against the zero percent requirements specified in the norms.

5.2 Toposheets

Toposheets numbered 47/F/10, 47/F/14, 47/F/15 of scale 1:50000 with contour interval of 20 metre was procured from Survey of India. Further detailed study toposheets are converted into subsets, shows river, streams, contours to major roads.



WITHOUT CONTEXT



WITH CONTEXT

FIG 4

5.3 Population

The ward wise population data was obtained and analysed for growth prediction.

Name	% of Built-up	Pop2001	Total Area in km ²	Built-up in km ²	Pop A density
Aundh	25.28	179886	44.77	11.32	4018.003
Ghole road	42.99	204316	12.05	5.18	16955.68
Kothrud	50.1	201527	10.38	5.2	19414.93
Warje	63.72	116386	13.81	8.8	8427.661
Vishrambagh	85.77	154425	4.71	4.04	32786.62
Kasba peth	95.85	100059	3.37	3.23	29691.1
Bhavani peth	99.53	205009	2.15	2.14	95353.02
Sangam wadi	17.31	213718	23.98	4.15	8912.344
Yerwada	26.02	251100	35.32	9.19	7109.287
Dhole patil road	36.57	218306	9.98	3.66	21874.35
Hadapsar	30.19	239370	29.94	9.04	7994.99
Bibvewadi	42.41	239530	21.95	9.31	10912.53

Pune -Population (Ward Wise)

5.4 Road

The road network map is obtained from PMC (Pune Municipal Corporation). In addition, the road network data downloaded from web site (www.openstreetmap.org).

5.5 Rainfall Data

Six rain gauge stations viz. IMD Katraj, Paud, Kiwale and Paud records daily rainfall for various period data was procured from IMD Pune.

Raingauge stations details and data availability.

Raingauge Station	East Longitude	North Latitude	Elevation in m	Observation period	Number of years of the data
Katraj	73°51'30.14"	18°23'49.60"	891	1970-2009	40
Khamgaon	74°13'1.35"	18°33'1.20"	530	1984-2009	26
Kivale	73°43'10.40"	18°39'20.29"	576	1971-2007	37
Paud	73°36'58.01"	18°31'52.68"	558	1976-2009	34
Wagholi	73°59'0.38"	18°34'59.01"	591	1970-2009	40
IMD	73°50'56.53"	18°31'45.95"	559	1977-2010	34

The Paud data was used in the for rainfall analysis of the region because kothrud is close to Paud. Further calculations suggest that a proper check and maintenance of present drainage system needs to be executed. New drainage system also is suggested.

5.6 Problem of Stormwater Runoff -

After detailed study, we noticed that drainage line networks are insufficient to discharge water into Mutha river and it creates major problems like Waterlogging.

The drainage line does not work properly due to blockage of waste materials into drains, sedimentation or siltation of soils which creates barriers or obstacles to stormwater drain flow.

In summer and winter season this is not creating any problem. But in the worst scenario like in some days of the rainy season, the situation is going out of our hand.

This stormwater runoff also spread some viral diseases, destroy the roads ways and damages the roads and the problems goes continuously occurring year on year.

6. CALCULATION OF RUNOFF

GIS technique is effective to determine the quantity of runoff but we used a rational method for determination of runoff quantity at various points.

The entire city is divided in 23 drainage basins and Kothrud is in basin B.

Runoff is calculated from formula

$$Q = 10 C.i.A$$

Where Q - Stormwater runoff m³/hour

C - Coefficient of runoff

i - Intensity of rainfall in mm/hour

A - Area of drainage district in hectares

various coefficients are available for different surfaces as used in publication.

7. SOLUTION OF WATERLOGGING

After study of the area and existing storm drainage, we conclude that the existing drainage was in bad condition due to blockage, sedimentation and does not work effectively. And in the rainy season it creates problems like water logging. The paved area decreases infiltration in the soil and runoff increases thereby.

So some small stormwater tables are introduced to store rainwater and stormwater for gardening, irrigation or emergence purposes.

The manhole on the road network needs to be redesigned for proper discharge. The green structure or permeable concrete blocks are suggested in the parking areas and near the Stream flow or drainage pores.

The main purpose of a storage tank is to store the runoff water during a storm event and supply or release it at cost rate to outflow or gardening purpose. This tank is provided in underground condition. The tank capacity is 80000 litre based on calculations and estimations (vary depending on sedimentation tank).

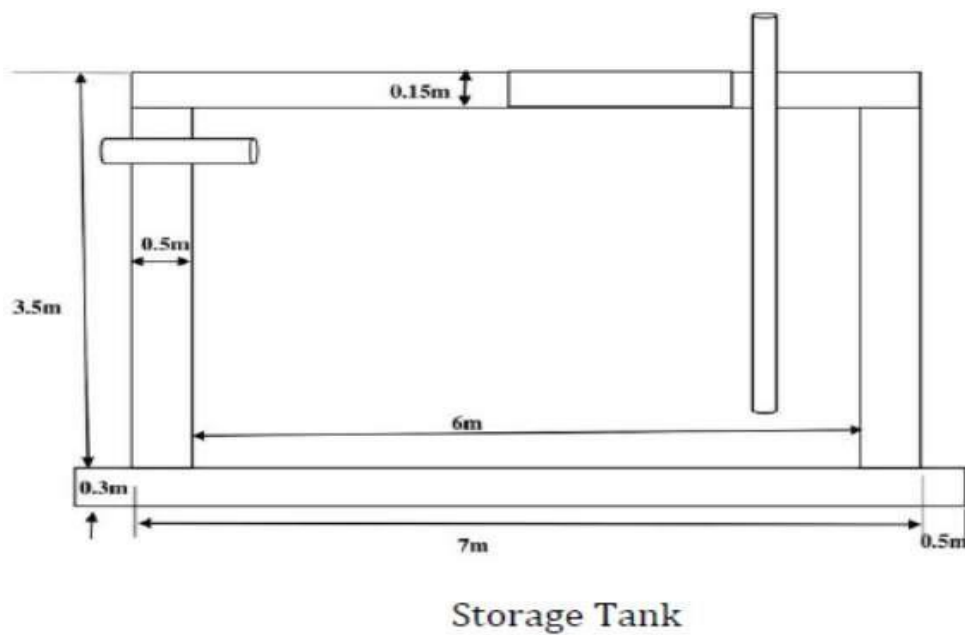
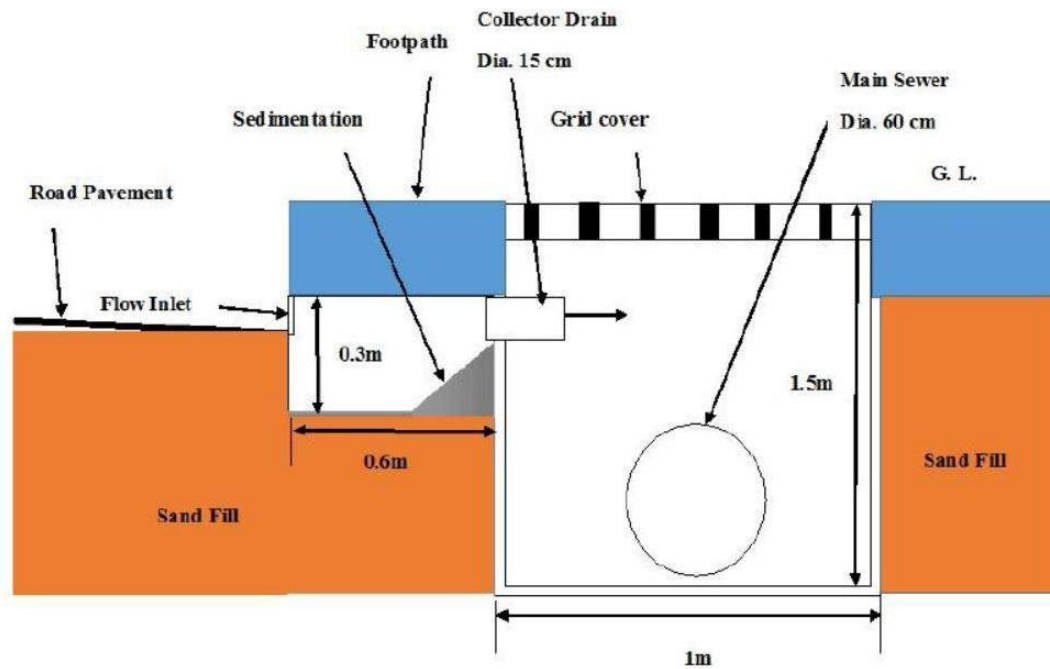


FIG 5

Net like manhole is to be provided at the road to avoid debris entries and no blockage problem occurs.



Designed Drainage Manhole

FIG 6

Also there is a scheme JNNURM (Jawaharlal Nehru National Urban Renewal Mission) launched by Indian Government which provides funds for development of the city. The development plan of Pune includes a master drainage network including roadside drains, widening of existing drain , cross drains whenever required.

8. CONCLUSION

This problem can be concluded as we have to prevent the impacts of stormwater. To provide sustainable, economic, social and safe practices for our environment. This can be achieved by adopting Green Infrastructure and utilization of resources in a proper and sustainable way. For most of the paved covered area which is impermeable there we have to provide Permeable paving which is one of the most important prevention to be done to avoid this major problem.

Constructing a similar water tank as proposed in the research paper is a little costly but is very practical in storing all the water which can be used for irrigation or reused for supply. All the objectives are achieved by the proposed solution. By practising all these steps we can overcome this problem of stormwater drainage in our populated urban areas.

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