

PHYSICAL VULNERABILITY ANALYSIS OF FLOOD 2019 A CASE STUDY OF VADODARA CITY

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Abstract - It Takes a long time in the settlement of the city and it run properly until a disaster activity happen. There are many cities who every year or in the interval of two to three years facing the hazardous stage because of flood in which Vadodara is one of them. In this study we discuss about the status of physical vulnerability of Vadodara city during the flood of Aug 2019 its impact and find out the high, medium and low hazardous zone in the city.

The zone can be identified on the study of various factors like Rainfall Data, Water logging period, water logging height, Drainage density and Population density. All the above data are collected and with help of GIS Application in with under local spatial analysis we identified the high medium and low hazardous Area. After which this map will help us to make solution or making guidelines by the local government for the resident of this area.

At last conclude this study with some solution of minizine the physical damages by the heavy rain fall which results in flood like situations.

Key Words: Flood, GIS, Spatial Analysis

1.INTRODUCTION (Size 11, Times New roman)

According to the State Emergency Operations Centre, the city gotten as much as 424 mm rainfall pouring inside a really brief span of six hours from 2 pm to 8 pm on Wednesday, July 31, 2019 Vadodara has never seen such exuberant deluge in recorded history. As per records of 1july 2005, 297.4 mm rainfall was measure for the rain fall continues for one day. The rainfall on Wednesday, July 31 has as of now crossed 500 mm inside 12 hours and finished up at two times the past record. To put this into point of view, the normal rainfall in Vadodara all through July is 299 mm. In this manner, July 31st rainfall is double the normal rainfall within the whole month of July. The flood caused 8 deaths and the evacuation of more than 6000 people by the NDRF and SDRF. Also, the all mode of transportation was either cancelled or Diverted i.e. many trains are cancelled or rerouted before the Vadodara station. Reasons are water logging and cutting of electric supply. Airport are closed because of water log in runway. GSRTC Bus services were cancelled owing to water-logging, Vishwamitri river is over flooded because of which crocodile from the river are get routed inside the residential area and harassing the people and animals as well like dogs and cow after flood.

Hence, it is our need to identify the low line area of the city and make the flood management plan for that area, so that the losses can be minimize in near future because of flood in terms of physical and social.

2. AIM & OBJECTIVE OF STUDY:

To find the high, medium and low hazardous zone of Vadodara city by heavy flood with the objective to study the flood history of city its topographical status and then prepare the flood management plan for the Vadodara city.

SCOPE AND LIMITATIONS

- The study is limited to Vishwamitri river basin of Vadodara city.
- Considering the past flood understanding and records of the Vishwamitri stream just as existing state of Vishwamitri waterway.
- Analysis is taken over Secondary survey data. Due to lock Down Period of COVID 19

3. DATA REQUIREMENT AND RESOURCES

The secondary data is collected from the various research papers as written over river basin along with the data provide over Narmada water resources and Kalpsar department Gujarat home site. The other land use land cover data is taken from the Bhuvan site of ISRO organization of India. Rainfall data are taken from the VMSS Office. After collecting all data, the hardcopy



of data is converted in soft copy and with the help of GIS Application. All this data is coordinates in the GIS and weighted overlay is carried out according to the conducive condition for the vector development and improvement for the thematic layers to get most vulnerable area for the event of the intestinal sickness. Based on all the over information several thematic layers were arranged in ARCGIS software. These layers were reclassified, based on the positions doled out, taking into consideration of relative significance of parameters which gives favorable conditions for the breeding of the mosquito. Finally, a few zones are recognized through weighted overlay investigation where in water features and height layer are assigned higher weight, taken after by, the arrive utilize and land cover and soil.

4. VADODARA CITY PROFILE

Vadodara is found at 22.30°N 73.19°E in western India at a rise of 39 meters (128 ft). It is the 18th-largest city in India with a region of 235 square kilometers and a population of 2.1 million, agreeing to the 2010-11 census. The city sits on the banks of the Vishwa Mitri Waterway, in central Gujarat. The Vishwa Mitri habitually dries up within the summer, clearing out as it were a little stream of water. The city is found on the ripe plain between the Mahi and Narmada Waterways. Concurring to the Bureau of Indian Benchmarks. the cosmopolis falls beneath seismic zone-III, in a scale of I to V (in arrange of expanding inclination to seismic tremors)

VADODARA CITY	TOTAL	MALE	FEMALE
City + Out Growths	1,752,371	912,721	839,650
City Population	1,670,806	869,647	801,159
Literates	1,364,157	732,121	632,036
Children (0-6)	165,559	89,402	76,157
Average Literacy (%)	90.63 %	93.83 %	87.18 %
Sexratio	921		
Child Sexratio	852		

Table -1:	Demographic	Profile of	Vadodara	City
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Fig -1: Vadodara City Zone Map

CLIMATE:

Vadodara district zone, in common, being found south of Tropic of Cancer and in move zone of overwhelming rainfall zones of South Gujarat and dry zones of North Gujarat fields, have sub-tropical climate with direct mugginess. The various season of the year are Monsoon - middle of June to October, winter -November to February, and summer – March to June. Due to Higher humidity it can be predicted that it may lead heavy rain.

WATER RESOURCES

Major water bodies of the locale are the Stream Mahi, a perennial waterway that streams at almost 15 km west of the city. Other major water body is the Vishvamitri waterway, a seasonal river streaming east to west, bisecting the city in two halves. Ajwa dam is built on the waterway Vishvamitri in upstream of Baroda city found at almost 23 km east. The Sayaji Sarovar lake made by this 5 km long earthen dam has capacity to go to water necessities of approximately 300.000 inhabitants in eastern parts of the city. Pratap Pura lake close Bodeli village is another major water body found in closest region at upstream of Baroda city, the check dam-cum-reservoir stores water for district's water system and drinking water needs.

5. REASONS BEHIND THE FLOOD IN THE CITY

a) HEAVY RAIN FALL

ANNUAL RAIN FALL DATA OF VADODARA CITY

The average yearly rainfall for Vadodara district is 550 mm. The rainfall is adequate and the locale has the stormy season amid July to September of the Season and rain gotten amid this period. A few sums of rainfall are gotten from western unsettling impacts in the midst



of winter. Due to less rainfall & its brief term the agrarian development for the foremost portion depends upon canal/ water system/ Tube wells/ Wells.

Table -2: Annual Rainfall Data of Vadodara Di

Year	Vadodara	Karjan	Padra	Savli	Desar	Dabhoi	Sinor	Waghodia
2008	864	1000	866	802	-	807	1071	869
2010	1570	785	756	981	-	759	505	852
2011	1138	1139	530	880	-	709	805	393
2012	934	645	689	757	-	695	889	466
2013	1726	1662	1126	1451	-	1132	1276	973
2014	1075	667	673	1303	719	649	485	725
2015	545	493	158	315	173	536	384	178
2016	714	593	263	459	475	657	467	483
2017	916	504	391	324	568	878	399	640

Chart -01: Annual Rainfall Data from 1990-2019



Chart -02: Average Rainfall Data from 1990-2019



Chart-03: Rain Fall Data 2019



By studying the rain fall data from Fig 02, Fig 03 & Fig 04 of the previous years along with current year 2019 it was observed floods wherein rainfall crossing 200 mm recorded in 2 -3 days period only.

Along with this it was also observed that the normal yearly rainfall was found 1020.68 mm. and many years the rainfall is above the normal rainfall but city face flood in 1994, 1996, 2005 and 2014 years only. This appears that the amount of rainfall gotten isn't the only factor causing serious flood within the city.

b) DEPLETION OF WATER BODIES

According to the records, there were 70 large and small water bodies within the city of Vadodara before 1970, but with urbanization many water bodies have either dried up or are encroaching, the result being that for the collection of rainwater today hardly 25 Water bodies are available. Due to this decrease in water bodies, the percentage of water accumulation and perforation process is also reduced gradually by the soil. Resulting in waterlogging in the city area and damage to physical infrastructure. So, there is need to water bodies in side city area.



c) LANDUSE LAND COVER



2011-2012







Fig 02 : land use land Cover Maps https://bhuvan-app1.nrsc.gov.in/thematic/thematic/ index.php#

A major increase of 50 % in the built-up area from 1991 to 2019 is observed which shows that urban area of the city is increase which reduce the open space for move out of the storm water. The fast urbanization increased anthropogenic pressure vacant land and hydrological status of the city as well.

d) SOIL CONDITION

The southern portion has exceptionally fine soil grains size and fine soil is transcendent in eastern portion as can be seen by the outline this may be one of the reasons for expansive waterlog patches in eastern portion. The outskirts of the city have uncovered soil which is within the utilize for development by large thus the water system propensity and edit sort map also contribute within the presence of breeding habitat of the vector which should be analyzed.

e) ELEVATION / SLOPE CONDITION OF CITY

The physical geography of the city in terms of elevation, changes from 20 M in the south and 40 M within the north and incline is very delicate with, Avg. slope (0.5 %) within the NE to SW heading with normal. rise of approximately 35mts. The ancient city is arranged on the hilly stage of rise 35 mts. A few lowlying tracks can be seen along the natural drains within the city. As such the natural height and incline are completely altered in due course of time driving to arrangement of various water logging patches and in this way it is required to think about the incline at exceptionally neighborhood level to orchestrate for the common way of runoff which will diminish the water logging hence to large extent hindering the arrangement of breeding grounds. The peri-urban regions of the city have generally less rise as compared to the core or center city.

f) WATER LOGGING

Due to drainage Clogging, Blocking Because of solid waste and sewerage mixing also silting of storm water Drains

6. LIST OF FACTORS FOR THE IDENTIFICATION OF HIGH MEDIUM AND LOW CATEGORY

Results of heavy rain fall like water logging period, logging depth, slope of the city drainage density, population density are taken as factors after study of which we can identified the high medium and low flood hazard zone in Vadodara city.



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S.NO	THEME	CLASS	RANK	WEIGHT
1	Built Up Coverage	0 to 25 %	1	15 %
		26 to 50%	2	
		51 to 75 %	3	
		76-99 %	4	
		100 %	5	
2	Slop (In Degree)	< 2	1	15 %
		2 - 5	2	
		5 - 15	3	
		15 - 30	4	
		> 30	5	
3	Drainage Density (Km/Km2)	< 1.5	1	15 %
		1.5 - 3.0	2	
		3.0 - 4.0	3	
4	Distance to Vishwamitri River (In Meter)	0-100	1	
		100 - 500	2	
		500 - 1000	3	
		1000 -<	4	
5	Population Density (Persons/ Sq. Km)	250- 500	1	15%
		500 - 1000	2	
		1000 - 2000	3	
		2000 - 4000	4	
6		4000 - <	5	20.01
6	Flood Depth (In M)	0.00 - 0.50	1	20 %
		0.51 - 0.75	2	
		0.76 - 1.00	5	
		1.01- 1.30	<u></u> Л	
7	Water Logging Deriod (In Hours)	1.31 - \	-+	200%
/	water Logging I erioù (III fiours)	0-1	1 2	2070
		1-2 2_5	2	
		<u> </u>		
		5 - 10	+	

LAYERS ON THE BASIS OF BUILT UP COVERAGE

The Map shows the Built-up coverage range of within the VMC Boundary. As higher percentage of built up will the less runoff condition. Higher congested area. Percentage of property damage and assets is more in higher built up area than in lower Built up area.

Built Up Coverage is range from 5 % Coverage to 80 % Coverage.

Fig 03: BUILT UP MAP OF VADODARA CITY



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LAYERS ON THE BASIS OF SLOPE

Slope of the natural land is one of the effective elements of flood. The danger from flash flood increases as the surface slope increases. It could be flood vulnerability. a solid marker for The flow velocities in the river will increase when river slope increases. Slant inclination may be a degree of the between alter relationship in even and vertical separations between at slightest two points usually communicated in rate. The output slope raster is calculated as percent slant or degree of slant utilizing the taking after equation:

Percent slope = Change in elevation (Rise) X100 / Distance (Run)

The alter in rise (rise, in feet) and distance (run, in between chosen points calculated feet) was to get the incline and prepare an incline outline of the city. Slope map of the study area is prepared using SOI top sheet having 10-meter contour interval within GIS environment.





Figure 0-4: Slop Map of Vadodara City

LAYERS ON THE BASIS OF DRAINAGE DENSITY

Drainage thickness could be a degree of stream dividing. Seepage thickness reflects basin's geography and climate. For the same topography and incline point, muggy locales tend to have lower thickness due to development of thick vegetation that advances invasion. A tall esteem of seepage thickness shows a generally tall thickness of streams and hence a fast storm handle.

Fig 04: Drainage Density of Vadodara City



LAYERS ON THE BASIS OF POPULATION DENSITY

It is one of the most powerful indicators for flood vulnerability mapping. It indicates the ratio of total population in a given area. Significance has given to this pointer that higher the thickness. flood defenselessness is additionally tall. Since more



individuals will be influenced and chances of property lose are more, every day movement will be ceasing. The present research, population density calculated as ward wise.

Fig 05: Population Density of Vadodara city



LAYERS ON THE BASIS OF FLOOD DEPTH LEVEL

Flood Depth level will indicate about the logging status of water in that area. Also, with more flood depth more Damage can happen either physically or economically. Even more depth level will support MAGAR to enter in the city area also in case of Vadodara city.



Fig 06: Flood Depth Level of Vadodara City

LAYERS ON THE BASIS OF FLOOD LOGGING PERIOD

Flood logging period will indicate about the effect level and difficulty facing hours by the people of that area. More logging period will give more damage time.

Fig 07: Flood Logging Period of Vadodara City

FLOOD HAZARD CATEGORY (HIGH MEDIUM AND LOW)



The flood Hazard category map generated by integrating the thematic layers like Built Up Area, Slope, Population density, Drainage density, flood level, flood logging period, the factors affecting the flood prone area and their weightages assigning based on paper review and self-observation opinion and previous case studies.

Fig 08: Flood Hazard Category Map (High, Medium & Low Zone)

7. FLOOD MANAGEMENT PLAN (STRATEGIES AND PROPOSALS)

The reality is that climate alter will bring with it unusual and exceptional climate changes. In Vadodara the onset of rainstorm has been seen to be postponed by a month compared to few decades prior. So, it is fundamental that the specialists and individuals of this city ought to arrange on a facilitated and compelling response on adjustment, moderation and readiness for lightening the effect of the climate alter.

There are a few approaches to flood moderation. These approaches run the extent of brief to long-term measures that incorporates both unstructured and organized approaches. Organized measures include long



term framework improvement to combat the unremitting flooding, though non-structured measures involve low capital venture brief term activities.

WHAT TO DO? @ DEVELOPMENT REGULATION LEVEL

- First of all, there is requirement of flood level survey map, and which must be consider during the new development plan.
- It should be considered to for the new drainage network also.
- 50 to 100 m of buffer area must be reserved for eco zone.
- The new layer of road surface at inside of the street must have slope towards the direction of main road. Which have slope towards the river direction.
- At high flood category the built-up area can be change from horizontally expansion to vertical expansion, so that more free area is available for the fast drain out of water.
- Drainage network of the high flooding period area must be open drainage with cover of jali so that the water drains out fast.
- In the development guide line all the new construction permission is given with the plinth ht must be more than the flood level height at that area.
- Minimize the usage of concrete at road level and a buffer lane must be provided in between the sewer line and road of open soil.

DUTIES AT MUNICIPAL LEVEL

- Remove encroachment of Natural Drains as this helps in mitigating flood/ water logging problem of the City.
- Develop and connect storm water network for the entire city including peripheral areas of the city
- Develop high resolution (preferably 0.5 m) Digital Elevation Model (DEM), which will be helpful to model and predict city flooding/waterlogging accurately at sub-ward level and for planning mitigation measures.
- Periodically clean existing storm drains, which are clogged due to waste dumping and indiscriminate developmental activities
- Improve the existing solid-waste disposal system and enforce non-dumping of solid waste in drains

8. CONCLUSION

As Vadodara city is not the only which faces the problem of flood. Many other cities of India facing this hazard. We can't stop the flood condition which appear naturally. But we can stop the flood condition whose occurrence is just because of rapid unplanned urbanization. this can be possible by thinking about the natural slop of the city, stop people to capturing the water collecting pond/ waterbodies by cover them with shelter or any other purpose. We can reduce the flood condition because of heavy rain fall, by stopping the troughing of solid garbage in the sever line. only the waste water should be wave off through the sever line. So that at the time of heavy rain fall the storm water can run faster through this sever lines. this makes our city safest from flood disaster situation. The Vadodara Mahanagar Seva Sadan has proposed a Vishwa Mitri River front Advancement Extend which points at the restoration of the Vishwa Mitri stream and flood control, together with recreational activities.

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