



ISSN: 2249-894X

IMPACT FACTOR : 5.7631 (UIF)

UGC APPROVED JOURNAL NO. 48514

VOLUME - 8 | ISSUE - 8 | MAY - 2019



CAUSES AND CONSEQUENCE OF URBAN FLOOD IN BANGALORE CITY – SOLUTION THROUGH GEOSPATIAL TECHNOLOGY

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ABSTRACT:

Indian is the country which observes drought, famine and flood in the same year because of the drastic changes in the climatic and weather conditions. The floods are common in the rural and urban areas in the Indian sub-continent. Urban flood is mainly happens in the Class 1 Cities other than town and other urban places. Urban flooding is the immersion of land or property in a manufactured domain, especially in

more thickly populated regions, brought about by precipitation overpowering the limit of waste frameworks, for example, storm sewers. Earlier Bangalore city is known as Garden City, but now it is consider as the Concrete city because of the majority of Land is used by the built-up areas. There are many causes for Bangalore Urban Flood, through this paper a sincere attempt has been made to give suggestion to control the Urban Flood in BBMP region. Many data's have been collected through KSNDMC, KRSAC to analysis the Flood condition in the BBMP Region. To map and do some sorts of analysis GIS software like Arc GIS and GPS have been used. Many measures to control flood have been listed in the paper.

KEYWORDS: KSNDMC, KRSAC, BBMP, Sub-continent, Drought, Famine and GPS.

INTRODUCTION:

Flooding is an accumulation of water in an area it can be directly through rainfall irresistible to the volume of drainage systems, in other words a spill of huge amount of water from water bodies beyond normal limits. On the other hand, AFlood is an overflow of water that submerges land that is usually dry. It's can be occurred as an overflow of water from water body such as river, Lake, or Ocean. It may occur due to

accumulation of rainwater on saturated ground. Now a day Flood is the most common and recurrent natural disaster in our country. The Flood basically occurs in urban area which lead to loss of human life, animal life, property and assets is known as Urban Floods. There are many natural and human activities are responsible for flooding in the urban scenario. Floods may happen gradually and also may take hours or even happen suddenly without any warning due to breach in the embankment, spill over, heavy rains etc.

FLOOD = Finally Loss Occurred after Opportunities Denied.

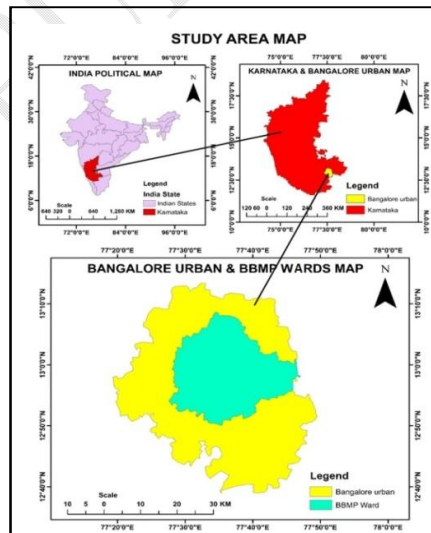
Urban flooding is the immersion of land or property in a fabricated domain, especially in more thickly populated territories, brought about by precipitation overpowering the limit of seepage frameworks, for example, storm sewers. Albeit some of the time activated by occasions, for example, streak flooding or snowmelt, urban flooding is a condition, portrayed by its dreary and foundational impacts on networks that can happen paying little respect to whether influenced networks are situated inside assigned floodplains or close to anyone of water. A potential flood of waterways and lakes, snowmelt,

storm water or water discharged from harmed water mains may gather on property and in open privileges of-way, leak through structure dividers and floors, or reinforcement into structures through sewer funnels, toilets and sink, financial hardship, loss of the travel industry, sustenance deficiency, remaking costs, cost increment and so on.. Unplanned urbanization has altered the drainage characteristics of natural catchments, or drainage areas, by increasing the volume and rate of surface runoff. Drainage systems are unable to hold with the increased volume of water and are often encountered with the blockage due to disposal of solid wastes.

Urban floods are a great disturbance of daily life in the city. It can be blocked the roads; people can't go to work or to schools. The economic damages are high but the number of casualties is usually very limited, because of the nature of the flood. The water slowly raises on the city streets. If the city is on flat terrain the water flow speed is low and can see people driving through it. The water rises relatively slow and the water level usually does not reach life endangering heights. A flood is an overflow of water which submerges land that is usually dry. The floods are mainly occurring in monsoon period which is bringing a great devastation for an Unplanned Urban area. Due to Increase in urbanization leading to climate changes and human activities have resulted in flood scenarios and High intensity rainfalls in the city. In the Urban Area due to Concrete and dense Settlement Infrastructure is not allow to Infiltration process and the Evaporation as like Rural area or Forest area as result the Runoff water increasing with the intensity of Rainfall. The Runoff water and poor Drainage system is the main indicator to developed an Urban Flood in an unplanned human Infrastructure of a Low Laying Area.

STUDY AREA:

Bangalore Urban is a district of Karnataka in India. It is surrounded by the Bangalore Rural district on the East and North, the Ramanagara district on the west and the Krishnagiri district of Tamil Nadu on the south. In 1986, Bangalore Urban district came into being, with the partition of the Bangalore into Bangalore Urban and Bangalore Rural districts. Its tree-lined streets, numerous parks and abundant greenery have led to it being called the '**Garden City**' of India. It has also known as the country's '**Silicon Valley**' and it is one of the technological innovation hubs with a technological achievement index of 13 according to the Human Development Report (United Nations Development Programme2, 2001).



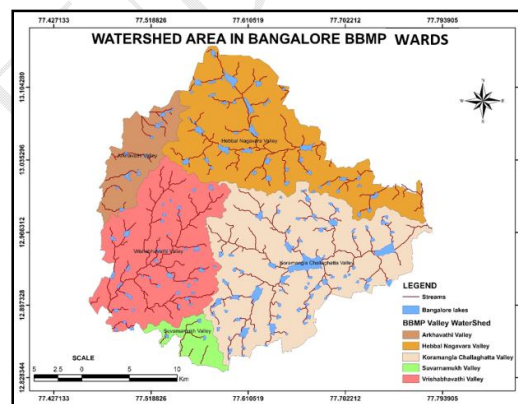
The Bruhat Bengaluru Mahanagara Palike (BBMP), is the regulatory body in charge of urban enhancements and some infrastructural resources of the Greater Bangalore metropolitan territory. BBMP is the fourth biggest Municipal Corporation in India being in charge of a populace of 6.8 million of every a region of 709 km². Its limits have extended in excess of

multiple times in the course of the most recent six decades. In January 2007, the Karnataka Government issued a warning to combine 100 wards of the recent Bangalore Mahanagara Palike with seven City Municipal Councils (CMC)s, one Town Municipal Council (TMC) and 111 towns around the city to frame a solitary regulatory region. The procedure was finished by April 2007 and the body was renamed 'Bruhat Bangalore Mahanagara Palike'(Greater Bangalore Municipal Corporation). It is located at 12.97°N 77.56°E and covers an area of 741 km² (286 sq. mi). **Bangalore Urban has a total of 198 BBMP wards** spread across the 4 taluks namely, Bangalore North, Bangalore South, Bangalore East and Anekal. It is categorised into **8 zones** namely, Byatarayanapura Zone, Dasarahalli Zone, Rajarajeshwari Nagar Zone, South Core Zone, West Core Zone, East Core Zone, Bommanahalli Zone and Mahadevapura Zone.

PHYSIOGRAPHY AND WATER SHED IN BBMP:

BBMP lies in the southeast of the South Indian state of Karnataka. It is in the heart of the Mysore Plateau at an average elevation of 900 mts. It's located at 12.97°N 77.56°E and covers an area of 709 km². The majority of the city lies in Bangalore Urban district of Karnataka is surrounding by the rural areas are a part of the Bangalore Rural district. The topography of Bangalore is **generally flat**, though the western parts of the city are hilly. The **highest point** is **Vidyaranyapura Doddabettahalli**, which is **962 mts** and is situated to the north-west of the city. The terrain of Bangalore is such that the water flows out on sloping land, but does not infiltrate quickly into the surface soil horizon. This phenomenon of water repellency is due to crusting of surface soils devoid of vegetation. No major rivers run through the city, although the Arkavathi and South Pennar cross paths at the Nandi Hills, 60 km to the north.

Watershed Area - In the earlier days Bangalore was very well known as "**The City of Lakes**". In Bangalore Urban BBMP Wards **Koramangala and Challaghatta valley** is the largest catchment around **255 km²** and also large water shed area with a greater number of lake than other and followed by **Hebbal valley with 207 km²** and followed by **Vrishabhavathi valley 165 km²** and followed by **Arkavathi Valley** and some of the part of the **Suvarnamukh Valley**.



Map 1: Valleys and Watershed in BBMP Region

The interconnected lakes in Koramangala and Challaghatta and Hebbal valley's join at Nagondanahalli village (BBMP Ward 94—Hagadur) and finally joins DakshinaPinakin River. Interconnected lake systems in Vrishabhavathi valley joins Arkavathi River which is a tributary of the river Cauvery. In the urban area of Bangalore, water bodies cover about **5%** of the land. The lakes of Bangalore have attained an important ecological status as the lakes have turned into lentic-closed aquatic habitats. There are nearly **170 lakes** in Bangalore. **Hebbal Valley, Koramangala & Challaghatta Valley and Vrishabhavathi Valley** are the three major valleys of Bangalore BBMP wards

OBJECTIVE:

Urban flood is common in cities like Bangalore because of every year built-up increase and other land use and land cover is decreasing. The major objective of this paper is Identification and Marking of Flood Prone Area in BBMP Region using the data given by the KSNDMC. Creating Low laying areas and stream network maps for the same. Analyzing the causes and consequences for the urban flood in Bangalore city or BBMP Region. Some controlling measure identifications.

DATA SOURCE:

Different data have been used for this research paper, its collected from the different government and non-government organizations those are as follows. **Spatial Data:** Satellite imageries of Resource SAT 2A & CARTOSAT 1 to prepare base map. **Non-Spatial Data:** Census Data for the year 2001 and 2011 are collected from Census of India. Rainfall Data, Flood prone area from KSNDMC and KSRSAC. BBMP official website for BBMP Ward Information. Websites of some particular departments and common website information. References from books, articles and magazines, journals, etc. Personal views and observations.

METHODOLOGY:

GIS Software has been used to prepare this research article. The major tools are spatial analysis tool, Data management tool, Buffer analysis and density tools in Arc GIS Software and GPS Instruments have been used to identification of spot and to get the data related to the low lying areas and flood prone zones.

RESULT AND DISCUSSION:

Floods bring misery to those that live in the area. That can cause loss of life and often cause a great disruption of daily life: water can come into people's houses, drinking water and electricity supplies may break down, roads can be blocked, people can't go to work or to school. Floods all over the world cause enormous damages every year like economic damages, damage to the natural environment and damage to national heritage sites. A flood is a situation in which water temporarily covers land where it normally doesn't. This water comes from the sea, lakes, rivers, canals or sewers.

Unplanned Urbanization has drastically altered the drainage characteristics of natural catchments, drainage areas, by increasing the volume and rate of surface runoff water. Drainage systems are unable to cope with the increased volume of water and often encountered with the blockage due to indiscriminate disposal of solid wastes from different sources. Encroachment of wetlands, floodplains, etc. obstructs floodways causing loss of natural flood storage.

As per IISC Study, unchecked concretization and intense loss of wetland and vegetation throughout the years are the two key reason causing continuous flooding during a spell of substantial downpour or rainstorm in Bengaluru. Specialist from IISC said high thickness Urban Development in Catchment zones prompts an expansion in impenetrable regions (where simple water stream is thwarted, therefore causing water logging or flooding) in the city.

In every year during the monsoon the following area are affecting by Flood:

East zone: Koramangala, Austin Town, Domlur, and Jayamahall.

West Zone: Rajkumar Road, RMV Layout, and Mahalakshmi Layout under; and

South zone: Bhuvaneshwari Nagar, Maruthi Nagar, Bapuji Nagar, and Tavarekere in the Sirsi Circle flyover, Mysuru Road, JC Road, Gandhinagar and Santhinagar, HSR Layout, Hebbal, Rajarajeshwari Nagar. Nayandahalli, Madiwala and BTM Layout.

To mitigate and manage these flood events the **Indian Institute of Science (IISc), Bangalore** in association with **Karnataka State Natural Disaster Monitoring Center (KSNDMC)** are working, but due to the rush of people, vehicles, Roads network, settlement in low lay area can't work successfully. The KSNDMC (Karnataka State Natural Disaster Monitoring Centre) has identified **174 low** laying areas which may turn into a watery nightmare for the residents of these localities.

According to the IISC researched, the SOI (survey of India) had identified 265 waterbodies with 2748 hectares of the area in Bangalore. Year by year the water bodies are got Change into buildup areas and as result the waterways become narrow. It is a huge change of the waterbodies from 1973 to 2018 can see in the graph. The Flood in BBMP Wards Natural factor are not responsible, it's the results of human causes.

	Number of waterbodies	Area in (ha)
SOI	265	2748
1973	210	2324
1992	185	1789
2002	132	1218
2007	110	1005
2011	91	908
2018	78	768

Table: 1 Waterbodies and Area in (ha) in BBMP Region

Causes of Flood in BBMP - Flood in BBMP Wards due to increase in urbanization leading to climate changes and human activities have resulted flood scenarios and High intensity rainfalls in the city. Recent calamitous floods have spawn way for many Flood management projects aimed at development of stronger flood monitoring and smarter flood protection systems.

BBMP Wards Human-induced factors:

- There is lack of infrastructure planning in BBMP Wards.
- Rapid land use changes due to drastic urbanization and government policies.
- Green Encroachment into natural habitats.
- A huge destruction of natural channel flow in lakes and rivers.
- There are several Lakes and tanks converted into public and private layouts for example KBS Bus stop was also a lake earlier.
- Haphazard advancement of seepage framework and ill-advised wastes in new zones.
- Reduction in the conveying limit of the channels because of siltation and infringements.
- Due to decrease in the tank numbers and live stockpiling and energize limit flood are happening.
- Outfalls being encroached. Layouts in the tank bed territories which are the low laying zones.
- Dumping of strong waste into the tempest water channels.
- Climate change causing microclimates in the city zone bringing about Urban Heat Islands.
- Overall urbanization has expanded the overflow coefficient from 30% - 40% to 80%-90% and has decreased the ground water capacity. Over misuse of the groundwater has brought about consumption of groundwater levels which has prompted disappointment of bore wells and furthermore decayed the ground water quality.

Effect of Urban Floods in BBMP- During Flood there are several effects which have a directly impact on people daily life, in an urban due to high concretization of man-made environment the Flood are occurring. In Bangalore Urban BBMP wards, it's almost 78% of Land cover by the Concrete settlement (acc.to IISc Report). Most of the Floods are occurred in low laying area, where also settlement has developed. During Monsoon due to the Rainfall the low laying area developed in Flood area. Due to high concretization of land the infiltration process of the soil has reduce, so during rainfall most of the water are drained to the Low Laying area. In BBMP wards, sewage drainage is not maintaining properly. There are many effects of flood in Bangalore Urban BBMP wards, those are...

- Loss of life due to accidents, tree falling, drainage pipe breakdown etc.
- Disturbance of Daily life

- Due to flood in Low laying area facing Traffic Congestions and Transportation problems.
- Waterborne diseases are common in the flood affected areas.
- During flood, water logging is one of the major problems, which are the main factor for damages to Building, Bridges, Sewerage systems, roadways, canals & other infrastructure.
- Man hole is one of the major accidental place during flood in BBMP.
- Various human utility resources are damaging. (electric post, power transmissions, telephone line, etc.)
- The major problem in the time of flood is water contamination.

Low-lying areas (Flood prone Area) identified by KSNDMC:

The list of areas is flood Prone Areas put out by the Karnataka State Natural Disaster Monitoring Centre (KSNDMC). There are around **174 Flood prone areas** with the heavy rainfall can change into a Flood Areas. Every year during the rainy season include the area near the Kino Theatre underpass in Sheshadripuram, Shivanand Circle, Okalipuram underpass, Koramagala, Ejipura, Shantinagar, KSRTC Depot, Magadi Road, Vijaynagar, Bapujinagar, GaliAnjaneya Temple, Nayandahalli, Gangondanahalli, HSR Layout, AnandRao Circle, Halasur Double Road, Kempegowda Layout, Wilson Garden, Arekere, Kurubarahalli, HRBR Layout, Nandini Layout and Laggere are **mainly chances for Flood occur**. They had issued a list of areas prone to flooding so the concerned agencies can take precautionary measures.

"Flood prone Area= FPA"

Table 2: Low Lying Areas Identified by KSNDMC

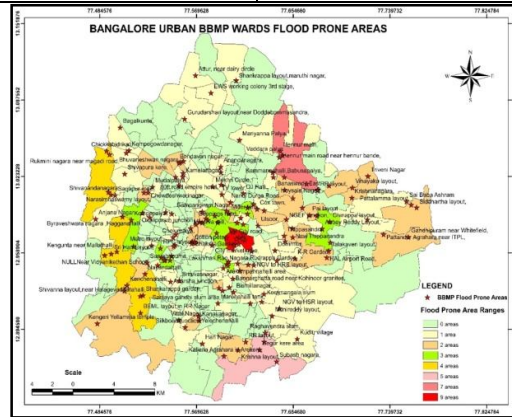
SL NO	LOW LYING AREA	WARDS	No of FPA	ZONE
1	Pai layout	A Narayanpura	3	Mahadevapura
2	Benniganahalli railway underpass			
3	Udayanagara near A Narayanpura			
4	Hosurlashkar road near Potlappa garden	Adugodi	2	South
5	LakshmanRaoNagara			
6	Rudrappa Garden	Agaram	1	East
7	Mekhri Circle	Aramane Nagar	1	West
8	Krishna layout	Arekere	2	Bommanahalli
9	RR layout			
10	Attur, near dairy circle	Atturu	1	Yelahanka
11	Bagalkunte,	Bagalkunte	1	Dasarahalli
12	Banaswadi, East	Banaswadi	1	East
13	Triveni Nagar	Basavanapur	2	Mahadevapura
14	Krishnanagara			Mahadevapura
15	1st main 8th cross N.R. Garden Cholarpalya	Basaveshwaranagara	1	West
16	VishwaPriyaNagara near Begur Main road	Begur	5	Bommanahalli
17	Begurkere area			
18	Raghavendra slum			
19	Subashnagara			
20	KallenaAgrahara in Arekere			
21	On the IRR near Dell company	Bellandur,	1	East
22	Kasturinagar down ramp	Benniganahalli	1	
23	Kamaraja road	Bharathi Nagar	1	
24	Someshwara colony near silk board	BTM Layout	1	South

	junction			
25	Sanjaya Gandhi slum area	Byrasandra	1	
26	Jayanagar 3rd block LIC Colony	Byrasandra Ward	1	
27	Bhuvaneshwarinagara	Chokkasandra	1	Dasarahalli
28	Cotton pete	Cottonpete	3	West
29	Bhakshi Garden			
30	Binny Mill tank			
31	NGEF junction	CV Ramannagar	1	East
32	Sampangiram Nagar	Dattatreya Temple ward	1	West
33	Ranganatha layout, BHEL circle	Deepanjalinaagra	1	South
34	City market area	Dharmrayswamy Temple	1	
35	Rukmininagara near magadi road	Doddabederakal	4	R R Nagar
36	Shivanandanagara			
37	KalikaNagara Main road			
38	Chickkabidrikal			
39	Dommlur	Dommluru	1	East
40	DrRajakumar road South Magadi police station	DrRajakumar word	1	North
41	NGV to HRS layout	Ejipura,	1	South
42	Railway underbridge near Kino theatre	Gandhinagar,	2	West
43	Pillappa garden			East
44	80ft road empire hotel	Gangenahalli,	1	East
45	GarudacharplayaBasavanagara	Garudacharpalya,	1	Mahadevapura
46	Hennur main	Geddalahalli railway gate	1	
47	Vittala nagar, near kempegowdanagar	Ghalianjaneya Temple	3	South
48	Rudrappa garden			
49	Samrudhinagar			
50	Adarsha junction	Girinagara,	1	
51	Shankarappa garden	Gopalapura	1	R R Nagar
52	Bismillanagar	Gurappanapalya,	1	South
53	PattandurAgrahara near ITPL	Hagaduru,	2	Mahadevapura
54	Gandhipuram near Whitefield			
55	Talakaveri layout	HAL	2	
56	HAL Airport Road			
57	RPC layout	Hampi nagar	3	South
58	Maruthinagara, near bapujinagara			
59	GaliAnjaneya temple road			
60	Anandanagara	Hebbala,	1	East
61	Sarjapur road	Hegganahalli	1	Dasarahalli
62	Kenchenahalli	Hemmigepura	2	R R Nagar
63	KengeriYellamma temple			
64	Anjana Nagar	Herohalli	1	
65	Yeshwanthpur Railway Station	HMT	2	South
66	Tumkur road Marappannapalya			
67	Wilson garden area up to bannerghatta road	Hombegowdanagara	3	
68	PWD quarters near Wilson Garden			

69	Venkatareddy nagar near Siddapura	Horamavu	7	Mahadevapura
70	Kalyananagara 100ft			
71	Babusapalya			
72	Bhovi colony, near Sane guruvanahalli tank			
73	Hennur main road near hennurbande			
74	Hoysala Nagar			
75	RR layout			
76	Vaddarapalya			
77	Thippasandra	Hoysalanagar	1	East
78	NGV to HSR layout	HSR Layout	1	Bommanahalli
79	Sai Baba Ashram	Hudi	1	Mahadevapura
80	Marenahalli tank	J P Nagar	1	South
81	Maruthi nagar, sankrappa layout	Jakkasandra	1	
82	TV tower	Jayachamrajendranagara	1	East
83	Jayamahal road from doordarshan center to j c nagar	Jayamahal	2	East
84	Miller tank			
85	Krishnappa garden behind byrasandra tank d/s	Jayanagar	1	South
86	Indiranagar 80ft road	Jeevanbhimanagar	1	East
87	Kengunta near Mallathalli	Jnanabharathi Ward	4	R R Nagar
88	NULLNearVidyanikethan School			
89	Sri Hari Layout			
90	Byraveswaranagara ,Hagganahalli			
91	Brindavan nagar	JP Park	3	
92	Brindavananagar below Matthikere tank market			
93	Sanjeevappa garden			
94	Pattalamma layout	Kadugodi	2	Mahadevapura
95	Siddhartha layout			
96	Kammannahalli	Kammannahalli	1	East
97	Srinivasnagar	Kathriguppe	1	South
98	Shankrappalayout,maruthi nagar	Kempegowda Ward	1	Yelahanka
99	Hari Nagar	Konankunte	1	Bommanahalli
100	K R Garden	Konnenaagrahara	1	East
101	Koramangala slum	Koramangala	1	South
102	Kottigepalya	Kottigepalya	3	R R Nagar
103	Kamakshipalya tank slum area			
104	VinayakaLayout,NearNagarabhavi			
105	Nagannanagar,nearbinny mill road	KR Market	1	West
106	DrAmbedkar Nagar	KR Puram	2	Mahadevapura
107	Vinayaka layout			
108	Silkboardjunction,	Kumaraswamylayout	1	South
109	Chowdeswarinagar,	Laggere	2	R R Nagar
110	Narasimhaswamy layout			
111	Bannerghatta road near Kohinoor granites	Lakkasandra	1	South
112	Munireddy layout	Magammanapalya	1	Bommanahalli

113	Kamalanagar	Malleshwaram	1	West
114	Jeevanahalli under bridge	Maruthiseva nagar	1	East
115	Metro layout	MarutiMandir ward	1	West
116	KEB compound maththikere	Matthikere	1	
117	DJ Halli	Muneshwaranagar	1	East
118	Mudalpalya	Nandini Layout	1	West
119	Nayandahalli	Nayandahalli	2	
120	Sarvabhuma			
121	New Thippasandra	New Thippasandra	2	
122	Suranjandas road near Ade			East
123	Jagajeevan Ram Nagar	Padarayanpura	2	West
124	Ppadarayanpura			
125	Shivapurakere	Peenya Industrial area	1	Dasarahalli
126	Sindhi Colony junction	Pulakeshinagar	3	East
127	Frazer town underpass			
128	Pulakeshinagara			
129	Janapriya Apartments near Rajarajeshwari temple	RR Nagara	3	R R Nagar
130	Shivanna layout, near Halagevaddarahalli			
132	BEML layout in RR Nagar			
131	Nandi Durga Road	Ramaswamypalya		East
133	Broadway road	Sampangiramanagar	3	
134	KR circle underpass			
135	OppChalukya hotel			
136	Cox town	Sarvagnyanagar	2	
137	Ulsoor			
138	Ashok nagar, museum road	Shantalanagara	9	
139	UB City road			
140	Anil Kumble junction			
141	Ashok nagar signal junction			
142	Commisiariat road opp to Garuda mall			
143	MG Road near Mayo Hall junction			
144	Preemarose road opp to sr Police officers mess			
145	Residency Road near Opera junction			
146	Richmond road opp to bus stand			
147	30Hosur-Lashkar road at gajendra nagar	Shantinagara,	1	
148	Seppings road	Shivajinagar,	1	
149	14th cross p&t colony, Cholarpalya	Shivanagara	1	West
150	Arekempannahalli area	Siddapura	1	South
151	Kudlu village	Singasandra	1	Bommanahalli
152	Okalipuram junction	Subash Nagar	3	West
153	KMF junction near Slum Board compound			
154	Minerva mill			
155	Kempegowdanagar	T Dasarahalli	1	Dasarahalli
156	Mariyanna Palya	Thanisandra	1	Yelahanka
157	Shivananda Circle railway underpass	Vasanth Nagar	1	East
158	Sanky road opp to Le Meridian hotel	Vasanthnagar	2	
159	Shivananda junction			

160	Vittal Nagar	Vasanthpura	1	Bommanahalli
161	Gurudarshan layout, near Doddabommasandra	Vidyaranyapura	1	Yelahanka
162	Abbay Reddy Layout	Vignayanagar	3	Mahadevapura
163	Chinappa layout			
164	Kallapa layout near basavanagara			
165	Cholurpalya	Vijayanagara	1	South
166	Kamakshipalya Tank slum area	Vrishabhavathi Nagar	1	West
167	EWS working colony 3rd stage	Yelahanka Sattelite Town	1	Yelahanka
168	Yelechenahalli	Yelechenahalli	2	Bommanahalli
169	Kanakanagar			



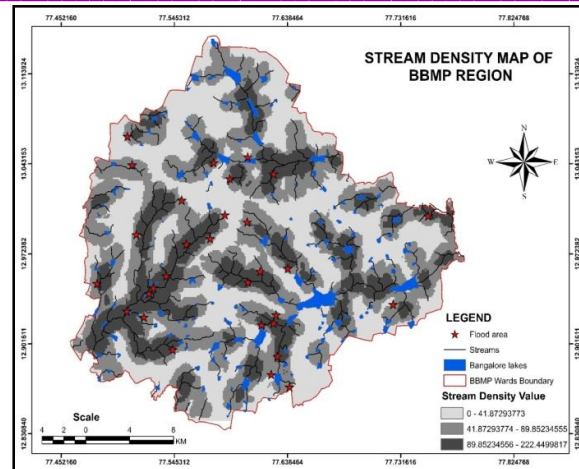
Map 2: Low lying areas and Flood prone areas in BBMP Region

The index Zero refers the safe zone and the Nine refers the danger zone according to the KSNDDMC Data related to the Low-lying areas and flood areas.

Stream Density in BBMP Wards - The Stream density calculates a magnitude-per-unit area from polyline features that fall within a radius around each cell. If the linear unit is meters, the output area units will default to **SQUARE KILOMETERS** and the resulting line density units will convert to kilometers per square kilometer. The end result will come as raster format.

The stream density map has created by the stream network available in BBMP Regions. The more stream join has greater accumulation of the water. The stream density classifying into 3 value. The 3rd value class has represented more water accumulation than other.

From the very light area (1st density value area) the surface runoff moves rapidly because of the hill slopes to the channels of 2nd density value area (medium dark area) and the 3rd density value area (dark area) have the greater accumulation of water. Due to poor management and the infrastructures the flood is develop over here.

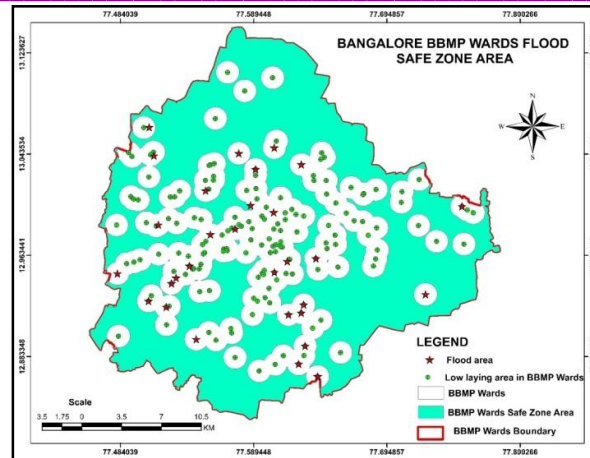


Map 3. Stream Density Map of BBMP Region

Measurement to control Urban Floods - Controlling the Urban flood is very difficult task for the local government. But they are trying in all the way to control and take care of the public. Many countries and local bodies adopted many mechanisms to control the urban floods. Some of the major steps towards controlling urban floods have been listed, these can be adopt in the BBMP Region.

- Development of 'sponge city': Chines Method to control urban flood.
- Green roofs/rooftop gardens
- Create flood plains and overflow areas for rivers
- Separating rainwater from the sewer system:
- Plant more vegetation for ground water recharge:
- Rain water storing conservations
- Develop more Water Conservation area in Low Laying area.

Creating Safe Zone in BBMP Regions - Safe zone is the concept where we are not having any type of influence of Urban floods. According to KSNDMC research they have mentioned 169 areas as urban flood areas in BBMP region. Below map detailed explains the areas which are affected by flood and which area safe as per the KSNDMC data. For creating the safe zone in BBMP Wards, here I select the area which are not come under 1 km from the Low Laying Area and Flooded area, that consider as Flood free zone. Basically, in BBMP wards floods area mainly occurring through the Water logging in the Low laying area and also where the area has less infiltration process due to Concretization of the surface and very poor condition of the drainage condition. These areas area out of Low Laying Area and Flooded area. The central part of the BBMP Wards has more flood prone area and from the center to outer boundary of the BBMP Wards flood prone area is reducing. If the Unplanned Urbanization is keep growing so after few years Bangalore Urban will be known as Concrete city instead of Garden City. According to IISc if the development keeps growing up to 2022 so.



Map 4 Flood Free Zone (safe Zones) of BBMP Region

CONCLUSION –

A sudden increasing of the water level in an Urban area due to uncertain rain and poor infrastructure development as result inundate the human habitation, loss of human and animal life, property known as Urban Flood. When we compare major cities among them, all cities one or another time faces the Urban Flood. Likely Mumbai, Bangalore, Chennai, Kolkata and other cities. In the Monsoon season living in metropolitans cities becoming more headache then other cities. In Karnataka, Bangalore Urban also one of the Flood prone area, during monsoon Bangalore facing flood in many places. The Karnataka State Natural Disaster Monitoring Centre (KSNDMC) has identified 174 low laying areas which can be turn into the Flood. According to the IISC researched, the SOI (survey of India) had identified 265 waterbodies with 2748 hectares (before 1973) of the area in Bangalore but the present situation 768 hectares (2018) of the area has cover by the water bodies. In Bangalore has identify around 30 flooded area in the past years. Through the Stream density analysis got to know the most of the flooded areas near to the high-density accumulation of the stream water. In Bangalore BBMP wards have few RWH center, so development of the RWH center is the main controlling factor to reduce the Urban Flood. It is difficult to increase the percentage of Green patches in the Bangalore city. But we can maintain the percentage of availability of the green patches. This can applicable to the waterbodies also. The proper measurements can easily reduce the Urban Flood in BBMP Regions.

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