



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

# IJIRSET

International Journal of Innovative Research in  
**SCIENCE | ENGINEERING | TECHNOLOGY**



# INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 13, Issue 5, May 2024

**ISSN** INTERNATIONAL  
STANDARD  
SERIAL  
NUMBER  
INDIA

Impact Factor: 8.423

# Influence of Land Use and Land Cover Changes on Urban Flooding Using GIS Mapping a Case Study on Bangalore City

Nandan S R, Narayan Naik, Nithin Kumar R, Prabhu

U.G. Student, Department of Civil Engineering, Dayananda Sagar College of Engineering, Bengaluru, Karnataka, India

U.G. Student, Department of Civil Engineering, Dayananda Sagar College of Engineering, Bengaluru, Karnataka, India

U.G. Student, Department of Civil Engineering, Dayananda Sagar College of Engineering, Bengaluru, Karnataka, India

U.G. Student, Department of Civil Engineering, Dayananda Sagar College of Engineering, Bengaluru, Karnataka, India

**ABSTRACT:** In past few years, Bangalore city is facing the flood disasters frequently during monsoon seasons. The land use change study is carried out for the most flood prone watersheds in the city for the years 1992, 1999, 2002, 2008, 2017 and 2020. Google earth image is used to investigate the land use and land cover changes using GIS mapping. Flood is one of the significant and frequent disasters in the world. Of these more than 50% of the events occur in Asia. Every year there is loss of human life, animals, houses, goods and property due to the outrage of floods. The study has showed an increasing imperviousness in the study area of Bangalore city watershed region. The average runoff coefficient corresponding to the land use and land cover changes has increased from 42% in the year 1992 to 95% in the year 2020. The case study of 2016 flood event in the city shows, location specific hydrological behavioral changes in few of the frequently flood vulnerable areas in Bangalore city. This paper describes the causes, circumstances and impact of flooding events in Bangalore city. In an urban scenario, like Bangalore, floods occur due to natural phenomenon such as heavy and / or high intensity rainfall, human factors such as blocking of storm water drains, population growth leading to improper land use & unplanned settlements etc. The study also shows details on missing water bodies and missing stream links which is also one of the major reasons for the flood events in the study area. Overall, it is evident that, land use changes in form of increased imperviousness, missing water bodies, missing stream links due to urbanizing factor has increased the flooding frequency in Bangalore city.

**KEYWORDS:** Flood disasters, Population growth, Imperviousness, Runoff coefficient.

## I. INTRODUCTION

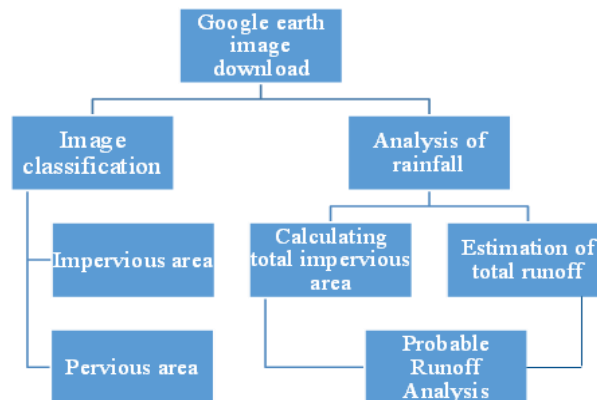
Due to urbanization dynamic and incremental process of increasing imperviousness in the urban catchment. The infrastructure demand in urban areas lead to lot of paved roads and building developments there by increasing the imperviousness. The developmental activities will officially or unofficially lead to encroached water bodies and stream links. This leads to the change in runoff coefficient and decreased carrying capacity of the storm drains. It will result in increased frequency of flood events [18]. Flood is a significant and recurring disaster. Repeated floods lead to loss of human life, animal life, property and assets. Many factors, natural and human activities is responsible for flooding in the urban scenario. Urban flood is a highlighted issue of disaster management which needs a first order priority focusing on the assessment of flood vulnerable areas, Flood hazardous mapping, mitigation plans and flood early warnings and forecasting [20]. There are four interrelated but separable effects of land-use changes on the hydrology of an area: changes in peak flow characteristics, changes in total runoff, changes in quality of water, and changes in the hydro-logic amenities (Leopold, 1968). Of all land-use changes affecting the hydrology of an area, urbanization is by far the most forceful. Census 2001 figured 285 million people in 35 metro cities of India, and is estimated to cross 600 million with 100 metro cities in 2021. Climatic variability and regional environmental challenges are known to aggravate flood risks. Urban flood, being significantly different from those of flooding natural or rural areas, has drawn attention of disaster risk managers [15]. All together 209 areas have been identified as flood prone in Bengaluru. Out of these 58 areas are hyper-sensitive and 151 areas are sensitive. Some of the flood-prone areas are Veerannapalya and HRBR Layout in eastern Bengaluru, Industrial Area of Rajajinagar in West Bengaluru, Bannerghatta Road, Nayandahalli Junction, Silk Board junction, Gali Anjaneya Swamy Temple junction, Jayadeva flyover, Magrath-Brigade Road junction, Wilson Garden PWD Quarters in South Bengaluru, Sarjapur Road, Varthur, Panathur, Belagere and Hoodi in the Mahadevapura zone and LBS Nagar in Yelahanka zone [10].

## II. RELATED WORK

A study reveals that 65% of Bangalore lakes are sewage fed, 12% are surrounded by slum dwellings and 70% of the water bodies show loss off catchment area. There is tremendous increase in the number of water bodies in the city from 80 in the year 1990 to 201 numbers in 2023 when the city spatial extent now is 741 sq km [1]. The 201 lakes under BBMP jurisdiction it plans to restore and carry out developmental activities at 69 lakes in 2023-2024. According to study reveals that in July 2023, out of the 41 lakes surveyed, 39 lakes are polluted. In the year 1990 the built-up area was approximately 28-30% and the vegetation land was approximately more than 40% so there was less risk of flooding [2]. In the year 2002 the build-up area was approximately 37.4 % and the vegetation land was approximately 38.07 %. In the year 2017 the build-up area was approximately 78.7 % and the vegetation land was approximately 6.46%. When compared to year 2020 the built-up area is 93.3% and vegetation land is 2.96% [5].

## III. METHODOLOGY

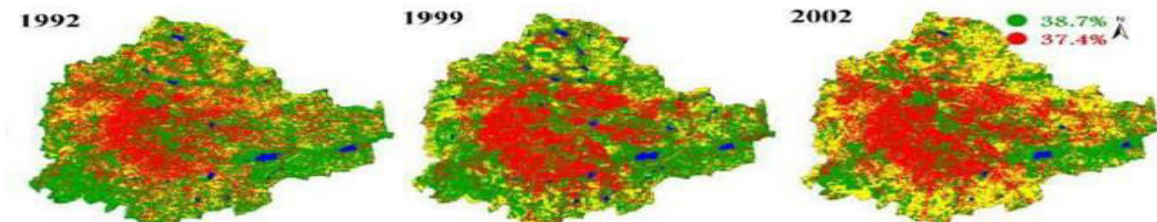
GIS mapping tool is a geospatial software application that displays a virtual globe, which offers the ability to analyze and capture geographical data. The program maps the earth by superimposing LISS IV images satellite images, aerial photography, and GIS data onto a 3D globe, allowing users to see cities and landscapes from various angles. Along with this ArcGIS is used for the image classification and Microsoft spread sheet for statistical calculations. A high-resolution image (4800x2761) of Bangalore region from the year 1992 to 2020 were downloaded to carry out the work. The flow chart shows the border method adopted to derive the land use and land cover change factors using Google earth images.

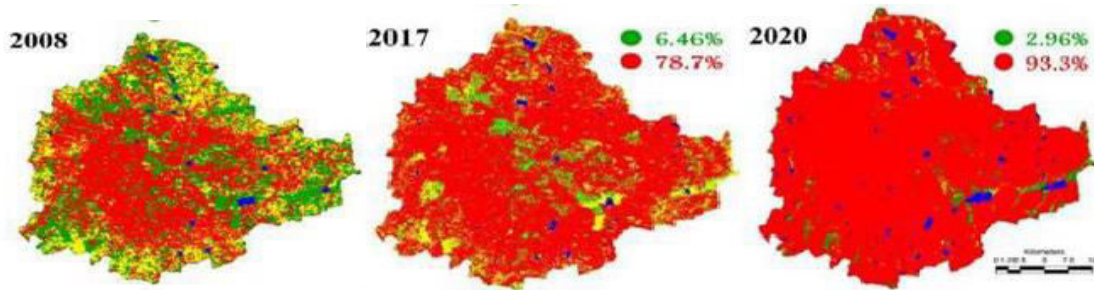


## IV. EXPERIMENTAL RESULTS

Utilize data and technology, such as geographic information systems (GIS), showing figures.

(a) Land Use (LU) & Land Cover (LC) for year 1992 - 2020





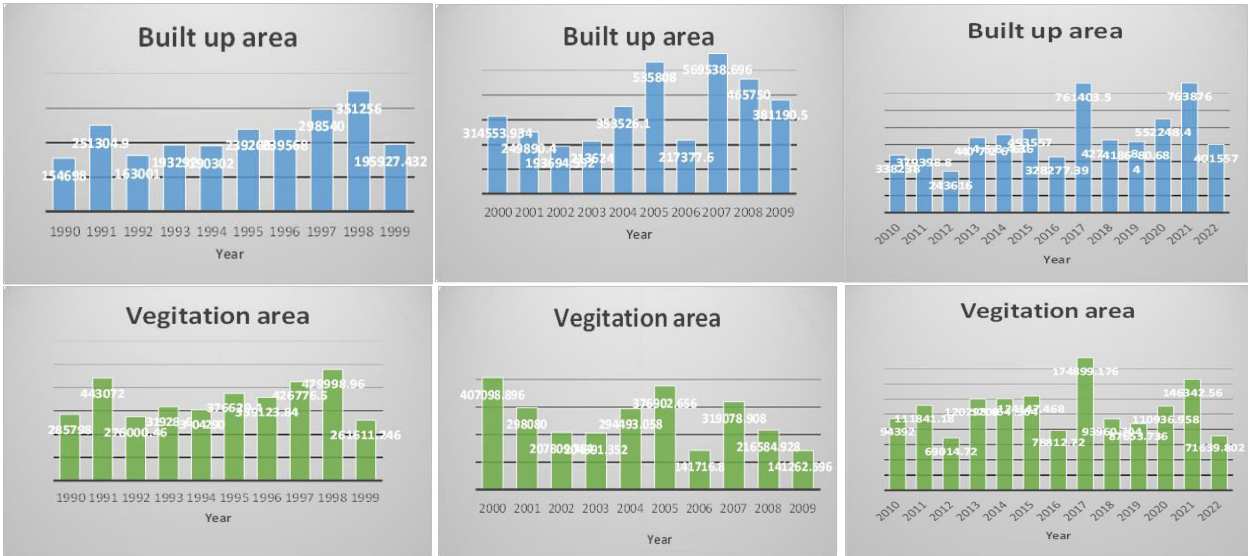
YEAR	T avg	T min	T max	PRCP	Built up area	Vegetation area	Coefficient of runoff	Q=CIA (m <sup>3</sup> /s) for built up area	Q=CIA (m <sup>3</sup> /s) for vegetation area	Q=CIA (m <sup>3</sup> /s) total area
1990	22.7	14.38	24.6	19	17700	32700	0.46	154698	285798	440496
1991	23.3	14.61	24.9	30.1	18150	32000	0.46	251305	443072	694377
1992	22.3	13	24.7	19	18650	31579	0.46	163001	276000	439001
1993	23.3	15.1	25.8	22	19100	31550	0.46	193292	319286	512578
1994	23.23	14.5	25.2	21	19700	31500	0.46	190302	304290	494592
1995	23.5	16.17	26.26	26	20000	31490	0.46	239200	376620	615820
1996	23.2	15.33	26.58	24.8	21000	31480	0.46	239568	359124	598692
1997	23.34	14.93	25.75	29.5	22000	31450	0.46	298540	426777	725317
1998	24.1	16.33	27.36	33.2	23000	31430	0.46	351256	479999	831255
1999	23.28	14.99	26.75	18.1	23532	31421	0.46	195927	261611	457539
2000	23.38	15.99	27.42	28.3	24163	31272	0.46	314554	407099	721653
2001	23.77	16.51	28.11	21.6	25150	30000	0.46	249890	298080	547970
2002	23.92	16.25	28.83	15.6	26992	28959	0.46	193695	207810	401504
2003	24.03	16.87	28.15	17.2	27000	25871	0.46	213624	204691	418315
2004	23.45	16.08	28.95	28.1	27350	22783	0.46	353526	294493	648019
2005	23.68	16.37	28.82	41.6	28000	19696	0.46	535808	376903	912711
2006	23.73	17.18	29.26	16	29535	19255	0.46	217378	141717	359094
2007	23.66	16.53	28.42	40.1	30876	17298	0.46	569539	319079	888618
2008	23.6	16.74	28.63	32.4	31250	14532	0.46	465750	216585	682335
2009	23.89	18.72	29.22	26.1	31750	11766	0.46	381191	141263	522453
2010	24.07	17.45	29.36	22.8	32250	9000	0.46	338238	94392	432630
2011	23.5	18.11	29.94	25.3	32600	9610	0.46	379399	111841	491240
2012	24.27	19.42	31	16	33100	9377	0.46	243616	69015	312631
2013	23.89	18.45	30.37	28.6	33500	9144	0.46	440726	120298	561024
2014	24.13	19.27	30.54	29.4	33900	8911	0.46	458464	120512	578976
2015	23.86	19.33	30.29	31.1	34500	8678	0.46	493557	124147	617704
2016	23.5	19.8	30.68	20.3	35155	8440	0.46	328277	78813	407090
2017	24.3	19.76	30.47	46.3	35750	8212	0.46	761404	174899	936303
2018	23.91	19.37	29.95	25.6	36300	7979	0.46	427469	93961	521430
2019	24.48	20.13	30.5	24.6	36999	7746	0.46	418681	87654	506334
2020	24.18	19.93	30.22	32.1	37400	7513	0.46	552248	110937	663185
2021	23.57	19.24	29.24	43.7	38000	7280	0.46	763876	146343	910219
2022	24.54	20.66	30.06	22.1	39500	7047	0.46	401557	71640	473197



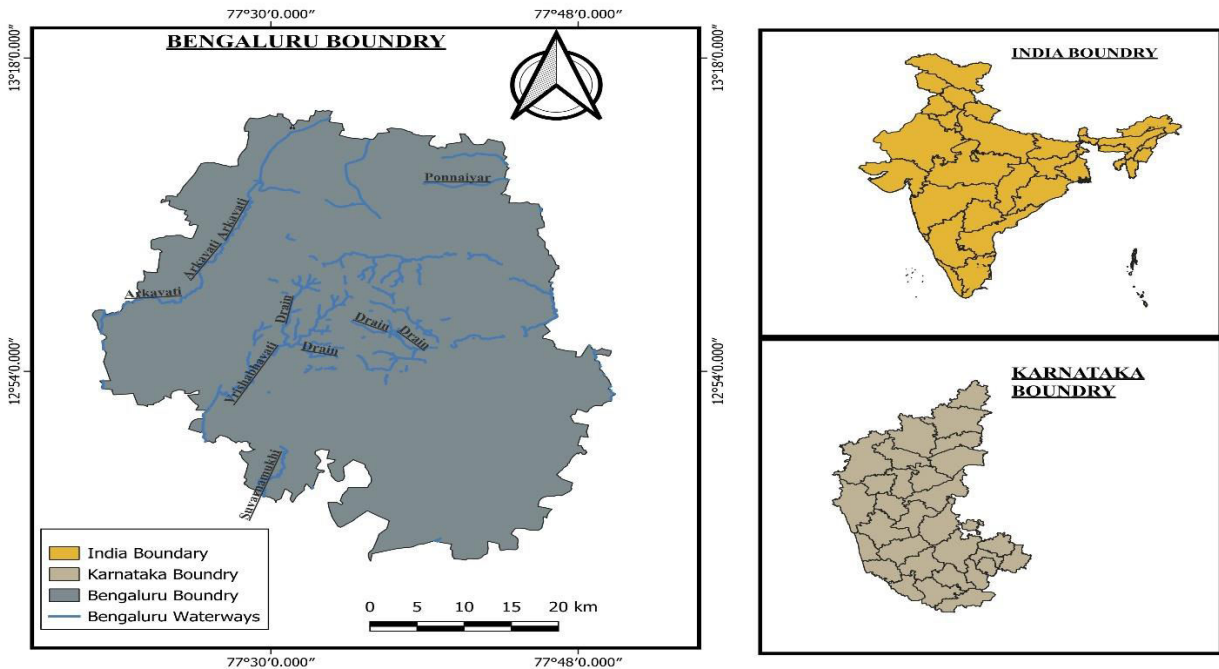
**ESTIMATION OF RUNOFF VOLUME**

Volume of rainfall is calculated by multiplying the area by the average rainfall in order to get the volume of rainfall. Calculate the runoff by multiplying the value of coefficient of runoff and volume of rainfall to get the total volume of runoff [14].

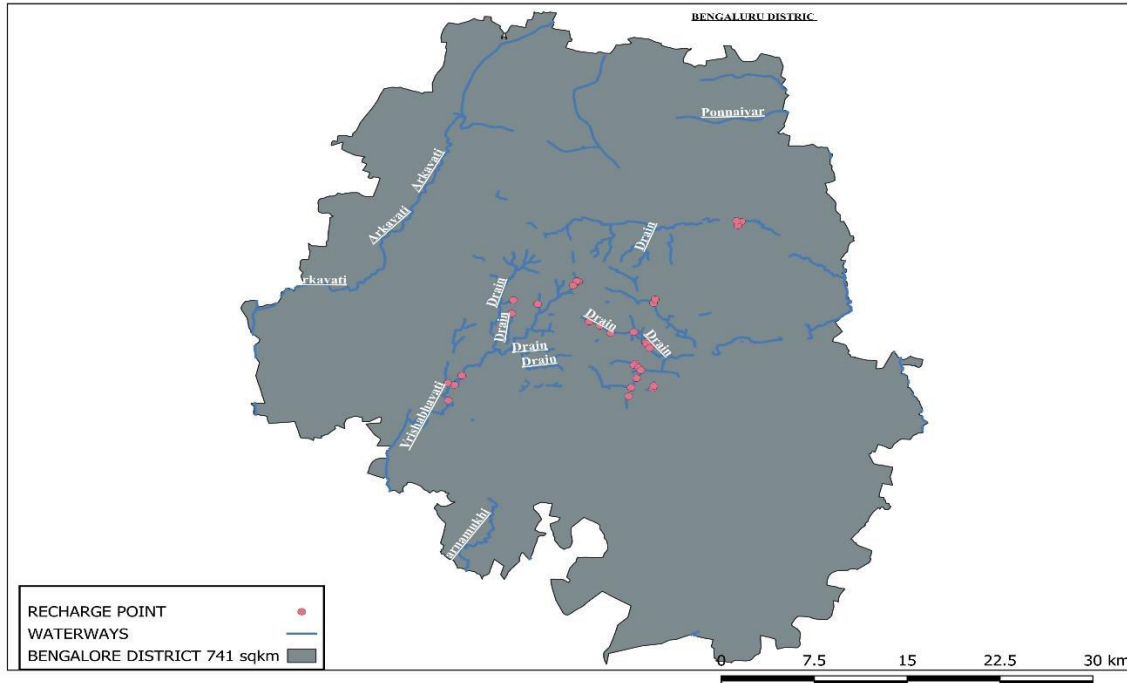
$$\text{Runoff volume} = \text{coefficient of runoff} \times \text{rainfall depth} \times \text{area} [3]$$



**WATER WAYS OF BENGALURU CITY USING (QGIS) SOFTWARE.**



**WATERWAYS WITH RECHARGE PITS INDICATIONS USING (QGIS) SOFTWARE.**

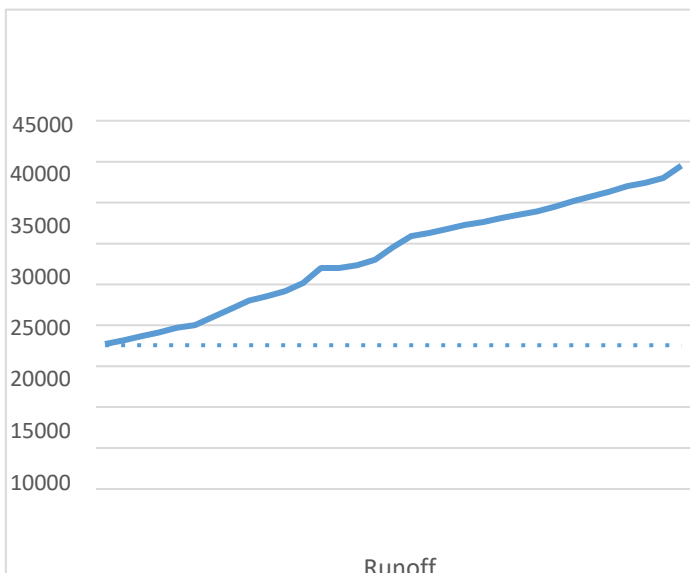


**RECHARGE PITS**

A recharge pit, often referred to as a recharge well or infiltration pit, is a simple, effective method designed to enhance the recharge of groundwater. Enhances Groundwater Recharge: Directly contributes to replenishing groundwater levels, which is especially crucial in areas facing groundwater depletion. Reduces Surface Runoff: Helps in managing runoff during rainstorms, thus reducing erosion and the risk of flooding. Improves Water Quality: The filtering action can improve the quality of the water infiltrating into the groundwater.

**SOLUTIONS FOR THE FEASIBLE OPTIONS FOR URBAN FLOOD CONTROL**

1. Green Infrastructure
2. Improved Drainage System
3. Urban Planning And Zoning
4. Storm Water Management
5. Natural Flood Management



### OUTCOMES

- GIS can be used to map and analyse the existing water sources in and around Bangalore, including lakes, rivers, and groundwater aquifers.
- Utilize GIS to analyse land use patterns and urban expansion to identify areas where development may impact water resources.
- Implement GIS-based on water quality monitoring systems to track pollution sources and identify areas with high flooding.
- Utilize GIS to delineate and analyse watersheds to understand the flow of water across different areas.
- Develop adaptive strategies

### V. CONCLUSION

In this study, land use and land cover change (urbanization) in watershed of Bangalore city over the period of 1990–2022 was investigated. This interesting development was noticed after 2002 when most part of the city started to host residential and commercial buildings [18]. Many water dried water bodies are converted to built-up areas, increasing the low lying areas and flood vulnerable areas. The area was well-developed with vertically high raised buildings, despite space being very limited for horizontal development [6]. This eventually increased the paved area in the city. The effects of urbanization on runoff characteristics and rainwater were examined. The average temperature of the city in 1990 was 23 degrees and when compared to the year 2022 the temperature increased to 25 degrees [10]. The intensity of rainfall was 190mm/hr. in the year 1990 and increased to 460mm/hr. in the year 2017 and again decreased to 220mm/hr. in year 2022. The built-up area was 17700 ha in year 1990 and increased to 39500 ha in 2022 and the vegetation area was 32700 ha in 1990 and decreased to 7047 ha in 2022.

### REFERENCES

- [1]“urbanfloods”.
- [2] P. P. Mujumdar *et al.*, “Development of an urban flood model for Bengaluru city, Karnataka, India,” *Curr Sci*, vol. 120, no. 9, pp. 1441–1448, May 2021, doi: 10.18520/cs/v120/i9/1441-1448.
- [3] E. Rukundo and A. Doğan, “Assessment of climate and land use change projections and their impacts on flooding,” *Pol J Environ Stud*, vol. 25, no. 6, pp. 2541–2552, 2016, doi: 10.15244/pjoes/63781.
- [4] P. E. Zope, T. I. Eldho, and V. Jothiprakash, “Impacts of land use-land cover change and urbanization on flooding: A case study of Oshiwara River Basin in Mumbai, India,” *Catena (Amst)*, vol. 145, pp. 142–154, Oct. 2016, doi: 10.1016/j.catena.2016.06.009.
- [5] “Bengaluru Urban Flood.”
- [6] M. T. B. Dalu, C. M. Shackleton, and T. Dalu, “Influence of land cover, proximity to streams and household topographical location on flooding impact in informal settlements in the Eastern Cape, South Africa,” *International Journal of Disaster Risk Reduction*, vol. 28, pp. 481–490, Jun. 2018, doi: 10.1016/j.ijdrr.2017.12.009.
- [7] D. Šulyová and M. Kubina, “Integrated water resources management in an urban concept: results from water smart cities and water management institutions in Slovakia,” *Entrepreneurship and Sustainability Issues*, vol. 10, no. 2, pp. 294–319, Dec. 2022, doi: 10.9770/jesi.2022.10.2(18).
- [8] D. Šulyová and M. Kubina, “Integrated management of limited water resources in Smart Cities,” in *IOP Conference Series: Earth and Environmental Science*, Institute of Physics, 2022. doi: 10.1088/1755-1315/10771/1/012003.
- [9] M. Lowe, R. Qin, and X. Mao, “A Review on Machine Learning, Artificial Intelligence, and Smart Technology in Water Treatment and Monitoring,” *Water (Switzerland)*, vol. 14, no. 9, May 2022, doi: 10.3390/w14091384.
- [10] P. Mukhopadhyay and B. K. Das, “Online mode,” 2023. [Online]. Available: <https://www.researchgate.net/publication/373397877>
- [11] J. D. Willard, C. Varadharajan, X. Jia, and V. Kumar, “Time Series Predictions in Unmonitored Sites: A Survey of Machine Learning Techniques in Water Resources,” Aug. 2023, [Online]. Available: <http://arxiv.org/abs/2308.09766>
- [12] “URBAN FLOODS IN GUWAHATI From Flood Knowledge to Urban Action`Page.”
- [13] P. Skougaard Kaspersen, N. Høegh Ravn, K. Arnbjerg-Nielsen, H. Madsen, and M. Drews, “Influence of urban land cover changes and climate change for the exposure of European cities to flooding during high-intensity precipitation,” in *IAHS-AISH Proceedings and Reports*, Copernicus GmbH, 2015, pp. 21–27. doi: 10.5194/piahs-370-21-2015.
- [14] C. D. Usman, A. P. Widodo, K. Adi, and R. Gernowo, “Rainfall prediction model in Semarang City using machine learning,” *Indonesian Journal of Electrical Engineering and Computer Science*, vol. 30, no. 2, pp. 1224–1231, May 2023, doi: 10.11591/ijeecs.v30.i2.pp1224-1231.



- [15] A. K. Gupta and S. S. Nair, "Flood risk and context of land-uses: Chennai city case," 2019. [Online]. Available: [www.internationalscholarsjournals.org](http://www.internationalscholarsjournals.org)
- [16] D. Shaji and J. E. M. Macwan, "A Study to Detect Urban Changes and its Relationship to Flash Flood in Thiruvananthapuram," *GRD Journal for Engineering*, vol. 2, 2017, [Online]. Available: [www.grdjournal.com](http://www.grdjournal.com)
- [17] M. Jamei and M. Karbasi, "Call of Papers: [Water] Special Issue "Application of Machine Learning Techniques in Water Resources Special Issue in 'Application of Soft Computing in Water Sciences' View project A Lax-Wendroff-IMPES scheme for a two-phase flow.





INTERNATIONAL  
STANDARD  
SERIAL  
NUMBER  
INDIA



# INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

 9940 572 462  6381 907 438  [ijirset@gmail.com](mailto:ijirset@gmail.com)



[www.ijirset.com](http://www.ijirset.com)

Scan to save the contact details