A Survey on Water Stagnation Detection and Prevention System in Smart Cities

E. Elavarasi
Department of Information Technology
SSN College of Engineering
Chennai, India
elavarasie@it.ssn.edu.in

I. Joe Louis Paul
Department of Information Technology
SSN College of Engineering
Chennai, India
joelouisi@ssn.edu.in

Abstract— **Water logging seems to be a common problem nowadays in the cities during heavy rains. The existing rainwater infrastructures in the cities are not adequate to assure the proper drainage of the water. This leads to streets in the low-lying areas get flooded causing traffic jams in the city. Moreover, it causes the spreading of waterborne diseases among the people especially who are living in the slums or squatters. Sometimes, they lose their homes due to waterlogging. In addition to that, pedestrians are actually clueless when they walk through the flooded streets. Hence, this paper intends to do a survey on waterlogging in the city, the causes of waterlogging, how to identify the waterlogging areas, what are the necessary measurements have to be followed for preventing the waterlogging. The main idea behind this paper is how to minimize the problems faced by the people that are caused to them due to water logging.**

Keywords— *water logging, waterborne diseases, traffic congestion*

I. Introduction

Typically, pools of stagnant water are created during monsoon or flood seasons. The prolonged standing water induced by heavy downpours poses a serious health threat to public and the environmental effects. In Chennai, most roads are getting water logged even within a single spell of rain. The monsoon rains that lashed the city in the recent days resulted in traffic snarls as most roads were full of water putting motorists to severe inconvenience. At the same time, pedestrians had a difficult time to walk on roads, as flooding of roads and streets is a regular problem. The residents of few areas in the city not only suffered from flooding of the streets, however waste water getting into their residences is another downside that people have to tackle. It is found that, water logging is a common problem in Chennai, especially during heavy rains. If remained unchecked, water logging can have serious implications for our environment[1]. Fig.1 depicts the effects of stagnant water to the surroundings.

The new conception of smart cities introduced by Government of India is aiming expedite the issue of water logging by implementing sustainable practices to retain recycle and reuse the water. Rain water harvesting is an ancient technology used in India to deal with a decreasing level of ground water. Recently, the Government of India has advised the authorities of metropolitan cities in the various states to adapt the new and high-end technologies to divert the flood water into the rivers or sea by availing the funds from Jawaharlal Nehru National Urban Renewable Mission (JNNURM). However, this is not the correct methodology, because a drainage system is not built as per the standard

leads to the reconstruction of the drainages making more expensive [2].

Fig. 1. Stagnant water.

We should utilize the runoff flowing through storm - water drains to revive the groundwater as the cities are extracting tremendous amounts of groundwater and lakes are found to be vanishing in the present scenario. The twin issues of diminished groundwater revive and water logging is mainly due to the loss of storm-water drains in urban areas and the same problem could be solved by the integration of green infrastructure into the process of storm-water administration. Hence, planning a resourceful drainage system with underground surface run-off collection pits and piece of water harvesting system is required to get relieve from water logging. To prevent pollution, the storm-water drainage system should always be isolated from the sewerage system.

II. Causes of Water Logging Problems in Urban Areas

A. Poor Design Standard of Drainage System

The city is increasingly vulnerable to flooding not because of rainfall but due to poor urban planning and

systematically destroyed traditional drainage systems. By expanding the size and speed of surface spillover, an unplanned urbanization has severely modified the drainage qualities of regular catchments, or drainage areas. Due to unsystematic disposal of solid wastes, the drainage systems can't adapt to the expanded capacity of water and are regularly encountered with blockage. In absence of planned and adequate drainage system, the urban area in places suffers from drainage congestion and water logging after heavy rainfall [3].

B.   Poor Design Standard of Road System

In earlier days, the streets and the roads of the many cities are paved and laid out in an unplanned way without any proper drainage leads into traffic congestion during heavy rain falls. The metro city has highly populated and high density which causes depression. The different part of roads causes the traffic congestion when small and large size or heavy vehicles found in the water logged areas. The traffic system affected at the time of water logging situation. Increases in water logged situation during the monsoon period result in traffic congestion, public threats and socioeconomic effects. Fig. 2 illustrates the road side stagnant water [4]-[6].
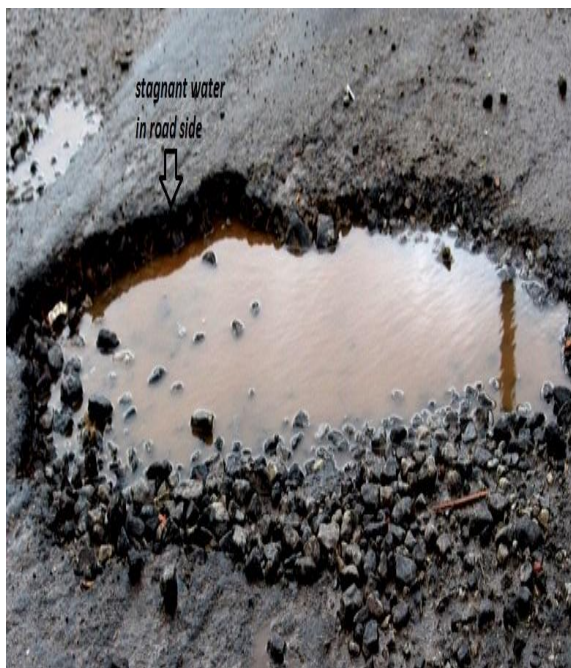

Fig. 2.   Road side stagnant water.

III.   RELATED WORKS

A.   Quadcopter based Detection

The water logging areas, the patches on the streets and roads could be identified with the use of quadcopter as described in [7]. Water being specula's in general inclines to mystify the conventional   image processing methods. Moreover, a non-traditional camera placed on a quadcopter poses new challenges to be addressed.

The methodology used in quadcopter based detection is a combination of color and optical flow based methods

respectively. This method is used to process the training dataset to produce positive and negative data.

The quadcopter is an inexpensive water stagnant detector and also it can detect under various lighting conditions, water pool areas, but the camera pixel size should be in 15 megapixel to capture the picture to better understanding for the reader.

B.   GIS Data Integration

Kaiser et al emphasized the use of Geographic Information System (GIS) for integrating remote sensing images with groundwater might be helpful to assess water logging issues and manage drain deficiency effectively [8]. In this work, underground tile drains and unwatering wells are utilized in both the eastern and western sectors of the study area to improve the drainage system.

This study was on based in the combination of GIS data integration and remote sensing technique is used to detect and monitor the water logging area and it is very useful for accurate mapping and quantification of water logged areas. The remote sensing procedure is based on the image classification and image enhancement operations. Even though the mapping is accurate the classification and identification of land cover changes is difficult.

C.   SOM-ANN

It is found in the literature that, Gross Domestic Product (GDP), population density, and traffic congestion could be employed as input data sets. In order to assess the risks associated with waterlogging quantitatively, the Self-Organizing Map - Artificial Neural Networks (SOM-ANN) is suggested as a suitable method. The ANN approach, GIS technology, SOM approach combined for process monitoring, analysis, modeling the collection of datasets and also used to identify the water resources related problems. The major advantage of SOM-ANN in the assessment of waterlogging risk is that it requires a priori knowledge about the classification of a dataset into various categories. But the classification of data often changes because waterlogging in urban areas appears more often due to severe rainstorms [9].

D.   SWMM

The urban rainstorm waterlogging model established and the actual hydraulic and hydrological conditions of pipe network in research zone is based on the American rainstorm management model of Strom water Management Model (SWMM). Here, three levels of framework structures of GIS are produced; a common forceful connection library of SWMM model is utilized to build up the waterlogging estimation analysis and visualization modeling. In this work, the various model parameters of SWMM module are seemed to be more interactive.

Moreover, the system incorporates different query functions like inquiry by factors, objects or time series. This makes the system more advantageous with the parallel processing of simulation water accumulated calculation. But SWMM method takes time to analyze the hydrological characters change before and after pipe transformation in waterlogging areas [10]. Table I shows the comparative study of waterlogging detection and prevention systems existing already [11]-[12].

TABLE I. COMPARATIVE STUDY ON WATERLOGGING DETECTION AND PREVENTION SYSTEMS

S.No.	Water Logging Detection and Prevention Systems		
	Existing Work	Idea	Pros and Cons
1	A case study on water logging problems in an urban area of Bangladesh and probable analytical solutions	Improvement of drainage network by construction of new primary and secondary drains. Cleaning and removal of blockage from existing drains and repair [11].	i) The developed technology can easily be transferred and applied to catchment areas experiencing water logging problems. ii) They are much unplanned and lack in systematic drainage network. The existing drains have to clean at regular interval.
2.	Research on Water-related Issues in Urban Road System [6]	Raising road drainage standard, improvement of road building materials and technology.	i) Reduces the runoff pollution to alleviate the water logging and urban drainage load, and improves the rain resources utilization. ii) Cost is high for upgrading the standard system.
3.	Quadcopter-based Stagnant Water Identification [7]	A Quadcopter used to inspect water stagnant areas and identify stagnant water patches.	i) Inexpensive quadcopter. Camera mounted on the quadcopter with only 5 megapixels.
4.	Analyzing the causes of urban waterlogging and sponge city technology in China [12]	The sponge city technology (the construction of large-scale storage tank, additional pumping stations, improving the drainage pipe network standards) to prevent waterlogging.	i) To maintain or restore the development area, after the construction. ii) Cost is high to develop the sponge city.
5.	Simulation of Rainstorm Waterlogging Based on SWMM and Visualization Module Research [10]	SWMM model is used to develop the waterlogging calculation analyses and visualization module.	i) The model parameters of the module are more interactive and also the system includes query functions like query by variables, objects or time. ii) SWMM method takes time to analyze the hydrological characters change before and after pipe transformation in waterlogging areas.

IV. CASE STUDY

Many models are currently available worldwide for studying about waterlogged areas. However, huge and proper usage of these models such as reservoir, drainage system, road system, etc in Chennai is inhibited by absence of standard design for their calibration and validation. One of the major issues is urban floods in Chennai, which creates more water logged areas. For example, the major drainage channels doesn't flow the water properly during December 2015 floods in Chennai such as Chembarambakkam. The flow of water was not available at other locations of the major drainages such as the Adyar River, the Cooum River etc. The statistical analysis about water logged areas in Chennai for the years 2015 as shown below [13].
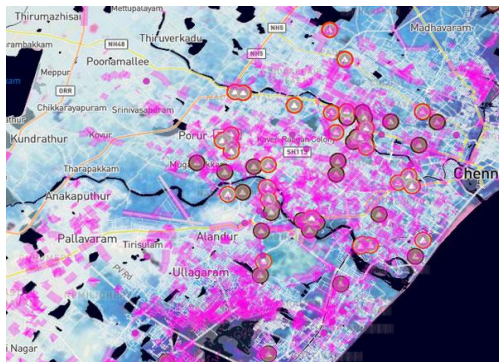

Fig. 3. Water logged areas in Chennai.

Source:
www.google.co.in/search?water+logged+areas+in+Chennai.

In Chennai, one of the contributing factors to this problem is the improper drainage system along with the blockage of drains with non-renewable plastic waste. When the drainage gets blocked, the flows of running water from the areas are not happening properly. This bottle up all the water logged in specific a spot which are low lying and do not have an opening to be released. All this water cannot penetrate underground and they need to run off. Even rain water collecting tanks are blocked and this is just a pathetic managing trait of the corporation. Banning plastic would do a lot of good, but it seems impossible in the near future.

V. CONCLUSION

Water logging has been turned into a serious issue by which the people are effected badly. It needs enhanced control of project management, planning, as there are several supply implementations. Waterlogging prone areas of the locality can be identified on real-time by detecting the water level accumulated to assist the people to find their way to their place where there is less traffic and reduce the water borne diseases.

REFERENCES

[1] Ria Roy, Md Kutubuddin Dhali, "Seasonal Water logging Problem In A Mega City: A Study of Kolkata, India", Journal of Research in Humanities and Social Science, Vol. 4, No. 4, pp. 01-09, 2016.

[2] Rana, M.M.P, "Urbanization and sustainability: challenges and strategies for sustainable urban development in Bangladesh", Environment, Development and Sustainability, Vol. 13, No. 1, pp. 237–256, 2011.

[3] Anil K. Gupta, Sreeja S. Nair, "Urban floods in Bangalore and Chennai: risk management challenges and lessons for sustainable urban ecology", Current Science, Vol. 100, No. 11, pp. 1638-1645, 2011.

[4] Ningyu Zhang, Huajun Chen, Jiaoyan Chen, Xi Chen, "Social Media Meets Big Urban Data: A Case Study of Urban Waterlogging Analysis", Computational Intelligence and Neuroscience, Vol. 2016, pp. 1-9, 2016.

[5] S. Sethuram, "Case Study: Water Management Issues in Chennai, India", Universal Journal of Environmental Research and Technology, Vol. 4, No. 6, pp. 299-306, 2014.

[6] Zhang Zheyu, Ye Suigao, Liao Chengbin, "Research on Water-related Issues in Urban Road System", Research on Water-related Issues in Urban Road System, in Proc. of IEEE Fourth International Conference on Digital Manufacturing & Automation, pp. 1148-1151, 2013.

[7] Meghshyam G. Prasad, Abhishek Chakraborty, Raviteja Chalasani, Sharat Chandran, "Quadcopter-based Stagnant Water Identification", in Proc. of Fifth National Conference on Computer Vision, Pattern Recognition, Image Processing and Graphics (NCVPRIPG), 2015.

[8] M. F. Kaiser, A. El Rayes, K. Ghodeif, B. Geriesh, "GIS Data Integration to Manage Waterlogging Problem on the Eastern Nile Delta of Egypt", International Journal of Geosciences, 2013, Vol. 4, pp. 680-687, 2013.

[9] Wen-li Lai, Hong-rui Wang, Cheng Wang, Jie Zhang, Yong Zhao, "Waterlogging risk assessment based on self-organizing map (SOM) artificial neural networks: a case study of an urban storm in Beijing", Journal of Mountain Science, Vol. 14, No. 5, pp. 898–905, 2017.

[10] Wenting Zhang, Xiang Wang, Yongzhi Liu, Tao Zhang, "Simulation of Rainstorm Waterlogging Based on SWMM and Visualization Module Research", in Proc. of 2016 International Conference on Smart City and Systems Engineering, pp. 394-397, 2016.

[11] Nureen Anisha, Shahadat Hossain, "A Case Study on Water Logging Problems in an Urban Area of Bangladesh and Probable Analytical Solutions", in Proc. of 2nd International Conference on Advances in Civil Engineering 2014 (ICACE-2014) CUET, Chittagong, Bangladesh 2014.

[12] Yun-Fang Ning, Wen-Yi Dong, Lu-Sheng Lin, Qian Zhang, "Analyzing the causes of urban waterlogging and sponge city technology in China", in Proc. of 2nd International Conference on Advances in Energy Resources and Environment Engineering, IOP Conf. Series: Earth and Environmental Science, Vol. 59 , pp. 1-4, 2017.

[13] https://itra.medialabasia.in/img/Chennai%20Floods-Rapid%20Assessment%20Report-May%2023, %202016.pdf