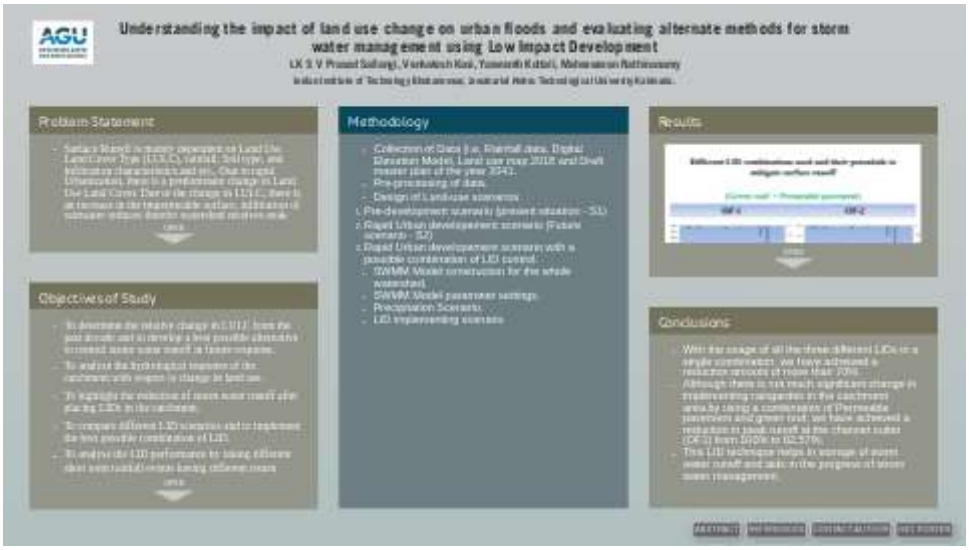
Understanding the impact of land-use change on urban floods and evaluating alternate methods for stormwater management using Low Impact Development



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PRESENTED AT:

PROBLEM STATEMENT

- Surface Runoff is mainly dependent on Land Use Land Cover Type (LULC), rainfall, Soil type, and Infiltration characteristics and etc., Due to rapid Urbanization, there is a predominant change in Land Use Land Cover. Due to the change in LULC, there is an increase in the impermeable surface, infiltration of rainwater reduces thereby watershed receives peak runoff volumes.
- To encounter this problem, the most widely used Low Impact development technique is used to control or reduce storm water runoff in the urban catchement.
- Low impact development (LID) controls are landscaping practices designed to capture and retain stormwater generated from impervious surfaces that would otherwise run off of a site.

OBJECTIVES OF STUDY

- To determine the relative change in LULC from the past decade and to develop a best possible alternative to control strom water runoff in future response.
- To analyze the hydrological response of the catchment with respect to change in land use.
- To highlight the reduction of storm water runoff after placing LIDs in the catchment.
- To compare different LID scenarios and to implement the best possible combination of LID.
- To analyse the LID performance by taking different short term rainfall events having different return periods and to find the quantity of runoff reduction.

METHODOLOGY

- Collection of Data (i.e, Rainfall data, Digital Elevation Model, Land use map 2018 and Draft master plan of the year 2041.
- Pre-processing of data.
- Design of Land-use scenarios

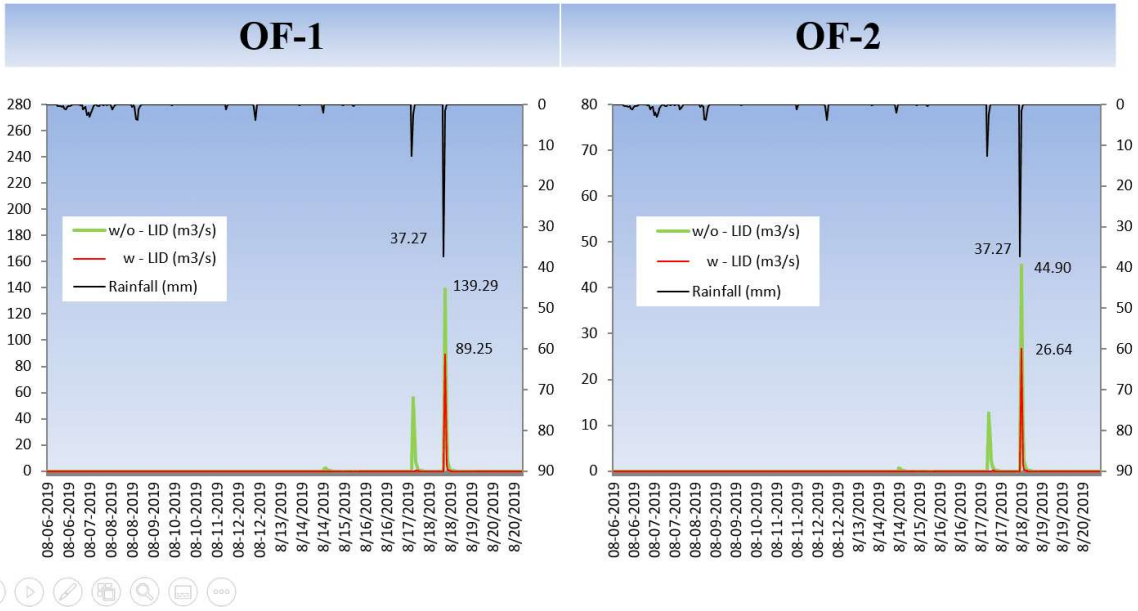
    1. Pre-development scenario (present situation - S1)
    2. Rapid Urban developement scenario (Future scenario - S2)
    3. Rapid Urban developement scenario with a possible combination of LID control.

- SWMM Model construction for the whole watershed.
- SWMM Model parameter settings.
- Precipitation Scenario.
- LID implementing scenario

RESULTS

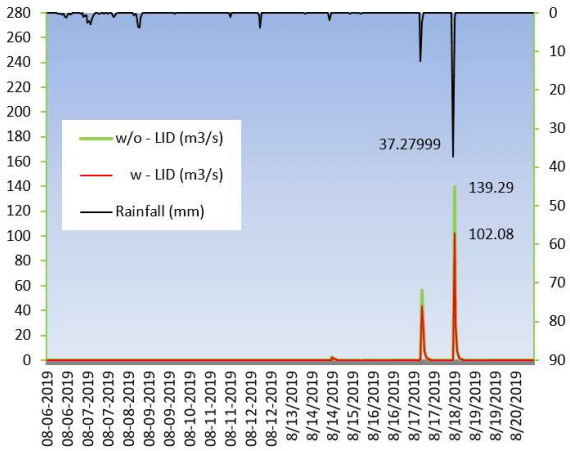
Different LID combinations used and their potentials to mitigate surface runoff

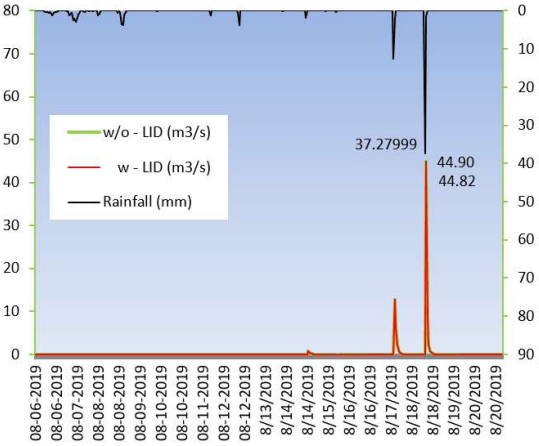
(Green roof + Permeable pavement)



(Rain Garden + Permeable pavement)

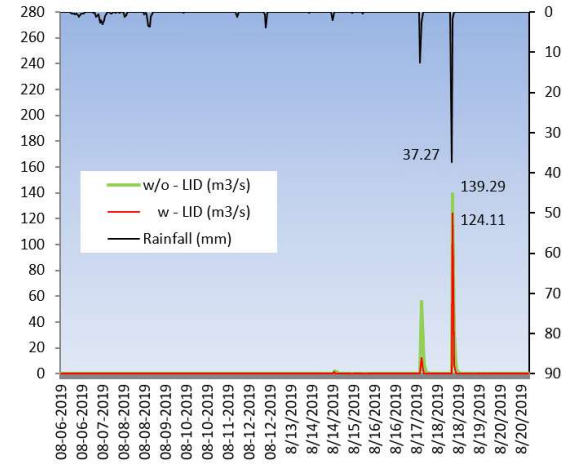
OF-1	OF-2

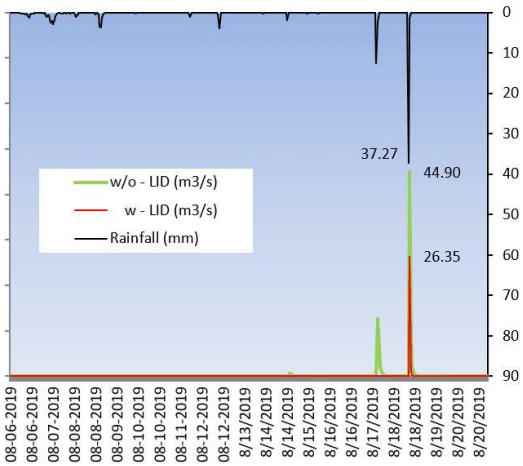




(Green roof + Rain Garden)

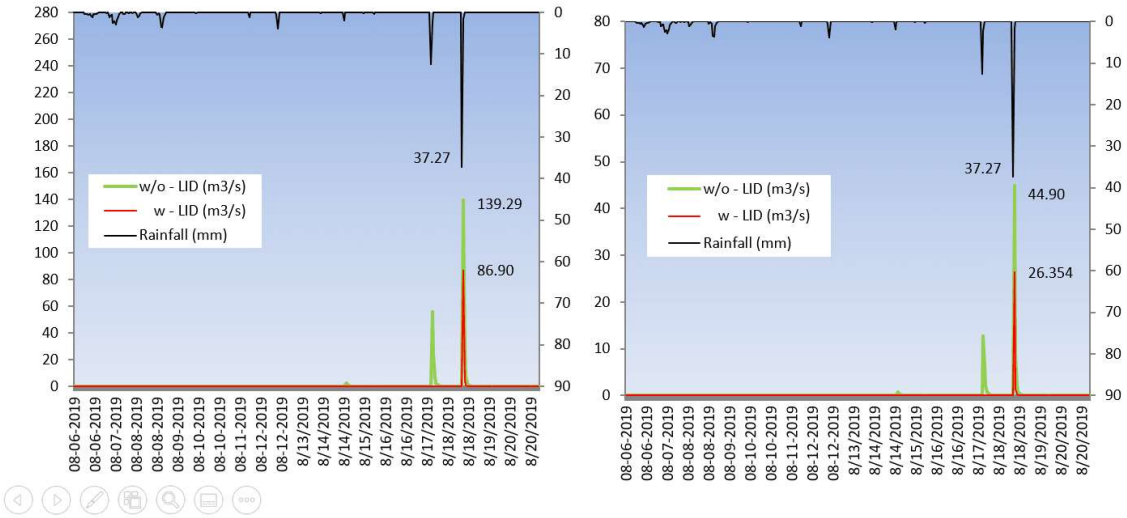
OF-1	OF-2





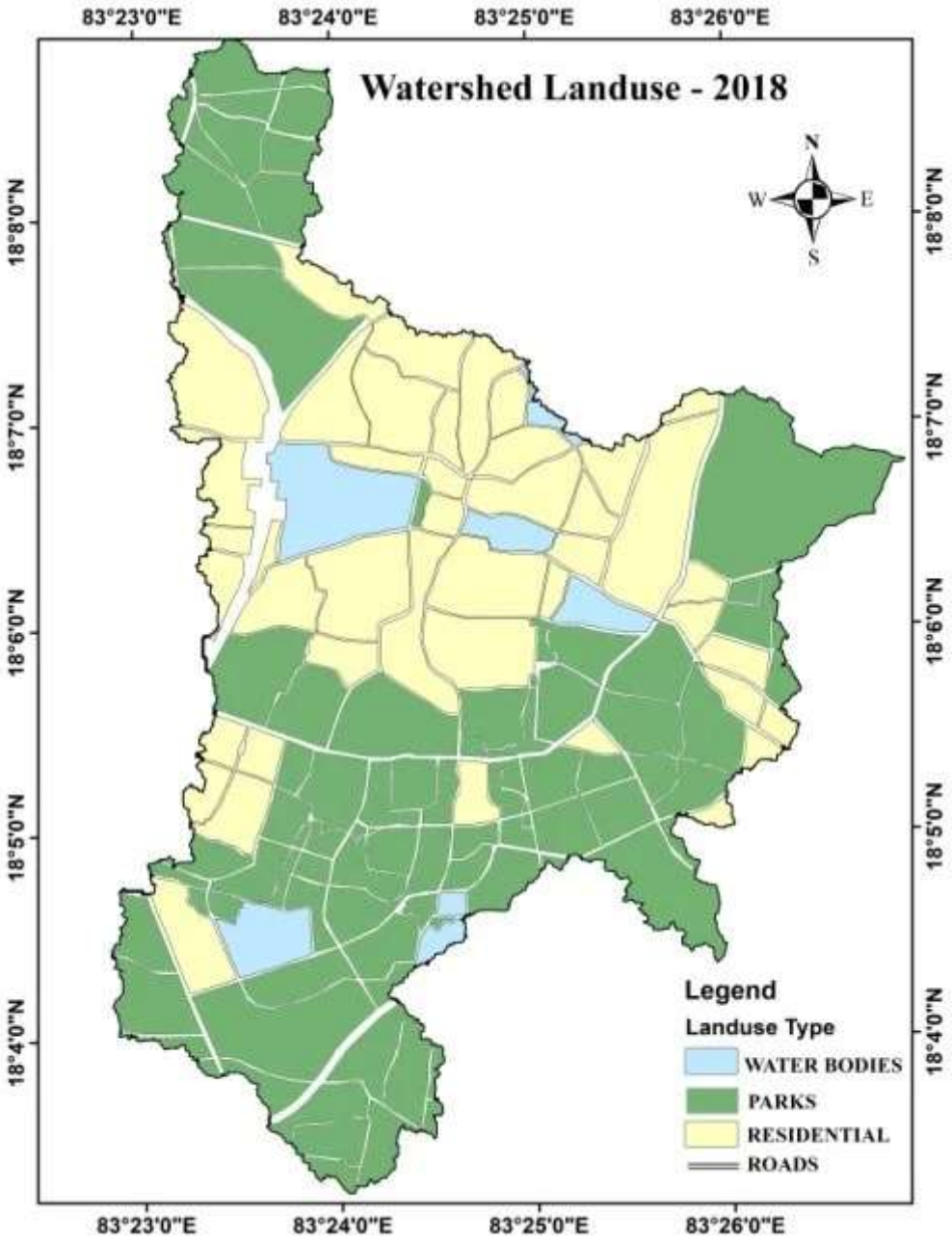
(Green roof + Rain Garden + Permeable pavement)

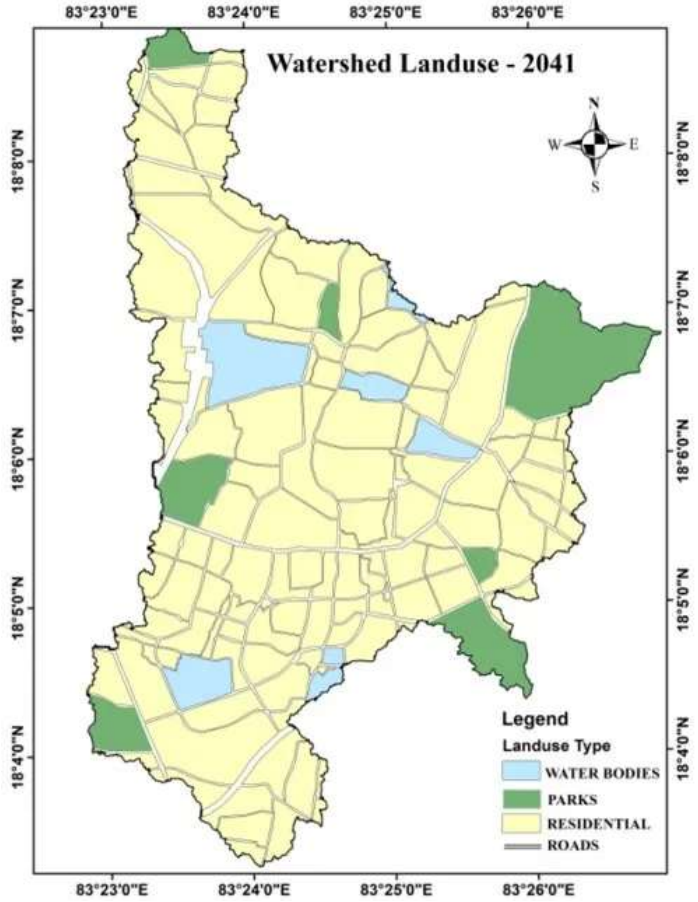
OF-1	OF-2



Results:

Scenario's	LID controls	Peak discharge (m^3/sec)		Total Runoff Volume (10^6 L)	
		OF1	OF2	OF1	OF2
S1	-	110.4	32	947.3	288.6
S2	-	139	44.9	993.8	281.8
S3	PP+RG	102	44.82	790.4	281.5
	GR+RG	124	26.36	539.6	101.8
	GR+PP	87	26.44	336.2	102.2
	GR+PP+RG	87	26.36	336.2	101.8


Watershed Landuse - 2018
N
W
E
S
83°23'0"E
83°24'0"E
83°25'0"E
83°26'0"E
18°8'0"N
18°7'0"N
18°6'0"N
18°5'0"N
18°4'0"N
Legend
Landuse Type
WATER BODIES
PARKS
RESIDENTIAL
ROADS


Watershed Landuse - 2041
N
W
E
S
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83°24'0"E
83°25'0"E
83°26'0"E
18°8'0"N
18°7'0"N
18°6'0"N
18°5'0"N
18°4'0"N
Legend
Landuse Type
WATER BODIES
PARKS
RESIDENTIAL
ROADS

CONCLUSIONS

- With the usage of all the three different LIDs in a single combination, we have acheived a reduction amount of more than 70%.
- Although there is not much significant change in implementing raingarden in the catchment area,by using a combination of Permeable pavement and green roof, we have acheived a reduction in peak runoff at the channel outlet (OF1) from 100% to 62.57%.
- This LID technique helps in storage of storm water runoff and aids in the progress of strom water management.

ABSTRACT

Due to urbanization, there is an increase in the impervious surface and in peak runoff volumes. In the past, there is significant damage caused by urban floods. Urban floods are becoming more frequent disasters in the recent decades due to rapid changes in the Land Use and Land Cover. In this study, we compare the impact of Land use changes on peak runoff and timing for the last three decades using PCSWMM model for semi urban cluster in South India. Further, we analyze the effect of future development on peak runoff. It was observed that there is a considerable increase in flood peak (82.49%) when compared to the last decade. We proposed and evaluated alternate methods under future land use (2040) using LID wherein different scenario were generated and tested. To evaluate the changes in hydrological characteristics, three scenarios at a regional scale were explored. The first scenario being the present situation. The second one being the traditional urban development scenario and the third one being urban development with LID controls. The model simulation results confirmed the effectiveness in reducing the surface runoff depth, peak flow rate, total flood volume and earlier peak times using LIDs

REFERENCES

Kong, F., Ban, Y., Yin, H., James, P., & Dronova, I. (2017). Modeling stormwater management at the city district level in response to changes in land use and low impact development. Environmental Modelling & Software, 95, 132–142.

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