Storm-water Mitigation using Urban Forest Management

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SPEA Lead for the Greater Good

INTRODUCTION

Stormwater management is an important component in city planning, especially as urbanization increases.

The more impervious surfaces reduce the water infiltration leading to an increase in stormwater runoff, which occurs when rainwater or melted snow flows over the streets, lawns and other sites creating negative economic and environmental impacts within the cities.

We identified the flooding zones in Bloomington and of those areas, we examined one specific block in Bloomington - Indiana between 7th and Kirkwood.

The purpose of the study was to (1) re-inventory the current tree cover (2) assess and evaluate the tree cover and potential areas for implementing stormwater management tools.

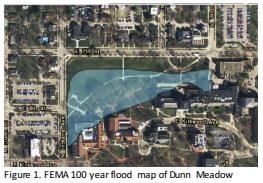

Figure 1. FEMA 100 year flood map of Dunn Meadow

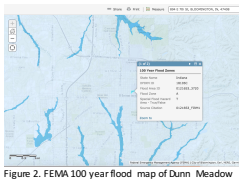

Figure 2. FEMA 100 year flood map of Dunn Meadow

METHODS

Conducted a re-inventory of the street trees on both sides of Indiana Avenue between 7th and Kirkwood.

Cataloged the existing trees' diameter at breast height (DBH), species, condition, maintenance requirements, and age.

Cross examined with the existing 2007 and 2012 tree inventory to identify the tree change over time.

Utilized data with direct observations to construct stormwater management recommendations.

Figure 3. Street trees on N Indiana Avenue

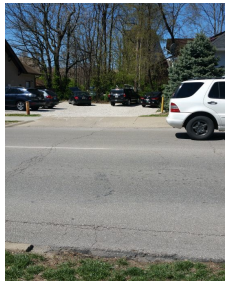

Figure 4. Street trees on N Indiana Avenue

QUESTION

Can trees be an effective tool in urban stormwater management?

RESULTS

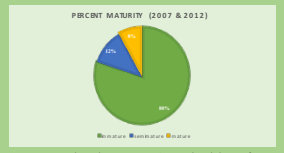

Figure 5. Pie chart showing 2007 & 2012 breakdown of tree maturity.

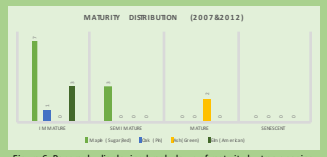

Figure 6. Bar graph displaying break down of maturity by tree species for 2007& 2012 data.

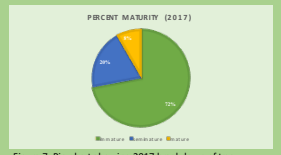

Figure 7. Pie chart showing 2017 breakdown of tree maturity.

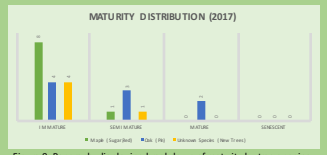

Figure 8. Bar graph displaying breakdown of maturity by tree species for 2017 data.

Maple	Oak
Immature is 0-20' Semi-mature is 21-39' Mature is 40-50' Senescent is 50'+	Immature is 0-10' Semi-mature is 11-24' Mature if 25-39' Senescent if 40'+
Elm	**Ash**
Immature is 0-5', Semi-mature is 6-19' Mature is 20-35' Senescent 45'+	Immature is 0-5', Semi-mature is 6-10' Mature is 11-25' Senescent 25'+

ANALYSIS

As a trees lifetime increases, the amount of rainfall intercepted increases, where more surface area = more evapotranspiration.

Trees are able to intercept this rainwater through two main mechanisms:
(1) Tree roots grow near the surface since that is where the majority of the nutrients lie. The roots are able to soak up and store more of the rainwater and prevent it from flushing chemicals into unwanted places and preventing soil erosion.
(2) The leaves, branches, and bark will also catch the rainfall reducing the overall amount of runoff.

The difference between semi-mature and mature: Once a tree is considered mature, it is providing the maximum amount of benefits available to the community.

Table 1 shows how each tree seen in the most recent inventory (2017) can provide between 3,000-5,000 more rainfall interception once full maturity is reached.

Tree	Semi-Mature (gallons/year)	Mature (gallons/year)
Sugar Maple	5,619 (21')	7,358 (40')
Red Maple	5,720 (21')	7,607 (40')
Pin Oak	2,569 (11')	7,353 (25')

Table 1. Values taken from the National Tree Benefit Calculator of gallons intercepted per year based on maturity level

RECOMMENDATIONS & CONCLUSION

Increase tree cover: The wider the canopy cover the more rainwater the tree will be able to absorb thus reducing a lot of costs in building sewerage treatment plants. The city of Seattle did a cost benefit analysis of increasing the canopy cover from 18% to 38% and the results suggested that it would double the storm water retention capacity by more than $41 million

Figure 9. Visual representations for increase forest cover

Convert impermeable surfaces: There was a computer modelling done which shows that for every 1% of impermeable land which is transformed into woodland , the runoff would be reduced by 0.5%. Tress which are planted as part of "sustainable urban drainage System schemes" have been proved to be effective in controlling flooding in urban areas.

Figure 10. Example alternative sidewalk design that could be adapted in Dunn Meadow

Creating tree wells and curb extensions: Tree wells do not take up space, in addition to providing ecological service they also provide shade to the vehicles parked under them and reduce the quantity of hydrocarbons and suspended particulate matter in the air.

Figure 11. Photo of permeable sidewalks from a successful study in Oregon

Creating artificial rain gardens and tree islands: Many of the tree lawn and areas that have a lot of utility lines can be converted into rain-gardens patches with native trees and plants. These rain gardens reduce storm water runoffs. In addition to reducing the quantity of storm water run-offs they add aesthetic value to the property, they are easy to maintain and they also keep the water clean.

Figure 12. Conceptual model of an adaptable rain garden

ACKNOWLEDGMENTS

Dr. Burney Fischer for the access to the 2007 and 2012 Bloomington Street Tree Inventory and use of the National Tree Benefit Calculator for tree maturity information.