Rock Creek Watershed

Stormwater Runoff Analysis

Executive Summary

Stormwater modeling case study presented at the 17th Annual EPA Region 6 Stormwater Conference

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The purpose of this modeling project is to estimate the benefits of increased urban tree canopy cover (TC) and reduced directly connected impervious area (DCIA) on stream water quantity and quality in the Rock Creek Watershed. The i-Tree Hydro model was used to estimate stormwater runoff volume and pollution loading for the watershed in its current condition (base case) and for various theoretical conditions (alternative case) such as increased TC and/or reduced DCIA.

Ten different treatment combinations were analyzed through i-Tree Hydro. Holding DCIA constant at 50%, we looked at the effects that tree canopy cover changes had on stormwater quantity and quality. Tree canopy cover treatments included 32%, 35%, 38%, and 42% TC. Holding TC constant at 32%, we analyzed the effects that reduced DCIA had on stormwater runoff. DCIA treatments included 50%, 45%, 40%, and 35%. To observe the cumulative effects of TC on DCIA, we analyzed several combinations of these treatments. They included 35% TC with 45% DCIA, 38% TC with 40% DCIA, and 42% TC with 35% DCIA.

Tree canopy results

Keeping the percentage of directly connected impervious area constant at 50% and increasing tree canopy cover incrementally from the estimated 32% to 35%, 38%, and 42%, i-Tree Hydro estimated that total streamflow volume would be decreased by up to 2.0%, overland impervious flow would be reduced by up to 2.4%, and stream base flow would also be reduced by approximately 2% with increasing canopy cover. Overall pollutant loading would be reduced annually by up to 2.5% with increasing tree canopy.

Directly connected impervious area results

Keeping the percentage of tree canopy cover constant at 32% and incrementally decreasing the percentage of DCIA from the base case of 50% to 45%, 40%, and 35%, i-Tree Hydro estimated that total, annual streamflow would increase by 1.4% with greater DCIA. Overland impervious flow showed

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tremendous decreases annually by up to 30% as DCIA decreased. We assumed that the end of these directly connected structures would flow over pervious land cover before reaching the creek thus increasing soil infiltration of stormwater. Because of this increased infiltration, i-Tree Hydro estimated that annual stream base flow volume would increase by up to 5.7%. By decreasing the volume of stormwater that is flowing over impervious surfaces (depositing directly into Rock Creek) and allowing it to infiltrate onto permeable surface cover, i-Tree Hydro estimated that pollutant loading to the creek would be reduced by up to 26.8%.

TC and DCIA combination results

Running various scenarios with increasing tree canopy cover and decreasing DCIA can help us see the cumulative effect that these systems have on water quantity and quality. Compared to the base case, overland, impervious flow showed a steady reduction of up to 31.7% as TC increased and DCIA decreased. By increasing tree canopy cover and decreasing DCIA incrementally, stormwater runoff pollution loading was shown to decrease by greater amounts than if TC were increased or DCIA were decreased alone. Hydro estimated that annual pollutant loads could be reduced by up to 28.5% compared to the base case.

Conclusion

Increasing tree canopy cover over a watershed mitigates stormwater runoff and pollution loading modestly. In the Rock Creek watershed, increasing tree cover by 30% (from 32% to 42%), we could expect total stormwater runoff to be reduced by about 2% and pollution loading by 2.5%. The results from this project show that a larger contributor to reducing pollution loading is by reducing the amount of directly connected impervious area and allowing more of the stormwater runoff to infiltrate into the soil before it reaches the stream.

Tree leaves and branches intercept rainfall and retain a portion thus preventing it from reaching the ground. Tree canopy also temporarily detains rainfall and releases it slowly as throughfall thus slowing the velocity of stormwater runoff. This slowing of stormwater velocity is beneficial for stormwater management as it allows the stormwater BMPs to work more efficiently and not become overwhelmed. By using trees in conjunction with reduced impervious area, we could expect to further reduce pollution loading. In this project i-Tree Hydro estimated that pollution loading was reduced an additional 6.2% when tree canopy cover was increased and DCIA decreased by 30% compared to decreasing DCIA by 30% alone.

The urban forest provides a myriad of environmental benefits that contribute to quality of life for a city's residents and visitors. Such benefits not only include stormwater runoff mitigation, but also energy conservation, urban heat island mitigation, air pollution removal, increased property values, and increased human health. By including urban forest management in a city's various management systems (i.e. stormwater management, air quality management, electrical utility management), we could expect to reduce some of the negative environmental outcomes that come with development.