Application Package

2009-10 TWRI Mills Scholarship

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3. Proposed Research

The United States and Texas continue to experience increasing urbanization through the conversion of forest, pasture, and crop lands to impervious areas, including roads, parking lots, sidewalks and rooftops. Urbanization directly impacts the health of water resources systems, as the increased impervious areas alter the hydrologic cycle. The results of urbanization in a watershed are increased peak discharges, increased volume of storm runoff, decreased time for runoff to reach receiving water body, increased frequency and severity of flooding, reduced streamflow during periods of prolonged dry weather (loss of base flow), and greater runoff and stream velocity during storm events. These dramatic shifts in the hydrologic flow regime severely impact receiving ecosystems, which depend on the duration, frequency, and magnitude of high and low flows, and human communities, which may experience extreme water shortages during dry weather, loss of property due to increased flooding, and loss of water supply due to poor water quality.

Development can be planned to maintain pre-development hydrologic flow characteristics through low impact development (LID) or best management practices (BMPs), which are a set of techniques, measures, or structural controls that are used to prevent or reduce the degradation of runoff water quality and/or quantity. BMPs that are designed to reduce alterations in runoff volumes, such as detention ponds, are typically designed based on a peak flow value, where the discharge for a certain frequency does not exceed pre-development conditions. This criterion is limited in achieving sustainability and in ensuring that humankind's use of natural resources and cycles will not lead to loss of future economic opportunities or adversely impact human health and the environment. Typical flow-based criteria do not provide a comprehensive measure of the downstream impact of development.

While BMPs are typically designed to provide flood control, literature reports that detention basins do not provide adequate protection in stream channels. A second objective in designing BMPs or LID is to reduce erosion downstream. BMPs such as detention ponds may instead increase erosion by inducing sustained flows downstream. The outlet flow for large storms may be prolonged, subjecting the stream channel a higher flow for a longer period of time. In addition, the basin only attenuates the flow of large storms. Most storms will pass through the structure unregulated, subjecting the downstream channel to erosive velocities more frequently.

Considering this motivation, a new metric, called the Hydrologic Footprint Residence (HFR), was developed to capture the extent of hydrologic change and the impact on downstream communities due urbanization. HFR is the product of land area inundated by duration of inundation for a specific flood in a stream. HFR captures both changes of runoff volumes, represented as the inundated area, and the temporal alteration of the flood wave.

HFR was demonstrated for a tributary on the Texas A&M University west campus watershed, located behind the George Bush Library, which has experienced increased velocities and erosion problems. Four scenarios of stormwater management were tested: current conditions, future development, future development with a detention pond, and future development implemented with combined LIDs, such as pervious pavements and green-roof tops. Three storms were evaluated, 2-, 10- and 100-years storms. For small storms, the LID scenarios resulted in lower stormwater impacts, as measured by the HFR, but higher peak flows when compared to the detention pond. Based only on the peak flow, the detention pond seems to be a better solution for the stormwater problems. However, the sustained high flow introduced by detention pond increases the HFR as compared to LID scenarios, due to the sensitivity of HFR to temporal alterations of the hydrological regime.

New demonstrations of this metric are needed to better understand its applicability in stormwater management and planning. Watershed with different soil types, geomorphologic characteristics, and development patterns will be evaluated. The objective of this research is to compute HFR and demonstrate its use for watershed planning for two different watersheds in Texas. The first watershed is also located on the west campus of Texas A&M University. This watershed is still relatively undeveloped. A second watershed is located in the urban area of Houston, which historically presents flooding issues. Results for these two watersheds will be compared with the preliminary studies to improve the knowledge of the effects of urbanization in the hydrological regime. It is expected that HFR will facilitate more sustainable designs for watershed management in order to improve watershed health.

4. Academic Qualifications

Education

PhD	Civil Engineering Department, Texas A&M University		2008-present
M.S.	Civil Engineering University of Rio Grande do Sul	(Brazil)	2005
B.S.	Civil Engineering University of Brasilia (Brazil)		2002

GRE:
GPR:
Courses Taken:

Scholarships/Fellowships

2009 - Zachry Department of Civil Engineering PhD Student Travel Grant. Travel to ASCE World Environmental and Water Resources Congress

2008 – Regents Fellowship

5. Proposed use of funds

The funds from this scholarship will be used to pay tuition and fees.

6. Intended career path

I intend to pursue an academic career, focusing both in research and teaching of water resources and environmental problems