Urban Stormwater as a Resource; Possibilities for a new public space in Clemson University

**Stormwater runoff:** Precipitation of rain and snow that flows over land, doesn't percolate into the ground.

**Capture and use of rainwater as fresh water supply**

- **Environment:** by 2020 more than 60% of world’s population live in urban areas
- **Global consumption of water has been:** increased, but the rate of human population growth.
- **Water scarcity issue:** Most cases designed for the flood issue not people

**Literature Review**

**Rainwater Harvesting**
- Capture and use of rainwater as fresh water supply
- **Ancient practice:** Use it as water resource

**Collection**
- Collection system directs stormwater from catchment area to storage or treatment area.
- Traditional - gutters, pipes and channels
- Natural stormwater management practices
- **Quality of captured water**
- Type of material it has run through
- **Surrounding environment**
- **First Flush:** Debris - clog the collection system - filters
- Smaller contaminants - stored or directed separately
- Divert one to two gallons of first flush for each 100 square feet of collection area

**Storage**
- Storage can serve purposes of water supply, flood mitigation, recreational amenity, aesthetic amenity, water quality improvement, habitat provision and firefighting supplies
- **Types of storage:**
  - Tanks
  - Minimum water loss
  - Expensive installation
- Algal bloom in sunlight exposure
- Smaller catchment area
- **Aquifer**
- Large catchment
- Open storage
- water loss
- **End-Use**
- No federal regulations and standards for rainwater harvesting with non-potable uses.
- States or local governors have regulations and policies which varies from one location to another.
- **End use of stormwater:**
  - 1. Potable
  - 2. Non-potable

**Treatment**
- Major obstacle in use of stormwater as a re-source is, lack of reliable and affordable treatment system concerning the public health.
- **Practices:**
  - United States
  - Georgia, North Carolina, Texas and Virginia
  - Municipalities: Los Angeles, San Francisco, Tucson and Portland
- **Natural treatments:**
  - Sedimentation, chemical treatments, ultraviolet, ozone treatment, reverse osmosis and etc.
  - Natural treatment can achieve the required quality for many uses.
- **Australia**
- Natural elements for upstream water treatment
  - Before the advanced treatment system.
  - **BMP**
- Small lot pump each practice - separate function
- Engineering
- **LID**
- Connects BMP facilities in a distributed network
- All parts provide a level of water treatment
- Planning
- **Advanced Treatment:**
- Pathogenic organisms:
  - Membrane filtration
  - Conventional media filtration
  - Reverse osmosis
  - Membrane bio-reactor
dissolved air flotation
  - Electrodialysis
  - Biologically activated carbon filtration
  - Ultrasonic distillation
- **Disinfection:**
  - Chlorination
  - Ultra violet radiation
  - Oxidation process
- **LID Principles**
  - Redundancy
  - Distributed network of facilities
  - Multiple routes connection
  - Resilience
  - Multiple facilities
  - Biological diversity
  - Maximum interfaces
- Distribution:
- Membrane filtration
- **Ion exchange**
- **Advanced Oxidation Processes**
- **Physical processes**
- **Pre-treatment**
  - Flow velocity, pre-treatment
  - Removal of debris, clog the collection system
  - **Filters**
  - Trap devices are commonly used at the beginning of the treatment process
- **Seepage**
- **Biological processes**
  - Nutrient removal
- **Pollution prevention**
- **Social Place Making**
- **Promenade**
- Place for social life.
- Need in mixing with other people.
- Gathering places in frequent intervals.
- Right size. Forms activity nodes, along its length
- **Activity nodes**
- **Garden irrigation 96%, Toilet flushing 95%, Laundry purposes 68%, Personal washing 50%, Potable uses 29%**

**Program Statement**

**Stormwater as a liability**
- Dispose of untreated stormwater into the surface waters
- Focus on infiltrating
- **Extraction from aquifer**
- **Most cases designed for the flood issue not people**
- **Water scarcity issue**

**Hypothesis**
- **Catch the rainwater before it runs through city**
- **Treat on site**
- Use it for treating public places to raise awareness
- Use it as water resource

**End-use harvesting:**
- **Collection**
  - 1. Passive Rainwater Harvesting
    - Volume - small (50-100 gallon)
    - Catchment - rooftops
    - End-Use: untreated - outdoor purposes, irrigation, car washes
  - Storage - on grade
  - Water Extraction - spigots, no connection to internal or external plumbing
- **2. Active Rainwater Harvesting**
  - Volume - large (1,000 – 100,000 gallon)
  - Catchment - any surface with runoff
  - End-Use: to be treated for any end use
  - Storage - under or above grade
  - Water Extraction - pumping, elevation change, connected to internal or external plumbing

**Steps of stormwater har-vesting:**
- 1. Collection
- 2. Treatment
- 3. Storage
- 4. End-use

**Public Perspective**

**Crucial to success of a project**
- Knowledge of urban water, water quality
- Frequency and severity of potable wa-ter restrictions
- Familiarity with alternative water sources
- Assurance of health risks
- Advocacy of authorities, government agencies and researchers
- Characteristics of each project like end use of water, cost of water supply, degree of contact with water in a project and environmental values.
- Opposition is common when a new concept is introduced, but education of the public can increase their trust and bring support.

**Urban Stormwater - Pollution and Floodling**
- **Low-Impact Development:** maintaining site's natural hydrology
- Green infrastructure - mimics nature by soaking up and storing stormwater.

**LID function**
- Physical process
  - Rain on hydraulic properties of water
  - Soil and vegetation
  - Collected through pipes
  - Best media sand or sandy-loam soil
  - Wetland
- **Biodegradation**
  - Physical and biological process to treat soil and vegetation
  - Collected through pipes
  - Best media sand or sandy-loam soil
  - Wetland
- **Proprietary Devices**
  - Gross pollutant, oil and grease, and sediment trap devices are commonly used at the begin-nning of treatment to remove fine sediments.

**Urban Low-Impact Development**
- **Promenade**
  - Place for social life.
  - Need in mixing with other people.
  - Gathering places in frequent intervals.
  - Right size. Forms activity nodes, along its length
  - **Activity nodes**
    - Small public square
    - Activity node. Promenade. Size. Diameter of 60 feet (general rule)

**Streets and paths**
- Place for being in public. Support diverse activities.
- Delicate balance between ‘being defined and yet not too defined’. Outdoor room designed unfinished, to be finished by activities people would bring to it.

**Water**
- Natural state of land and streams
- Boundaries can be formed
- More human places
- Quite refuge
- Psychological effect on humans
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Methodology

Case Study

Review of relevant literature has created a basic guideline on approaching a stormwater reuse project, but there remains two main information gaps in fulfilling the goal of the research. The first gap is the information on designing a public space with the stormwater reuse facility. For this matter some of the best projects in creating public space within stormwater reuse/treatment, was studied. Second gap is the information about the treatment of water. Although there are many guidelines on the use of stormwater management facilities with LID principals and there exist documents on the characteristics of each facility. But no comprehensive guideline were found on the treatment process of water or best facility for achieving specific quality of water (pollutant). For this matter the researcher has gathered information about each facility and has categorized them based on the type of treatment, drainage size, degree of treatment and the type of contaminant treated.

The studied cases are as follows:

Availability of water
Changing amount of water
Natural and urbanized areas
Active places designed for leisure
Serene, calm places for pleasure, relaxation or learning
Interaction with water can be defined as visual, touch and hearing

These experiences: any part of the process, the conveyance, treatment or storage

Site Selection

Major drivers for selection of the site were proximity for site visits and an urbanized area. It is know that a university campus has to support all the community activities as a city, hence the design of a campus is like the design of an urban area. The Clemson University campus was selected as the campus. Further analysis and studies of the campus has led to several possibilities for development on campus. Among the choices the one with more similarities to a dense urban context was selected, the underdeveloped area located on Campus Green, the backyard of the main library. This area being in the core of the campus is a valuable choice for the purpose of raising the public awareness about the water conservation issues.

Site Analysis

2. Site Analysis

Project Site

Water Budget

SCDNR: Highest level of precipitation in 100 years, for Pickens county 3.98 in/h

Q=CiA

Peak Runoff = Dimensionless coefficient * rainfall intensity * area of drainage

Asphalt C: 0.85
Grassland C: 0.3
Roof surface C: 0.9

Rooftop: 4.3 ft³/s
Asphalt: 2.03 ft³/s
Grassland: 1 ft³/s

Table of Infiltration: Throughput for Rain

Graph of precipitation per hour
BLUE HABITAT

Thesis Research and Project
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