Rain gardens: exploring solutions to non-point source pollution

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Introduction

Rain gardens offer several environmental benefits, including water conservation, groundwater recharge, stormwater treatment, reduced sedimentation, , and flood prevention (Kraus and Spafford, 2009). While rain gardens and other low impact development (LID) techniques are successfully implemented in several states, there has been limited application in Florida, and specifically in Alachua County, where end-of-pipe stormwater retention basins are the primary stormwater treatment for residential and commercial developments. This practice has been shifting in recent years after several studies have found that performance efficiencies of traditional stormwater management systems (wet and dry retention ponds) were much lower than previously assumed (Environmental Research & Design, Inc., 2007). Yet, large and small scale applications of LID stormwater treatment techniques are lacking in Alachua County and thus there is a need for on the ground projects and studies demonstrating their application and efficiencies.

The Alachua County Environmental Protection Department (ACEPD) developed a rain garden LID pilot project in Alachua County, Florida to teach students about the impacts of daily activities (such as littering, applying fertilizer and pesticides, and increasing stormwater runoff from developed areas) on water pollution in our creeks and watersheds. The focus of the project was to engage students in exploring solutions to non-point source pollution, as well as provide examples of low-cost techniques, such as installing rain barrels and constructing rain gardens, that could be adopted by homeowners.

Project Activities

The project took place during the 2011 school year and included a variety of

educational activities presented to students to enhance their understanding of non-point source pollution issues and allow them to be active participants in finding solutions that they could share at home and with their peers. We conducted four interactive teaching modules:

1. An interactive classroom presentation on non-point source pollution using the Enviroscape® Model
2. A field trip to a local stormwater treatment wetland
3. A classroom planning workshop on designing and constructing the rain garden, and
4. Workdays for the construction of the rain garden

In the first module, the Enviroscape ® Model was utilized to illustrate the effects of daily activities, and point and non-point source pollution, on our water resources. This presentation was followed by a field trip to a local enhanced stormwater treatment, where students took turns at 5 interactive stations: 1. Soils, 2. Vegetation, 3. Hydrology and water quality, 4. Aquatic life, and 5. a wetland walk. At each station, students engaged in hands-on activities such as utilizing a YSI meter to test water quality, comparing infiltration rates of different substrates (sand, clay and organic matter), collecting upland and wetland vegetation, and calculating biotic index scores based on collected macro-invertebrates. Following the field trip, a presentation was given to review concepts and introduce rain gardens and native vegetation. This was followed by the students designing and landscaping their rain garden from a pre-determined native vegetation palette. The classroom workshop was integral in allowing students to take ownership in the project and preparing them for the construction of the rain garden.

Finally, workdays were scheduled for the construction of the rain garden exhibit, which consisted of building and connecting two rain collection barrels to existing roof downspouts and routing overflow to the rain garden. To receive stormwater treatment credit from Florida regulatory agencies, runoff volumes and infiltration rates have to be considered to properly size a rain garden that will meet the designed treatment volume. However, since we did not seek stormwater credit and were simply providing a demonstration project, we did not conduct extensive soil surveys and did not size the gardens based on runoff volumes.

Rain gardens were excavated approximately 8-12 inches deep and were 200 square feet in size, located in sandy soils with high infiltration rates. The roof size draining to the gardens ranged between 1,000 and 3,000 square feet, and

any overflow under extreme rain events would simply sheet flow over a grassy field. In each garden, 65 plants spanning six different species (wild iris, swamp sunflower, swamp hibiscus, Fakahatchee grass, sand cord grass, canna, and blue eyed grass) were installed at approximately 2-foot centers spacing and in groupings by size. Soil amendments (manure and compost mixed in with native soil) and a layer of mulch were added to retain moisture, provide a carbon source for microbial activity, and enhance plant survival. The total cost of materials, including rain barrels and related supplies, plants, soil amendment, river rock for channel, mulch, and interpretative sign, was approximately $800.

Before construction, we administered a pre-quiz to determine students' baseline knowledge of the subject that focused on their understanding of concepts such as watersheds, point and non-point source pollution, and water quality. Following students' participation in the first three modules (Enviroscape ® Model presentation, fieldtrip, and rain garden workshop), we administered a post-quiz to determine their level of learning and understanding. In all, 231 students and 10 teachers from three Alachua County public schools (Glen Springs Elementary, Williams Elementary, and Kanapaha Middle School) participated in the project.

Results

The following goals were accomplished by completing the four modules at each school:

1. We developed an ongoing relationship with the schools for continued cooperation,
2. Increased teachers' knowledge about environmental issues and provided access to resources for future assistance,
3. Developed a curriculum tailored to our region's needs that will be adopted by a local agency and carried forward in other schools.
4.

Overall, students gained a significant knowledge about non-point source pollution, watershed protection, and water quality and conservation measures, with an average improvement of 64% (range 52-76%) above baseline scores (Table 1). At the end of the program, teachers were asked to evaluate the curriculum and modules, and the overall project scored an average of 9.3 out of 10 points.

Discussion

Our goal was to inspire students and the community to adopt some of these

	Pre-project % Correct	Post-project % Correct	% Improvement
Glen Springs	45	80	76
Williams	43	65	52
Kanapaha	65	Not Available*	Not Available*

*Unable to collect quiz due to teacher relocation.

Table 1: Pre and Post project quiz results (provided as a percentage of correct answers for each school).

Figure 1: Rain garden at Kanapaha Middle School, Gainesville, Florida.

practices and techniques in their everyday lives and homes by providing them with resources and low-cost solutions to improve our community's waters. The project complements ACEPD water quality protection goals and new water conservation initiative.

Early in the project it became apparent that many 5th and 6th graders lacked knowledge related to point and non-point source pollution, the source of our drinking water, and how everyday activities can impact our water resources. Many students had no knowledge of the issues of stormwater runoff and had never had the opportunity to investigate what happens to water running off developed areas, what types of pollutants it can carry with it, and where it eventually ends up. By the end of the project, many students could tell us the fate of rain water falling on their properties or school ground accurately, as well as discuss what types of contaminants water may carry depending on the source (parking lot vs. landscaped areas). In other words, many students began

Figure 2: Glen Springs Elementary 5th Grade class after completing their rain garden.

to critically think about the impacts of runoff, and suggest ways to improve the situation (such as install rain barrels, create rain gardens, and replace pavement with permeable pavers or asphalt). Many students also indicated that some of these projects were already taking place in their homes.

Creating the outdoor exhibit and planting the rain garden was by far the highlight of the project and every single student enjoyed the physical labor of digging and planting. One of the most significant findings was that several students in both 5th and 6th grade level classes had never been exposed to gardening or installing plants. This indicates that our student population lacks adequate exposure to outdoor environmental activities in elementary and middle school grade levels.

Many students who were having difficulty focusing and paying attention during the classroom activities were very much engaged and productive during our work days. In fact, because each student participated in the creation of the outdoor exhibit, they were able to ask questions and draw connections from our classroom learning experience through their work.

The authors' opinion and recommendation is that additional funds and resources should be devoted to environmental education activities that bring students outdoors and allow them to be actively engaged in outdoor "work," such as the creation of gardens or other outdoor exhibit, to achieve learning through doing as well as acquiring basic life skills.

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