Report as of FY2010 for 2009SC66B: "Sediment Pollution Potential Assessment of Abandoned Developments Using Remote Sensing and GIS"

Publications

Project 2009SC66B has resulted in no reported publications as of FY2010.

Report Follows

Sediment Pollution Potential Assessment of Abandoned Developments Using Remote Sensing and GIS

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Executive Summary

The current economic crisis has left numerous residential developments in the Southeastern United States in various states of construction. Many of them are currently graded and essentially abandoned creating a major source of sediment runoff to waterways. Residential development locations with significant bare soil areas were identified through classification of Landsat 5 TM satellite imagery and subsequently verified from high-resolution county aerial photographs.

Initial GIS identification indicated 301 sites with a total bare soil area of 2,378 hectares over three counties in upstate South Carolina. A random sample of 153 sites was visited and results indicate that 77.8% of the sites were classified correctly (residential construction sites in varying stages of completion); 88.3% of identified areas were less than 25% built compared to the previous year; 47.9% were categorized as moderate to severe problems. Abandoned and unfinished developments in upstate South Carolina may represent a major source of sediment pollution to streams and this study indicates maintenance of erosion control devices and establishment of ground cover as possible solutions.

Introduction and Background

Over recent years the upstate region of South Carolina has experienced an unprecedented amount of growth in population and in the area of developed land (Allen and Wyche, 2008). Residential housing construction in the upstate often involves the conversion of forest or pasture to low-density housing developments. During the development process, careful management of exposed soil and storm runoff is necessary to prevent sediment from being transported to nearby water bodies. Best management practices (BMPs), when properly installed and maintained, can minimize the amount of sediment pollution, but research has shown that even with BMPs sediment runoff can occur (Goddard et al., 2008). The environmental impact of sediment runoff is well known and can devastate aquatic ecosystems (Sciera et al., 2008).

The current economic crisis has left numerous residential developments in the Southeastern United States in various states of construction. Anecdotal evidence suggests that many of these development sites in the upstate region of South Carolina are currently graded and essentially abandoned. Even if BMPs and sediment/water quantity control structures were properly installed during active development, they will not continue to function if they are not maintained. To further exacerbate the potential environmental impact of these developments, the long-standing drought has prevented ground cover crops from being established, leaving even more soil surfaces exposed to the environment.

Methodology

Identification of abandoned developments. Initial identification of bare soil areas was determined using a 30m resolution Landsat 5 TM satellite image from June 2, 2009 for WRS-2 path 18, row 36 (scene center: 34˚37'N, 82˚48'W). This image was selected as the most recent haze/cloud free image for the study area at the time of analysis. Atmospheric and radiometric corrections were performed in ERDAS Imagine 9.3 (ERDAS 2008) using the Chavez cost model (Chavez 1996). A supervised classification was performed in Imagine to determine locations of bare site areas. Training sites were selected in Microsoft Bing Maps (http://maps.bing.com) by drawing polygons around sites using tools provided by

the interface. Two bare soil classes representing bare developments were used in the classification. Initial sites were selected from those classes where pixel groups were greater than 2 acres in area. Selected pixel groups were converted to vector polygons in ESRI ArcGIS 9.3 (ESRI 2009**)** to represent initial bare soil areas. Polygons were overlaid on recent high resolution county aerial photos and systematically verified visually as barren residential sites. Commercial sites, residential sites greater than approximately seventy-five percent complete, and areas whose status was unable to be determined visually were excluded from the study. Sites were typically easy to identify based on the characteristic red hue of the clays prevalent in the region and cul-de-sacs surrounded by bare soil.

Soil loss risk analysis. The revised universal soil loss equation (RUSLE, Renard et al. 1997) model was selected to quantify risk of soil loss for each site based on its ease of use, and readily available data.

Random Selection of Sites. A proportional stratified random sample was used to select approximately fifty percent of the 301 sites. Sites were stratified according to area (ha). Fifty percent of each strata were randomly selected for validation site visits

Site Visits. Typical site visits durations were between thirty minutes and two hours depending on the size of the site and extent of problems. All of the sites in the random sample were visited in seventeen days averaging nine sites per day. Data were collected at each site utilizing a tablet computer with ESRI ArcPad 8.0 mobile GIS software, digital camera, and GPS unit (small number of sites). Each site was visually inspected to identify erosion related problems. Points or polylines were collected on each site to represent erosion related problems such as buried or destroyed silt fences and catch basin protection, evidence of sediment output from sediment basins, and erosion features such as gullies or off-site sediment deposits. On each site, the location of off-site storm water outlets was determined and evaluated based on evidence of sedimentation and erosion at outlets (visual inspection).

Results and Conclusions

Out of the 153 sites in the random sample, 34 were deemed as a misclassification meaning that sites were determined to be commercial or private residences during field verification (includes 3 sites that were not able to be accessed due to gate or other barrier). Over three quarters (119 sites, 77.8%) of sites in the sample were correctly classified as residential developments in varying stages of construction. The misclassified sites (34 sites, 22.2%) were outside of the scope of this study and were not evaluated for erosion and sedimentation problems.

It is evident that very little construction has occurred in the study area within the time period between the aerial photographs and field verification (approximately 1 year for Spartanburg and Greenville counties; approximately 2 years for Pickens). Of the 119 correctly classified sites, 88.3% were less than 25% built in the identified areas; 59.7% had zero new houses or buildings. Over half of the sites showed evidence of sediment leaving the site, and nearly half directly entered a stream. Typically, sediment loss was due to bare lots eroding to catch basins and carrying sediment to unmaintained sediment basins which have filled with sediment, are undersized, or have damaged control structures. Several sites exhibited buried, damaged, or otherwise ineffective silt fence that was not holding back sediment from directly leaving the site.

The classification success rate for the techniques we developed for rapid location and verification of abandoned and unfinished residential developments was greater than 75%. This would likely be improved based upon the experience of the individual performing the aerial photo verification process. This study also considered commercial sites and private residences to be misclassifications despite their potential to yield similar problems. GIS mapping suggests that the sites are highly clustered at the urban-rural interface surrounding large population centers (cities of Spartanburg and Greenville in this study). Further research is necessary to quantify this clustering and determine its usefulness as a predictor for locating and prioritizing these sites.

Over the area encompassing three counties, very little construction has occurred in over a year. Our study suggests that nearly half of all unfinished residential construction sites pose a moderate to severe problem in terms of erosion and offsite

sedimentation. This study also suggests the importance of performing erosion control maintenance and establishing ground cover as a long-term solution on abandoned or unfinished sites.

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