Flood Zone Determination

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Objectives

The objective the flood zone determination project was to develop a methodology for local governments that would allow them to more easily update flood discharges, elevations and flood boundary maps using high resolution remote sensing. Timely updates are needed by rapidly growing communities because it is this increase in impervious surface which increases flooding. Cities must enforce regulations to restrict building in the floodplain. These regulations are tied to requirements of the Federal Emergency Management Agency (FEMA) Flood Insurance Program and to other local building regulations. The FEMA flood study for Columbia, MO published in the early 1980's was based on watershed development at that time. The study was updated slightly in the early 1990's, but with no more recent development information. This reliance on outdated flood maps is a problem in most cities in the U.S. The results of this project will assist cities and their consulting engineers in using remote sensing to update these maps and conduct other storm water planning and management.

User Community

The user community for the flood zone determination project consists of several separate, but related users. The first set of users are engineering consultants who will incorporate the remote-sensing derived information into flood elevation assessments. Other users include individuals in local government who must make decisions on a daily basis regarding building permit approvals. Additional end users are the property owners and builders whose property will be affected by the results of the flood zone determination. These additional end users and their consultants will closely scrutinize the results and may also use remote-sensing information as part of legal challenges to the local government's flood zone decisions. Users from the City of Columbia and Boone County requested the development of this capability. The Bear Creek Watershed was selected for this flood zone prototype and it is located within the city limits, so the City of Columbia is the actual end user.

Product Development

The flood zone determination products utilize a direct land *cover* classification developed from IKONOS 4 m multispectral imagery to assess the potential for rainfall to be converted to storm water runoff. This is in contrast to current practices that rely on land *use* classifications and zoning (e.g., residential, commercial) within the urban environment to estimate land cover (e.g., woods, grass, impervious surfaces). The land cover classification is used to generate a weighted average curve number for an area under analysis. The curve number is used in hydrologic modeling to determine the peak discharges associated with ultimate development. Peak discharges are used with a rating curve developed from previous FEMA hydraulic

modeling (i.e., determination of water surface elevations associated with various flood events) to determine the peak water surface elevation for the calculated peak discharge. Peak water surface elevations are applied to a digital topographic map to indicate those locations expected to be flooded during a 10-, 25-, 50- and 100-year rainfall event. Overall products thus include the land cover classification, curve number distribution, peak discharges, flood elevation estimates, and maps displaying land covers, curve numbers, flood zones.

Experience of User Community

The current experience of local government is that the existing FEMA defined floodplains and floodways are incorrect because they are based on outdated land use/land cover estimates. Officials know that flooding above the FEMA limits would occur with the 100-year rainfall event, but do not have the expertise, time or funding to easily quantify the increase in flooding extent. They are uncomfortable making use of the existing outdated FEMA maps for decision making. Through further discussions, the end users indicated that what would be most useful for the decisions required of them would be to know whether (a) proposed development is clearly subject to flooding and building permits should be denied, (b) proposed development is clearly not subject to flooding and permits should be granted, or (c) proposed development is located in an area of uncertainty where a more detailed, site-specific engineering analysis should be required before a decision is made. This information, in the form of a band around the line indicating the extent of flooding, can be developed to suit the particular end user requirements of incorporating uncertainty with respect to flood elevations or peak discharges. The City of Columbia has not yet used the revised flood zone information in development decision-making. They will be able to do so once the updated peak discharges are applied to the FEMA flood profiles and the resulting flood elevations are plotted on a topographic map. These products will be developed and delivered to the City early in the Synergy III effort.

Financial resources, both public and private, can be saved if 1) detailed engineering analyses are not required for all proposed developments near a stream, 2) flood damage is averted by identifying and preventing development that would be subject to flooding, and 3) scientifically justifiable decision making can limit the number and duration of lawsuits challenging the regulatory flood boundaries. The involvement of the legal profession in storm water management issues is a reality for the City of Columbia where local building developers have hired an attorney to challenge land use/impervious surface restrictions. In addition, the end users understand how remote sensing land cover classification can improve their current practice by providing a means to check whether an area has been developed consistent with the planning documents used in the storm water master plans, and whether the development within a given community is consistent with the standard assessments of percent impervious surfaces, for example.

Lessons Learned

The flood zone determination project was initiated by targeting local government as the end user. Experience on the project has shown that consulting engineers are an additional category of end users with their own requirements for the methodology and results based upon their professional experience. We also learned that property owners and builders are a separate category of end users. These end users bring an additional requirement for accuracy and reasonableness because of the potential for litigation. When decisions are made that impact the

use of real estate, and thus the monetary benefit that can be derived, all methodologies and data interpretation that could lead to the denial of development rights must be able to withstand legal challenges. Flood zone determinations must be supported by analyses that can identify and explain differences in the results among FEMA floodway delineations by conventional practices and methodologies that incorporate high-resolution remote sensing imagery.

Involving the end users in the process of identifying tools and methodologies that support their activities and decision making is absolutely essential. Researchers can guess at the problems facing local governments, but can never be sure that they are working in the right direction without cooperating with the actual end user.

Potential Activities for Synergy III

Potential activities for Synergy III include going beyond flood zone determination to developing more proactive strategies for management of storm water and protection of receiving stream water quality using high resolution remote sensing. These strategies are driven by new federally mandated requirements from the Environmental Protection Agency's (EPA's) Phase II storm water regulations that now apply to all U.S. cities greater than 100,000 and will soon apply to all U.S. cities with populations greater than 10,000, including Boone County and the City of Columbia. These strategies include the development and implementation of best management practices (BMPs). Specific areas for control, as identified by the EPA, include development planning on a watershed basis and the monitoring of construction sites as small as 1 acre in size both during and after construction.

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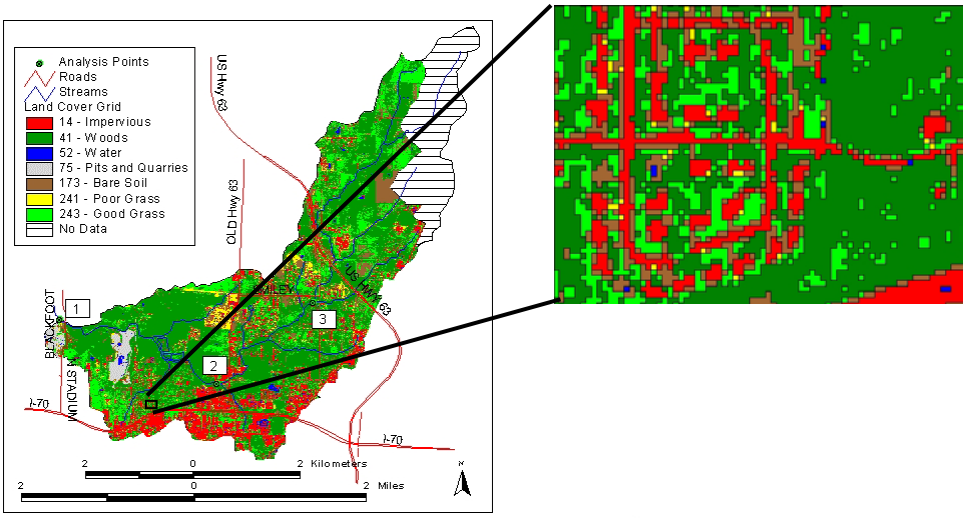
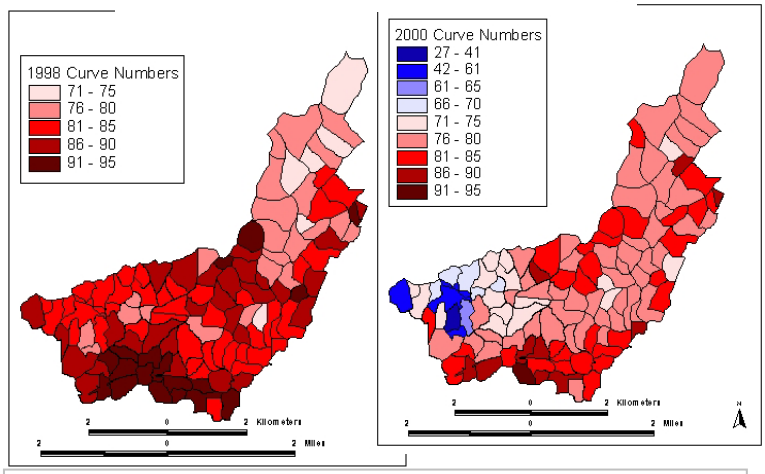
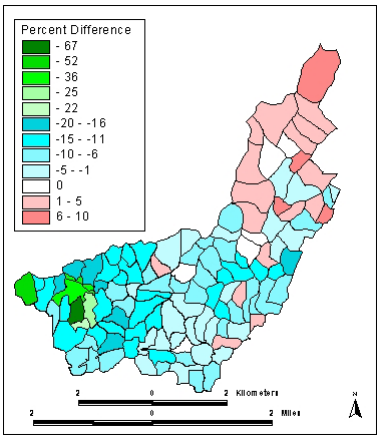
Demonstration Of Flood Zone Determination For Bear Creek Watershed In Columbia, Missouri: Comparison Of Remote Sensing Results (Based On Land Cover) From Current Practice (Based On Land Use)

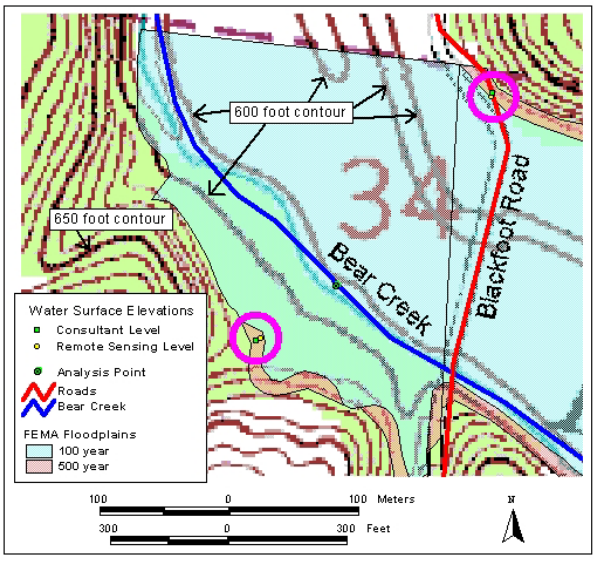




Curve Numbers per Subbasin for Years 1998 (from consultant; based on land use) and 2000 (from Remote Sensing imagery; based on land cover)



Percent Change Between 1998 (land use) and 2000 (land cover) Curve Numbers



100-year Flood Zone Boundary at Blackfoot Road from consultant report (1998) and from remote sensing imagery (2000).
Graphic shows that current estimates of 100-yr flood zone exceed those established by the FEMA analysis (red circles).