HYDROLOGIC MODELING FOR STORM WATER MANAGEMENT DECISION MAKING

STATEMENT OF PROBLEM

Land within the City of Columbia, MO is being developed, changing from agricultural to urban land uses. Urbanization of agricultural land increases storm water discharges and may cause additional flooding along the creeks fed by the urbanizing areas. New development must be kept out of areas subject to flooding as regulated by ordinance. The ability to accurately calculate peak discharges for particular rainfall events directly impacts the ability to control development and limit flooding. Because the City of Columbia has been growing since the development of the last comprehensive storm water management plan, existing assessments of land use and land cover maps may not represent the current conditions.

PRESENT SITUATION

The City of Columbia has a preliminary storm water management plan prepared by a consulting engineering firm. The report was developed to analyze storm water management options and techniques and includes calculations of peak discharges for the 100-year storms, for watersheds within the city limits. The assessment of land use used in the management plan, developed from aerial photography and zoning, is represented in large aggregate blocks. The flood elevations (and the areas flooded) associated with peak discharges for the 100-year flood are used by city personnel in decisions on whether to allow particular development to take place.

NEW APPROACH AND POTENTIAL BENEFITS

Land cover classifications developed from satellite imagery allow for an up-to-date assessment of land cover. The level of detail available from the satellite imagery also allows for greater differentiation of land cover within an area as to whether specific portions are covered by woods, grass, open water, bare soil, or impervious surfaces. Greater accuracy in the representation of land cover should allow for the calculation of a truer representation of runoff curve number, and thus a truer representation of peak discharges. Assessments of peak discharges can be used as a part of the decision making process to evaluate what property will be inundated by the 100-year flood and to preclude development in those areas.

TECHNICAL APPROACH TAKEN

A portion of the Bear Creek watershed in Columbia, MO was used as the test case for incorporating land cover classifications from satellite imagery into hydrologic modeling. The preliminary calculations of peak discharges from the consultant were used for comparison of peak discharges calculated using land cover developed from satellite imagery. Demonstration of this capability was undertaken for a Bear Creek tributary where all the required information was available (missing pieces of information limited the calculations possible): the entire area contributing to the tributary is in the city limits and peak discharges were calculated by the consultant, complete land use information was available for the consultant's preliminary report, soil groups delineated for the entire area are available on MSDIS, and IKONOS imagery available for entire area contributing to the tributary.

In order to assess the impact of the different methods of determining land use/land cover, the consultant calculations were rerun changing only the runoff curve numbers. The Corps of Engineers' HEC-1 model runs prepared by the consultants were rerun in HEC-HMS (successor program to HEC-1) in order to import all of the modeling characteristics from the consultant's evaluation. This comparison was necessary in order to ensure that any variations in peak discharges calculated were only a result of changing the runoff curve number and were not a result of changing other model input parameters. This means that all basin delineations and all other basin characteristics used in the modeling are those established by the consultant rather than being developed separately from currently available satellite imagery.

The watershed delineation used is that from digitizing the watershed basins used in the consultant report. Land cover classes were developed using IKONOS multispectral images with 4 meter spatial resolution available for the project area. Land use for the Bear Creek area was determined by supervised classification using a maximum likelihood classifier. The hydrologic soil groups used to develop runoff curve numbers were taken from the MSDIS on-line database. Runoff curve numbers were calculated from land use classifications and soil groups using modified script files from CRWR-PrePro3a.

Specifically, the year 1998 runoff curve numbers and peak discharges developed by the consultant are compared with the year 2000 runoff curve numbers and peak discharges developed by ICREST from satellite imagery.

PRODUCTS

(1) Maps showing the land use classifications of the portions of the Bear Creek watershed contributing to the tributary for existing 1998 conditions (used by the consultant) and showing the land cover classifications using the 2000 satellite imagery.
(2) Table displaying the runoff curve numbers from the consultant's preliminary report and calculated using satellite imagery (by subbasin).
(3) Table displaying the peak discharges from the consultant's preliminary report and calculated using satellite imagery (by subbasin).
(4) Table displaying the peak discharges at the tributary analysis points from the consultant's preliminary report and calculated using satellite imagery (by subbasin).

INTEGRATION OF INFORMATION INTO THE HYDROLOGIC MODELING ACTIVITIES

The hydrologic modeling effort utilizes information developed by other ICREST team members, specifically the land cover classification for area contributing to the Bear Creek tributary.

LIMITATIONS ON THE USE OF THE INFORMATION

A comparison of the runoff curve numbers and peak discharges between the two methodologies shows considerable variation. Before the information would be used in decision making by local government, it is anticipated that end users would need additional information about why the changes are so great, whether the differences are due merely to differences in surface coverages or from the methodology of calculating and aggregating curve numbers. The methodological implications can be represented in part by the fact that the consultant's calculations were based on land use, i.e., agricultural activities, and various residential, commercial, and industrial developments, the curve numbers for which incorporate pervious and impervious surfaces, while the satellite imagery provides an assessment of land cover, i.e., various crops, open water, bare soil, or impervious surfaces.

ANTICIPATED IMPLEMENTATION FOR LOCAL GOVERNMENT

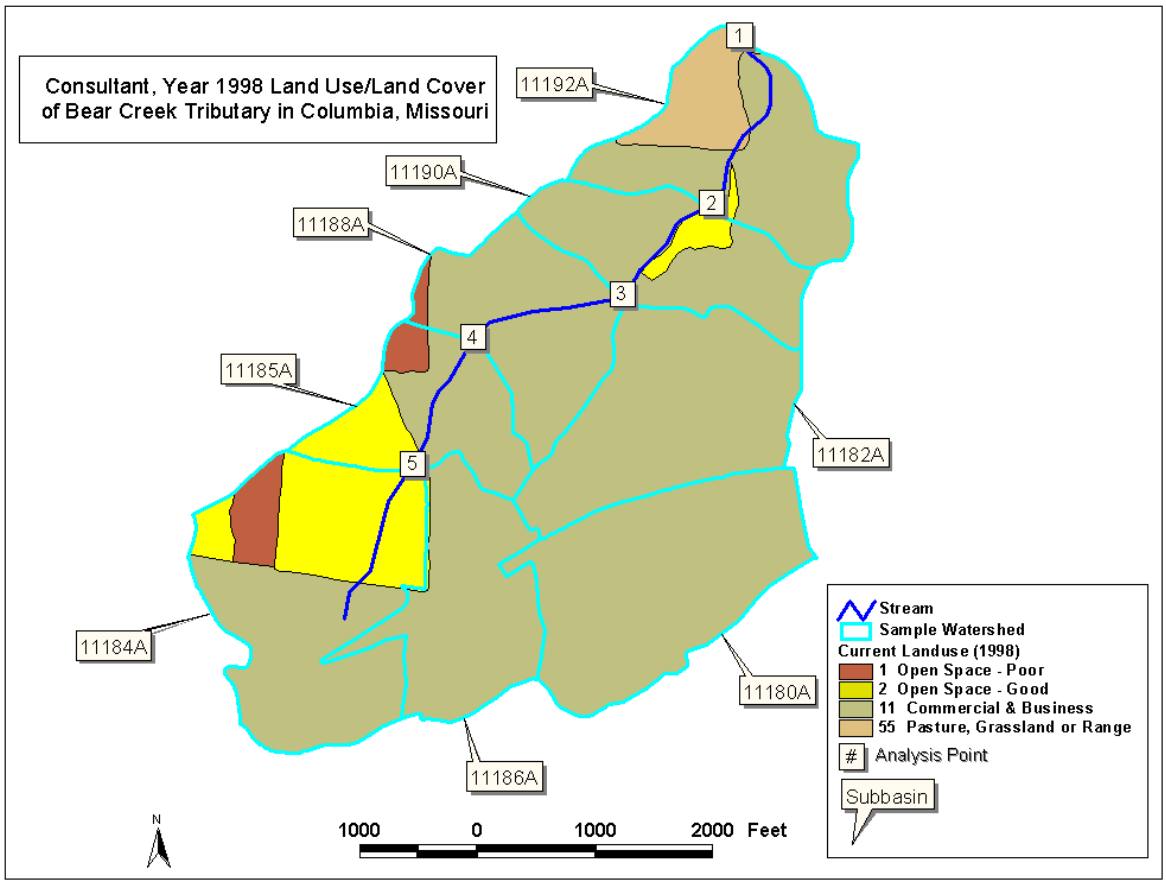
The maps and tables comparing runoff curve numbers and peak discharges can be used in presentations and discussions with the end users. End users need to indicate what supporting information is necessary before information based on satellite imagery can replace information developed from other means. This is particularly important where the change in information sources could possibly result in changes in different decisions being made depending on what information source is used. When sufficient supporting information is available, satellite imagery based calculations can be used in development decision making.

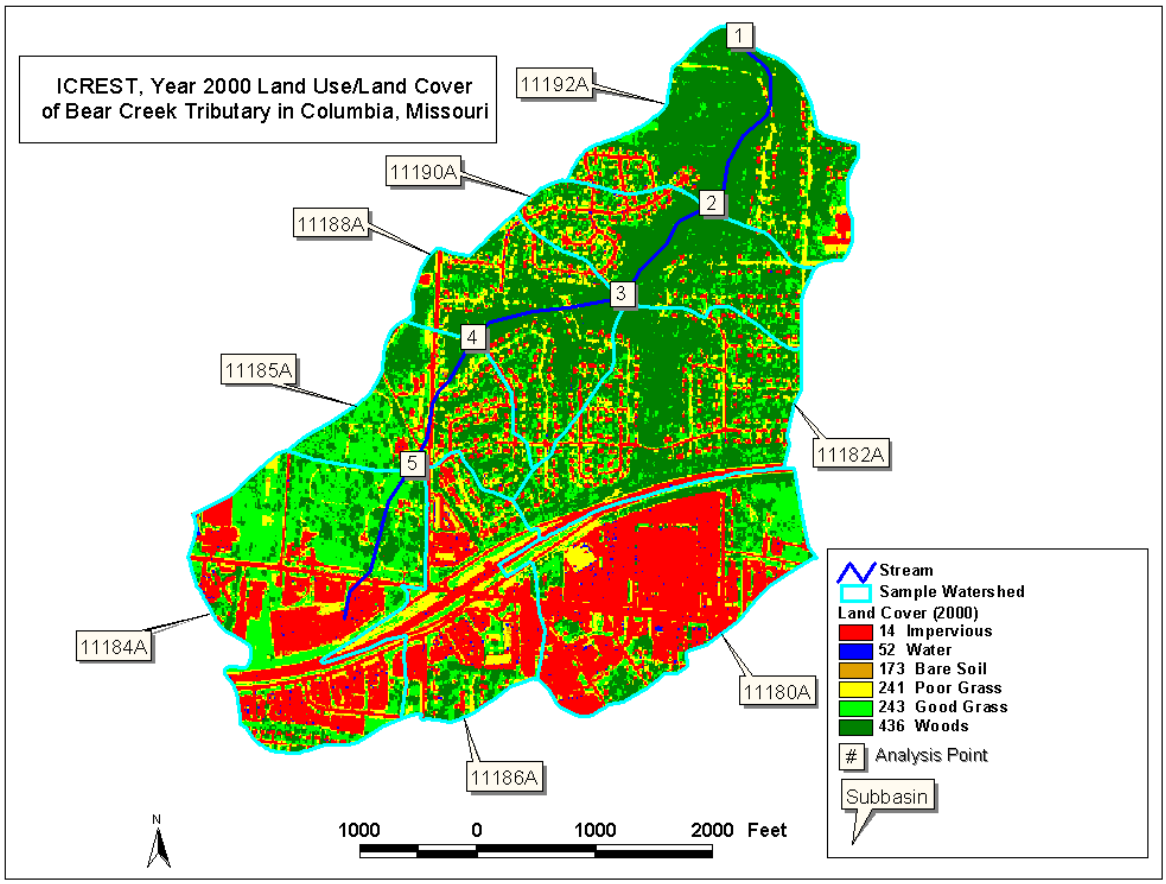
ADDITIONAL WORK

(1) Find new locations for analysis where FEMA rating curves (discharge versus elevation curves) are available in order to show the differences in property expected to be inundated between conventional calculations and satellite imagery supported calculations.
(2) Investigate the basis for the differences in the runoff curve numbers and in the peak discharges.

PROJECT PARTICIPANTS

Dr. R. Lee Peyton, Dr. Kathleen M. Trauth, Mr. Harold E. Johnson, Dr. Aderbal C. Corrêa, and Mr. Janggam Adhityawarma of the Center for Environmental Technology (CENTECH), Department of Civil and Environmental Engineering, carried out the project for ICREST.


Consultant, Year 1998 Land Use/Land Cover of Bear Creek Tributary in Columbia, Missouri
1
2
3
4
5
11192A
11190A
11188A
11185A
11182A
11184A
11180A
11186A
N
1000 0 1000 2000 Feet
Stream
Sample Watershed
Current Landuse (1998)
1 Open Space - Poor
2 Open Space - Good
11 Commercial & Business
55 Pasture, Grassland or Range
Analysis Point
Subbasin



Preliminary Curve Numbers for
Subbasins in Bear Creek

Subbasin	Consultant Year 1998	ICREST Year 2000
11180A	95	87
11182A	94	75
11184A	90	82
11185A	89	79
11186A	95	85
11188A	93	75
11190A	91	73
11192A	89	69

Preliminary Peak Discharge for
Subbasins in Bear Creek

Subbasin	Consultant Year 1998	ICREST Year 2000
11180A	321	266
11182A	485	287
11184A	336	269
11185A	170	124
11186A	207	160
11188A	259	149
11190A	266	144
11192A	317	149

Preliminary Peak Discharge for
Analysis Points in Bear Creek

Analysis Pt.	Consultant Year 1998	ICREST Year 2000
1 (mouth)	1825	1164
2	1580	1092
3	1405	1021
4	665	417
5	374	283