Mar 22nd, 3:00 PM

Session 2C

Kentucky Water Resources Research Institute, University of Kentucky

A FIELD PROTOCOL FOR MEASURING THE HYDROGEOMORPHIC EFFECTS OF LAND-USE CONVERSION IN NORTHERN KENTUCKY STREAMS

Robert J. Hawley, Ph.D.
Principal Scientist, Sustainable Streams, LLC
Research Assistant, Colorado State University
2038 Eastern Parkway, Suite 1, Louisville, KY 40204
502.718.2912
bob.hawley@sustainablestreams.com

Matthew S. Wooten
Aquatic Biologist, Northern Kentucky Sanitation District No. 1
1045 Eaton Drive, Fort Wright, KY 41017
859.578.6887
mwooten@sd1.org

Streamflow alteration associated with development in Kentucky has typically been regulated in terms of preventing flood level increases at specific return-intervals such as the 100-, 50-, 10-, or even 2-year peak flows. Such policies generally do not address channel stability in that they exclude two import components of the flow regime: 1) durations of the high-energy flow events, and 2) magnitudes and durations of potentially sediment-transporting flows below the minimum regulated flow (e.g. below the 2-year flow magnitude). Consistent with the rest of the nation, the altered delivery of water and sediment from a previously undeveloped watershed (i.e. 'hydromodification') has resulted in an imbalance between erosive forces and the channel's inherent resistance causing predictable, systematic responses in stream channel networks. The threshold of instability depends upon an interaction of hydrogeomorphic factors that vary regionally. Scientific literature documents that once the threshold is surpassed, the resulting system-wide instability may take periods of decades and even centuries for the degraded channel networks to return to some semblance of equilibrium and ecological function.

Field reconnaissance of 46 sites in northern Kentucky documented that 1) the threshold of instability has been crossed in many regional watersheds, and 2) the evolutionary trajectories of channel responses include both incision-driven and lateral adjustments, depending on the resistance of the bed materials relative to the banks. In order to better assess the effects of hydromodification, in conjunction with the water chemistry, biology,

and habitat monitoring protocols, 24 sites were selected for a multi-year monitoring program. Semi-permanent (rebar) benchmarks were set for repeated, spatially-integrated cross-section and profile surveys, along with 100-particle pebble counts. From the multi-year surveys, we populated a broad array of potentially-important measures of channel stability (e.g. change in 'bankfull' area, topwidth, and depth, rate of longitudinal headcut migration, change in average riffle length, pool length, and pool depth, change in the size of the median bed-material particle, etc.). Preliminary analyses indicate that the most developed watersheds tend to be associated with the most unstable channel reaches, which, in many cases, also correspond to streams with the most impacted biological communities.

SUBWATERSHED CLUSTERING BASED ON GEOMORPHIC AND HUMAN INDUCED LANDSCAPE MODIFICATIONS: THE LICKING RIVER BASIN

Brian D. Lee[1] (Anticipated Oral Presenter), Corey L. Wilson[1], Angela Schörgendorfer[2], Lajuanda Haight-Maybriar[3] and John Webb[3]

[1]Department of Landscape Architecture
College of Agriculture
University of Kentucky
S305 Agriculture Science North
1100 Nicholasville Road
Lexington, Kentucky 40546-0091

[2]Department of Statistics
College of Arts and Sciences
University of Kentucky
859 Patterson Office Tower
Lexington, Kentucky 40506-0027

[3]Division of Water
Department for Environmental Protection
Energy and Environment Cabinet
Commonwealth of Kentucky
200 Fair Oaks Lane, Fourth Floor
Frankfort, Kentucky 40601

Watershed boundaries rather than political boundaries are increasingly advocated to address a variety of water resource issues. Effective watershed assessment processes are needed that classify watersheds by geomorphic and human modified landscape scale characteristics. This platform presentation expands upon the presentations at the 2008 and 2009 KWRRI Symposiums. The research continues exploring the opportunities and constraints of an ongoing descriptive categorization approach. Watershed sample size has been increased to over 800 subwatersheds encompassing the entire Licking River Basin. Using a semi-automated process through ModelBuilder of ArcGIS and publically available data from the Kentucky Geography Network, over 50 landscape scale indicators are derived by Hydrologic Unit Code (HUC) 14 subwatersheds to describe land surface conditions. Example indicators include proportion and spatial configuration measures of human population, imperviousness, and agriculture/forest cover characteristics.

Once the data are derived for each subwatershed, they can be visualized geographically with a color ramp indicating conditions for each indicator independently or in combination. A quantitative matrix can also be made to allow for comparisons by indicator across the study area. The process provides a guide to relative watershed condition both in relation to a specific indicator and amongst all indicators. This enables

indicator recombination as needed for particular issues under consideration by planners, policy makers and interested stakeholders for more informed subwatershed scale land use decision-making. In particular, statistical cluster analysis based on 17 geomorphic and human influenced variables was utilized to identify similar subwatersheds. The statistical clustering using complete linkages identified 11 clusters in total with eight clusters comprising the majority of the subwatersheds. These data and the statistical clustering approach are anticipated to lead to a better understanding of subwatershed categorization as well as implementation and management opportunities and constraints.

Acknowledgement: This material is based upon work supported by the Cooperative State Research, Education and Extension Service, U.S. Department of Agriculture, under Agreement No. 2008-34628-19532. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the view of the U. S. Department of Agriculture.

UPDATING THE NHD IN A DYNAMIC LAND COVER CHANGE ENVIRONMENT: THE CASE OF THE ELUSIVE WATER BODIES IN KENTUCKY'S EASTERN COAL FIELD REGION

Demetrio P. Zourarakis
Ph.D., Remote Sensing/GIS Analyst - Kentucky Division of Geographic Information

Commonwealth Office of Technology
120 Glenns Creek Road
Frankfort, KY 40601
502-564-2480
demetrio.zourarakis@ky.gov

Constant maintenance and update of the spatial and attribute information contained in the National Hydrography Dataset (NHD) is of critical importance to water resource managers. Water bodies in Kentucky – such as ponds and reservoirs, provide essential and diverse services to fish and wildlife, livestock, crops, industry, commerce and humans, including flood and sediment control. Inventorying these water bodies is often challenging due to the patterns of land use and ownership in the Commonwealth. Both the USGS National Land Cover Dataset (NLCD) 1992/2001 Retrofit Land Cover Change Product (LCC9201) (http://www.mrlc.gov/multizone.php); and the 2001-2005 land cover change product (LCC0105) created by the Kentucky Landscape Census Project (KLC) (http://kygeonet.ky.gov) document significant changes in number and extent of water bodies in Kentucky. Due to the dynamic nature of the changes and to access issues, inventorying of new water bodies and deletion of no longer extant features is often accomplished by delineations utilizing high resolution (e.g. aerial) imagery as photobase.

For several years now, the Landsat mission archives have been available to the public at no cost (http://landsat.usgs.gov/). The continued operation of the Landsat 5 and 7 missions counteracts the low resolution of the multispectral imagery. On the other hand, while aerial imagery acquisitions are typically carried out at much higher spatial resolution, their episodic nature poses a problem for periodic monitoring of resource change. The third band resulting from applying a tasseled-cap transformation – a spectral enhancement method to visible and infrared bands in Thematic Mapper (TM) Landsat 5 data, is known as the "wetness" band (Crist et al., 1986). Landsat 5 TM scenes, 2009 epoch (green up) and high resolution aerial imagery (leaf-on, 2008) were used to detect and photo-verify both pre-existing, and new but unmapped bodies of water in counties from the Eastern Coal Fields physiographic region (Frazier and Page, 2000). Water bodies and area features contained in the Kentucky portion of the NHD (http://nhd.usgs.gov) (downloaded January 2010) were used as a mask to calculate pixel-based statistical measures for the wetness values. By using a threshold wetness band value as an indicator of open water (i.e. water bodies), a preliminary analysis yielded features not present in the NHD, with areas between slightly less than 1 Ha to almost 17 Ha, distributed in eight counties (Table 1). This method, however, failed to detect smaller features and also yielded some false positives due to snow ground cover, water ponding,

clouds and cloud shadows. Based on preliminary evidence, it seems a technique including spectral enhancements of low resolution – but current – imagery from Landsat 5 or 7 could guide the discovery and inventorying of features, concomitantly assisting with the update of the NHD.

Feature	County	Latitude			Longitude			Area (Ha)	No. Pixels (30 m)
		Degrees	Minutes	Seconds	Degrees	Minutes	Seconds		
1	Johnson	37	45	42.7	-82	51	45.1	1	11
2	Knox	36	57	55.9	-84	3	44.5	0.8	9
3	Laurel	36	58	20.2	-84	8	52.1	0.8	9
4	Lawrence	37	57	33.4	-82	35	17.9	5.7	63
5	Martin	37	48	12.1	-82	24	22.5	6.9	77
6	Martin	37	45	21.9	-82	31	50.6	3.1	34
7	Martin	37	45	10.1	-82	31	31.7	1.3	14
8	Martin	37	44	35.3	-82	31	54.7	1.2	13
9	Martin	37	44	45.4	-82	32	0.8	1.6	18
10	Perry	37	3	29.3	-83	9	16.9	7.7	86
11	Perry/Knott	37	23	36.5	-83	7	26.3	15.1	168
12	Pike	37	37	56.6	-82	22	6.5	11.4	127
13	Pike	37	37	39.1	-82	20	35.4	16.8	187

Table 1. Water body features detected from Landsat 5 TM scenes (acquired February and March 2009; paths 19 and 18, row 34, respectively; geographic coordinates are for approximate feature centroids, captured at an approximate scale of 1:40,000; North American Datum of 1983).

References

Crist, E. P., R. Laurin, and R. C. Cicone. 1986. Vegetation and soils information contained in transformed Thematic Mapper data. In *Proceedings of IGARSS 86 Symposium*, 1465-70. Ref. ESA SP-254. Paris: European Space Agency.

Frazier, P.S., and K.J. Page. 2000. Water body detection and delineation with Landsat TM Data. Photogrammetric Engineering and Remote Sensing. 66(12): 1461-1467.

RELATIONSHIPS ASSOCIATED WITH LAND COVER AND THE MACROINVERTEBRATE COMMUNITY OF NORTHERN KENTUCKY WATERSHEDS

Matthew S. Wooten
Aquatic Biologist, Northern Kentucky Sanitation District No. 1
1045 Eaton Drive, Fort Wright, KY 41017
859.578.6887
mwooten@sd1org

Robert J. Hawley, Ph.D.
Principal Scientist, Sustainable Streams, LLC
Research Assistant, Colorado State University
2038 Eastern Parkway, Suite 1, Louisville, KY 40204
502.718.2912
bob.hawley@sustainablestreams.com

As adaptive watershed management becomes an increasingly more prevalent means of managing water quality in streams, it is vital to understand the role that surrounding land covers play within the biological communities of streams. This is especially true in highly developing watersheds, such as many of those located in the Northern Kentucky counties of Boone, Kenton and Campbell. Sanitation District No. 1 (SD1) is charged with the regional management of both sanitary wastewater and storm water systems, evaluation of current and potential impacts, planning for future regional needs and the implementation of sanitary and storm water systems projects in Northern Kentucky. One of the first steps in understanding the various roles and influences within a watershed is the characterization of the watershed itself (i.e. biological, physical and chemical aspects). In order to accomplish this, SD1 launched a monitoring program to initiate the characterization process in Northern Kentucky streams. The objective of this project is to present the preliminary findings of the biological portion of this monitoring program. Specifically, this study focuses on the relationship of the macroinvertebrate communities and the surrounding land covers within these streams, and will also begin to examine the relationship of stream hydromodification and the marcroinvertebrate community. Macroinvertebrate samples were collected using protocols developed by the Kentucky Division of Water (KDOW 2008). Community data were analyzed using various multivariate techniques and the Kentucky Macroinvertebrate Index (MBI) (KDOW 2003, 2008). Habitat assessments developed by USEPA and adapted by KDOW were performed at each sampling location, and primary land cover was determined by visual interpretation of GIS coverage. Preliminary results indicate both positive and negative relationships between macroinvertebrate community structure, the MBI, the degree of development (i.e. percent impervious), and the degree of stream stability/instability of a given watershed.

NOTES