Progress Report for

NASA Project LCLUC-0024

Time Scales of Land Use Change and Export of N and P from Coastal Plain Basins to the Coastal Zone

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Project goals

Changing landuse frequently leads to enhanced N and P export to lakes, rivers, estuaries, and the coastal zone, resulting in eutrophication. Estuaries such as Chesapeake Bay have been especially impacted due to efficient utilization and retention of these fertilizing elements. In two coastal plain basins within the Chesapeake Bay drainage (Choptank and Chester River basins), landuse and soils are the primary controls on nutrient export, and we have calibrated a hydrochemical model which can predict water flow and NP export with accuracies of 15-30%. The goal of our research is to link our model of N and P export with historical landuse patterns derived from LANDSAT imagery, aerial photographs, and maps. Changes in landuse will be used to estimate export of N and P, and we will also use these watersheds as field verification sites for extrapolation over a larger region of the coastal zone under current conditions.

Project accomplishments

ERDAS Imagine

One of the initial tasks of this project was to add remote sensing capability to our existing work on stream chemistry and hydrochemical modelling. When funds first became available (Sept. 1997), I purchased a computer dedicated to hydrochemical modelling and analysis of satellite imagery, aerial photographs, and maps. We have also purchased and installed ERDAS Imagine and NT versions of ArcInfo/ArcView on this computer. These now provide us with the tools for analysis of landuse patterns from several data sources.

Imagery acquisition

We have begun the acquisition of a variety of imagery as sources of landuse information. We have submitted a request to EDC for available TM imagery for 1990, purchased four 1980 MSS scenes from EDC, obtained copies of 1972 aerial photos, obtained enlargements of 1964 satellite photographs (recently declassified by DOD), ordered 1938 aerial photos, and obtained xerox copies of 1847 hand-drawn maps from the National Archives. These and other available sources of landuse data for the Delmarva Peninsula are listed in more detail in the attached table. Some that we have worked with over the last six months are described in the next section.

Historical landuse time horizons

We have identified several important time horizons for quantification of landuse patterns in the Choptank and Chester basins (see attached table). The 1847 map was created by one surveyer over two years and contains especially detailed landuse information. This map is so accurate that 1972 aerial photos with 3 m resolution overlay almost directly when projected on the same coordinate system. We have digitized three of these maps, and now have an 1847 landuse data layer in our ArcInfo coverages. Other data sources of note are the 1980 MSS scenes from which we have extracted landuse for the Choptank and Chester for 1980, which is the beginning of the calibration decade for our hydrochemical modelling with GWLF. We can now test our assumption that landuse was constant during the 1980-1990 calibration decade; this will be important for a model that we hope to use to estimate export of N and P over a 150 year time window (1850-2000).

Hydrochemical modelling

We have made substantial progress in the use of the hydrochemical model GWLF. The model has been transported from Quick Basic to Visual Basic for easier interfacing with ArcInfo, and we have calibrated the model using a decade of data from the USGS gauging station in the Choptank Basin. We have also estimated the accuracy of the model's predictions at two locations, and at the annual time scale the model sucessfully reproduced the observed discharge of water, N, and P in both verification data sets to within 15-30%. This effort will be the subject of a talk at the 1998 ASLO meeting, and the third draft of a manuscript has been written (Lee et al. 1998a). A second effort with GWLF is an attempt to add spatial features to this lumped parameter model by linking the model with ArcInfo (Lee et al. 1998b).

Water chemistry sampling

We have maintained several water quality monitoring programs in the Choptank. Most of these have a long history or are directly related to the hydrochemical modeling. We have continued our sampling at the USGS gauging station at Greensboro, MD (used for the model calibration and verification). In addition, we continued a long-term monitoring program at two sewage treatment plants in the Choptank for our basin-wide nutrient budgets, and we have been doing monthly surveys of the distribution of nutrients and algae in the saline section of the Choptank to examine the effect of the exported nutrients on algal populations of the estuary.

Web page

Our web page (http://people.hpl.umces.edu/~klee/timescale1.html) contains initial results from our project. This is a temporary site which will be moved to a permanent location on a new mail server at our laboratory, and we will update the site as new results become available.

Remote sensing course

My students and I have been meeting twice per month to review concepts of remote sensing, aerial photography, and image analysis. This is an informal class (UM directed reading class MEES 608F) which is designed to add remote sensing expertise to all project participants.

Publications

Fisher, T. R., K.-Y. Lee, H. Berndt, J. A. Benitez, and M. M. Norton. 1998. Hydrology and chemistry of the Choptank River basin. Water Air Soil Poll. in press

Lee, K.-Y., T. R. Fisher, T. E. Jordan, D. L. Correll, D. E. Weller, and L. Darrell.1998a. Modelling the hydrochemistry of the Choptank River basin using GWLF. in prep (third draft).

Lee, K.-Y. Aand T. R. Fisher. 1998b. A modelling tool for hydrochemistry using GWLF and GIS. in prep (first draft).

Mayers, M. G. and T. R. Fisher. 1998. The effects of forest on stream water quality in two coastal plain watersheds of the Chesapeake Bay. sub. Ecol. Engin.

Mayers, M. G. 1998. Landscape effects of land cover, soil properties, and geomorphology on stream water quality draining two agricultural watersheds in the Chesapeake Bay basin. PhD thesis, University of Maryland.

Rochelle-Newall, E. J., T. R. Fisher, C. Fan, and P. M. Glibert. in review. Dynamics of chromophoric dissolved organic matter and dissolved organic carbon in experimental mesocosms. Int. J. Rem. Sensing

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NASA MTPE Project: Landuse History of the Choptank and Chester Basins

year	data source	comments/status
1847	maps	Hand-drawn 1:20,000 scale maps of Delmarva from National Archives. 3 available at HPL; others to be ordered from National Archives or borrowed from local libraries. 6 landuse categories (agriculture, structures, forest, marsh, beach, shoreline) digitized and stored as arcinfo coverages (see Fig. X).
1938	aerial photos	first aerial photos of Delmarva. Ordered from EROS data center.
1952	aerial photos	All MD counties of Delmarva Peninsula available for visual interpretation of landuse at MD Geol. Survey Library in Baltimore. We have access to these via MD DNR.
1964	aerial photos	All MD counties available for visual interpretation of landuse and tracing on mylar overlays at MD Geol. Survey Library.
	satellite photos	Enlarged, declassified DOD photos available at HPL for visual interpretation.
1972	aerial photos	1:40,000 scale maps of Talbot and Caroline counties available in MD Geol. Survey Library; others available from EROS data center. We have scanned, mosaiced, and interpreted four of these to provide landuse coverage for a subbasin of the Choptank (see Fig. X).
1973	landuse maps	1:63,360 scale maps (1" = 1 mile, Anderson level 2) available from MD Office of Planning
1980	MSS imagery	Landsat 123, path 15, row 33: 4 dates (Feb.13, June9, Aug.2, Oct.31) purchased from EROS Data Center. Files from CDs ingested by Imagine, and supervised classification performed (see Fig. X).
1981	landuse maps	1:63,360 scale maps (1" = 1 mile, Anderson level 2) available from MD Office of Planning.
1985	landuse maps	1:63,360 scale maps (1" = 1 mile, Anderson level 2) available from MD Office of Planning.
1990	digital landuse file	previously compiled by Mayers (1998). See Fig. X.
	TM imagery	Landsat 45, path 14, row 33: submitted request for available dates to EROS Data Center.
1994	digital landuse file	ArcInfo export files by MD county available from MD Dept. Planning.