Using Land-Cover Change as Dynamic Variables in Surface-Water and Water-Quality Models

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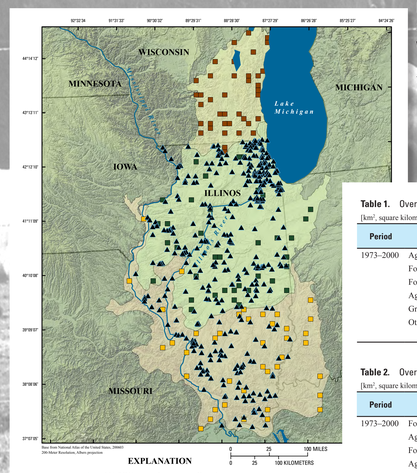
Introduction

Land-cover data are typically used in hydrologic modeling to establish or describe land surface dynamics. This project is designed to demonstrate the use of land-cover change data in surface-water and water-quality models by incorporating land-cover as a variable condition. The project incorporates three different scenarios that vary hydrologically and geographically: 1) Agriculture in the Plains, 2) Loon habitat in New England, and 3) Forestry in the Ozarks.

Agriculture in the Plains

The Illinois River flows across the Central Corn Belt Plains and Interior River Lowlands ecoregions before its confluence with the Mississippi River. The Illinois River Basin (IRB) is supported by sample blocks from both of these ecoregions. To create a new region covering the specific area of interest in the IRB, the statistics must be re-sampled. Although the Interior River Lowlands has a lower average annual nitrogen yield than the Central Corn Belt Plains (Goolsby and others, 2001), monitoring the impact of land-cover yield change between these two ecoregions is essential. This revised assessment will be used to examine how land-cover change relates to recently assessed water quality and trends developed from baseline measurements of recharge and surface water.



NAWQA groundwater-quality sampling sites, associated ecoregions, and areas with detailed land use classification.

Reference

Goolsby, D.A., Battaglin, W.A., Aulenbach, B.T., and Hooper, R.P., 2001, Nitrogen input to the Gulf of Mexico: Journal of Environmental Quality, v. 30, p. 329–336.

Table 1. Overall leading land cover conversions for Ecoregion 54 - The Central Corn Belt Plains.

[km², square kilometers; n/a, not applicable]

Period	From class	To class	Area changed (km²)	Standard error (km²)	Percent of ecoregion
1973–2000	Agriculture	Developed	2,039	697	2.1
	Forest	Agriculture	192	56	.2
	Forest	Developed	187	86	.2
	Agriculture	Grassland/Shrubland	171	54	.2
	Grassland/Shrubland	Forest	162	61	.2
	Other	Other	824	n/a	.8
		Total	3,575		3.6

Table 2. Overall leading land cover conversions for Ecoregion 72 - The Interior River Lowlands.

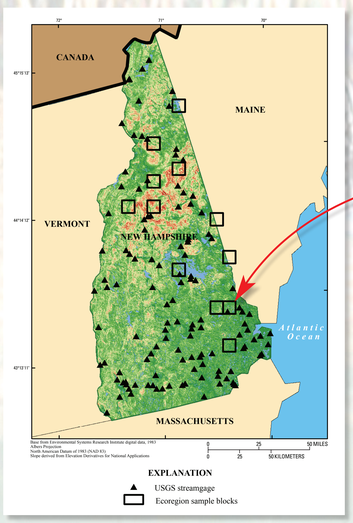
[km², square kilometers; n/a, not applicable]

Period	From class	To class	Area changed (km²)	Standard error (km²)	Percent of ecoregion
1973–2000	Forest	Agriculture	2,114	409	2.3
	Agriculture	Developed	1,186	606	1.3
	Forest	Developed	243	124	.3
	Agriculture	Forest	236	57	.3
	Agriculture	Mining	210	116	.2
	Other	Other	1,727	n/a	1.9
		Total	5,716		6.1

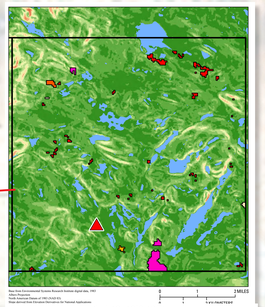
Background photograph from Ag in the Plains (USGS, 2005)

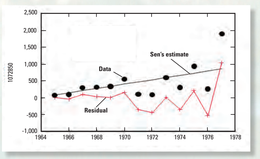
New England Common Loon Habitat

The Environmental Protection Agency's (EPA) Atlantic Ecology Division is working in conjunction with the Loon Preservation Committee (LPC) to develop loon-specific demographic models that integrate the risk of mercury and human disturbance across a range of stressor levels. To test the potential contribution of historic land-cover change, the areas that underwent multiple changes in land-cover classes from ecoregions in New Hampshire are related to trend magnitudes in peak flow and water-quality values from USGS streamgaging stations. This research will augment the EPA's data and enable researchers to back-calculate the impacts of human disturbance based on land-cover changes with time.



USGS streamgage 01072850, Mowhawk Brook near Center Strafford, New Hampshire has an increasing trend magnitude from 1973–1978.



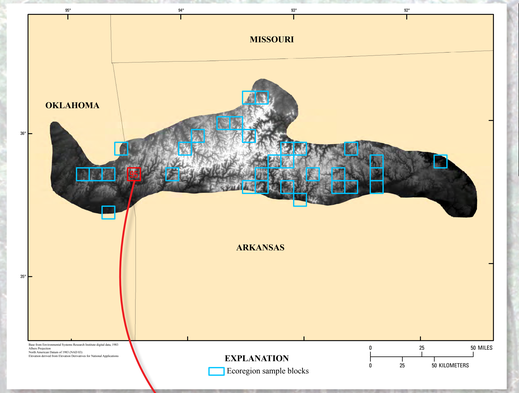


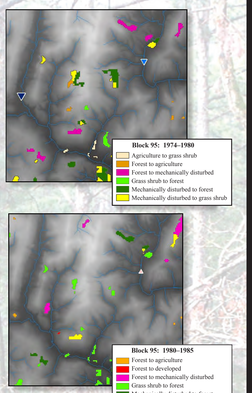
NAWQA groundwater-quality sampling sites, associated ecoregions, and areas with detailed land use classification.

Background photograph from Loons (EPA, 2010)

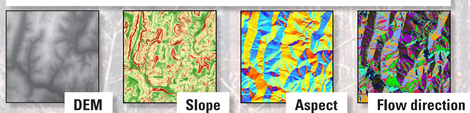
Forestry in the Ozarks

The timber industry has played a significant role in land-cover change in the Boston Mountains ecoregion. Generally, a land-cover class change from forest to mechanically-disturbed can be representative of forest cutting for development or timber harvesting. Forest cutting can have a significant effect on land-surface dynamics including rates of surface water runoff. Slope, aspect, flow direction, and land-cover multi-change data from 1973 to 2000 for the ecoregion sample blocks was organized in ArcGIS to analyze the effects of land-cover change on magnitudes of change in peak flows at streamgages.





Block 95



Peakflow data from USGS streamgage 07249500 (east side of block), Cove Creek near Lee Creek, Arkansas, returns a decreasing trend from 1974–1980 and an increasing trend from 1980–1985. Whereas USGS streamgage 07249650 (west side of block), Mountain Fork near Evansville, Arkansas, returns a decreasing trend from 1974–1980 and no trend from 1980–1985.

Background photograph from Forestry in the Ozarks (USGS, 2005)

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