Landscape Modeling and Geovisualization Workshop

Effect on Water Quality of Urbanization within the James River Basin

Chris Wood[1,2,6], Holly Neill[3] and L. Monika Moskal[4,5]

[1]Remote Sensing and Geospatial Analysis Laboratory
Department of Geography Geology and Planning
Southwest Missouri State University
http://ozarksgeography.smsu.edu/RSGAL/

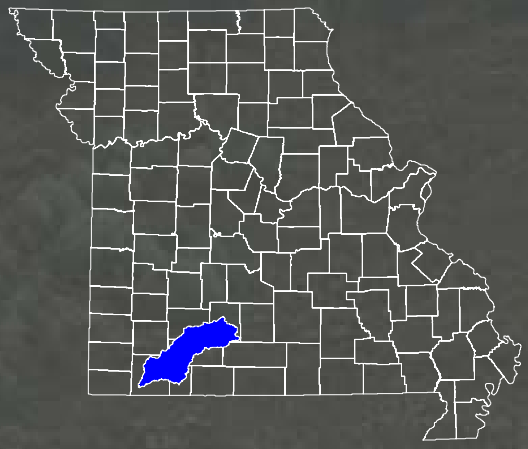
[2]Computer Science Department
Southwest Missouri State University

[3] James River Basin Partnership
http://www.jrbp.smsu.edu/

[4]Assistant Professor
Department of Geography Geology and Planning
Southwest Missouri State University

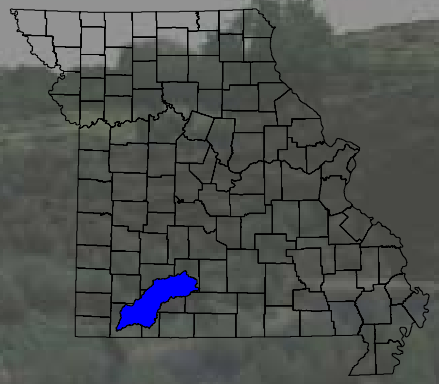
[5]Director
[6]Graduate Student Assistant (JRBP)
Remote Sensing and Geospatial Analysis Laboratory
Department of Geography Geology and Planning
Southwest Missouri State University

James River Basin, MO



- Located in southwest Missouri
- James River flows southwest through the basin
- Springfield, in the north, largest urban area within the basin
- James River Basin Partnership (JRBP) is an autonomous not-for-profit organization working to protect and improve the water quality in springs, stream, rivers and lakes within the basin
- Grant funds provided to JRBP for non-point source conservation programs are being used for educational and restoration programs within the basin
- Overall goal of improving water quality by addressing non-point source pollution.

Land Use/Land Cover
James River Basin, MO



Upper James River

Middle James River

Finley Creek

Lower James River

Flat Creek

Lower James-Table Rock

Urban
- Impervious
- High intensity urban
- Low intensity urban
- Barren or sparsely vegetated

Cropland
- Cropland

Grassland
- Grassland
- Herbaceous-dominated wetland

Forest and Woodland
- Deciduous forest
- Evergreen forest
- Mixed forest
- Deciduous woody/herbaceous
- Evergreen woody/herbaceous
- Mixed woody/herbaceous
- Woody-dominated wetland

Water
- Open water

Mo NRC - Lake of the Ozarks February 4th, 2005

Land Use/Land Cover map produced by MoRAP

Urban Growth of Springfield, MO

- Springfield is amongst the fastest growing urban areas in the country
- Population change of Springfield and surrounding areas:
  - 1972 Population
    - Greene Co. (163,400)
    - Christian Co. (20,500)
  - 1990 Population
    - Greene Co. (207,949)
      - Springfield (141,115)
    - Christian Co. (32,644)
      - Ozark (5,118), Nixa (5,131)
  - 2000 Population
    - Greene Co.
      - Springfield (151,580)
    - Christian Co. (54,285)
      - Ozark (9,665), Nixa (12,124)
- Concerned with the effect of this urban sprawl on surrounding environment
- How to translate measured effects into a medium that could be used to educate the general public

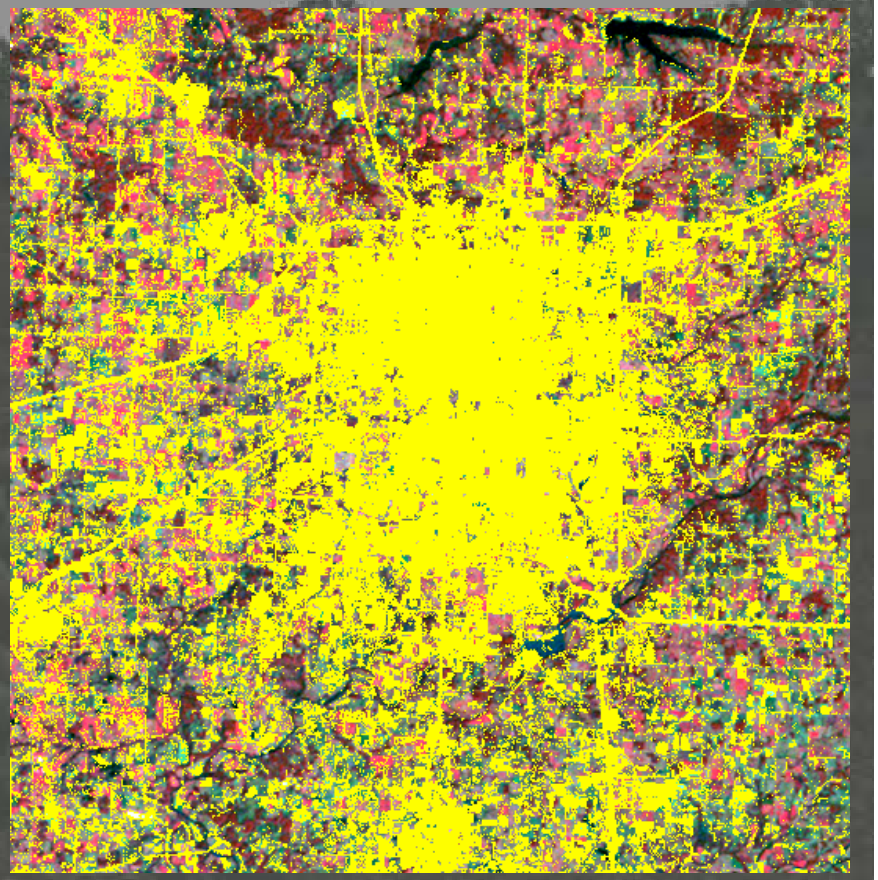
Springfield, MO

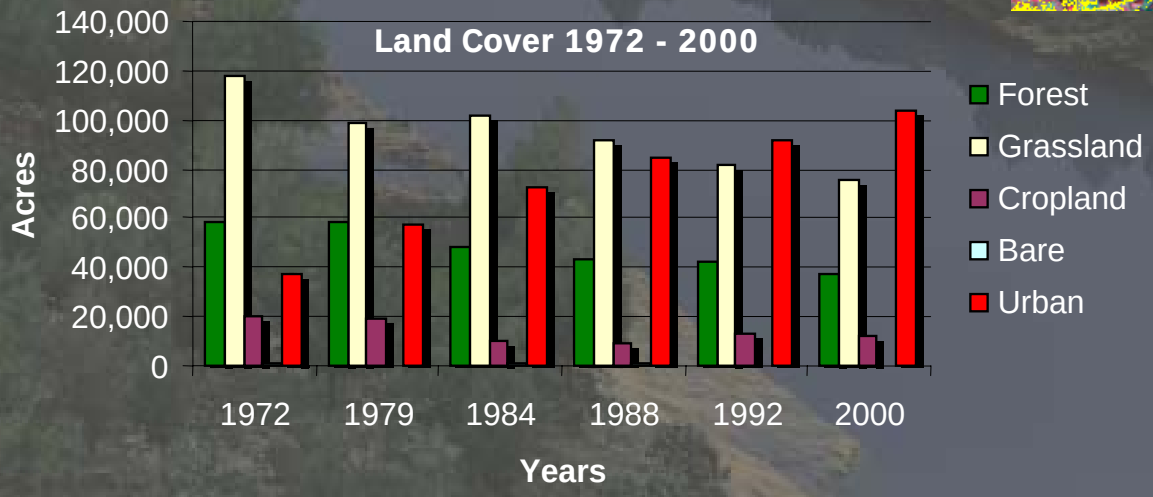
1972

36,996 Acres of urban

2000

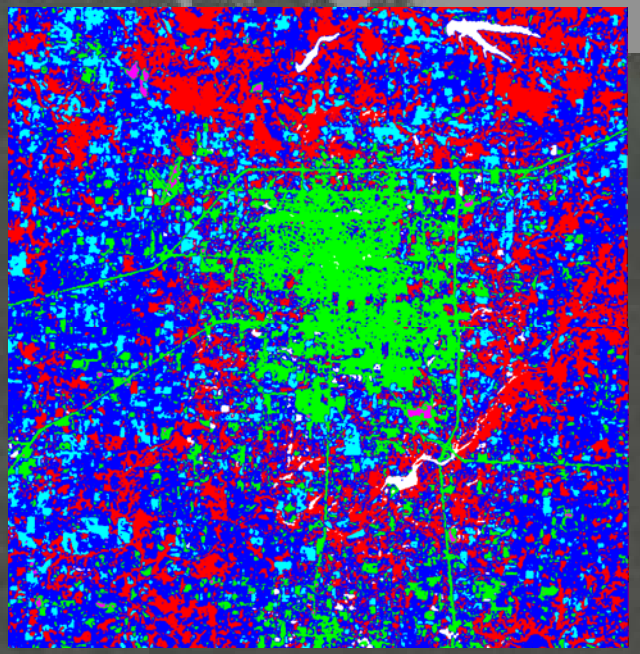
103,567 Acres of urban (11,504 acre increase)



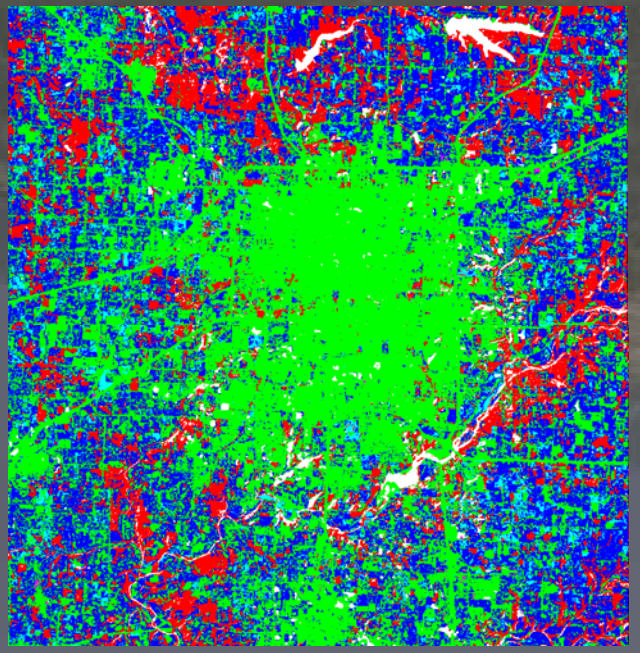


Urban and land cover change results from MoRAP

- LandSat Imagery for Springfield covering various 6 years within [1972 – 2000]
- Imagery classified according to various land-use, land-cover types
- Concerned with increase in urbanization and decrease in forested areas throughout this period



1972



2000

Effect of Urban Growth

- James River on ‘bad’ (impaired waterways) EPA list
- The continued urban growth in the area has had significant effect on surrounding environment
- Specifically the water quality in surrounding water ways is impaired

Measuring Water Quality Change

- Historical water quality data does not date back that far
- In fact water quality data for selected locations only available from 2002 onwards
- Change was assumed to be linear and back projected to 1972

Visualizing Urban Growth Effects

- Perform temporal analysis on study area
- Calculate relevant landscape metrics
- Progress from ‘standard’ temporal change analysis to generating moving animations; producing 3D visualizations of change within the study area

Temporal Analysis

- Various Landsat Images of the study area were classified according to land use or land coverage
  - water, grassland, forest, urban, cropland, bare or sparsely populated
- Compared to determine change in land cover and land use over the last 30 years

Image Reclassification

- When considering only urban growth, the other classes are not required
- LandSat images were re-classified to binary form of either “Urban” or “Not Urban”
- To allow images to be cascaded – such that from any one point on the final image, one can determine exactly how it has changed over time – a matrix for the binary re-classification was developed (shown on next slide)
- Fortunately in this case, once a pixel became urban it never changed after that
- Each image was re-classified and cascaded, resulting in a final temporal analysis image

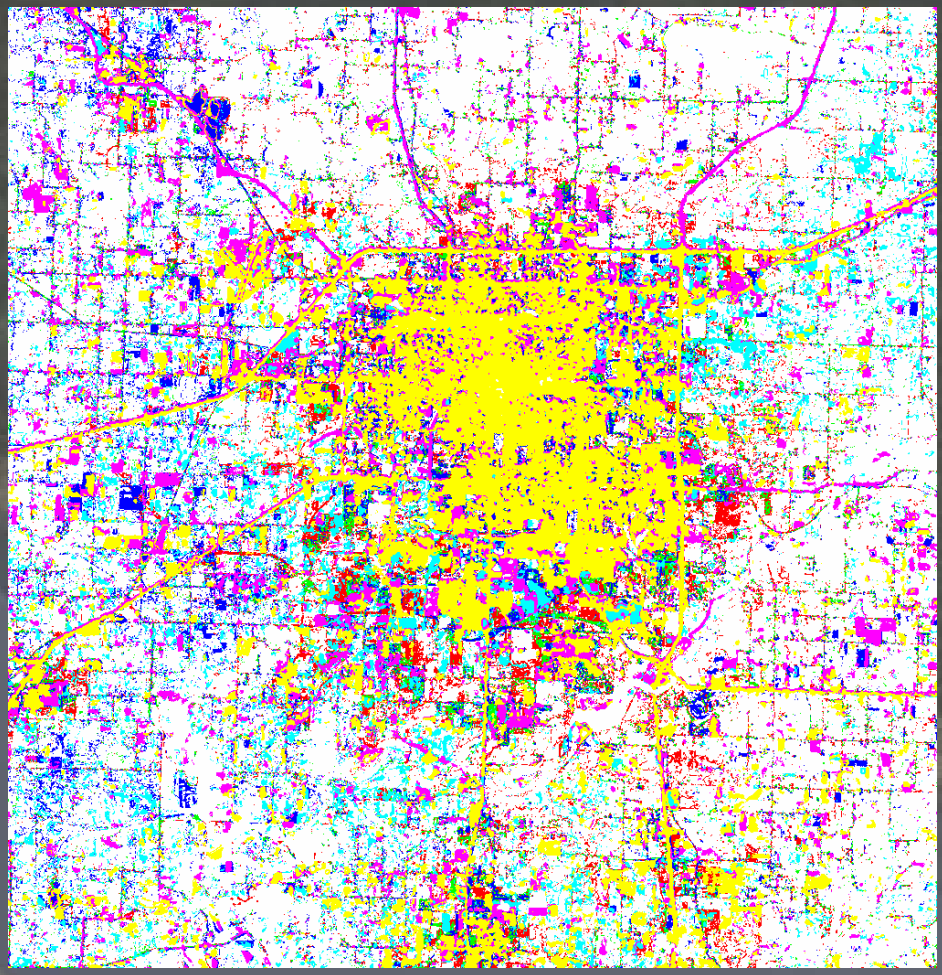
Binary Re-classification Matrix

1972		1979		1984		1988		1992		2000	
Not	0	Not	2	Not	8	Not	32	Not	128	Not	512
Urban	1	Urban	4	Urban	16	Urban	64	Urban	256	Urban	1024

1972		1979		1984		1988		1992		2000		Scaled
Not	0	Not	2	Not	10	Not	42	Not	170	Not	682	0
Not	0	Not	2	Not	10	Not	42	Not	170	Urban	1194	1
Not	0	Not	2	Not	10	Not	42	Urban	298	Urban	1322	2
Not	0	Not	2	Not	10	Urban	74	Urban	330	Urban	1354	3
Not	0	Not	2	Urban	18	Urban	82	Urban	338	Urban	1362	4
Not	0	Urban	4	Urban	20	Urban	84	Urban	340	Urban	1364	5
Urban	1	Urban	5	Urban	21	Urban	85	Urban	341	Urban	1365	6

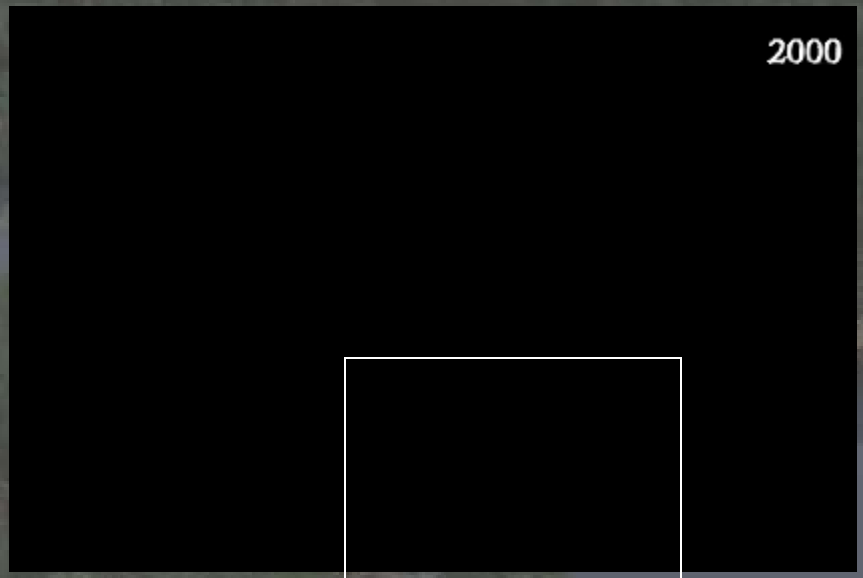
The Case For Animation

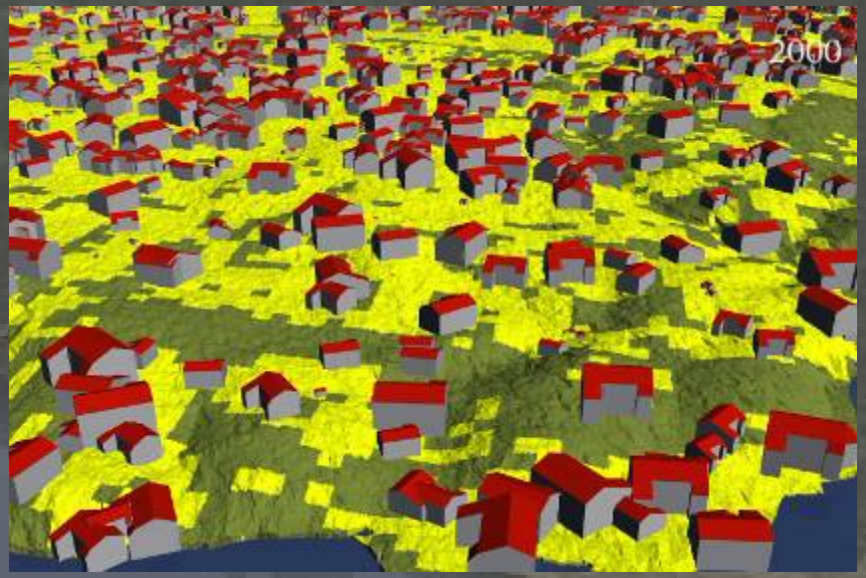
- It is easily seen that the final classification image is very difficult to understand and is not visually aesthetic
- How to display something that has a 4D component in/on a 2D (or 3D) medium?
- By visualizing the re-classified image in another manner the change in the study area becomes easier to understand



Re-classified Urban Growth Image

Final Animations





Urban visualizations conclusions

- The visualizations show temporal change and the dates are recorded in top right-hand corner
- The next step is to develop a similar overlay on top of Lake Springfield with the subjective water quality assessments
- To develop ecosystems that show grassland or forested areas when the land is not urban as well as houses when the land is urban requires incredible amount of computer resources
- It would be nice to have non-urban ecosystems in the animations, the rendering process will be exponentially increased, but it is possible
- Another possible alteration is draping facades over the buildings rather than using the default buildings provided by VNS, again considerably increasing rendering time

Acknowledgments

http://ozarksgeography.smsu.edu/RSGAL/

JRBP James River Basin Partnership

MoRAP