The Use of Geographic Information Systems for Watershed Partnerships: LaBarque Creek Watershed, Jefferson County, Missouri

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Keywords: Geographic Information Systems (GIS), Watershed, Planning, Conservation, Community Profiles, Land Type Profiles, Digital Elevation Model (DEM)

Abstract

This paper analyzes the use of GIS as a tool to enhance decision-making regarding development in the LaBarque Creek Watershed, and the process by which important natural resource information can be made available to county planners who seek to identify critical areas for protection as development occurs. GIS was used to assemble and organize readily available data and to create secondary data needed for analysis and planning. Geospatial analysis was conducted using a ten-meter digital elevation model, soils, parcels, and community characteristics. Analysis enabled identification of critical habitats, erosion hazards, and biological connectivity. The results of this analysis permit Jefferson County Planning Department to identify key habitats and important landforms that will assist them in making decisions about development proposals. Furthermore, the LaBarque Creek Watershed Partnership can identify landowners to be targeted for education on habitat preservation or restoration. LaBarque Creek Watershed study results and GIS data will provide future land management and development decisions that impact the watershed. In addition, this GIS application can be used as a template for other watershed planning efforts throughout Jefferson County.

Introduction

East-West Gateway Council of Governments (EWG), the metropolitan planning organization for the eight counties that make up the St. Louis region, provides a variety of resources and assistance to local government members. In 2002, EWG staff began to work with the Jefferson County Department of Land Use Development and Code Enforcement and the Planning Department to develop a watershed model plan for Jefferson County. EWG Planning staff enlisted the assistance of the GIS Department to help in the planning process. Other key partners included Missouri Department of Conservation (MDC), non-profit organizations, and residents of the watershed.

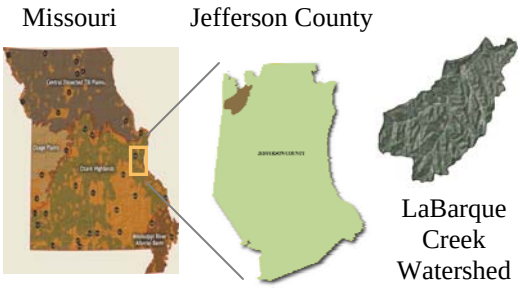
As an effort to identify and prioritize high quality natural areas, MDC worked with agency and non-profit partners to identify 33 Conservation Opportunity Areas (COA) within the state. A COA is a natural area that has high quality characteristics. LaBarque Creek watershed has been identified as one of these areas. As a part of the wildlife strategy employed in the COAs, MDC's Natural Heritage Program identifies and manages a list of declining plants and animals, and works

Herrera, Tracy. 2008. The Use of Geographic Information Systems for Watershed Partnerships: LaBarque Creek Watershed, Jefferson County, Missouri. Volume 10, Papers in Resource Analysis. 8pp. Saint Mary's University of Minnesota Central Services Press. Winona, MN. Retrieved (date) from http://www.gis.smumn.edu

with partners to develop habitat protection strategies (Missouri Department of Conservation, 2005).

LaBarque Creek Watershed is located in the northwestern corner of Jefferson County, and consists of 8,392 acres, or about 13 square miles, with a population density of about 100 people per square mile (Figure 1). LaBarque Creek was chosen as a COA due to the high quality of the creek and the unique geologic features in the watershed. With over 42 species of fish, LaBarque Creek is the first healthy tributary on the Meramec River, 42 miles upstream from the Mississippi River. Its underlying sandstone geology allows flowing water to carve caves, waterfalls, bowls and overhangs, and also provides habitats for several state-listed rare plants.

Figure 1. LaBarque Creek Watershed Location.



With LaBarque Creek being on the outskirts of a very urbanized and sprawling St. Louis Metropolitan Area (Figure 2), the Jefferson County Planning Department understood the high demand for development within the watershed and surrounding areas. Population growth for the City of Eureka, immediately north of the watershed, was an astounding 83 percent between 1990 and 2000 (growing from 11,269 to 20,588). The City of Pacific, just west of the watershed, grew 17 percent in the same decade, while population in the census tract that includes the watershed grew by 27 percent (US Census Bureau, 2000). Knowing the growth of development in this watershed as well as other watersheds is unreasonable, Jefferson County, in cooperation with stakeholders of the LaBarque Creek Watershed Partnership, banded together to develop a watershed development plan. A goal of this plan will aid in decision making by the Jefferson County Planning Department. The LaBarque Creek watershed partnership's goals are to protect and enhance the watershed's biodiversity by completing inventories and involving stakeholders including the county planning department and landowners. To assist in the development of this process, GIS was used to create a layer, at the watershed scale, identifying potential rare and sensitive areas.

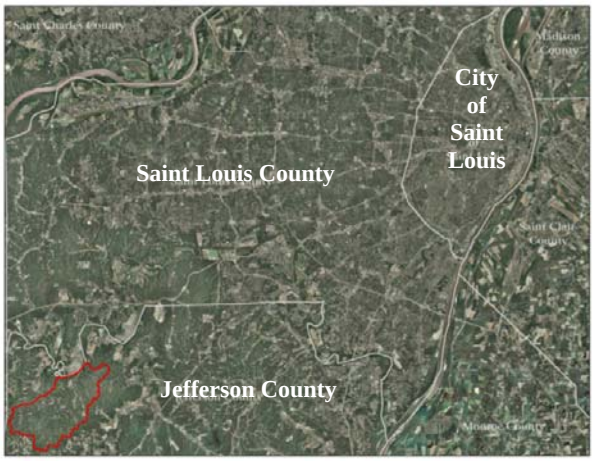


Figure 2. Proximity of LaBarque Creek Watershed to urbanized St. Louis, MO.

Analysis Methods

Data Collection

The data used in this project include both information that is publicly available to GIS users and also data obtained with a memorandum of

agreement from various organizations. Most of the layers that were used in this project were obtained from EWG, with the exception of the soils data obtained from the NRCS Soil Data Mart (NRCS, 2004), 10 meter Digital Elevation Model (DEM) from MDC, and the parcel data from Jefferson County. East-West Gateway Council of Governments is a regional planning agency. The EWG GIS department collects and creates data that is pertinent to the projects they are involved in. This project will be set up to be used by the watershed partnership and the Planning Department of Jefferson County.

Data Creation

Using the Spatial Analyst extension in ArcGIS 9.0, a 10-meter DEM was transformed into a percent slope layer and an aspect layer. Intermittent streams that drain into LaBarque Creek were digitized using the topographic map of the area.

Land Types and Community Types

Using the NRCS soils data, the soil classes were separated into slopes, ridges and benches, based on the percent slope, soil depths stated in the descriptions and parent material from the bedrock geology layer (NRCS, 2004). Using this combination of characteristics along with the expertise of Tim Neigh, a Resource Scientist with MDC, 13 land type classes were assigned to create the LBQLandtype shapefile (shown in Table 1 and Figure 3). Natural communities that are associated with each of the land types were subsequently added to the attribute table (shown in Table 2 and Figure 4).

Table 1. Land types of LaBarque Creek Watershed.

Land types
0 ponds/lakes
1 loess ridges
2 loess slopes
3 limestone ridges
4 protected cherty limestone slopes
5 exposed cherty limestone slopes
6 variable depth to limestone/dolomite
7 exposed sandstone slopes
8 protected sandstone slopes
9 sandstone benches
10 loess benches
11 variable depth to sandstone
12 sandstone glades
14 high floodplain
15 low floodplain

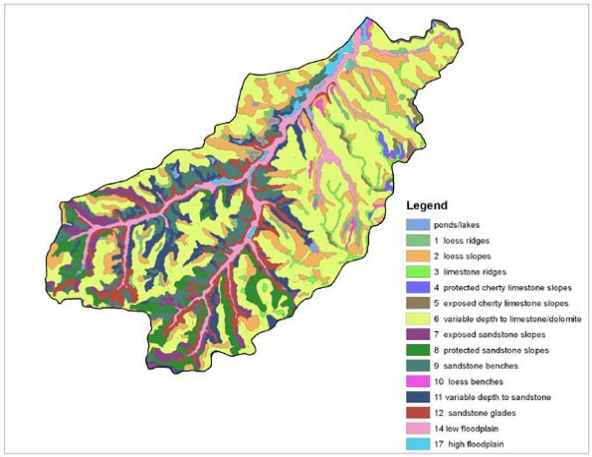


Figure 3. Land types of LaBarque Creek Watershed.

Rare and Critical Areas

The sandstone natural community, Sandstone Glade/Woodland/Cliff Complex, was extracted from the land type layer. The aspect grid, created from the 10m DEM of the watershed using Spatial Analyst, was converted into a shapefile and intersected with the community type. The slivers that were created when the grid was converted and intersected, were then merged into larger adjacent sections, to smooth out the data.

Table 2. Natural Communities of LaBarque Creek Watershed.

Natural Communities
0 ponds/lakes
1 Post Oak-Black Oak Dry Loess/ Glacial Till Woodland
2 White Oak-Red Oak/Dogwood Dry-mesic Loess/Glacial Till Forest
3 White Oak, Black Oak Dry Chert Woodland
4 Mixed Oak-Hickory Dry-mesic Chert Forest
5 Dry Chert Woodland
6 Dolomite Glade/Woodland Complex
7 Mixed Oak-Hickory Dry-mesic Sandstone Forest
8 White Oak/Dogwood Dry-mesic Sandstone Forest
9 White Oak (Red Oak)/ Dogwood Dry-mesic Sandstone Forest
11 Sandstone Woodland Complex
12 Sandstone Glade/Woodland/Cliff Complex
14 Mixed Hardwood Mesic Bottomland Forest
15 Riverfront Bottomland Forest

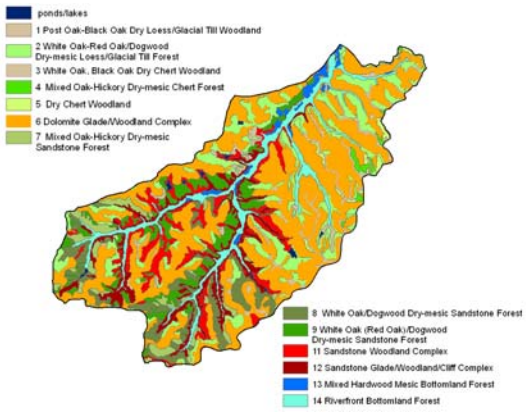


Figure 4. Natural Communities of LaBarque Creek Watershed.

Soils were broken into aspect values of 135 – 315 degrees for Southwest facing exposed slopes and 315 – 135 for Northeast facing protected slopes. Areas that are protected, or north facing, are more likely to contain rare or sensitive species. This information was then added back into the LBQLandtype shapefile.

All of the features that were associated with a sandstone community, whether it was a glade, woodland complex, forest or cliff, were extracted to a separate shapefile. Sandstone communities from this file were then ranked according to priority rankings to create SSLT (Sandstone Land Types) sections.

Rankings

1. Areas of Sandstone Glade/Woodland/Cliff Complex surrounded by White Oak (Red Oak)/Dogwood Dry-mesic Sandstone Forest
2. Sandstone Glade/Woodland/Cliff Complex
3. White Oak/Dogwood Dry-mesic Sandstone Forest
4. Mixed Oak-Hickory Dry-mesic Sandstone Forest
5. White Oak (Red Oak)/Dogwood Dry-mesic Sandstone Forest
6. Sandstone Woodland Complex

The parcel data was overlaid with the SSLT sections shapefile, and a spreadsheet was made for each priority level. Because a parcel may contain several priority areas, a field was added to each spreadsheet that signified the priority and the tables were merged together and the priorities combined into one record per parcel. The area and acreage, based on the feature shapefile, of each priority rank was also calculated. All public/semi-public parcels were omitted from the extractions.

Erosion Hazards

LaBarque Creek watershed is a topographically rich area, including many cliff areas. When the creek floods it increases the risk of erosion on areas with a steep slope (Kocher and LeBlanc, 2008), depending on the landuse practices of these areas. For this reason, the watershed partnership wanted to identify those areas that have a slope

greater then 30% , generally considered steep, and were within a 100 feet of the stream. To identify these areas, a 10-meter DEM was used to calculate slope for the entire watershed and the intermittent stream shapefile was buffered 100 feet. Those areas whose slope was 30% or greater and were within a sandstone or alluvial land type were extracted from the watershed slope grid. Once the cells were extracted, they were overlaid on the 100-foot buffer and clipped using N-Band Raster Clipper, and converted into a shapefile, using Spatial Analyst. The Select by Location function was used on those parcels containing areas of 30% or higher sandstone cliffs within 100 feet of a stream. The information was then extracted from the attribute table. All public/semi-public parcels were omitted from the extractions.

Biological Connectivity

All species are affected not only by their immediate community, but by their surrounding environment as well. For this reason, protecting all areas around the creek branches within the watershed was important. The watershed partnership needed to identify the areas to which the streams cross, excluding public/semi-publicly owned land that were already protected. For this, the streams layer was overlaid on the parcel file. All parcels that bordered or intersected LaBarque Creek's main stem were selected, and public/semi-public lands were taken out of the selection. Then, any parcel that bordered or intersected LaBarque Creek or any of its branches was extracted in the same way as LaBarque Creek's main stem.

Results

Rare and Critical Areas

This analysis identified 2670 of the 8629 acres in the LaBarque Creek Watershed as priorities for conservation (Figure 5). This acreage was comprised of 385 of the 758 parcels; a total of 321 landowners were affected. These numbers excluded public and semi-public lands. Parcel numbers indicated in Table 3 may contain multiple rankings, in which the highest priority ranking was used in the calculation.

Table 3. Acres per priority group. (Numbers placed before the description refer to the numbers used in Table 2.).

Natural Community	Priority	Acres	Parcels
12 Sandstone Glade/Woodland/Cliff Complex, surrounded by 9	1	40.65	36
12 Sandstone Glade/Woodland/Cliff Complex	2	584.76	139
8 White Oak/Dogwood Dry-mesic Sandstone Forest	3	549.25	45
7 Mixed Oak-Hickory Dry-mesic Sandstone Forest	4	293.63	29
9 White Oak (Red Oak)/Dogwood Dry-mesic Sandstone Forest	5	573.32	90
11 Sandstone Woodland Complex	6	628.03	46
TOTAL ACRES		***2669.64***	***385***

Erosion Hazards

Seventy-nine parcels (excluding publicly/semi-publicly owned parcels) contain slopes of 30% or more within 100 feet of LaBarque Creek, on a sandstone formation. This equates to 38.65 acres, as shown in Figure 6. This information, along with property owner names and addresses, were extracted from the attribute table and given to the watershed partnership for community education.

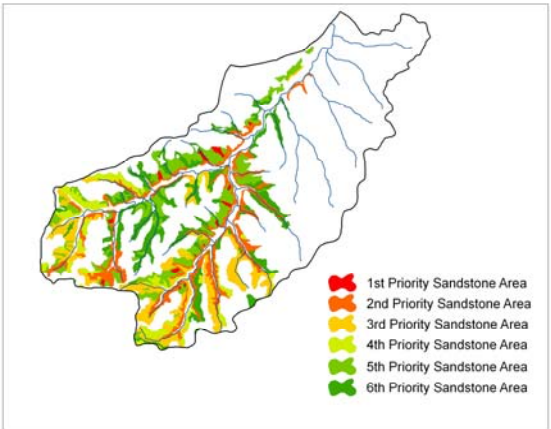


Figure 5. Rare and Critical Areas of LaBarque Creek Watershed.

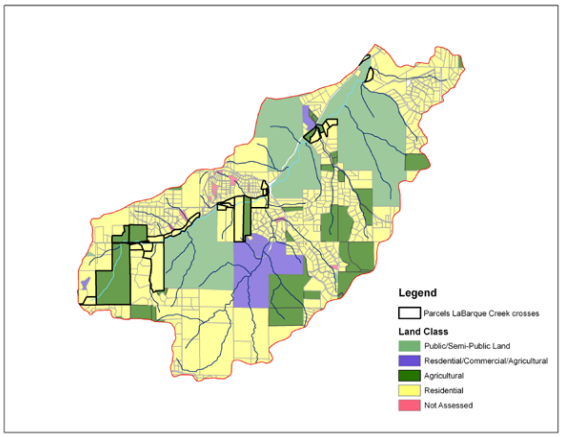


Figure 7. Parcels selected for biological connectivity, LaBarque main stem.

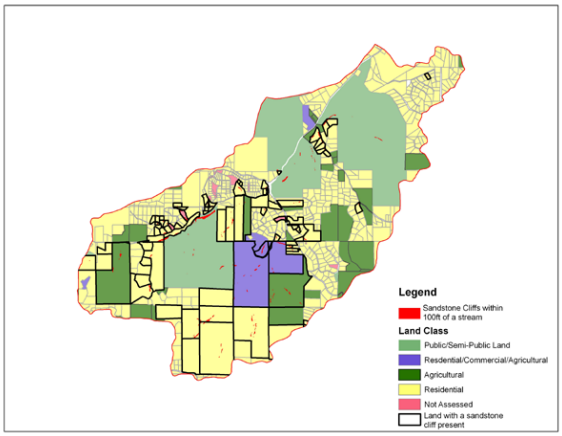


Figure 6. Properties selected that contain slopes of 30% or more w/in 100 ft of LaBarque Creek on a sandstone formation.

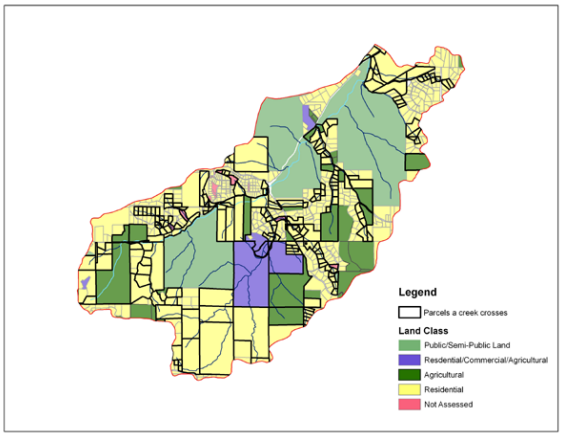


Figure 8. Parcels selected for biological connectivity, LaBarque Creek (all branches).

Biological Connectivity

The analysis was carried with two variations, each yielding separate results. When the analysis was conducted using LaBarque Creek's main stem, 24 properties equaling 664.42 acres were selected for acquisition/community outreach (Figure 7).

During the second analysis, using all branches of the creek, substantially more properties were selected for education and/or acquisition, with this analysis returning 195 parcels equaling 4,291.67 acres (Figure 8).

Discussion

The current method of conservation planning in Jefferson County has been reactive. Once a development application has been received, if the county or MDC planners think there is reason to assess the property for conservation values, they then send a representative to the property to assess the land for conservation requirements including habitat, rare plant species, etc. This new GIS project for watershed planning will enable the county planning department to make a preliminary assessment on any property for which they receive a development plan. This

additional information will assist the county in protecting valuable resources and in making these types of decisions in a more timely manner, without as much manpower.

Rare and Critical Areas

Walking every inch of a watershed to determine where rare species would/could be found is timely. GIS is a quicker and more scientific method. Instead of physically looking for the features on the landscape, the use of digital files that specify the special characteristics of an area were used to approximate where a set of criteria would be found and what could be found within them. Jefferson County is now able to use this GIS project to evaluate permits and issue building constraints. Agencies like MDC will be able to use this as a tool for consulting with landowners on proper conservation techniques, not only in answering questions about if the property can be developed, but where on the property development can take place while protecting natural features.

Erosion

Using the results of the analysis, the planning department will be able to look at the area to be built upon and determine the percentage of slope the property contains and aid in the decision whether to issue a permit. This also provides the watershed partnership the opportunity to identify landowners and surrounding community members for erosion control education.

Biological Connectivity

Using two different analyses (LaBarque Creek's main stem and all branches of the creek), allowed the watershed partnership to start with a lower number of property owners to target for community outreach and provided the county with a larger list of properties to evaluate in the instance a building permit is requested. Since both analyses were performed at the parcel level, this was just a starting point, to alert the planning office to any areas that could contain rare or sensitive species and recognize that further investigation would be needed. If the area to be built on was not near the stream and was not discovered by the results of the analysis, a permit could be issued without further concern.

Conclusion

Although this project started as a collaborative effort to educate the landowners within the watershed on conservation opportunities, and as a part of the watershed partnership program, it will be distributed to county planners to aid in planning and policy decisions. The completed project, which includes a CD of the pre-packaged project and all layers that went into the project and this paper, will be distributed to MDC staff and to county planning staff. The county planning department has requested that the project be used as a template and be expanded to a countywide database. EWG will provide assistance in expanding the project to include the entire county, so that this kind of data can be used in other watershed planning efforts and by the planning department in plan review.

All the information obtained from the current analysis will be used in the LaBarque Creek watershed planning document and will be used to fulfill the

community education portion of the document.

Although watershed planning is not new, the use of GIS to aid in watershed planning is relatively new. The use of GIS, as in many GIS applications, has advanced the planning process and made it easier for targeting and identifying areas of interest and concern.

This has been an enormous step for Jefferson County, MDC, and the watershed partnership in the direction of preserving the environment that could have suffered the fate of surrounding watersheds.

References

Kocher, S. D. and LeBlanc, J. W. University of California Cooperative Extension. Retrieved 06/08 from http://www.cnr.berkeley.edu/departments/espm/extension/EROSION.HTM.

Missouri Department of Conservation. August 18, 2005. “Missouri’s Comprehensive Wildlife Conservation Strategy."

Natural Resources Conservation Service. February, 2004. Jefferson County SSURGO 2.0 Soil Survey.

U.S. Census Bureau. 2000. Retrieved 06/08 from http://www.census.gov/geo/www/relate/rel_tract.html.