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GEOGRAPHIC INFORMATION SYSTEMS: A TOOL FOR RURAL COMMUNITY RESEARCH

By Sarah Dewees and Timothy Collins

ABSTRACT

Because of their traditional application in the environmental and geological sciences, geographic information systems are not usually considered to be useful tools for rural community research or analysis. The 1990 census made socio-economic data available at the block-group level, however, and this has facilitated the mapping of socio-economic variables in small areas. Insight, explanation, and understanding can come from seeing data in their spatial context. Citizen researchers in the Jackson County, KY, Empowerment Zone used block-group level data in maps of their county to study socio-economic patterns in their communities. This paper provides an example of a way to use simple mapping techniques to illuminate social and economic patterns in small areas.

INTRODUCTION

Geographic information systems (GIS) were initially developed as tools for the storage, management, and display of geographic information. Traditionally, the majority of GIS applications have been focused on some aspect of the physical environment and have been used for environmental, engineering, or infrastructure projects. Socio-economic applications of GIS have been increasing in the last decade, but these have been concentrated in the field of "geodemographic" applications including marketing, health care and service delivery.

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management, and environmental monitoring (Martin, 1996). The role of GIS in providing new opportunities for understanding socio-economic conditions across space, beyond those concerned with the simple reporting of patterns, remains relatively undeveloped.

Goodchild (1991) states that "the case for spatial data analysis rests on the argument that explanation, understanding, and insight can come from seeing data in their spatial context" (p. 41). GIS is very effective for presenting data in their spatial context in a way that tabular data cannot. Goodchild suggests that presenting data in a spatial context can provide information on the relative locations of objects or events, and proximity can facilitate insight. He gives the example of an 1854 map showing the clustering of cholera victims around a well. Through this simple presentation of proximate location, the well was identified as being contaminated (Gilbert, 1958). Similar techniques have been used to assess charges of environmental racism (Bullard, 1994).

The social implications of GIS research and application have recently become the subject of debate. Pickles (1997a) argues that there is clearly a political economy of GIS in terms of technology access, cost, and surveillance capabilities. Others argue that the mode of "top-down" data creation and "expert policy making" associated with GIS inherently favors the powerful and disenfranchises the weak, especially in impoverished areas (Weiner et al., 1995). GIS applications are seen as particularly inappropriate for social science projects because of the rigid nature of the digital technology, the inability of GIS to represent local knowledge, the limitations of access to GIS technology, and the social control of GIS information (Obermeyer, 1995; Pickles, 1997b; Taylor & Overton, 1991).

While the debates surrounding GIS have not been fully resolved, the use of GIS for culturally sensitive research and project management has been defended by some authors (Dunn et al., 1997; Weiner et al., 1995). Dunn et al. (1997) suggest that GIS can provide an ideal instrument for local management of a project and can even be used to represent locally produced data. The utility and relevance of a project rests on who has control of the construction, analysis, and management of the GIS (Bell, 1996). For a resource redistribution project in South Africa, Weiner et al. (1995) used community involvement to design a GIS that combined community histories and local knowledge with agency-driven environmental and infrastructural data.
Despite many applications in the social sciences, GIS is rarely considered as a tool to be used for rural community research, analysis, or education. Given the technical nature of most GIS programs and their traditional application in geological and environmental sciences, their utility in analyzing social and economic patterns in small areas is often overlooked. Although applications in the fields of census mapping and socio-economic modeling have experienced massive growth in the 1990s, most studies of social science data present patterns at a county, state, or regional level (Martin, 1996).

The 1990 census made many socio-economic variables available at the block-group level for the first time. The detailed assessment of smaller areas is now possible with this data set, which provides the opportunity to represent socio-economic patterns at a more refined level of analysis (Cromartie & Swanson, 1996). For example, the University of Kentucky Appalachian Center used census tract data to suggest patterns of spatial inequalities in eastern Kentucky mountain counties (Eller et al., 1994). The use of sub-county areas is especially useful for the rural community development practitioner. Many community action programs require data that are much more geographically specific than a county or regional level analysis (Farmer et al., 1992). Block group level data can also help avoid aggregation problems. Aggregation to different units of analysis can yield considerable differences in research results, and county-level data may mask intra-county variation (Farmer et al., 1992; Hannan, 1971). By representing socio-economic data at a relatively small scale with a GIS, the concentration or stratification of variables within parts of a county or small area is illuminated.

Block-group level data also provide the opportunity to find empirical referents of community that can be more clearly linked to theoretically driven definitions of community (Farmer et al., 1992). This is a difficult task, however. The methodological limitations of census-defined geographic boundaries have not disappeared. In most states, perceived community boundaries do not correspond with census boundaries, and census definitions have little to do with the socio-cultural identity of a community’s residents (Herbers, 1996). However, a block-group level data set does provide the advantage of finer geographic divisions to data that may be more successful in representing the boundaries of small settlements or communities that often exist in rural areas.
Perhaps because of perceived limitations, there have been very few applications of GIS to mapping patterns in small areas. In Jackson County, Kentucky, a group of citizen researchers used block-group level maps to assess the spatial distribution of social and economic variables in their county. While there are some limitations to the use of GIS as a research tool, it can contribute to the study of social and economic patterns in rural areas.

GIS AND RURAL COMMUNITY RESEARCH: JACKSON COUNTY, KENTUCKY

The federal Empowerment Zone/Enterprise Community (EZ/EC) program, passed by Congress in 1993, is perhaps the most significant rural-development and anti-poverty program since the 1960s' War on Poverty. Nationally, 33 rural communities were chosen to receive funds based on a competitive grant process. Three of these communities were designated as rural Empowerment Zones, and are qualified to receive $40 million over ten years. Thirty grantees designated as Enterprise Communities were to operate for 2 years with about $3 million dollars in funding. Of the 33 rural communities selected to receive EZ/EC funding, 10 were chosen to participate in a national program that trained local citizens in program assessment techniques.²

In the 10 selected communities, "Local Learning Teams" were established to conduct research on the ongoing EZ/EC programs. This research was to result in a report that provided an overview of the Learning Teams' findings and recommendations regarding the success of the EZ/EC project in their communities. Each of these Learning Teams was assisted by a Regional Researcher, usually from a nearby university, and a Local Learning Team coordinator. Guided by the principles of participatory research, the Local Learning Team program was designed to help a panel of Empowerment Zone citizens enhance their understanding and knowledge of the EZ program and evaluate its effectiveness in meeting its stated goals (Gaventa, 1988; Tandon, 1981). The Learning Team project was an exercise in collaborative research, in

² The University of Tennessee, Knoxville Community Partnership Center obtained grants from USDA and the Ford Foundation to train local citizens to take part in this evaluation.
which citizens conducted a study based on their own research questions, with some project management and technical assistance provided by the Regional Researcher. Collaborative research can be a highly effective learning experience for community members and can be a catalyst for the solution of community problems (Yoak, 1979). It can also provide an opportunity for community members to build trust and social capital through cooperation and collective learning (Gage & Harker, 1997).

Jackson County, Kentucky, one of three counties that make up the Kentucky Highlands Empowerment Zone (KHEZ), was chosen to participate in the Local Learning Team program in early 1996. The Jackson County Empowerment Zone, under the leadership of the Kentucky Highlands Investment Corporation, will receive more than $8.75 million in federal funds over 10 years, from 1995 to 2005. These funds have been allotted for various physical infrastructure improvements, such as a new industrial park, a community center, a lake for water supply, and downtown renovation.

The Jackson County component of the KHEZ is, true to its name, based on a definition of community that relies on the census-designated geographic boundaries of the county. This definition of the community was mandated by the United States Department of Agriculture in the initial grant application for the Empowerment Zone funds, which required that the recipient communities be delineated on some aggregation of census tract areas, including counties. In rural Kentucky, this definition of community is less of a problem than in other parts of the country. Kentucky county boundaries tend to represent relatively small geographic areas. The structure of rural local government in Kentucky ensures that individuals interact on county-related matters, as the County Judge Executive makes political and economic decisions that affect the smaller localities. However, there are many social divisions within the existing rural Empowerment Zones and Enterprise Communities that might have been avoided if a better definition of community were used from the outset.

The boundaries of Jackson County, Kentucky, encompass the two main incorporated communities of McKee and Annville. The county also contains several other smaller settlements; the most populous is Sand Gap in the north of the county (see Figure 1). Jackson County has a total population of nearly 12,000 people, with four census tracts containing approximately 3,000 people each. Jackson County has 11 block-groups
overall, with each block-group containing 700 to 800 people. According to Learning Team members, some of these block-groups roughly follow the geographic boundaries of some of the smaller communities located in the county.

The Jackson County EZ Learning Team was faced with the difficult task of performing citizen research and evaluation in a county both hopeful for a successful outcome of the EZ project and also suspicious of the current leadership of that project. There had been problems with low citizen involvement in some of the programs, and there were allegations that the Empowerment Zone board had tried to exclude segments of the county population from participating in the grant. Interviews conducted by the Learning Team and the Regional Researcher revealed that there were long-standing political, cultural, and social divisions between the northern and southern ends of the county. Speaking of the power structure in the south of the county, one interviewee stated, "There's that group that always gets what they want and puts it where they want it. And us up here north of the 'Waneta Wall' have been ignored so long that it never occurred to anyone that we were still up here..." Another interviewee stated that members of northern end of the community were not as optimistic about the EZ project as people in the south because "they've never done anything before, for us."

One of the most serious contentions regarding the Jackson County EZ grant was that the communities in the northern part of the county had been shut out of the Empowerment Zone grant monies for political reasons. While the northern community of Sand Gap had been included in the original draft of the KHEZ grant, the final proposal submitted to the USDA did not include funding for this community in the downtown renovation proposals. In fact, it appeared that most of the funded projects were taking place in the only two incorporated towns in the county, McKee, in the center of the county, and Annville, in the south of the county. Given that the northern end of the county was known as the "poorer" end of the county, it seemed that the Empowerment Zone funds were not going to those most in need.

3 The term "Waneta Wall" is used by some Jackson County residents to describe an imaginary boundary between the north and the south of the county that runs through the unincorporated town of Waneta. Waneta is more or less the "gateway" to the northern end of the county, where the terrain is rougher, more heavily forested, and less populated than the rolling southern end.
There was also concern that representation on the Jackson County Empowerment Zone board was limited to individuals who lived in the southern areas of the county. According to informants who gave interviews during a 1995 study of the Empowerment Zone (Collins & Eller, 1995), the membership on the KHEZ board was perceived to be handpicked by the KHEZ board chairman, the local County Judge Executive. There was a concern that the citizens of the county were not being equitably represented.

The main goal of the Learning Team was to assess three ongoing projects of the Jackson County EZ and evaluate their success in relation to the grant’s benchmarks and to the EZ program’s overarching goals of enhancing economic opportunity, bringing about sustainable community development, developing community-based partnerships, and providing a strategic vision for change (U.S. Department of Housing and Urban Development, 1994). Related to these research goals, the Learning Team was also interested in questions about cultural, political, and social divisions in the county. Specific to their program evaluation, the Learning Team was interested in whether the EZ funds were being spent in the poorest parts of the county and whether the EZ board included representation from all regions of the county. With help from the Regional Researcher, the Learning Team members employed a variety of research techniques to gather data on these questions, including collecting tabular data from the census and conducting structured interviews with Jackson County residents.

The Learning Team also used GIS as a research tool. The Enterprise Community and Empowerment Zone projects are especially suited for this type of tool because the original boundary for these programs relied on census defined divisions. In the case of Jackson County, the whole county was included in the Empowerment Zone. With the help of the Regional Researcher, several maps of Jackson County were generated using Atlas GIS for Windows. Using data from the 1990 Census, Summary Tape File 3A, these maps displayed several socio-economic variables at the block-group level. The broad set of indicators used in this GIS analysis were selected by the researchers and then approved by the Learning Team. The smaller set of variables used in the final report were chosen by the Learning Team.

The maps generated for the Learning Team were used to show the relative levels of several socio-economic variables in the county, as well
as the spatial distribution of these variables. One of the maps showed the percentage of people in poverty in each block-group. Another map displayed the percentage of population receiving public assistance. A third map showed the percentage of people under age 18 living in poverty, and a fourth demonstrated the percentage of the population with at least a high school diploma. Several other maps were generated for variables of interest to the Learning Team. Because of the relatively small population size of 11 block-groups, the data were broken into quartiles, and then mapped at the block-group level for the whole county. These maps also included other important geographic features such as the location of settlements and major roads.

Not only were several socio-economic variables in the community mapped, but an index of several key indicators was also generated and mapped. An index of economic distress was generated by ranking each block-group based on 6 main variables: percent of persons living below the poverty level, percent of land with slope greater than 6 percent (not suitable for development or farming), percent of housing without a public water supply, percent of total persons under 18 in poverty, percent of total population who are not high school graduates, and percent of persons receiving public assistance. Given the ruggedness of the physical terrain in Jackson County, a measure of the steepness of slope was useful for assessing barriers to residential, industrial, or agricultural development. The measure of the number of houses without a public water supply provided a picture of physical infrastructure limitations. The other socio-economic variables provided insight into both poverty levels and human capital deficiencies. The percent of the total population in poverty captured overall poverty levels, and the percent of the population under age 18 in poverty captured the poverty levels of youth. The percent of the total population without a high school diploma indicated barriers to high wage and high skill employment. Each of the block-groups was ranked according to these variables, and then a composite score was generated for each block-group by adding up the rank for each variable. Each block-group was then ranked according to this composite score.

The results of the mapping exercise are presented in Figures 1-3. Figures 1 and 2 show the levels of two socio-economic variables by

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4 A similar index had been used in a previous Appalachian Center report, titled Kentucky River Area Development District: Historic Trends and Geographic Patterns (Collins et al., 1996).
block-group in the county. Although there is no overwhelming pattern, the northern end of the county appears to rank consistently higher than the southern end on individual indicators of economic distress.

Figure 3 presents the map of the index of economic distress. Two important patterns emerge in this map. First, when an index of indicators is used, it becomes clear that the southern end of the county is noticeably less distressed than the rest of the county. Second, it appears that McKee, the county seat and the site of several Empowerment Zone projects, actually exhibits high levels of socio-economic distress. Some of the highest ranked block-groups appear in the area around the town of McKee. While it appears that the northern communities may not have received a fair share of grant funds, it appears that the grant funds spent in McKee were well directed to an existing need.

In order to evaluate the question of whether or not there was equitable representation on the Empowerment Zone board, a map of the residences of all the members of the Jackson County Empowerment Zone board was generated (see Figure 4). This map illustrates the spatial location of each board member’s home residence. According to this map, the board seemed to include broad representation from the most populated areas in the county. Overall board membership did appear to be slightly more concentrated in the southern end of the county. While residence in a particular geographic location does not definitively reveal a board member’s politics, in a politically divided county like Jackson County, geographic location can be important. While this map does not decisively answer questions about EZ board representation, it provides additional information to add to other available data.

There were several advantages to using GIS for the Learning Team research projects. First, the GIS maps, presented in a straightforward way with no statistical manipulations of the data, simply provided a different way to study the socio-economic data available to the Learning Team members. The graphical display of data was useful both for corroborating other tabular data and for providing a more visual way to interpret that data. The members of the Learning Team responded positively to the spatial display of data and seemed to be more engaged by the maps than by the tabular data. Members of the Learning Team took interest in locating their house or home community on the maps and assessing the corresponding level of the socio-economic variables.
Figure 1: Percentage of the population living in poverty.
Figure 2: Percentage of the population receiving public assistance.
Figure 3: Ranking of economic distress measures by block group.
Figure 4. Home residences of EZ board members.
displayed. While the building of trust and social capital was a long, intricate process for the Learning Team, the maps of the county stimulated conversations related to the community, geography, and identity that were an important part of this process.

Second, displaying socio-economic data at the block-group level for the whole county provided a visual way of linking different socio-economic indicators to the smaller settlements and communities in the county. While the block-group boundaries did not clearly follow "community" boundaries in all cases, the spatial display of the data allowed individuals to locate their communities in relation to the spatial display of block-group level data and thus ascertain the likely value of the variables for their community. These measures of community well-being were approximate but did not suffer from the same problems of aggregation that is presented by county-level data (Farmer et al., 1992). The members of the Learning Team were able to identify the communities with the highest rates of economic distress by examining the level of variables in the block groups surrounding those communities.

Third, displaying socio-economic data at the block-group level for the county illustrated the variability present in Jackson County as a whole. While the whole county has relatively high poverty measures, displaying the data at the block-group level illuminated the distributional patterns of poverty within the county. Learning Team members found that the maps sometimes corroborated their perceptions of their county. Most of the maps revealed higher levels of economic distress in the northern end of the county, something that matched the cognitive maps of most of the team members (Jacob & Luloff, 1995). Other times, these maps rendered surprising results. For example, the concentration of poverty near McKee was a surprise to both the Regional Researcher and Learning Team members. In addition, some block-groups in the north revealed relatively low indicators of distress on variables such as the percent of the population under age 18 living in poverty.

Fourth, the spatial display of the data helped to link economic and social patterns in the data. For example, the concentration of indicators of economic distress (low income, high poverty) in the section of the county that was most politically disenfranchised provided an illustration of the coincidence of social and economic patterns in Jackson County. Again, Learning Team members found that these maps frequently matched their cognitive maps of the county.
There are also some limitations to the use of GIS maps with citizen researchers such as the Jackson County Learning Team. The generation of GIS maps requires a great amount of technical assistance, and if there is no training involved, there is little transfer of skills to the local researchers. GIS data are not a tool that can stand alone, but is best used in conjunction with other research tools, such as interviews and tabular data. Block-group level maps also may have limited utility in counties where census boundaries provide no useful referent for local communities. In Jackson County, block-group maps were a useful addition to the citizen Learning Team’s community research "toolbox," but they were used in combination with other research tools and fell into the "technical assistance" category of community development with no transfer of GIS skills.

DISCUSSION

The mapping exercises in Jackson County, Kentucky, used simple, block-group level maps of socio-economic data. These exercises yielded a wealth of information about economic and social patterns in the county. In combination with interview and tabular data, these maps were used to help answer questions about the distribution of Empowerment Zone funding in the county and to assess political representation on the Empowerment Zone board. Based on the maps of socio-economic variables, the Learning Team concluded that the EZ funding in Jackson County was well directed in the town of McKee, but that Sand Gap, a community of great need, was not being well served by the EZ project. Based on the map of the EZ board member residences, the Learning Team concluded that there was relatively equitable geographic representation on the EZ board, although the representation from the south of the county may have been disproportionate (the political composition of the EZ board was further researched through interviews with county residents). The Jackson County EZ Learning Team included these maps in its final report and considered them to be important tools in their assessment process.

The mapping exercises used in Jackson County, Kentucky, do not use complicated formulas or draw on the models for "spatial data analysis" that are filling geography journals. Goodchild (1991) argues that spatial data analysis may be accused of emphasizing mathematical
sophistication at the expense of practicality. Simple, intuitive techniques for exploring data in a spatial context have often been ignored in the search for more complex formulas. The mapping used in Jackson County employed this simple, intuitive approach to understanding spatial data.

GIS can be effectively used as a tool to help citizen researchers if the project and research questions are locally directed and controlled. Insight, explanation, and understanding can come from seeing data in their spatial context. The spatial presentation of socio-economic data can be helpful in understanding or identifying political, social, or economic patterns in a small area. Given the current availability of socio-economic data at a very small geographic scale, the use of GIS to map rural community- or county-level patterns can be considered another technique for the community assessment "toolbox." The patterns illuminated by such an exercise can be useful for both community education and community analysis.

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