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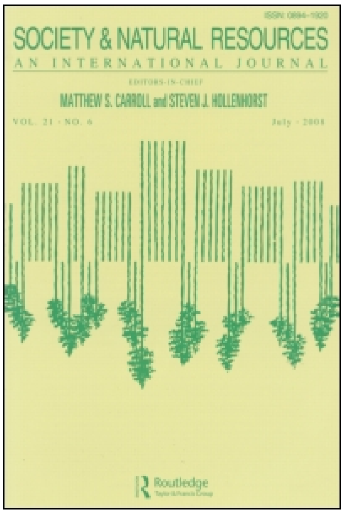

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Research Note

Mapping Social Change: A Visualization Method Used in the Monongahela National Forest

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Many communities in and around national forests are experiencing social change. It is important for public land managers to keep abreast of this change to provide appropriate forest uses while considering resource impacts, conflict management, and potential partnerships with local communities. The social assessment is one tool used to follow sociodemographic trends, but it can be difficult to wade through the volumes of tables and visual displays to make informed management decisions. To improve decision making, literature suggests presenting information in a usable manner, such as the weather (color isopleth) map. By creating an index of overall social change and presenting the results in the form of an isopleth, social assessments can be made more usable by reducing multiple variables into one composite map. A method is described to compute an overall index and map of social change, followed by a discussion of management implications, limitations, and avenues of future research.

Keywords GIS, isopleth mapping, social assessment, social change

Rapid population growth and social change in the regions surrounding federal lands are having an unprecedented impact on the management of public lands (Frentz et al. 2004). For example, an increase of people into a community can lead to the need to involve more people in the decision-making process in order to achieve consensus (Radeloff et al. 2001). This is in part because new residents may bring into the new community a different set attitudes, beliefs, and values that they gained from their prior area of residence (Flora and Flora 1996). McCool and Kruger (2003) suggested that population growth and migration create new challenges for managers. Migration into and out of communities adjacent to public land can change the demand for recreational opportunities, which requires managers to be abreast of

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local recreational needs to provide quality opportunities to federal land users. Additionally, as the community demographic changes and people migrate into and out of a community, it can be difficult to maintain the long-term interactions between agencies and the public necessary for mutual learning and understanding needed for collaborative management (Brown 1995).

To describe the sociodemographic conditions of a region over time, social change data, such as census data, are compiled in a social assessment (Taylor et al. 2004; Jakes et al. 1998). However, to adequately capture the spectrum of social change, numerous tables and figures are needed, each describing a different sociodemographic variable, for example, age, at each geographic unit of analysis within the study region, such as, county, block group, or place. This amounts to a large volume of data, generally in the form of tables or maps, which can be difficult for a manager to assimilate, compare, and contrast. Too much information can lead to information overload, resulting in recall mistakes and confusion (Shenk 1997), and can impair decision making (Farhoomand and Drury 2002).

To improve decisions in response to social change, new spatial planning tools are needed (Machlis and McKendry 1996). Machlis and Bagby (2002) suggest that new spatial planning tools must emphasize usable knowledge—characterized by state-of-the-art science, directly addressing a decision maker's needs, created from previously understood information, and delivered in a clear and effective method. They propose using weather maps as a means to represent usable knowledge. Formally known as color isopleth maps, these maps can be used to display social change in a usable manner: easily understood, timely, and quickly conveying information to the reader.

Color isopleth maps enhance understanding because of their repeat and constant use. For example, meteorological weather maps are ubiquitous—they appear in every newspaper and television weather report (Monmonier 1996). They are timely because they are based on real-time data to monitor meteorological conditions. In contrast, social changes occur at a slower scale, but timely data are still available. Sociodemographic data of states, counties, and communities are updated annually by federal and state agencies. The presentation of isopleth maps enhances their usability. They can efficiently display rapidly changing data in a simple and concise manner (MacKay 1951). In the case of the meteorological weather map, data from multiple hydrologic and meteorological sources are combined to form one map of continuous data presented with smooth lines grouping similar data points. In fact, there is evidence suggesting weather maps are among the most easily understood maps. When comparing learning from several maps types in elementary school children, Young (1994) found that thematic maps, including isopleth maps, were among the easiest to learn and interpret.

Lastly, color isopleth maps have been used to map other social phenomenon. Brown (2005) used this mapping technique to visualize sense of place by mapping landscape values across five study sites and determining "hotspots" of highly valued areas (31). Though not sociodemographic, Brown (2005) successfully applied a surface map to help identify areas of high value. Others have created surface maps of sociodemographic data (Moon and Farmer 2001; Bracken and Martin 1989, 1995; Martin 1989). However, these maps focused on one sociodemographic variable, generally population density. Each of these authors argued for the use of point-based mapping and the increased need for improved visualization techniques when mapping social phenomenon.

Therefore, the purpose of this study is to describe the methodology used to construct a "social weather map" of sociodemographic change data in communities adjacent to public lands. In addition, this article demonstrates how social change maps were applied to a social assessment being conducted for the Monongahela National Forest. Implications for the mapping approach for public land managers are discussed, particularly as a tool in public land decision making.

Mapping Social Change

The creation of a social change map requires only several steps. It is created by fitting community (point) data to a contour map by applying a point interpolator to estimate data between communities (as in ArcGIS/ArcMap spatial analyst extension). Sociodemographic data often have a high degree of geospatial variability; for example, one geographic location may have a high number of ethnic minorities while its neighbor does not, as seen in Dorling's (1995) cartograms of the United Kingdom census. The inverse distance weighted (IDW) algorithm has been shown to be the best interpolator of surface models with high variances between points when compared to other techniques, including kriging and spline interpolators (Priyakant et al. 2004). The IDW interpolator assumes that points (communities) closer to their neighboring points (communities) are given greater weight than those farther away (Chou 1997). For example, when mapping social change of 10 communities in a forest, any one community has nine neighboring points, each with its own social change, that affect the target community. The further a community is from a neighboring community, the less influence its assumed social change has on the other community. Given the local variability of social change data, the IDW was chosen as the appropriate surface model interpolator.

Data needed to compute the IDW function was provided by the U.S. Census Bureau (American Fact Finder 2004). As suggested by Taylor et al. (2004), indicators of social change in a social assessment are particular to every assessment region. The indicators used in this study were comprised from the suggested indicators provided by Taylor et al. (2004), as well as indicators deemed meaningful to the managers of the Monongahela National Forest who live and work in the region.[1] The geographic unit of analysis was census identified places within a 10-mile distance of the Monongahela National Forest border.

An overall index of social change (IoSC) was calculated for each community by the following formula:

$$\text{IoSC} = [|Z(\%\Delta\ \text{indicator}_1)| + |Z(\%\Delta\ \text{indicator}_2)| + \cdots + |Z(\%\Delta\ \text{indicator}_n)|]$$

Within each indicator variable, percent change between 1990 and 2000 was calculated and standardized using *z* scores. The absolute value of the *z* scores was derived and the result was summed across all indicator variables to create an overall index score for each community.

Variables were standardized to make them comparable across communities. The absolute value was obtained to place magnitude of change on the same scale. Without this step, positive and negative change would cancel each other out. Additionally, a negative standardized score can be confused as an indicator of decline when in reality it is an increase below the mean increase. For example, median household income was increasing across all communities of the study region. In this case, a negative standardized value would not indicate a decrease in income, but a less than average increase when compared to all other communities, that is, a small increase in income. The absolute value removes the direction component of the standard score and focuses on magnitude of change. An extreme value of 3 standard units would indicate either a higher or lower than average deviation from the mean change across all communities for a given social indicator. When the IoSC was input into the IDW interpolator, the result was an isopleth map of change. To ease interpretability of the map, the IoSC was classified using standard deviation units, so the result is that negative index scores indicate less change and positive scores indicate "hot spots" or areas of more change.

Using Social Change Maps in Forest Planning

The social change map can serve as a rapid assessment for managers and planners to determine where the most change is occurring in the forest. Once hot spots were identified, a detailed analysis of the socioeconomics of each community was investigated by focusing on the specific sociodemographic conditions within these communities. Figure 1 illustrates the social weather map for the Monongahela National Forest region. Of interest are two "hot spots" of activity indicated by arrows. The first is radiating from the community of Hillsboro in the south central region of the forest, while the second is a southwestern migration of social change in the northeastern communities. These two trends provide an indication of face validity for the methods and results of the social change map.

Snowshoe Mountain resort, to the northeast of Hillsboro, in Pocahontas County, changed ownership in the 1990s and became a year-round resort. As its popularity increased, Snowshoe needed to increase its staff to meet increased demands, and the resort has become a center of economic revitalization. The population in Hillsboro is up 30% since 1990, and the median household income is the highest of any of the communities in the study extent. Second-home growth in Pocahontas County is the highest in the state of West Virginia (American Fact Finder 2004), and the resort is a driving factor behind this growth. The social dynamic of this region of the forest is changing.

Deep Creek, Maryland, is a popular destination for metropolitan residents of Baltimore and Washington, DC. The style of recreation at Deep Creek Lake has grown from a rural, country escape based primarily on the amenities of its natural resources, such as fishing and camping, to now having an increased focus on commercialized recreation such as arcades, minigolf, and go-carts. During this transition, West Virginia has begun to see this type of recreational development slowly migrate southwest of Deep Creek and into the northern communities of the Monongahela National Forest over the last decade and specifically around the Spruce Knob/Seneca Rocks National Recreation Area. The "hot spots" of communities of the northeastern portion of the national forest are recipients of this migration. A majority of the change in these communities may be the result of recreation demand, as they had a higher than expected increase in recreation homes and recreation-based employment. This trend is expected to continue with the creation of Corridor H, a highway being built to create a more direct route into this region from points east, namely, Washington, DC, and Baltimore, MD, two of West Virginia's top sources of out-of-state recreational visitors (Siniscalchi et al. 2004). These communities have also had an increase in the number of long-term residents, raising

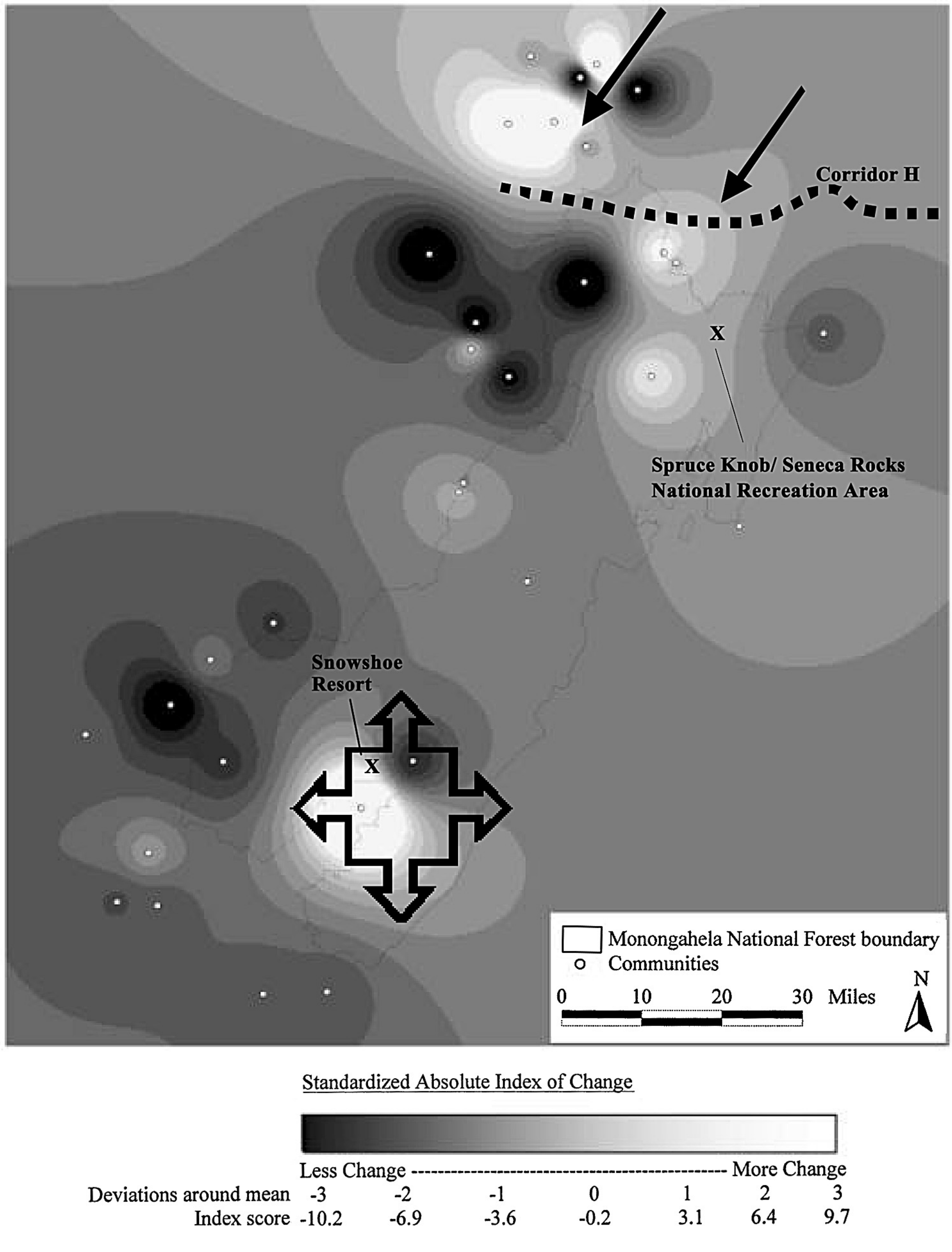

Figure 1. Index of social change. Color can be used to further distinguish "hot spots" of rapid change. The authors suggest a red to white to blue gradation representing more to less change. Arrows indicate trends of change.

concerns of forest managers about potential land use conflicts between these two groups.

The social change in this area of the forest prompted the Forest Service to revise its management plan for the Spruce Knob/Seneca Rocks National Recreation Area. The previous management plan, created in the 1960s during the national recreation area's establishment, was deemed outdated due to the current and expected social change in the region. Since the spring of 2004, visitor and community data have been collected to help guide the future management of the national recreation area in response to the changing social conditions.

Discussion

This mapping technique shows promise as a management tool. It can identify broad trends of social change (Learmonth and Pal 1959). By investigating a wide extent of communities, regional analyses can be performed with greater specificity than using county-level data. It can reveal patterns other thematic maps cannot due to the interpolation between points (Cambell and Knight 1976), and its simplicity, analogous to a meteorological weather map, can aid in management by presenting data in a more readable and intuitive manner to the agency and public (Monmonier 1996).

The social mapping process is not without its limitations. Isopleth mapping assumes the variable mapped is continuous and proportionally distributed between communities (i.e., neighbors). This may not be the case in reality (Hsu and Robinson 1970). For example, variables such as new home development may not be evenly distributed across a region. Similarly, the isopleth map is based on the IDW interpolation between places. This interpolation is calculated using a weighted distance function, so if the mapped places are few or far between, the interpolator may be less reliable. Since national forests are in rural areas, there may not be enough Census-designated places for reliable interpolation. In these cases it may be best to use weighted block-group centroids (Bracken and Martin 1989, 1995; Martin 1989). This approach would increase the number of points and alleviate some of the interpretation concerns of distance. Communities at the boundary of the mapping extent are also subject to error as they have fewer neighboring data points.

The validity of the composite score is also noteworthy. The index of change is dependent on the input variables, which may suffer from multicollinearity. Its interpretation can be misleading because a hot spot of change does not identify the direction of change—only magnitude; some of this change can be negative. Regarding the calculation and indicators used in the index, social indicator variables came from both standard social assessment variables and variables of interest from the managing agency. Though some indicators are commonly used in social assessments, Taylor et al. (2004) suggested indicators of social change are particular to every assessment region. This adds a degree of subjectivity to nonstandard items and can alter the results of the IoSC calculation. Additionally, we chose an equal-weighted criterion (z score) approach because we felt no one indicator was more important than another. The IoSC calculation could easily be weighted using a multiple-criteria weighting methodology if one indicator was deemed more important than another. Or, smaller indices modeling specific phenomena could be created. For example, an index of rural rebound (Beale and Johnson 1998), a phenomenon where there is migration from metropolitan to nonmetropolitan areas, could be constructed. Johnson (1999) suggested that the sociodemographic components of rural rebound include an older population with higher income, and more technical knowledge. Creating a composite index of immigrants who are middle-aged, higher income professionals may point managers to hot spots of rural rebound (Siniscalchi et al. 2005).

Questions still remain about the efficacy of isopleth maps of social change as tools. Future research should focus on measuring the extent these maps improve readability, understanding, and decision making compared to other point-based representations of social change data, such as proportional or graduated color dot maps for both the land manager and public. In addition, this technique was applied for one geographic region. When applied to other regions, do weather maps of social change accurately depict localized changes as seen in the case study of the Monongahela National Forest? Despite these questions, this social mapping approach is a tool that can be used by forest managers to better understand the socioeconomic composition of forest communities and identify areas of rapid change.

Note

1. Individual variables used in the index of social change all measured as a percent change (2000 − 1990). If parentheses follow a social indicator, each variable within the parentheses was included in the index calculation: population, age group (<18, 18–64, >64), marital status (never married, married, divorced, widowed), ethnicity (white or minority status), educational attainment (no or partial high school, partial college, college, advanced degree), median household income, occupation (agricultural, management, office, production, service related), same home residence (percentage of residents maintaining primary residence since last Census), new homes less than 1 year old, median home value, community size (in acres), recreational/seasonal homes (percent of all nonprimary resident homes indicated as recreational homes), occupancy status (living alone, living with others, single female alone and with children).

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