Incorporating scenic quality and cultural heritage into farmland valuation: Results from an enhanced LESA model

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ABSTRACT: Farmland often contributes scenic quality and cultural heritage to a region; however, these factors are challenging to incorporate into standard farmland valuation schemes because of their qualitative nature. This research develops a method for enhancing the Land Evaluation and Site Assessment (LESA) model to incorporate scenic quality and cultural heritage elements into the rating scheme. Data on the scenic quality and cultural heritage values of the community was gathered via a participatory geographic information system (PGIS) exercise and combined with traditional LESA factors to develop a GIS-linked enhanced LESA model. This method provides a holistic valuation of farmland characteristics and directly incorporates community values. When a LESA model is augmented with scenic quality and cultural heritage elements, farmland protection priorities in the study region are impacted.

Keywords: Farmland valuation, planning, Land Evaluation and Site Assessment (LESA), scenic quality, cultural heritage, GIS, participatory GIS, qualitative values
INTRODUCTION

Optimal conservation planning requires the incorporation of both ecosystem service supply and demand (Naidoo et al, 2006; McDonald 2009). However, the demand for some ecosystem services such as aesthetic and cultural values are notoriously difficult to quantify. As a result, even the economic methods developed to quantify these so-called “non-market” values, known generally as nonmarket valuation methods, have been challenged to effectively incorporate the scenic quality and cultural heritage elements of landscapes.

Bergstrom and Ready (2009) offer a thorough review of nonmarket valuation studies that estimate the value of farmland. Most studies have focused on estimating the preferences of local residents and have excluded ecological and environmental benefits associated with farmland. Pressures to convert farmland remain strong, and farmland valuation estimates are increasingly being used to rationalize expenditures on conservation easements and other protection measures. As a result, improving the capacity of farmland valuation estimates to holistically value all of the benefits of the landscape is necessary. However, at the same time, funds for conducting nonmarket valuation studies are increasingly rare; an alternative way of estimating farmland values is thus necessary.

One alternative tool for improving policy decisions about which farmlands are most critical to protect is the Land Evaluation Site Assessment (LESA) model. LESA was created by the USDA Natural Resources Conservation Service (NRCS) to evaluate a parcel’s relative agricultural importance; it was used initially by federal agencies to evaluate projects causing agricultural land conversion (Pease and Coughlin, 1996). The numerical rating system is based on a composite of land evaluation (LE) and site assessment (SA) factors. The LE component measures soil quality; it is often based on soil potential or productivity ratings, land capability and/or important farmland classes (Pease and Coughlin 1994). The site assessment (SA) evaluates other factors that indicate development pressure (Pease et al 1994). In addition, public amenities such as wildlife habitat or scenic views could be incorporated as SA factors (Pease and Coughlin 1996); in practice, however, these are challenging to incorporate and are thus often excluded from LESA assessments.

BACKGROUND

One tool utilized by policy makers to determine the relative value of farmland to be protected is the Land Evaluation Site Assessment (LESA) model. LESA was created by the USDA Natural Resources Conservation Service (NRCS) to evaluate a parcel’s relative agricultural importance; it was used initially by federal agencies to evaluate projects causing agricultural land conversion (Pease and Coughlin, 1996). The numerical rating system is based on a composite of land evaluation (LE) and site assessment (SA) factors. The LE component measures soil quality; it is often based on soil potential or productivity ratings, land capability and/or important farmland classes (Pease and Coughlin 1996). The site assessment (SA) evaluates other factors that contribute to the site’s agricultural importance such as parcel size and on-farm investments. SA factors may also include agricultural support services, distance to water and sewer infrastructure or other factors that indicate development pressure (Pease et al 1994). In addition, public amenities such as wildlife habitat or scenic views could be incorporated as SA factors (Pease and Coughlin 1996); in practice, however, these are challenging to incorporate and are thus often excluded from LESA assessments.
LESA assigns points to each of the LE and SA factors; the points are then weighted according to an assigned weighting scheme. A LESA score is derived by calculating the sum of the weighted ratings; high LESA scores reflect the site’s importance for agriculture. The LESA system can be modified to reflect state and local needs; local modifications can include changes in the LE and SA factors and the weighting scheme used. If a local system is derived and approved by NRCS, the NRCS is required to use the local version when reviewing federal projects (American Farmland Trust 2006).

The need to link LESA and geographic information systems (GIS) has been stressed (Soil and Water Conservation Society 2003). An early attempt conducted by Williams (1985) was limited by data availability and computing power. Lee and Linebach (2008) utilized methods described by Pease and Coughlin (1996) to incorporate GIS and LESA in a study of seven central Kentucky counties; they describe how these methods may be combined in a desktop application. Hoobler et al (2003) linked LESA with GIS in east Park County, Wyoming to enhance land-use planning efforts. They found that their study results were fairly consistent with the county’s land use plan, “suggesting the combination of LESA and GIS is a rapid, versatile and up-to-date approach to assist in land management decisions.”

Tulloch et al (2003) integrated GIS into a process used to evaluate properties for a purchase of development rights program in Hunterdon County, New Jersey. Their method incorporated spatially explicit data on soils, neighboring land uses, proximity to preserved farms, and communities’ commitment to practices contributing to sustaining farming in their area. This allowed them to use a parcel-based approach at a county-wide scale, providing both individual farm assessments and county-level patterns.

Machado et al (2006) developed a LESA-style framework for prioritizing farmland conservation projects. Acknowledging the importance of ecosystem services contributed by farmland, their model included those services with available data into their ranking criteria; whether the farmland was visible from a scenic highway was used as a proxy for scenic quality, for example. Their model then ranked farms for protection based on several factors including the opportunity cost of farmland loss, the amount of farmland already protected in the area and how much it would cost to secure the benefits associated with the tract. The authors note that the spatial visualizations of the distribution of farmland attributes and conservation objectives “can be very educational for planners and citizens alike.”

While these studies have incorporated GIS into the LESA framework or created a LESA-style model to account for multiple conservation objectives, no studies incorporate scenic quality or cultural heritage into a spatially explicit LESA model. This research fills that gap.

THE FARMLAND VALUES PROJECT AND STUDY REGION

The Farmland Values Project (www.unca.edu/farmlandvalues) was designed to collect, analyze and communicate the benefits that residents and visitors gain from farmland in a four-county region of Western North Carolina including Buncombe, Henderson, Haywood, and Madison counties (Figure 1). Western North Carolina is a primarily rural region that is rapidly changing and under threat of significant farmland conversion. A thriving local food movement exists in the area with many profitable community supported agriculture operations and several bustling tailgate markets, especially in Buncombe County; regionally, the demand for local food exceeds the supply (Kirby, Jackson, & Perrett, 2007).

However, the pressures on agricultural lands in Western North Carolina are greater than a thriving local food demand can surmount. USDA’s Natural Resource Inventory shows a rapid decrease in farmland in Western North Carolina over the past 20 years (USDA 2000); if this trend continues much of the remaining farmland will be lost in the next 20 years. Buncombe County, the population center of the region, led our four county study region in loss of farmland acreage in the 2002-2007 period with a 24% loss; reduction in farmland acreage in Henderson, Madison, and Haywood was reported at 22%, 21%, and 13% respectively (USDA National Agricultural Statistics Service 2009). Buncombe County is fairly urbanized, while Henderson County is rapidly urbanizing and Haywood and Madison Counties have great potential for urban growth. Madison County, in particular, is perceived to be under an urgent threat of urbanization since the recent completion of Interstate 26 through the county now makes it more accessible to commuters and tourists, thus raising the
likelihood that property values will increase and create additional stressors on farmland.

Buncombe is the most populated county in our study area with 121.2 people per square kilometer (315 people per square mile) and 7523 non-farm establishments. Henderson is less populated but growing at a faster rate with 91.9 people per square kilometer (238 people per square mile) and 2,789 non-farm establishments. Haywood’s population density is 37.7 people per square kilometer (98 people per square mile); the county has 1580 non-farm establishments. Madison is the least populated with 16.9 people per square kilometer (44 people per square mile) and 350 non-farm establishments (US Census Bureau 2010). According to the North Carolina Department of Agriculture and Consumer Services, Buncombe and Henderson counties have the highest cash receipts from farm goods in Western North Carolina (NCDA & CS, 2010).

These four contiguous counties provided an excellent region for testing an enhanced LESA model incorporating scenic quality and cultural heritage for several reasons. First, while LESA has the potential for being a useful tool for farmland preservation, it has not been used in Western North Carolina. Second, all four counties are part of the Blue Ridge National Heritage Area which recognizes the area’s potential to capitalize on coordinated efforts to brand our cultural heritage and landscapes (Blue Ridge National Heritage Area 2009). Third, the area boasts a high quality of life for residents and popularity with tourists largely because of its scenic quality (Brothers & Chen 1997; Kask et al 2002; Mathews, Stewart & Kask 2003; Mathews 2009). Thus, both scenic quality and cultural heritage are viewed as important contributors to the region’s economy. Fourth, each county had land use and other data available in a GIS format. Finally, the region’s recent rapid land use change has prompted significant interest in land protection; an enhanced LESA model derived with community input can thus assist planning efforts in this region.

METHODS

A primary goal of the Farmland Values Project (FVP) was to develop an enhanced LESA model in order to provide communities, citizens and policymakers with a single, spatially described dataset showing the multiple sources of farmland value. The traditional LESA data layers include population, land value per acre, agricultural soils potential, and land use/land cover. Population data was acquired from Landscan’s 1 km population data base available from the Oak Ridge National Laboratory (ORNL 2003). Land value per acre was based on the tax value of land parcels from each county’s tax database. The most productive agricultural soils represent the best combination of physical, chemical and organic soil characteristics for agricultural productivity. We combined soil type and slope, an important feature in the mountainous study region, to form the agricultural soils potential layer in the model. Land use/land cover data was collected from the U.S. Geological Survey’s National Land Cover Dataset (Homer et al, 2004). Fourteen land cover categories identified by the National Land Cover Dataset are found in our study area; these were reclassified into five categories for purposes of this model.

To these standard LESA data layers we added two new data layers, scenic quality and cultural heritage, because of their significance to this region. To construct the scenic quality and cultural heritage layers, we needed to develop a method to gather site-specific information on those characteristics that had to meet several criteria. First, the method had to account for the fact that scenic quality and cultural heritage are subjectively determined. In addition, to avoid potentially biasing the geographic locations selected, our method had to allow respondents to select for themselves the places with significant cultural heritage and scenic quality elements. Third, to ensure spatial specificity, the method would need to allow participants to directly identify in a spatial database the points they were describing and rating. Finally, the method would need to be quick and easy for participants to complete.

We developed a participatory geographical information system (PGIS) exercise, a community mapping activity. Individuals were invited to a session held in a computer lab and, after a brief introduction to the method, asked to use Google Earth™ mapping service to pinpoint 5 to 10 specific locations that, in their mind, had significant cultural heritage or scenic quality elements. After respondents had “place marked” locations, they were asked to describe the elements of each place they identified on the map, including whether it was a specific landmark such as a barn or a more general location such as a river valley or farmstead;
place marks were accurate to 400 meters. The final step was for participants to rate each place on a scale of 1 to 5 for scenic or cultural value. Participants were reminded that an identified location may not possess both scenic and cultural value; they were asked to rate their locations according to their personal values.

Subjects for the community mapping activity were recruited in two ways. The survey that the FVP had previously conducted (fall 2007) asked respondents if they would be willing to participate in the effort to collect information about specific places they valued. The 150 respondents who indicated interest were then invited to participate in the community mapping activity; 16 of the participants were able to attend one of our sessions. Additional recruitment was done by inviting participation via flyers in grocery stores, radio and print media sources; 17 participants were recruited through these methods. No compensation was provided to participants.

Seven PGIS sessions were held (at least one in each study county) during January and February 2008. A total of 33 participants participated; two-thirds of participants were from Buncombe (11 participants) or Henderson counties (11), while fewer came from Haywood (5) and Madison (6) counties. The PGIS participants identified and rated a total of 236 data points for analysis; these points appear on Figure 2.

RESULTS

The points identified by respondents in our PGIS activity were analyzed using CrimeStat™ software, a spatial statistics program for the analysis of crime incident locations, to determine whether or not there were statistically significant groupings of points by location (Anselin, 2003; Levine, 2005). That is, cluster analysis was used to identify “hot spots” of value. The clusters identified by respondents include several agriculturally rich areas of the study region including Fairview, Sandy Mush and Leicester communities in Buncombe County; the Bethel community of Haywood County; Fruitland (a prime apple growing region), Mills River, and Etowah in Henderson County; and the Spring Creek and Big Pine communities of Madison County. The regions with a significant cluster of points are highlighted in red on Figure 2.

Figures 3 and 4 show the cultural heritage and scenic quality values assigned to each point by respondents. These point values were used to generate a surface in order to have coverage for all land area in the study region. Conversion required the selection of an interpolation method; in this case the nearest neighbor algorithm was applied to the scenic value and cultural heritage participant scores. The surfaces are displayed in Figures 5 and 6.

ANALYSIS

The six input data layers were analyzed using the weighted overlay tool provided in ArcGIS ModelBuilder. Each raster data layer was reclassified with values ranging from 1 to 5 to allow for a common scale among layers. Each input data layer was then weighted based on its importance to the model; this yielded a percent of influence. The total influence for all layers equals 100 percent. The cell values of individual input layers were multiplied by the layer weights; the resulting cell values are added together to produce the output layer.

Because the weighted overlay tool only accepts discrete values as input, the continuous surfaces in our data were reclassified as discrete layers. These included the Land Value per Acre, Population per Square Mile, and Scenic and Cultural Value Surfaces.

Because LESA uses a weighting scheme, and because the weighted overlay tool allows for straightforward re-weighting, we experimented with alternative weights for the various factors. Some of our weights were derived from a nonmarket valuation study also conducted as part of the Farmland Values Project to estimate the multiple functions of agricultural land in four western North Carolina counties. As a result of these two community-based research elements, we have an enhanced LESA model for the study region that much more significantly incorporates community values than a traditional LESA model.

For example, the Rank Importance Model used weights derived directly from a question that we asked on the Farmland Values Project survey. Respondents were asked to read a set of statements about farmland and then rank them in order of their importance to them. The top ranked statements corresponded to layers in the LESA
model that were then assigned weights of influence based on the survey rankings. Local food was highly ranked by respondents, but because spatially explicit information on the supply of local food was not available, we used the soils layer as a proxy for this characteristic. The results of this Rank Importance Model appear in Figure 7.

Another set of alternative weights came from the results of a choice model that was also conducted as part of the FVP survey. A subset of respondents to the FVP survey completed a choice experiment that asked them to choose between various farmland scenarios with differing bundles of characteristics. These responses yielded implicit prices to be estimated for each attribute; our sample valued scenic quality, cultural heritage, and access to local food approximately equally. As a result, we developed an enhanced LESA model that weighted these attributes equally. The results appear in Figure 8. These results can be used to identify areas of concentrated benefit such as those that appear in Figure 9.

The standard and enhanced LESA models will yield different land evaluation outcomes. Figure 10 compares a standard LESA model with the four basic data layers weighed equally with an enhanced LESA model containing scenic quality and cultural heritage layers; all six layers are weighed equally for comparison purposes. There are significant differences in the two models. One noticeable difference is that in the original LESA model (on the left), there are more locations receiving the highest rating (5) than in the Enhanced LESA model. For example, the Henderson County region around Dana and Fruitland has much less land area rated a score of 5 in the Enhanced LESA model; thus the additional data included in the Enhanced model allows for more precision in the ranking of locations.

A thorough depiction of the model differences are displayed in Figure 11. White areas on the map indicated places that were rated the same using both the standard and enhanced LESA models; colored areas represent places that were rated differently in the two models. Red areas indicate places where the enhanced model rated the area higher than the standard LESA; blue areas are places rated higher under the standard LESA. Darker shades (of either red or blue) indicate differences at the higher end of the rating scale. It is clear that for most of the land area in the study region, there are differences in the land valuation rankings. Focusing on the regions identified earlier as “hot spots,” one can see several significant differences. In southern Haywood County, for example, there are several areas of red that indicate the Enhanced LESA model ranked those areas more significantly than the traditional model. This confirms what local residents have been saying for a very long time: this region contributes significantly to their quality of life through cultural heritage and scenic quality characteristics but, if compared to other lands using traditional criteria, the lands won’t appear as highly ranked.

DISCUSSION

The methods utilized in this research allow for a more significant incorporation of community values than a typical LESA model. This method effectively complicates the term “value” since it reflects value(s) in both the quantitative and qualitative sense. The PGIS community mapping activity allowed us to incorporate into the LESA model information from respondents about how they experience the scenic quality and cultural heritage elements of farmland. This new community-based methodology reveals and displays the spatial relationships between the farmland resource and community members’ values for the scenic quality and cultural heritage elements of those resources.

The policy implications of this research are clear: farmland preservation priorities will be different if different factors are included in the valuation rubric. While this is not surprising, the specific ways in which the priorities change in an Enhanced LESA model are important to analyze. The specific factors that should be included in order to ensure accurate community reflections of value are going to be unique to each region. In Western North Carolina it made sense to use scenic quality and cultural heritage given the importance of these factors to the region’s economy and the quality of life of its residents (Mathews, 2009). These same factors would seem important to include in Oregon’s Willamette Valley, Pennsylvania’s Lancaster County, or other regions with similar characteristics. The specific factors that should be added to enhance a traditional LESA model should reflect community values and conditions, and should not limited to scenic quality or heritage. PGIS could also be used to better understand the recreational and ecotourism values, sense of place, or other cultural services provided by a particular parcel.
Incorporating non-agriculturally oriented criteria in LESA or other farmland protection criteria could increase public support for farmland preservation (Kline and Wichelns, 1996); this would be especially true if the public helped define the criteria that would be utilized to rank properties. Our method of enhancing the LESA model can be used to better inform policy decisions about land protection. In our study region, the inclusion of scenic quality and cultural heritage helps to differentiate agricultural regions based on these factors. Local governments in Western North Carolina have long recognized the importance of these factors in our economy and quality of life; the enhanced LESA model formally acknowledges and effectively incorporates these values. While the method developed in this research provides enhanced information about the benefits associated with a particular parcel of land, this benefit information must be combined with measures of cost to get the most effective conservation planning (Machado et al, 2006; Messer, 2006; Naidoo et al, 2006). In addition, because the results of any multi-criteria weighting scheme are dependent on the selected weights, transparency of weight selection will be essential for policy purposes.

There are limitations of this research. The first is the relatively small number of community residents involved in the PGIS sessions (n=33). While these residents identified over 200 points of significant value in our study region, the number of participants was constrained by the necessity to complete the PGIS exercise in a computer lab. It would be ideal to have a larger group of participants to ensure that the community’s preferences are accurately reflected. Future research could collect preference information via a website, on-site interview or in-person survey using a laptop computer. Providing compensation (financial or other) as an acknowledgement of the opportunity cost of participants’ time could also help increase participation.

A second, related limitation of this model is that only the preferences of local residents were gathered as part of the PGIS exercise; this implies that ecosystem service demand is inherently local. In Western North Carolina visitors have repeatedly expressed strong preferences for the scenic quality characteristics of farmland (Kask et al, 2002; Mathews, Stewart, and Kask 2003; Mathews, 2009). Other agricultural regions possess heritage and scenic qualities that are valued by national and even international stakeholders; Lancaster County Pennsylvania and the Napa Valley of California come to mind. Future studies should seek to incorporate input from all stakeholder groups. While comparisons of preferences from local and non-local stakeholders could be interesting in and of itself, the information from non-resident groups may also provide insights for local tourism development authorities that could help direct agricultural tourism efforts.

A third limitation of this study deals with the simple quantitative ranking measures used to measure the scenic quality and cultural heritage values. While Steiner, Dunford and Dodsall acknowledge that “site assessment is not mathematically precise,” a more refined measure for quantifying the qualitative that allows for a more nuanced understanding and measurement of the importance of scenic quality and cultural heritage factors would be ideal. This could be achieved by offering respondents a set of criteria that they would be asked to rate or rank. For example, following Johnson, Orr and Rotegard (1997), landscape architecture criteria such as composition, framing, depth, and other factors could be offered to respondents; their value assignment would lead to numerical scores for each place that then could be incorporated into the Enhanced LESA model. Another option for enriching the scenic quality measure is to follow a method such as that presented in Cañas, Ayuga and Ayuga (2009) that asked respondents to award points based on their aesthetic preference of various photographic images. However, the use of more formal visual criteria should be used with caution. A study by Vouligny, Domon and Ruiz (2009) finds that for ‘ordinary’ agricultural landscapes, “the formal visual criteria used by the expert appear to be clearly less important in the evaluation by lay people.”

Another limitation of the current study is that while it incorporates two very important characteristics of agricultural land for this region, scenic quality and cultural heritage, our method may not have allowed participants to fully document the values they have for farmland. Emotion, everyday experience and intimate knowledge of places have been documented as being important to the value of ordinary landscapes (Vouligny, Domon and Ruiz); psychological components have also been demonstrated to be important predictors of preference.
While a great number of descriptive responses provided by participants in our PGIS exercise hint at these and other factors as motivation for their ratings, it may be that some respondents would have liked to value other elements of the landscape such as public accessibility, or historical or social connections to the land. Future studies should consider a debriefing exercise upon completion of the PGIS to determine if participants have fully documented the values they have for a particular landscape.

A final limitation of the study is related to the fact that we asked PGIS participants to identify sites that were important to them; as a result, all of the points they selected were deemed significant. Using these significant sites to interpolate the whole study area likely led, in the generation of the scenic quality and cultural value surfaces, to some over-valuation of non-selected areas. Future PGIS protocols could ask participants to also select a set of sites that were not significant to them so that the lower end of the spectrum could be calibrated more effectively.

**CONCLUSION**

This research developed a novel modification of a community research technique more frequently used in geography and anthropology, the mapping exercise, to gather information on the scenic quality and cultural heritage characteristics of farmland. The mapping activity was conducted using Google Earth™ which allowed us to pin-point particular regions or “hotspots” of cultural and scenic value and gain additional quantitative and qualitative information about these places. This information complements traditional farmland valuation data as respondents both described the places they identified and assigned a numerical rating to each place.

The enhanced LESA model developed in this research provides a more holistic valuation of farmland in this region than the traditional LESA model. Specifically, it allows us to incorporate the community’s values for scenic quality and cultural heritage which are significant contributors to the region’s economy and quality of life. Another noteworthy contribution of our method is that it provides the opportunity for significant community involvement in both defining and measuring the site factors deemed important to the region; this augmented stakeholder participation can enhance planning efforts. Once site and benefit measures are tied to GIS data, various future land use scenarios can be applied to identify which strategies maximize all the factors determined best for farmland preservation. In this way, the combined GIS-LESA is a tool to evaluate various farmland preservation policies.

Future research should enhance the interdisciplinary methods utilized here by refining the method used to quantify qualitative information. Any future applications of an enhanced LESA model should carefully consider the character of the region so that appropriate additional factors are incorporated into the model.

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Figure 1: Farmland Values Project study region.
Figure 2: Areas identified as important by PGIS participants.

North Carolina by County

Clusters of Areas Identified as Important
Places Identified as Important
Blue Ridge Parkway
Interstates
Major Roads
Major Rivers
County Boundaries
Asheville Watershed
Pisgah National Forest
Great Smoky Mountains National Park

Point data was collected in a community mapping activity with residents from the region. Clusters were derived from a nearest neighbor hierarchical spatial clustering analysis based on distance.
Figure 3: Cultural values assigned to areas identified as important.
Figure 4: Scenic values assigned to areas identified as important.
Figure 5: Cultural value surface generated from values assigned by PGIS participants.

Cultural value data was derived from a community mapping activity with residents from the region.
Figure 6: Scenic value surface generated from values assigned by PGIS participants.
Figure 7: Land ratings based on rank importance weights for the enhanced LESA model.
Figure 8: Land ratings based on Choice Model weights for the enhanced LESA model.
Figure 9: Areas of concentrated benefit identified by Choice Model results.

North Carolina by County

Choice Model weighted value 22% Scenic, 22% Cultural, 11% Land Value, 11% Wildland-Urban Interface, 23% Agricultural Soil Potential and 11% Land Use/Land Cover
Figure 10: Standard and enhanced LESA model outcomes.

**LESA Model**

LESA (Land Evaluation Site Assessment) Model equally weighted values - 25% Land Value, 25% Wildland-Urban Interface, 25% Agricultural Soil Potential and 25% Land Use/Land Cover.

**Enhanced LESA Model (TVAL-Farm Model)**

Enhanced LESA (TVAL-Farm) Model equally weighted values - 18% Scenic, 18% Cultural, 16% Land Value, 16% Wildland-Urban Interface, 16% Agricultural Soil Potential and 16% Land Use/Land Cover.
Figure 11: Comparison of land evaluation ratings between the standard and enhanced LESA models.
LITERATURE CITED


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