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Sustainable community indexing, a process approach

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ABSTRACT

A multidisciplinary team with background in environmental, economic, and social disciplines has developed and is piloting a sustainable community index (SCI) and process. The process is designed to invite wide community participation and the index allows the community to benchmark and map how is it doing with its economic vitality, social quality of life, and environmental integrity. An overview of the development of the index and the process for applying it within a community is given. A review of literature and practice examines other sustainable community indicator efforts and highlights the uniqueness of this SCI indexing process. The analytical hierarchy process (AHP) used in developing the SCI index is summarized and the objective basis for the index will be discussed. AHP is a powerful and flexible decision making process to help people set priorities and make the best decision when both qualitative and quantitative aspects of a decision need to be considered. When used for an SCI, AHP offers a unique opportunity to combine multiple objectives, some of which may be contradictory, into a single goal.

The sustainability of local, regional and national communities is furthered when communities are able to create and use an SCI to guide their planning and development. The SCI is unique both in its scale and utility, providing communities with a presently unavailable tool. Applying the SCI allows neighborhoods, villages, townships, and larger communities to visualize how the current set of relationships among people and the land measure up in terms of sustainability, where on the landscape the current conditions are more and less sustainable, and what underlying conditions make them so. The process of developing the index is valued by the community because it derives from the values and choices of the people who make up the community.

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Key words: Community Sustainability, Sustainable Community Index

I. INTRODUCTION:

This paper and the related project is testing the hypothesis that the sustainability of local, regional and national communities is furthered when communities are able to create and use a Sustainable Community Index (SCI) to guide their planning and development. In what follows we review the literature on indicators and indices of sustainability, describe the Agroecosystem Health Index upon which the SCI is modeled, and describe the development, modeling, and piloting of the SCI. The paper finishes with brief conclusions and ideas for future work.

2. BACKGROUND

2.1 Introduction: Indicators of sustainable development can provide “solid bases for decision making at all levels and to contribute to the self-regulating sustainability of integrated environment and development systems” (UN Rio Conference1992, p. 8). Despite such affirmations, success in developing and using them has been elusive. The practice is widespread but the process and theory have not matured to the point of consistency and have not been used consistently for policy decisions by nations and regions (United Nations Division for Sustainable Development, May 2006). Parris (2003) and Parris and Kates (2002) describe more than 650 indicator projects in their reviews of the body of work on sustainability.

Reviewing the literature on indicators of sustainability reveals several interwoven threads of conversation. Discussions centre around the community based process of developing and using indicators; the role of science and scientific experts in this process; the criteria for good indicators; and the indicators themselves.

2.2 Community Involvement: There is a real opportunity to create civic capital through the process of planning for sustainable development. “Civic capital is the engine that drives a community to overcome barriers, create accountability, manage change, and get things done. Further, communities rich in civic capital have numerous ways to confront challenges” (Potapchuk and Crocker, 1999, p. 179). Widespread involvement of citizens in planning for sustainable development ensures that social capital is built during the process. By engaging with the data and with each other, relationships are developed among citizens even across boundaries of difference (Fraser, 2005; Potapchuk and Crocker, 1999). Lopez-Ridaura et al. (2005) emphasize the importance of stakeholder involvement to ensure both accurate assessment scales and participation toward positive change. Conroy and Berke (2004) also emphasize the value of diverse participation in planning for sustainable development on the quality of resulting land use plans to promote the concept.

2.3 Defining Sustainability:

When developing indicators of sustainability, the community’s understanding or definition of sustainability is a logical first consideration that will direct the choice of indicators and the weight that each will be given. Discussions of this topic suggest that any definition must balance the often competing values of economic development, environmental protection, and social and intergenerational equity. The United Nations Division for Sustainable Development (May 2006) offers an analysis of efforts at sustainability indicators and reporting systems. They discuss several categories:

- Issue- or theme-based frameworks are the most widely used type of frameworks, especially in official national indicator sets. A main reason for their prominence is the suitability to link indicators to policy processes and targets.
- Frameworks based on variations of the Pressure-State-Response model continue to be used in indicator systems concentrating on the environmental dimension of sustainable development.
- Increasingly, countries and organizations are using headline indicators, short core sets of indicators closely linked to policy priorities.
- On the international level, there is a continuing interest in the development of aggregate indices.

Berke and Conroy (2000) define sustainable development as: "a dynamic process in which communities anticipate and accommodate the needs of current and future generations in ways that reproduce and balance local social, economic, and ecological systems, and link local actions to global concerns" (Berke and Conroy 2000/21). They operationalize the definition through *six basic principles* related to the location, shape, scale, and quality of human settlements: harmony with nature, liveable built environments, place-based economy, equity, polluters pay, and responsible regionalism

There is a growing consensus (Parris and Kates, 2002) that, while all of the elements of true long-term sustainability may not be clear at the present time, it is nevertheless possible and important to define the necessary elements of a transition to sustainability. Meadows (1998) echoes the importance of beginning the effort even without unanimity about the targets of sustainable development.

2.4 Sustainability Science*:* The role of science in the development of sustainable communities is acknowledged as an important contribution but one that needs to be applied with sensitivity. Cash and others (2003) propose that it is the manner in which the scientific community relates to the civic community that will impact the effectiveness of the scientific data on public policy decisions. Their research shows that when the scientific data is presented with credibility, salience and legitimacy based on a respect for the stakeholders' values and beliefs, it will have most impact. Kates et. al. (2001) define the task of sustainability science as helping decision makers to span the spatial scales from globalization to local farming practices, to understand the urgency of addressing issues with long term effects, to deal with functional complexity in ecosystem balances and to navigate the wide range of outlooks within both science and society. They maintain that "progress in sustainability science will require fostering problem-driven, interdisciplinary research; building capacity for this research; creating coherent systems of research planning, operational monitoring, assessment, and application; and providing reliable, long-term financial support" (Kates et. al., 2001, p. 641).

Martens (2006) emphasizes that the science must be applied with an understanding of the extended temporal and geographic nature of sustainability. The concept is intergenerational; sustainability science, for example, must be able to account for environmental impacts that may not surface for decades. The science must also look at multiple geographic levels since sustainability must avoid shunting negative consequences from one country or region to other countries or regions. Likewise, it must be interdisciplinary, working in at least three multiple domains: the economic, the ecological, and the socio-cultural. "Although sustainable development can be defined in terms of each of these domains alone, the significance of the concept lies precisely in the interrelation among them" (Martens, 2006, p. 37). This interrelationship often necessitates tradeoffs among the domains to address the unique problems and opportunities of a community planning for sustainable development.

2.5 Selecting Indicators: Meter (1999) focuses the discussion on indicators as a tool for change, noting that they can be used by a community to hold itself and its leaders accountable. He introduces the concept of "nested" indicators that address the same goal at various levels and geographic scales as effective in helping that process of change. Maclaren (1996) maintains that indicators of sustainability should be integrating, forward looking, distributional, and developed with input from multiple stakeholders in the community.

Parris and Kates (2003) stress that indicators must match the purpose the group has for them: understanding, policy change, impacting individual activity, advocacy, etc. Regardless, they encourage that the process of selection should be marked by salience, credibility, and legitimacy: "*Salience* refers to relevance of the measurement system to decision makers; *credibility* refers to the scientific and technical adequacy of the measurement system; and *legitimacy* refers to the perception that the process is fair in its treatment of opposing views and interests" (Parris and Kates, 2003, p. 15). They emphasize that an important aspect of indicator selection is scale based on the intended audience, the availability of data, and the way in which aggregation anomalies will be handled.

Meadows (1998) reviews the literature on selecting indicators and emphasizes the importance of the process of selecting indicators. As noted previously, this is an opportunity to involve the community and build social capital. The experience of Sustainable Seattle highlights an extensive public participation process which led to the institutionalization of not only a set of indicators, but also an organization to monitor their application. The ten steps suggested by Meadows for indicator selection are integrated with the six steps given by Valentin and Spangenberg (2000) to develop the comprehensive set of nine steps shown in Table 1.

Table 1: Steps in developing and using indicators of sustainability

1.	Preparing the process: Making the decision to develop indicators and setting a time line.
2.	Forming a working group to guide the process through to completion
3.	Clarify the purpose of the indicator set by reaching a common understanding of sustainability
4.	Identify the community's shared values and vision.
5.	Choosing indicators and data: Review indicator sets from other communities and then identity the unique set of indicators suitable for the local community.
6.	Draft a set of proposed indicators and then finalize
7.	Research the data.
8.	Publish and promote the indicators.
9.	Update the report regularly.

Adapted from Meadows (1998), and Valentin and Spangenberg (2000).

2.5.a Indicators that balance "sustaining" and "developing:"

Parris and Kates (2003) join other practitioners in defining sustainability around the questions of what to develop, what to sustain, and for how long. Hart (1999) and Neuport et al. (2003) show a strong preference for indicators that address multiple dimensions of the sustainability framework. Such multi-dimensional indicators can assist a community toward understanding the trade-offs necessary in achieving sustainability. Berke and Conroy (2000) assert that sustainability plans achieve their goals best when they balance among environmental, economic, and social values.

2.5.b Environmentally based indicators:

Environmentally based indicators represent a special subset of measures of sustainability performance which concentrates on ecosystem health. The National Research Council (NRC) (2002), for example, focuses its definition of sustainability on ecosystem factors and builds its indicators around three ecological categories: i) Indicators of Ecosystem Extent and Status; ii) Indicators of Ecological Capital; and iii) Indicators of Ecosystem Functioning. NRC also urges for the selection of an Indicator of Independence -- the degree to which the species richness of an area depends on immigration of individuals from surrounding areas; an Indicator of Species Density -- whether an area supports more or fewer species than a reasonably defined reference area does; and Indicators of Deficiency in Natural Diversity -- the degree to which a site preserves exotic species of little or no conservation value rather than valued native species. Finally, they recommend indicators specifically designed to capture the performance of particular ecosystem types.

2.5.c Pressure-State-Response indicator sets:

Jesinghaus (1999) joins others e.g. Executive Council, Government of Manitoba (1995) in favouring the Pressure-State-Response schema for making sets of indicators. He speaks of *Driving forces* − underlying factors influencing a variety of relevant variables; *Pressure indicators* − variables which directly cause environmental problems; *State indicators* − show the current condition of the environment; *Impact indicators* − describe the ultimate effects of changes of state; and *Response indicators* − demonstrate the efforts of society to solve the problems. The Environmental Pressure Indices Project, conducted by Eurostat, aims at a comprehensive description of the most important human activities that have a negative impact on the environment. Their first indicator publication, *Towards Environmental Pressure Indicators* (Eurostat, 1999), covers 60 indicators organized in ten categories.

2.6 Indexing Sustainability Indicators

Combining indicators into a unitary index has a definite, if limited, history within the discussion of indicators of sustainability. Rao (2006) asserts that a “sustainability index allows integrated assessments about the sustainability of the system, after taking into account all information provided by indicators” (Rao, 2006, p. 439). Sands, and Podmorea (2000) offer an Environmental Sustainability Index (ESI) – albeit only from an agricultural and environmental perspective. Neumayer (2001) proposes an index of sustainability that compares the depreciation and the investment a country makes in its manufactured and natural capital stock.

Estey et.al. (2005 and 2006) as well as the Yale Center (2005 and 2006) outline an ambitious process of international indexing -- the Environmental Sustainability Index (ESI) with a heavy but not exclusive environmental focus. Conway (1997) focuses on the scale of indexing sustainability and encourages approaching sustainability on a several levels from global to local with an agricultural focus. Lopez-Ridaura and colleagues address the limitations to a composite index which will need to be addressed in any attempt to use such a system. They affirm: “Such composite indices, however, may add to the problem rather than solving it, as the risk exists that in defining composite indices, controversies will come to the fore with respect to the weight to be attached to each indicator. Moreover, the single numerical value, resulting from their application in the evaluation of systems, generally offers little or no explicit insights in their functioning, as a basis for design of alternatives” (Lopez-Ridaura et al. 2005, p. 52). The use of the analytical hierarchy process as part of the agroecosystem health index (AHI) addresses these concerns (Vadrevu et al. In review). The Agroecosystem Health Index (AHI) described below has become a model for the Sustainable Community Index (SCI) described in this paper.

2.7 The Analytical Hierarch Process

Saaty (1994) describes the Analytical Hierarchy Process (AHP) and its suitability for dealing with complex decisions by decomposing the problem in a hierarchical structure. The decision maker is able to evaluate the trade-offs among objectives by comparing two alternatives at a time in a pair-wise decision process. The AHP approach is applicable to the development of the SCI because it acknowledges and incorporates the knowledge and expertise of the participants in the priority setting process. It makes use of their individual subjective judgments and builds a consensus judgment.

Saaty (1994) describes three steps within the AHP: 1) decomposition of the issue or problem, 2) comparative evaluation of the elements involved, and 3) synthesis of the priorities.

Decomposing the issue or problem in *step one* involves the formulation of a hierarchy with the “goal” of the decision (in this case community sustainability) as the top level. The second level (and perhaps additional levels) in the hierarchy consists of the criteria relevant for reaching this goal, (in this case general dimensions into which indicators of sustainability might be categorized, and perhaps sub-categories and sub-sub-categories, etc.). At the bottom level are the indicators the community chooses to measure the specific attributes that make up each dimension.

In *step two*, after the hierarchy is established, the dimensions and indicators are compared and ranked in hierarchy. For this comparison, the scale of Table 2 is used which allow participants to express the comparisons in verbal terms which are then translated in the corresponding numbers. Only two criteria are compared at the same time using the verbal terms of the scale (Saaty, 1994).

Table 2: Fundamental scale for pair-wise comparisons (after Saaty, 1994).

Verbal scale	**Numerical values**
Equally important, likely or preferred	1
Moderately more important, likely or preferred	3
Strongly more important, likely or preferred	5
Very strongly more important, likely or preferred	7
Extremely more important, likely or preferred	9
Intermediate values to reflect compromise	2, 4, 6, 8

In the final, *step three*, the numerical values assigned to each comparison are used to calculate weights, which are multiplied by the normalized indicator values to produce an index on a 0 to 1 scale that sums the contribution of each indicator and dimension with respect to the goal, in this case Sustainability.

3. HYPOTHESIS

The hypothesis driving the Sustainable Community Index (SCI) effort is that communities will benefit from having a process and a framework that will enable them to quantify and spatially visualize the relative contribution of policy decisions toward sustainability of various areas across their community. Providing communities with a framework for developing a unique local SCI and a process for applying it across a community, we hypothesize, will bring that community together to make progress toward sustainability. Indexing the relative contributions of each area within the community and mapping them at the US census block level (or more finely when data or surveys make this possible) will provide the community as well as the individuals and organizations within the community with a tool useful for making and monitoring decisions that will impact sustainability.

The SCI process described in this paper offers the option to communities of a local, integrated, index. While the *Yale Pilot 2006 Environmental Performance Index* (Esty, 2006) tackles the problem of combining a variety of indicators into one index that would be useful for policy decisions, it does this on a national level that would not provide the information needed for local community decisions. Its other limit is its focus on only the environmental aspects of sustainability rather than overall sustainability.

4. METHODOLOGY

The application of the AHP to creating an index of community sustainability is founded upon a similar effort that has been applied to agricultural lands. This Agroecosystem Health Index has been revised to consider broader community concepts in a sustainable communities index process and application. The process and application have been thus far developed and modeled through a modeling endeavor based on an anonymous community in Ohio. The index is planned to be piloted in a new community in the spring of 2006.

4.1 The Agroecosystem Health Index (Vadrevu et al, In Review)

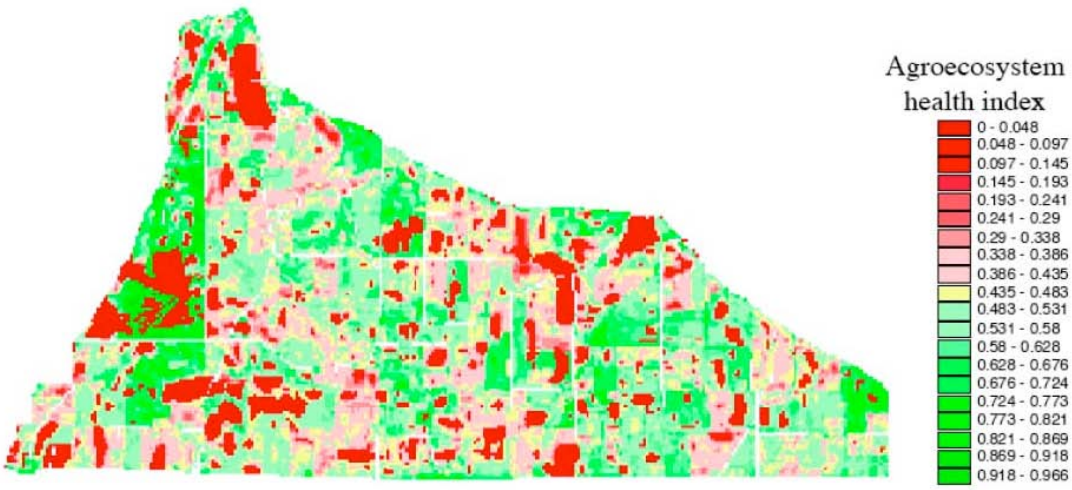
The Agroecosystem Health Index (AHI) is a model the authors are expanding for use by local communities, urban as well as rural. The AHI has been developed to assist agricultural communities with measuring the current status of agroecosystems with respect to the properties of agroecosystem health proposed by Conway (1987) including productivity, stability, sustainability, and equitability.

Vadrevu et al. (In review) describe and analyze the AHI as a method to quantify agroecosystem health through a combination of geographically referenced data at various spatial scales. Six dimensions are used in this index to quantify agroecosystem health: soil health, biodiversity, topography, farm economics, land economics, and social organization. The index quantifies each of these dimensions and then combines them by the analytical hierarchy process to yield an agroecosystem health index. Data sources included remote sensing, digital elevation models, soil maps, county auditor records, and a structured questionnaire of landowners in the study area. The two steps in the process were first to combine the data at the pixel scale (30 m2) into key variables with normalized values, and then to combine the key variables into the final index.

"The AHI permits estimation of agroecosystem health as a function of specific underlying conditions which combine in complex ways. Because values of the AHI and the data underlying them can be analyzed for a particular landscape, the method proposed could be useful to policy makers, educators, service agencies, organizations, and the people who live in the area for finding opportunities to improve the health of their agroecosystem" (Vadrevu et al, In review).

Diagram 1 shows the application of the index to a six square mile portion of the Apple Creek watershed in Wayne County, OH. As shown in the legend for diagram 1, higher index numbers show greater agroecosystem health.

Diagram 1: Agroecosystem Health Index application in Wayne County, OH



4.2 The Sustainable Community Index (SCI) Process

The Sustainable Community Index (SCI) adapts key elements of the Agroecosystem Health Index to create a tool and process that local communities can use to benchmark and monitor the economic, social, and environmental health of their community. The index is developed with community input and is spatially mapped using Geographic Information Systems (GIS). In this way it helps pinpoint how sustainability factors vary from place to place within their community, and how they change over time.

For the SCI to effectively serve as a tool for decision making toward sustainability, the process is of great importance. The balance of local input and objective science is critical. The community must have a part in the development of the index and, at the same time, the process must assist the community to make decisions that will truly move it toward sustainability. The following five steps have been developed for communities to operationalize the SCI framework:

> **STEP I:** Community members become familiar with the sustainability concept as they define it and give it parameters that are meaningful to them.
>
> **STEP II:** Community representatives then select the set of indicators that will measure the state of sustainability across their community as matched against their goal of a healthy and sustainable community.
>
> **STEP III:** The indicators or measures are next combined through the analytical hierarchy process (AHP) into a single index that becomes a tool for planning. The AHP assists community members to develop an index that carefully balances the relationship among a variety of indicators and measures which jointly contribute to sustainability.
>
> **STEP IV:** The SCI is mapped spatially across the community to provide a synoptic view of sustainability of the community and how it varies from place to place. The community can then focus on places here improvements may be needed most and by decomposing the index back down to the underlying data, understand what specific indicators would need to be changed to make the desired improvements.
>
> **STEP V:** Conversations within the community based on the information contained in the SCI model can become the basis for benchmarking the current state of sustainability and evaluating the cost effectiveness of alternatives. Communities can assess local changes within the SCI framework and the cost effectiveness of various changes in policy or practice can be estimated.

The SCI was developed as a tool by modeling the community process in which it would be used. A multidisciplinary team of twenty-three researchers, practitioners, and graduate students from a wide variety of disciplines (ecology, planning, community development, organizational development, and ministry) gathered to model the first three steps of the SCI process: defining sustainability; selecting indicators, and using the analytical hierarchy process (AHP) to combine the indicators into an index of community sustainability. Participants took the viewpoint of community members or stakeholders in a role play process. Representatives of this team will continue to refine the process as well as serve as coaches for communities electing to go through the process as a means of planning for community sustainability.

The development process for the SCI required the identification of critical dimensions that should be included in any index of sustainability. Six dimensions surfaced as indicative of sustainability across the social, environmental, and economic fabric of the community: 1) Equity: fairness and shared opportunity for all community members; 2) Diversity: variety and inclusiveness in all aspects of life; 3) Connectedness: people relating to each other without isolation; 4) Renewability: resources available to regenerate and keep going regardless of setbacks or losses; 5) Adaptability: ability to anticipate and respond to change; and 6) Scalability: what works locally also works regionally and what works in the short term also works in the long term. These dimensions, shown in table 3, are consistent with the framework offered by Lopez-Ridaura et al. (2005) and Conroy & Berke (2004).

Table 3: Dimensions of Sustainability for use in the Sustainable Community Index (SCI)

Equity	***Diversity***	***Connectedness***	***Renewability***	**Adaptability**	**Scalability**
Fairness and shared opportunity for all community members	Variety and inclusiveness in all aspects of life	People relating to each other without isolation	Resources available to regenerate and keep going regardless of setbacks or losses	Ability to anticipate and respond to change	What works locally also works regionally and what works in the short term also works in the long term

4.3 Modeling the SCI process

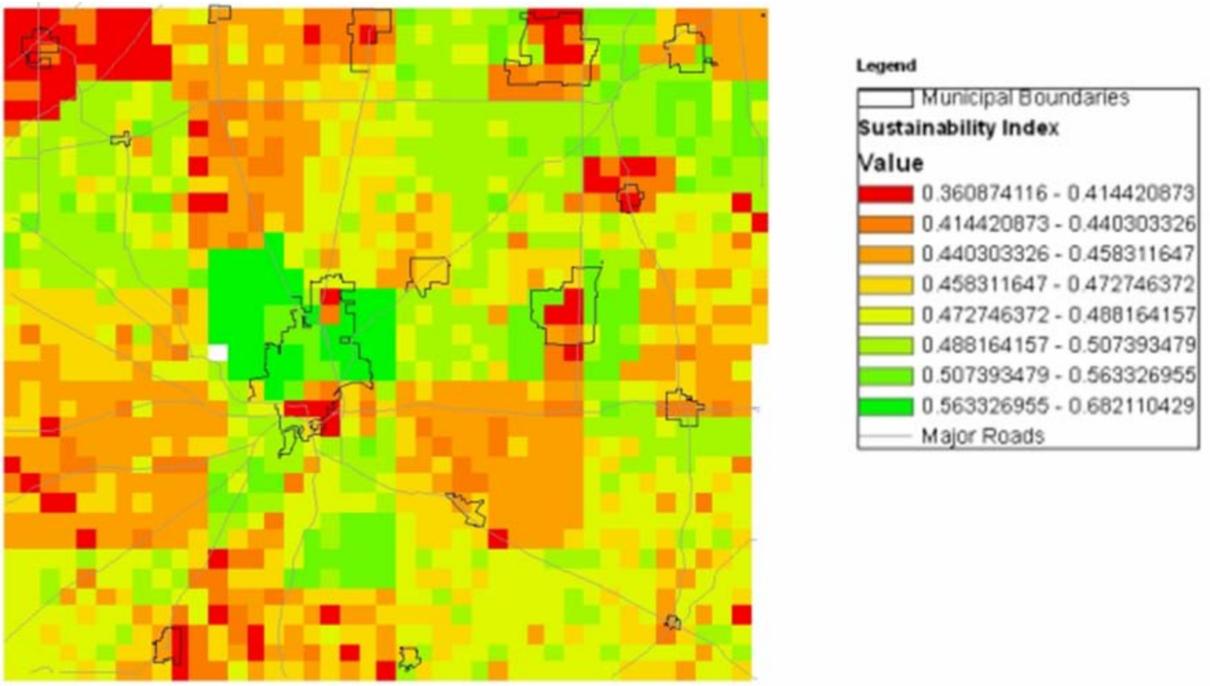
A “model” community was chosen for modeling the SCI index and mapping process. The eighty-five block groups in the community are the areas used for mapping the index. The block groups vary in geographic size and shape with roughly equal numbers of residents in each group. The map in Diagram 2 shows these block groups. Twenty-one indicators were chosen for the modeling activity and data has been assembled for each indicator in each census tract; these indicators are shown in Table 4 grouped by dimension. A group representing a steering committee of county residents ranked the dimensions and indicators using the analytical hierarchy process.

The “model” community is being mapped to apply the index across the census tracts within the geographical community. In the manner that the mapping takes place, each value of the many that enter into the single number index is mapped on a separate layer. The index can thus be “mined” for the specific components of the index number. This responds to criticism of a single index e.g., Lopez-Ridaura et al. (2005).

Table 4: Indicators of Community Sustainability listed under the appropriate dimension

Equity	***Diversity***	***Connectedness***	***Renewability***	**Adaptability**	**Scalability**
Jobs Access Housing	Biodiversity Business/ Enterprise Land Use Cultural/ Demographic	Social Networks Shared Vision Public Transportation Positive Conflict Resolution	Public Investment Educational Opportunities Financial and Natural Capital	Leadership Technology Investment Civic Engagement Skilled Workforce	Public Policy Land Use Regionalism

Diagram 2: Block groups for the model community



4.4 Piloting the SCI process

Selecting a community for a pilot of the SCI is taking place in conjunction with a practice-based studio class of The Ohio State University's department of City and Regional Planning. Critical to the success of the pilot will be extensive participation on the part of the community members through both open meetings as well as a steering committee. Such representation is important not only to garner community support for the endeavor, but also to gain a shared definition of sustainability for the community and insight into potential indicators, or performance measures. Since the kinds of things that communities could measure that are relevant to sustainability are almost endless, the SCI framework provides categories for selecting and organizing measures to provide a complete picture of sustainability for the community. A facilitator will assist the community through the process.

A steering committee of interested local residents, identified in collaboration with community leaders, will guide the community through a process with broad participation. The committee should have representatives from decision making and implementation facets of government, as well as the general citizenry. The role of the steering committee is to provide consistent leadership and take a long range view of the process, inviting wide community participation and providing an interface between citizens and government to institutionalize the process.

The steering committee will ensure there are a variety of opportunities for community members to discuss the issue of sustainability, review the facts, and come to a common understanding of sustainability. The steering committee will also coordinate the selection of indicators and measures that will be tracked to guide the community toward increased sustainability. The effectiveness of the process will be enhanced when indicators can be chosen that cross the three traditional areas of economic, social, and environmental sustainability. An excellent example of a multidimensional indicator is percentage of local food consumption. Local food projects contribute toward each area of sustainability: environmentally (less transport energy), socially (relationships between grower and consumer), and economically (multiplier effect of keeping food dollars local).

After the indicators and related data sets are selected, the index will be calculated and mapped for each geographical unit across the community by: a) assigning each indicator to one or more of the dimensions listed in table 3; b) using the analytical hierarchy process to weight the indicators in hierarchical combination into an index (SCI); and c) mapping the index as a function of the underlying indicators across the community's geographical area.

With the index and mapping complete, the community will be able to use the SCI for planning toward sustainability. Community leaders, planners and citizens can use the SCI to prioritize what individuals, groups, organizations, businesses, and policymakers could do to increase the community's sustainability. They can then monitor their progress toward sustainability by periodically repeating the measuring and mapping.

5. CONCLUSIONS

The Sustainable Community Index (SCI) promises to be an effective tool to assist communities, rural and urban, to plan and make progress toward sustainability. It is applicable at a scale where decisions are able to be made by individuals, groups, and policy makers. It strongly represents all aspects of sustainability and not merely the environmental. Further piloting will refine the challenges of selecting indicators and combining them through the analytic hierarchy process into a single numerical index. It will also test the cost to the community of data collection, index calculations and geographic mapping of the index.

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