Local Environment, Vol. 8, No. 6, 641–660, December 2003 Carfax Publishing Taylor & Francis Group

ARTICLE

Developing Statewide Indices of Environmental, Economic, and Social Sustainability: a look at Oregon and the Oregon Benchmarks

MARC SCHLOSSBERG & ADAM ZIMMERMAN

ABSTRACT *This research develops a method to transform the Oregon Benchmarks, a set of internationally recognized quantitative indicators designed to measure a broad array of state-level trends, into indices of social, economic, and environmental sustainability. Through multiple means, an original set of 90 Oregon Benchmarks has been narrowed into a smaller set of sustainability indicators in order to gain an integrated view of statewide sustainability as well as the capacity to look at social, environmental, and economic sustainability in isolation. The three-domain sustainability indices presented here are designed both to understand the current sustainability situation and to create a useful and informative tool for state-level policy makers interested in incorporating sustainability principles into their decision making.*

Introduction

The concept of sustainability has emerged in the past thirty years as a leading framework for understanding economic development, community development, and natural resource management around the world. The information generated by the study of sustainability, alongside the creation and implementation of sustainability policies and practices, has taken many forms including policy initiatives that utilize quantitative indicators to track trends associated with sustainability.

The research presented here is concerned with transforming a quantitative indicator program designed to measure a broad set of state-level trends into indices of social, economic, and environmental sustainability. The Oregon Benchmarks, an internationally recognized set of data points for the state of Oregon (United States), is being used as the basis of this research. The Oregon Benchmarks are currently used by policy makers to get a sense of individual elements of the social, environmental, and economic conditions in Oregon, such as stream water quality, poverty rates, or business investment. What is not done with this comprehensive set of quantitative data is to integrate multiple measure-

Marc Schlossberg, University of Oregon, Planning, Public Policy, and Management, 128 Hendricks Hall, Eugene, OR 97403, USA. Email: schlossb@uoregon.edu

1354-9839 Print/1469-6711 Online/03/060641-20 © 2003 Taylor & Francis Ltd.
DOI: 10.1080/1354983032000152743

ments into a larger index consistent with sustainability principles. Therefore, the research presented here results from the question: Can the general, quantitative measures of the variety of state conditions known as the 'Oregon Benchmarks' be converted into an index, or series of indices, that measures sustainability? Once such a set of sustainability indices is created, then state policy makers will have a tool directly related to sustainability principles to measure the progress of different conditions over time so that a determination can be made as to whether there has been progress toward or away from statewide sustainability.

Through multiple means, an original set of 90 Oregon Benchmarks has been narrowed into a smaller set of sustainability indicators. These indicators have been synthesized together, as well as grouped into subsets, in order both to measure an integrated view of statewide sustainability and to have the capacity to look at social, environmental, and economic sustainability in isolation.

This study contributes to the ongoing discussion about how a governing body (whether state, regional, or local) should measure progress. The study provides both an experimental index that includes a series of key trends associated with sustainability for the state of Oregon and a roadmap for other state, regional, and local governments to use to transform existing data into longitudinal analyses of sustainability.

Background

The use of indicators in guiding public policy decisions has long been practiced in countries throughout the world. In the United States, indicators like the gross domestic product have been employed to inform both the public and private sectors about the condition of national economic health. However, many of the widely used indicators of economic health do not accurately reflect larger trends of societal health (Anderson, 1991). Although the volume of information about sustainability and sustainable development has grown exponentially since the 1960s, early efforts to define sustainability focused almost exclusively on the relationship between human economic activities and the impact of those activities on the natural environment (Meadows *et al*., 1974; Hardin, 1968).

Many early advocates for sustainability and sustainable development were scientists and economists interested in the use of models to predict sustainable levels of natural resource extraction, economic production and consumption. Two key reports of this early era included *The Limits to Growth* (Meadows *et al.*, 1974) and *Our Common Future* (World Commission on Environment and Development [WECD], 1987), which placed environmental degradation and carrying capacity at their center.

By defining sustainability as an ongoing process in which people take actions leading to development that meets the needs of the present without compromising the ability of future generations to meet their own needs, *Our Common Future* did open up the possibility for an expanded notion of sustainability beyond purely environmental terms (World Commission on Environment and Development, 1987).

The concept of sustainability, as it often appears today, attempts to reach beyond the pure environmental approach and embrace elements of the human

social community. The concept of sustainability has begun to look at reconciling the 'three E's': environment, economy, and equity (Brugmann, 1997; Holling, 2001; Jepson, 2001; Michalos, 1997). That is, a new definition of sustainability focusing on *intra*-generational equity, as well as inter-generational equity as delineated in the WCED's definition, is increasingly of concern to policy makers (Farrell & Hart, 1998). And while environmental sustainability is often characterized on a scientific basis, social and economic sustainability is ultimately a political issue because it involves social equity and the potential redistribution of resources (Gahin, 2001). Having a measure of sustainability that is accessible to a wide variety of policy makers is an important component in what is an inherently political notion.

Measuring sustainability usually involves some sort of index creation, which itself has a long and evolving history (see Table 1). Over the past two decades, worldwide efforts to identify indicators of sustainability have resulted in the creation of hundreds of indicators. Most of the indicators identified are linked to environmental sustainability. A 1998 report by the Organisation for Economic Co-Operation and Development (OECD) listed 51 environmental indicators designed to measure progress toward sustainable development. The indicators are broken down into environmental indicators and socioeconomic indicators (Organisation for Economic Co-Operation and Development, 1998). Review of the indicators selected by the OECD reveals two trends that are common throughout the field of sustainability indicators. First, the OECD indicators focus entirely on conditions of the natural environment or on economic production trends. Second, although a framework for linking indicators is suggested, an actual example of a framework to show linkages between the indicators is not developed. Both points are key driving factors behind the development of this study.

New systems of sustainability indicators are appearing that stretch beyond the discrete measurement of environmental and economic conditions. An emphasis on community well-being and social capital is influencing the make-up of current sustainability indicators (Meadows, 1974). Good measurements of environmental and economic conditions remain very important to gauging progress toward sustainability, however, other indicators, especially social indicators, are playing a role in helping communities determine sustainability. A system of linking separate indicators becomes useful when communities are seeking to

TABLE 1. History of indicator development

Initial work done in the …	Indicator area
1920s–1930s	Social indicators
1940s–1950s	Economic indicators
1960s	Quality-of-life indicators
1970s	Health information system indicators
1970s	Environmental indicators
1980s	Healthy communities indicators
Current	Sustainability indicators

Source: Hodge, 1997; Innes, 1990.

discern how social trends (e.g. poverty) vary with environmental trends (e.g. water quality) and economic trends (e.g. economic diversification).

Because indicators do not simply reflect objective knowledge, but rather reflect and inform a complex process of technical and political decision making, valuable indicators result from a synthesis of social vision and shared understandings with well-developed technical data (Innes, 1990). To put it another way, indicators are not only the product of a scientific process, they also must have roots in the political process. To be effective in the political process, indicators must be 'easy to understand, inexpensive to measure and supported by a political consensus' (Gustavson *et al.*, 1999, 118).

Addressing Sustainability in Oregon

In 1989, the Oregon State Legislature created the Oregon Progress Board as a state agency that tracks quantitative indicators for the State of Oregon. The Oregon Progress Board (OPB) was further charged with keeping Oregonians focused on the future by developing and implementing a state strategic plan. The plan, called 'Oregon Shines', has three major goals: (1) quality jobs for all Oregonians; (2) safe, caring, and engaged communities; and (3) healthy, sustainable surroundings (Oregon Progress Board, 2001). To measure progress toward each goal, the Progress Board developed a program to collect quantitative measurements of up to 100 trends in Oregon, called the 'Oregon Benchmarks'. Currently there are 90 benchmarks and the data for each benchmark are collected annually, usually on a county-by-county basis. The OPB selects a subset of 25 benchmarks referred to as the 'Key Benchmarks', which are given special consideration when assessing Oregon's progress and are given considerably more weight by the OPB when grading Oregon's performance.

The state of Oregon's definition of sustainability was established by an Executive Order from Governor John Kitzhaber in 2000. The definition states that 'sustainability requires simultaneous meeting of environmental, economic and community needs'. The state further delineates its goals into four parts:

1. Increase the economic viability of all Oregon communities and citizens.
2. Increase the efficiency with which energy, water, material resources, and land are used.
3. Reduce releases to air, water, and land of substances harmful to human health and the environment.
4. Reduce adverse impacts on natural habitats and species (Kitzhaber & Bradbury, 2000).

The 90 benchmarks are grouped into seven principle categories: economy, education, civic engagement, social support, public safety, community development, and environment. The selection, addition, and removal of benchmarks constitute a political process negotiated by the 11 members of the OPB. For the most part, data are collected at the county level and aggregated to develop statewide measures for each phenomenon. Periodically, the Oregon Progress Board reports back to the state on the performance of each measurement and

assigns a letter grade (e.g. A, B, C, D, F) to quickly categorize how the state is doing.

The Oregon Progress Board also sets targets to achieve and compares current performance with future goals. The benchmarks, however, are reviewed and analyzed individually and are not currently synthesized or integrated in a way that attempts to look at sustainability. That is, the OPB tracks individual statewide accomplishments and failures, but has not pursued the more integrated approach that the lens of sustainability provides.

In 2000, Governor John Kitzhaber asked the Oregon Progress Board to assess whether Oregon's benchmarks could measure sustainability (Tryens & Silverman, 2000). This paper and research respond to that request.

Research Methodology

This research is primarily concerned with creating simultaneous indices of social, economic, and environmental sustainability, using an existing collection of regularly collected statewide data. The research approach synthesizes three distinct methods: (1) a review of sustainability indicator programs in the United States and internationally; (2) a survey of sustainability experts to better understand the relative usefulness of the Oregon Benchmarks for assessing sustainability; and (3) a synthesis of the identified benchmarks into indices of sustainability.

Indicator Program Comparison

Analyzing other sustainability efforts, both within the United States and internationally, formed an important context for evaluating the suitability of the Oregon Benchmarks to measure sustainability. The goals of the analysis were: (1) to identify commonly measured phenomena in the field, and (2) to highlight trends that the Oregon Benchmarks do and do not measure. Eight sustainability indicator programs were selected and compared in a matrix format. Cases were initially identified through the literature review process and were subsequently screened by the following five criteria:

1. *Sustainability.* The indicator project or program currently provides, or is seeking to provide regularly measured indicators of sustainability. For example, the New Jersey Futures project specifically chooses indicators based on data to 'measure significant trends that impact our progress toward the sustainable state goals' (New Jersey Future, 1999).
2. *Specified measures*. Specific measures must be assigned to each indicator. For example, the Bay Area Alliance for Sustainable Development has identified a set of core indicators and specific measurements, such as educational investment, to support the indicators (Bay Area Alliance for Sustainable Development, 2000).
3. *Range of issues*. Indicator programs should cover a broad range of issues related to sustainability. For example, the Thomas Jefferson Sustainability Council project includes four broad categories: human resources, produced

resources, social resources, and natural resources (Thomas Jefferson Sustainability Council, 1996).
4. *Accessibility of data*. The indicators for the projects/programs must be available for public access through either the World Wide Web or publicly available documents.
5. *Program capacity.* A specific effort was made to collect comparative programs at the level of state government to compare with Oregon's efforts. However, statewide sustainability indicator projects in the United States are limited, so preference was given to regional-scale projects, or projects that covered a population similar in size to the state of Oregon (approximately 3.5 million).

Expert Survey

In order to address the range of attitudes about sustainability indicators and the usefulness of existing Oregon Benchmarks for measuring sustainability, a questionnaire was constructed to quantify attitudes about sustainability measures among experts. The questionnaire was designed with two general questions in mind: (1) Do the existing benchmarks provide adequate information for measuring statewide sustainability? (2) Are there gaps in the existing benchmarks that hinder the ability of the benchmarks to assess statewide sustainability, and what additional information could assist in filling those gaps?

Sixty participants in the expert opinion poll were selected. A selected sample of experts was identified based on publications, organizational information, and peer contacts that identified potential respondents as being 'knowledgeable' in the field of sustainability. A roughly proportional number of questionnaires were sent to respondents from government, business, non-profit, and academic researchers. Twenty-five surveys were returned (40% response rate) and were evenly distributed across these four sectors.

In order to quantify the questionnaire responses, a close-ended scale was developed to measure responses. Pre-tests of the rating instrument were conducted to refine the scale. Experts were asked to use a zero to ten scale to rate the usefulness of each individual benchmark for assessing sustainability.

The questionnaire was limited to approximately 60 data measurements (out of 90 benchmarks), including all of the 25 Key Oregon Benchmarks. The reduction in benchmarks was based on the results of the indicator program comparison-benchmarks that appeared in a set of other comparison indicator efforts were generally included in the questionnaire, while benchmarks that did not arise in the other sustainability programs were generally omitted from the questionnaire. The resulting benchmarks that were included in the questionnaire continued to reflect a wide spectrum of topical areas and reflected the breadth of subject areas covered by the Oregon Benchmarks. Table 2 includes a summary of the number of benchmarks surveyed by benchmark category.

The questionnaire provided room for the respondents to comment on each of the benchmarks in the survey. The form also provided the opportunity for respondents to suggest additional indicators or measurements (see Table 3 for an example of the survey format). Allowing room for comment allowed respon-

TABLE 2. Surveyed benchmarks by category

Categories	Total number of benchmarks	Number of measures surveyed	Percentage of total
Economy	17	11	65
Education	12	7	58
Civic engagement	9	4	44
Social support	22	12	55
Public safety	7	3	43
Community development	7	6	86
Environment	16	13	81

dents to identify potential new benchmarks that were not included in the questionnaire.

Sustainability Index Development

Once the sustainability program matrix was analyzed and the responses from the expert poll were received, the next step was to develop three indices of sustainability (economy, environment, community) from the existing benchmarks data.

Four broad criteria were developed to assist with selecting the measures for the indices and placing the measures in the three index categories:

- highly rated by experts
- broad-based rating with respect to categories
- valued in field of sustainability indicators
- consistent with values and priorities of the Oregon Progress Board

Each criterion was assigned a measurement and integrated into a formula to determine a core set of benchmarks for inclusion in the three indices. Each of the four criteria was assigned a possible score of 1.5, resulting in a total possible score of 6.0 for all four criteria.

This study used percentage change from a base year as a method for selecting a common metric. By converting each measurement (e.g. stream water quality) to a rate of change from a base year within its own metric, disparate measures can be looked at simultaneously. That is, 'percentage change' creates a foundation upon which different measures can be analyzed together. Biennial data starting with a base year of 1990 and extending to 2000 were used for this study. Using a simple weighting method, the percentages for each measure (MP = measure percentages) were summed in each of the six biennial data periods (BS = biennial sums). The index was derived for each biennium by dividing the sums of the biennial data by the sum of the base data point (BP = base point biennial sum) (1990–1991). The resulting percentage was then multiplied by 100. For the three indices, the base point of 1990–1991 was assigned an index value of 100. Change for each of the five subsequent biennial points was evaluated as positive or negative change from the base point of 100.

TABLE 3. Sample survey excerpt

	Area of Concern: Community Development	Sustainability Rating (0–10)	Area(s)	Comments:
36	Traffic Congestion: Percentage of miles of limited-access highways in urban areas that are congested			
37	Drinking water: Percentage of Oregonians served by public drinking water systems that meet health-based standards			
38	Commuting: Percentage of Oregonians who commute during peak hours by means other than single occupancy vehicles			
39	Vehicle Miles Traveled: Vehicle miles traveled per capita in metropolitan areas (per year)			
40	Affordable Housing: Percentage of low income households spending more than 30% of their household income on housing (including utilities)			
41	Owner Occupied Households: Percentage of households that are owner occupied			
Add				
Add				

Results and Analysis

All of the 60 benchmarks were ranked according to the four criteria above. Thirty-two of the benchmarks scored above 2.0 (out of 6.0) and were included in the final potential set of benchmarks to be transformed into indices of sustainability. A few final adjustments needed to be made, however. 'Sustainability' still tends to be a term identified with environmental conservation and thus experts of sustainability tend to be biased toward environmental issues. Thus, minor adjustments were made to the final set of social and economic sustainability benchmarks utilizing a heavier reliance on the program comparison results.

Also, benchmarks with less than two data points between 1990 and 2000 were removed. The existence of at least two data points was necessary to track change over time. Additionally, benchmarks with two data points but with no data available before 1996 were also removed because of concerns about the use of

TABLE 4. Sustainability index benchmarks

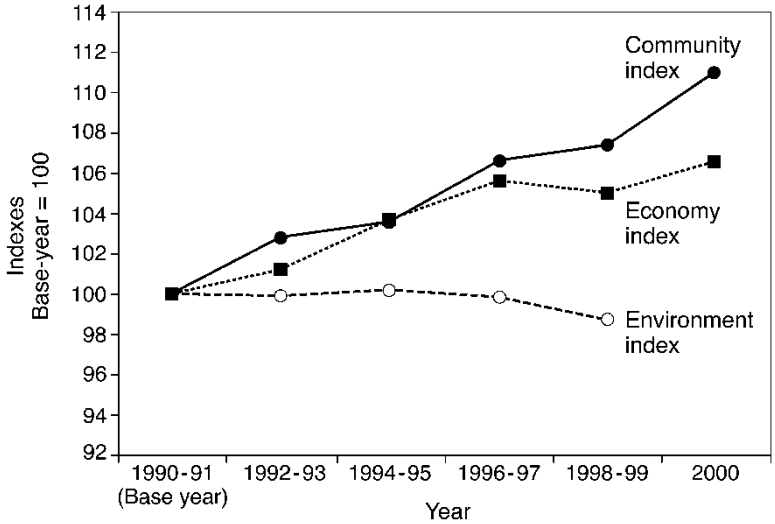
Sustainability benchmarks: Environment	Sustainability benchmarks: Community	Sustainability benchmarks: Economy
Stream Water Quality	Child Abuse or Neglect	Drinking Water
Native Plant Species	Teen Pregnancy	Research and Development
Forest Land	Homelessness	Eighth Grade Skill Levels
Air Quality	Health Insurance Coverage	New Companies
Agricultural Land	Overall Crime	College Completion
Marine Species at Risk	Teen Alcohol Abuse	Living Wage
Native Fish and Wildlife	Juvenile Arrests	Poverty
Carbon Dioxide Emissions	Commuting	Per Capita Income
State Park Acreage	Vehicle Miles Traveled	Economic Diversification
Municipal Waste Disposal	Volunteerism	High School Dropout Rate
Nuisance Species		Employment Dispersion
		Affordable Housing
		Timber Harvest
		Income Disparity

data from 1996–2000 as proxy data for earlier years. Two benchmarks were also removed because the Progress Board decided that the past data measurements were no longer an accurate depiction of the benchmark. Table 4 lists the 35 benchmarks included in the final three sustainability indices.

In looking at the lists of measures above, it is quite easy to intuitively place many of the measures into their eventual categories. Some measures, however (e.g. Drinking Water, Commuting, or Affordable Housing) seem to be open to debate on where they are to be placed. And while it is possible to argue for their placement here (i.e. a sustainable economy is one in which there are high rates of affordable housing), their eventual placement into categories is less of a scientific exercise than of a political process. Developing indices of sustainability is an inexact science, but creating defendable groupings and presenting complex data in easier to understand ways can help direct policy making into new directions.

The percentage change in benchmark performance over the 1990s was calculated, and then combined into three distinct indices of sustainability using equal weights. Figure 1 visually displays the composite indices for the three domains of sustainability. The three separate indices present the performance for each domain, as well as providing an opportunity to compare indices with each another. By plotting the performance of the environment index side by side with the economy index, one can gain a sense of whether or not positive economic performance is accompanied by negative environmental performance. Thus the use of indices in this way provides the opportunity to gauge, albeit roughly, the correlations between the three sustainability domains.

The performance of each index is depicted relative to a base-point value of 100. On each chart, upward movement of the lines represents movement *toward*



GRAPH 1. Base-Year Sustainability Indices.

sustainability; downward movement represents movement *away* from sustainability. Looking at Graph 1, the Environment index rose slightly between 1992 and 1995, and then decreased by almost three points between 1996 and 2000. Both the Economy and Community indices showed significant improvement over the decade. The Economy index rose by almost seven points, and the Community index rose by 11 points.

Graphing the indices simultaneously allows policy makers and the public to get a general sense of the direction the state is moving in terms of sustainability. While specific policy prescriptions do not immediately flow from such a summary display, the easy-to-understand presentation of data allows one to understand the movement of trends over time and allows one to focus effort and resources into particular areas.

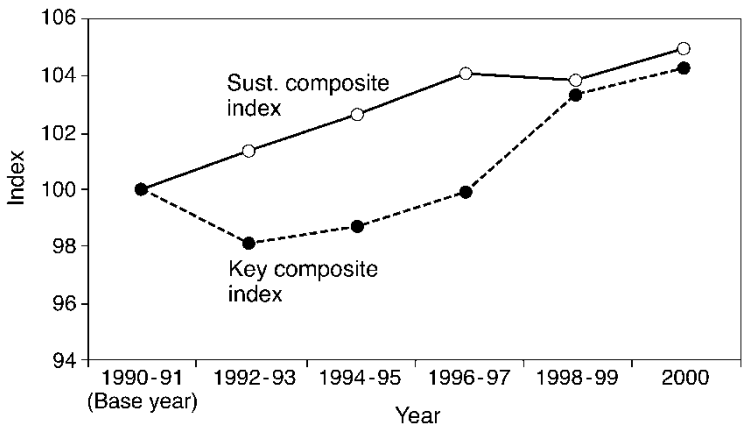
The individual benchmarks that make up any one of the indices can be looked at in isolation as well. This is especially helpful in seeing whether there are any particular individual measures that provide disproportional influence on the direction of the particular sustainability index. Table 5 delineates the individual benchmarks within the community sustainability index and their corresponding change compared with their 1990 base level. Note that positive percentages correspond to positive change; thus the first category below, 'Child Abuse or Neglect', has seen an improvement or lowering of cases during the 1990s.

In the Community index, then, improvement over time was driven by improvements in the Child Abuse and Neglect and Teen Pregnancy benchmarks. Improvements were also recorded in Homelessness, Health Insurance Coverage, Overall Crime, and Teen Alcohol Abuse. Decreases in sustainability were recorded in Juvenile Arrests, Commuting, Vehicle Miles Traveled, and Volunteerism, but none of these measures experienced more than a 5.4% decrease.

Another way to look at the benchmarks is to combine all of the sustainability measures into one overall measure of statewide change in sustainability. Figure

TABLE 5. Community benchmarks performance from base point

Sustainability benchmarks: Community	Percentage change 1990–2000
Child Abuse or Neglect	42.75
Teen Pregnancy	32.32
Homelessness	8.70
Health Insurance Coverage	6.00
Overall Crime	3.49
Teen Alcohol Abuse	3.40
Juvenile Arrests	− 1.36
Commuting	− 1.80
Vehicle Miles Traveled	− 4.29
Volunteerism	− 5.40



GRAPH 2. Benchmarks and Sustainability Benchmarks Comparison.

2 displays the composite of the sustainability benchmarks (all 35 sustainability benchmarks grouped together) and contrasts it with a composite line representing the 25 Key Benchmarks as previously identified by the Oregon Progress Board.

In this case, both indices reached the same amount of positive change over the decade, although they took different paths to get to that ending point. Interestingly, the sustainability index showed a consistently positive movement over the decade compared with the Key Benchmarks, which include both benchmarks within and outside of the sustainability index.

Reflection

Oregon, like many state, regional, or local governments, collects a variety of data and compiles such data in some regularly maintained format. While looking at individual data types for trends over time is useful and instructive in gauging

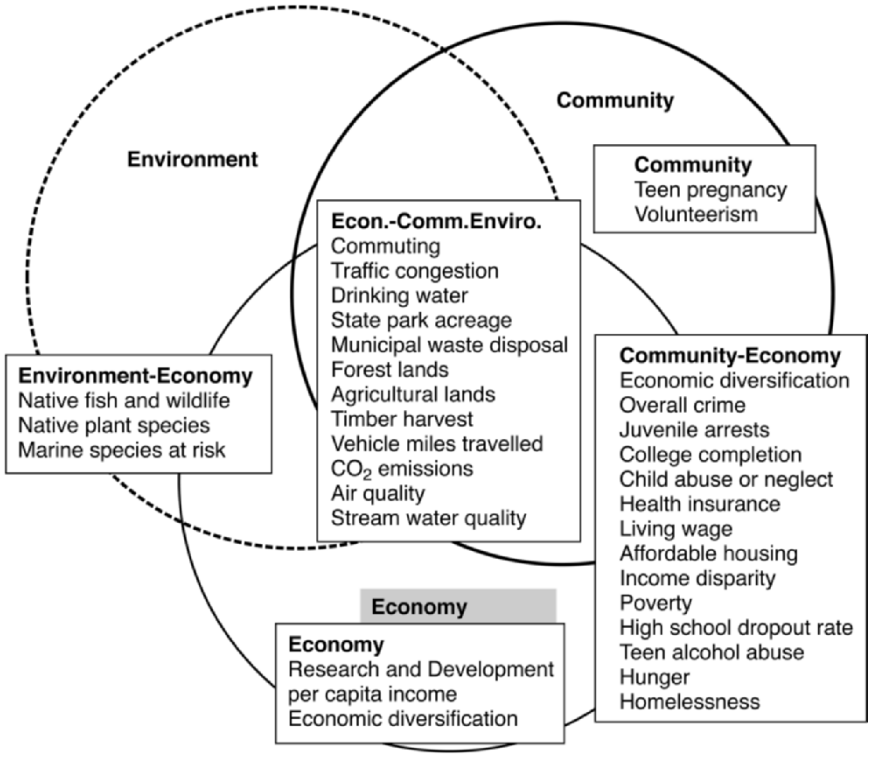


FIGURE 1. Cross Domain Benchmarks.

the current state of affairs, such analysis is usually done independently of an overarching, long-term strategic goal like that incorporated in the tenet of sustainability. Moreover, characterizing such data along three different domains of sustainability can further help inform policy makers and the public about the state and progress of multiple types of sustainability issues.

The most promising aspect of the three-domain index framework is that it provides the ability to evaluate the performance of each domain of sustainability relative to the other domains. As three pieces of a whole system, the domain indices represent rough approximations of the overall performance of the complex idea that is the state of Oregon. Based on the selected benchmarks, the indices show Oregon's performance, in terms of sustainability, over time. The three-domain framework shows that the domains of sustainability are *not* moving in harmony. The Economy and Community indices are rising, but the Environment index is falling. On average, when the indices are combined, the resulting single index implies that the state of Oregon is becoming more sustainable. However, based on Hodge's assertion that sustainability is an expression of interdependence, the three-domain framework suggests that unless all three indices are rising, the state of Oregon is not moving toward sustainability.

Looking at the indices in Graph 1, it is easy to see and compare the performance of each of the three domains over the time period. In this way the

indices here correspond positively with Hart's assertion that the aggregation of indicators allows for the communication of 'the concept of sustainability meaningfully and accurately in a compact form' (Farrell and Hart, 1998, p. 21). The aggregation of 35 data measurements into three indices allows the overall average performance of the measures in each domain to be communicated quickly. The indices can be displayed in either a visual form or as numbers of index performance (e.g. Economy 106.7, Community 111.1, and Environment 97.2). The scores for each index give quick-hit pieces of data that are tailor made for short information media (newspaper articles or television news). The simple structure of the indices is also convenient for communicating with policy makers and legislators who have multiple demands on their time. The index format can assist in delivering a big-picture understanding of the issue of sustainability in a matter of minutes.

The indices developed for this research are only a reflection of the data measures used to generate them. For indices to be transparent, the specific data measurements that are used to generate the indices must be understandable and readily available. The transparency of indices is of crucial importance if the indices are to be used to inform public policy decisions. The limited number of benchmarks in each index (Economy 14, Community 10, and Environment 11) reduces the size and complexity of the indices and facilitates quick breakdown of each index for an analysis of the individual trends. Even the largest index (Economy), at 14 benchmarks, can be displayed and understood on a single, simple line chart. One can quickly compare the performance of individual benchmarks by examining them side by side on a line chart, or examining a simple table depicting the percentage change in each benchmark over the time period.

Figure 1 illustrates the relationships of the sustainability benchmarks used in this research to the three domains within which they have been placed. Many benchmarks can be placed in more than one domain, but in order to make the three discrete indices, individual benchmarks were eventually placed in only one of the three areas.

The three-index framework provides both a simple indication of performance with regard to sustainability over time, as well as a slightly more complex indication of the performance of each domain relative to the other domains. What the framework does not adequately address are the complexities of the interconnections between each domain, and the individual benchmarks included in each domain. A more prescriptive model, a model that seeks to illuminate the linkages between phenomena represented by the benchmarks, could become a more useful instrument in terms of crafting policy for sustainable development. As an example, Dorcey's systems analysis of sustainable development uses a three-domain format similar to the framework used in this research, but aligns the domains in a nested framework that suggests the inherent interconnections between the domains (Dorcey & Westwater Research Centre, 1991). In Dorcey's model, the Economy domain is nested in the Social domain, which is nested in the Environment domain. The nested systems approach suggests that all the elements are part of a single whole system.

The current Oregon Benchmarks system does little to explicitly recognize the

interconnections between the broad arrays of subjects that the benchmarks cover. The indices developed for this research move a step closer to recognizing interconnections by combining seven discrete benchmark categories into three more comprehensive discrete sustainability domains and simultaneously visualizing their performance over time. However, the indices do remain primarily descriptive in nature, and do not describe the relationships between the benchmarks. The next step of this research, therefore, may be to add some complexity in analysis by more directly incorporating the interconnectedness between sustainability domains, whether through an overlapping model as in Figure 1 or in a nested model as proposed by Dorcey and Westwater Research Centre (1991). Furthermore, additional research could be undertaken to develop ways to understand a set of interconnected measures without masking important subthemes. That is, how can an integrated sustainability measure both inform policy makers and the public about the overall path toward sustainability without masking individual trend lines that may represent unsustainable activities?

Conclusion

The key contributions of this research, then, are characterizing sustainability along three domains instead of just the single environmental domain common to current sustainability discussion and simultaneously displaying the changes over time of the three indices, which gives users the capacity to make the linkages between the different elements of sustainability. The indices developed for this research move a step closer to both understanding sustainability more holistically and developing a method for communicating movement toward sustainability for policy makers at a state level. Public policy creation is inherently political and it is important that policy makers have access to current sustainability trends in order to make better-informed policy decisions. The three-domain sustainability indices presented here are designed to combine expert understanding of sustainability, an existing set of already measured statewide performance measures, and a current survey of the state of the field in sustainability indicators into a useful and informative tool for state-level policy makers interested in incorporating sustainability principles into their decision making.

References

Anderson, V. (1991) *Alternative Economic Indicators*. London: Routledge.

Bay Area Alliance for Sustainable Development (2000) *Draft Compact for a Sustainable Bay Area: Economy, Environment, Equity* (Oakland).

Brugmann, J. (1997) Is there a method in our measurement? The use of indicators in local sustainable development planning, *Local Environment*, 20(1), pp. 59–72.

Dorcey, A. H. J. & Westwater Research Centre (1991) *Perspectives on Sustainable Development in Water Management: towards agreement in the Fraser River Basin* (Vancouver, Westwater Research Centre, Faculty of Graduate Studies, University of British Columbia).

Farrell, A. & Hart, M. (1998) What does sustainability really mean? The search for useful indicators—attempts to measure sustainability are giving us new insights into the meaning of this concept as well as helping us to analyze trends and set goals, *Environment*, 40(9), pp. 5–31.

Gahin, R. (2001) Indicators as a tool to help create sustainable communities: a study of the outcomes of five community indicators projects. Thesis, Department of Planning, Public Policy and Management, University of Oregon.

Gustavson, K. R., Lonergan, S. & Ruitenbeek, H. J. (1999) Selection and modeling of sustainable development indicators: a case study of the Fraser River Basin, British Columbia. *Ecological Economics*, 28, pp. 117–132.

Hardin, G. (1968) The tragedy of the commons, *Science*, 162(1243), pp. 1243–1248.

Hodge, T. (1997) Toward a conceptual framework for assessing progress toward sustainability, *Social Indicators Research*, 40, pp. 5–98.

Innes, Judith (1990) *Knowledge and Public Policy: The Search for Meaningful Indicators* (New Brunswick, NJ, Transaction Publishers).

Jepson, E. J. (2001) Sustainability and planning: diverse concepts and close associations, *Journal of Planning Literature*, 15(4), pp. 499–510.

Kitzhaber, J. A. & Bradbury, B. (2000) Development of a state strategy promoting sustainability in internal state government operations. Executive Order EO—00–07 (State of Oregon, Salem, Oregon).

Meadows, D. H., Club of Rome & Potomac Associates (1974) *The Limits to Growth: a report for the Club of Rome's project on the predicament of mankind*, 2nd edn (New York, Universe).

Michalos, A. C. (1997) Combining social, economic and environmental indicators to measure sustainable human well-being, *Social Indicators Research*, 40(1–2), pp. 221–258

New Jersey Future (1999) *1999 Sustainable State Project Report: living with the future in mind, goals and indicators for New Jersey's quality of life* (Trenton).

Oregon Progress Board (2001) *Achieving the Oregon Shines Vision: the 2001 benchmark performance report* (Salem, Oregon).

Organisation for Economic Co-Operation and Development (1998) *Towards Sustainable Development: Environmental Indicators* (Paris).

Thomas Jefferson Sustainability Council (1996) *Indicators of Sustainability: interim report* (Charlottesville, VA).

Tryens, J. & Silverman, B. (2000) *The Oregon Benchmarks as a Measurement System for Sustainability* (Oregon Progress Board, Salem, Oregon).

World Commission on Environment and Development (1987) *Our Common Future* (Oxford, Oxford University Press).

Appendix A. Benchmark Summary

All benchmarks	Surveyed benchmarks	Sustainability benchmarks
Adult Literacy (Key)	Adult Literacy	
Adult Non-smokers		
Affordable Child Care	Affordable Child Care	
Affordable Housing (Key)	Affordable Housing	Affordable Housing
Agricultural Lands (Key)	Agricultural Lands (Key)	Agricultural Lands (Key)
Air Quality (Key)	Air Quality (Key)	Air Quality (Key)
Annual Payroll	Annual Payroll	
Associates Degree		
Available Child Care	Available Child Care	
Carbon Dioxide Emissions	Carbon Dioxide Emissions	Carbon Dioxide Emissions
Child Abuse or Neglect (Key)	Child Abuse or Neglect	Child Abuse or Neglect
Child Support Payments		
College Completion	College Completion	College Completion
Commuting	Commuting	Commuting
Computer/Internet Usage		
Cooperative Policing		
Disabled Living in Poverty		
Drinking Water	Drinking Water	Drinking Water
Economic Diversification	Economic Diversification	Economic Diversification
Eighth Grade Skill Levels (Key)	Eighth Grade Skill Levels	Eighth Grade Skill Levels
Elder Abuse		
Emergency Preparedness		
Employment Dispersion (Key)	Employment Dispersion	Employment Dispersion
Exports	Exports	
Feeling of Community	Feeling of Community	
Foreign Language Skills		
Forest Land (Key)	Forest Land (Key)	Forest Land (Key)
Hazardous Waste Sites Clean-Up		

Health Insurance (Key)	Health Insurance (Key)	Health Insurance (Key)
High School Completion	High School Completion	
High School Dropout Rate (Key)	High School Dropout Rate	High School Dropout Rate
High School Experience		
HIV Early Diagnosis		
Homelessness	Homelessness	Homelessness
Hunger	Hunger	
Income Disparity	Income Disparity	Income Disparity
Immunizations		
Independent Disabled		
Independent Seniors		
Infant Mortality	Infant Mortality	
Instream Water Rights		
Juvenile Arrests (Key)	Juvenile Arrests (Key)	Juvenile Arrests (Key)
Juvenile Recidivism		
Labor Force Skills Training		
Living Wage	Living Wage	Living Wage
Marine Species at Risk	Marine Species at Risk	Marine Species at Risk
Municipal Waste Disposal	Municipal Waste Disposal	Municipal Waste Disposal
Native Fish and Wildlife	Native Fish and Wildlife	Native Fish and Wildlife
Native Plant Species	Native Plant Species	Native Plant Species
Net Job Growth	Net Job Growth	
New Companies (Key)	New Companies	New Companies
Nuisance Species	Nuisance Species	Nuisance Species
On-Time Permits		
Overall Crime (Key)	Overall Crime (Key)	Overall Crime (Key)
Owner Occupied Households	Owner Occupied Households	
Per Capita Income	Per Capita Income	Per Capita Income
Perceived Health Status	Perceived Health Status	
Poverty (Key)	Poverty (Key)	Poverty (Key)
Premature Mortality		
Prenatal Care	Prenatal Care	

Appendix A.—*continued*

All benchmarks	Surveyed benchmarks	Sustainability benchmarks
Professional Services (Key)	Professional Services	
Public Library Service		
Public Management Quality		
Ready to Learn (Key)	Ready to Learn	
Recidivism	Recidivism	
Research and Development (Key)	Research and Development	Research and Development
Road Condition		
Standard & Poor's Bond Rating		
Salmon & Steelhead (Key)	Salmon & Steelhead (Key)	
Some College Completion	Some College Completion	
State Arts Funding		
State Park Acreage	State Park Acreage	State Park Acreage
Stream Water Quality	Stream Water Quality	Stream Water Quality
Students Carrying Weapons		
Substance Use during Pregnancy		
Taxes per US$1000 Income	Taxes per US$1000 Income	
Teen Pregnancy (Key)	Teen Pregnancy	Teen Pregnancy
Teen Substance Abuse (Key)	Teen Substance Abuse	Teen Substance Abuse
Third Grade Skills		
Timber Harvest	Timber Harvest	Timber Harvest
Traffic Congestion (Key)	Traffic Congestion	
Traded Sector Strength		
Understanding Tax System		
Unemployment Rate	Unemployment Rate	
Vehicle Miles Traveled	Vehicle Miles Traveled	Vehicle Miles Traveled
Venture Capital		
Volunteerism (Key)	Volunteerism	Volunteerism
Voting	Voting	
Wetlands (Key)	Wetlands (Key)	
Workers Compensation		

Note: Key = Key Benchmarks as designated by the Oregon Progress Board.

Appendix B. Data Points and Conversions of 35 Final Indicators

Sustainable Economy: data conversion notes

Income Disparity. Ratio of top-fifth families' incomes to lowest-fifth families' incomes. Conversion notes: percentage of 1980 ratio, inverted, 90 data used as proxy for 92–93 data point; 94–95, 96 and 98 data used for remaining points.

Poverty. Percentage of Oregonians with incomes below 100% federal poverty level; modified 2001 data. Conversion notes: actual percentage, inverted, 90–91 averaged per biennium; all other points are based on single data points, 99 used as proxy for 00.

Per Capita Income. Per capita personal income as a percentage of the US per capita income. Conversion notes: actual percentage, all points average per biennium, 99 point used as proxy for 00.

Economic Diversification. Oregon's national rank in economic diversification. Conversion notes: inverted percentage, all points averaged per biennium, 99 point used as proxy for 00.

College Completion. Percentage of Oregon adults who have completed a bachelor's degree. Conversion notes: actual percentage, data points available for 90, 92, 94, 96, 98, 00.

High School Dropout Rate. Percentage of students (annually) who leave grades 9–12 before graduating. Conversion notes: actual percentage, inverted, all points averaged per biennium, 99 used as proxy for 00.

Living Wage. Workers at 150% or more of poverty level. Conversion notes: actual percentage, all points averaged per biennium, 99 used as proxy for 00.

Affordable Housing. Percentage of low-income households (renters) spending more than 30% of household income on housing. Conversion notes: actual percentage, inverted, data points available for 90, 92, 96, 98, 00; 96 data used as proxy for 94–95 data point.

Employment Dispersion. Percentage of Oregonians employed outside the Willamette Valley and the Portland Tri-County Area. Conversion notes: actual percentage, all points averaged per biennium, 99 used as proxy for 00.

Research and Development (old benchmark). Industry research and development expenditures as a percentage of gross state product. Conversion notes: Oregon's expenditures on R & D as a percentage of gross state product as a percentage national expenditures on R & D as a percentage of gross national product, data available for 90, 91, 93, 95 and 97; 97 data used as proxy for 98–99 and 00; the 2005 target is the ratio of the 2005 target (1.2%) to the 1997 national figure (1.8%).

New Companies. Oregon's national rank in new companies. Conversion notes: inverted percentage, all points average per biennium, 99 point used as proxy for 00.

Eighth Grade Skill Levels. Percentage of eighth-graders who achieve established skill levels. Conversion notes: actual percentage, averaged reading and math scores, data available for 91, 93, 95, 96, 97, 98, 99, 00, data points average per biennium for 96–97, 98–99.

Timber Harvest. Actual harvest levels as a percentage of sustainable harvest levels. Conversion notes: averaged percentage of public lands and private lands, 95 data used as proxy for all earlier data points, data points available for 95, 96, 97, 98, 99; 99 data used as proxy for 00. (A sample 2005 target of 100% was assigned.)

Drinking Water. Percentage of Oregonians served by public drinking water systems that meet health based standards. Conversion notes: actual percentage, 95 used as proxy for 90–91, 92–93, 94–95, 96–97, 98–99 averaged per biennium, 99 used as proxy for 00.

Sustainable Community: data Conversion notes

Homelessness. Number of Oregonians that are homeless on any given night (per 10 000). Conversion notes: percentage of 92 data point, 92 data point = 100%, inverted, data available for 92–00, all data points averaged per biennium, 92 data used as proxy for 90–91 data point.

Juvenile Arrests. Total juvenile arrests per 1000 juvenile Oregonians per year. Conversion notes: percentage of 1980 data point, inverted, data available for all years 90–99; 99 data used as proxy for 00, all data points averaged per biennium.

Volunteerism. Percentage of Oregonians who volunteer at least 50 hours of their time per year to civic, community, or nonprofit activities. Conversion notes: actual percentage, inverted, data available for 92, 96, 98, 00; 92 used as proxy for 90–91, 94–95.

Vehicle Miles Traveled. Vehicle miles traveled per capita in Oregon metropolitan areas (per year). Conversion notes: percentage of 1980 data point, inverted, data available for all years 90–99; 99 data used as proxy for 00, all data points averaged per biennium.

Commuting. Percentage of Oregonians who commute during peak hours by means other than single-occupancy vehicle. Conversion notes: actual percentage, data points available for 90, 92, 94, 96, 98, and 00.

Health Insurance Coverage. Percentage of Oregonians without health insurance. Conversion notes: actual percentage, inverted, only single data points available per biennium.

Overall Crime. Overall reported crimes per 1000 Oregonians. Conversion notes: all crimes, percentage of 90–91 base point, 90–91 = 100%, all points averaged per biennium, 99 used as proxy for 00.

Teen Pregnancy. Pregnancy rate per 1000 females age 15–17. Conversion notes: percentage of 90–91 base point, 90–91 = 100%, all points averaged per biennium, 99 used as proxy for 00.

Child Abuse or Neglect. Number of children, per 1000 persons under 18, who are neglected/abused. Conversion notes: percentage of 90–91 base point, 90–91 = 100%, all points averaged per biennium, 99 used as proxy for 00.

Teen Alcohol Abuse. Percentage of eighth-grade students who report using alcohol in the previous month. Conversion notes: actual percentage, data available for 90, 92, 94, 96, 98, 00.

Sustainable Environment: data conversion notes

Air Quality. Percentage of time that the air is healthy to breathe for all Oregonians. Conversion notes: actual percentage, all points averaged per biennium.

Municipal Waste Disposal. Pounds of municipal solid waste landfilled or incinerated per capita. Conversion notes: percentage of 1992 pounds per capita, all points averaged per biennium, 92 data used as proxy for 90–91; 98–99 data point used as proxy for 00.

Agricultural Lands. Percentage of all Oregon agricultural land in 1982 still preserved for agricultural use. Conversion notes: actual percentage, 92 data used as proxy for 90–91, 92–93, 94–95; 97 data used as proxy for 96–97, 98–99, and 00. (A sample 2005 target of 100% was assigned.)

Forest Lands. Percentage of Oregon forest land in 1970 still preserved for forest use. Conversion notes: actual percentage, all data points averaged per biennium, 99 data used as proxy for 00. (A sample 2005 target of 100% was assigned.)

Nuisance Species. Number of nuisance invasive species established in Oregon. Conversion notes: percentage of 90, inverted, 90 data used as proxy for all data points except 00. (A sample 2005 target was set at the 1990 level.)

Marine Species at Risk. Percentage of assessed marine species at risk. Conversion notes: actual percentage, inverted, all data points average per biennium. (A sample 2005 target equal to the 1980 data point [9.1%] was assigned.)

State Park Acreage. Acres of state-owned parks per 1000 Oregonians. Conversion notes: percentage of 1980 data, all data points averaged per biennium.

Stream Water Quality (new benchmark). Percentage of stream sites with water quality in good to excellent condition. Conversion notes: actual percentage, 90–91 data point based on 1980 data, 94 figure used as proxy for 92–93 (no data available 92–93), 94–95, 96–97 points averaged per biennium, 98 data point used as proxy for 00.

Native Fish and Wildlife (old benchmark). Percentage of native fish and wildlife species that are healthy. Conversion notes: actual percentage, all points averaged per biennium except 90–91; 99 data used as a proxy for 00.

Native Plant Species. Percentage of native plant species that are healthy. Conversion notes: actual percentage; all points averaged per biennium except 90–91; 99 point used as a proxy for 00.

Carbon Dioxide Emissions. Carbon dioxide emissions in the state relative to 1990 emissions. Conversion notes: actual percentage, inverted, all points averaged per biennium except 90–91; 96–97 point used as proxy for 98–99 and 00 points.