The South Shore Journal, Vol. 3, 2009, pp. 11-33.

Quantitative Analysis of Sustainable Development: A Case Study of Northwest Indiana

K. Surekha Rao[1], Ph.D.
Indiana University Northwest

Abstract

Human development is generally measured by the ability to have food, level of literacy and the capacity to live a long and healthy life, whereas sustainable development implies a healthy lifestyle with fresh air, clean water and pure natural surroundings. This premise of sustainable development has lead to the convergence of conventional quality-of-life concept with that of the quality-of-environment. In this paper we propose an indicator, the Sustainable Development Index or SDI that combines the traditional quality of life indicators like personal income, educational attainment and healthcare facilities with some important environmental quality indicators like the quality of air, land and water, biodiversity and use of natural resources. Empirical application of this index to the counties of northwest Indiana demonstrates its usefulness for comparing and ranking different regions in terms of sustainable development.

Keywords: quality of life, quality of environment, sustainable development, SDI

JEL code: Q01

[1] I would like to thank the Center for Regional Excellence, Indiana University Northwest for the financial support. Thanks are due to Adam Castor, Prakash Patel, and Maryann Grgic for the research assistance, to the participants of the 6th International Conference on Quantitative Methods for Management at Indian Institute of Management, Indore, India and the 1st annual conference of the CRE at IU Northwest for valuable comments and suggestions.

Quantitative Analysis of Sustainable Development:
A Case Study of Northwest Indiana

The duty imposed by sustainability is to bequeath to posterity not any particular thing……. but rather to endow them with whatever it takes to achieve a standard of living at least as good as our own and to look after their next generation similarly. We are not to consume humanity's capital in the broadest sense.

Robert Solow
Nobel Laureate 1987

Introduction

The idea of sustainable development arose from the concerns that zealous pursuit for high incomes and development might cause excessive burden and exploitation of our environment and other natural resources. It was the Brundtland Commission report (WCED 1987) that introduced the term sustainable development and popularized the fundamental idea that sustainability is about an obligation to future generations and there seems to be fairly wide support for this perception. In the words of Nobel laureate Robert Solow sustainable development conveys a commitment to the basic belief that development is a matter of intergenerational equality; that the future generations must receive the same kind of consideration as those of the present. It is the integration of the concern for the present and future economic development. It is an amalgamation of human progress with environmental conservation. Economists, social and environmental scientists all agree that the case for the convergence of the conventional quality-of-life concept with the quality-of-environment is extremely compelling and needs timely attention. The big question is how do we set the benchmarks for quality of life and

environment to achieve sustainable development goals and how do we go about implementing these objectives

Human development(UNDP, is generally measured by the ability to have food, level of literacy and the capacity to live a long and healthy life, whereas sustainable development implies a healthy lifestyle with fresh air, clean water and pure natural surroundings. Sustainability refers to an integrated view of the world that shows the links among a community's economy, environment, and society. Not only it is the opportunities to work, good schooling, and quality health care, but increasingly it would be the sustainable growth of a region that is likely to play a central role in choosing a place to work, live and raise a family. Sustainability is a multidimensional concept and has already assumed great significance for individuals' decision making. In this study we characterize and quantify the basic essence of sustainable development, and develop a comprehensive indicator to measure and rank different regions, states and countries. We apply this index to the counties of northwest Indiana and demonstrate its usefulness for comparing and ranking different regions in terms of sustainable development.

2. Sustainable Development Index (SDI)

We propose the Sustainable Development Index, later referred to as SDI that combines the traditional quality of life and human development indicators like income, educational attainment, life expectancy, infant and maternal mortality rates with a comprehensive environmental quality index like the Virginia Environmental Quality Index, that combines the quality of air, water, land use, biodiversity, habitat and other natural resources. We develop and construct this index and examine its statistical properties. We

further show that it is an ideal index for measuring and ranking several different regions, cities and countries according to the level and quality of sustainable development. We suggest that use of this index serves as an important instrument in assessing and improving the green quality of life for many regions and countries. It is not to say that our index is exhaustive measure of all possible dimensions of sustainability but it is unique in that it combines concepts from two of the most comprehensive indexes one for the human development, the HDI, with a comprehensive index of environment VEQI. In the next two sections we describe the mathematical and statistical properties of this index and the show its empirical application and compare the seven counties in Northwest Indiana.

Our proposed SDI is a comprehensive index of 'green' quality of life and is much broader in scope than any other existing quality of life index or an environmental quality index. The existing human development indicators like the Human Development Index of the United Nations and the quality of life indicators like the Calvert-Henderson indicators (2000), Virginia environmental quality indicators VEQI and the most recent indicators like the Yale Environmental Sustainability index (2005) only partially measure the common sense notion of sustainable development. Northwest Indiana Quality Of Life Council report (2006) provides a detailed account of several dimensions of quality of life and gives a picture of individual dimension. However, it fails to provide us a composite index. It is like several other reports and indicators, which monitor the performance in one or more dimensions of incomes, poverty, education, health, housing, and environment but fail to provide a comprehensive picture, the multi- dimensional aspect of the sustainable development. Our index proposes to fill this gap in the literature and we provide empirical analysis for the northwest Indiana.

Some of the other well-known development and quality of life Indictors are Physical Quality of life Index PQLI, Index of Sustainable Economic Welfare (ISEW). The PQLI (Physical Quality of life Index) was developed by Morris D. Morris of the Overseas Development Council developed a measure of (physical) quality of life many years ago. It combines literacy rate, infant mortality rate, and life expectancy with equal weights and per capita income indirectly by taking spending levels on education as its function. The PQLI is useful for observing changing distribution of social benefits among countries by region and sector. The PQLI, with signs of lowered infant mortality and lengthened life expectancy, paints a less fatalistic pessimistic picture than the GNP but it completely ignores the environmental issues facing our planet. The Index of Sustainable Economic Welfare (ISEW) by Herman Daly and Clifford Cobb is an economic index which is calculated from GNP minus the cost of environment. Financial costs have to be assigned to non-financial impacts such as climate change and ozone depletion to make these corrections. This problem of the use of such 'non-statistical' judgments invalidates the utility of ISEW. Calvert- Henderson Quality of Life Indicators suggest twelve individual indicators that concern almost all important economic, social, political and many other areas that could possibly affect quality of life from unemployment to social justice, poverty and infra structure. Though C-H indicators are used extensively in practice, and are great stand alone indicators of quality of life, they do not give a consolidated picture of sustainable development.

Methodology

Construction of Sustainable Development Index

In all discussions on the topic of economic development and for ranking different countries and regions, the most used measure of comparison is the Human Development Index of UNDP. The HDI takes into consideration the following three characteristics:

1. Ability to have food and /shelter; income and consumption level as measured by per capita incomes and percentage of people classified as poor
2. Level of literacy and educational attainment as measured by enrollments and percentage of high school graduates
3. Health as measured by life expectancy and infant mortality.

These three indicators together tell us only a part of the story of "sustainability"! For a more comprehensive story of sustainability, we propose an extension of the above HDI index by introducing the fourth dimension to the above index. The **fourth** dimension of sustainability is the quality of environment as measured by the QUE Index which is developed on the lines of Virginia Environmental Quality Indicator VEQI. The QUE index is a single number summarizing the air, water and land quality, the forest cover, population growth, birds' sightings, toxic releases and such fine features that explain the overall environmental quality of a region. It is the merger of the HDI with the QUE index which gives us this unique and new index called the Sustainable Development Index.

There are two ways to approach this issue:

Shortfall perspective: We set the goalposts for each of the individual categories for measuring quality of life and then evaluate for each region/ county /state or a country as the case may be, its distance from that target value or percentage or the target rate. This will give us the ***Deprivation Index***

Attainment Perspective: On the other hand we could also judge and measure the performance of each region or country in terms of their achievement and how far the countries have moved towards the achievement goal. We refer to this the ***Achievement Index***

Deprivation Index

We can pursue **either** direction for the construction of this index. Let us introduce the following notation:

$D\ I_1 j$ (PCI) = Income Deprivation Index

$DI_2 j$ (E & L)) = Educational Deprivation Index

$D\ I_3 j$ (H &LE) = Health Deprivation Index

$DI_4 j$ (EN) = Quality of Environment Deprivation Index

An index DI_{ij} measures the extent of deprivation of a variable X_{ij} or a category, from the targeted maximum value $Max(X_{ij})$ relative to the most deprivation for that category. based on the minimum value, $Min(X_{ij})$ and is computed as follows:

$$DI_{ij} = \{max(X_{ij}) - X_{ij}\} / \{max(X_{ij}) - min(X_{ij})\} \quad (1)$$

for all j=1,2….n regions or countries;

and for i= 1, 2, ….,k , all possible dimensions which are included in a particular index. In our study we consider k=1 to.4 for income, education, health and environment respectively.

$Max(X_{ik})$ is the maximum value or the targeted value of the i th criteria . This target may be chosen as a future goalpost value for a particular variable or a characteristic.

$Min(X_{ik})$ is either the observed or natural minimum value of the ith Criteria

By definition, each deprivation index lies between 0 and 1. When the Deprivation index is zero, it implies that the target or goal has been met and a value of 1 would imply maximum deprivation form the target value.

Achievement Index:

Alternately we could construct the Achievement Index. In this case the Index would be calculated as the distance a country or a region has moved towards the goalpost.

$$A_{ik} = \{X_{ik} - Min(X_{ik})\} / \{Max(X_{ik}) - Min(X_{ik})\} \quad (2)$$

A_{ik} can take values between 0 and 1. In this case the interpretation of the Index value is the opposite of Deprivation index. When A_{ik} is one, the index would imply that the target has been achieved and a value of zero would imply that there is no progress towards the goal.

It is easy to see that the Achievement Index and the Deprivation Indexes are complements of each other and that:

$A_{ik} = 1 - I_{ik}$

$I_{ik} = 1 - A_{ik}$

$A_{ik} + I_{ik} = 1$ (3)

Hence we can work with either one of these two indexes and derive the other.

Achievement Index will measure how far a region has attained the target and hence the ranking of all the regions will be based on the level of achievement. On the other hand when we analyze the deprivation, we rank according to the least deprived region for a ranking of the regions in descending order.

SDI as a deprivation Index:

Sustainable Development Index (SDI) is a composite index characterizing all four dimensions of sustainability. If wi's are the weights assigned to each of the k individual deprivation indexes DI_{ij}s as defined in (1), the SDI can be constructed as follows

$SDI = \Sigma DI_{ij} \; w_i \; / \; \Sigma \, w_i$ i.=1,2…….,k ; J=1.2,…n (4)

Sustainable Development (Deprivation) Index for a region with equal weights for the four dimensions discussed above would be simply one quarter of the sum total of individual indexes. That is

$$SDI\ (D) = \tfrac{1}{4}\ (\Sigma DI_{ij}) \qquad (5)$$

From 3, we can easily show that a Sustainable Attainment Index would be

$$SDI\ (A) = 1 - SDI\ (D) \qquad (6)$$

We can use either of the two Sustainable Development indexes SDI(D) or SDI(A) for comparing and ranking different regions, towns, industries, and organizations. Such an analysis and comparison would be greatly useful in policy analysis, strategic planning and decision making.

Empirical Results and Application to Northwest Indiana:

Our interest here is to demonstrate the application and usefulness of the proposed index SDI. We have chosen to apply this to assess and measure the sustainable development of northwest Indiana. We compare the index for all seven counties that make up this geographical region. This region has the advantage of close proximity to City of Chicago and extends east and south to the sparsely populated Strake and Pulaski counties and southwest to Newton County. The data sources are Indiana Business Research Center (IBRC) and Indiana Department of Environmental Management (IDEM), and Northwest Indiana Quality of Life Council(QLC). The data is for 2004-05. Although more recent data are available for some of the categories and variables, for the sake of completeness,

we have chosen to work with an earlier data set which is more complete and comprehensive.

For empirical application of our newly developed index SDI, we first need to set target values or the goalposts. We take cue from the United Nations Millennium Development goals and other goalpost set up for environmental quality by Environmental Protection Agency and the local and state governments.

The Goalposts are given below

Variable	Target	Minimum
Per Capita Income	$40,000	$21167
Median Income	$68,800	
Poverty Rate	6%(half of present rate)	0
Infant Mortality	3(half of present rate)	0
Life Expectancy	85	70.4
Literacy	100	
School Enrollments	100	
Air Quality	50	0
Water Quality	50	70

Income index:

In the last 30 years per capita incomes (PCI) have increased from 3000 to over 30,000 dollars with growth rate of over 10% in some of the counties during the 90's. With the target PCI of 40000 dollars[2], using data on PCI in current dollars we calculate the Income Deprivation Index DIij for the seven counties of NWI

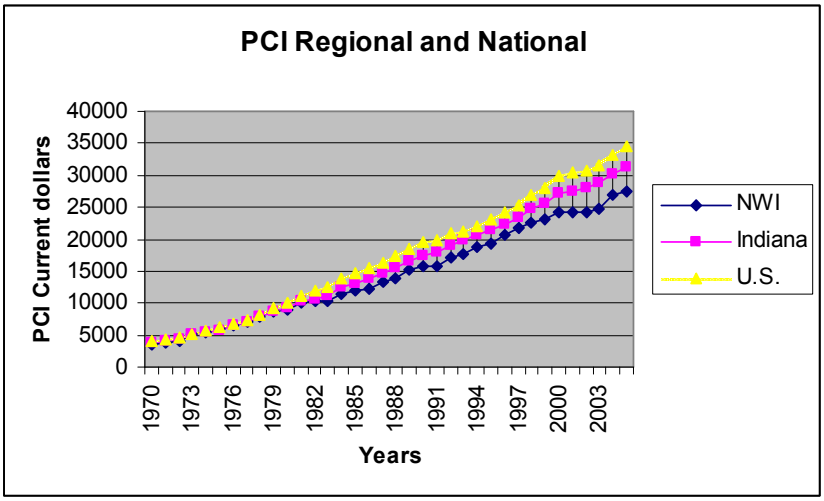
[2] UNDP Human Development Report uses this amount as the Targeted Per Capita income. Data on county incomes are obtained from http://www.bea.gov/bea/regional/reis/drill.cfm

TABLE 1: PCI deprivation Index DI_{ij}

Counties	PCI 2004	PCI 2005	PCI Deprivation Index 2004	2005
Jasper	26,524	27,250	0.721	**0.695**
Lake	28,004	29,136	0.642	**0.593**
La Porte	26,371	27,222	0.729	**0.697**
Newton	24,888	24,940	0.808	**0.821**
Porter	34,226	35,605	0.309	**0.240**
Pulaski	26,997	27,137	0.695	**0.702**
Starke	21,303	21,667	1.000	**1.000**

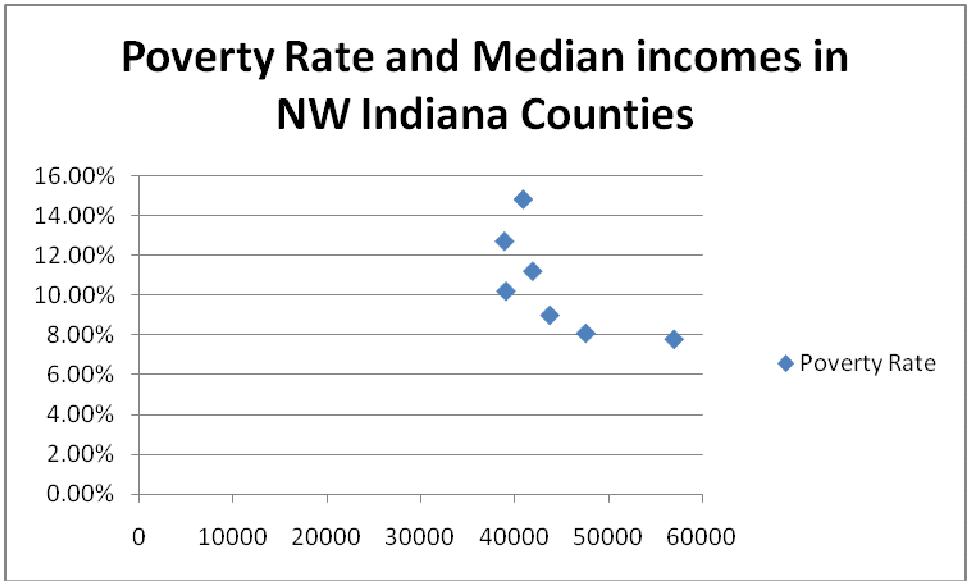
Porter County has the highest per capita income and highest growth rate since 1970 followed by Lake County and closely followed by Jasper, La Porte and Pulaski. Newton and Strake Counties have the lowest PCI. The minimum value for per Capita incomes is taken to be the observed minimum PCI which is for the Starke County. From Table 1, Porter County is the least deprived and the Starke County has the highest deprivation and it became worse off from 2004-to 2005. The per capita incomes were marginally better and the Deprivation index marginally lower from 2004 to2005 except for Newton and Pulaski counties.

FIGURE 1: Regional and National Per capita Incomes



From figure 1, we note that the per capita incomes for northwest Indiana (NWI) and Indiana are lower than the national average and NWI has the much lower PCI than the state of Indiana. Since 1978 this gap is getting bigger and wider over time. The average PCI is about four fifth of the national average. Although per capita income is the most popular measure of the standard of living, another dominant view in the literature is to consider median incomes and look at the poverty rates. We develop our Income Deprivation Index by looking at the median incomes and the poverty rate.

FIGURE 2: Median Incomes and Poverty Rates



The scatter plot of the median incomes and poverty rates shows that correlation between poverty and the median incomes is negative[3]. We obtain income Deprivation Index based on median incomes and poverty rates taken together as described in (7).

$$DI_{income\ j} = 4/5(\text{Median Income index}) + 1/5(\text{ Poverty Index}) \quad \ldots\ldots\ldots\ldots(7)$$

[3] From this data r = -0.65 and for the national data r =-0.80. higher the median incomes, lower would is the poverty rate

TABLE 2: Median Incomes and Poverty Rates

COUNTIES	Median Household Income($)	Median Income index of deprivation	Poverty Rate	POVERTY deprivation index	Income Deprivation Index
Jasper	47557	0.7108	8.10%	0.2386	0.616349
Lake	40894	0.9337	14.80%	1.0000	0.946974
LaPorte	41906	0.8999	11.20%	0.5909	0.838067
Newton	43726	0.8390	9.00%	0.3409	0.73935
Porter	56935	0.3970	7.80%	0.2045	0.358505
Pulaski	39066	0.9949	10.20%	0.4773	0.891359
Starke	38913	1.0000	12.70%	0.7614	0.952273
Indiana	43217	0.8560	11.10%	0.5795	0.800702
US	44334	0.8186	12.70%	0.7614	0.807166

These results are based on the assumption that the target Median income is the highest per capita income for any country in the present times. This was reported as $68800 for Luxembourg. For the poverty rate, ideally the target rate should be 0%. However, in the context of US, the current poverty rate is over 12.5%. Following UN millennium Goal of halving Poverty rates, we take 6% as the Target rate for calculating the deprivation index.

Porter County is the least deprived and Lake and Starke counties are most deprived. We also find that most counties have higher deprivation as compared to the national deprivation index and state deprivation index.

Health Deprivation Index: DI_{2j}

For the health dimension of the SDI, following the HDI, we calculate the deprivation index for both life expectancy and the infant mortality rates[4] for all the counties. For the infant mortality, the target rate is Zero percent. However we take the Millennium Development Goal of 3 as the target for calculating the infant mortality deprivation index. The target rate for life expectancy is taken as 85, the goalpost number for life expectancy for HDI 2006 by UNDP program. Although we did calculate indexes with a target rate of zero for the infant mortality and the Life expectancy index with a goalpost of life span of 100 years, we will take the more pragmatic approach and use the moderate targets which are being used by the international organizations.

Table 3: Health Deprivation Index DI_{2j}

County	Infant Mortality rate	Deprivation Index 5(UN Millennium Goal 14)	Life Expectancy	Deprivation Index 85	Health Deprivation Index
Jasper	6.4500	0.3042	73.1000	0.8151	0.6933
Lake	10.7700	0.6852	70.4000	1.0000	0.9170
LaPorte	6.6000	0.3175	71.8000	0.9041	0.7562
Newton	7.5200	0.3986	76.2000	0.6027	0.5766
Porter	8.3700	0.4735	71.7000	0.9110	0.8019
Pulaski	6.2900	0.2901	77.9000	0.4863	0.4704
Starke	14.3400	1.0000	71.0000	0.9589	0.9726
NWI	9.6800	0.5891	77.3000	0.5274	0.5766
Indiana	8.0300	0.4436	76.2000	0.6027	0.5885
USA	7.0000	0.3527	77.5000	0.5137	0.5052

[4] Maternal Mortality data was not available at the county level and hence we did not include this data.

We find that except for Pulaski County, most counties have greater deprivation than the state and national index. We also find that the Porter County has least deprivation in income dimension, and has very high deprivation index in terms of the health dimension. This is mainly due to the lower life expectancy than the state and the national average.

Education Deprivation Index DI_{3j}:

We constructed the Education and Literacy Deprivation Index in two ways. We took the UNDP approach for HDI and constructed the Education Deprivation index DI(E&L) as a weighted average of 2/3 Adult literacy (25 + who hold High School Diploma) and 1/3 as the percentage of students who are in ages 5-17 and are enrolled in Schools.

$$DI(E\ \&L)_k = (2/3) * \text{Adult Lit Index} + (1/3) * \text{Enroll Index} \qquad (8)$$

However, the high School graduation rate has become an important variable in sustainable development of any region and if we give equal weightage to three components we obtain $DI(E\&L)^*$ Index.

$$DI(E\&L)^{**}_k = 1/3 * (\text{Enroll Index} + \text{Adult Lit Index} + \text{HS Grad Index}) \qquad (9)$$

This gives a different set of values for the DI(E&L)** and a new relative ranking of the Counties . The least deprived County has the highest rank and the most deprived will be ranked lowest and others in the order of deprivation.

Below we provide individual and composite education deprivation indexes for all three types of educational targets and can be used for different policy purposes. The table below provides

Table 5: Enrollment, Literacy and Graduation Rates Indexes

County	% of students (5 to 17)enrolled in Schools	Enrollment Index	Adults25+ high school	Adult literacy Index	2003 High School Graduation Percentage	Graduation Index
Jasper	0.938	0.5306	82.4	0.6286	88	0.75
Lake	0.996	0.0326	80.7	0.6893	87	0.8125
LaPorte	0.959	0.3498	80.6	0.6929	84	1
Newton	1.005	0.0000	78.7	0.7607	88	0.75
Porter	0.979	0.1850	88.3	0.4179	94	0.375
Pulaski	0.884	1.0040	79.8	0.7214	91	0.5625
Starke	0.972	0.2404	72	1.0000	88	0.75

TABLE 6: Education Deprivation Index DI_{3j}

County	$DI(E\&L)_k$	$DI(E\&L)^*$
Jasper	0.5959	0.6364
Lake	0.4704	0.5115
La Porte	0.5785	0.6809
Newton	0.5071	0.5036
Porter	0.3402	0.3260
Pulaski	0.8156	0.7627
Starke	0.7468	0.6635

As in earlier two dimensions, Porter County is the least deprived in terms of traditional Education deprivation index and a modified education deprivation index. Pulaski is the

most deprived county with or without high school graduation rates being included in the calculations. The relative ranking of Laporte County goes down when we include the High School Graduation rates. These individual deprivation indexes and composite education deprivation indexes can be excellent guiding tools for new policies for northwest Indiana.

Environment Quality Deprivation Index:

Since the inception of Environmental Protection Agency (EPA) in 1970, there has been tremendous work done for the construction and calculation of various dimensions and measures of environmental quality. Indiana Department of Environmental Management (IDEM) maintains a large data base and provides various indicators of Air and Water quality and the violations of clean air and water acts. It has monitoring stations in different parts of northwest Indiana. There are a large number of organizations and civic groups engaged in improving regional environment[5]. According to EPA, Indiana has met the standards for CO2 (carbon dioxide) SO2(Sulphar dioxide), NO2(Nitorgen) and Lead(PB). However Indiana needs to improve in other particular matter and volatile other contents(VOC). Using the *Ambiant Air Quality* Standards as proposed by EPA and the weightage specified for different air pollutants, the AQDI(air quality deprivation index) was calculated using only data on PM, VOC and PM2.5

[5] Grand Calumet Task Force, NIRPC Environmental Management Policy Committee, Indiana Dunes ,Environmental Learning Center, Save the Dunes, Northwest Indiana Forum Environmental Committee, Steel and Refining Industry Community Advisory Committees , and Quality of Life Council

Public drinking water supplies depend on surface waters such as lakes, rivers, streams and reservoirs, in addition to ground water sources in rural settings. The Safe Drinking Water Act (SDWA) passed in 1976 and revised in 1990 and 1996 authorizes the Environmental Protection Agency to set primary standards for water contaminants to ensure adequate protection for both human and ecological health, and secondary standards for aesthetic purposes such as taste, odor and color. The primary standards called, Maximum Contaminant Levels (MCL's) regulate concentrations of biologics, chemicals, physical agents and radiologics.

WQDI(Water Quality Deprivation Index) was calculated based on number of violations of water quality in each of the seven counties.

Another indicator used was the (TRDI) Toxic Release Deprivation Index, based on the data for Toxic release.

A composite (ENDI) Environment Deprivation Index was obtained by taking a weighted average of all three dimensions of environmental quality. We note that we begin by taking equal weight for all three dimensions and the table below gives us the relative index of deprivation.

Table 7: Environment Deprivation Index

County	WQDI	AQDI	TRDI	ENDI
Jasper	0.4064	0.732336	0.249025	0.462587
Lake	0.656	0.168198	1	0.608066
Laporte	1	0.906681	0.075423	0.660701
Newton	0.1615	0.998994	0.219605	0.460033
Porter	0.4493	0.439048	1.03E-06	0.296116
Pulaski	0.1191	0.99977	0.005875	0.374915
Starke	0.1717	0.994079	0	0.388593

We notice that the LaPorte County has the highest deprivation and Porter County is the least deprived in this dimension as well.

SDI, Public Policy Implications and Conclusions

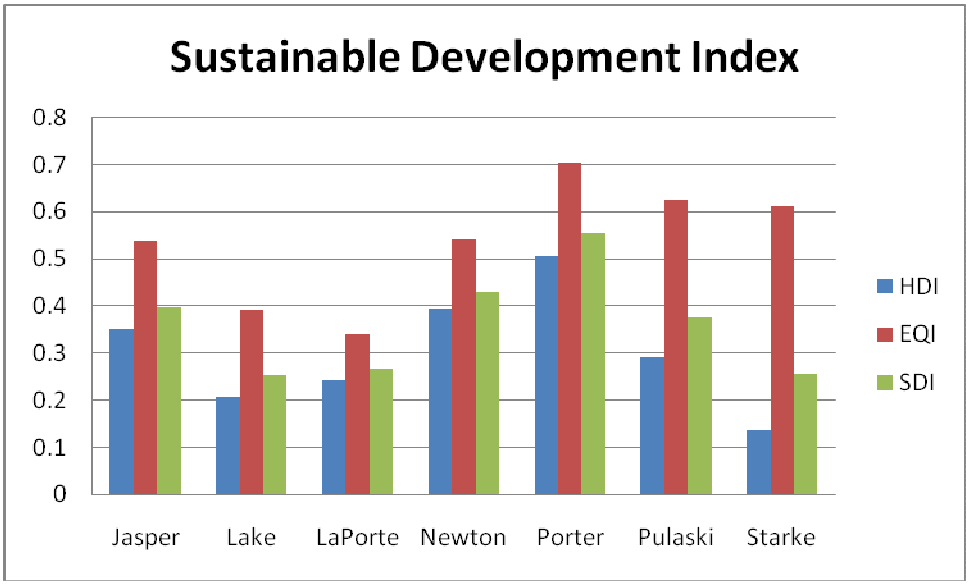
We first provide two tables which give us the values for SDI and another index known as the Human Development Index (HDI) and the relative ranks for these indicators.

Human Deprivation Index and Human Development Index:

If we consider only the income, education and health dimensions as part of Sustainable development like the United Nations development Program, we get a clear ranking of our region in terms of these vital socio economic indicators.

County	Health Deprivation Index	Income Deprivation Index	Education Deprivation Index	Human Deprivation Index	**Human Development Index**	**Rank**
Jasper	0.69330926	0.61634908	0.6364	0.648686114	**0.35131389**	**3**
Lake	0.91701534	0.9469736	0.5115	0.791829647	**0.20817035**	**6**
LaPorte	0.75615674	0.83806672	0.6809	0.758374486	**0.24162551**	**5**
Newton	0.5766289	0.73934988	0.5036	0.606526262	**0.39347374**	**2**
Porter	0.80186661	0.35850537	0.326	0.495457325	**0.50454267**	**1**
Pulaski	0.47041198	0.89135912	0.7627	0.708157032	**0.29184297**	**4**
Starke	0.97260274	0.95227273	0.6635	0.862791822	**0.13720818**	**7**

Sustainable Development Index (SDI) for Northwest Indiana



This chart is self explanatory and quite enlightening. This chart gives us a relative ranking of the seven counties in terms of Human Development Index (HDI), Environmental Quality Index (EQI) and a comprehensive Sustainable Development Index (SDI). The index can be used for setting future development goals, funds allocation and setting priorities among different counties and several other countless purposes.

Public policy makers and all stake holders of the region can prepare similar indexes for each year and have a longitudinal study to compare the performance and effectiveness of their policies and gauge the relative development of the region over time.

We can also use SDI to compare the development trajectory of our region with that of the neighboring regions and with the state of Indiana. The index can be adapted for other variables and expanded to include social and human diversity dimensions.

References

1. Anand, S. and Sen, A. (1996) Sustainable Human Development: Concepts and Priorities, Office of Development Studies, UNDP, New York.
2. Anand S. and Sen, A.(2000) Human Development and Economic Sustainability , World Development, Vol. 28, No.12
3. Henderson, H, Lickerman J., Flynn, P., Quality of Life Indicators", 2000, The Calvert Group.
4. Solow, R.M. (1992) An Almost Practical Step Towards Sustainability, Invited lecture on the occasion of the Fortieth Anniversary of the Resources for the Future, Washington, D.C.
5. UNDP reports 2005-08: www.undp.org
6. World Commission on Environment and Development (WECD), (1987) Our Common Future, the Brundtland Report, New York, Oxford University Press.