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An Analysis of Environmental Performance of the World in the Time Period of 1990-2010

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The world around us is changing. Change is in the form of huge advances we have made in the field of industrialization and technology. When we look at the other side we find some aspects which negate all the developments we have achieved. The environment continues to bear the burden of human activities and more so in the recent times. In this paper, an effort has been made to understand the environmental changes we have in reality and what challenges we face to overcome these factors. We have also tried to relate the factors in the environment by use of statistical techniques and other methods of classification and prediction. We hope that some serious efforts will be made by people in charge of these domains and humans & other species of plants and animals can co-exist together for a long time to come.

Keywords: Environment Performance, Greenhouse gases, forest, support vector machine.

Introduction

The word **Sustainability** foretells the capacity to survive in a long term among competing forces of natural and artificial factors which are dynamic in nature. For human's beings, sustainability becomes long-term endurance of responsibility, which has environmental, economic, and social dimensions, and also includes the concept of managing available resources and optimizing their usage. Ecologically, sustainability describes how different mutually dependent biological systems remains diverse and productive over a period of time, and which implicitly affects how humans and other species around the planet. During the long period of evolution of human beings as dominant specie and their continuous struggle for superiority over other surviving beings, the face of billionaire old biological systems are changing and the world believes it shall have some serious impact on human beings in the future.

Principles of sustainability

Consumption — population, technology, resources

A major driver of human impact on Earth systems is the destruction of biophysical resources, and especially, the Earth's ecosystems. The environmental impact of a community or of humankind as a whole depends both on population and impact per person, which in turn depends in complex ways on what resources are being used, whether or not those resources are renewable, and the scale of the human activity relative to the carrying capacity of the ecosystems involved. Careful resource management can be applied at many scales, from economic sectors like agriculture, manufacturing and industry, to work organizations, the consumption patterns of households and individuals and to the resource demands of individual goods and services. One of the initial attempts to express human impact mathematically was developed in the 1970s and is called the I PAT formula. This formulation attempts to explain human consumption in terms of three components: population numbers, levels of consumption (which it terms "affluence", although the usage is different), and impact per unit of resource use (which is termed "technology", because this impact depends on the technology used). (Source: Brower & Leon (1999). 1

The equation is expressed as:

$$I = P \times A \times T$$

Where: I = Environmental impact, P = Population,

A = Affluence, T = Technology

(Source: Ehrlich, P.R. & Holden, J.P. (1974)).[2]

The impact of population growth, affluence or consumption and technological growth of due to industrialization has some effect on the environment where human beings sustain and continue to enrich themselves. On one hand we humans have made significant growth in terms of industrialization & modernization and on the other side, this has led to destruction of forest lands, wildlife, increase in pollution levels, greenhouse gases, carbon dioxide content in the atmosphere and other non biodegradable substances, which are by-products of the former. Therefore, it becomes necessary for us to understand how these factors are related to each other and how they affect the environment. Moreover, what suitable measures can be planned to control some of these factors can also be deciphered.

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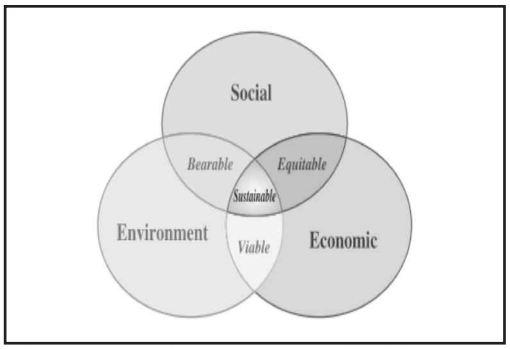
1.3 Dimensions of Sustainability



(http:// www.ohioenvironmentallawblog.com)

The three dimensions of sustainability are:

1. Economic Viability
2. Social Welfare
3. Protection of Environment

a. Economic Viability

Whenever we are talking about sustainability issue, the foremost element that comes to our mind is how viable or feasible it is in terms of economy. We need to measure how much we require investing in certain actions which gives profitable returns in future. Majority of the planning and actions needs to be undertaken at higher levels of government and international bodies such as UNO, WWF but the question of investments on such projects still remain plausible. Even, during implementation phase, some issues may become ethical and may not be performed at expected levels of accuracy and perfection.

b. Social Welfare

Most of the human actions are determined keeping in mind their effect on social issues. These social issues range from poverty alleviation, reducing unemployment, providing education, agricultural development etc. According to Eduardo Segarra , eco-tourism is becoming an important option to enhance the economic welfare of rural areas, but it requires a delicate balance between environmental protection and economic development.3 We have big MNC's (Multi-national corporations) who have included several corporate social responsibility based activities in their regular charter of periodical activities. The relationship of social development at the cost of environmental degradation remains a tough ethical dilemma in the mind of researchers as well as people who are directly or indirectly being affected by them.

c. Protection of Environment

Environmental protection is considered as the practice of protecting the natural environment, at an individual, organizational or government levels, for the common benefit of the natural environment and (or) humans. It is a known fact that due to the pressures of population and technology, the biophysical environment is getting degraded, sometimes permanently. Several species of plants, animals, and other natural harbingers have disappeared during last two to three decades. This has been recognized by the governments of the world and they have started to put serious restraint on the activities which infatuates this level of degradation. Environment protection is no longer considered as only a government initiative but includes positive inputs from industry, indigenous groups, environmental group and community representatives Some of these organizations include international environmental protection organizations, as the United Nations Environment Programme (UNEP), Earth system governance project, European Environment agency,WWF (worldwide fund for nature) etc. Several countries such as china, Tanzania & Brasil have taken positive steps towards ensuring protection of wild life by creating wildlife reserves, national parks, bio-reserves around their countries.

Research Objectives

The major objectives of the research on Environment performance Index (EPI) are as follows:

1. To identify the factors which affect the environment performance of various countries.
2. To rank the major factors which are responsible for deciding calculation of EPI.
3. To find the inter-relationship between different factors involved in EPI.
4. To give suggestions for controlling or de-limiting the unavoidable factors and eliminate avoidable factors.

Hypothesis

The current paper explores certain possibilities or probable circumstances.

a) Null Hypothesis(H0):

Environment performance Index is highly dependent on Greenhouse gas emissions.

b) Alternate Hypothesis(H1):

Environment performance Index is not dependent on Greenhouse gas emissions

Data Collection

The data was collected from different sources. The most prominent of them being secondary source of UNDP. (http://hdr.undp.org/en/reports/national/asiathepacific/timorleste/Timor-Leste_NHDR_2011_EN.pdf). Data variables used were adjusted net savings, Ecological footprint, Environmental performance index, Share of fossil fuels, Share of renewable,

CARBON DI-OXIDE Per capita, CARBON DIOXIDE Growth, Greenhouse gas emissions per capita, Urban pollution, Natural resource depletion, Fresh water withdrawals, Forest Area, Change in forest area & Endangered species. The data has been spread across the time period between 1990-2010.

Data Analysis

Analysis of the data which included 12 variables. Variable EPI was considered as dependent variable and predictor variables were other eleven factors Share of fossil fuels, Share of renewable, CARBON DOXIDE Per capita, CARBON DOXIDE Growth, Greenhouse gas emissions per capita, Urban pollution, Natural resource depletion, Fresh water withdrawals, Forest Area, Change in forest area & Endangered species.

5.1. Descriptive Statistics

	Valid N	Mean	Sum	Minimum	Maximum	Variance	Std. Dev.	Standard Error
Share of fossil fuels	195	48.48566	9454.704	0.0000	100.673	1574.18	39.6759	2.84125
Share of renewables	195	18.57853	3622.813	0.0000	163.123	795.83	28.2105	2.02020
CARBON DOXIDE Per capita (tonnes)	195	4.83925	943.654	0.0000	53.465	49.20	7.0145	0.50232
CARBON DOXIDE Growth	195	1.06225	207.138	-4.9621	12.450	5.41	2.3262	0.16658
Greenhouse gas emissions per capita	195	1.75960	343.122	0.0000	17.964	6.31	2.5110	0.17982
Urban pollution	195	36.42920	7103.693	0.0000	159.522	906.33	30.1052	2.15588
Natural resource depletion	195	4.56195	889.579	0.0000	66.035	87.17	9.3365	0.66860
Fresh water withdrawals	195	25.04977	4884.706	0.0000	2032.000	26896.75	164.0023	11.74445
Forest Area	195	30.96322	6037.829	0.0000	94.649	567.09	23.8136	1.70532
Change in forest area	195	0.92497	180.368	-68.3333	222.989	700.59	26.4686	1.89545
Endangered species	195	9.04335	1763.452	0.0000	24.953	22.24	4.7154	0.33768
Environmental performance index	195	48.71468	9499.362	0.0000	93.500	596.32	24.4196	1.74872

Table 1. Descriptive Statistics of data used for analysis

In the above table1, we can see that during the process of analysis we had used 11 variables as independent and 1 as dependent. We had used data for 194 countries some of which are USA, Brazil, Russia, China, and India. We had also taken aggregated data for world as 195th row. The standard error for most of the variables varies between 0.16658 to 2.84125 except fresh water withdrawals (11.74445).

5.2 Decision Tree

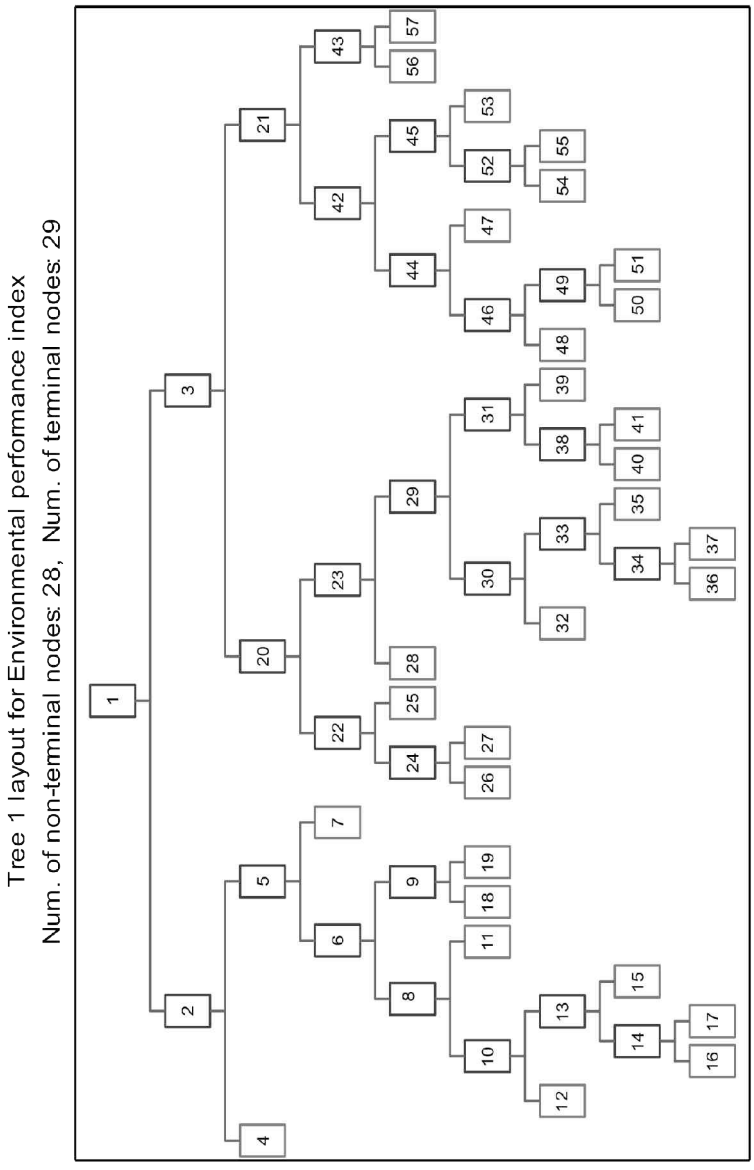


Figure 1 *Classification & regression Tree (C & RT) for Environmental performance index*

	Left branch	*Right branch*	*Size of node*	*Node mean*	*Node variance*	*Split variable*	*Split constant*
1	2	3	94	49.14681	533.0006	**Greenhouse gas emissions per capita**	0.60111
2	4	5	32	29.8625	775.683	**Urban pollution**	6.00824
4			8	0	0		
5	6	7	24	39.81667	637.9022	**CARBON DOXIDE Growth**	4.38695
6	8	9	21	45.50476	470.1957	CARBON DOXIDE Per capita	0.60506
8	10	11	13	34.36154	379.9008	Change in forest area	-2.14716
10	12	13	10	40.21	213.0409	CARBON DOXIDE Growth	-2.91213
3	20	21	62	59.1	116.7387	Urban pollution	35.179
20	22	23	34	64.44118	88.2312	Share of fossil fuels	48.22573

Table 2. *Table showing top 3 prominent splitters of regression*

In the table 2, we can see that most of the countries environment performance index is primarily based on greenhouse gas emissions per capita.These greenhouse gas per capita are further dependent on urban pollution and carbon dioxide growth is phenomenonal in causing urban pollution. Growth in carbon dioxide can be related to change in forest area. Also, increase in share of fossil fuels and their usage has a big impact in causing urban pollution.

5.3 **Support Vector Machine**

Regression summary	Regression summary (Support Vector Machine), Overall
	Number of support vectors= 54 (33 bounded)
	Environmental performance index
Observed mean	49.1468
Predictions mean	46.2432
Observed S.D.	23.2106
Predictions S.D.	19.122
Sum of squared error	322.1271
Error mean	2.9036
Error S.D.	17.8064
Abs. error mean	11.8049
S.D. ratio	0.7672
Correlation	0.6616

	Value
Number of independents	11
SVM type	Regression type 1
Kernel type	Radial Basis Function
Number of SVs	54 (33 bounded)

Figure 2. *Support Vector Machine*

Figure 2 shows the Support vector machine, which we had used to identify the most significant factors resulting in environment performance of different countries. The function used was radial basis network function which uses feed backward propagation method to reduce errors in subsequent functions used in the process. The numbers of support vectors drawn were 54 out of which 33 were bounded or laid within same space. The total number of factors taken into consideration was 11.

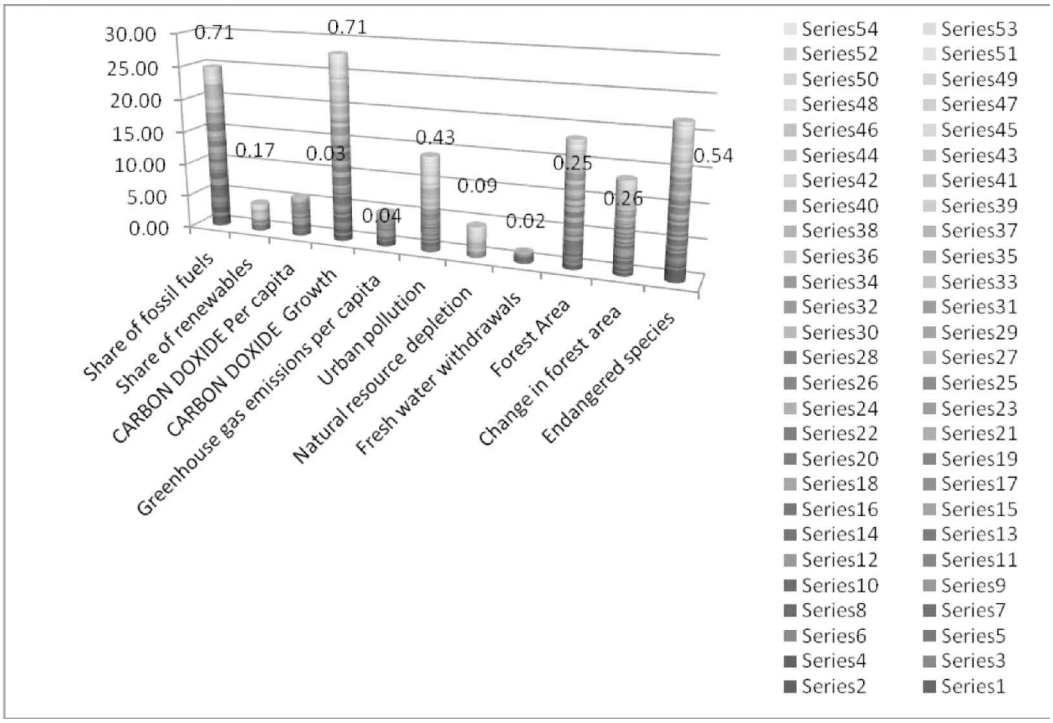


Figure 3. *Graph showing Support Vector Machine being affected by eleven different factor*

In figure 3 we can see the factors which were mainly considered for different series (number of support vectors). Carbon dioxide growth and share of fossil fuels were consistently present in almost all the series at 71% each. Reduction in number of endangered species (54%), urban pollution (43%), and forest area and change in forest area (25 %) were also responsible for environmental performance of different countries.

5.4 K-nearest Neighbors

Model summary (K-Nearest Neighbors), (Split Input Data into Training and Testing Samples (Classification))	
	Value
Number of independents	11
Number of dependent variables	1
Number of nearest neighbours	1
Input standardization	on
Averaging	uniform

Table 3. *Table showing Classification model k-nearest neighbors*

Table 3 shows the use of k-nearest neighbors which is considered as a popular model of classification. The number of factors present were 11independents and one dependent (Environment performance index) which we had also used in support vector machine. The number of nearest neighbors considered was 1 i.e. k=1.

Examples	Share of fossil fuels	Share of renewables	CARBON DOXIDE Per capita	CARBON DOXIDE Growth	Greenhouse gas emissions per capita	Urban pollution	Natural resource depletion	Fresh water withdrawals	Forest Area	Change in forest area	Endangered species
3	84.9547	5.3607	17.27157	-0.5752	3.73536	19.4023	0.73466	15.57	33.15212	2.3357	21.35122
4	66.6972	33.1335	7.81071	1.16506	10.04819	11.9287	0.85536	0	31.46785	7.329	24.95274
5	74.8726	16.9967	16.35482	0.05756	4.68714	14.9978	2.3389	0	34.10498	0	6.97674
7	52.6513	20.5568	5.31715	-0.4967	1.24668	22.3645	0	0	30.77	6.9331	6.46154
8	94.8836	0.4054	5.53717	2.55831	0.49325	0	0	0	0	0	9.01468
9	96.5509	4.8816	5.35382	-0.10408	1.05201	27.5739	0.19406	101.9	7.13494	16.9697	11.68599
10	71.6348	27.0956	8.14074	0.46663	1.8573	29.0266	0.11662	0	47.02244	2.6748	10.92437
11	81.723	7.8879	7.40734	2.02431	1.65784	27.5597	0.01872	29.02	35.70596	28.9672	16.47373

Figure 3. *Graph showing k-nearest neighbours being affected by eleven different factors*

FACTORS	AVERAGE
Share of fossil fuels	49.78521857
Fresh water withdrawals	45.08152857
Urban pollution	35.29317286
Forest Area	30.04111643
Share of renewables	16.28461857

Table 4. Factor average in K-nearest neighbours

In table 4, we can see the different factors which were likely to be used more frequently during classification of the 11 variables. Share of fossil fuels (49.05%), fresh water withdrawals (45.08%), urban pollution (35.29 %), forest area (30.04%) and share of renewable (16 %) were considered as frequent neighbors during the classification process.

Research Findings

The major research findings which have been identified can be listed as below:

1. We can see that most of the countries environment performance index is primarily based on greenhouse gas emissions. Greenhouse gases are mainly produced due to accumulation of industrial and commercial wastages. The burning of these wastes releases gases such as water vapour, carbon dioxide, methane, nitrous oxide and ozone. They emit radiation and heat into the atmosphere which increases Earth's temperatures.
2. Greenhouse gas per capita is further dependent on urban pollution and carbon dioxide growth The concentration of carbon dioxide (CO2) in Earth's atmosphere has reached 395 ppm (parts Per million) by volume as of June 2012. 4 and rose by 2.0 ppm/yr during 2000–2009.5 This current concentration is substantially higher than the 280 ppm concentration present in pre-industrial times with the increase largely attributed to anthropogenic sources.[6]
3. Growth in carbon dioxide can be related to change in forest area. Overall, deforestation has been taking place at a pace of about 130 000 km2 (13 million hectares) per year during the period 1990–2005 (an area the size of Greece), with few signs of a significant decrease over time. Though deforestation continues at an alarming rate, the annual net loss of forest area is decreasing due to tree planting and natural expansion of forests in some countries and regions. Thus when taking into account both estimated gains and losses, the total net loss in forest area between 1990 and 2000 was about 89 000 km2 per year. Thereafter, in the period between 2000 and 2005 estimated net loss in forest area was somewhat lower with 73 000 km2 per year, equivalent to a loss of 200 km2 of forest per day.[7]
4. Increase in number of endangered species. In the last 100 years several species of plants and animals have just disappeared from the Earth while others continue to fight for space and habitat from human poaching and industrial expansion. IUCN (International Union for Conservation of Nature) has issued a Red list of threatened and endangered species. It includes species of mammals, fishes, reptiles etc. [8]
5. Share of fossil fuels and fresh water withdrawals are also considered to be the factors which might affect environment performance to some extent. In many countries around the world, availability of fresh water has been reducing at a considerable rate. Water tables are falling from the over-pumping of groundwater in the bread baskets and rice bowls of central and northern China, northwest India, parts of Pakistan, much of the United States, North Africa, the Middle East, and the Arabian Peninsula. Farmers in these regions are pumping groundwater faster than nature is replenishing it. [9]

Conclusions

We may conclude from the above analysis of environmental factors that the primary step should be control the greenhouse gases such as carbon dioxide, methane. The way in which the percentage of these gases is growing is alarming and needs serious attention. The industries around the world should find alternative ways in which these emissions need to be controlled. Urban pollution is a serious threat, and governments around the world should initiate strict rules to curb the activities which results in such high level of pollution. Also, our null hypothesis (H0) that Environment performance Index is highly dependent on Greenhouse gas Emissions, stands to be true. We also reject the alternate hypothesis (H1) that Environment performance Index is not dependent on Greenhouse gas emissions

Suggestions And Recommendations

Some of the suggestions to tackle the problems are as follows:

1. Greenhouse gas emissions should be strictly controlled and new policies with higher implementation rates should be initiated. A common forum shall be required for countries of the world to act wisely and co-operatively towards honest implementation of framed rules and policies.
2. The world organizations should make a common consensus to increase use of green technology and replacing the age old traditional methods in industries.
3. Protection of forests, planting of trees should be made mandatory and deforestation of forest lands should be discouraged as conscious efforts towards preservation.
4. Coastal areas need to be protected from dumping of wastages, emission of poisonous radioactive materials and industrial wastes.

Future Work

We know that our current area of research is more inclined towards the assessment of

the factors which has led to environmental performance of the countries around the world. In our future work, we shall try to extend the current level of research to a new level which may throw extensive light into the current topic of research.

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