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Environmental performance as one of the indicators of sustainable development in Asia

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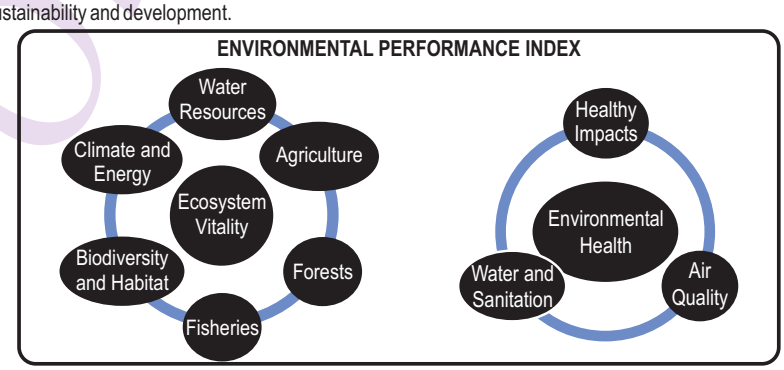
Abstract

Aim : The present study examined the correlation between the achieved environmental health and ecosystem vitality measured by Environmental Performance Index and factors, represented as independent variables – Health Index, Environmental Sustainability, Innovations and Human Development Index in Asia. Selecting appropriate indicators and methodology for arriving at the acceptable environmental quality of life, which quantify the impacts of environmental degradation on well-being, including impacts on health, access to natural resources, and losses caused by natural disasters is a subject of much debate and research.

Methodology : Association between independent variables and Environmental Performance Index were assessed using Pearson correlation and regression models. Descriptive statistics were used in order to hierarchical classification of countries in the sample based on their competitiveness score on nine issue categories, each of which fit under one of two overarching objectives.

Results : Although significant positive correlations were found between the selected independent variables such as Health index, Environmental Sustainability, Innovation, Human Development Index and two sub-indexes of Environmental Performance. High correlation between Environmental Performance and Human Development Index suggested that the analyzed countries should improve environmental health and ecosystem vitality to improve the overall long-term sustainable development. In other words, improvement in the partial competitiveness of a country empowers growth in its long-term environmental competitiveness.

Interpretation : It is important to point out that incensement of Environmental Performance Index significantly contributes to the Human Development. In order to create sustainable and efficient green environment essential for human health that would result in desired ecosystem vitality and environmental health outcomes, there has to be cooperation between the environmental sector and others sectors in a country. The outcomes of the present research strongly highlight that high-developed Asian countries demonstrate commendable achievement regarding most effective indicators of environmental sustainability and development.



Introduction

Climate change and its impact on ecosystems is one of the main problem of 21st century (Lagidze *et al*., 2015). Hsu *et al.* (2014) considered factors that can explain differences in performance on these issues. Authors measured environmental degradation by five policy categories related to objectives in the Millennium Development Goal 7: Water (Effects on Human Health), Biodiversity and Habitat, Forestry, Fisheries, and Climate Change and Energy. In this context, better focus on pollution abatement, promotion of adherence to environmental standards, natural resources conservation and embracing the 3Rs (reuse, recycle, recover) / 4Rs (reuse, recycle, recover and remanufacture) will lead to efficient and balanced utilization of the country's resources.

The concept of environmental performance is similar in the definitions of scientific disciplines particularly in those focusing on ecological and biological measures. Likewise, research conducted by Blanc *et al.* (2008), indicated that Environmental Performance Index determined the adverse impact of driving forces on the environment, and the expected pressure effect on the natural state of the accessible resources, which cause harmful effects on environment. Similarly, Volpe *et al.* (2013) emphasized the concept mentioned above and asserts that a sustainable development of resource enterprises, a suitable environmental performance system should be developed based on internationally widely recognized standards, given some principles. Costantini and Monni (2008) also mentioned the quoted characteristics of specialization in the construction of composite environmental policy indicators. Authors illustrate this issue of undesirable specialization in DEA-based evaluations, compares the Environmental Performance Index (EPI) as computed by the upbeat and pessimistic version of DEA-model as proposed by Rogge (2012).

Synthetic understanding of the Environmental Performances content, particularly its interpretation become most of all construction, which emanated from the understanding of the interactions between the elements and their synergistic effect. The need to identify the environmental impact caused by environmental and human activities has induced a constant search for robust and efficient tools that provide useful information for the design of public policies aiming to optimize citizens' quality of life (Moldan *et al*., 2012). Systematic approach; contributed the most to the correctness and exactness in cognition of the environmental performance issue. The environmental sustainability presenting in this sense represents the ability to maintain the factors such as a substrate, water, air, soil, vegetation, animal world, and by man-modified or created structures not to mention practices that contribute to the quality of environment landscape on a long-term basis.

Spatial knowledge of these individual elements, especially with ecological and human issues of the landscape significantly contributed to the complexity understanding of the environmental sustainability contents (Okurut, 2015).

Ecologists and social scientists have attempted to explain trends among the states for various indices of Environmental Performance based primarily on Environmental Health, Ecosystem Vitality and different indices of environmental performance, with varying results (Negiz et *al*., 2015; Urbanc *et al*., 2014; Lou *et al*., 2014).

The primary objective of the research was to analyze key determining factors of Environmental Health and Ecosystem Vitality that construct Environmental Performance Index. Therefore, particular factors of environmental performance competitiveness could be especially relevant for understanding the drivers of environmental development in different countries. Considering the impact of natural resources exhaustion and continuous contamination on many sectors of economy, the Environmental Health and Ecosystem Vitality were emerged to identify the endeavor created by states to suspend degradation of the environment.

Materials and Methods

The paper validates selected indicators and methodology for quantitative evaluation of environmental performance help gauge progress towards ecological issues and environmental sustainability of Asian countries. There are nine categories of Environmental Performance Index. The nine policy categories are as follows: (A1) Health Impacts; (A2) Air Quality; (A3) Water and Sanitation; (B1) Water Resources; (B2) Agriculture; (B3) Forests; (B4) Fisheries; (B5) Biodiversity and Habitat and (B6) Climate & Energy.The EPI measures two core objectives of environmental policy: (A) Environmental Health, which measures environmental stresses to human health; and (B) Ecosystem Vitality, which measures ecosystem health and natural resources management (Fig. 1).

Additional independent variables were comprised in the statistic model:

Health index (HDR 2013): life expectancy at birth expressed as an index using a minimum value of 20 years and the maximum value of 85 years.

Environmental sustainability (TTCI 2014): One of the pillars of Travel and Tourism Competitiveness Index is crucial for ensuring that a country will continue to be an attractive destination in the future.

Innovation (GCI 2014-2015): Is the twelfth pillar of Global Competitiveness Index and can emerge from new technological and non-technological knowledge. Technical knowledge leads to new and more stable quality of life and environmental sustainability globally.

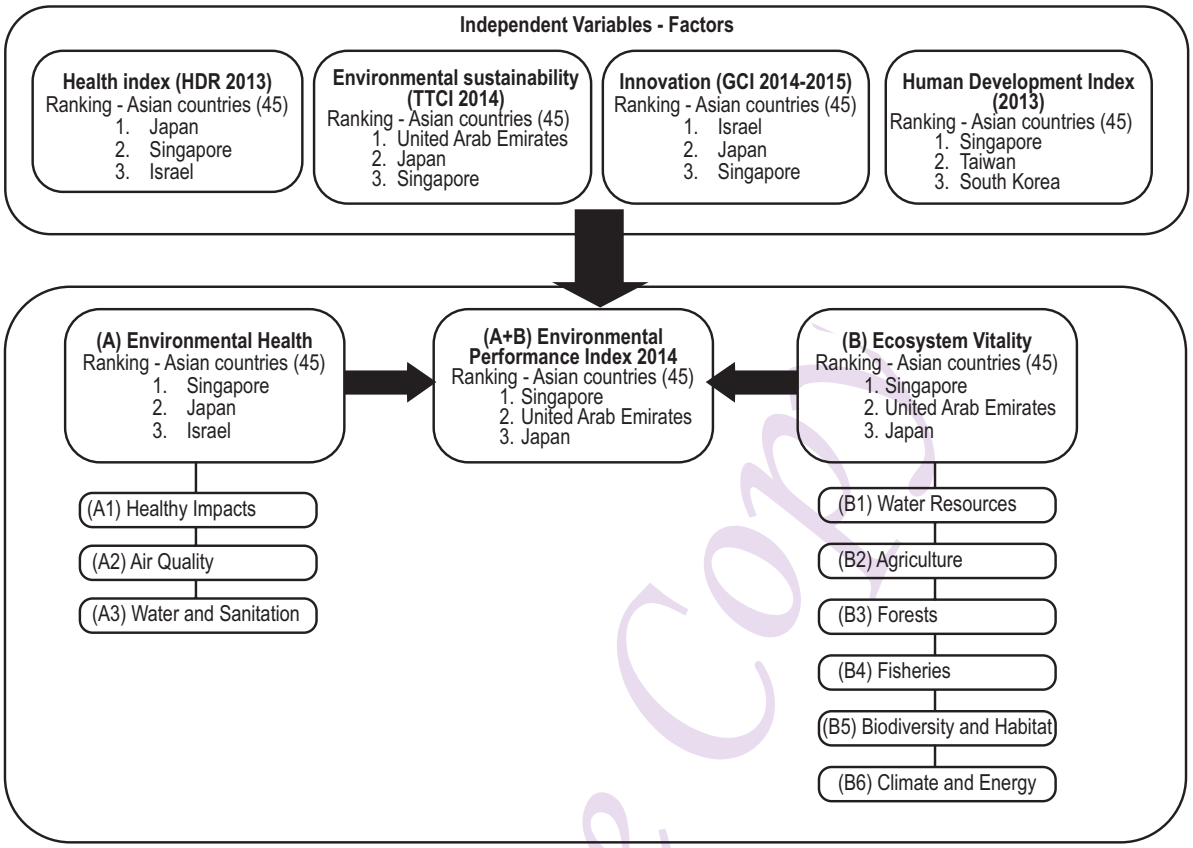


Fig. 1 : Hierarchy structure for the Environmental Performance Index 2014 and independent variables – factors Source: Hsu *et al.* (2014) and Author's research

Human development index (2013): Created to emphasize that people and their capabilities should be the ultimate criteria for assessing the sustainable environment of a country, not economic growth alone.

The United Nations Development Programme (UNDP) published the most recent human and environmental development indices for 187 nations in 2014 including Human Development Index (Hotez *et al.*, 2015).

The presented paper is based on the data published by the Yale Center for the Environmental Law & Policy, Yale University and the Center for International Earth Science Information Network, Columbia University, in cooperation with World Economic Forum in Geneva.

Explore national differences, the study of environmental performance was analyzed at the level of countries. To characterize Environmental Performance and sustainable development, the study area collected useful data for 45 Asian countries. There was no available data for North Korea.

To describe the association between chosen variables, two statistical methods were used – linear regression analysis and Pearson and Spearman correlations. The statistical analysis consisted of simple regression model to sense a problem and help set effective actions. Simultaneously, the analysis of the Environmental Performance of Asian countries according to selected variables allows identifying the strengths and weaknesses of each country. The impact of this change on the EPI variables can be implemented into the environmental agenda and strategies of each country. Analyzes were made using Statgraphics Centurion version XVI, SPSS version 22.0 and MapInfo version 11.0.

The limitation of this research based on published datasets from different sources, a short period of observations as well as not including other indicators that represent sustainable environmental development in the presented model.

Results and Discussion

The spatial distribution of development of environmental health in Asia shows that there were significant inequalities between selected high-income countries located in the Arab Peninsula, East Asia on one side and low-income

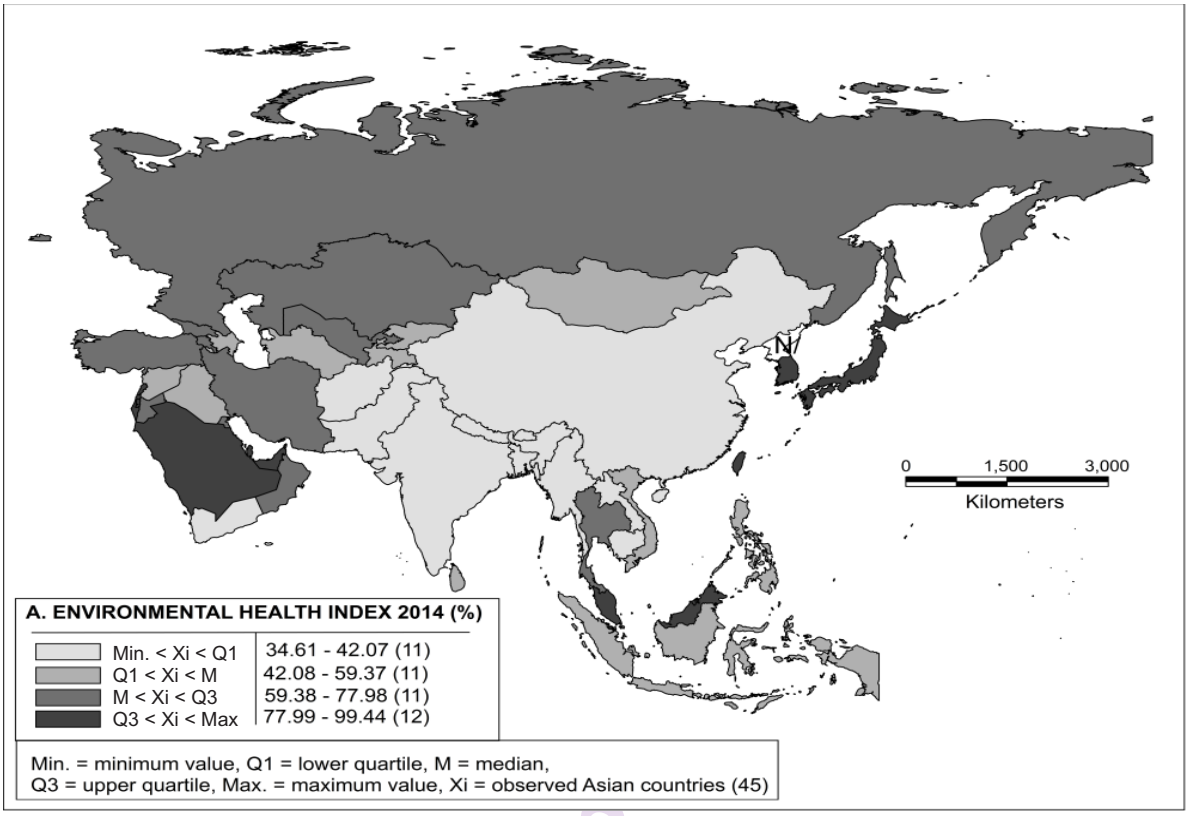


Table 1 : Basic statistics of environmental performance Indicators for the Asia in the year 2014

Indicators	Min.	Max.	Q1	Q3	Range	Variance	Std. Deviation
A 1 Health Impacts	33.8	100.0	56.8	89.7	66.2	360.1	19.0
A 2 Air Quality	13.8	98.3	62.3	85.6	85.5	540.0	23.24
A 3 Water and Sanitation	7.7	100.0	30.7	79.8	92.3	802.8	28.33
A 1-3 Environmental Health	30.4	99.4	46.8	82.5	69.0	397.2	19.93
B 1 Water Resources	0.0	99.7	0.08	40.1	99.7	849.4	29.14
B 2 Agriculture	12.0	96.0	50.0	92.0	84.0	589.5	24.28
B 3 Forests	0.0	84.1	23.2	53.8	84.1	810.0	28.46
B 4 Fisheries	0.0	62.4	0.0	22.3	62.4	201.3	14.20
B 5 Biodiversity and Habitat	0.0	100.0	23.5	73.4	100.0	932.8	30.54
B 6 Climate and Energy	21.6	86.9	38.2	51.0	65.2	190.1	13.80
B 1-6 Ecosystem Vitality	12.9	70.0	29.3	47.0	57.1	165.2	12.85
A+B Environmental Performance Index	21.6	81.8	39.3	60.5	60.2	189.6	13.77

Source: Author's research

countries in South Asia on the other side (Fig. 2). Moreover, Table 1 shows a comparison of environmental health indicators for quartile 1 (with the lowest value) and quartile 4 (with the highest value).

The highest values of the improved environmental health in the evaluated countries were Singapore (99.44%), Japan (94.66%), Israel (92.57%) and Taiwan (90.44%). These countries reached an admirable overall Environmental Health score; because of exceptional conditions of past and current investments in supporting human health, including availability and access to public health infrastructure, as well as low level of indoor and outdoor air pollution and high access to clean water and sanitation (Table 1 and Table2).

Table 2 : Ranking of the top 3 and bottom 3 Asian countries according to World Score of Environmental Performance Index

Ranking/Indicators	Environmental health (A)	Ecosystem vitality (B)	Environmental performance index (A+B)	Factor 1– Health index	Factor 2– Environmental sustainability	Factor 3– Innovation	Factor 4 – Human development index
1 Singapore	99.4	70.0	81.8	0.96	4.34	5.21	0.90
2 United Arab Emirates	88.3	62.6	72.9	0.84	4.41	4.42	0.83
3 Japan	94.7	57.5	72.4	0.98	4.36	5.52	0.89
41 INDIA	33.2	29.9	31.2	0.71	2.95	3.53	0.59
43 Myanmar	41.4	18.1	27.4	0.70	3.61	2.31	0.52
44 Bangladesh	30.4	22.4	25.6	0.78	3.05	2.63	0.56
45 Afghanistan	34.6	12.9	21.6	0.63	2.51	2.51	0.47

Source: Author's research

Table 3 : Correlations between Health Index (HDR 2013), Environmental Sustainability (TTCI 2014), Innovation (GCI 2014-2015), Human Development Index (HDI 2013) and Environmental Health and Ecosystem Vitality Sub-indexes of EPI 2014 (Pearson correlations)

	Indicators					
	EH	EV	EPI	Factor 1	Factor 2	Factor 4 (HDI 2013)
A 1-3 Environmental Health (EH)						.926**
B 1-6 Ecosystem Vitality (EV)	.542**					.671**
A+B Environmental Performance Index (EPI)	.882**	.874**				.912**
Factor 1 – Health Index (HDR 2013)	.764**	.625**	.792**			.836**
Factor 2 – Environmental sustainability (TTCI 2014)	.670**	.550**	.696**	.592**		.677**
Factor 3 – Innovation (GCI 2014-2015)	.676**	632**	.745**	.732**	.549**	.774**

Source: Author's research

**Correlation is significant at the 0.01 level (two-tailed), *Correlation is significant at the 0.05 level (two-tailed)

With this in mind low developed public and social services, health care system, including high level of social and environmental inequality in societies, lack of access to clean and drinkable water, air pollution, was found in low-income Asian countries such as Bangladesh (30.42%), Nepal (31.67%), India (33.19%), and Laos (34.49%). What's more poorly-performing countries did not make necessary investments to curtail environmental pollutants, provide adequate water and sanitation to their inhabitants, or build effective health care systems, yet research conducted by Hsu *et al.* (2014) shows that diarrhea, lower respiratory tract infections, and other preventable disease were associated with water and air pollution.

Spatial distribution of Ecosystem Vitality in Asia was rather varying with significant divergences between the states (Table 1). The best outcomes, i.e., the highest values of the Ecosystem Vitality of the evaluated countries were found in Singapore (70.01%), United Arab Emirates (62.64%), Japan (57.48%) as well as Kuwait (54.59%). These high developed Asian countries, perform the best in the Ecosystem Vitality categories. Overall, these countries achieved the best marks across a whole spectrum of environmental indicators – such as air pollution, climate change and fishery policy. On the contrary, the lowest values for this sub-index was noted in Afghanistan (12.87%), Iraq (16.98%), Myanmar (Burma) (18.14%) and Yemen (18.97%) among the others. Information on the quality and quantity of industrial wastewater and black-water with additional chemical contaminants, using a high amount of pesticides, overexploitation of resources such as water and soil nutrients, intensification the process of deforestation areas greater than fifty percent tree cover and degradation of biodiversity and habitat. However, improvement of biodiversity and habitat enhance prevention and sustainability of Land use and microclimate changes, decrease the probability of invasive species, and uncover overexploitation of remain environment.

Environmental Performance Index scores vary widely across Asian countries and so do their trends over time. The mean of Environmental Performance Index in the Asia was 49.29% in the year 2014; ranging from 21.57% for Afghanistan to 81.78% for Singapore (Table 1 and Fig. 4).

Following the empirical part of the research, the correlation matrix was generated that enables to test for a statistical relationship between four factors and nine Environmental Performance variables (Table 3). There was evidence of relatively high correlation and concordance among the composite selected indicators. The results of Pearson

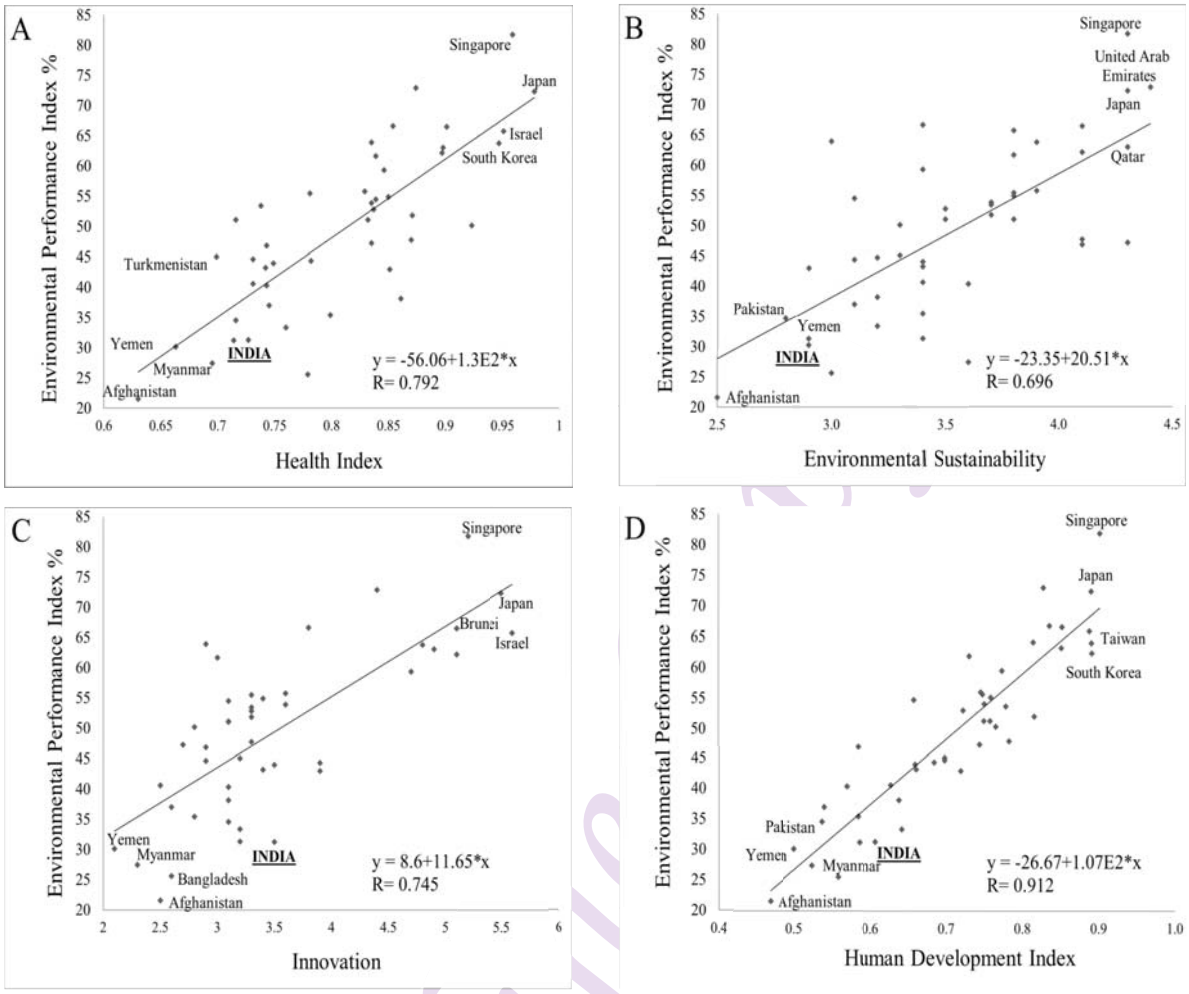


Fig. 3 (A, B, C, D) : Scatters charts comparing Environmental Performance Index with selected environmental and social indicators in Asia; Source: Author's research

correlation is givenin Table 3, which pointed out the relationship between the selected independent variables such as Health Index, Environmental Sustainability, Innovation, Human Development Index and two sub-indexes of Environmental Performance – Environmental Health and Ecosystem Vitality.

The parametric estimates of multiple linear structural relations between elected countries common factors scores extracted by PCA as an explanatory variable and "Environmental Performance Index" as dependent variable are present in Table 4 and Fig. 3. Furthermore, results showed that the Environmental Performance Index has positive and significant at 1 % level association with factor-1 and significant at 1 % level association with factor-4 according to standardized coefficient Beta. Zero-order correlation also showed that the factor-1had .792 and factor-4 had .912 active relationship with Environmental Performance Index in the evaluated Asian countries.

Considering the above information, a good linear regression model was constructed between the response variable of Environmental Performance Index and independent variables (Health Index, Environmental Sustainability, Innovation, and Human Development Index). According to that model, R-square, the percent of the Environmental Performance Index, explained by four factors was .848. This means that four independent model explained 84.8 % of the variance.

In ANOVA test, the significance of F value was below .05, it confirmed that the model was significant. Information regarding model coefficients, B, and Beta, as well as the constant, are also presented in Table 4. Other important values mentioned are the value of Beta, the standardized regression coefficient, and the

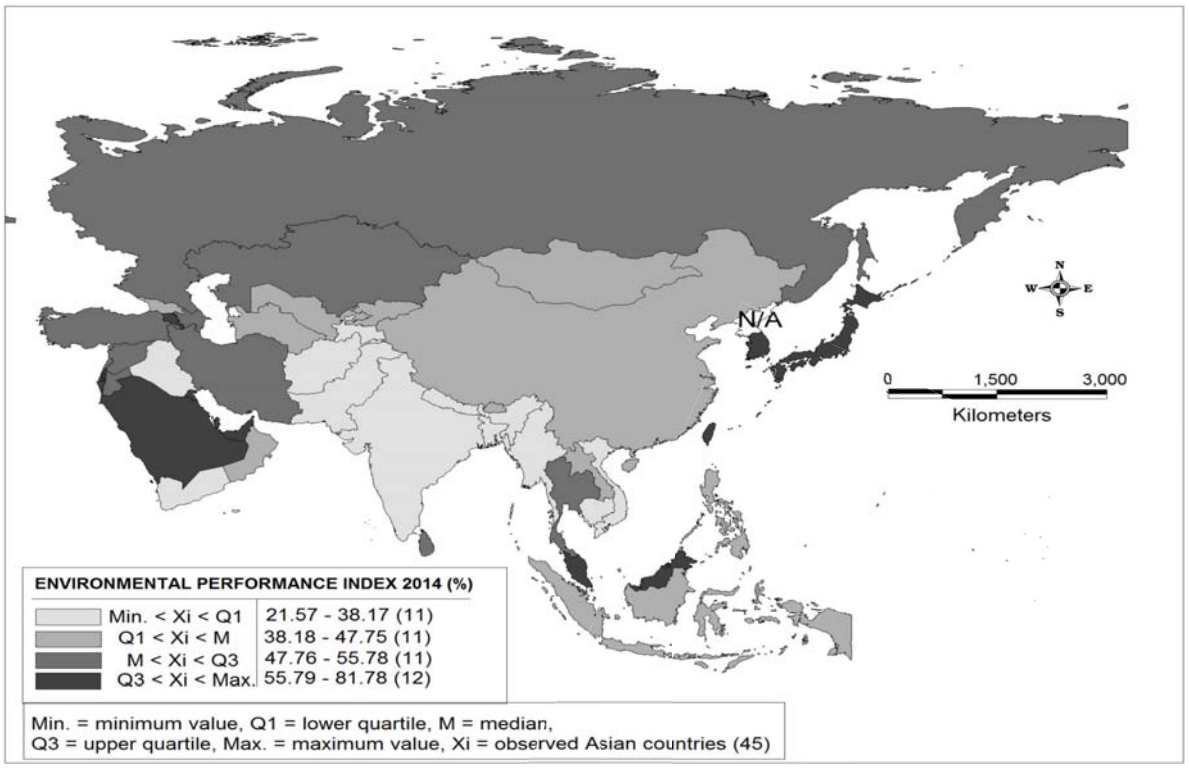


Fig. 4: Environmental Performance Index in Asia (year 2014); Source: Author's research

Table 4 : Environmental Performance Index in relation to Environmental, Health and Human development factors

Model	Unstandardized coefficients		Standardized coefficients	t	Sig.	Correlations		
	B	Std. Error	Beta			Zero order	Partial	Part
(Constant)	-36.638	9.962		-3.678	0.001			
Factor 1 – Health Index (HDR 2013)	10.689	19.110	0.065	0.559	0.579	0.792	0.088	0.035
Factor 2 – Environmental sustainability (TTCI 2014)	4.056	2.479	0.138	1.636	0.110	0.696	0.250	0.101
Factor 3 – Innovation (GCI 2014-2015)	1.188	1.571	0.076	0.756	0.454	0.745	0.119	0.047
Factor 4 – Human Development Index (2013)	82.633	15.695	0.706	5.265	0.000	0.912	0.640	0.325

Source: Author's research; a. Dependent variable: Environmental Performance Index, R2= 0.848, Adjusted R2= 0.832, DW= 2.114 F= 55.655

levels of significance of the t-test that showed a significant Beta coefficient, as well as a significant constant.

About the selected variables, it is recognizable, that richer Asian countries tend to have a better Environmental Performance and population growth, and density are the factors that increase the driving force, which reduces the environmental inequality of the countries(Fig. 3 and Fig.4).

High correlation between Environmental Performance and Human Development Index suggests that the analyzed countries should improve Environmental Health and Ecosystem Vitality to increase the overall long-term sustainable development. The Environmental Performance Index clearly demonstrates that the crucial to winning the competitive race in the sustainable environment are improvement and investment in the future: infrastructure (sanitation, water, and electricity facilities), healthcare and education. In other words, improvement in the partial competitiveness of a country empowers growth in its long-term competitiveness. It is important to point out that incensement of Environmental Performance significantly contributes to the Human Development.

Less developed countries, as measured by Human Development Index, are likely to have more severe environmental issues caused by degradation of Air Quality, Water Resources, Agriculture, as well as Biodiversity and Habitat. The findings of the present study suggest a need to pay attention to the environmental control in less developed Asian countries where lower socioeconomic status might have accelerated the Environmental Health and Ecosystem Vitality degradation more rapidly.

Transparency with which the Environmental Performance Index is constructed and the open nature of the underlying data make the indicator a starting point for countries to take further action. Ideally, these actions would involve development of better measurement and monitoring systems to improve environmental data collection; creation of policies to address particularly weak areas; communication and reporting of national-level data and statistics to international agencies such as the United Nations and delineation of sub-national metrics and targets for improved environmental performance.

Various ecological studies have presented different approaches and types of indicators developed which are used for the assessment of environmental sustainability (Michaeli, Ivanova and Koco, 2015; Legros *et al.*, 2011; Ozkan, 2009).

Many such rankings exist, such as Well-Being Index, Living Planet Index, Human Development Index, Genuine Savings Index, Environmental Sustainability Index, Ecological Footprint, and the City Development Index (Ekins, 2011). The available indicators mostly succeed at measuring unsustainable trends that can be targeted by management action, but fall short of defining or ensuring sustainability (Dahl, 2012). However, neither science nor practitioners have provided major support developing reliable as well as innovative new method for indicator assessment from the perspective of their relevance (Hak *et al*., 2012).

Environmental sustainability is crucial to preserve ecosystem services essential for human well-being. Presented study provides country-specific environmental impact ranks – based on Environmental Performance Index, Health Index, Environmental Sustainability, Innovation and Human Development Index. So, this study demonstrates that Environmental Performance Index is a simple and robust tool to assess and encourage environmental protection in less-developed countries especially those in Asia. There is also a requirement to identify key indicators and focus the priority areas where appropriate policies, programs, and measures would have the most efficient impact on the overall positioning of the country in terms of environmental friendly practices and sustainable development.

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