The Environmental Human Development Index.[1]

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Abstract

Human Development Index is one of the (if not *the*) most widely used measure of well-being, still missing, however, an "environmental dimension" (as suggested during the *Rio+20-United Nation Conference on Sustainable Development*, as part of Millennium Development Goals post-2015). This paper tackles this issue and introduces an original quantitative measure, named *Environmental Human Development Index*. The proposed index augments the Human Development Index with the Environmental Performance Index (a complete indicator of environmental quality of countries and a benchmark of policy goals achievement). The paper eventually simulates a country ranking using the new index.

KEYWORDS: *Sustainable development, Human Development Index, Environmental Performance Index, Kyoto Protocol.*

JEL Classification: O13; O15; Q01; Q56

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1. Introduction

The achievement of sustainability requires the integration of economic, environmental and social dimensions, at all levels.

The concept of sustainable development arises in the economic theory and other scientific fields in early 1970's, with the first report "Limits to Growth" (Club of Rome, 1972), who focuses its attention on the exponential growth in world population, industrialization, pollution, food production, resource depletion and its limits.

The first document calling for "sustainable development" by means of conserving our living resources was the World Conservation Strategy (IUCN et al, 1980). Several years later, the Brundtland Report "Our Common Future" (United Nation General Assembly, 1987) defined the *sustainability* in terms of intergenerational equity, clarifying also the concept of sustainable development, connected with mutual interaction of the economics with the environment.

Nowadays the debate is opened to a wide range of fields due the interdisciplinarity of sustainability, from the economic and social equality, to the climate change. Recently, the United Nations Sustainable Development Summit on 2015 proposed the *2030 Agenda for Sustainable Development*, which includes a set of 17 Sustainable Development Goals (SDGs) to end poverty, to fight inequality and injustice, and to tackle climate change by 2030.

Among the many, Guest (2010) warns scientific community about the intergenerational extension of environmental damages from actions taken today, the effect of both uncertainty and irreversibility on investments in environmental protection, the optimal level of reproducible capital and the management of the global *commons*, all threatening the global environment. In this context different approaches and indicators are developed to assess environmental sustainability (e.g. Moldan et al., 2012, for a review).

Dahl (2012) suggests that national level indicators are not sufficient to have a clear and complete perspective on the environment. Challenges ahead include constructing indicators of change in dynamic systems, establishing sustainability targets towards which national progress can be measured, developing global level indicators of planetary sustainability.

Human Development Index (**HDI** in the sequel) provides a summary measure of human development, capable to describe both the social and the economic dimensions. Even though it is one of the most widely used measure of well-being, its weak point is that it does not take into account the notion of sustainability: it lacks environmental components specification.

It is interesting noticing that even though the idea of sustainable development arises essentially from concerns relating to the overexploitation of natural and environmental resources (see seminal paper by Sen and Anand, 1994), quite unexpectedly, the HDI has never included a dimension of environmental conditions.

The necessity of the HDI empowerment with environmental dimensions was a theme of discussion during the *Rio+20-United Nation Conference on Sustainable Development* 2012, as part of Millennium Development Goals (MDGs) post-2015; also the United Nation Human Development Report (HDR) in 2013 and 2014 is moving in this direction analyzing the environmental scenario, in comparison with HDI.

Along the only environmental dimension, there exist selected indexes providing useful information on countries' environmental health:, the Environmental Performance Index (EPI) and the Ecological Footprint (EF). Both differently describe the environmental condition and the anthropogenic degradation of the environment, but without taking into account other sides of development.

This paper seriously tackle the question, introducing the Environmental Human Development Index (**EHDI** in the sequel), a measure merging human development with environmental dimension.

The paper is organized as follow: the Section 2 reviews the literature about the integration of the environmental component in the human development field, Section 3 provides a preliminary analysis between our two benchmarks examined: HDI and EPI. Next, Section 4 contructs the of EHDI, and compares it with HDI. Finally, a brief discussion concludes the paper.

2. Literature review

World Wildlife Fund's (1993) defines sustainable development as *"Improvement in the quality of human life within the carrying capacity of supporting ecosystems"*. Environmental crises and unsustainability of economic development have been widely discussed among scientific debates and during international conferences. On 2012, Rio+20 it has been discussed the requirement of an empowerment of human development index with the issue of sustainability and, from 2013, UNDP is moving forword with the analyses of the environmental data in its annual Human Development Reports (HDRs).

More specifically, HDR 2013 and HDR 2014 compare primary energy supply, GHGs emissions, natural resources and environmental impacts statistics with HDI values, without merge or link each other's.

The first study, among the very few attempts in the scientific literature, to consider a greening of HDI is ascribable to Morse (2003). Its approach hybridize HDI with the EF with the ratio HDI/EF and examine the potential for 'greening' the HDI with an environmental and resource-consumption dimension[4]. A project of United Nations University developed from Chuluun and Gaffney improve the HDI 2010, inserting carbon dioxide per capita as fourth indicator, to assess the human sustainable development index[5] (HSDI). Bravo (2014) provides a first critical analysis of HSDI, updating the new calculations of the HSDI and comparing it with the HDI. What he found is that, while the HSDI represents a step ahead from the HDI, it remains insufficient in its representation of environmental sustainability, Sudova (2012) summarize the issue comparing HSDI with HDI and GDP, as well. Busato and Maccari (2015), provide instead a new measure, the Sustainable Income Index, rebalancing the GDP with GHGs.

As defined by Morse (2003), any greening of the HDI should take on board three basic requirements: the change in the structure of the HDI should be avoided in order to assure comparability over time (Trabold-Nübler, 1991), a new index should be avoided (Neumayer, 2001) and the underlying methodology should be transparent and easily understood (Guy and Kilbert, 1998).

Abiding by these leanings, we will enhance the ability to synthesize information of HDI with an environmental component.

There are two main available measures differently analyzing the environmental component: the Ecological Footprint (EF) and the Environmental Performance Index (EPI).

The **EF** of Wackernagel & Rees (1997) provides a scientific calculation that highlights the relevance of bio-capacity limits for decision-making (Boruckea et al., 2013). The National Footprint Accounts measure how much the bio-capacity human's demand is in comparison to how much is available. The six components of land and sea surface demand are: energy, settlement,

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[4] Morse (2003) suggests that the best gain in HDI/EF is with a HDI between 0.4 and 0.5. This result means that countries beyond the boundary of the low and medium human development categories experience a higher pressure on their bio-capacity.

[5] For more details visit: http://ourworld.unu.edu/en/the-2010-human-sustainable-development-index

timber and paper, food and fiber, seafood and water. All components are, then, translated into equivalent number of global hectares which human population demands. From 1999, WWF updates the EF calculation on its biannual Living Planet Report.

The **EPI** compares the environmental performance of countries through a benchmark, providing a global picture of sustainability level. The first version of EPI was developed as Environmental Sustainability Index (ESI) (1999- 2005) provided by Yale Center for Environmental Law and Policy and Columbia University[6]. From 2008, it was developed as the EPI. The structure of the index is a weighted averages of two objectives: *Ecosystem Vitality (EV)* and *Environmental Health (EH)*. 22 indicators are used (reduced from the 25 used in 2010) to identify 10 policy categories.[7]

Each of those indicators offers a partial picture of a nations' sustainability level (CIESIN, 2012). As for HDI, the weighting and aggregation method of calculation of the EPI has been refined over time.[8].

This paper uses the EPI to augment the HDI, because it is a relatively more complete index available on environmental issue. This choice comes from the compatibility of EPI with our purpose to achieve a global picture of the relationship between human development and environment in a unique index, focusing on the quality of those components.

The EF, being a biophysical measure for natural capital and being focused on the bio-capacity human's demand, gives relatively less information about the quality of the ecosystem.

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6 The consortium is formed with the Center for International Earth Science Information Network (CIESIN) Columbia University, in collaboration with the World Economic Forum and the Joint Research Centre European Commission.

7 Seven of the ten policy categories belong in the EV component and are air pollution (ecosystem effects), water resources (ecosystem effects), biodiversity and habitat, forestry, fisheries, agriculture and climate change. The other three policy dimensions belonging in the EH dimension are water (effects on human health), environmental burden of disease and air pollution (effects on human health).

8 Before the methodology of the EPI report 2012, the EH and EV objectives were given the same weight. This caused the overall composite EPI scores to be strongly influenced by Environmental Health, which included just three policy categories in comparison with the seven of the Ecosystem Vitality. To correct this statistical imbalance between objectives, it was adjusted the weighting of the EH objective to 30 percent and the EV objective to 70 percent of the overall score (CIESIN, 2012)

3 Human Development Index and Environmental Performance Index

This section examines the relationship between the HDI 2012 and EPI 2012.

We constructed a dataset for HDI using data from United Nations (see Appendix A for datails about HDI calculation), and for EPI using data from the EPI website (www.epi.yale.edu). We use 129 observations (countries). The sample covers a very large section of Earth surface, since the total area of the 129 countries is 119.326.395 sq. km against the 148.940.000 sq. km total Earth surface, accounting for 80,12% of the global land surface (authors calculations on World bank data, 2012).

First, we estimate Person's correlation coefficient between HDI and EPI to 0,54 (P < 0,001), and then, we investigate the relationship between the two indexes. In particular, we test for a linear, a quadratic and cubic regressions.

The RESET test suggests that the linear functional form ($EPI = \alpha + \beta HDI + \varepsilon$) is not appropriate to describe the relation between HDI and EPI (RESET statistic is 11,738 with p-value 2,13e-005) (see Table below for details).

Linear Model	**(*** P < 0.001)**			
EPI = 0,286- 0,344 HDI				**Adjusted R^2 = 29% ; N = 129**
	Coefficient	**Std. Error**	**p-value**	**RESET test**
Costant	0,285609	0,111525	6,36e-011***	**H_0: Correct specification of the model**
HDI	0,343693	0,344479	0,0003***	F = 11,738432
				P(F(2,125) > 11,7384) = 2,13e-005

Table 1. HDI and EPI correlation matrix and RESET test on linear functional form.

Thus, we reject the null hypothesis H0, of correct specification of the functional form, at 5% level of significance. Adding a quadratic term, we estimate the following model

$$EPI = \alpha + \beta HDI + \gamma HDI^2 + \varepsilon \quad (1)$$

The resulting U-shaped curve[9] provides a first perspective on the relationship between human development and environmental quality.

[9] We could imagine it as a reverse Environmental Kuznet curve. The classic EKC (e.g. Shafik and Bandyopadhay, 1992) takes into account the relationship between income and pollutants, which are indicators of air quality degradation and about the contribute of a country to the climate change, whereas in this study we take into account human development and environmental quality.

The environmental performance decreases for countries with a relatively low HDI (till a level of about 0.53 of HDI); then, it increases for countries with relatively higher HDI.

A relatively higher concentration of countries is observed on the increasing side of our function. That means for most countries human development and environmental quality move in the same direction.

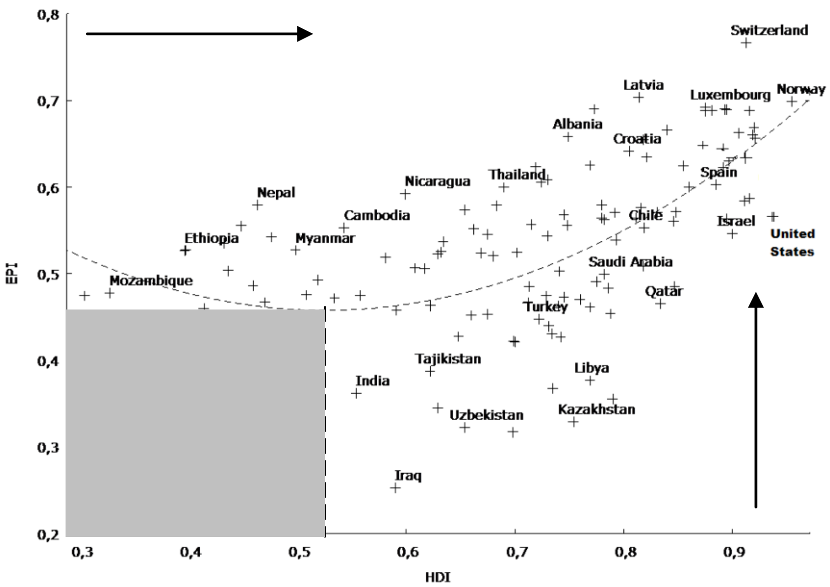

Figure 1. Regression analysis HDI 2012-EPI 2012. Arrows are desirable directions of policy for sustainable development. Data source UNDP statistics and EPI database.

We observe a sprawl plot, which, however, could be divided in two regions, above and below the regression function.

Above the function, we mainly observe countries of Central and Southern Africa, Latin America, Western Europe and New Zealand that experience a higher level of environmental quality for each value of HDI. Below the function, we find at most African (especially Northern African) countries, Asia, United States, Northern America and Australia.

UNDP claims that an HDI 2012 value below 0,466 indicates a low human development (HDR, 2013, p.146) and that the EPI shows a low performance benchmark when it falls in the 0 to 0,50[10].

[10] EPI index is converted to the same order of magnitude of HDI. For more detail on EPI methodology of calculation: http://epi.yale.edu/our-methods.

Therefore, countries, in the shaded region evidence a very low sustainability level (e.g. Eritrea, Yemen and Haiti).

Within this framework, we can infer that for all levels of HDI, the environmental quality of countries that lie below the regression line is poor, and then the objective of national policies should be in direction to enhance the level of environmental performance, at least up to the average value fixed from the estimated function.

Countries located in the left side of the plot should implement policies to increase the level of HDI, such as public policy to enhance the access to health, education and employment, avoiding strategies detrimental for the ecosystem. The two arrows represents the directions in which should move domestic and international policies for sustainable development..

To consolidate our analysis we further run a cluster analysis to study the variables trend for regional groups; the estimation were not significant, nevertheless we leave to future research the deepening of the analysis at panel data level.

4.Constructing the Environmental Human Development Index

The EHDI takes into account both human development and environmental performances with a holistic approach, assuming that both are unavoidable for a sustainable development.

We calculate the Environmental Human Development Index, for 129 countries, as the geometric mean of HDI (with the methodology of 2010) and EPI (with the methodology of 2012), both for the year 2012:

$$EHDI = \sqrt{HDI \cdot EPI} \quad (2)$$

This methodology gives the same weight to Human Development and Environmental components.

The geometric mean is important chiefly in the construction of index numbers since Huntington (1927) and is meaningful when applied to normalized numbers (Fleming and Wallace, 1986; UNDP, 2010).[11] **Table 2** presents the results of the EHDI calculations, in comparison with HDI.

[11] The United Nation Development Program opted for a change from arithmetic to geometric mean for HDI calculation. Furthermore, Fleming and Wallance (1986) demonstrate that the use the arithmetic mean, to summarize normalized benchmark results, leads to mistaken conclusions that can be avoided by using the preferred method of the geometric mean.

Rank 2012	Country	HDI Value	Rank 2012	Country	EHDI Value
1	Norway	0,955	1	Switzerland	0,837
2	Australia	0,938	2	Norway	0,817
3	United States of America	0,937	3	Sweden	0,794
4	Netherlands	0,921	4	Austria	0,785
				France	0,785
				Germany	0,785
5	Germany	0,920	5	Italy	0,779
				New Zealand	0,779
6	New Zealand	0,919	6	Luxembourg	0,778
				Netherlands	0,778
7	Ireland	0,916	7	United Kingdom	0,776
	Sweden	0,916			
8	Switzerland	0,913	8	Iceland	0,775
9	Japan	0,912	9	Japan	0,760
10	Canada	0,911	10	Finland	0,758
11	Iceland	0,906	11	Denmark	0,757
				Latvia	0,757
12	Denmark	0,901	12	Czech Republic	0,752
				Belgium	0,752
13	Israel	0,900	13	Slovakia	0,748
14	Belgium	0,897	14	Slovenia	0,745
15	Austria	0,895	15	Ireland	0,733
	Singapore	0,895			
16	France	0,893	16	Lithuania	0,732
17	Finland	0,892	17	Brunei Darussalam	0,731
	Slovenia	0,892		Spain	0,731
18	Spain	0,885	18	Costa Rica	0,730
19	Italy	0,881	19	Canada	0,729
				Australia	0,729
20	Luxembourg	0,875	20	United States of America	0,728

	United Kingdom	0,875			
21	Czech Republic	0,873	21	Poland	0,722
22	Greece	0,860	22	Croatia	0,719
				Greece	0,719
23	Brunei Darussalam	0,855	23	Singapore	0,710
24	Cyprus	0,848	24	Albania	0,702
25	Malta	0,847	25	Israel	0,701
26	Estonia	0,846	26	Cyprus	0,696
27	Slovakia	0,840	27	Malaysia	0,693
28	Qatar	0,834	28	Hungary	0,689
				Estonia	0,689
29	Hungary	0,831	29	Portugal	0,686
30	Poland	0,821	30	Argentina	0,677
31	Chile	0,819	31	Chile	0,673
32	Lithuania	0,818	32	Panama	0,672
	United Arab Emirates	0,818		Uruguay	0,672
33	Portugal	0,816	33	Colombia	0,669
34	Latvia	0,814	34	Brazil	0,667
35	Argentina	0,811	35	Cuba	0,664
36	Croatia	0,805	36	Bulgaria	0,663
37	Belarus	0,793	37	Ecuador	0,662
38	Uruguay	0,792	38	Belarus	0,654
39	Kuwait	0,790	39	Georgia	0,651
40	Russia	0,788	40	United Arab Emirates	0,645
				Venezuela	0,645
41	Romania	0,786	41	Thailand	0,643
42	Bulgaria	0,782	42	Malta	0,641
	Saudi Arabia	0,782			
43	Cuba	0,780	43	Sri Lanka	0,631
	Panama	0,780			
44	Mexico	0,775	44	Jamaica	0,630

45	Costa Rica	0,773	45	Gabon	0,629
46	Libya	0,769	46	Saudi Arabia	0,625
	Malaysia	0,769			
	Serbia	0,769			
47	Trinidad and Tobago	0,760	47	Qatar	0,623
48	Kazakhstan	0,754	48	Mexico	0,617
49	Albania	0,749	49	Romania	0,616
50	Venezuela	0,748	50	Philippines	0,613
51	Georgia	0,745	51	Peru	0,610
51	Lebanon	0,745	52	Bolivia	0,607
52	Iran	0,742	52	Dominican Republic	0,607
53	Peru	0,741	53	Egypt	0,604
54	Ukraine	0,740	54	Russia	0,598
				Trinidad and Tobago	0,598
55	Bosnia and Herzegovina	0,735	55	Serbia	0,596
56	Azerbaijan	0,734	56	Nicaragua	0,596
57	Oman	0,731	57	El Salvador	0,595
58	Brazil	0,730	58	Lebanon	0,594
	Jamaica	0,730			
59	Armenia	0,729	59	Paraguay	0,592
60	Ecuador	0,724	60	Algeria	0,588
				Armenia	0,588
61	Turkey	0,722	61	Ukraine	0,585
62	Colombia	0,719	62	Botswana	0,584
63	Sri Lanka	0,715	63	Tunisia	0,576
				Honduras	0,576
64	Algeria	0,713	64	Indonesia	0,574
65	Tunisia	0,712	65	Turkey	0,569
66	Dominican Republic	0,702	66	Oman	0,567
67	Jordan	0,700	67	Iran	0,563
				Azerbaijan	0,563

68	China	0,699	68	Viet Nam	0,559
69	Turkmenistan	0,698	69	Namibia	0,555
70	Thailand	0,690	70	Mongolia	0,553
71	Gabon	0,683	71	Guatemala	0,549
72	El Salvador	0,680	72	Cambodia	0,548
73	Bolivia	0,675	73	Moldova	0,546
	Mongolia	0,675			
74	Paraguay	0,669	74	China	0,543
				Jordan	0,543
75	Egypt	0,662	75	Libya	0,538
76	Moldova	0,660	76	Kyrgyzstan	0,537
77	Philippines	0,654	77	Kuwait	0,530
	Uzbekistan	0,654			
78	Syria	0,648	78	Syria	0,526
79	Botswana	0,634	79	Morocco	0,520
				Bosnia and Herzegovina	0,520
80	Honduras	0,632	80	Nepal	0,518
81	Indonesia	0,629	81	Ghana	0,515
	South Africa	0,629			
82	Kyrgyzstan	0,622	82	Myanmar	0,512
	Tajikistan	0,622			
83	Viet Nam	0,617	83	Tanzania	0,508
84	Namibia	0,608	84	Kenya	0,506
85	Nicaragua	0,599	85	Congo	0,502
86	Morocco	0,591	86	Zambia	0,499
87	Iraq	0,590	87	Kazakhstan	0,498
88	Guatemala	0,581	88	Angola	0,492
89	Ghana	0,558	89	Tajikistan	0,491
90	India	0,554	90	Côte d'Ivoire	0,481
91	Cambodia	0,543	91	Togo	0,473
92	Congo	0,534	92	Turkmenistan	0,471

93	Kenya	0,519	93	Benin	0,469
				Senegal	0,469
94	Bangladesh	0,515	94	Bangladesh	0,468
95	Pakistan	0,515	95	South Africa	0,466
96	Angola	0,508	96	Cameroon	0,461
97	Myanmar	0,498	97	Uzbekistan	0,459
98	Cameroon	0,495	98	Zimbabwe	0,458
99	Tanzania	0,476	99	Ethiopia	0,457
100	Nigeria	0,471	100	Pakistan	0,451
101	Senegal	0,470	101	India	0,448
102	Nepal	0,463	102	Sudan	0,436
103	Togo	0,459	103	Nigeria	0,435
104	Yemen	0,458	104	Haiti	0,433
105	Haiti	0,456	105	Yemen	0,403
106	Zambia	0,448	106	Mozambique	0,395
107	Benin	0,436	107	Iraq	0,387
108	Côte d'Ivoire	0,432	108	Congo Dem. Rep.	0,380
109	Sudan	0,414	109	Eritrea	0,367
110	Zimbabwe	0,397			
111	Ethiopia	0,396			
112	Eritrea	0,351			
113	Mozambique	0,327			
114	Congo Dem. Rep.	0,304			

Table 2. HDI and EHDI ranking comparison.

To understand the importance of the EHDI, it is convenient to rely on the four classes for the HDI (as suggested by UNDP, 2013, see Table 3). Usually UNDP divide the rank of HDI in four quartiles[12] and establish the values of groups on the basis of the sample size.

[12] A country is in the very high group if its HDI is in the top quartile, in the high group if its HDI is in percentiles 51–75, in the medium group if its HDI is in percentiles 26–50 and in the low group if its HDI is in the bottom quartile (HDR, 2013).

For HDI 2012 values are:

Very High Human Development	1 <HDI<0,800
High Human Development	0,800<HDI<0,710
Medium Human Development	0,710<HDI<0,535
Low Human Development	0,535<HDI<0

Table 3. UNDP quartile values for 2012.

Assuming that environmental quality is essential for the existence of life on the Earth and that the implementation of environmental policy are itself a measure of the development of a country, the question that arises at this point is: what happens when we re-think to HDI ecologically and environmentally?

Figure 2 presents the distribution of groups change in size, when we compare HDI with EHDI, using the quartiles values of HDI 2012[13].

Only Switzerland and Norway remains in the "Very High level "group, most of the countries moved over High level, Medium level and Low level quartile when the environment becomes relevant. Inserting the EHDI in this configuration, we found a higher concentration of countries in the Medium, Low and High group of sustainability.

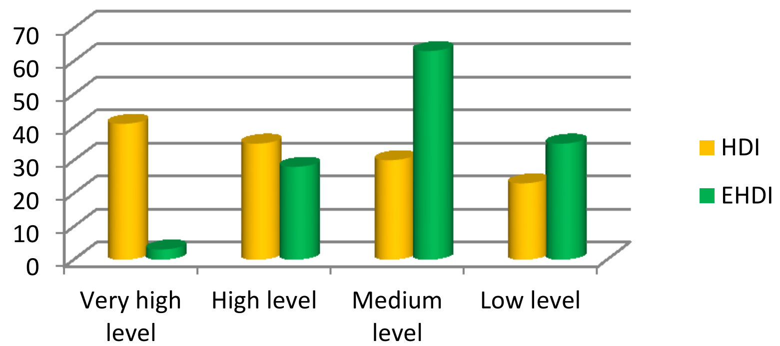

Figure 2. Change in the distribution from HDI to EHDI.

[13] Different values and rankings between the two indices arise when we compare both, in the context of the human development. Furthermore, the EHDI is homogenized with the HDI order of magnitude and is coherent with its calculation, so it may be utilized as a single measure of human development, in the frame of environmental sustainability.

More precisely all counties should implement policy to raise the environmental quality. As can be seen from table 2, also countries that advance in ranking does not benefit a higher or equal value of EHDI respect to HDI. Even if around 24% of countries enjoy High level of sustainability, at least 30% of the whole sample is far from an acceptable sustainability level.

The requirement of a unique index, which merge the human development and the environment, answer to the necessity of the sustainability assessment an comparison of each country in relation to the others.

As it results from our study, HDI reveals an incomplete measure to assess and compare the level of sustainability of countries. In this regard, tab.2 evidences some countries close in the HDI ranking which move in opposite directions in EHDI ranking. Few example are:

- United States and Switzerland: United States decrease its ranking form position 3 for HDI to 20 in EHDI ranking, while Switzerland increase from position 8 for HDI to 1 in EHDI.
- Slovakia and Qatar: Slovakia increase it position from 27 for HDI to 13 for EHDI, while Qatar decrease its position from 28 for HDI to 47 for EHDI.
- Costa Rica and Libya: Costa Rica increase its position from 45 for HDI to 18 for EHDI, while Libya decrease from 46 for HDI to 75 for EHDI.

It would continue with many example for each level of HDI, but at this point, we prefer to highlight that the inclusion of a full explanatory variable of environmental quality changes the relationship existing between the countries. Obviously, every country has its historical and political evolution, which needs further analyses to understand differences. Furthermore, in this case indices are a sort of dashboard to assess differences between countries and warning situations. In the following part, we will conclude our discussion, engaging to the Kyoto Protocol.

5. Conclusion

Global unbalance about sustainability is attributable to a variety of causes, such as the general level of development of countries, the achievement of national policy and the participation in global agreement. Considering results of our study, we could attempt to discuss the linkage between the level of sustainability of regional groups and the Kyoto Protocol participation of countries in exam. All countries surveyed in this study ratified the first commitment period 2008-2012 of the Kyoto protocol, which commits 192 Parties by setting internationally binding greenhouse gas emission targets reduction, with the aim to stabilize the GHGs concentrations in the atmosphere and prevent dangerous anthropogenic interference with the climate system. The Kyoto Protocol entered into force on 2005 and during the UN Climate Change Conference 2012, governments extended the global response to climate change[14] with the second commitment period 2013-2020.

Our paper introduces the Environmental Human Development Index as a measure of the human sustainable development. The empowerment of HDI with environmental sustainability is a recent issue, discussed among the emerging debates of academics, policymakers and international conferences (e.g. *Rio+20-United Nation Conference on Sustainable Development 2012).*

The value added of our study is the provision of a unique index of sustainability in which is synthetized human development and environmental quality with a holistic approach.

From Tab.3, we can observe that European region benefit of a high level of sustainability, coherently with its average human development level. Its accomplishment on sustainability is ascribable to the effort and the achievement of Europe in its policy, especially for what concern environmental policy.

In effect, Europe is involved in the Kyoto protocol as regional economic integration organization as well as each nation. First two countries in EHDI ranking are Norway and Switzerland, but good sustainability performances are observed also for United Kingdom, Italy, France, Albania, Latvia and others.

North America is a very high-developed region, nevertheless its general level of sustainability is still high but not as it would expect. Although United States and Canada are among top ten larger GHGs emitters (per capita), U.S. is the only major country, which has not signed the Kyoto protocol and hence not accepted obligations under it (UNFCCC, 2009), while Canada withdrew from the treaty on 2011[15].

United Nations exempted developing countries from the requirement of the Kyoto protocol, because developed countries, with about 150 years of industrial activity, are principally responsible for the current high levels of GHG emissions in the atmosphere, even though some of developing countries have massively increased their GHGs emissions.

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[14] For more details visit:
http://www.unep.org/NewsCentre/default.aspx?ArticleID=9353&DocumentID=2700#sthash.64z0Q3Pf.dpf

[15] For the Canada withdrawal depository notification see:
http://unfccc.int/files/kyoto_protocol/background/application/pdf/canada.pdf.pdf

Countries with a medium level of sustainability are mainly developing countries of Asia, Central-South American region, Central-Southern America and Eastern European countries. Almost all African region and part of South-Eastern Asia are in the area of unsustainability. Some warning situation should be traced for China, Russia, Brazil and India which are among the most polluting counties and experience a high growth rate of economic activities and population, but as developing countries, they were non-binding to the Kyoto protocol.

Summing up our paper attempts to draw a global picture of sustainable human development, analyzing the issue through two major existing benchmark. What result is that if we take into consideration the environmental variable, there is a gradual lowering of human development, even though most of the countries seems to move their environmental quality in the same human development direction. Future research could extend the issue deepening the analysis at panel level or at country level, using different indicators, as well.

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Appendix A

A.1 The Human development index calculation

The Human Development Index (HDI) is a composite measure of health, education and income, where its first result was published by the United Nations Development Program (UNDP), in the first *Human Development Report* on 1990.

The HDI is normalized establishing a minimum and a maximum value for each dimension, called goalposts, in such a way that each country is marked in relation to these goalposts, within a value between 0 and 1. This method allows reaching a rank of the countries, based on the human development achievement. Before 2010, HDI was calculated combining three indicators: life expectancy index (LEI), educational index (EI) and income index (II) with a simple mean. At a later stage, with Human Development Report 2010, was introduced a new methodology of calculation through a geometric mean of the same three components.

Unlike the old HDI, the new HDI takes into account differences in attainment across dimensions. In this way, poor performance in any dimension is directly reflected in the new HDI, which captures how well a country's performance is across the three dimensions (Human Development Report, 2011).

The changes in the method of aggregation led a moderate impact on HDI rankings.

Adopting the geometric mean it results a lower index values for all countries, because the higher range in one dimension compensate the lower accomplishment in another one but less as we can observe in the linear mean[16].

We calculated the Human Development Index following the new methodology with the data of 2012, using the goalposts of the Human Development Report, 2013.

The formula for HDI calculation is:

$$HDI = \sqrt[3]{EI \cdot LEI \cdot II} \quad (1)$$

The pattern of all sub-indices follows the basic formula:

$$Dimension\ index = \frac{actual\ value\ - minimum\ value}{maximum\ value\ - minimum\ value} \quad (2)$$

[16] For a discussion about the structure of composite indices, see Paruolo et al., (2012)

Where the maximum values are chosen from the actual observed maximum of the data from the countries in the time series 1980–2012 and the minimum values will affect comparisons, so values that can be appropriately conceived of as subsistence values or zeros are used (HDR, Technical note, 2010).

In the following table, we indicate the goalposts of HDI 2012 components calculation, which will be briefly discussed in the following parts.

Dimensions 2012	Maximum value	Minimum value
Life expectancy	**83,6** (Japan, 2010)	20
Mean years of schooling	**13,3** (United State, 2010)	**0**
Expected years of schooling	**18**	**0**
Combined education index $\sqrt{MYSI \cdot EYSI}$	**0,971** (New Zeland, 2012)	**0**
GNI per capita (PPP$)	**87.478** (Quatar, 2012)	100

Table 1A. Goalposts of the Human Development Report, 2013.
Data Source: Human Development Report, Technical Notes (2013), goalposts to calculate HDI 2012.

A.2 The life expectancy index (LEI)

The life expectancy at birth is the measure chosen to describe quantitatively the quality of life of people in each country. The life expectancy index formula is:

$$LEI = \frac{actual\ value\ LE - minimum\ value\ LE}{maximum\ value\ LE - minimum\ value\ LE} \qquad (3)$$

A.3 The Education Index (EI)

The education dimension is measured with the geometric mean of two components: Mean of years of schooling for adults aged 25 years index (MYSI) and Expected years of schooling for children of school entering age index (EYSI). Expected years of schooling estimates are based on enrollment by age at all levels of education and population of official school age for each level of education. Mean years of schooling and expected years of schooling are estimations based respectively on educational attainment data from censuses and surveys available in the UNESCO Institute for Statistics database and Barro and Lee (2010) methodology.

The Educational Index is calculated applying the basic formula, where the value of the calculation is the geometric mean of the two subcomponents MYSI and EYSI:

$$EI = \frac{\sqrt{MYSI * EYSI} - minimum\ value\ \sqrt{MYSI * EYSI}}{maximum\ value\ \sqrt{MYSI * EYSI} - minimum\ value\ \sqrt{MYSI * EYSI}} \quad (4)$$

A.4 The Income index (II)

The Gross National Income per capita represents the wealth component of the index with purchasing power parity (PPP), which replaced the old Gross Domestic Product. This measure allow to make a real comparison among economic statistics across countries, taking into account the price differences between countries, holding the purchasing power fixed. In that way, GNI per-capita (PPP US$) better reflects people's living standards (Human Development Report, 2011). Its data source is the World Bank.

The income index formula is calculated as follows:

$$II = \frac{LN\ (actual\ value\ GNIpc\ PPP) - LN\ (minimum\ valueGNIpc\ PPP)}{LN\ (maximum\ value\ GNIpc\ PPP) - LN\ (minimum\ value\ GNIpc\ PPP)} \quad (5)$$

Correlation coefficients (*** P < 0.001)			
	LEI	**EI**	**II**
LEI	1	0,72***	0,62***
EI		1	0,58***
II			1

Table.2 Pearson's Correlation matrix among LEI, EI, II.