DOI: 10.24387/CI.SI.2025.2.7

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Has the Kyoto Protocol Affected the CO_2–GHG Emissions and GDP Growth of Countries With Different HDI?

Summary

The objective of our article is to examine whether some countries with different HDI could meet their reduction commitment of the Kyoto Protocol and if it had any impact on their GDP growth. In addition to conducting a systematic literature review, statistical data analysis was also carried out to better identify a potential research gap. Countries with high HDI were only able to meet their reduction commitment in terms of total GHG per capita. However, the already low-HDI countries increased their overall GHG emissions while having low levels of consumption. The higher their GDP growth, the lower their CO_2 levels. In the case of developing countries, it is less related to the changes in GPD.

Keywords: climate change, GHG and CO_2 emission, Kyoto protocol, HDI, GDP growth

JEL codes: Q53, Q56

Introduction

The problem of climate change has been acknowledged for over three decades and is still ongoing. However, relatively few articles have analysed the interrelatedness of GHG reduction, human development index and economic development (GDP growth). The UN Framework Convention on Climate Change (UNFCCC), enacted at the 1992 Rio Earth Summit, is the first international agreement that directly addresses climate change and is legally enforceable.

The objective of our article is to examine whether some countries with different HDI could meet their reduction commitment of the Kyoto Protocol and it had any impact on the GDP growth. To this end, two research questions were drafted.

RQ1: Have international environmental agreements such as the Kyoto Protocol resulted in both economic (GDP growth) and environmental benefits (lower CO_2 and GHG emissions) in both developed and developing countries?

RQ2: Is there a relationship between a country's involvement in international environmental agreements such as the Kyoto Protocol and its economic development level (GDP growth, HDI)?

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Methodology

Our research was carried out with combining systematic literature review (secondary research) and statistical data analysis by means of analytical methods (ANOVA in SPSS Statistics V22).

In order to respond to a clearly stated research question, a systematic literature review identifies, selects, and critically evaluates previous research (Tawfik *et al.*, 2019) by checking numerous databases and literature sources using search terms and tactics (including database names, platforms, and dates of search).

A quantitative secondary research strategy seeks to establish a cause-and-effect relationship between two variables through the use of mathematical, computational, and statistical methods. Large sets of data such as the World Development Indicators (WDI, 2020) of the World Bank and the Human Development Report 2020 list were used to select groups of nations previously ranked on several criteria.

The Human Development Index (HDI) is an aggregate of key achievement in human development, such as living a long and healthy life, being knowledgeable, and having a good standard of living. The Human Development Report (HDR, 2020) distinguishes 4 groups of country categories:

1. Very high human development: Norway, Ireland, Switzerland, Germany, Sweden, Australia, the Netherlands,
2. High human development: Iran, Mexico, Thailand, Colombia, Brazil, China, Egypt,
3. Medium human development, and
4. Low human development: Iraq, India, Kenya, Pakistan, Uganda, Nigeria, Sudan

The medium and low HDI groups were combined and analysed jointly because the medium and low HDI group had a total of as many countries as the high category in addition to numerous small or recently formed poor countries. GHG emissions were also analysed how successfully the nations met their Kyoto Treaty obligations, and how GHG emissions changed in each nation.

Research data was displayed in several ways but here only a scatter plot figure is presented which illustrates data in a coordinate system where regression values are displayed.

Findings

Climate change is a serious environmental problem that affects all countries (Nordhaus, 2018) resulting in harm to people and nature (Ramanathan *et al.*, 2016). The general history of climate change (Clark *et al.*, 2001; Weart, 2008) starts with Arrhenius (1896) or even earlier scientific studies. However, it was not until the late 1980s that nations realized that in order to offset the negative impacts of hazardous gas emissions, international collaboration is vital (Purvis *et al.*, 2019).

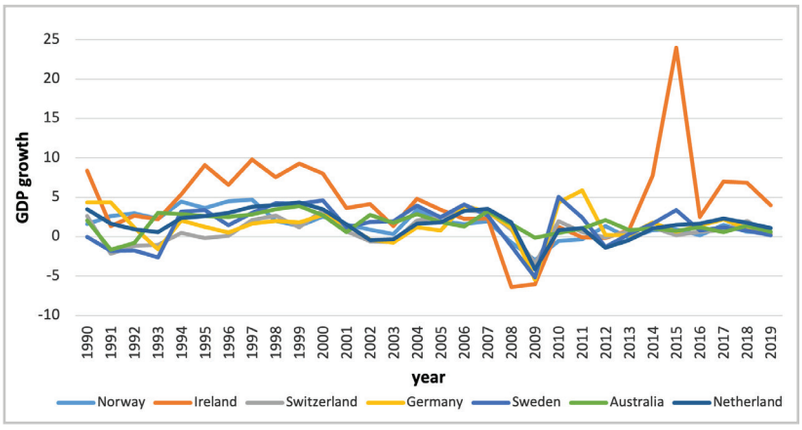

Figure 1. Changes in GDP growth in very high HDI countries (1990-2019)
Source: authors' own elaboration based on WDI, 2020

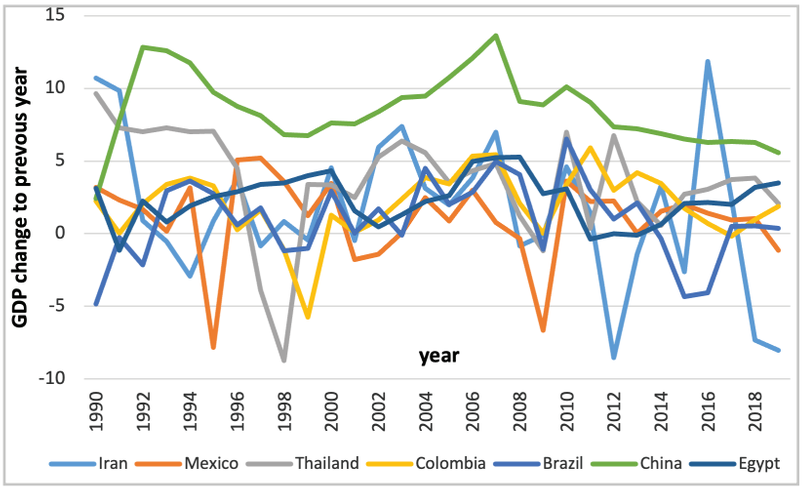

Figure 2. Changes in GDP growth in high HDI countries (1990-2019)
Source: authors' own elaboration based on WDI, 2020

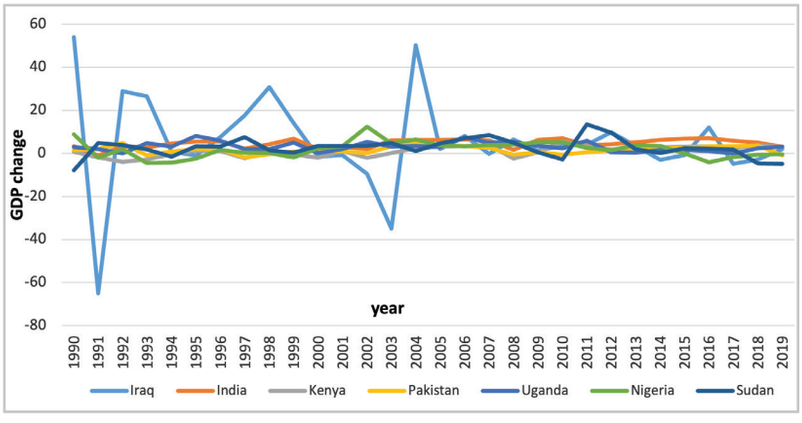

Figure 3. Changes in GDP growth in medium and low HDI countries (1990-2019)
Source: authors' own elaboration based on WDI, 2020

Following the first summit of the UN in Stockholm, the second one was held in Rio, Brazil (a developing country) in 1992, which reaffirmed the links between environment and development, and introduced the notion of common but differentiated responsibilities.

The next turning point in climate regulation is the Kyoto Protocol, adopted in 1997 and effective from 2005. The Kyoto Protocol is criticized for focusing on governments that permit businesses to emit lower HGs. According to Fawzy *et al.* (2020) the restrictions outlined by the Kyoto Protocol incur the cost of new, ‚clean' technologies in developed countries or nations in transition to a market economy.

The Paris Agreement, adopted in 2015 and ratified in 2016 by 196 countries, is referred to as the culmination of decades of climate diplomacy and a historic milestone in multilateral diplomacy which is 'the most optimistic outcome possible in a deeply discordant political setting' (Rajamani, 2016: 501). Some legal professionals emphasize that the Agreement incorporates comprehensive, legally binding obligations for all countries (Rajamani, 2016; Klein *et al.*, 2017).

Based on the objectives and the research questions of this study together with the literature review, the following theoretical propositions are developed.

Proposition 1: International environmental agreements such as the Kyoto Protocol have resulted in environmental benefits (lower CO_2 and GHG emissions).

Proposition 2: International environmental agreements such as the Kyoto Protocol have played a significant role in developing the economy (GDP growth) of all HDI countries.

The analysis of GDP growth in very high, high and medium-low HDI countries

By using the WDI database for the period between 1990 and 2019, Figure 1 was drawn from which a relatively stable GDP growth of very high HDI countries can be concluded. It was Ireland that showed the largest difference, with the largest increase in 2015 and the lowest in 2008-2009. Moreover, between 1991 and 1993 several countries reached negative values before the next through in 2008 as a result of the global economic crisis.

As the next step, the GDP growth on high HDI countries was analysed. Figure 2 below reflects that GDP growth is more diverse here. All countries have achieved a negative GDP growth value at least once but not at the same time. Between 2003 and 2008 there were no negative values in GDP growth and 2007 was the peak period almost everywhere. For high HDI countries, the minimum ranged from -8.7 (Thailand) to a maximum of 13.6 (China). It can be stated that the fluctuation of GDP growth is more intense here than in the very high HDI countries.

As the final step in this chapter, the GDP growth in medium and low HDI countries is analysed. As presented by Figure 3, the largest fluctuation among all country groups can be found here. The first Iraq-Iran conflict created certain fluctuations in Iraq's economic indices, and the Arab Spring later contributed to a greater depression. Consequently, the two extreme numbers range between +53 and -64. Other nations, however, display a generally steady value with Kenya being the most stable of them.

Their GDP growth was not as significantly impacted by the 2008 financial crisis as it was in very high or high HDI countries.

Apart from the HDRO classification, other databases such as the CIA Factbook (2017) are also used to differentiate between developed and developing countries. Based on the 2017 data as the starting point, the ranking order of the developed countries was as follows based on their GDP-PPP in USD ranging from $25,360,000,000,000 (China) to $2,856,000,000,000 (France): China, USA, India, Japan, Germany, Russia, Indonesia, Brazil, UK, France. With the help of the CIA database, the ranking order of developed countries was also created from 80 to 90 based on their GDP-PPP in USD ranging from $134,000,000,000 (Ghana, 80th position) to $89,000,000,000 (Jordan, 90th position): Ghana, Puerto Rico, Serbia, Panama, Turkmenistan, Croatia, Cote d'Ivoire, Lithuania, Cameroon, Uganda, Jordan.

The analysis of the relationship between GDP growth and CO_2 emissions in developed and developing countries

While GDP increased continually in both developed and developing nations, we can see from Table 1 that it stagnated in developed countries until 2009 and in developing nations until 2009 and 2010. In contrast, CO_2 emissions steadily decreased by 60% in developing nations and 65% in developed nations, respectively. In contrast to developed nations, where emissions were declining more evenly, those of developing countries stalled in 2010.

Table 1. GDP and CO_2 emission in developed and developing countries

	Developed		Developing	
year	**Ave. GDP**	**Ave. CO_2**	**Ave. GDP**	**Ave.CO_2**
1995	19670.72	0.416	3024.84	0.391
1996	20018.61	0.415	3166.85	0.359
1997	20460.71	0.395	3311.18	0.380
1998	20764.77	0.380	3442.65	0.372
1999	21212.75	0.369	3451.54	0.363
2000	21884.18	0.357	3562.32	0.347
2001	22145.63	0.348	3727.03	0.346
2002	22322.49	0.342	3877.41	0.350
2003	22633.84	0.341	4079.62	0.360
2004	23188.11	0.338	4306.46	0.357
2005	23662.71	0.331	4559.41	0.339
2006	24270.83	0.321	4841.66	0.352
2007	24845.48	0.305	5211.45	0.350
2008	24874.26	0.308	5443.06	0.311
2009	23841.84	0.298	5154.11	0.280
2010	24557.29	0.299	5244.23	0.287
2011	25083.00	0.298	5497.62	0.282
2012	25376.40	0.295	5664.59	0.271
2013	25700.92	0.281	5847.67	0.258
2014	26030.09	0.270	5999.01	0.246
2015	26321.40	0.282	6181.46	0.247
2016	26563.21	0.272	6396.25	0.236

Source: authors' own elaboration based on WDI, 2020

According to Figure 4, the average GPD of developed nations is six times that of developing countries, which experienced a four-fold decline by 2016. Despite CO_2 emissions changed practically at the same rate, GDP rose more slowly in developed nations than it did in developing nations.

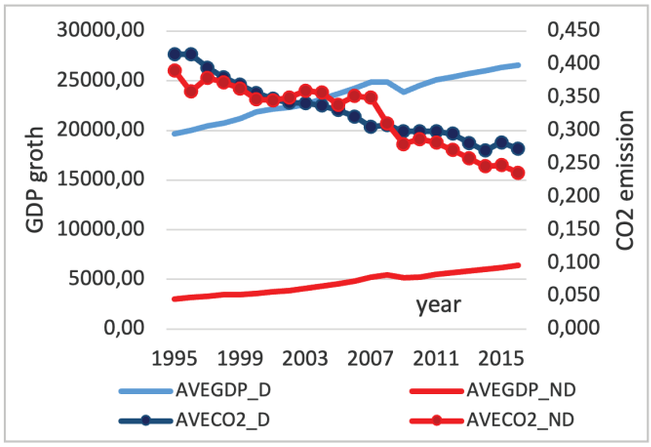

Figure 4. GDP and CO_2 emissions in developed and developing countries (1995-2015)

Source: authors' own elaboration based on WDI, 2020

Based on Figure 4 above and Table 2 and Table 3 below, both developed and developing countries have a significant negative correlation between GDP and CO_2 although this relationship for developed countries is stronger than that of developing ones.

Table 2. The significance between the GDP of developed countries and CO_2 emissions

		Ave.DD	Ave. DDC
AVE.DD	Pearson Correlation	1	–0,980**
	Sig. (2-tailed)		0,000
	N	22	22
AVE.DDC	Pearson Correlation	–0,980**	1
	Sig. (2-tailed)	0,000	
	N	22	22
**. Correlation is significant at the 0.01 level (2-tailed).			

Source: authors' own elaboration based on WDI, 2020

Table 3. The significance between the GDP of developing countries and CO_2 emissions

		Ave. Developing GDP	Ave. Developing CO_2
Ave. Developing GDP	Pearson Correlation	1	–0,915**
	Sig. (2-tailed)		0,000
	N	22	22
Ave. Developing CO_2	Pearson Correlation	–0,915**	1
	Sig. (2-tailed)	0,000	
	N	22	22
**. Correlation is significant at the 0.01 level (2-tailed).			

Source: authors' own elaboration based on WDI, 2020

If the relationships between the GDP of developed and developing countries are compared, a significantly strong positive relationship r = 0.985 (p = 0.01) can be seen from Table 4. However, in the case of CO_2 emissions, this relationship is also strong (Table 5) but lower (r = 0.879 (p = 0.01)) and also positive.

Table 4. The significance between the GDP of developing and developed countries

		Ave. Developed GDP	Ave. Developing GDP
Ave. Developed GDP	Pearson Correlation	1	,985**
	Sig. (2-tailed)		,000
	N	22	22
Ave Developing GDP	Pearson Correlation	,985**	1
	Sig. (2-tailed)	,000	
	N	22	22
**. Correlation is significant at the 0.01 level (2-tailed).			

Source: authors' own elaboration based on WDI, 2020

Table 5. The significance between the CO_2 emissions of developing and developed countries

		Ave. Developed CO_2	Ave. Developing CO_2
Ave. Developed CO_2	Pearson Correlation	1	0,879**
	Sig. (2-tailed)		0,000
	N	22	22
Ave. Developing CO_2	Pearson Correlation	0,879**	1
	Sig. (2-tailed)	0,000	
	N	22	22
**. Correlation is significant at the 0.01 level (2-tailed).			

Source: authors' own elaboration based on WDI, 2020

It can be concluded that developed and developing countries show a strong opposite relationship between GDP and CO_2 emissions, *i.e.* the higher their GDP, the lower their CO_2 levels. In the case of developing countries, the relationship is also similar, but it is weaker, meaning that it is less related to the changes in GPD.

In summary, international environmental agreements affect the GDP of developed countries in a way that their GDP is decreasing. However, in the case of developing countries, the link between the decrease of CO_2 emission and the increase of GDP was not justified.

The analysis of CO_2 and GHG emissions in very high HDI countries

GHG emissions were also analysed to find out how well countries complied with the Kyoto Treaty, and how their GHG emissions changed. In accordance with the Kyoto Protocol, greenhouse gas emissions were to be cut by 5.2% between 1990 and 2008-2012, and by 8% in EU nations, respectively. The indicators for GHG gases used here are expressed in kilotons of CO_2 equivalent.

First, it is important to examine how CO_2 emissions changed between 1990-2008 and 2012 in very high HDI countries. Significant reductions can be seen in the case of Sweden and Germany: the former reduced its CO_2 levels to 82%. However, all other countries increased their CO_2 levels between 1990 and 2008, and by 2012, if not by 5%, overall, all high HDI countries were able to achieve significant reductions. The best example of this is Ireland, which increased its CO_2 levels by more than 140% between 1990 and 2008 similarly to Australia. By 2012 this level was the highest in Ireland falling to 81%, while the highest in Australia with 98%. These data are presented by Table 6.

Table 6. Total CO2 emissions of very high HDI countries (1990-2012)

country	CO_2_1990	CO_2_2008	CO_2_2012	base year 1990–2008	base year 1990–2012	base year 2008–2012
Australia	279.365	409.653	402.666	147%	144%	98%
Sweden	57.378	50.887	46.774	89%	82%	92%
Norway	35.098	44.837	44.342	128%	126%	99%
Ireland	32.944	47.367	38.242	144%	116%	81%
Switzerland	44.153	44.714	42.255	101%	96%	95%
Germany	1052.477	854.927	813.985	81%	77%	95%
Netherlands	161.807	174.862	164.7	108%	102%	94%

Source: authors' own elaboration based on WDI, 2020

Table 7. Total GHG emission in very high HDI countries (1990-2012)

country	total GHG 1990	total GHG 2008	total GHG 2012	base year 1990–2008	base year 1990–2012	base year 2008–2012
Australia	558.21	617.09	643.12	111%	115%	104%
Sweden	70.26	47.38	30.98	67%	44%	65%
Norway	30.91	25.29	30.03	82%	97%	119%
Ireland	54.11	69.64	60.06	129%	111%	86%
Switzerland	51.19	51.65	49.04	101%	96%	95%
Germany	1109.28	889.47	837.46	80%	75%	94%
Netherlands	205.44	197.69	188.48	96%	92%	95%

Source: authors' own elaboration based on WDI, 2020

Table 8. GHG per capita emission in very high HDI countries (1990-2012)

country	GHG per capita 1990	GHG per capita 2008	GHG per capita 2012	base year 1990–2008	base year 1990–2012	base year 2008–2012
Australia	32.912	28.928	28.079	88%	85%	97%
Sweden	8.201	5.13	3.246	63%	40%	63%
Norway	7.278	5.301	5.99	73%	82%	113%
Ireland	15.412	15.77	13.033	102%	85%	83%
Switzerland	7.694	6.776	6.124	88%	80%	90%
Germany	14.032	10.972	10.343	78%	74%	94%
Netherlands	13.728	11.932	11.224	87%	82%	94%

Source: authors' own elaboration based on WDI, 2020

Table 9. Total CO_2 emission of high HDI countries (1990-2012)

country	year	1990	2008	2012	base year 1990–2008	base year 1990–2012	base year 2008–2012
Iran	1990	209.944	534.644	602.738	255%	287%	113%
Mexico	1990	317.042	492.98	496.3	155%	157%	101%
Thailand	1990	87.916	226.873	270.268	258%	307%	119%
Colombia	1990	56.898	66.65	79.727	117%	140%	120%
Brazil	1990	218.658	412.638	498.309	189%	228%	121%
Chile	1990	32.891	70.795	79.684	215%	242%	113%
Egypt	1990	75.218	194.764	208.718	259%	277%	107%

Source: authors' own elaboration based on WDI, 2020

Table 10. Total GHG emission of high HDI countries (1990-2012)

country	total GHG 1990	total GHG 2008	total GHG 2012	base year 1990–2008	base year 1990–2012	base year 2008–2012
Iran	240.54	669.06	761.05	278%	316%	114%
Mexico	417.45	595.78	674.16	143%	161%	113%
Thailand	174.02	310.02	386.03	178%	222%	125%
Colombia	217.08	236.44	221.94	109%	102%	94%
Brazil	1642.29	2030.84	1311.58	124%	80%	65%
Chile	30.34	55.06	20.68	181%	68%	38%
Egypt	129.43	268.73	294.89	208%	228%	110%

Source: authors' own elaboration based on WDI, 2020

Accordingly, similar results were expected for both total and per capita GHG as CO_2 is one of the most important part of GHG.

All very high HDI countries surveyed were among the signatories to the Kyoto Protocol committed to reduce GHG emissions. Sweden, Germany and the Netherlands were able to comply with the Kyoto Protocol in terms of total GHG emissions as Table 7 presents.

Looking at the per capita results (Table 8), we can see a different scenario. While emissions fell in all countries except Ireland (102%) between 1990 and 2008, the decline in GHG emissions was much higher in all countries between 1990 and 2008. With the exception of Ireland, there is no country that would go above 90% and this change continued until 2012, but the rate of decline slowed down during this period. To conclude, all countries reduced their GHG emissions by at least 15% in terms of per capita figures but the highest value belongs to Sweden, where it fell below 60%.

When the per capita consumption of GHG is compared to its total emission, a contradiction can be seen: per capita values are decreasing while total values are increasing.

The analysis of CO_2 and GHG emissions in high HDI countries

As the next step of the research, the high HDI countries are analysed in terms of their CO_2 and GHG emissions. All the nations involved in the research were committed to and signed the Kyoto Treaty. Table 9 shows that since 1990, CO_2 emissions have increased in all of the nations; Iran, Thailand, and Egypt more than doubled their emissions by 2008 while Thailand reached triple amounts by 2012. Colombia has the lowest CO_2 emissions, at „only" 140, out of all the countries, which all increased them further to 2012.

The indicators in Table 10 further demonstrate that most of these nations did not even attempt to reduce their GHG emissions between 1990 and 2008, with Iran raising them to 278% before increasing them to 316% in 2012. But the overall GHG emissions also climbed in Mexico, Thailand, and Egypt, reflecting the CO_2 figures. Colombia's growth rates were only 9% and 2%, respectively. Brazil and Chile, in comparison, went in an entirely different direction. By 2012, both nations drastically cut their GHG emissions when compared to 1990, and they

Table 11. GHG per capita emission of high HDI countries (1990-2012)

country	GHG pc 1990	GHG pc 2008	GHG pc 2012	base year 1990–2008	base year 1990–2012	base year 2008–2012
Iran	4.267	9.277	10.075	217%	236%	109%
Mexico	4.973	5.376	5.749	108%	116%	107%
Thailand	3.077	4.66	5.691	151%	185%	122%
Colombia	6.558	5.343	4.817	81%	73%	90%
Brazil	11.022	10.576	6.581	96%	60%	62%
Chile	2.286	3.295	1.188	144%	52%	36%
Egypt	2.306	3.374	3.412	146%	148%	101%

Source: authors' own elaboration based on WDI, 2020

Table 12. CO_2 emissions of medium and low HDI countries (1990-2012)

country	CO_2 1990	CO_2 2008	CO_2 2012	1990 basis year to 2008	1990 base year to 2012	2008 base year to 2012
Iraq	49.057	91.803	152.815	187%	312%	166%
India	578.518	1462.815	1963.586	253%	339%	134%
Kenya	5.687	9.911	11.988	174%	211%	121%
Pakistan	67.827	155.356	153.876	229%	227%	99%
Uganda	0.761	2.78	3.627	365%	477%	130%
Sudan	4.769	13.634	14.539	286%	305%	107%
Nigeria	38.857	94.772	116.331	244%	299%	123%

Source: authors' own elaboration based on WDI, 2020

Table 13. Total GHG emission of medium and low HDI countries (1990-2012)

country	total GHG 1990	total GHG 2008	total GHG 2012	base year 1990–2008	base year 1990–2012	base year 2008–2012
Iraq	78.65	104.97	175.68	133%	223%	167%
India	1009.44	2317.48	2758.53	230%	273%	119%
Kenya	34.15	77.78	74.73	228%	219%	96%
Pakistan	166.5	316.9	332.43	190%	200%	105%
Uganda	34	54.95	61.57	162%	181%	112%
Sudan	73.23	116.38	120.84	159%	165%	104%
Nigeria	249.87	277.1	303.64	111%	122%	110%

Source: authors' own elaboration based on WDI, 2020

Table 14. GHG per capita emission of medium and low HDI countries (1990-2012)

country	GHG pc 1990	GHG pc 2008	GHG pc 2012	base year 1990–2008	base year 1990–2012	base year 2008–2012
Iraq	4.515	3.698	5.509	82%	122%	149%
India	1.156	1.93	2.179	167%	188%	113%
Kenya	1.439	1.955	1.685	136%	117%	86%
Pakistan	1.547	1.846	1.775	119%	115%	96%
Uganda	1.959	1.806	1.782	92%	91%	99%
Sudan	3.635	3.52	3.339	97%	92%	95%
Nigeria	2.624	1.844	1.816	70%	69%	98%

Source: authors' own elaboration based on WDI, 2020

had also greatly increased their GHG bans. Brazil and Chile both lowered it by 45% and 62%, respectively.

We examined whether the amount of GHG emissions per person could be lowered (Table 11). Between 27 and 40% of Colombia, Brazil, and Chile's emissions were in line with Kyoto predictions. Thailand stands out of the other high HDI nations in that it virtually doubled its growth above 180% between 1990 and 2008 and was able to further increase GHG per capita by 22% between 2012 and 2008. In contrast, all other high HDI countries had an increase in GHG emissions per capita.

Based on the facts above it can be concluded that the high human development countries did not adhere to, or perhaps greatly increased, their overall GHG emissions failing to fulfil their Kyoto Protocol obligations.

Table 15. ANOVA test total GHG emission

			Sum of Squares	df	Mean Square	F	Sig.
total GHG 1990* code	Between Groups	(Combined)	106492.597	2	53246.298	0.268	0.768
	Within Groups		3577098.860	18	198727.714		
	Total		**3683591.457**	**20**			
total GHG 2008* code	Between Groups	(Combined)	372517.436	2	186258.718	0.451	0.644
	Within Groups		7439729.297	18	413318.294		
	Total		**7812246.733**	**20**			
total GHG 2012* code	Between Groups	(Combined)	349093.442	2	174546.721	0.415	0.666
	Within Groups		7564541.757	18	420252.320		
	Total		**7913635.199**	**20**			

Source: authors' own elaboration based on WDI, 2020

The analysis of CO_2 and GHG emissions in medium-low HDI countries

Finally. the CO_2 and GHG emissions of medium and low HDI countries are analysed. Iraq and Kenya boosted their CO_2 emissions by 174% and 187%, respectively, yet these levels went even higher. Iraq grew so rapidly between 2008 and 2012 that the CO_2 rate jumped by 166%. From 2008 to 2012, Pakistan is the only nation to have cut its CO_2 emissions by 1% (Table 12). The minimum CO_2 level for Kenya increased by twofold throughout the evaluation period, and Uganda's CO_2 level nearly doubled overall between 1990 and 2012.

Following the CO_2 results, the level of total GHG was examined. We found that in all cases the GHG level increased for the low and medium HDI countries that ratified the Kyoto Protocol, as shown in Table 13. Kenya was the only nation during the review period to only be able to demonstrate a 4% decrease between 2008 and 2012 in one instance, hence it failed to meet the requirements of the Kyoto Protocol.

It is anticipated that the amount of GHG emissions per capita will likewise be higher than the amount set forth in the Protocol.

Table 14 demonstrates that between 1990 and 2008 Uganda, Sudan and Nigeria all had a decline in their per capita GHG rates, which continued to decrease by 2012. Therefore, despite the fact that earlier indicators saw a rise in the proportion of GHG, a considerable decline was detected in the proportion of the population per capita.

However, this is not the case for Iraq, India, Kenya and Pakistan, whose GHG rates grew from 1990 to 2012. With an 18% reduction but a 1.5-fold increase in GHG consumption over the following 4 years. Iraq can demonstrate compliance by 2008. Between 2008 and 2012 there was a discernible drop for Kenya and Pakistan with Kenya cutting its GHG consumption by 14% and Pakistan by 4%, respectively.

Although data show a slight decrease in the GHG per capita emi ssion. total emission increased significantly in line with population growth.

To examine the research question, it is necessary to look at whether there is a demonstrable relationship between the development of each country and GHG emissions and per capita emissions. In order to examine the relationship between the development of countries and total GHG emissions, Pearson's significance test was taken. Total GHG emissions for each nation were higher than those of the very high HDI countries (Code 1) and the lowest of the low HDI nations (Code 3) according to Table 15, but this ratio had changed by 2012.

From the table it is also seen that the strongest connection could be detected in 1990 where the significance rate was 0.768 and the value of the degree of freedom F was 0.268. By 2008 the significance level decreased to 0.644, which is the lowest but still considered high and this number increased to 0.666 by 2012.

In summary, it can be stated that the level of total GHG emissions depends on the period examined in each country (the highest in 1990) but the data for 2008 and 2012 show that although all countries signed the Kyoto Protocol a common improvement can be seen but it also depends on the HDI index of each country.

The per capita mean of each nation is the highest in the very high HDI countries and the lowest in the low and medium HDI countries according to an analysis of the mean and standard deviation values (Table 16). Therefore, the standard deviation rate confirms that the higher a country's development rate, the more GHG its population consumes. Time has shown that the low and medium HDI countries' 2008 HDI was the lowest ever and they failed to fulfil the 5% Kyoto threshold.

Table 16. Total GHG per capita

code		GHG pc 1990	GHG pc 2008	GHG pc 2012
1	Mean	14.17957	12.11557	11.14843
	N	7	7	7
	Std. Deviation	8.926422	8.377566	8.217389
2	Mean	4.92700	5.98586	5.35900
	N	7	7	7
	Std. Deviation	3.096071	2.843315	2.753122
3	Mean	2.41071	2.37129	2.58357
	N	7	7	7
	Std. Deviation	1.254390	.848650	1.413352
Total	Mean	7.17243	6.82424	6.36367
	N	21	21	21
	Std. Deviation	7.357827	6.378239	6.041371

Source: authors' own elaboration based on WDI, 2020

Further examining the data obtained in total GHG per capita. a scatter plot figure (Figure 5) was created that shows that countries with the highest GHG per capita emissions are Australia, Ireland, Germany, the Netherlands and Brazil whereas very high human development countries have the highest GHG rates per capita.

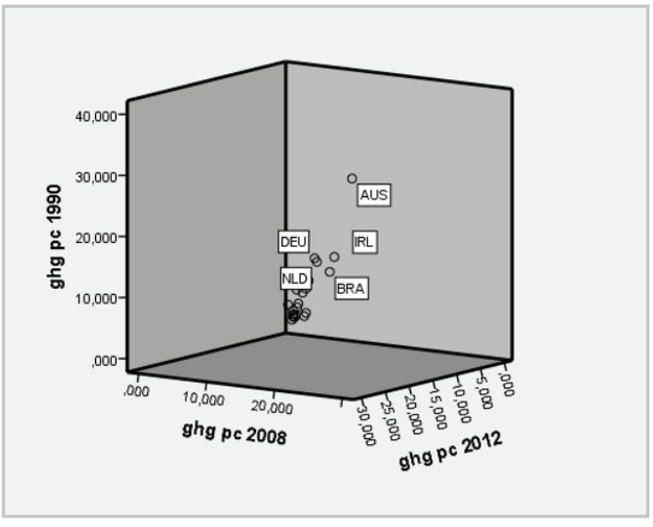

Figure 5. Scatter plot of GHG per capita 1990-2012
Source: authors' own elaboration based on WDI, 2020

Conclusions

Our paper analyses the relationship between groups of countries selected on the basis of their HDI and GDP growth, CO_2 as well as GHG emissions and their interrelatedness.

Based on the literature review we can conclude that The Kyoto Protocol was only the first step in the line of international agreements to solve the problem of the environment. Comparing the commitments made in the Kyoto Protocol by the four groups of nations. *i.e.* very high, high, low and medium HDI countries it can be stated that most countries were able to meet the 5% reduction of the Kyoto agreement, but the reduction was less as in their original commitment.

The high HDI countries were able to reach the reduction commitment only in case of total GHG per capita data. The already low-consumption low-HDI countries did the opposite, *i.e.* increased their total GHG emissions. Thus, developed and developing countries show a strong opposite relationship between GDP growth and CO_2 emissions. The higher their GDP growth, the lower their CO_2 levels. In the case of developing countries, the relationship is also similar, but it is weaker, meaning that it is less related to the changes in GPD.

To sum up, the Kyoto Protocol cannot be considered successful, which has been proven in terms of CO_2 and total GHG emissions, but there has always been an effort to comply with it in terms of per capita GHG emissions.

As all research, ours also has its limitations. It fails to describe causality. Further research into the causality of variables is suggested by employing Granger causality test. The relationship between several quantities could be described by a statistical model known as a vector autoregression (VAR) as they change over time. Future studies must focus on a wider variety of nations and take into account more economic indices. Our article embraces just a short period of more than twenty years to see the immediate effects of the Kyoto Protocol, but the examination could be extended by more recent periods.

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