A clean environmental week: let the nature breathe

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Highlights:

- About 36 billion tons of carbon dioxide (CO2) were produced in 2015 worldwide.
- Six countries emit CO2 more than all the rest.
- The biosphere could be seen as a living being that needs breaks to ingest pollutants.
- The cost of action to reduce pollution and CO2 emission today is less than the cost of inaction tomorrow.
- A 'clean environmental week' would allow reducing CO2 emission by about one billion ton a year.

Abstract

High levels of CO_2 emissions in the atmosphere and toxic pollutants in air, water and food have serious repercussions on all life's systems, including living beings, environment and economy. Everyone on the Earth is concerned by pollution in some way or another, no matter where and how the pollution is produced as airborne and foodborne pollutants could circulate around the world in different ways, through for example climate components (wind, rain) and/or import and export of foodstuffs. Similarly to living beings that take advantage of day-night circadian rhythms to recover after diurnal hardships, the environment in its entirety could also be seen as a complex living system that needs regular breaks to assimilate or ingest toxic pollutants produced during intensive and continuous industrial activities. A global "Clean Environmental Week" is discussed as an attempt toward reducing air pollution and CO_2 emissions through the interruption or the reduction of industrial polluting activities regularly for a week or so per year to let the nature 'breathe' or recover from environmentally challenging pollutions. If greenhouses gas emissions and pollution rates continue to increase at the same rates as they are today, uncontrollable serious climate effects might be inevitable and the air quality in some cities in the world might be hardly respirable in the future.

Keywords: air quality; alternate-day travels; carbon dioxide emission; clean environmental week, climate change; global warming; greenhouse gas emission; industrial pollution; no drive days; no work days; odd–even traffic restriction; pollution; renewable energy; traffic

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Increasingly 'carbonized' atmosphere

Air pollution with greenhouse gases is a pervasive and chronic anthropogenic product of fossil fuel combustion, intensive vehicle traffic and unceasing industrial processes. Except for a handful of climate skeptics (most of whom are non-scientists) it is well admitted now that pollution and CO_2 concentrations in the atmosphere in the few past centuries are virtually due to human economic activities and industrial processes (Solomon et al., 2007). Air pollutants and greenhouse gases emitted by human activities comprise mainly carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), chlorofluorocarbons and other macro- or micro-industrial products (commonly known as particulate matter ≤2.5 µm in aerodynamic diameter [$PM_{2.5}$]). According to the United States Environment Protection Agency (EPA), the carbon dioxide alone represents about 76% of the total greenhouse gases emitted by fossil fuel, industrial processes, forestry and other land use[1]. Methane in turn is about 16% and nitrous oxide is about 6%[1]. The economic sectors that produce the most of greenhouses gases are: 1) electricity and heat production systems (25%), 2) agriculture and other land use (24%), 3) industry (21%), 4) transportation (14%), 5) other energy (10%)[1] and 6) cement industry (5%) (Worrell et al., 2001). In 2015, the top carbon dioxide emitters were China (about 30% of the total CO_2 emitted), the United States (15%), India (7%), Russia (5%), and Japan (4%) (Table 1.). The first five countries in the table (China, USA, India, Russia, Japan and Germany) produce altogether more than 60% of the global CO_2 emitted from fossil fuel combustion and industrial processes. Between 1970 and 2015, the production of CO_2 has more than doubled, shifting from about 15 billion tons per year to more than 36 billion tons in 2015 (Figure 1). By 2050, the emission of greenhouse gasses will continue to increase by at least 50% due to a projected 70% growth in CO_2 emissions from fossil energy uses (Marchal et al., 2011). Transport CO_2 emissions are also projected to double owing to a strong increase in demand for cars in emerging countries (Marchal et al., 2011). Compared to the natural range of CO_2 of about 180–300 ppmv over the last 650,000 years (Solomon et al., 2007), the Earth's CO_2 has already passed the threshold of 400 part per million by volume (ppmv) in 2016 (Kahn, 2016). As such, the Earth's atmosphere seems to be more increasingly saturated or 'carbonized' with CO_2 emissions than it was in the past, which could lead to some unexpected climate consequences in the next decades if the emission level continues to rise without immediate and efficient actions to stabilize it.

Effects of climate change and air pollution

A large number of studies demonstrate that greenhouse gases and chronic exposures to air pollution could lead to serious effects on the environment, on the biome and on the entire human life from birth to the elderly. Increasing concentrations of CO_2 are projected to induce climate change that in turn would affect all aspects of the biodiversity (Gitay et al., 2002). Due increasing pressures arising from human activities and natural processes, many of the current species are already under risk of extinction on the Earth (Gitay et al., 2002) and in the sea (Cheung et al., 2009). Some reports are more alarming than these by projecting the

[1] https://www.epa.gov/ghgemissions/global-greenhouse-gas-emissions-data

consequences of anthropogenic climate change on biodiversity as a potential cause of underway sixth mass extinction episode (Rohr et al., 2008) (Bellard et al., 2012) (Pievani, 2014) (Ceballos et al., 2010) (Wake and Vredenburg, 2008) (Collins, 2010). At best, if CO_2 emission continues to increase, it may contribute to uncontrollable and irreversible long-term climate change, such as dry-season rainfall reductions and inexorable sea level rise (Solomon et al., 2009). About 20% of coastal wetlands could also be lost due to sea-level rise as a consequence of potential climate change in the next decades (Gitay et al., 2002). In humans, elevated levels and/or long-term exposure to air pollutants can cause congenital anomalies and preterm births (Jacobs et al., 2016) (Gianicolo et al., 2014). Chronic air pollution is also associated with hypertension (Pitchika et al., 2017) (Liu et al., 2016) cardiovascular diseases (Burroughs Pena and Rollins, 2017) (Brook et al., 2010) and respiratory issues (Moustris et al., 2016) (Tsangari et al., 2016). Other reports associate air pollution to cancer such as lung cancer (Chen et al., 2016) (Kanwal et al., 2017) (Raaschou-Nielsen et al., 2013) (Bidoli et al., 2016) (Pope et al., 2002), pediatric cancer (Ortega-Garcia et al., 2017) (Lavigne et al., 2017), breast cancer (Gonzales et al., 2017) (Keramatinia et al., 2016), liver cancer (Pedersen et al., 2017), kidney cancer (Raaschou-Nielsen et al., 2017), gastric cancer (Chiu et al., 2011), and an elevated risk of cancer in various other digestive accessory organs (Wong et al., 2016). It was also reported that airborne particles induce important changes in the expression of pro-inflammatory cytokines and psoriatic skin disease-related genes, leading to potential dysfunction of the human epidermis (Kim et al., 2017). Chronic exposures to air pollutants would also increase DNA damages and cancer risks in traffic policemen (Tan et al., 2017) and would reduce life expectancy (Dziubanek et al., 2017) particularly among tuberculosis patients (Peng et al., 2017). Scaling down greenhouse emissions and improving air quality by reducing air pollutions could thus ameliorate the public health and save important medication costs while enhancing benefit–cost ratios (Simons et al., 2016) (Pascal et al., 2013) (Lu et al., 2016) (Gao et al., 2016).

Potential actions on air pollution and CO2 emissions

The climate system is currently close to enter, if not already entered, a zone of dangerous anthropogenic interference with potentially abrupt, irreversible and unmanageable consequences (Molina et al., 2009). To avoid such disasters, there is a paramount need for early, urgent and fast-action solutions (Molina et al., 2009). Taking early actions to tackle climate change issues has a number of advantages that could help reduce the risks of passing critical thresholds that trigger irreversible effects (Michaelowa and Rolfe, 2001). Environmentally engaged policies to reduce air pollution and CO_2 emissions can take a multifaceted approach that could vary from simple actions, such as improving the design and efficiency of cooking devices, to more complex strategies in using alternative energy sources and reducing reliance on fossil energy to manufacturing new transportation means and constructing new eco-buildings. Climate-resilient and low emissions approaches could also be enhanced by other actions as simple as the establishment of walkways and cycling paths and encouraging the use of bikes to high-tech transportation means based on electric, hybrid or fully solar-energy sources. Good waste management and recycling systems (i.e., paper, plastic, and glass, etc.) and standardized manufacturing of all portable electric devices to always work with solar energy wherever and whenever available are also potential approaches to think of (Moustafa, 2016). As plants are the lungs of the earth, other actions to improve urban air quality and reduce air pollution and greenhouse gas emissions should include increasing the green surface planted by trees and shrubs (Nowak et al., 2006).

Let the nature breathe for at least one week per year

Emissions of air pollutants and greenhouse gases can also be reduced by cutting down the economic and industrial activities that lead to their production. In its entirety as a biological and integral ecosystem, the Earth's biosphere could be seen as a complex 'living being' that needs to recuperate after long exhausting industrial and polluting activities. Living organisms take advantages of day-night circadian rhythms to rest and recover from diurnal hardship events. In this context, the work rate of 24 hours per day and 7 days per week (24/7) might need rethinking. Is such a system economically and environmentally justified in regard with the endeavors to reduce CO_2 emissions and its environmental consequences?

Similarly to living organisms, the environment could be treated as a living being in the sense that it needs time to 'ingest' its gas, solid and liquid pollutants. To reach such a goal and to allow natural ecosystems recover to some extent, anthropogenic polluting activities need to be slow down at least temporally or regularly to maintain a healthy and respirable atmosphere. Some countries already apply a driving restriction system (alternate-day travels or odd–even traffic restriction) at periods of urban pollution peaks to reduce urban exhaust gas emissions (Cai and Xie, 2011). However, such a policy has a little effect as it is applied for a short time and restricted to traffic and local levels only. In other words, the impact of alternate-day travel system is limited in time and space so that its effects on pollution are minor and transient. To produce more positive and more lasting impacts, global policies are required to stop or at least to decrease polluting industrial operations (i.e., those mentioned in table 1 that produce the most of CO_2 emissions) for longer and regular periods of time at a worldwide level. For this, I propose a new concept of "*Clean Environmental Week*" to be observed and respected worldwide at the same calendar date of every year, independently of current cutoff days in each country. That is, a same week of the same month or, alternatively, a week at a rotating basis each month (for e.g., the first or last week of the respective months every year) could be defined as an international "Clean Environmental Week" in which major polluting industrial and traffic activities could be reduced to the bar minimum needed. As such, five days of no work week plus a weekend before and a weekend after will make a total of nine days of reduced-polluting activities that could have a tremendous and tangible impacts on the global environment. Concretely, the global emission of CO_2 in 2015 was about 36 billion tons (table 1), which means that about one hundred million tons of CO_2 was produced per day in 2015 (36 billion tons per year = 98,630,137 tons per day). A period of 9–10 days of non-emission as suggested here, would thus save the production of CO_2 by about 1 billion tons (98,630,137*10 = 986,301,370 tons), which is roughly the equivalent to the amount of CO_2 produced in an entire year some centuries ago, in 1890[2] for instance.

To be as efficient as possible, the "Clean Environmental Week" needs to be respected worldwide and to include the interruption of most of the polluting industries (table 1 summarizes some of these), excluding the necessary and minimal vital functions of an economic system (for e.g., those to provide eating, drinking and urgent health cure materials, though the stock of many of such materials are usually manufactured in excess that could usually suffice for at least some weeks if not longer beyond the period suggested here as a 'clean environmental week'.

How to set up the proposed approach?

The approach could be set up simply by determining the culprit industrial operations in each country and then to stop them or to reduce them as if it was a prolonged weekend without major industrial activities. However, an important question could be raised here about the cultural and economic levels between industrialized and less industrialized countries; would it be fair to ask countries without heavy industry and countries relying on heavy industry make a total of nine days of reduced-polluting activities compared with those who pollute more and produce the most of CO2 emissions? And, how would we adjust these differences for clean environmental week to improve environmental health and minimize economic impact? To answer these questions, we need to bear in mind that the overproduction of CO_2 is now a fact that makes all people concerned regardless of the industrial level of each country because a global climate change would not stop on custom services or pass through administrative borders. Rather, it would affect all of us, poor or rich, northern or southern, eastern or western with opposed or mixed changes (i.e., extreme drought here and severe floods elsewhere, harsh cold in somewhere and suffocating heat elsewhere and so on). Of course, there should be more responsibility and efforts to reduce CO_2 rates on major CO_2 emitters than on small ones, proportionally to each contribution in CO_2 emission, but a climate change would likely induce global consequences that can affect the entire world. The responsibility should ideally be proportional to the contribution in CO2 emission but there is a risk that asking only countries with heavy CO2 emissions to reduce their emissions might lead them to relocate some of their polluting industries to other countries with less restriction to escape the limit regulation. This is currently the case for many industrial processes that have been relocated to China (where the production costs are relatively cheap compared with other countries), making China as a major

[2] http://www.wri.org/blog/2014/05/history-carbon-dioxide-emissions

CO2 emitter (table 1) because a lot of industries have been relocated there. So, reducing the emission in one country and increasing it in another would not solve the problem.

In all cases, a potential clean environmental week is not incompatible with other engagements or actions signed or taken during the United Nations series of conferences on climate change and environmental programs (e.g., Conference of the parties; COP) but as a possible complimentary and global action to consider for producing the most positive impact achievable alongside with other procedures in the same direction. As inferred above, about ten days of simple environmentally clean week would cut off about 1 billion tons of CO_2 per year, suggesting the potential importance of such a measure. Ideally and logically, the countries that produce more CO_2 should incur more responsibility and, why not, economic sanctions in case of non-compliance with the obligations and agreements to reduce CO_2 emissions and other pollutants. A global environmental week applied worldwide would sensitize more people on the importance of climate change and encourage them to participate in mitigating it, each with the means at hand.

However, a “clean” environmental week should not be seen as a “vacation week” to induce traffic congestion on holiday roads, but as a cleaning and curing environmental week to enhance nature recuperation from global pollution. During such a “no-work” week, the emission of toxic pollutants and dangerous gases such as carbon monoxide, sulfur dioxide, nitrogen oxides, methane, and chemical vapors released from polluting industries, motor vehicle exhaust and factories should be reduced to the bare minimum. The perception of pollution risks associated with such pollutions in some European countries makes many people ready to pay to avoid pollution-related health risks (Istamto et al., 2014). The long-term benefits on environment and health of reduced industrial and polluting activities during a week or so would outweigh minor short-term losses that might be associated with slowed economic activities during that week. The international Organization for Economic Co-operation and Development (OECD) compared the cost of actions/inactions on climate change and it projects that the cost of maintaining the 2 °C goal would reduce the growth of global GDP (Growth Domestic Product) from only 3.5 to 3.3% per year (or by 0.2 percentage points) on average, costing roughly 5.5% of global GDP in 2050 (OECD, 2012). When this cost is compared with the potential cost of inaction that could be as high as 14% of average world consumption per capita, it appears that delaying action is extremely costly (OECD, 2012). Moderate or delayed action up to 2020 (such as implementing the Copenhagen/Cancun agreements only, or waiting for better technologies to come on stream) would imply 50% higher costs in 2050 compared to timely action, and potentially entail higher environmental risks (OECD, 2012). As such, to reduce the risk of potential catastrophic climate change, we should act now to slow down and reverse the trend of CO2 emission and pollutant release in the atmosphere to stabilize their concentrations within the natural ranges to limit global warming. Whatever the cost of actions today, it would be much less than the cost of inaction tomorrow, both from economic and human perspective.

A global and momentous problem needs global and momentous policies. A universal "Clean Environmental Week" can be one of those actions that could potentially be considered among other actions to slow down pollution and reduce CO_2 emissions at least in part to improve environmental healthiness, mitigate global warming and avoid future worst-case scenarios in health and environmental management systems.

Disclosure: None.

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Table 1. "CO_2 emissions of fossil fuel use and industrial processes (cement production, carbonate use of limestone and dolomite, non-energy use of fuels and other combustions, chemical and metal processes, solvents, agricultural liming and urea, waste and fossil fuel fires). Excluded are: short-cycle biomass burning (such as agricultural waste burning), large-scale biomass burning (such as forest fires) and carbon emissions/removals of land-use, land-use change and forestry"*****.

	Global CO2 emission per year per country (Ktons)										
Country	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**Percent of CO2 emitted in 2015**
China**	6870759	7515037	7699949	8246582	8986614	9844525	10056756	10503137	10711037	10641789	29.50996
USA**	5765135	5847966	5659277	5243236	5519484	5391417	5164192	5255530	5312226	5172338	14.34303
India**	1367406	1439192	1536650	1738106	1848710	1961663	2090857	2191277	2334381	2454968	6.80769
Russia**	1764650	1766346	1743343	1652898	1735583	1820098	1833976	1824579	1822210	1760895	4.88301
Japan**	1289035	1310630	1226781	1163613	1219095	1258289	1293511	1312750	1281569	1252890	3.47430
Germany**	844435	817319	828292	768284	811861	793891	801677	815812	773020	777905	2.15715
Iran	500311	534178	544451	565166	568920	578502	591310	600055	625021	633750	1.75740
South Korea	530686	535783	546589	556099	600870	617612	614771	611531	611741	617285	1.71175
Canada	545677	570974	563980	532609	545088	551261	556797	568364	572262	555401	1.54014
Saudi Arabia	321190	338145	363299	390882	420058	438213	455673	459502	486767	505565	1.40195
Indonesia	383593	398802	396354	411644	423416	433103	443625	452744	483633	502961	1.39472
Brazil	363134	379565	399717	373531	423798	442313	457077	485620	505395	486229	1.34833
Mexico	425604	440779	437759	434049	445291	460511	481703	486432	480692	472018	1.30892
Australia	407286	427487	430374	435530	420677	428610	428229	429079	438504	446348	1.23774
South Africa	409496	429678	453072	426752	433086	414565	410065	423218	431469	417161	1.15680
United Kingdom	555854	546532	533279	478784	493734	455843	467584	455878	415177	398524	1.10512
Turkey	275440	300130	303359	297693	307985	328282	339238	324736	352593	357157	0.99041
Italy	489493	482151	466539	413512	422825	412039	395145	362512	335610	352886	0.97856
France	399752	394216	391486	370957	380777	352560	351479	355664	323495	327787	0.90896
Poland	322674	324151	319010	304068	324465	319354	309560	304238	289144	294879	0.81771
Thailand	228576	234029	236316	229451	243361	249874	258478	268589	277664	279253	0.77438
Taiwan	279710	282292	270256	256235	273033	272157	274256	277397	280987	279174	0.77416
Kazakhstan	216166	225573	259843	232848	249093	269958	256771	267585	274067	267978	0.74311
Spain	356423	370293	338163	298370	284604	286096	276360	250801	245637	262683	0.72843
Malaysia	183252	200817	213613	192125	205448	212224	215643	232041	235668	245371	0.68042
Ukraine	367116	378228	358243	297733	320148	336311	326701	316849	274682	228688	0.63416
Egypt	180715	192951	198847	204072	210109	221507	228318	219686	222551	226985	0.62944
Viet Nam	101950	112782	124584	140823	154589	161729	165021	169176	187942	206028	0.57132
United Arab Emirates	125920	136352	158731	163605	170972	176736	187450	190141	190540	199253	0.55253
Argentina	169468	176467	189628	181170	187466	192018	191557	188068	189189	191199	0.53020
Venezuela	165856	150156	184624	184084	197246	176173	196460	185748	183400	178568	0.49517
Pakistan	143627	159407	155820	158387	154325	154691	153809	156045	165985	174843	0.48485
Netherlands	174300	175962	178854	172314	183239	171874	170902	169529	160706	165317	0.45843

Iraq	73198	79652	90416	107856	121820	129930	140741	153829	158010	160623	0.44541
Algeria	101399	104251	108779	112547	114750	120271	128343	131435	141615	147692	0.40955
Philippines	73399	77285	79126	79908	85914	86841	87559	97034	103666	113035	0.31345
Czech Republic	129494	130658	125599	116798	121353	119867	117827	113429	110923	111092	0.30806
Uzbekistan	118897	119417	119137	107737	106254	114548	115947	104189	107752	109845	0.30460
Belgium	114716	111277	114779	104786	111211	102672	98124	98363	93733	97002	0.26899
Kuwait	76763	76636	80652	86955	86836	90310	92098	91235	91818	95013	0.26347
Turkmenistan	54360	60169	63274	54895	61710	67220	69720	70893	80553	94236	0.26132
Qatar	47789	54562	59731	63930	71805	76264	83164	85811	84471	88825	0.24631
Nigeria	81550	75553	78074	72174	80468	87683	81596	80467	81768	86896	0.24096
Romania	108929	106484	104502	85279	82238	88909	89796	78715	79264	81247	0.22530
Chile	61386	69783	72827	69135	73590	80151	78538	83115	81492	81110	0.22492
Colombia	59420	61108	61642	65034	64377	71659	69906	72600	77044	80967	0.22453
Oman	42298	46338	52761	60425	64665	71677	72829	75202	74855	78446	0.21753
Austria	78632	76434	77140	69551	75992	75495	74638	74540	71626	74244	0.20588
Bangladesh	40982	44676	50639	55070	60356	60559	61732	64445	67039	71360	0.19788
Greece	102575	106202	102121	96235	89188	86109	83454	74927	71095	68292	0.18938
Israel	65167	67550	67916	67102	70421	69827	70929	64889	63035	65716	0.18223
Belarus	67605	64248	67238	64890	69641	65534	66478	66654	68016	64800	0.17969
Serbia & Montenegro	63194	61505	61222	57055	58261	62862	61931	62856	59974	63374	0.17574
North Korea	80841	67595	74584	72771	68836	56646	56973	58004	61344	62995	0.17469
Morocco	46269	47965	48631	48444	51172	54731	55583	54636	58392	59246	0.16429
Bulgaria	53143	57078	53940	45887	48473	53631	53305	47707	50799	53432	0.14817
Peru	31255	34179	38723	41618	44939	47985	48000	49701	51140	52572	0.14578
Libya	54711	52373	53735	61075	63877	41654	53183	52400	50067	52153	0.14462
Portugal	61123	60622	57933	57753	52027	51622	49107	47732	47283	50792	0.14085
Singapore	41769	43390	44036	42191	45444	44715	44651	45136	46786	48531	0.13458
Finland	72096	69527	61352	58903	67310	59517	57948	58477	53728	48505	0.13451
Hungary	59834	58243	57168	50900	51804	50044	49084	46350	45866	48186	0.13362
Syrian Arab Republic	61325	64581	65943	61645	61451	56357	52435	44649	44902	45898	0.12728
Hong Kong	42551	45583	44572	47753	42418	47367	47416	48413	49261	45703	0.12674
Norway	43956	44743	44596	43720	45963	44925	43574	43765	43048	43109	0.11954
Sweden	56722	53388	51364	47063	53223	47738	46101	44463	43671	42496	0.11784
Ecuador	29118	30985	30883	34506	36226	37913	37984	40834	42498	41749	0.11577
Switzerland	47190	45219	46743	45209	46924	42833	42910	43550	39394	40283	0.11171
Denmark	58761	53985	50730	48492	48216	43081	41748	43645	40238	36908	0.10235
Ireland	48863	47671	46992	41850	41717	36962	36364	35409	34882	36635	0.10159
Slovakia	42793	41605	42008	37772	40088	37900	37833	38212	35415	36254	0.10053
Trinidad & Tobago	34545	37722	37006	35342	38654	36531	34080	35446	35533	35283	0.09784
Cuba	26525	27446	25951	33314	30692	29305	29841	32871	33753	34459	0.09555
New Zealand	36762	35977	36869	33941	33900	33261	33664	33124	33739	33660	0.09334

Azerbaijan	30683	27880	30713	25699	24534	27785	29291	30320	31706	32727	0.09075
Yemen	22292	24792	24897	27047	27042	22499	22655	29990	30440	30679	0.08507
Tunisia	23966	24716	25155	24835	25600	24270	25229	25296	27255	29506	0.08182
Estonia	16080	20637	19086	15510	18541	20230	27132	29255	28099	29252	0.08112
Bosnia & Herzegovina	18896	19912	21820	21857	22539	25419	24880	24757	23516	24637	0.06832
Dominican Republic	21062	21081	21903	20273	20673	22250	22891	22633	23860	24273	0.06731
Angola	15759	16376	18637	20483	23221	23212	22184	22012	22497	23025	0.06385
Jordan	20223	21105	20665	21175	20658	21157	21891	21991	22696	22929	0.06358
Bahrain	16166	18890	18239	18686	19075	19686	19743	21433	21003	22146	0.06141
Lebanon	15557	14132	17732	21486	20543	20880	21084	20986	21435	21562	0.05979
Croatia	22888	24599	23279	21673	20735	20623	20354	20151	20226	20538	0.05695
Bolivia	11098	12040	13106	13834	15141	16406	16930	17109	17849	18123	0.05025
Sudan (former)	12790	13969	14773	15331	16102	16694	16401	16447	16422	16808	0.04661
Mongolia	10992	11561	11700	12159	13089	13566	14082	15055	16060	16438	0.04558
Slovenia	18075	18004	18941	17098	16138	16111	15994	15511	15178	15610	0.04329
Kenya	9864	9865	10408	12203	13233	13548	13123	14444	14869	15201	0.04215
Ghana	8607	8953	8078	9799	11298	12447	13512	14436	14487	14916	0.04136
Sri Lanka	12970	14214	13524	13225	14459	15330	15554	13717	14495	14704	0.04077
Guatemala	11880	12639	11427	12036	11774	11731	11899	13550	14234	14538	0.04031
Zimbabwe	10875	10527	8032	8727	9673	10568	10889	11427	13973	13692	0.03797
Lithuania	13957	15070	14991	12616	13425	13516	13833	12752	12478	12478	0.03460
Myanmar	10162	10633	8094	7595	8356	8504	9011	10419	11262	11640	0.03228
Cameroon	8717	9695	10024	10612	10069	9879	10007	10682	10858	11117	0.03083
Tanzania	5983	5836	6128	5868	6402	7617	8800	9852	10278	10778	0.02989
Panama	7552	7285	7368	8495	9061	9571	10288	9752	10056	10263	0.02846
Luxembourg	11874	11277	11163	10538	11147	11017	10636	10034	10097	10235	0.02838
Côte d Ivoire	6328	6196	6932	6553	7223	7028	7910	8687	9201	9889	0.02742
Ethiopia	5667	6164	6616	6619	6290	6864	7810	9365	9671	9885	0.02741
Macedonia	9648	10328	10118	9093	9130	10132	9820	9841	9607	9787	0.02714
Jamaica	12297	12212	11745	8276	7904	8337	8266	8776	9012	9180	0.02546
Honduras	7169	8857	8574	8102	8001	8241	8527	8607	8887	9081	0.02518
Afghanistan	3245	2902	3958	5055	6316	6952	7482	8021	8542	8663	0.02402
Costa Rica	6825	7624	7553	7278	7212	7439	7561	7875	8099	8285	0.02297
Brunei Darussalam	7644	7246	7949	7934	7289	7463	7127	7079	7777	8257	0.02290
Senegal	5595	6192	6137	6461	6881	7530	7332	7839	8026	8200	0.02274
Latvia	8425	8799	8295	7545	8546	7792	7797	7769	7816	7973	0.02211
Papua New Guinea	5353	5204	5741	5511	6113	6602	6841	7287	7794	7906	0.02192
Moldova	8073	8107	7936	7705	8298	8389	8343	7365	7375	7569	0.02099
El Salvador	7246	7644	6894	6913	6676	6889	7079	7206	7301	7455	0.02067
Uruguay	6413	5951	7830	7991	6607	7914	8072	7076	7230	7395	0.02051
Georgia	5225	6125	5394	6129	5647	6951	7006	7068	7017	7184	0.01992

Kyrgyzstan	4002	4975	5370	4100	4963	5174	7290	6977	6832	7050	0.01955
Nepal	2751	2767	3088	4072	4794	5420	6151	6446	6828	6984	0.01937
Botswana	4610	4565	4624	4417	5190	4827	5028	6088	6990	6936	0.01923
Netherlands Antilles	6006	6526	6456	6045	4940	6480	6470	6471	6471	6471	0.01795
Cyprus	7899	8251	8420	8226	7937	7654	7244	6107	6107	6164	0.01709
Benin	3856	4387	4353	4671	5040	5266	5424	5714	5668	5811	0.01612
Paraguay	3949	4076	4131	4449	4930	5121	5341	5287	5422	5553	0.01540
Cambodia	2972	3468	3923	4099	4137	4458	4650	4784	5211	5292	0.01468
Gabon	5221	4762	5050	5073	5147	4742	4635	4809	5086	5242	0.01454
Uganda	3205	3467	3865	3714	4085	4336	4486	4676	4820	4941	0.01370
Democratic Congo	2656	2899	2985	2922	3040	3475	3689	4436	4858	4934	0.01368
Nicaragua	4562	4689	4491	4490	4758	4784	4902	4686	4811	4927	0.01366
Mozambique	2807	3347	3197	3432	3753	4205	4191	4538	4709	4825	0.01338
Zambia	2714	1819	1938	2126	2224	2623	3378	4296	4767	4818	0.01336
Congo	4345	3844	4029	4478	4851	4481	4121	4834	4620	4734	0.01313
Armenia	4472	5185	5687	4549	4124	4715	4714	4552	4525	4637	0.01286
Tajikistan	3465	4037	3732	3529	3597	3590	3570	4227	4481	4581	0.01270
Albania	4098	4209	4167	3751	4075	4328	4209	4401	4354	4439	0.01231
Lao Republic	1689	1688	1903	2440	2832	3068	3263	3436	4012	4111	0.01140
Bahamas	2857	3061	3141	3180	3440	3730	3736	3851	3954	4036	0.01119
Iceland	3232	3428	3787	3803	3656	3570	3610	3852	3893	3874	0.01074
Namibia	2370	2448	2811	2877	3010	3162	3311	3562	3594	3679	0.01020
Mauritius	2448	2553	2735	2702	2863	2980	3010	3093	3173	3239	0.00898
Madagascar	2138	2372	2450	2405	2609	2731	2810	2885	2960	3022	0.00838
Guyana	2365	2478	2392	2478	2705	2717	2728	2812	2888	2948	0.00817
China, Macao SAR	1909	1890	1931	1972	2130	2297	2342	2497	2666	2704	0.00750
Mauritania	1863	1977	1992	1968	2178	2267	2361	2433	2477	2536	0.00703
Martinique	1908	2008	1997	2034	2159	2302	2308	2377	2439	2493	0.00691
Malta	2603	2755	2592	2478	2468	2492	2432	2341	2303	2353	0.00653
Suriname	1842	1888	1853	1887	1986	2132	2155	2226	2283	2333	0.00647
Burkina Faso	1479	1672	1991	1935	2111	2187	2265	2292	2283	2333	0.00647
Haiti	2257	2402	2485	2504	2172	2262	2135	2222	2273	2329	0.00646
Togo	1212	1202	1577	1635	1774	2288	2163	2279	2225	2292	0.00635
Guadeloupe	1767	1875	1854	1914	2125	2114	2120	2182	2237	2289	0.00635
Equatorial Guinea	2962	3043	2863	2557	2651	2796	2232	2216	2230	2234	0.00619
Niger	1438	1564	1645	1630	1763	1851	1987	2097	2138	2178	0.00604
Guinea	1394	1496	1714	1633	1735	1851	1868	1937	2027	2075	0.00575
New Caledonia	1692	1584	1493	1514	1647	1763	1787	1899	2019	2048	0.00568
Malawi	1276	1349	1434	1421	1508	1546	1573	1666	1752	1792	0.00497
Mali	1108	1223	1285	1279	1389	1444	1494	1534	1573	1605	0.00445
Bhutan	676	733	800	1068	1166	1358	1365	1454	1575	1595	0.00442

Djibouti	1046	1121	1180	1204	1277	1337	1342	1432	1539	1575	0.00437
Fiji	943	933	1012	1033	1173	1260	1295	1390	1482	1506	0.00417
Barbados	1180	1222	1206	1213	1267	1343	1328	1356	1391	1422	0.00394
Chad	966	1085	1055	1017	1084	1126	1306	1389	1392	1418	0.00393
French Guiana	1001	1061	1061	1089	1204	1253	1261	1296	1327	1356	0.00376
Rwanda	960	1042	1091	1071	1162	1208	1246	1280	1323	1352	0.00375
Sierra Leone	924	989	1042	1012	1110	1155	1184	1205	1241	1269	0.00352
Somalia	922	1001	1060	1013	1102	1149	1179	1211	1242	1267	0.00351
Réunion	917	951	988	961	996	1017	1056	1099	1124	1151	0.00319
Burundi	762	830	880	841	916	967	1008	1044	1060	1081	0.00300
Maldives	614	630	680	681	817	890	930	991	1058	1073	0.00298
Belize	798	826	815	853	946	941	945	974	1000	1021	0.00283
French Polynesia	593	581	599	611	681	736	757	807	861	873	0.00242
Liberia	584	628	643	616	670	700	728	772	826	846	0.00235
Swaziland	495	520	538	544	580	607	610	627	644	657	0.00182
Eritrea	528	517	450	471	501	586	623	623	633	652	0.00181
Bermuda	465	449	460	466	496	541	542	559	574	586	0.00162
Saint Lucia	413	440	448	460	482	513	516	532	546	557	0.00155
Central African Republic	389	427	448	434	471	490	505	519	532	543	0.00151
Seychelles	381	410	423	435	460	482	483	496	509	519	0.00144
Grenada	422	433	405	427	507	470	471	486	499	509	0.00141
Gibraltar	425	422	431	472	478	459	466	495	499	502	0.00139
Timor-Leste	233	190	209	257	278	320	534	509	444	448	0.00124
Antigua and Barbuda	303	321	322	330	352	371	372	384	394	402	0.00112
Cayman Islands	265	290	297	303	321	344	344	355	365	372	0.00103
Saint Vincent Grenadines	256	272	271	278	295	306	308	317	325	332	0.00092
Guinea-Bissau	230	249	261	260	279	291	296	304	312	319	0.00088
Lesotho	238	256	268	256	277	289	296	304	312	318	0.00088
Montserrat	207	274	242	261	354	294	294	303	312	318	0.00088
Puerto Rico	896	826	768	620	281	284	284	292	299	304	0.00084
Solomon Islands	155	152	173	196	227	247	258	275	293	297	0.00082
Aruba	199	229	216	233	278	242	244	251	258	263	0.00073
Gambia	181	196	206	205	221	231	236	243	249	254	0.00070
Tonga	203	170	191	182	186	189	190	202	216	219	0.00061
Western Sahara	148	159	168	171	182	191	193	198	203	207	0.00058
Saint Kitts & Nevis	141	143	146	149	164	171	172	178	182	186	0.00052
Dominica	137	141	139	142	150	157	158	163	167	170	0.00047
Samoa	105	93	97	107	115	124	128	137	146	148	0.00041
Vanuatu	64	59	67	76	90	99	104	111	118	120	0.00033
Comoros	74	84	88	87	94	98	101	104	106	108	0.00030
Cabo Verde	72	80	82	81	87	91	93	95	98	100	0.00028

British Virgin Islands	64	72	73	76	81	84	85	87	90	91	0.00025
Turks & Caicos Islands	38	46	46	50	55	55	56	57	59	60	0.00017
Sao Tome & Principe	41	44	46	46	49	52	52	54	55	56	0.00016
Kiribati	27	24	27	31	35	38	40	42	45	46	0.00013
Falkland Islands	31	33	35	35	37	41	41	42	44	45	0.00012
Palau	35	29	33	31	32	32	31	34	36	36	0.00010
Cook Islands	31	26	29	28	29	29	28	30	32	33	0.00009
Anguilla	13	12	15	20	24	26	26	27	28	28	0.00008
International Aviation	438250	452326	460670	441762	462439	478469	482636	490044	493592	502936	
International Shipping	608482	638565	638428	612204	660730	666633	608735	618491	625292	642024	
World per year	**30795629**	**31959109**	**32132724**	**31821609**	**33660629**	**34725758**	**34968014**	**35672026**	**36084040**	**36061684**	
World in 10 years						**337881222**					

***Source**: Emission Database for Global Atmospheric Research (EDGAR), Joint Research Center (JRC), European Commission (EC): http://edgar.jrc.ec.europa.eu/overview.php?v=CO2ts1990-2015&sort=des9 (Accessed on April 08, 2017). The original record is for CO_2 emissions from 1970-to-2015 but here only the data of the last ten years (2006–2015) are presented. The full data list (1970–2015) is accessible at the aforementioned link.

**: These countries (China, United States, India, Russia, Japan and Germany) emitted in 2015 about 60% of the global CO_2 emission. The rest of the world emitted the remaining 40% of CO_2.

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