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Review Article

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Stockholm Conference to Kyoto Protocol – A Review of Climate Change Mitigation Initiatives

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INFORMATION

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ABSTRACT

The journey from the Stockholm Conference to Kyoto Protocol has been long, whereby the moot point has been to raise awareness and implement policies that would improve the global environment by reducing greenhouse gasses (GHGs). Over the past few decades, apart from some irradiative forces owing to anthropogenic activities, climate change is a stark reality today, endangering the Earth's environment. The Stockholm conference was the first earth summit conceived by the United Nations at Stockholm way back in 1972; the focus was on the conservation and development of the human race and environment. Ever since, several summits on environmental protection have been held, focusing on raising awareness while implementing policies with well-defined objectives aiming to achieve feasible output in reducing the burning of fossil fuel and minimizing the output of GHGs through a mechanism called clean development mechanism (CDM). The concept of CDM came into vogue during the Kyoto Protocol, which was signed in December 1997, and was only effectuated in February 2005. The Kyoto protocol under UNFCCC is a well-defined policy and framework by which one could assess the actual implementation of GHG concentration reduction in the atmosphere. This paper presents the chronology of the progress and the latest status of an agenda and policy that was initiated during the Stockholm conference and was given a structure at the Kyoto protocol.

1. Introduction

Since the 1800s, global atmospheric CO_2 levels have risen by over 30%. As we stand today, the level of GHGs is increasing steeply, leading all of us to precarious conditions in at least the 650,000 years (UNFCCC, Nov 2009). In order to reduce carbon footprint to at least an acceptable level (i.e. below 450 ppm), we would need to reduce CO_2 emissions to by approximately 80% globally by the year 2050 (Baer and Mastrandrea, 2006).

In fact, protecting the global environment has been the prerogative even much before Stockholm Conference in 1972, almost a century earlier, the International Meteorological Organization was established in 1872 specifically for this purpose (Bekiashev and Serebriakov, 1981). In 1972 (Conca,1995), the Stockholm declaration came into being in the United Nations Conference on Human Environment (UNCHE), ushering in what was known then as the 'Stockholm era' the United Nations Environment Program (UNEP), 16 June 1972), wherein the global environment began to be viewed and studied in a 'holistic' way. The Stockholm agreement has been a landmark in environment conservation studies as it was the first International Conference on Human environment by United Nations.

If we were to look back deep into the annals of history, we would note that the inception and advancement of the international system, dynamism, and interest in human development as we see it today, revolve around the fulcrum of the 'Stockholm-Rio-Johannesburg and Kyoto protocol'. Back in 1967, the United Nations General Assembly (UNGA) had suggested that Sweden convene a global conference on human development and the environment.

This resulted in the birth of the United Nations Conference on the UNCHE in 1972 at Stockholm. The next major chronological landmark may be traced back to 1992, the United Nations Conference on Environment and Development (UNCED), held at Rio de Janeiro, commonly known as the 'Earth Summit. A commission of 'sustainable development' (CSD) was set up at this forum to ensure that the major decisions taken at the UNCED were followed-up aggressively at the national, local, regional, and international levels, which would be reviewed in five years, i.e. 1997. The CSD at the UNCED in 1992 formed the platform of the 'Kyoto Protocol', which was finally adopted in December 1997. In simple terms, this became the globally binding environmental doctrine, which essentially extends the 1992 UNFCCC.

UNFCCC's objective was to balance out GHG concentration within the atmosphere, bringing it to a level whereby the Earth could be saved from threatening anthropogenic interferences with its climate systems. The Paris agreement was passed at the UNFCCC's 21st Conference of the Parties in December 2015. This agreement aimed to limit global warming to less than 2 °C and pursue efforts to limit it to 1.5 °C. Great efforts such as deep carbon emission cuts and even carbon capture are being implemented to lower the projected warming by 0.5 °C. We believe that the impacts of such a 0.5 °C warming mitigation at regional scales deserve to be assessed to justify the cost of mitigation (Wang et. al., 2017). As per UNFCCC 2009, the Share of global greenhouse gas emissions by major sectors is presented in Table 1 and Fig. 1.

Table 1. Share of global GHG emissions by major sectors

Major Sector	Contribution (%)
Power supply	21
Industry	19
Forestry	17
Agriculture	14
Transport	13
Building	8
Fossil fuel Supply	5
Waste	3

The overall protection, safety, and development of the Earth's environment are crucial issues impinging on global civilization today, including social and economic development and sustainability. It is thereby the prerogative of people and the custodians or authorities living in the Earth to live in harmony, whereby each one should work together for the common good of our planet earth (French,1992; Linnér and Jacob, 2005; Seyfang, 2003; Handl, 2012). The autonomous body called the United Nations, the primary guardian of this initiative, has driven this movement by conducting important conferences and reports thus far, some of the salient ones being:

- UN Conference on the Human Environment (Stockholm, 1972)
- World Commission on Environment and Development (Brundtland Commission, 1987)
- United Nations Conference on Environment and Development (Rio de Janeiro, 3–14 June1992)
- Third Conference of the Parties to the UN FCCC (Kyoto Protocol, 1–11 December, 1997)

2. Stockholm Conference

The drive to convene the UN's first conference on the UNCHE was at Stockholm in 1972, which essentially laid the foundation for global collaboration on environmental development. Alarmingly, as on 2017, almost half a century since the WMO Greenhouse Gas Bulletin reported the global average concentration of CO_2 stood at a staggering 405.5 parts per million (ppm). What's worse, there was also a phenomenal rise in methane and nitrous oxide concentrations, along with the revitalization of a potent GHG and ozone-depleting material known as CFC-11, regulated under an international agreement to protect the ozone layer (WMO, 20 November 2018).

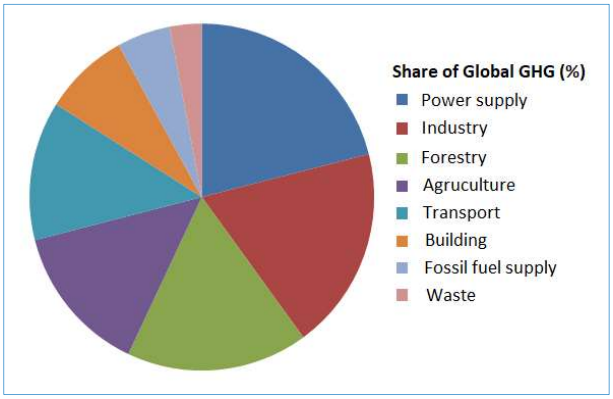

Fig. 1. Share of global GHG emissions by major sectors

The action plan of the Stockholm conference in 1972 drafted the first global environmental assessment program, commonly referred to as the 'earth watch', whereby there were actionable environmental management measures, which were drawn up to tackle and support both national and international actions of assessment and management (Sohn, 1973; Leonard and Morell, 1981; Gray, 1990; Stephan and Zelli, 2007; Handl, 2012). Further, the Stockholm conference had come up with 26 principles (Campbell, 1973; Joyner and Joyner, 1974; Koester, 1990; Rajamani, 2003; Shelton, 2008), has been presented in Table 2.

3. Bruntland Commission (1987)

The UNGA established the United Nations World Commission on Environment and Development (WCED) in 1983. WCED, commonly known as the 'Brundtland Commission', was set up primarily to discuss and devise protectionist environmental strategies and promote sustainable development. At the outset, Gro Harlem Brundtland chaired this commission; he was the erstwhile Prime Minister of Norway and was responsible for chalking out long-term strategies up to the year 2000, and possibly even beyond, on 'sustainable development. In 1987, i.e. four years since its inception, Brundtland Commission came up with its first report titled 'Our Common Future, which in fact went on to play a pivotal role in preparing the fundamental charter for the UNCED in 1992, held at Rio de Janeiro.

Although the report from the Brundtland commission was published in 1987, there were some concerns; the primary concern is that this report attempted to secure global equity, which included focusing on the redistribution of resources mainly for developing and underdeveloped nations to boost their economic growth. This viewpoint may have looked skewed to some. Moreover, the report 'apparently' emphasized global population growth, which would not continue indefinitely. Interestingly, for the 21st century, the report predicted that the global population would be 7.7 billion to 14.2 billion people and stabilize. Additionally, most of this populous would live in cities, and that rural area would almost be obsolete. The report also suggested that the UN establish an actionable program under its aegis on 'sustainable development in order to implement its directives (Keeble,1987; Keeble,1988; Burton,1987; Borowy, 2013)

Table 2. Principle of Stockholm conference (UNEP)

Principal	Recommendations
1	Fundamental rights of human beings to equality, freedom and applicable state of life within the Earth's environment. The onus of protecting the environment for present and future generations lies with humans, irrespective of any condition, which includes racial, colonial or others.
2	The natural resources of the Earth must be safeguarded for the benefit of present and future generations with proper policy and planning.
3	Proper usage of renewable resources and restore and enhance utilization wherever feasible.
4	Manage and safeguard wildlife and its habitat with proper economic development and planning.
5	Non-renewable resources need to be shared amongst one and all with proper usage to ensure that they're not exhausted for the future generation.
6	In order to safeguard the ecosystems, toxic elements must be safely discharged inappropriate places with protection.
7	All countries shall protect the sea and marine ecosystems from harm and damages caused by man-made activities.
8–12	The connections between environment and development with the special situation of developing countries. Principle 10 & 11 especially recommend the international community act in order to meet the economic consequences of environmental protection for the sake of developing countries.
13	Proper development planning to achieve and optimize resources planning, thus helping to develop the environment.
14	Rational planning to avoid conflict between the development needed and the importance of environment protection and development.
15	Proper planning for settlement and urbanization of the human community to avoid any adverse effect within the environment irrespective of any race or colonies.
16	Proposal for demographic policies for the low or excessive populated area to improve human environment.
17	Establish national-level institutes for planning and controlling environment quality.
18	Establish a scientific organization and research center for monitoring environmental risks and safety, and provide a better solution for environmental problems for mankind at large.
19	Environmental education awareness for all level of citizens to protect the environment as a responsibility of every individual of the society for their betterment.
20	Establish a scientific research and development center national and international level to provide better solutions for the protection and improvement of the environment and open up a common information hub to get ready access for providing basic knowledge of the environment.
21	States should follow the principle of the united nations with respect to environmental policy and implantation in order to ensure that there is no damage done to the environment of other states.
22	States shall look to proactively co-operate in order to develop and revise international laws relating to environmental liabilities, and, whenever necessary, compensate the suffering state in case of any environmental damage, which may have occurred voluntarily or otherwise within the jurisdiction of such states.
23	Without any prejudice, states would have to comply with the ethos and value systems of each country. The extent to which standards are appropriate for a developed country may not be applicable or even inappropriate for developing countries, at times even at an unnecessary social cost.
24	Matters and issues pertaining to environmental protection should be well-coordinated and organized in a spirit of cooperation between all countries, regardless of caste, creed, or size. Cooperation should be formed either through multilateral or bilateral forums, as may be the case, whereby the common objective has to be to effectively prevent, control, and eliminate harmful environmental effects, which may result from several activities in a way that the sovereignty along with the interests of all states is considered.
25	States should ensure that international organizations, such as the UN, for instance, do have a role to play an active, coordinated, and dynamic role in order to protect and improve the environment.
26	Ban on nuclear weapons

Table 3. GWP

Manes of major GHGs	Chemical formula	GWP	Sources	Share of global emissions in 2004 (Source: UNFCCC , Nov 2009)
Carbon dioxide	CO_2	1	Fossil fuel combustion, deforestation, agriculture	- 76,7%, - with 56.6% from fossil fuel use
Methane	CH_4	21	Biomass burning, landfills, natural wetlands	- 14.3%
Nitrous oxide	N_2O	310	Fossil fuel combustion , industry , agriculture	- 7.9%
Fluorinated gases (F-gases)	HFCs, CFCs, HCFCs	1000–11700	Industrial manufacturing	- 1.1%
Sulphur hexafluoride	SF_5	23900	Electric transmission , manufacturing	

(Source: Climate Change 1995: The science of climate change pp, 22. IPCC, 1996)

In 1988, the UNEP in collaboration with the World Meteorological Organization (WMO) formed an Intergovernmental Panel on Climate Change (IPCC). The objective of this body was to assess the science behind climate change and provide state governments with adequate scientific information to enable them to develop climate policies for their respective states. Even to this day, the IPCC reports provide key inputs for international climate change negotiations (Bolin, 1991). Thus, as standard practice, all scientists empanelled under IPCC offer their time and

expertise to assess thousands of scientific papers, thereby providing a detailed report to the governing body of the known drivers of climate change, including future risks and their impacts and how to deal with them. It may be noted here that the seminal contribution of GHG emissions had been tabled and published by IPCC in 1996, and has been presented in Table 3.

4. United Nations Conference on Environment and Development (Rio de Janeiro, 3–14 June 1992)

Another milestone called Rio de Janeiro (3-14 June 1992) organized the UNCED; the convention entered into force in 1994. The primary objective of this conference was the status of the global environment and the relationship between economics, science, and the environment in a political context throughout the world. The conference concluded with the Earth Summit, at which respective leaders of 105 nations presented to demonstrate their commitment to sustainable development (Declaration, 1992; Hens, 2005; Handl, 2012).

5. Kyoto Protocol (Third Conference of the Parties to the UN FCCCL, 1 –11 December 1997)

Since 1972, the International conference on climate change has played an essential role in building proper pathways to save this planet through various protocols formed by representative of all nations. The UNFCCC introduced the Kyoto Protocol in December 1997 (Lau et al., 2012); this was the third conference of the parties to the UNFCCC, commonly known as the COP3, it only came into vogue eight years later, i.e., 16 February 2005, wherein 192 countries were signatories to this milestone treaty. The Kyoto Protocol predominately targeted six greenhouse gases mentioned in UNFCCC of Annex A presented in Table 4.

One of the vital elements of the Kyoto protocol is that it encompasses legally binding emission reduction targets of GHG for Annex I parties to reduce by 5.2% from 1990 levels by 2008–2012 (Swedish Environmental Protection Agency, 2002; Lau et al., 2009; UNFCCC, 1997; Halvorssen, 2007), from 2008 to 2012, i.e. within the first period of quantified emission limitation and reduction, the designated amount for each Party (Annex I) should be equal to the percentage mentioned in Annex B, presented in Table 5, which is its aggregate anthropogenic CO2 equivalent emission of GHGs enlisted in Annex A of Table 4 (UNFCCC, 1997).

5.1. The Primary Kyoto Mechanisms

The CDM
Joint implementation (JI)
Emissions trading (ET)

5.1.1. CDM

Let us now discuss the mechanisms in detail; CDM is a pivotal instrument to limit GHG emissions and push for sustainable development. In order to ensure that developed and developing countries could both benefit from CDM, they must first increase their awareness and understanding. Through appropriate usage of CDM protocol, the emission savings of each country are certified as certified emission reductions (CERs); these CERs may be credited to the country's account (generally for developed countries). The developed countries could then access these CERs either by participating directly in a CDM project or purchasing them (which may not be feasible for developing countries) (Wiser, 2002; Sutter and Parreño, 2007).

Table 4. Annex A of six GHG

No	Gas
1	Carbon dioxide
2	Methane
3	Nitrous oxide
4	Hydro fluorocarbons
5	Per fluorocarbons
6	Sulphur hexafluoride

Table 5. Annex B (Quantified emission limitation or reduction commitment -percentage of base year or period)

Party	Quantified emission limitation or reduction commitment (% of base year or period)
Australia	108
Austria	92
Belgium	92
Bulgaria	92
Canada	94
Croatia	95
Czech Republic	92
Denmark	92
Estonia	92
European Community	92
Finland	92
France	92
Germany	92
Greece	92
Hungary	94
Iceland	110
Ireland	92
Italy	92
Japan	94
Latvia	92
Liechtenstein	92
Lithuania	92
Luxembourg	92
Monaco	92
Netherlands	92
New Zealand	100
Norway	101
Poland	94
Portugal	92
Romania	92
Russian Federation	100
Slovakia	92
Slovenia	92
Spain	92
Sweden	92
Switzerland	92
Ukraine	100
UK and Northern Ireland	92
USA	93

The moot objective of the CDM project is to make emission reductions cost-effective. Through the CDM project, developing countries could look for assistance from developing countries, possibly in the form of technology transfer, for instance, to achieve sustainable development (Samaniego and Figueres, 2002; Baumert et al., 2002; Barrett, 2003). The definitive conditions of the CDM project

are elaborated in the Marrakesh Accords, and herein it states that all CDM projects, regardless of developing and or developed countries, have to be thoroughly examined and approved by a competent body before the CDM points can be credited. The Schematic details diagram of the CDM pipeline is shown in Fig. 2.

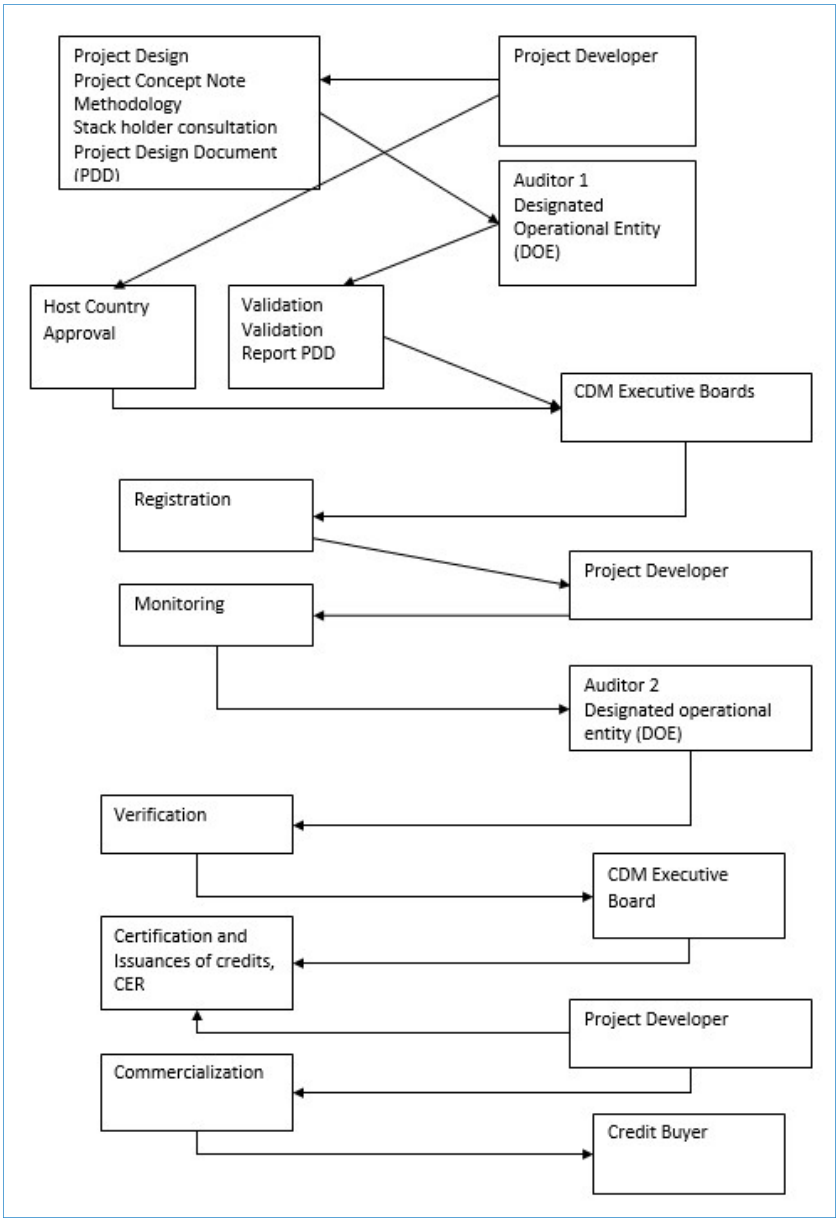

Fig. 2. Schematic presentation of CDM pipeline

5.1.2. Joint Implementation (JI)

When there are environmental projects jointly done by two developed countries, for instance, whereby both have committed to the emission reduction target prescribed by the Kyoto Protocol, the projects naturally fall within the ambit of joint implementation.

On the other hand, if one developed country either finances or even carries out an environmental project in another developed country, the former could credit the resulting emission reduction points to the latter, i.e. the second developed country, if it so chooses. Joint implementation projects generally contribute significantly to emission reductions (Wohlgemuth and Missfeldt, 2000)

5.1.3. Emissions trading

Emission trading is supposedly the most well-known among the three instruments. As the name suggests, it enables trading emission units between developed countries, but how does this work! Generally, by default, each country has been assigned a few emission units, which are allocated so that they would be able to use up their entire allocated units if they comply to the Kyoto emission reduction target to the hilt. As and when a country can achieve this feat and can move to greater reduction, it is at this point that it could look to sell its surplus emission units as licenses.

On the other hand, a country that possibly fails to achieve the minimal prescribed Kyoto emission reduction units could

buy from the country where there has been a surplus and in the process, credit the units to its own emission reduction targets (Woerdman, 2000; Driesen, 2008). It may be noted that the licenses are internationally sold to the highest bidder. Interestingly, while this instrument (i.e. ET) is market-driven, CDM and JI are project-based mechanisms (Helm, 2003).

Table 6. Transgressing planetary boundaries

Process of Earth Systems	Parameters	Proposed boundaries	Status as on (2009)	Pre-industrial value
Climate change	i) Atom CO_2 (ppm by volume)	350	387	280
	ii) Change in radiative forcing (watt p. meter squares' i.e. rate of energy change per unit area of the globe at the top of the atmosphere)	1	1.5	0
Rate of biodiversity loss	Extinction rate (number of space per million species per year)	10	>100	0.1-1.0
Nitrogen cycle (part of a boundary with phosphorus cycle)	Amount of N_2 remove from the atmosphere for human use (millions of tons per year)	35	121	0
Phosphorus cycle (part of a boundary with nitrogen cycle)	Quantity of P flowing into the oceans (millions of tons per year)	11	8.5-9.5	-1
Stratospheric ozone depletion	The concentration of ozone (Dobson Unit)	276	283	290
Ocean acidification	Global mean saturation state of aragonite (carbonate material) in the seawater	2.75	2.9	3.44
Global freshwater use	Consumption of freshwater by human (km^3 per year)	4000	2600	415
Change in land use	Percentage of global land cover converted to cropland	15	11.70	low

(Source: Rockstrom et al., 2009. Planetary boundaries, nature, p 461, 472-475)

Table 7. Total aggregate anthropogenic emissions of greenhouse gases, including emissions /removals from land use, land-use change, and forestry, 1990, 2000, 2007 and 2008

Party	Gg CO_2 eq				Change in emissions (%)		
	1990	2000	2007	2008	1990–2008	1990–2000	2000–2008
Australia	464 497	493 679	880 861	618 058	33.1	6.3	25.2
Austria	65 032	63 143	69 569	69 303	6.6	–2.9	9.8
Belarus	110 584	43 544	56 402	60 078	–45.7	–60.6	38
Belgium	140 649	143 018	128 957	131 978	–6.2	1.7	–7.7
Bulgari	117 806	61 394	68 913	64 183	–45.5	–47.9	4.5
Canada	540 306	636 836	795 868	721 740	33.6	17.9	13.3
Croatia	23 148	15 806	21 123	19 977	–13.7	–31.7	26.4
Czech Republic	191 559	139 977	146 755	136 655	–28.7	–26.9	–2.4
Denmark	73 276	71 411	72 126	68 314	–6.8	–2.5	–4.3
Estonia	35 029	16 675	12 484	10 557	–69.9	–52.4	–36.7
EU-27b	5 223 181	4 663 034	4 681 293	4 529 841	–13.3	–10.7	–2.9
Finland	54 459	46 592	47 492	34 888	–35.9	–14.4	–25.1
France	532 801	515 288	466 440	465 323	–12.7	–3.3	–9.7
Germany	1 231 056	1 028 377	1 024 733	1 013 900	–17.6	–16.5	–1.4
Greece	101 953	123 212	130 333	125 344	22.9	20.9	1.7
Hungary	112 820	76 830	73 436	69 797	–38.1	–31.9	–9.2
Iceland	5 771	5 951	6 529	6 877	19.2	3.1	15.6
Ireland	55 032	67 902	66 694	65 999	19.9	23.4	–2.8
Italy	452 292	473 868	500 361	454 187	0.4	4.8	–4.2
Japan	1 205 317	1 264 028	1 287 234	1 203 076	–0.2	4.9	–4.8
Latvia	8 145	–11 231	–16 495	–16 936	–307.9	–237.9	50.8
Liechtenstein	221	250	237	257	16.1	12.9	2.9
Lithuania	35 611	5 817	12 746	10 997	–69.1	–83.7	89
Luxembourg	13 466	9 516	12 517	12 222	–9.2	–29.3	28.4
Monaco	108	120	98	95	–11.4	10.9	–20.1
Netherlands	214 604	217 084	209 456	209 363	–2.4	1.2	–3.6
New Zealand	30 133	38 783	58 381	48 943	62.4	28.7	26.2
Norway	38 465	40 802	28 147	25 852	–32.8	6.1	–36.6
Poland	545 524	365 750	358 538	357 882	–34.4	–33.0	–2.2
Portugal	63 763	79 901	77 232	75 424	18.3	25.3	–5.6
Romania	250 452	102 387	119 992	116 520	–53.5	–59.1	13.8
Russian Federation	3 394 690	1 573 820	1 651 921	1 601 610	–52.8	–53.6	1.8
Slovakia	71 543	46 876	44 783	46 923	–34.4	–34.5	0.1
Slovenia	12 121	10 168	12 061	12 753	5.2	–16.1	25.4
Spain	245 761	334 738	388 891	353 934	44	36.2	5.7
Sweden	41 396	32 736	51 349	49 595	19.8	–20.9	51.5
Switzerland	50 215	53 068	51 955	53 629	6.8	5.7	1.1
Turkey	142 159	229 448	303 702	285 922	101.1	61.4	24.6
Ukraine	859 586	341 605	390 331	411 257	–52.2	–60.3	20.4
United Kingdom	777 634	675 672	641 871	629 791	–19.0	–13.1	–6.8
United States	5 217 347	6 380 232	6 212 669	6 016 408	15.3	22.3	–5.7
Number of Parties showing a decrease in emissions by more than 1 percent					24	23	19
Number of Parties showing a change in emissions within 1 percent					2	0	1
Number of Parties showing an increase in emissions by more than 1 percent					15	18	21

(Source: UNFCCC: FCCC/SBI/2011/INF.1/Add.1, Distr.: General 23 May 2011)

Table 8. Total aggregate anthropogenic greenhouse gas emissions with emissions and removals from land use, land-use change and forestry, 1990, 2000, 2010 and 2016

Party	kt CO_2 eq				Change in emissions (%)		
	1990	2000	2010	2016	1990–2016	1990–2000	2000–2016
Australia	576 801	546 999	561 902	525 037	–9.0	–5.2	–4.0
Austria	66 708	64 067	79 053	75 464	13.1	–4.0	17.8
Belarusa	118 169	47 974	54 121	69 639	–41.1	–59.4	45.2
Belgium	144 220	147 894	131 176	116 578	–19.2	2.5	–21.2
Bulgaria	101 519	50 141	51 427	52 523	–48.3	–50.6	4.8
Canada	535 510	690 468	662 068	676 356	26.3	28.9	–2.0
Croatiaa	25 281	18 427	20 975	18 882	–25.3	–27.1	2.5
Cyprus	5 323	8 333	8 937	8 856	66.4	56.5	6.3
Czechiaa	190 913	140 254	133 570	124 246	–34.9	–26.5	–11.4
Denmark	75 387	74 914	63 693	57 034	–24.3	–0.6	–23.9
Estoniaa	38 854	13 934	19 145	16 903	–56.5	–64.1	21.3
European Union	5 386 300	4 844 478	4 448 675	3 989 760	–25.9	–10.1	–17.6
Finland	57 124	47 628	47 930	31 680	–44.5	–16.6	–33.5
France	523 489	532 863	479 254	428 550	–18.1	1.8	–19.6
Germany	1 220 323	1 007 008	926 414	894 925	–26.7	–17.5	–11.1
Greece	100 982	124 410	115 325	88 299	–12.6	23.2	–29.0
Hungary	107 682	72 986	61 331	57 197	–46.9	–32.2	–21.6
Iceland	13 727	14 156	15 162	14 891	8.5	3.1	5.2
Ireland	61 889	74 866	66 267	66 491	7.4	21	–11.2
Italy	515 321	538 809	473 349	397 935	–22.8	4.6	–26.1
Japan	1 204 248	1 284 423	1 230 488	1 247 797	3.6	6.7	–2.9
Latviaa	15 733	872	11 017	10 363	–34.1	–94.5	1 088.5
Liechtenstein	235	272	249	196	–16.5	15.7	–27.8
Lithuaniaa	43 046	10 912	11 727	11 638	–73.0	–74.6	6.7
Luxembourg	12 834	8 965	12 014	9 537	–25.7	–30.2	6.4
Malta	2 105	2 814	2 970	1 913	–9.1	33.7	–32.0
Monaco	100	108	86	79	–21.2	7.8	–26.9
Netherlands	226 658	225 122	219 302	201 710	–11.0	–0.7	–10.4
New Zealand	36 275	44 012	47 605	55 953	54.2	21.3	27.1
Norway	41 333	30 389	28 701	28 887	–30.1	–26.5	–4.9
Poland	553 914	356 696	375 577	367 872	–33.6	–35.6	3.1
Portugal	60 980	77 463	59 032	62 227	2	27	–19.7
Romania,	283 995	117 875	99 170	88 250	–68.9	–58.5	–25.1
Russian	3 893 153	1 847 582	1 943 666	2 009 362	–48.4	–52.5	8.8
Slovakia	64 434	39 617	39 921	34 176	–47.0	–38.5	–13.7
Slovenia	15 862	14 329	14 347	12 728	–19.8	–9.7	–11.2
Spain	248 307	342 602	315 432	283 962	14.4	38	–17.1
Sweden	35 589	30 666	19 771	9 923	–72.1	–13.8	–67.6
Switzerland	52 466	56 954	52 592	46 328	–11.7	8.6	–18.7
Turkey	181 792	258 754	356 607	427 989	135.4	42.3	65.4
Ukraine	889 283	375 125	370 178	320 642	–63.9	–57.8	–14.5
United Kingdom	797 787	708 924	601 077	471 726	–40.9	–11.1	–33.5
United States	5 536 014	6 463 882	6 206 014	5 794 522	4.7	16.8	–10.4
Number of Parties showing a decrease in emissions by more than 1%					32	23	29
Number of Parties showing a change in emissions within 1%					0	2	0
Number of Parties showing an increase in emissions by more than 1%					11	18	14

(Source: UNFCCC: FCCC/SBI/2018/INF.8/Add.1, Distr.: General 27 November 2018)

6. Historical Background

In the pre anthropogenic age (Pre-1850), the temperature variation was mainly due the solar irradiation and volcanism (Crowley, 2000), but in the post-industrial age, the reason for global warming has accelerated significantly due to the anthropogenic GHG (Houghton et al., 2001; York et al., 2003). Since 1900 the increase rate of global temperature is 0.6 ± 0.2 C has occurred unmatched in the last 1000 years (Matthews et al., 2004; Houghton et al., 2001; Crowley, 2000).

Over the geological time scale earth's climate is mainly accelerated by varying the enormity of total solar irradiance (TSI) and varying in greenhouse gas concentrations in the atmosphere. If CO_2 concentration continues to increase further into the twenty-third century, then the behavior of the Earth's climate will be unpredictable, whichever thought in the last 5 million years (Foster et al., 2017). Over the last few decades, due to pollution regulation and the distribution of emissions substances, the energy balance in the atmosphere has changed (Myhre et al., 2017). There is a possibility of abrupt changes of earth systems if the global mean surface temperature rise threshold of 2° C in respect to pre-industrial levels (Wang at al., 2017).

The possible reasons for instantaneous climate change have to make attention to the scientific communities and political authorities throughout the globe. Researchers are striving to find out the proper way of sustainability and explore the insight of earth environmental systems, which further extends the research to the context of "earth systems process" dealing with mainly different elements relating to the earth climate systems called "planetary boundaries". Galaz et al. (2012), Rockstrom et al. (2009) and Johan Rockstrom et al. (2009) were presented a summary of comparison on values and magnitude of earth systems process as pre-industrial to

present age defined as "Transgressing Planetary Boundaries" shown in Table 6.

It has been evident that all parameters of earth process systems have been increasing gradually compared to the pre-industrial age described in Table 6. The global CO_2 emission should decline 80% below the 1990 level by 2050 so that it would be possible to keep the atmospheric CO_2 concentration level within or below 450 ppm (Baer and Mastrandrea, 2006).

Whereas the research data evident that the average CO2 concentration in the atmosphere reached 405.5 ppm in 2017, 403.3 ppm in 2016, and 400.1 ppm in 2015, respectively (WMO, Greenhouse Gas Bulletin 2017). Atmospheric concentrations of CO_2 emission at present are 145% in respect of the pre-industrial level (Prior of 1750) (Greenhouse Gas Bulletin, 2017). As per WMO 2018, to increase global radiative force, CO_2 has contributed 82% since 1990 (WMO, 20 November 2018). The increase of GHG concentration in the atmosphere is mainly due to the human activity, UNFCCC (2009), published a report on the sector-wise contribution of global GHG presented in Table 1 and Fig. 1.

The main objective of the UNFCCC is to reduce the GHG concentration in the atmosphere for the sake of a better climate on the Earth. Carbon dioxide is the largest contributing gas to the greenhouse effect. Hope that the mechanism of the Kyoto Protocol can succeed the emission reduction target specified by the parties' agreement and would reduce the concentration of anthropogenic GHGs in the atmosphere within the probable specified period. (Capoor and Ambrosi, 2007).

Table 9. Summary of emission changes (increase/decrease) by the parties mentioned in Table 7 and Table 8

Description	Number of parties		
	1990–2016	1990–2000	2000–2016
Parties showing a decrease in emissions by more than 1%	32	23	29
Parties showing a change in emissions within 1%	0	2	0
Parties showing an increase in emissions by more than 1%	11	18	14
Description	**Number of parties**		
	1990–2008	**1990–2000**	**2000–2008**
Parties showing a decrease in emissions by more than 1%	24	23	19
Parties showing a change in emissions within 1%	2	0	1
Parties showing an increase in emissions by more than 1%	15	18	21

Table 10. Total GHG emissions for worlds and few selected country (1990-2012)

Country	1990 Gg CO_2eq	1995 Gg CO_2eq	2000 Gg CO_2eq	2005 Gg CO_2eq	2010 Gg CO_2eq	2011 Gg CO_2eq	2012 Gg CO_2eq	Change of emission, % (1990- 2012)
World total	32409720	33621340	35451110	40500730	44745350	45981160	46423330	43.24
USA	6030000	63480000	6877000	6856000	6474000	6361000	6125000	1.58
EU 28	5593752	5220755	5097451	5165661	4768989	4617400	4577402	-18.17
China	927000	5034000	5363000	8296000	10894000	11808000	12102000	1205.50
UK	764500	712000	693000	677000	592500	551800	559700	-26.79
UAE	79794	107730	122220	149530	205640	212090	225190	182.21
South Korea	317980	451800	534800	564100	644700	658400	653900	105.64
Germany	1230500	1103500	1014700	961000	928200	907500	916200	-25.54
Japan	1269200	1344900	1344600	1376900	1291500	1329000	1368700	7.84
France and Monaco	524200	518200	522900	527500	495300	463900	462600	-11.75
India	1425000	1699000	1925000	2187000	2892000	3020000	3166000	122.18

(Sources: EDGARv4.2, 1990; European Commission, Joint Research Centre (JRC)/PBL Netherlands Environmental Assessment Agency. EDGAR's Global Fossil CO_2 Emissions from 1990 to 2016 EDGARv4.3.2_FT2016 dataset)

Table 11. Total CO_2 emissions of worlds and few selected country (1990-2017)

World total/ Country	1990 (kton)	1990 (kton)	1990 (kton)	1990 (kton)	1990 (kton)	1990 (kton)	1990 (kton)	1990 (kton)	Change of emission, % (1990- 2017)
USA	22674089	25697193	30049770	33924230	35451841	36515871	36652267	37077341	63.52
EU 28	85896.78	5942427.8	5971571.2	5580707.8	5273584.6	5247226.4	5146300.7	5107393.2	5845.97
China	4409339	4121754	4249995	3918289	3725681	3510993	3510449	3548345	-19.53
UK	2397048.1	3671621.9	6263064.4	9124808.3	10256379	10808380	10777368	10877218	353.78
UAE	589037.69	552842.74	561543.48	502367.01	486995.49	416748.7	391471.52	379150.27	-35.63
South Korea	56922.36	88382.03	122394.72	171855.3	185719.36	202156.6	201939.15	202801.99	256.28
Germany	270055.94	481823.49	514946.07	596454.57	628583.97	646110.3	650768.94	673323.53	149.33
Japan	1018097.1	871124.85	837283.83	815945.35	803978.52	789892.52	798582.12	796528.91	-21.76
France and Monaco	1149399.8	1241516.9	1276862.9	1197379.5	1289286.3	1336499.7	1319801.9	1320776.1	14.91
India	386213.86	402048.66	408157.88	378391.15	349349.07	327725.36	332034.01	338193.16	-12.43

(Sources: Fossil, 2018; Fossil CO_2 emissions of all world countries - 2018 Report, EUR 29433 EN, Publications Office of the European Union, Luxembourg, 2018, ISBN 978-92-79-97240-9, doi:10.2760/30158, JRC113738)

7. Post Kyoto Scenarios of Climate Change

Since 1972, the International conference on climate change has played an important role in building a proper pathway for saving this planet through various policies and agendas formed by representatives of all nations. Finally, the Kyoto Protocol proposes to achieve the reduction by capping

emissions of all signatory nations to annual levels that many experts believe that it will reduce the anthropogenic contributions to global warming. However, there is considerable uncertainty surrounding the nature and magnitudes of the threats global warming poses. After 1972, almost two decades have been taken to make awareness to the nations to formulate the policy and mechanism procedure being implemented for GHG reduction, and finally, the Kyoto Protocol came to the picture. The Kyoto Protocol is the first legally binding commitment by nations to curb greenhouse gas emissions to 5% of 1990 levels. CDM process helps to work mutually understanding with incentives to reduce anthropogenic emissions of greenhouse gases in the atmosphere. (UNFCCC 1998; UNFCCC 2018b; CDM Tools). In the year 1998, UNFCCC published Annex B (Table 5) for Quantified emission limitation or reduction commitment (percentage of a base year or period); subsequently, 23 May 2011 and 27 November 2018, UNFCCC published the report on the status of change in anthropogenic emissions (%) concerning base year's level 1990, presented in Table 7 and Table 8, respectively.

Summary from the Table 7 and Table 8 presented in Table 9, it has been observed that number of parties showing a decrease in emissions by more than 1% during 2000-2016 is 29, whereas during 2000-2008 it was 19, also the number of parties showing an increase in emissions by more than 1% was 21 during 2000-2008 and it has been reduced during 2000-2016 as 14, so there is a positive trend to reduces the GHG and CO_2.

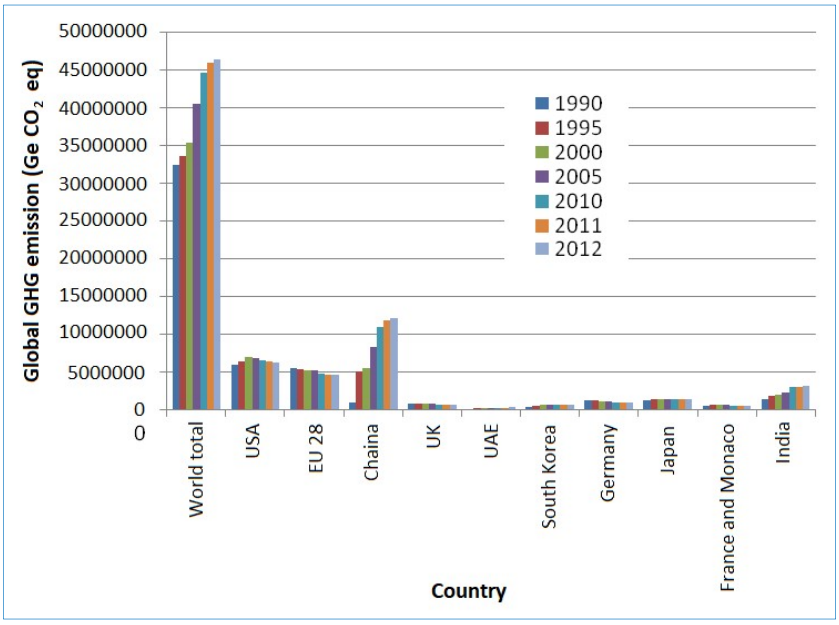

Fig. 3 Total GHG emissions for worlds and few selected country (1990-2012)

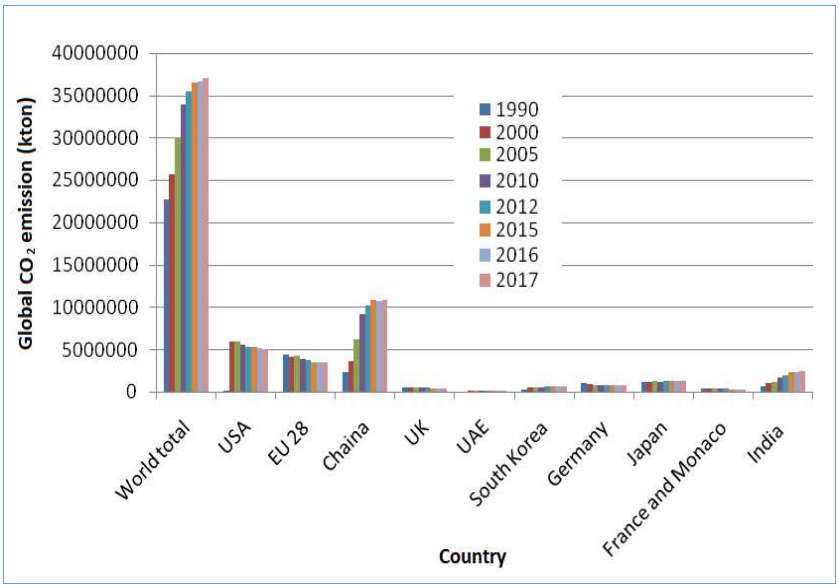

Fig. 4 Total CO_2 emissions of the world and a few selected countries (1990-2017) (Sources: Fossil CO_2 emissions of all world countries - 2018 Report)

Table 12. Top 10 countries plus European Union in absolute and relative contribution to temperature increase in 2100 resulting from emission including LULUFC

Country/Region	Contribution to temperature increase in 2100 resulting from Kyoto GHG emissions (°C)	Contribution to temperature increase in 2100 resulting from CO_2 emissions (°C)	Relative contribution in 2100 from Kyoto GHG emissions (%)
World total	1.015	0.784	100
USA	0.205	0.172	20.2
EU 28	0.176	0.140	17.30
China	0.123	0.100	12.1
Russia	0.063	0.049	6.2
India	0.054	0.038	5.3
Brazil	0.045	0.035	4.4
Germany	0.040	0.034	3.9
Great Britain	0.035	0.030	3.4
Japan	0.026	0.023	2.5
Indonesia	0.025	0.020	2.5
Canada	0.021	0.017	2.1
Rest of the World*	0.379	0.268	37.3

*The rest of the world include European Union countries that are not in the top ten *e.g., Italy or Poland.
(Source: Rocha et al., 2015 Policy-maker Model)

In the year of 2017, European Commission, Joint Research Centre, Ispra (VA), Italy, published a report on status of GHG emission (1990-2012) country-wise as well as world total, from that report a GHGs emission for few of major country and world total has been presented Table 10 and Fig. 3. In the year 2018, published another report of CO_2 emissions (1990-2017) country-wise as well as world total has been presented in Table 11 and Fig. 4, respectively.

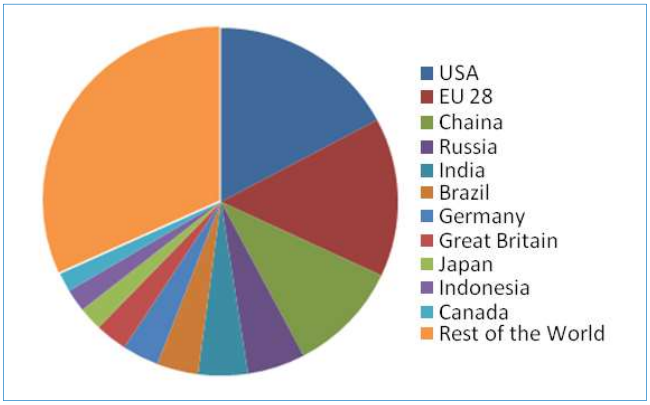

Fig. 5. Contribution to temperature increase in 2100 resulting from Kyoto GHG emissions (°C) (Rochaet. al., 2015)

Since the formation of the framework called CDM under Article 12 of the Kyoto Protocol to the UNFCCC, countries have been striving to mitigate GHG emissions the as per Kyoto mechanism regulation (Uddin et al., 2015; Zainuddin et al., 2017; Ellis et al 2007).

Tables 7-9, present the changes of aggregate anthropogenic emissions of GHG (CO_2 eq) which show mix trend of changes; however, due to the binding treaty of Kyoto protocol overall trend of emission changes and it seems that parties are striving to reach their targeted emission reduction quantity as set by the parties itself.

From the data presented in Tables 10-11, the trend of global greenhouse gas emissions and CO_2 has increased since the beginning of the 21st century in comparison to the past three decades, which is mainly due to the volume increase in carbon emissions from China and the other few countries. In turn, the concentrations of greenhouse gases in the atmosphere substantially increased, enhancing the natural greenhouse effect as a whole, causing a negative effect on life on the planet earth. Despite climate change mitigation agreements, the CO_2 emissions, which are the main responsible for global warming, are still increasing globally (Tables 10-11). The status of the GHG emission trend is already internationally addressed in the framework of UNFCCC.

Tables 10-11present that the emissions within the EU28 have decreased in the last two decades. Whereas emission increases by china and a few Asian countries. Man-made activities largely influence the total GHG, including CO_2 emissions mainly, thermal power generation and transport sector, fossil fuel burning domestic and commercial sectors play a key role. Research data shows that EU28, USA, UK, and UAE have emissions decreasing trends for the total for CO_2 and GHG presented in Tables 10-11 and in Figs. 3-4, respectively.

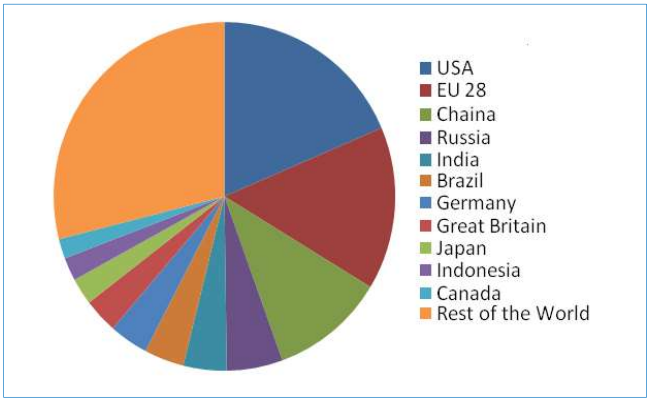

Fig. 6 Contribution to temperature increase in 2100 resulting from CO2 emissions (°C) (Rochaet. al., 2015)

There are grave concerns that the current and projected emissions rate will lead to irreversible damage to the Earth's

climate system (Ripple et al., 2017; Rockström et al., 2009; Steffen et al., 2015). As coordinated by UNFCCC, global climate change policy has made less progress. The first and only international agreement that sets outs of quantitative targets - the Kyoto Protocol - has seen limited success.

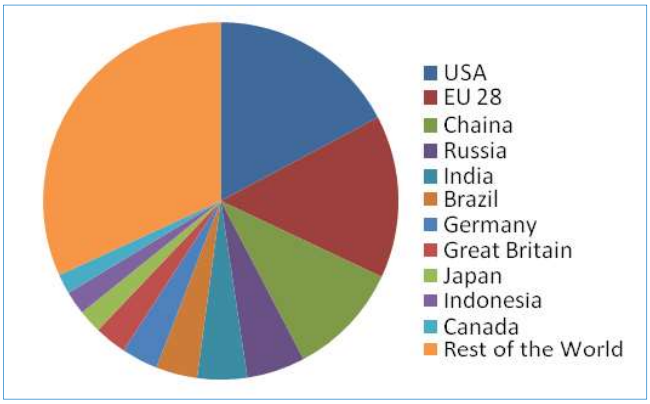

Fig. 7. Relative contributions in 2100 from Kyoto GHG emissions (Rochaet. al., 2015)

8. Future Prediction of Climate Change

The historical data and evidence demonstrate that species do respond to climate change; however, it is difficult to predict the scenario of the future reaction to climate change among species and creatures (Moritz and Agudo., 2013). Climate change projections and its impact on the future would be significant challenges facing the global community. Researchers and scientists are working diligently to predict the future climate scenario following various methodologies and modeling techniques (Dufresne, 2013), such as the scenario simulation (Meehl et al., 2005) and decadal climate prediction (Keenlyside et al., 2008). Rocha et al. (2015) emphasized a model called the 'Policy-maker Model', this model summarises an absolute and relative contribution to temperature increase in 2100 resulting from historical emissions, including LULUFC presented in Table 12 and Figs. 5-7.

Nevertheless, proper mitigation of future climate change would also necessitate an abrupt change in our lives regarding our living system and adaptation process. If the global emission concentration follows the current trend, it could increase by 2.0 °C–2.4 °C in temperatures. However, if we want to stabilize the atmospheric concentrations of GHG, global emissions would have to be reduced by 60–80% immediately (Mazo, 2009). The recent Paris Climate agreement hinges on the belief that all signatory nations would be trusted, whereby they would have their own environmental policies looking to reduce carbon footprint to the maximum extent possible. The US, one of the leaders of global carbon emissions, has withdrawn from this agreement, too, leaving a large financial gap in the Green Climate Fund (Harmsen, 2018; UNFCCC, 2018e, The Paris Agreement - main page).

9. Conclusion

From Stockholm to Kyoto, progress has been made indeed in terms of policies, regulations, and agreements pertaining to global climate change, including global initiatives to reduce anthropogenic emission concentration in the atmosphere. Progress in science and technology and the emergence of climate change research are giving us a clear understanding of the uncertainty of Earth's climatic systems and its probable reactions to anthropogenic and natural influences. Science, as it is today, observes that most of the global warming over the past several decades has been due to human activities. Mechanisms and initiatives for global climate change like the Kyoto mechanism and other carbon trading forums could certainly contribute to reducing anthropogenic emission concentration in the atmosphere, but this would be limited because the Earth's climate systems vary across a wide range of time scales with uncertainty. The Kyoto mechanism for emission stabilization doesn't precisely forecast the future climatic conditions, but it does give us plausible future anthropogenic emissions trends based on the analysis of available authentic scientific and technological information, and thereby it has been a landmark in terms of global climatic condition literature. Mitigation or adaptation alone will not solve the complication of climate change. It would need to find a combination of mitigation and adaptation to meet the provocation of climate change.

List of Abbreviations and Symbols

Abbreviation	Explanation
CDM	Clean development mechanism
CSD	Commission of Sustainable Development'
Gg	Giga Gram
GHGs	Greenhouse gas emissions
IPCC	Intergovernmental Panel on Climate Change
LULUFC	Land use, land-use change, and forestry, also referred to as Forestry
UNCED	United Nations Conference on Environment and Development
UNCHE	United Nations Conference on Human Environment
UNEP	United Nations Environment Program
UNFCCC	United Nations Framework Convention on Climate Change
UNGA	United Nations General Assembly
WCED	World Commission on Environment and Development
WMO	World Meteorological Organization

References

Annex, I., 1992. Report of the United Nations conference on environment and development. In Rio de Janeiro (3–14 June 1992) A/CONF (Vol. 151, No. 26, p. 12).

Baer, P., Mastrandrea, M., 2006. High stakes-designing emissions pathways to reduce the risk of dangerous climate change.

Barrett, S., 2003. Environment and statecraft: The strategy of environmental treaty-making: The strategy of environmental treaty-making. OUP Oxford.

Blanchard, O., Baumert, K.A., Perkaus, J.F., Llosa, S., 2002. Building on the Kyoto Protocol: Options for Protecting the Climate, World Resources Institute, Washington, DC

Bekiashev, K.A., Serebriakov, V.V., 1981. World Meteorological Organization (WMO). In International Marine Organizations (pp. 540-552). Springer, Dordrecht.

Bolin, B., 1991. The intergovernmental panel on climate change (IPCC). In Proceedings of the Second World Climate Conference (pp. 19-21).

Borowy, I., 2013. Defining sustainable development for our common future: A history of the World Commission on Environment and Development (Brundtland Commission). Routledge.

Burton, I., 1987. Report on reports: Our common future: The world commission on environment and development. Environment: Science and Policy for Sustainable Development 29 (5), 25-29.

Campbell, T.E., 1973. The Political Meaning of Stockholm: Third World Participation in the Environment Conference Process. Stan. J. Int'l Stud., 8, 138.

Capoor, K., Ambrosi, P., 2007. State and trends of the carbon market 2007. World Bank. Washington DC.

Conca, K., 1995. Greening the United Nations: Environmental organizations and the UN system. Third World Quarterly 16 (3), 441-458.

Crowley, T.J., 2000. Causes of climate change over the past 1000 years. Science 289 (5477), 270-277.

Declaration, R., 1992. Rio declaration on environment and development. Centre for Our Common Future, 52, rue des Paquis, 1201 Geneva, Switzerland.

Driesen, D.M., 2008. Sustainable development and market liberalism's shotgun wedding: Emissions trading under the Kyoto Protocol. Ind. LJ, 83, 21.

Dufresne, J.L., Foujols, M.A., Denvil, S., Caubel, A., Marti, O., Aumont, O., Bony, S., 2013. Climate change projections using the IPSL-CM5 Earth System Model: from CMIP3 to CMIP5. Climate Dynamics, 40(9-10), 2123-2165.

EDGARv4.2, 1990. European Commission, Joint Research Centre (JRC)/PBL Netherlands Environmental Assessment Agency. EDGAR's Global Fossil CO_2 Emissions from 1990 to 2016 (EDGARv4.3.2_FT2016 dataset).

Ellis, J., Winkler, H., Corfee-Morlot, J., Gagnon-Lebrun, F., 2007. CDM: Taking stock and looking forward. Energy Policy 35 (1), 15-28.

Fossil, 2018. Fossil CO_2 emissions of all world countries - 2018 Report, EUR 29433 EN, Publications Office of the European Union, Luxembourg, 2018, ISBN 978-92-79-97240-9, doi:10.2760/30158, JRC113738.

Foster, G.L., Royer, D.L., Lunt, D.J., 2017. Future climate forcing potentially without precedent in the last 420 million years. Nature Communications 8, 14845.

French, H.F., Hagerman, E., Ryan, M., 1992. After the Earth Summit: the future of environmental governance (Vol. 107). Washington, DC: Worldwatch Institute.

Galaz, V., Biermann, F., Folke, C., Nilsson, M., Olsson, P., 2012. Global environmental governance and planetary boundaries: An introduction.

Gray, M.A., 1990. The United Nations Environment Programme: An Assessment. Environmental Law 20 (2), 291-319.

Halvorssen, A.M., 2007. Common, but differentiated commitments in the future climate change regime-amending the Kyoto Protocol to include Annex C and the Annex C mitigation fund. Colorado Journal of International Environmental Law and Policy 18 (2), 247-266.

Handl, G., 2012. Declaration of the United Nations conference on the human environment (Stockholm Declaration), 1972 and the Rio Declaration on Environment and Development, 1992. United Nations Audiovisual Library of International Law, 11.

Harmsen, H., 2018. Effectiveness of UNFCCC in addressing climate change. Technical Report February, WMI, Nairobi.

Helm, C. 2003. International emissions trading with endogenous allowance choices. Journal of Public Economics 87 (12), 2737-2747.

Hens, L., 2005. The rio declaration on environment and development. Regional sustainable development review: Africa. Oxford, UK, Eolss Publishers.

Houghton, J.T., Ding, Y.D.J.G., Griggs, D.J., Noguer, M., van der Linden, P.J., Dai, X., Johnson, C.A., 2001. Climate change 2001: the scientific basis. The Press Syndicate of the University of Cambridge.

Joyner, C.C., Joyner, N.D., 1974. Global Eco_management and International Organizations: The Stockholm Conference and Problems of Cooperation. Natural Resources Journal 14 (4), 533-555.

Keeble, B.R., 1987. The Brundtland Commission: environment and development to the year 2000. Medicine and war, 3(4), 207-210.

Keeble, B.R., 1988. The Brundtland Report:'Our common future'. Medicine and War 4 (1), 17-25.

Keenlyside, N.S., Latif, M., Jungclaus, J., Kornblueh, L., Roeckner, E., 2008. Advancing decadal-scale climate prediction in the North Atlantic sector. Nature 453 (7191), 84-88.

Koester, V., 1990. From Stockholm to Brundtland. Environmental Policy and Law 20, 14.

Lau, L.C., Lee, K.T., Mohamed, A.R., 2012. Global warming mitigation and renewable energy policy development from the Kyoto Protocol to the Copenhagen Accord – A Comment. Renewable and Sustainable Energy Reviews 16 (7), 5280-5284.

Lau, L.C., Tan, K.T., Lee, K.T., Mohamed, A.R., 2009. A comparative study on the energy policies in Japan and Malaysia in fulfilling their nations' obligations towards the Kyoto Protocol. Energy Policy 37 (11), 4771-4778.

Leonard, H. J., Morell, D., 1981. Emergence of environmental concern in developing countries: a political perspective. Stan. J. Int'l L., 17, 281.

Linnér, B. O., Jacob, M., 2005. From Stockholm to Kyoto and beyond: a review of the globalization of global warming policy and north–south relations. Globalizations 2 (3), 403-415.

Matthews, H. D., Weaver, A. J., Meissner, K. J., Gillett, N. P., & Eby, M., 2004. Natural and anthropogenic climate change: incorporating historical land cover change, vegetation dynamics and the global carbon cycle. Climate Dynamics, 22(5), 461-479.

Mazo, J., 2009. Chapter five: Climate change and security. The Adelphi Papers 49 (409), 119-136.

Meehl, G. A., Washington, W. M., Collins, W. D., Arblaster, J. M., Hu, A., Buja, L. E., Teng, H., 2005. How much more global warming and sea level rise? Science 307 (5716), 1769-1772.

Moritz, C., Agudo, R., 2013. The future of species under climate change: resilience or decline? Science 341 (6145), 504-508.

Myhre, G., Aas, W., Cherian, R., Collins, W., Faluvegi, G., Flanner, M., Mülmenstädt, J., 2017. Multi-model simulations of aerosol and ozone radiative forcing due to anthropogenic emission changes during the period 1990–2015. Atmospheric Chemistry and Physics 17 (4), 2709-2720.

Philibert, C., Pershing, J., Gray, K., 2002. Beyond Kyoto: energy dynamics and climate stabilisation. OECD/International Energy Agency.

Rajamani, L., 2003. From Stockholm to Johannesburg: The anatomy of dissonance in the international environmental dialogue. Review of European Community & International Environmental Law 12 (1), 23-32.

Ripple, W.J., Wolf, C., Newsome, T.M., Galetti, M., Alamgir, M., Crist, E., 2017. World scientists' warning to humanity: a second notice. BioScience 67 (12), 1026-1028.

Rocha, M., Krapp, M., Guetschow, J., Jeffery, L., Hare, B., Schaeffer, M., 2015. Historical Responsibility for Climate Change–from countries emissions to contribution to temperature increase. Climate Analytics and Potsdam Institute for Climate Impact Research: Potsdam, Germany.

Rockström, J., Steffen, W.L., Noone, K., Persson, Å., Chapin III, F.S., Lambin, E., Nykvist, B., 2009. Planetary boundaries: exploring the safe operating space for humanity. Ecology and Society 14 (2), 32.

Rockström, J., Steffen, W., Noone, K., Persson, Å., Chapin III, F.S., Lambin, E. F., Nykvist, B., 2009. A safe operating space for humanity. Nature 461 (7263), 472.

Samaniego, J., Figueres, C., 2002. Evolving to a sector-based Clean Development Mechanism. KA Baumert, O. Blanchard, Llose and JF Perkaus (Editors), Options for protecting the climate. WRI, Washington.

Seyfang, G., 2003. Environmental mega-conferences - from Stockholm to Johannesburg and beyond. Global Environmental Change 13 (3), 223-228.

Shelton, D., 2008. Stockholm Declaration (1972) and Rio Declaration (1992). Max Planck Encyclopedia of Public International Law.

Sohn, L.B., 1973. Stockholm declaration on the human environment. Harvard International Law Journal 14, 423-515.

Steffen, W., Richardson, K., Rockström, J., Cornell, S.E., Fetzer, I., Bennett, E.M., Sörlin, S., 2015. Planetary boundaries: Guiding human development on a changing planet. Science 347 (6223).

Stephan, H., Zelli, F., 2007. International Organizations and the Global Environment. in "The Politics of the Environment" Ed. Okereke, C., London.

Sutter, C., Parreño, J.C., 2007. Does the current Clean Development Mechanism (CDM) deliver its sustainable development claim? An analysis of officially registered CDM projects. Climatic Change 84 (1), 75-90.

Swedish Environmental Protection Agency, 2002. Kyoto and Beyond. Issues and Options in the Global Response to Climate Change," Stockholm.

Uddin, N., Blommerde, M., Taplin, R., Laurence, D., 2015. Sustainable development outcomes of coal mine methane clean development mechanism Projects in China. Renewable and Sustainable Energy Reviews 45, 1-9.

Wang, Z., Lin, L., Zhang, X., Zhang, H., Liu, L., Xu, Y., 2017. Scenario dependence of future changes in climate extremes under 1.5 C and 2 C global warming. Scientific Reports 7, 46432.

Wiser, G., 2002. Frontiers in trade: the clean development mechanism and the general agreement on trade in services. International Journal of Global Environmental Issues 2 (3-4), 288-309.

Woerdman, E., 2000. Implementing the Kyoto protocol: why JI and CDM show more promise than international emissions trading. Energy Policy 28 (1), 29-38.

Wohlgemuth, N., Missfeldt, F., 2000. The Kyoto mechanisms and the prospects for renewable energy technologies. Solar Energy 69 (4), 305-314.

York, R., Rosa, E. A., Dietz, T., 2003. A rift in modernity? Assessing the anthropogenic sources of global climate change with the STIRPAT model. International Journal of Sociology and Social Policy 23 (10), 31-51.

Zainuddin, Z. B., Zailani, S., Govindan, K., Iranmanesh, M., Amran, A., 2017. Determinants and outcome of a clean development mechanism in Malaysia. Journal of Cleaner Production 142, 1979-1986.