

AVIATION ENVIRONMENTAL PROTECTION: IMPERATIVE FOR A SUSTAINABLE MOVEMENT THROUGH OMISSION OF (TOXIC) EMISSION

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Abstract

In the wake of increasingly organized movement of goods and services in a globalized world order, there is rising pressure on civil aviation as super fast mode of transportation. A moot point involved herein is whether and how far heavy resort to such a mode of transportation is conducive to new *mantra* like sustainable development in the post-*Rio* world.

Of the two major points of concern, e.g., aviation noise and emission, the latter constitutes focus of this paper. Aviation Turbine Fuel stems from nonrenewable fossil fuels and to be exhausted sooner or later. Further the same seems much more toxic in intensity and frequency to any other form of automobile emission in terms of air pollution. Above all, such air pollution at so high altitude seems to have overt underpinnings vis-à-vis integrity of the ozone layer and consequent greenhouse effect leading to the human induced climate change and global warming to the detriment of existing life forms on the planet. On another side of the same coin, super fast movement of goods and services seems to be an insignia of and *sine qua non* for emerging international trade. Thus civil aviation may collide at the crossroads of environment and development.

The author hereby submits few points for a rudimentary roadmap to transcend the dichotomy toward sustainable movement of goods and services all over the world. Thus crux of the points put forth is (i) decentralization of manufacturing goods and commercial services (ii) revival of modern maritime movement of goods and services (iii) resort to alternative Aviation Turbine Fuel non-toxic to ozone layer (iv) strict compliance of all state parties to international norms of emission standard set by the International Civil Aviation Organization (v) research and development for control of intensity and frequency of toxic emission from aircraft at least while flying at high altitude. Together the measures may initiate a crusade for clean movement of goods and services to facilitate transnational movement in amicable environ of trade without trade of the habitable environ of this planet being the only celestial object carrying life. Such carrying capacity of the Earth ought to prevail over the carrying capacity of goods and services through civil aviation.

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Introduction

In postwar world, and more so in the wake of newer international trade regime after establishment of the World Trade Organization, emergence of civil aviation industry all over the world seems to have appeared as one of the most crucial one which transcends territorial jurisdiction of all the nation states day in and day out in true sense of the term. To be specific, civil aviation has cut across the so called territorial sanctity of states with due permission from each one of them, an issue which seems otherwise sacrosanct under public international law. As an exception to international jurisprudence, transnational flight between nations is construed as *"dialogue between peoples"* as per the declared theme of the 2001 edition of the International Civil Aviation day, celebrated annually to mark the creation of the International Civil Aviation Organization (hereafter referred to as "the ICAO") on 7 December 1944.

Indeed an irony of fact that, on September 11 of 2001, such *"dialogue between peoples"* fell heavily on both towers of the World Trade Centre with a result that next year being centenary year of the historic flight by Wright brothers the ICAO preferred *"powered, controlled and sustained flight"* as the theme of the 2002 edition of the International Civil Aviation day. At bottom, however, the so called 9/11 attack was in a way or other an attack on official agenda of the ICAO as well safe and orderly growth of civil aviation.

Immediately thereafter, paragraph 3 of the Political Declaration of World Summit on Sustainable Development at Johannesburg, 2002 offered another lethal blow to civil aviation with corollary underpinnings over emission of Aviation Turbine Fuel (hereafter referred to as the ATF) and that also at so high altitude of atmosphere which has already had a delicate phase of deterioration out of greenhouse effect. Thus, methodology of *"dialogue between peoples"* seems to be apprehended to fell heavily on the new mantra of sustainable development as well. As a matter of fact, the ICAO was left with no other option but to call for the greening of aviation. Accordingly, *"maximizing compatibility between safe and orderly development of civil aviation and the quality of the environment"* was the theme for the 2005 edition of the International Civil Aviation Day. Such an emerging regime vis-à-vis aviation environmental protection with special reference to emission of the ATF constitutes focus of this paper.

Even thereafter, spectre of aviation environmental protection seems after the ICAO with the result that subsequent theme for the 2006 edition of International Civil Aviation Day was *"safety and security—first and always the top priority"* which covers experience of both—the World Trade Centre and Johannesburg Declaration. Through preference of its theme as *"global air transport—a driver of sustainable economic, social and cultural development"* for the

2007 edition of International Civil Aviation Day, the ICAO has once again put its priority over the new mantra of sustainable development for civil aviation in the post-Johannesburg world order along with introduction of a set of checks and balance instrumental to minimize aviation environmental pollution, at least in terms of emission of the ATF while meeting increasing pressure of international trade.

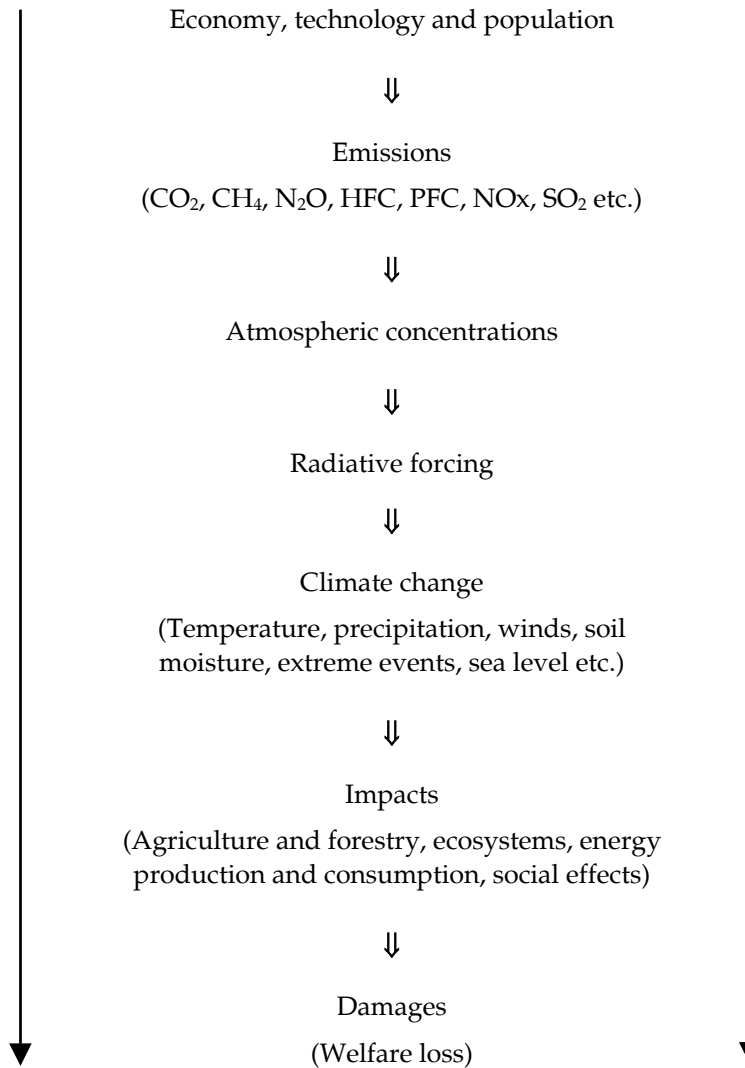
Political economy of energy efficiency

Nowadays, in an age of increasing threat toward a human induced climate change, myriad issues are involved therein which are otherwise unrelated to one another. Civil aviation and climate change constitute such nexus to hyperlink one another, along with umpteen others, since *Rio*.

As we may understand that civil aviation industry is run by uninterrupted supply of the ATF which is a refined end product and raw material of which is fossil fuel in one form or other and for the same reason exhaustible sooner or later. Supply of such non-renewable fossil fuel is therefore unsustainable as a means of production and consumption which is anathema to emerging sustainable development regime, and more so after Johannesburg Declaration.¹ Thus civil aviation industry cannot offer clean movement of goods and services instrumental for international trade. Through civil aviation in its present *modus operandi*, goods and services do move across international border at the cost of toxic emission of the ATF and that also at higher altitudes and thereby pose potential a threat to protective ozone layer leading to human induced climate change.

There seems vicious cycle operative at present mode of development-environment equation. First, constant pressure of economy and population to resort to available technology tends to emission of greenhouse gases and thereby allow the same to concentrate at high altitude of atmosphere. Second, consequent radiative forces lead toward human induced climate change with (c) overt impact on the flora and fauna of the Earth. Thus impacts occur in multiple ways, e.g., agriculture, forestry, ecosystem, etc. and thereby cause havoc damage leading to welfare loss of the people. Hard-earned result of development may thus be eaten up by unruly environment with the result that after complete cycle is over, dichotomy between development and environment may offer no passage to either. The same may be presented thus:

Chain of influences on climate²



Above all, consequent global warming will be melting hitherto concentrated polar icebergs and thereby contribute to rise in sea level to submerge considerable areas of human habitat including island states. Thus oncoming catastrophe is scheduled to throw seashore people in deeper water in true sense of the term. While seashore people will move elsewhere, population density will grow higher than ever before with newer predicament in decades ahead which may in turn catalyze intensity and frequency of human induced climate change.

While automobile industry contributes a lot to the process of climate change and consequent global warming,³ contribution of civil aviation industry to this end from so called developed countries needs no introduction.⁴ Under such circumstance development initiatives on the part of developing and least developed countries, most of them founded on traditional agrarian economy end in smoke out of such development induced smoke so emitted on the part of handful states in the Occident. Aftermath of toxic emission of greenhouse gases (hereafter referred to as the GHG) by such state tends to transboundary harm beyond territorial jurisdiction of state.

Idiosyncrasy of modern environmental pollution is such that, even if it so wishes, an errant state cannot contain its GHG emission within its own territorial domain as the same will spill over at higher altitudes and thus sinful emission of one state may be retributive to every sundry state on the Earth. Environment of this planet is globalized enough in true sense of the term and which state(s) may suffer from sin of which state(s) is beyond exact prediction at the given development of science. Thus the same resembles inhumanity in antipersonnel landmines to which friend and foe are all alike and which is meant for destruction irrespective of absence of belligerent object and purpose on the part of perpetrator state(s) and perpetrator state(s) themselves are not spared from adverse effects of global climate change. In fact, emission of the GHG will backfire its producer state(s) in a way or other, but along with other(s) even if not all states on the Earth. Thus, energy efficiency seems an insignia of and *sine qua non* for clean development of international trade in contemporary globalized economy.

Dichotomy between development and environment

While movement of goods and services is imperative for emerging international trade, civil aviation as a super fast mode of transportation is the flagship industry of modern market economy growth of which seems to be a moot point in the post—Copenhagen world. So often than not development and environment are perceived as antithesis of one another—a cliché which is misnomer and needs no clarification but an axiomatic erratum that development and environment are complementary and supplementary to one another and not at all at loggerheads. What is required in the post—Rio world is a pro-environment development agenda which is sustainable enough toward intra-generational and intergenerational equity all over the world. And, to this end, emission of toxic ATF and that also at high altitude is a matter of concern for civil aviation industry. Even if political economy of development and energy efficiency may be set aside, the question of sustainable development in terms of aviation environmental pollution needs to be addressed with urgency. The ICAO has identified two problems on a worldwide basis, namely aircraft noise and the impact of aircraft engine emissions.

The ICAO has established a Committee on Aviation Environmental Protection (hereafter referred to as the CAEP) in 1983 which consists of members

and observers from states, intergovernmental and non-governmental organizations representing aviation industry and environmental interests. The current structure of the CAEP includes five working groups. Of them, three deal with technical and operational aspects of aircraft emissions, and with the study of market-based measures to limit or reduce emissions such as emissions trading, emissions related charges and voluntary measures. So far the CAEP has held seven meetings ranging from 1986 to 2007 and thereby produced reports to facilitate the ICAO Council to act upon which is subject to supervision on the part of the ICAO Assembly in its meeting every three years.

Such a latest version is Resolution no. A36-22 as adopted by the ICAO Assembly in its 36th session during 18-28 September 2007. The Assembly thereby recognizes potential threat of anthropogenic intervention posed by the ATF toward climate and thereby encourages the Council to move ahead for settlement of the matter.⁵ The Council is also requested to cooperate with the IPCC to ascertain the matter.⁶ In the same document, the Assembly dealt with aviation impact on global climate and thereby requests the Council to offer leadership in issues like GHG emissions in particular and thereby continue its cooperation toward Conference of Parties under the UNFCCC regime.⁷

Thereafter the Assembly declared an ICAO Programme of Action on International Aviation and Climate Change,⁸ to be followed by a set of market-based measures including emissions trading⁹ as a comprehensive approach toward climate policy on the part of civil aviation as responsible stakeholder in international community. Whether and how far the emissions trading defeats purpose of climate protection is a point apart.

Besides the ICAO put initiative way back in 1999 to approach Intergovernmental Panel on Climate Change to work out a set of methodological issues to this end and, consequent to its endeavour, there was a draft conclusion by the Chairman of Subsidiary Body for Scientific and Technological Advice on November 3, 1999 which ascertained effects of emissions resulting from fuel used for international transportation.¹⁰ In such official document, however, there was no clear evidence on the part of the UNFCCC regime due to want of any scientific proof to this end. Together these measures reflect a bona fide political will on the part of the ICAO vis-à-vis prevention of further contribution of the ATF toward climate change and thereby resist further deterioration of environment as the cost of development of civil aviation industry.

Such a position of the ICAO seems conducive toward progressive development of law vis-à-vis climate change being the first ever global environmental agendum which by and large depends on scientific prediction of the oncoming catastrophe and demonstration of systemic lethargy over which may be too late to lament on. At least the ICAO cannot be blamed for the same.

And there lies a twist in such otherwise neat texture of climate diplomacy. The ICAO, being mindful as another organ under the United Nations

administration, handed over a contentious matter to concerned forum of the same administration and thereby played safe on its part. The IPCC, while approached by the ICAO to assert on its part, could not commit itself to declare the ATF as a potential threat since there is no such scientific evidence available to this end. So called rationale on the part of the UNFCCC regime seems contradictory enough while the regime itself dilutes seriousness of philanthropic consciousness by subversive measures like emissions trading which will allow covert trade of environ and thus facilitate environ of trade even in the wake of a proclaimed beginning of the end, if at all. As the concerned forum indulges in contentious measures like emissions trading, the ICAO follows the same. The UNFCCC, being a regime subverted from within, is yet to have a breakthrough in terms of its declared object and purpose, such as reduction of global warming and coping with hitherto increases in temperature so also is the case in case of aviation environmental pollution and climate change as corollary to the concerned regime.

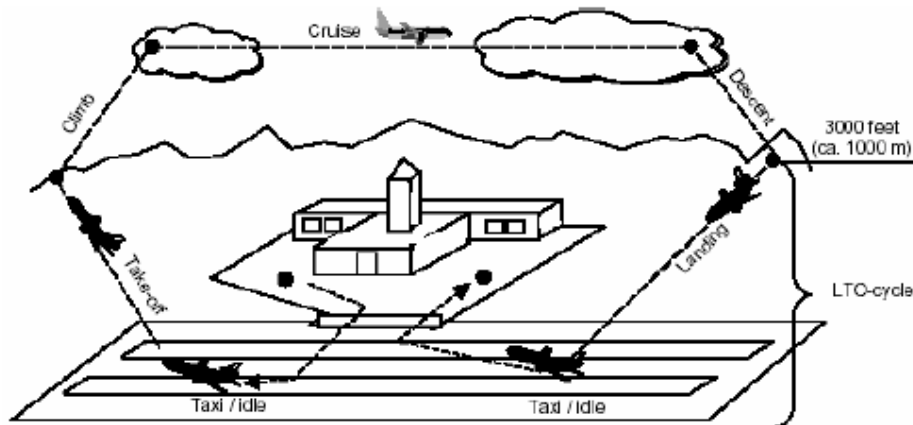
Not only could the climate change regime not move ahead with its own agenda, the concerned forum could offer no leadership to this end even after being asked for the same as happened to aviation environmental protection vis-à-vis emission of the ATF and climate change. Thus the contentious matter was mutually surfed between two platforms of the United Nations administration with no result while global public opinion may be camouflaged by such ocular opulence to this end.¹¹ But, at the same time, such a position on its part proves beyond reasonable doubt that the hitherto contention of pro-establishment lobby over partisan approach of the UNFCC regime in favour of an engineered craze toward protection of climate sounds empty as the UNFCCC could have otherwise (ab)used such an opportunity offered by the ICAO for whatever reasons may be. The forum seems not so moved by either side- corporate world and civil society.

Toxic emission of the ATF and climate change

Impact of aircraft—both in terms of its noise and emission- on climate is proved beyond doubt.¹² Indeed too difficult to quantify in terms of its climate impact,¹³ adverse effect of toxic emission of the ATF toward anthropogenic intervention in climate change has become an axiom. While taking the take-off upto the altitude of 3000 feet, emission seems much more than cruising flight at constant altitude.¹⁴ Thus, even if aircraft noise is set aside- another contentious issue to be dealt with elsewhere, toxic air pollution around airport atmosphere happens at highest level. Indeed extent of emission seems not so high while cruising at a constant altitude, such emission is equally toxic and at times may do more havoc than take-off time while aircraft is at higher altitude and thereby in closer proximity with stratosphere. Thus aircraft emission is instrumental to climate change during entire flight time.

Intensity and frequency of emission of the ATF may vary with the variable nature and feature of aircrafts concerned, but carbon neutral gas emission from

aircraft is still fiction till date. In a figure and a table below, there is illustration of aircraft movement and calculations of fuel burn respectively:



Representative calculations of fuel burn for a Boeing 737¹⁵

B737 400		Standard flight distances (nm) [1nm = 1.852 km]						
		125	250	500	750	1000	1500	2000
Distance (km)	Climb/cruise/descent	231.5	463	926	1389	1852	2778	3704
Fuel (kg)	Flight total	1603.1	2268.0	3612.8	4960.3	6302.6	9187.7	12167.6
	LTO	825.4	825.4	825.4	825.4	825.4	825.4	825.4
	Taxi cut	183.5	183.5	183.5	183.5	183.5	183.5	183.5
	Take off	86.0	86.0	86.0	86.0	86.0	86.0	86.0
	Climb out	225.0	225.0	225.0	225.0	225.0	225.0	225.0
	Climb/cruise/descent	777.7	1442.6	2787.4	4134.9	5477.2	8362.3	11342.2
	Approach landing	147.3	147.3	147.3	147.3	147.3	147.3	147.3
	Taxi in	183.5	183.5	183.5	183.5	183.5	183.5	183.5

Apart from technical database cited above, there is a summary of climate change impacts of aviation emissions annexed herewith in the appendix after conclusion of this paper which provides brief introduction of atmospheric pollutant factors toward climate change. Besides CO₂ being a GHG of 100 years odd life span, non-CO₂ GHGs of relatively shorter life span also contribute toward climate change. Together all these types of aircraft emissions may constitute a potential threat to atmosphere at the level of stratosphere. Of all hitherto GHG emissions, aircraft emission seems the only one which produces toxic GHGs at such higher altitude in closer proximity of stratospheric air and thereby more likely to destabilize the delicate balance of the same.

March of law against climate change

As per the age-old maxim of *salus populi suprema lex*, which prioritizes interest of the people over and above interest of individual or interest group in particular, no action (which includes omission) is allowed to the detriment of community. There are general exceptions to an offence in the statute book of any legal system of which the underlying principle is such maxim in a way or other. Accordingly, gross violation of the same seems to constitute tort or crime, as the case may be. This principle may be applicable here.

Commercial activities, along with civil aviation as major one, indulge culpability on the part of errant states on the points mentioned below. First, civil aviation is commercial enterprise and therefore subject to public policy. While transnational civil aviation transcends territorial jurisdiction of states in terms of its trajectory, the same is subject to universal public interest and global warming is inimical to such collective interest. Thus civil aviation cannot continue emission of either CO₂ or non-CO₂ GHG to the detriment of international community. Second, emission of GHG is tantamount to unjust enrichment of one sector at the cost of others and thereby attracts the *quantum meruit* as international trade through civil aviation cannot be allowed to grow at the cost of local occupations including agriculture, being a fundamental one. Third, even unintentional damage to other(s) constitutes tort of negligence irrespective of absence of *mens rea* at the back of human mind. Thus civil aviation industry cannot plead ignorance, at least in the post-*Rio* world, and thereby stuck into last but not the least point of allegation, that of culpability while there is a series of increasingly frequent international endeavours—from *Rio* (1992) to *Kyoto* (1997) to *Johannesburg* (2002) to *Bali* (2007) to *Copenhagen* (2009) to break the pace of anthropogenic interference with the climate system. While such a potential climate threat is matter of public record all over the world, *ignorantia juris non excusat* is at ease applicable to errant civil aviation industry for intentional pollution of life sustaining climate in the only planet carrying life to the detriment of such carrying capacity of the Earth. Thus onus of proof seems to lie on the accused to unfound the allegation of *mens rea* behind such emission which may trigger slow but steady motion of climate holocaust all over the world. Even if such *mens rea* cannot be established beyond reasonable doubt, allegation of criminal negligence may be pleaded and proved against civil aviation industry in terms of intensity and frequency of such offence(s).

And above all, whether such culpability being proved or civil aviation industry be condemned, effect of continued emission at contemporary intensity and frequency will not spare integrity of climate and thus existing life forms including humanity will suffer irreversible damage with impunity. Irreparable loss of bio-diversity will leave the world of flora and fauna at bay with its perennially broken food chains. Irrespective of the same is yet to be internalized by fraternity of international law, carrying capacity of the Earth is finite. Civil aviation as a means of anthropogenic intervention to climate system is engaged

in a deadly endgame across borderline of subtle balance of climate system. In long-term interest of humanity, global leadership just cannot indulge industry to play modern *Kalidasa*—to destabilize the life sustaining habitat on the planet we live since “*The Genesis*”¹⁶ and while there is no second life sustaining habitat in the universe.

There are emerging issues in public international jurisprudence like responsibility of states for internationally wrongful acts¹⁷ and international liability for injurious consequences arising out of acts not prohibited by international law which is again sub-divided into two—prevention of transboundary damage from hazardous activities¹⁸ and allocation of loss in the case of transboundary harm arising out of hazardous activities¹⁹ which may tentatively suit such an omission of emission and emission of omission on the part of civil aviation industry at higher altitude of atmosphere. While the former covers culpability on the part of people in power of states and thereby provides for responsibility for acts (which may include omission as well) perpetrated in official capacity, the latter (two) covers other action (or omission) not condemned under law for the time being in force but hazardous enough for other states to withstand such activities.²⁰

In built difficulty, however, lies in the corporate identity of aviation industry. Except few- too few- state-run corporations, aviation industry is by and large full of private players; the fact which poses legal conundrum whether and how far such private players are subject to (public) international law to apply international law commission prescriptions over them. Thus matter seems to remain in domain of the conflict of laws governed by the Hague Conventions regime. Public-private confusion plays vital role to offer clandestine players to operate from safe haven. The author hereby suggests to book concerned state as per registration of errant private operator as concerned state thereby allows the same to arrive and continue at aviation industry with deficient supervision on its part. Such a norm resembles vicarious liability which is an age-old legal doctrine to determine accountability under the common law system and thereby extends wider trajectory of law beyond the phenomena at a glance. Another common law principle of strict liability also may be applicable here to book the wrongdoer through procedural technicality of judicial process. While such matter generally lies in civil jurisdiction, doctrine of criminal negligence may be invoked as well.

In a nutshell, contribution to climate change can no longer be dealt with cliché of ‘polluter pays’ while question of survival of all hitherto life forms on this planet seems to be in the dock. An urgent need of the hour is to prefer prevention as first and better option, and thereafter, disaster management mechanism to cure lapses, if any. As an instrument of social transformation, law ought to respond to such an unprecedented threat to humanity through jurisprudential policymaking over the matter according to requirement of changing climate- before change in environ initiates, the world needs environ of change in world order.²¹

Conclusion

In post-Copenhagen world, such a change may not arrive at one conference of parties or ministers. Efforts must be on to this end to resist beginning of the end. Carrying capacity of the planet ought to prevail over carrying capacity of aviation industry as continuance of the former is instrumental to sustenance of the latter. The same is the case in case of climate diplomacy. Politics may only be played within the planet and not without. At least in larger interest of humanity, climate cannot be set as pawn in shrewd political chessboard of international community. As one among innumerable life forms on this planet, civilized humanity has had accountability toward other stakeholders as well. While suppressing unlawful act against the safety of civil aviation under relevant international instrument of 1971, civil aviation industry cannot be allowed to be inimical to the safety of the WTC. But aviation industry continues to be inimical to the safety of the Earth despite a decade-old mutual wordplay between the UNFCCC and the ICAO which cannot prevent the scheduled unholy to happen.

To this end, alternative method of clean development is the best policy to adopt. Decentralized production of goods and delivery of services may limit requirement of such transportation. Rest of the part being essential transportation may be done through maritime transportation which is more cost effective and less hazardous. Revival of maritime transportation is essential to this end.

Unless and until such paradigm shift is possible, alternative aviation turbine fuel which may emit carbon neutral gas(es) is a viable resort for green transportation. In the absence of such green ATF to be introduced with the passage of time, the industry must undertake scientific research endeavour to reduce the intensity and frequency of toxic emissions from the existing ATF, at least to higher altitudes. States ought to comply with aviation environmental norms set by the ICAO from time to time to this end and enforce the same for all civil aviation companies registered to them. While complying with the same, technical nitty-gritty like that of technology transfer cannot be a point of pleading common but differentiated responsibilities etc. Climate fund may be constituted to take care of bona fide fiscal constraint on the part of least developed countries. Only the strong political will of civil(ized) world may stop such countdown and thereby save the world from such self-induced anthropogenic intervention toward climate change in the decades ahead. Time is running short to this end.

Appendix

Climate change impacts of aviation emissions-summary²²

Climate Effect	Nature of Impact	Scientific Understanding
CO ₂ generation	<ul style="list-style-type: none"> • Has same impact wherever it is emitted. • Lasts in atmosphere for up to thousands of years. • The effect is global. • Warming. 	<p>“Good”. There is widespread acceptance that research provided a robust understanding of the scale and climate impacts of aviation related CO₂.</p>
Tropospheric ozone generation	<ul style="list-style-type: none"> • Emissions of NO_x during cruise generate tropospheric ozone (which can cause climate warming). The extent of the ozone effect also depends on altitude, location and atmospheric conditions. • The lifetime of ozone is weeks. • The warming effects are regional rather than global. 	<p>“Fair”. There is uncertainty over the extent of the impact. The IPCC notes that changes in tropospheric ozone levels are mainly in the Northern Hemisphere, while those of methane are global in extent. Given this, the net regional radiative effects do not cancel.</p>
Methane reduction	<ul style="list-style-type: none"> • Emissions of NO_x result in the reduction of ambient levels of methane (from other sources) in the atmosphere, which results in cooling. • The lifetime is around 8-12 years. • The effects are global. 	<p>“Fair”. There is uncertainty over the extent of the impact. The IPCC notes that changes in tropospheric ozone levels are mainly in the Northern Hemisphere, while those of methane are global in extent. Given this, the net regional radiative effects do not cancel.</p>

Contrails and cirrus cloud formation	<ul style="list-style-type: none"> • Contrails only form at altitude in very cold, humid atmospheric conditions. Ambient temperature and level of icesupersaturation regulate the lifetime of a contrail, which may vary from seconds to hours. Contrails may in turn lead to the formation of cirrus clouds. • Warming effects are highly dependent on altitude, location and atmospheric conditions. The extent of enhanced cirrus that arises from aircraft contrails and particle emissions is not well quantified, although there is some evidence of a correlation between cirrus trends and air traffic. 	"Fair" for contrails, but "poor" for Cirrus. Generally, the role of clouds, including cirrus, in climate change is one of the least understood aspects.
Soot and aerosols	<ul style="list-style-type: none"> • Effects are more pronounced at altitude than at ground level. • Soot traps outgoing infrared radiation and has a small warming effect. • Sulphate aerosols reflect solar radiation and have cooling effect • The lifetime of both is brief. • The effects are regional. 	Understanding is "Fair".

Endnotes

1. "At the beginning of this Summit, the children of the world spoke to us in a simple yet clear voice that the future belongs to them, and accordingly challenged all of us to ensure that through our actions they will inherit a world free of the indignity and indecency occasioned by poverty, environmental degradation and patterns of unsustainable development".

Paragraph 3, Johannesburg Declaration on Sustainable Development, 2002. Available at: <http://www.un-documents.net/jburgdec.htm> accessed on February 12, 2010.

2. Dr. Christian N. Jardine, Part I, Calculating the Environmental Impact of Aviation Emissions, Figure 4, Environmental Change Institute, Oxford, June 2005, p. 6. Available at:
http://www.jpmorganclimatecare.com/media/documents/pdf/aviation_emissions__offsets.pdf accessed on February 13, 2010.

3. "The Greenhouse Effect is the process by which the Earth's atmosphere absorbs infrared radiation coming from the planet's surface and radiates some of it back to the ground. This phenomena leads to a cycling of heat between the Earth's surface and atmosphere which increases the planet's average surface temperature to a level that supports life forms dependent on water in its liquid state. Greenhouse gases (GHG) are the naturally occurring gaseous components of the atmosphere that contribute to the Greenhouse Effect. Anthropogenic greenhouse gases, on the other hand, are those emissions produced by human activity (e.g. burning fossil fuels, land use changes) and are mainly CO₂, CH₄, N₂O and Halocarbons. The increasing levels of these anthropogenic GHGs increase the capacity of the atmosphere to absorb the infrared radiation emitted from the Earth and re-radiate a portion back to the planet, called the anthropogenic Greenhouse Effect. These emissions increase the earth's natural Greenhouse Effect, which in turn raises the mean surface temperatures of the Earth and the troposphere. This is known as Global Warming, and the consensus among relevant scientific communities is that this anthropogenic Greenhouse effect is changing the Earth's climate.

"The transportation sector is a major contributor to anthropogenic GHG emissions, in particular, through the use of internal combustion engines (ICE) vehicles. It is therefore not surprising that reducing GHG emissions from the transportation sector in general and ICE vehicles in particular is seen as an important part of any GHG reduction strategy".

Executive Summary of Life Cycle Greenhouse Gas Emission Assessments of Automotive Materials, 7 December 2007. Available at:

http://www.worldautosteel.org/uploaded/GHG_Study_ExecSummary_20071231.pdf accessed on February 14, 2010.

4. "Greenhouse gas emissions from aviation currently account for approximately 3.5% of emissions from developed countries".

Greenhouse gas emissions from the international aviation industry, Sourcewatch. Available at:

http://www.sourcewatch.org/index.php?title=Greenhouse_gas_emissions_from_the_international_aviation_industry accessed on February 13, 2010.

5. "The (ICAO) Assembly

... ..

Encourages the Council to promote improved understanding of the potential use, and the related emissions impacts, of alternative aviation fuels; and

Encourages the Council and States to keep up to date and cooperate in the development of predictive analytical models for the assessment of aviation impacts.

Paragraphs 3 & 4, Appendix I, Resolution A36-22, Consolidated statement of continuing ICAO policies and practices related to environmental protection, September 2007. Available at: http://www.icao.int/icao/en/env/A36_Res22_Prov.pdf accessed on February 14, 2010.

6. "The (ICAO) Assembly

Requests the Council to:

continue to cooperate closely with the IPCC and other organizations involved in assessment of aviation's contribution to environmental impacts on the atmosphere.

Paragraphs 1(b), *Ibid.*

7. "The Assembly:

Requests the Council to:

- (a) ensure that ICAO exercise continuous leadership on environmental issues relating to international civil aviation, including GHG emissions.
- (b) continue to study policy options to limit or reduce the environmental impact of aircraft engine emissions and to develop concrete proposals and provide advice as soon as possible to the Conference of the Parties of the UNFCCC, encompassing technical solutions and market-based measures, and taking into account potential implications of such measures for developing as well as developed countries; and
- (c) continue to cooperate with organizations involved in policy-making in this field, notably with the Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC) and its Subsidiary Body for Scientific and Technological Advice (SBSTA).

Paragraph 1, Appendix J, *Ibid.*

8. For details, refer Appendix K, *Ibid.*

9. For details, refer Appendix L, *Ibid.*
10. For details, refer English text of the UNFCCC document no. FCCC/SBSTA/1999/CRP.11 dated 3 November 1999. Available at: <http://unfccc.int/resource/docs/1999/sbsta/crp11.pdf> accessed on February 13, 2010.
11. For details, refer update on the continuing progress of ICAO on international aviation and climate change. Available at: <http://unfccc.int/resource/docs/2009/smsn/igo/059.pdf> accessed on February 14, 2010.
12. "Aircraft emit gases and particles directly into the upper troposphere and lower stratosphere where they have an impact on atmospheric composition. These gases and particles alter the concentration of atmospheric greenhouse gases, including carbon dioxide (CO₂), ozone (O₃), and methane (CH₄); trigger formation of condensation trails (contrails); and may increase cirrus cloudiness- all of which contribute to climate change". Joyce E. Penner et al (ed.), IPCC Special Report: Aviation and the Global Atmosphere, in collaboration with the Scientific Assessment Panel to the Montreal Protocol on Substances that Deplete the Ozone Layer, Intergovernmental Panel on Climate Change, 1999, p. 3.
13. "The climate impacts of the gases and particles emitted and formed as a result of aviation are more difficult to quantify than the emissions; however, they can be compared to each other and to climate effects from other sectors by using the concept of radiative forcing. Because carbon dioxide has a long atmospheric residence time (<100 years) and so becomes well mixed throughout the atmosphere, the effects of its emissions from aircraft are indistinguishable from the same quantity of carbon dioxide emitted by any other source. The other gases (e.g., NO_x, SO_x, water vapour) and particles have shorter atmospheric residence times and remain concentrated near flight routes, mainly in the northern midlatitudes. These emissions can lead to radiative forcing that is regionally located near the flight routes for some components (e.g., ozone and contrails) in contrast to emissions that are globally mixed (e.g., carbon dioxide and methane)".
Ibid.
14. "The fuel burn is attributed to different sections of the flight, which each use fuel at different rates. Emissions occur during:
 - The Landing and Take Off cycle which includes all activities near the airport that take place below the altitude of 3000 feet. This consists of taxi-out, take-off and climb out, and at the end of the flight, the landing approach and taxi-in. This is the fuel required to get the aircraft into the air (and down again) and are constant

irrespective of flight length. Ascents require a much more intense fuel burn than cruising at constant altitude.

- The Climb, Cruise and Descent cycle (CCD) is defined as all activities that take place at altitudes above 3000 feet (1000 m). This fuel use accounts for the bulk of the flight distance, and naturally varies with flight length.

Supra, note 3, p. 3.

15. *Supra*, note 3, p. 4.
16. Vide "The Book of Genesis", ed. by James M. Bower and David Beeman, Internet edition, 2003. Available at: <http://www.genesis-sim.org/GENESIS/iBoG/iBoGpdf/> accessed on February 13, 2010.
17. Text adopted by International Law Commission at its fifty-third session, 2001 and submitted to the General Assembly as part of the Commission's report covering the work of that session. Available at: http://untreaty.un.org/ilc/texts/instruments/english/draft%20articles/9_6_2001.pdf accessed on February 13, 2010.
18. Text adopted by International Law Commission at its fifty-third session, 2001 and submitted to the General Assembly as part of the Commission's report covering the work of that session. Available at: http://untreaty.un.org/ilc/texts/instruments/english/draft%20articles/9_7_2001.pdf accessed on February 13, 2010.
19. Text adopted by International Law Commission at its fifty-eighth session, 2006 and submitted to the General Assembly as part of the Commission's report covering the work of that session. Available at: http://untreaty.un.org/ilc/texts/instruments/english/draft%20articles/9_10_2006.pdf accessed on February 13, 2010.
20. For details, refer commentaries of concerned drafts available at website of the Commission.
21. For details, refer W. Friedmann, *Law in a Changing Society*, 2nd ed., 1972, first Indian reprint, 1996, chapter 13.
22. Table 1, "Non-CO₂ Climate Change Effects of Aviation Emissions", *Sustainable Aviation*, November 2008, p. 3. Available at: <http://www.scottish.parliament.uk/s3/committees/ticc/inquiries/documents/SustainableAviationnonCO2effects.pdf> accessed on February 6, 2010.