10 December 2008

ENGLISH ONLY

UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

AD HOC WORKING GROUP ON LONG-TERM COOPERATIVE ACTION UNDER THE CONVENTION
Fourth session
Poznan, 1–10 December 2008

Agenda item 3 (a–e)
Enabling the full, effective and sustained implementation of the Convention through long-term cooperative action now, up to and beyond 2012, by addressing, inter alia:
A shared vision for long-term cooperative action
Enhanced national/international action on mitigation of climate change
Enhanced action on adaptation
Enhanced action on technology development and transfer to support action on mitigation and adaptation
Enhanced action on the provision of financial resources and investment to support action on mitigation and adaptation and technology cooperation

Ideas and proposals on the elements contained in paragraph 1 of the Bali Action Plan

Submissions from intergovernmental organizations

Addendum

1. In addition to the eight submissions contained in document FCCC/AWGLCA/2008/MISC.6 and Add.1, 10 further submissions from eight organizations have been received.

2. As requested by the AWG-LCA, these submissions have been posted on the UNFCCC website.[1] In accordance with the procedure for miscellaneous documents, they are attached and reproduced[*] in the language in which they were received and without formal editing. The secretariat will continue to post on the relevant web page the submissions received after the issuance of the present document.

[1] <http://unfccc.int/4578>.

[*] These submissions have been electronically imported in order to make them available on electronic systems, including the World Wide Web. The secretariat has made every effort to ensure the correct reproduction of the texts as submitted.

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PAPER NO. 1A: INTERNATIONAL CIVIL AVIATION ORGANIZATION

INTERNATIONAL CIVIL AVIATION ORGANIZATION

Submission from the International Civil Aviation Organization - ICAO to AWG-LCA in relation to the elements contained in paragraph 1 of the Bali Action Plan
(FCCC/AWGLCA/2008/16)

The submission below was prepared following the text structure of the Assembly Paper - Note by the Chair of the AWG-LCA, *Ideas and proposals on paragraph 1 of the Bali Action Plan* (FCCC/AWGLCA/2008/16). Please note that the suggestion of a specific paragraph for the insertion of the ICAO proposed text in the Assembly Paper is only intended to facilitate its consideration.

Para. 23. (a)

(iv) Be based on the realization that in a carbon-constrained world, fossil fuels should be used in those applications where alternatives are least available (ICAO);

Para. 23 (b)

(v) Assign appropriate priority to drivers of economic activity, such as air transport. Such drivers are key contributors to not only the well-being of hundreds of millions of people around the world but also to achieving the United Nations Millennium Development Goals, particularly for less-developed and island countries that rely on air travel to reach international markets for their goods and for attracting business and tourist travel (ICAO);

Para. 23.(c)

(iv) Regarding the issue of funding adaptation/mitigation measures in relation to climate change through levies imposed on international aviation, ICAO is concerned over the proliferation of charges and taxes on air traffic, aviation being too often used as an easy target to raise revenue in various fields. It is important to remember that whenever levies are applied to address the protection of the environment, the principles of non-discrimination, transparency and cost-relatedness enshrined in the UNFCCC and the ICAO policies on charges and taxes should be taken into consideration, as well as the impact on all parties concerned, in particular the developing countries (ICAO);

Para. 66

(d) Emissions from international aviation are, by definition, global in nature and are not restricted to national boundaries. Accordingly, the task of assigning them would be extremely complex at best and equally difficult to implement or enforce (ICAO);

Para. 67

(h) Given the projected growth of aviation emissions, it is essential that aviation is addressed by a global policy framework encompassing a basket of measures of a technological, operational and market-based nature, one that takes into account the specific realities of States, Regions and stakeholders and that the level of emissions to be reduced be based on science-based information (ICAO);

Para. 85

(h) ICAO is currently preparing a Programme of Action on aviation and climate change, a comprehensive framework for addressing the global impact of aircraft emissions, that is intended to ultimately reflect the shared vision and strong will of all Member States of ICAO to address emissions from international aviation. It is important to note that the membership of ICAO represents a virtually identical constituency as the States that are parties to the UNFCCC (ICAO);

Para. 129

(d) Optimum compatibility between environmental sustainability and the safety and efficiency of the global air transport system must not be compromised. An environmentally friendly aviation industry that is not safe or efficient is not viable. An effective and lasting solution to handling emissions from international aviation must therefore involve a global organizational framework encompassing a basket of measures of a technological, operational and market-based nature, one that takes into account the specific realities of States, Regions and stakeholders. This will require unprecedented levels of cooperation with all parties concerned.(ICAO);

Para. 135

(d) Research and development in aviation technologies, such as advanced materials, improved aerodynamics, and use of alternative fuels, offers great promise and, once developed for aviation, will also trickle down to other sectors for an overall better environmental performance (ICAO);

Para. 140

(c) Technological research is essential for development in aviation. Although technology alone cannot resolve aviation's emissions of CO_2, it has been and will continue to be a key element of the solution in improving efficiencies in the air transport system. Significant research and development efforts are underway on further reducing aviation's impact on the environment. These efforts are expected to result in technological solutions that will enable a continuing trend of improvement in aviation efficiencies and benefits that, in turn, will allow ICAO to develop appropriate policies. A new and very promising area for research and development is aviation alternative fuels. This could be a win-win solution in that it would reduce aviation's GHG emissions while reducing its dependency on fossil fuels and stabilizing the associated economic volatility (ICAO);

Para. 166

(e) The main principles of non-discrimination, transparency and cost-relatedness should be considered in any measure contemplated, as well as the impact on all parties concerned, in particular the developing countries (ICAO);

(f) ICAO is concerned with the simultaneous implementation of several different schemes to address the same aviation CO_2 emissions. Initiatives such as the application of air transport environmental levies, the inclusion of aviation emissions in emissions-trading schemes and the use of aviation emissions offset programmes at a government, airline or individual level, would be directed at the same unit of CO_2 emitted by air transport operations (ICAO);

The text to Para.166 (e) and (f) above also apply to paragraph 172 (c) and (d).

PAPER NO. 1B: INTERNATIONAL CIVIL AVIATION ORGANIZATION

**Written Submission of the International Civil Aviation Organization (ICAO)
to the Workshop on Shared Vision for Cooperative Action
in the Fourth Session of the AWG-LCA**

(Poznan, Poland, 1-10 December 2008)

Shared Vision on International Aviation and Climate Change

Executive Summary

This submission summarizes the on-going efforts of ICAO in the development of a global framework to address GHG emissions from international aviation, which would be relevant to the discussions under the AWG-LCA relating to the Bali Action Plan paragraph 1(a) on *"A shared vision for long-term cooperative action, including a long-term global goal for emission reductions, to achieve the ultimate objective of the Convention, in accordance with the provisions and principles of the Convention, in particular the principles of common but differentiated responsibilities and respective capabilities, and taking into account social and economic conditions and other relevant factors"*.

While emissions from domestic aviation can be considered using the same approach applied to emissions from other sectors situated within a State, emissions from international aviation differ as they are not contained within a single State, and may occur within the territory of other States or in areas outside of recognized national boundaries such as over the high seas. Actions on international air transport taken by a State might have direct impact on the operations in another State. In this context, a well harmonized global framework is indispensable to effectively and globally deploy equitable measures to address international aviation emissions.

ICAO is actively working to develop this global framework through an aggressive *ICAO Programme of Action on International Aviation and Climate Change*, based upon the Resolution adopted in the 36th Session of the ICAO Assembly in September 2007, encompassing three key elements of 1) global aspirational goals for international aviation, 2) comprehensive measures to reduce emissions and 3) monitoring and implementation framework.

ICAO has formed an ad hoc high level group, consisting of 15 senior government officials from States that are geographically representative of developed and developing countries. This Group on International Aviation and Climate Change (GIACC) is tasked to develop the ICAO Programme of Action, a comprehensive framework for addressing the global impact of aircraft emissions. The GIACC has met twice and is currently considering the establishment of short, medium and long-term aspirational goals for fuel burn for the international aviation sector.

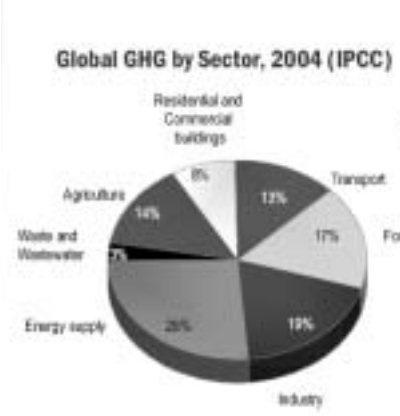
It must be emphasized that the development schedule of the Programme of Action by ICAO is aligned with the Bali Action Plan and supports UNFCCC efforts. The Programme of Action will be reviewed at a high-level meeting of ICAO and it is intended to ultimately reflect the shared vision and strong will of all Contracting States of ICAO to address emissions from international aviation. It is important to note that the Contracting States of ICAO represent a virtually identical constituency as the States that are parties to the UNFCCC.

1. CONTEXT : INTERNATIONAL AVIATION'S CONTRIBUTION TO GLOBAL CLIMATE

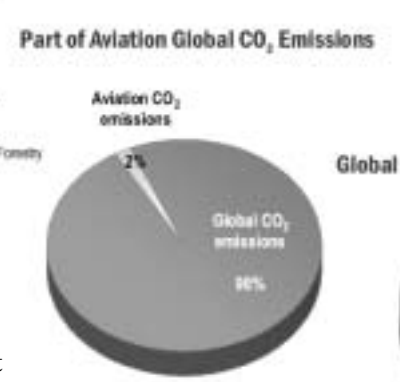
The ultimate objective of the United Nations Framework Convention on Climate Change (UNFCCC) is to achieve stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent an irreversible change in the global climate system. In this regard all activities, independent of their share of the contribution must pursue the means necessary to address their part of responsibility in the global picture.

The most comprehensive assessment to-date concerning aviation's impact on the upper atmosphere is contained in the *IPCC Special Report on Aviation and the Global Atmosphere* in 1999. The IPCC AR4 includes an update of the main finding of the Special Report as well as new findings related to aviation emissions. Findings related to aviation emissions *inter alia* that total aviation (domestic and international) CO_2 emissions is approximately 2 percent of all global CO_2 emissions.

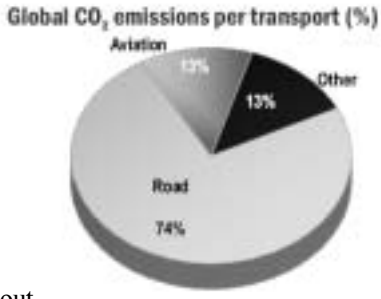
Within this 2 percent of the global CO_2 emissions attributed to the aviation sector, a substantive part represents domestic aviation emissions, which follow the same treatment agreed under the UNFCCC and Kyoto Protocol as other emissions of a domestic nature. Slightly more than half of aviation emissions are attributed to international aviation operations. However, this amount is projected to grow around 3 to 4 percent per year, and ICAO has been actively developing a global framework to address emissions from international aviation as described in paragraph 2.



In 2004, the entire global transport sector was responsible for 13% of all greenhouse gases emissions.



Total aviation (domestic and international) accounts for about 2% of all global CO_2 emissions.



Total aviation accounts for about 13% of CO_2 emissions from transport sources compared to 74% of total transport CO_2 emissions from road transport.

Figure 1 - Global CO_2 emissions and global Green House Gases (GHG) per sector Source – IPCC

The Kyoto Protocol includes binding emissions reduction targets for developed countries for the period 2008-2012. Emissions from domestic aviation are included in the total emissions reported and subject to these targets. Emissions from international aviation are addressed under Article 2.2 of the Kyoto Protocol, which reads: *"The Parties included in Annex I shall pursue limitation or reduction of*

emissions of greenhouse gases not controlled by the Montreal Protocol from aviation and marine bunker fuels, working through the International Civil Aviation Organization and the International Maritime Organization, respectively".

Several key characteristics of international aviation led to its inclusion in Article 2.2 of the Kyoto Protocol. One of them is the complexity of monitoring and collecting information and assigning emissions of a mobile nature. An international aircraft route might include over-flying different sovereign States and the high seas, and there is currently an unresolved debate over the allocation of these emissions.

Air transport is a fast and reliable mode of transport with no comparative alternative for long distance travel. Actions on international air transport taken by a State might have direct impact on the operations in another State. In order to collect the required data and put in place effective measures to address international aviation emissions, a globally harmonized framework is indispensable.

2. ICAO'S VISION ON AVIATION EMISSIONS

2.1 Group on International Aviation and Climate Change (GIACC)

All 190 Contracting States of the ICAO agreed to the formation of an ad-hoc high-level group called GIACC (Group on International Aviation and Climate Change) in the 36th Session of the ICAO Assembly in September 2007. The GIACC has been tasked to develop a global framework through an aggressive *ICAO Programme of Action on International Aviation and Climate Change* with technical support provided by CAEP (Committee of Aviation Environmental Protection), a technical committee of the ICAO Council. The GIACC was formed in January 2008, comprising of 15 senior government officials representative of all ICAO regions with the equitable participation of developing and developed States.

Three key elements of the ICAO Programme of Action to be developed are 1) global aspirational goals for international aviation, 2) comprehensive measures to reduce emissions, and 3) monitoring and implementation framework consistent with the Assembly Resolution A36-22 Appendix K (attached). GIACC held its first and second meetings in February 2008 and July 2008, respectively, in which the three working groups were formed to expedite work on each of the three key elements of the ICAO Programme of Action, as follows:

WG/1 Global Aspirational Goals Working Group "*Establish the feasibility of possible aspirational goals which emerged from discussion at GIACC/2 and to provide a set of options for global aspirational goals in the form of fuel efficiency, to GIACC/3 for consideration."*

WG/2 Measures to Achieve Emissions Reductions "*Provide information on measures and good practice examples of which States could take to address the climate change impact of international aviation."*

WG/3 Monitoring and Implementation Working Group "*Recommend to the GIACC how best to monitor and report on progress towards aspirational goals, in accordance with international obligations."*

These working groups have been tasked with bringing specific proposals forward for consideration at the 3rd GIACC meeting, to be held from 16 to 18 February 2009. In parallel with the GIACC activities, CAEP has been progressing its technical work that will support and continue to inform the GIACC process, mainly on goal setting and mitigation activities.

Goal Setting Activities

Prior to the formation of GIACC, the 7th meeting of CAEP in February 2007 decided to establish medium and long-term fuel burn goals relating to technological development of airframe and engines, as well as those goals relating to operational measures such as the improvement of air traffic management. Utilizing the Independent Experts (IE) processes under CAEP, both activities are steadily underway and the projections on technological and operational improvements will be incorporated into the environmental goals assessment for year 2016, 2026, 2036 and 2050 timeframes using prediction models. The "Commercial Aircraft System Fuel Efficiency Metric" (CASPER) is the product of payload and distance and was agreed as the fuel-efficiency metric for the analyses of the environmental goals assessment.

Mitigation - Comprehensive Measures to reduce emissions from international aviation

Much work of the Organization has been focused on measures to reduce emissions. Measures explored and under development by ICAO are being made available to the GIACC process and a summary of this work is provided below.

ICAO published in 2004 the guidance to achieve fuel efficiency through operational measures - *Operational Opportunities to Minimize Fuel Use and Reduce Emissions* (Circular 303). This guidance identifies and reviews various operational opportunities and techniques for minimizing fuel consumption and hence GHG emissions in civil aviation operations. Operations covered in the guidance are: ground-level and in-flight aircraft operations, ground service equipment (GSE) and auxiliary power units (APUs), with potential actions to facilitate their broader application. A new guidance document replacing the current Circular 303, is being prepared with an update on current initiatives relating to fuel-burn reductions as well as extended provisions including reporting and monitoring of aviation emissions and aviation emissions assessment methodologies.

ICAO has also developed guidance - *Global Air Navigation Plan* (Doc 9750) which provides a planning strategy aimed at achieving benefits of Air Traffic Management (ATM) to assist Contracting States and regional planning groups in identifying the most appropriate operational improvements and to support their implementation such as, flexible use of airspace, reduced vertical separation minimum, performance based navigation, air traffic flow management, and terminal area design and management. Each ICAO region has identified specific performance objectives, supported by the Global Air Navigation Plan Initiatives, and has developed work programmes to bring near and medium term benefits, while integrating those programmes with the extensive work already accomplished.

With regard to market-based measures, ICAO has developed policies and guidance material and has been collecting information on three market-based measures: 1) voluntary measures; 2) emission-related charges; and 3) emissions trading.

ICAO developed a template in 2004 for voluntary agreements between aviation industries and public organizations, and has collected information on voluntary actions to reduce aviation GHG emissions by Contracting States and various stakeholders in 2007. Sharing the information would help other entities to initiate similar measures or improve their current measures. In 2007 ICAO has published guidance on local emission-related charges in 2007 (*Guidance on Aircraft Emissions Charges Related to Local Air Quality*, Doc 9884) and developed the guidance for use by States for incorporating international aviation emissions into their trading schemes (*The Guidance on the Use of Emissions Trading for Aviation,* Doc 9885).

CAEP is now studying the main issues related to linking emissions trading schemes including aviation. It is also exploring the potential for emissions offset measures to mitigate effects of aviation on climate change. In June 2008, ICAO hosted a workshop on Aviation and Carbon Markets that provided further information on this issue to the consideration of GIACC.

Alternative fuels are also part of the possible solutions and GIACC has requested ICAO to provide updated information on this subject by its next meeting. A workshop with information on the main current activities in this field is being organized from 10 to 12 February 2009.

2.2 Timeline to complete the ICAO Programme of Action

The outcomes of on-going three working groups will be considered at GIACC's third meeting in February 2009, followed by its final meeting in June 2009. Finally, the recommendations from GIACC on the ICAO Programme of Action will be reviewed at a high-level meeting at a time which would take into account COP 15 in December 2009.

3. INTERNATIONAL AVIATION IN THE BALI ROAD MAP

The 36th Session of the ICAO Assembly, held in September 2007, agreed on the development of a Programme on International Aviation and Climate Change. In December 2007, a comprehensive programme was also launched at the UNFCCC COP13 to enable the development of future climate change agreement - the so called "Bali Road Map". Interestingly, ICAO and UNFCCC have set up two separate but parallel streams of activity, which will culminate at the end of 2009.

Although international aviation does not figure amongst the major focus areas in the new climate agreement architecture, substantial discussions have already taken place in the various subsidiary bodies of the convention on the best way to address these emissions in the future. ICAO has cooperated with consistent and timely information to respond to the UNFCCC requests with a view to facilitate the process leading to COP/15 and has firmly reiterated its commitment for full cooperation in the pursuit of the best results in addressing international aviation emissions. The paragraphs below describe ICAO's contributions to the process.

3.1 **Bangkok Climate Talks (March 2008)**

The need to include aviation and maritime bunker emissions with specific targets in the commitments of Annex I countries under the post-2012 framework was a main subject of discussion at the first part of the fifth session of Ad Hoc Working Group on Further Commitments for Annex I Parties under the Kyoto Protocol (AWG-KP). ICAO provided presentations to two sessions of the workshop, namely "Possible approaches targeting sectoral emissions" and "The greenhouse gases (GHG), sectors and source categories to be covered". Information was provided on emissions from international aviation and ICAO polices on quantification, mitigation, adaptation and technology transfer; and on the challenges regarding emissions data, methodological and legal issues. This information can be found at http://www.icao.int/icao/en/env/statements.htm. On the ensuing discussions there was a difference of opinion where some parties expressed the need to maintain discussions related to international aviation in ICAO while others called for action under UNFCCC. After deliberations, it was agreed that discussions on this item should continue during the next meetings.

ICAO provided a Statement to the First session of the Ad hoc Working Group on Long-term Cooperative Action under the Convention (AWG-LCA1), highlighting the ongoing work in ICAO to develop a Programme of Action on Aviation and Climate Change, the results of the first meeting of the GIACC and the need to further strengthen the cooperation between the two organizations, building upon and making the best use of their expertise. ICAO also called for a more effective collaboration within member States, emphasizing how essential it is to align and coordinate the positions and views of the States representatives taking part in meetings in UNFCCC and ICAO when discussing environmental future international agreements in order to have successful policies for civil aviation and the environment.

3.2 **Bonn Climate Talks (June 2008)**

In the AWG KP, the main issue for aviation remained the possible inclusion of international aviation in the Annex I countries targets. Under the item "sectors and source categories", Parties discussed possible actions under the UNFCCC, IMO, and ICAO. Some Parties supported controlling maritime and aviation emissions under the UNFCCC, while others preferred addressing them through IMO and ICAO.

The meeting was provided with the summary of the Chair containing all ideas raised by Parties. This summary included the following options: 1) ICAO and IMO should take the lead, 2) UNFCCC should agree on mitigation objectives, and ICAO and IMO should implement these objectives, and 3) UNFCCC should take the lead by allocating emissions from bunker fuels to national totals, and ICAO and IMO to provide technical expertise. Strong insistence by some parties led to the bracketing of the section dealing with bunker fuels in the final document. The AWG KP agreed to continue discussions at their following meeting in Accra.

Discussions on bunker fuels were historically conducted under the Subsidiary Body for Scientific and Technological Advice (SBSTA), where no progress had been achieved since the 22nd sessions of SBSTA three years ago. The 28th session of SBSTA in June 2008 agreed that: "for the next three sessions, the UNFCCC expects to receive information from both ICAO and IMO on bunker fuels, and Parties under the UNFCCC will have an exchange of views on this information". The issue of bunker fuels will again be considered by SBSTA to decide on any follow-up activities starting in May-June 2010.

3.3 **Accra Climate Talks (August 2008)**

Aviation was not the main focus of this meeting, nevertheless there were a few side events related to aviation. ICAO Secretariat, in cooperation with aviation manufacturers (ICCAIA), airlines (IATA) and air navigation providers (CANSO) held a side event entitled “Aviation Actions and Initiatives on Climate Change”. Information was presented on the main achievements and current work to address emissions from international aviation at both technological and operational levels.

The main focus of the meetings was on how to involve developing countries on a new post 2012 agreement. Most of the attention in the AWG-LCA discussions was on reducing emissions through deforestation, and on cooperative sectoral approach and sector specific actions, the so called “Sectoral approach”. The Accra meeting made clear that sectoral approaches were not about establishing mandatory targets. ICAO provided the meeting with the developments on ICAO’s Carbon Calculator, the results of the second GIACC meeting, and the results of the ICAO’s Aviation and Carbon Markets Workshop.

The AWG KP 6 in Accra when discussing agenda item (Agenda item 3 (c)) "Greenhouse gases and source categories to be covered, and possible approaches targeting sectoral emissions" concluded that the group did not have time to consider the sub-item "Emissions from aviation and marine bunker fuels" and agreed that it would be considered at the resumed sixth session.

Discussions also focussed on the need for finance and technology transfer for mitigation and adaptation. Of note is that aviation was mentioned by some parties as an example of source of revenue for these measures.

4. **NEXT STEPS**

There remains very short time available for preparing and drafting the Copenhagen agreement. ICAO will continue to follow up and provide information and advice to the UNFCCC process leading to the 15th Session of the Conference of the Parties (COP15) in Copenhagen and is attaching high priority to the activities supporting this process. Currently there is synchronisation of activities is as follows:

<table>
<tr><th>ICAO/GIACC PROCESS</th><th>DATES</th><th>UNFCCC PROCESS</th><th>DATES</th></tr>
<tr><td>Third GIACC meeting</td><td>16-18 Feb. 2009</td><td>AWG-KP7 and AWG-LCA5</td><td>29 March-8 April 2009</td></tr>
<tr><td>Aviation and alternative fuels workshop</td><td>10-12 Feb. 2009</td><td rowspan="3">Thirtieth sessions of the UNFCCC Convention subsidiary bodies - SBSTA and SBI, AWG-LCA6 and AWG-KP8</td><td rowspan="3">1-12 June 2009</td></tr>
<tr><td>Fourth GIACC meeting</td><td>1-3 June 2009</td></tr>
<tr><td>High Level Meeting in connection with COP/15</td><td>(date tbd)</td></tr>
<tr><td>CAEP Steering Group</td><td>22-26 June 2009</td><td>AWG-KP9 and the AWG-LCA7</td><td>August 2009</td></tr>
<tr><td>Alternative fuels Conference</td><td>November 2009</td><td rowspan="2">COP 15</td><td rowspan="2">30 Nov.-11 Dec. 2009</td></tr>
<tr><td>Eight Session of Committee on Aviation Environmental Protection (CAEP/8)</td><td>1-12 Feb. 2010</td></tr>
</table>

5. CONCLUDING REMARKS

Emissions from international aviation are global in nature and cannot be allocated to national or recognized geographic boundaries. Assigning international emissions is an extremely complex task at best and difficult to implement or enforce as made clear in the past discussions of SBSTA.

As a specialized agency responsible for the highest possible degree of uniformity and harmonization among its Contracting States and stakeholders on international aviation matters, ICAO is working actively and aggressively for a global framework to address emissions from international aviation sector through the development of ICAO Programme of Action.

It should be noted that *ICAO and its Contracting States recognize the critical importance of providing continuous leadership to international civil aviation in limiting and reducing its emissions that contribute to global climate change* in the last ICAO Assembly (Resolution A36-22 Appendix K).

It should also be noted, as a result of intensive discussions during the last ICAO Assembly, that all Contracting States *acknowledged the principles of non-discrimination and equal and fair opportunities to develop international civil aviation set forth in the Chicago Convention, as well as the principles and provisions on common but differentiated responsibilities and respective capabilities under the UNFCCC and the Kyoto Protocol* (Resolution A36-22 Appendix K).

Good progress is being achieved in the developments of the ICAO's Programme of Action under three key elements: global aspirational goals, comprehensive measures, and monitoring and implementation framework, with the support of technical expertise in the fields of aviation and environment. The ICAO Programme of Action will ultimately reflect the vision and strong will of all Contracting States of ICAO to achieve the best results on addressing aviation emissions.

ATTACHMENT

Resolution A36-22: Consolidated statement of continuing ICAO policies and practices related to environmental protection

APPENDIX K

ICAO Programme of Action on international aviation and climate change

Whereas ICAO and its Contracting States recognize the critical importance of providing continuous leadership to international civil aviation in limiting or reducing its emissions that contribute to global climate change;

Whereas the rapid growth of civil aviation, has generally increased the aviation industry's contribution to greenhouse gas emissions;

Acknowledging the principles of non-discrimination and equal and fair opportunities to develop international civil aviation set forth in the Chicago Convention, as well as the principles and provisions on common but differentiated responsibilities and respective capabilities under the UNFCCC and the Kyoto Protocol;

Whereas the ICAO Council has developed policy options to limit or reduce the environmental impact of aircraft engine emissions from civil aviation and work is in progress on technology and standards, on operational measures and on market-based measures to reduce emissions;

Noting that, to promote sustainable growth of aviation, a comprehensive approach, consisting of work on technology and standards, and on operational and market-based measures to reduce emissions is necessary;

Noting that emphasis should be on those policy options that will reduce aircraft engine emissions without negatively impacting the growth of air transport especially in developing economies;

Acknowledging the significant progress made in the aviation sector, with aircraft produced today being about 70 percent more fuel efficient per passenger kilometre than 40 years ago, with airlines of some Contracting States achieving net reductions in emissions over the past several years despite a simultaneous increase in operations, and with the commitment of the international airline industry to achieving a further 25 percent fuel efficiency improvement between 2005 and 2020;

Noting that the next generation of aircraft technology and modernization of air traffic systems are expected to deliver additional improvements in flight and fuel efficiency that can be encouraged by ICAO through its Global Air Navigation Plan;

Recognizing that ICAO Standards and goals for NO_x, although intended to address local air quality, will also help reduce the impact of aviation on the climate;

The Assembly:

1. *Requests* that the Council facilitate action by States by vigorously developing policy options to limit or reduce the environmental impact of aircraft engine emissions, developing concrete proposals and providing advice as soon as possible to the Conference of the Parties of the UNFCCC, encompassing technical solutions and market-based measures, while taking into account potential implications of such measures for developing as well as developed countries;

2. *Requests* the Council to:

a) form a new Group on International Aviation and Climate Change composed of senior government officials representative of all ICAO regions, with the equitable participation of developing and developed countries, with technical support provided by the Committee on Aviation Environmental Protection, for the purpose of developing and recommending to the Council an aggressive Programme of Action on International Aviation and Climate Change, based on consensus, and reflecting the shared vision and strong will of all Contracting States, including:

1) an implementation framework consisting of economically efficient and technologically feasible strategies and measures that Contracting States can use to achieve emissions reductions, encompassing *inter alia*:

— voluntary measures (e.g. offsetting);

— effective dissemination of technological advances both in aircraft and in ground based equipment;

— more efficient operational measures;

— improvements in air traffic management;

— positive economic incentives; and

— market-based measures;

2) identification of means by which progress can be measured;

3) identification of possible global aspirational goals in the form of fuel efficiency for international aviation and possible options for their implementation; and

4) reporting progress resulting from the actions implemented by Contracting States and Stakeholders;

b) convene at an appropriate time, taking into account the fact that the fifteenth meeting of the Conference of the Parties (COP15) of the UNFCCC will be held in December 2009, a high-level meeting to review the Programme of Action recommended by the Group;

3. *Requests* that the Council, working through the Committee on Aviation Environmental Protection, continue to develop and keep up-to-date the guidance for Contracting States on the application of measures aimed at reducing or limiting the environmental impact of aircraft engine emissions and to conduct further studies with respect to mitigating the impact of aviation and climate change;

4. *Encourages* Contracting States and the Council, taking into account the interests of all parties concerned, including potential impacts on the developing world, to evaluate or continue evaluating the costs and benefits of the various measures, including existing measures, with the goal of addressing aircraft engine emissions in the most cost-effective manner;

5. *Requests* that the Council provide the necessary guidance and direction to ICAO's Regional Offices to assist Contracting States with studies, evaluations and development of procedures, in collaboration with other States in the region, to limit or reduce GHG emissions on a global basis and work together collaboratively to optimize the environmental benefits that can be achieved through their various programmes;

6. *Requests* States to encourage the industry to establish challenging goals to constantly improve its performance in aviation emissions reduction;

7. *Requests* Contracting States to accelerate investments on research and development to bring to market even more efficient technology by 2020;

8. *Requests* States to elaborate and report on a set of actions and plans to reduce by 2020 airspace congestion that is contributing to delays and unnecessary fuel burn;

9. *Request* States to encourage airport operators to improve efficiency of airside operations and to implement ground side efficiency measures to reduce carbon intensity;

10. *Requests* that the Council, working through the Committee on Aviation Environmental Protection:

c) report on an annual basis on the progress achieved in average in-service fleet fuel efficiency and the aggregate annual amount of fuel burned in international civil aviation working in close cooperation with the industry;

d) forecast the overall potential for aviation emissions reduction in the in-service fleet; and

e) evaluate and quantify further reduction opportunities for consideration by the upcoming session of the Assembly;

11. *Requests* the Council to undertake the necessary action in support of the ICAO emissions initiative, including the pursuit of the ICAO objectives to limit or reduce the impact of aircraft emissions, to foster collaboration among its Contracting States, and to monitor and report on progress made in this area. In particular, the Council should:

f) explore relevant parameters and develop medium and long term technology goals for aircraft fuel burn and report back by the next Assembly;

g) continue to develop the necessary tools to assess the benefits associated with ATM improvements, and to promote the use of the operational measures outlined in ICAO guidance (Cir 303) as a means of limiting or reducing the environmental impact of aircraft engine emissions;

h) implement an emphasis on increasing fuel efficiency in all aspects the ICAO's Global Air Navigation Plan;

i) foster, as appropriate, regional, inter-regional and global initiatives with Contracting States to enhance air traffic efficiencies to reduce fuel consumption;

j) encourage Contracting States to improve air traffic efficiency, which leads to emissions savings and to report on progress in this area;

k) request Contracting States to submit an inventory of actions they are taking to reduce aviation emissions in their respective countries; and

l) promote the use of new procedures and technologies that have a potential to provide environmental benefits on the operation of aircraft;

12. *Requests* the Council to encourage States and stakeholders in promoting and sharing best practices applied at airports in reducing the adverse effects of GHG emissions of civil aviation;

13. *Requests* the Council to encourage States and stakeholders to develop models of flow control and air traffic management that optimize environmental benefits;

14. *Requests* States to:

m) encourage the necessary research and development to provide more environmentally efficient engine and aircraft designs;

n) accelerate the development and implementation of fuel efficient routings and procedures to reduce aviation emissions;

o) accelerate efforts to achieve environmental benefits through the application of satellite-based technologies that improve the efficiency of air navigation and work with ICAO to bring these benefits to all regions and States;

p) promote effective coordination between their authorities involved in aviation in designing more environmentally beneficial air routes and improved operational procedures for international civil aviation;

q) reduce legal, security, economic and other institutional barriers to enable implementation of the new ATM operating concepts for the environmentally efficient use of airspace; and

r) cooperate in the development of a regional measurement and monitoring capability in order to allow for the assessment of the environmental benefits accrued from the measures above;

15. *Encourages* action by Contracting States, and other parties involved, to limit or reduce international aviation emissions through voluntary measures, and to keep ICAO informed, and r*equests* the Council to instruct the Secretary General to keep up-to-date guidelines that ICAO has developed for such measures, including a template voluntary agreement, and to make available such experience to all parties concerned.

PAPER NO. 1C: INTERNATIONAL CIVIL AVIATION ORGANIZATION

**Written Submission of the International Civil Aviation Organization (ICAO)
to the Workshop on Cooperation on Research and Development
in the Fourth Session of the AWG-LCA**

(Poznan, Poland, 1-10 December 2008)

Technology Progress

Executive Summary

ICAO is very conscious of its responsibility for pursuing limitation or reduction of GHGs from international aviation. At the same time, ICAO believes that cooperation with other UN bodies and in particular with the UNFCCC process is paramount to achieving a sound and effective solution for addressing aviation emissions. ICAO has made previous submissions summarizing its efforts on reducing GHG emissions using various measures such as promulgating Standards, publishing guidance documents, encouraging technology improvements, and pursuing market-based measures. This submission is to apprise AWG-LCA of trends and progress in the aviation sector related to the Bali Action Plan paragraph 1(d)(iii) "cooperation on research and development of current, new and innovative technology, including win-win solutions".

ICAO and aviation stakeholders fully understand that technological research is essential for development in aviation. Although technology alone cannot resolve the aviation's emissions of CO_2, it has been and will continue to be a key element of the solution in improving efficiencies in the air transport system. The industry together with the research organizations are dedicated to intensive research aimed at developing new technologies to improve air transport efficiencies. Significant research and development efforts are underway to further reduce aviation's impact on the environment.

A new and very promising area for research and development is aviation alternative fuels. This could be a win-win solution in that it will reduce aviation's dependence on climate changing fossil fuels while stabilizing the economic volatility associated with conventional fuels. Much progress has been achieved to date and there are high expectations for the use of more environmentally friendly drop-in alternative fuels for aviation in the short term. At the same time, research is underway with potential for alternative fuels, that are available on a global basis, in the mid to long-term. However, concerted international action will be necessary to translate this possibility into a reality. ICAO is at the forefront of this international coordination and is leading the way to a internationally agreed road map that will identify the roles and responsibilities of the main stake-holders as well as provide a timeline of actions.

ICAO realizes the urgency to implement solutions that reduce aviation's environmental footprint while allowing economic growth, especially in developing countries and islands that greatly depend on aviation for travel and trade. Research and development in aviation technologies, such as advanced materials, improved aerodynamics, and use of alternative fuels, offers great promise. These are win-win technologies and, once developed for aviation, will also trickle down to other sectors for an overall better environmental performance.

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1. Introduction

In December 2004, the ICAO Council approved six Strategic Objectives for the period 2005-2010, Safety, Security and Environmental Protection being the core ones. Specifically for Environmental Protection three goals have been adopted as set forth in Assembly Resolution A36-22:

a) limit or reduce the number of people affected by significant aircraft noise;
b) limit or reduce the impact of aviation emissions on local air quality; and
c) limit or reduce the impact of aviation greenhouse gas emissions on the global climate.

Annex 16 to the Convention on International Civil Aviation (Chicago Convention) sets the Standards and Recommended Practices relating to aviation environmental protection – Volume I for aircraft noise and Volume II for aircraft engine emissions. The Committee on Aviation Environmental Protection (CAEP), a technical committee of the ICAO Council, addresses aviation environmental aspects, updating and developing ICAO's Standards and Recommended Practices as well as related guidance material for both aircraft noise and aircraft engine emissions. In light of the heightened climate change concerns, ICAO has formed an ad hoc high level group, consisting of 15 senior government officials from States that are geographically representative of developed and developing countries. The Group on International Aviation and Climate Change (GIACC) is to develop the ICAO Programme of Action, a comprehensive framework for addressing the global impact of aircraft emissions. It must be emphasized that the development of the Programme of Action by ICAO is aligned with the Bali Action Plan and supports UNFCCC efforts. The Programme of Action will be reviewed at a high-level meeting of ICAO and it is intended to ultimately reflect the shared vision and strong will of all Contracting States of ICAO to address emissions from international aviation. It is important to note that the Contracting States of ICAO represent a virtually identical constituency as the States that are parties to the UNFCCC.

ICAO has developed studies, guidance and policies to reduce aviation emissions based on three approaches: reduction of emissions at source through technological innovation (cleaner and more efficient engines and airframes); reduction of emissions through operational measures (e.g. more efficient air traffic management); and through market based measures. One of the most challenging tasks for ICAO consists of assessing aviation environmental progress against its high level goals as described above. In this task, several sub-groups are reviewing the contributions from technology and also looking at current and future research and development programs to assess what improvements are possible in the mid and long terms. There have been periodic reviews of technology progress and promise under the ICAO umbrella since its inception. Most recently, the process has been formalized to be led by impartial panels of independent experts. In this respect, an IE review of NOx reduction technologies was requested in 2004. Based on the success of this event, ICAO initiated IE Reviews for Noise, Operations, and Fuel Burn, respectively and requested a review of the NOx results. ICAO is also leading the way in establishing a global roadmap for the use of alternative fuels in aviation. The present submission provides a summary of the progress in improving air transport system efficiencies through technology and also highlight areas of current research and development efforts.

2. Aviation and Climate Change

The Kyoto Protocol includes binding emission reduction targets for developed countries (Annex I parties), for the period 2008-2012. Emissions from domestic aviation are included in the total emissions reported and subject to the above targets. Emissions from international aviation, due to the methodological and legal issues involved (including provisions under the Chicago Convention) were included under Art. 2.2 of the Kyoto Protocol, which reads: *"The Parties included in Annex I shall pursue limitation or reduction of emissions of greenhouse gases not controlled by the Montreal Protocol from aviation and marine bunker fuels, working through the International Civil Aviation Organization and the International Maritime Organization, respectively".*

ICAO has been at the forefront of environmental stewardship since the early 1970s through its work on reducing aviation noise, improving local air quality, and encouraging fuel efficiency. As a result of ICAO's efforts, the aircraft of today are much quieter and have far less emissions than a few decades ago. ICAO has promulgated standards for emissions of oxides of Nitrogen, Carbon Monoxide,

Hydrocarbons, and smoke. Worldwide there has been tremendous improvement in this regard. Local air quality pollutants have declined steadily over the past several years although, admittedly, NOx has been the most challenging pollutant to constrain.

Similarly, aircraft energy efficiency has improved substantially, especially when compared to the other form of mass transit that move passengers. As an example, Figure 1 shows this trend for the US where aircraft energy efficiency has improved by more than 70% from 1960s to today. This downward trend directly translates into less impact on climate change.

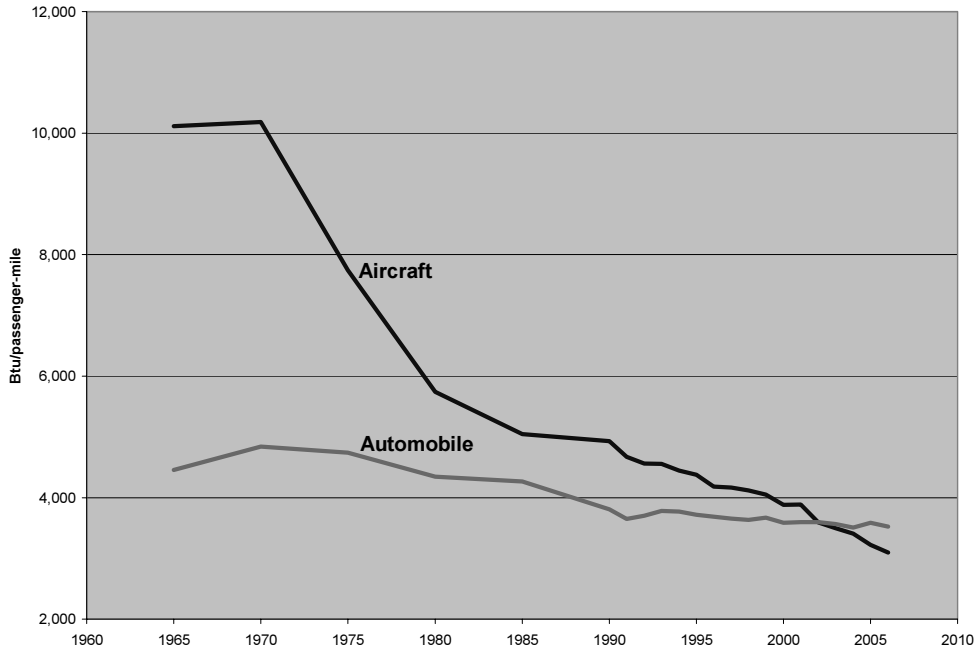


Figure 1: Energy Intensity per Passenger Mile Source: US BTS, National Transportation Statistics 2008

In terms of aviation's contribution to the world, it is agreed that aviation is a major catalyst of economic development. Around 2.2 billion passengers are transported by air every year. International traffic represents almost 60% of the total scheduled passenger traffic and about 83% of freight air traffic. International aviation's contribution to the total CO_2 emissions generated by anthropogenic activities is relatively small compared to other energy and transport sectors, but it is growing. Total scheduled passenger traffic worldwide is forecast to increase at an average annual rate of 4.6% (2005–2025). This increase, although of tremendous benefit to the global economy and especially to the developing world, can off-set the gains obtained improved technology.

Figure 2 shows the trend of CO_2 growth due to aviation despite the improvements in aircraft technology. This trend is expected to continue if the economic growth meets its forecast of 4.6% average annual increase at a global level.

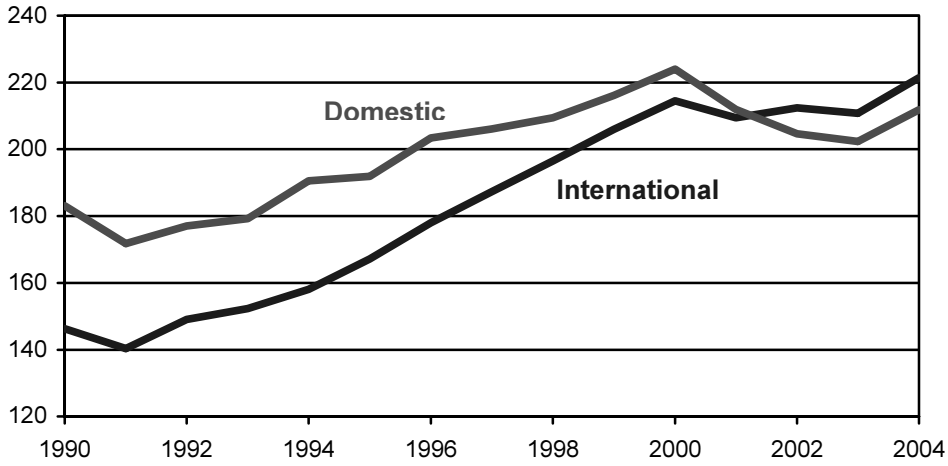


Figure 2: Annex I Parties - International and domestic aviation emissions CO_2 growth Source: UNFCCC (data excludes the Russian Federation)

Clearly, we need to redouble our efforts to reduce aviation emissions through technological innovation, operational initiatives, and utilizing market based measures realizing the constraints that aviation, by its very nature, faces regarding these issues. The following paragraphs describe the opportunities and challenges that research and development offers to aviation in order to reduce its environmental impact.

3. Research and Development of Current, New and Innovative Technology

Aircraft engine emissions are directly linked to fuel consumption. Overall fuel efficiency for civil aviation can be improved through a variety of methods, for example, by increasing aircraft efficiency through technology, improved operations and efficient air traffic management. ICAO's work on environmental protection began as far back as the 70's. In 2001, the ICAO Assembly requested the Council to continue studying policy options to limit or reduce the environmental impact of aircraft engine emissions calling for special emphasis to be placed on the use of technological solutions.

3.1. Fuel-Burn Reduction Technology

With constant improvements in fuel efficiency from technological innovations, carbon dioxide emissions from aviation are growing at a slower rate than air traffic. Today's modern, large transport aircraft are 70% more efficient than they were 40 years ago. Improvement in engine fuel efficiency has come mainly from the use of modern high-bypass engine technology that relies on increasing engine pressure ratios and higher temperature combustors as a means of increasing engine efficiency.

There are several practical issues when designing aircraft for fuel efficiency. Aerodynamic add-on technologies such as riblets and winglets reduce fuel consumption on long flights by reducing aerodynamic drag but may increase fuel consumption on shorter flights due to increased weight. They may also increase LTO emissions due to weight/performance tradeoffs and are not equally effective on all wing designs.

There are advanced propulsion concepts such as the unducted fan or the geared fan. The unducted fans reduce fuel consumption by increasing propulsive efficiency but result in higher noise since the fan duct is eliminated. In addition, fuel consumption benefits may be reduced by added weight to accommodate a large fan. The geared fan concepts improve aerodynamic efficiency by optimizing fan and turbine speeds but the fuel consumption benefits may be reduced by added gearbox weight. They do however reduce noise by decreasing fan speed.

The most prominent win-win technologies for improving aircraft efficiency are:

- Reduced weight materials and designs decrease NOx/noise/CO_2
- Components with improved aerodynamics decrease NOx/noise/CO_2 if weight is not affected

Weight saving is very important to aircraft design for obvious efficiency reasons. Weight saving has been and will be mainly achieved due to new materials, improved calculation methods, and possibly different airframe layout. Figure 3 shows an example of how materials technology (composites and advanced materials) has resulted in overall structural weight reductions.

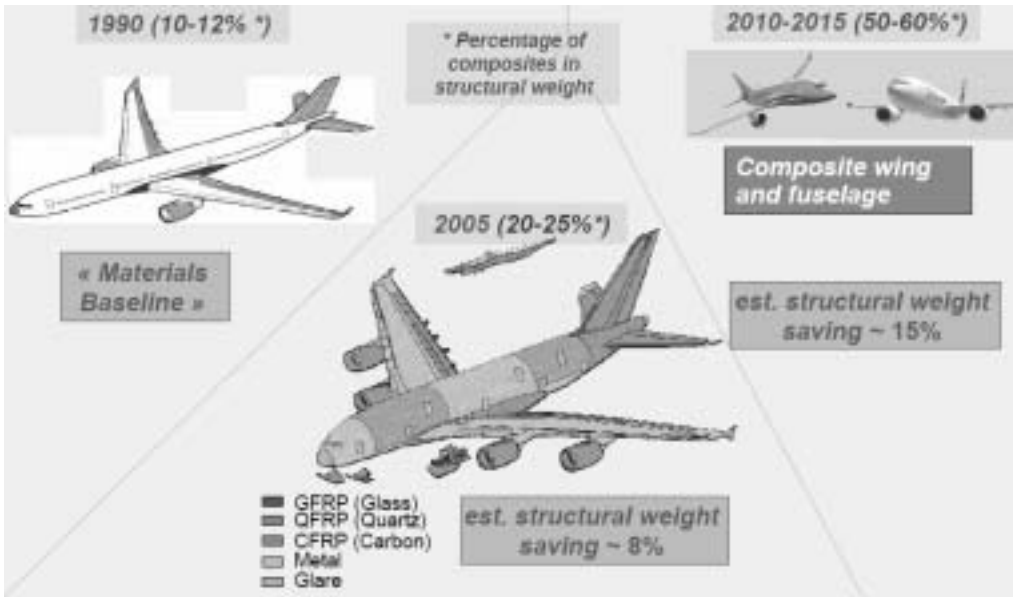


Figure 3: Structural Weight Reductions Source: ICCAIA

The main challenge in improved aerodynamics is to design components that have less drag and therefore require less thrust to fly the aircraft. This results in less thrust per unit of weight, therefore, better efficiency and lower fuel burn. The other aerodynamic improvement is generally achieved through laminar airflow which is done through structural optimization and improved integration (slats, flaps). Many improvements in wing design and engine integration optimization have been made over the years. Figure 4 demonstrates the efficiency improvements that have been achieved through improved wing design.

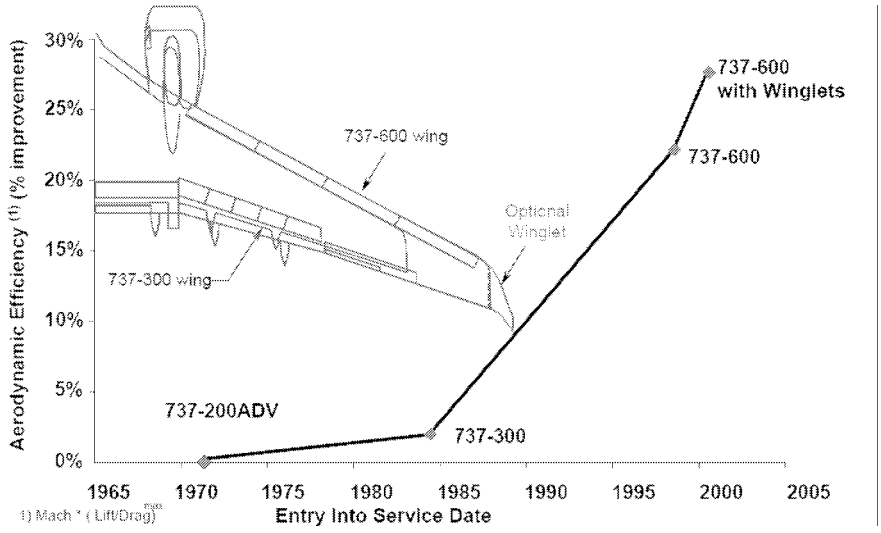


Figure 4: Aerodynamics: Airfoil technology has been improving Source: ICCAIA

Despite the significant improvements in efficiency over the last few decades, the challenge in aviation is to maintain continuous improvement.

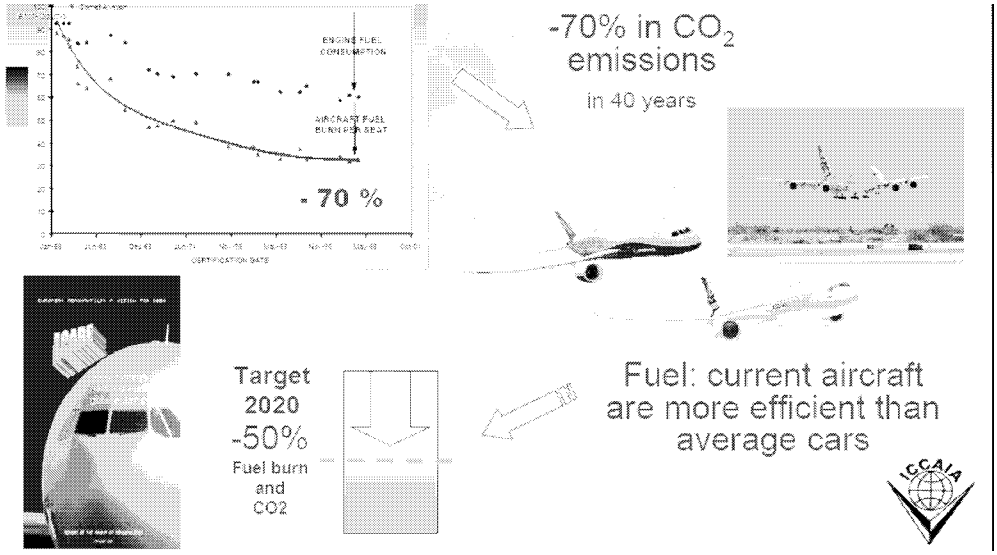


Figure 5: The challenge is continuous improvement Source: ICCAIA

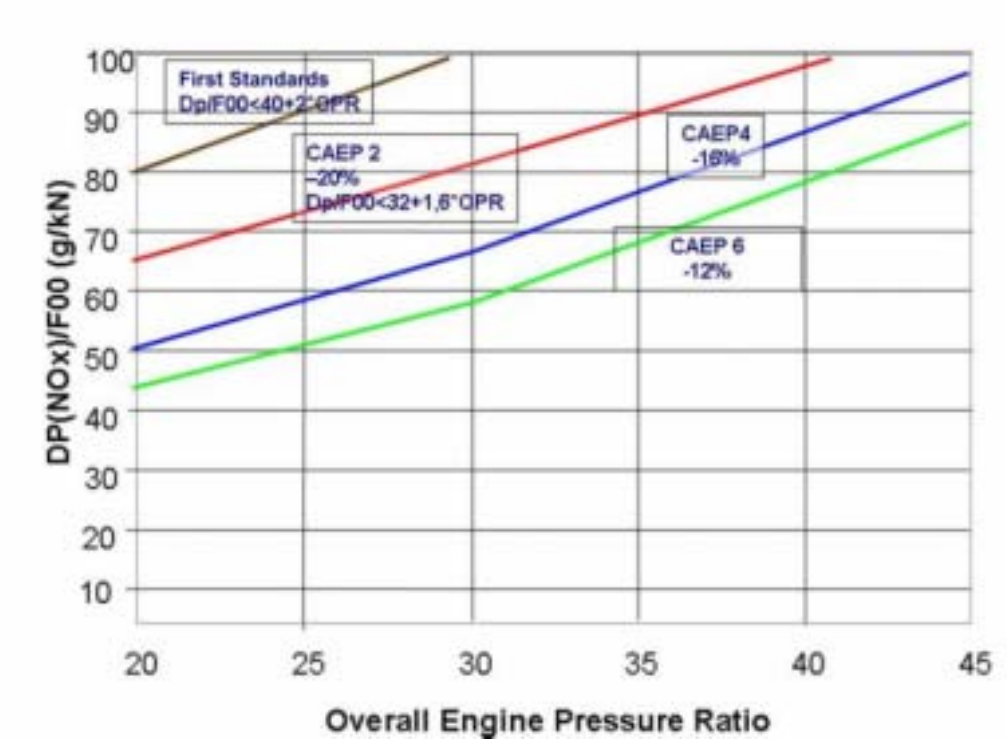
Establishing Fuel Burn Reduction Technology Goals

For the work on establishing mid and long term goals for fuel burn technologies, a phased approach has been agreed upon whereby, as a first step, the manufacturers will produce a paper on fuel burn technology advances to date with preliminary views on prospects for future fuel burn technologies. An initial report is expected to be made available by February 2009. A fuel burn technology workshop will be arranged in March 2009 and the output of this workshop will be the basis for a report on available technologies in the mid and long term. Following this, an Independent Expert (IE) Panel would propose/comment on the range of any fuel burn/efficiency projections the workshop suggests for future analysis. The outcome of this activity will then be reviewed by technical committees of ICAO.

Aviation stakeholders are committed to continuously improving the aircraft efficiei ng that lower fuel burn means less CO_2 emitted. It is estimated that technology alone can bri ıan 1% improvement per year. However, to achieve this or faster improvement, strong and powerful research programmes supported by governments are needed. Improved coordination between governments and regions will mean less duplication of efforts and more efficient use of resources, especially in today's economic situation.

3.2. NOx and Other LTO Emissions Reduction Technology

There has been a notable increase in NO_x stringency translating into a reduction in allowed NOx levels, of about 40 percent beyond the original ICAO standard for NO_x adopted in 1981 (applicable in 1986), as shown in Figure 6. Although NO_x Standards were initially intended to address local air quality, they also contribute to reduce the impact of aviation on climate, as NO_x may be a precursor of ozone formation.



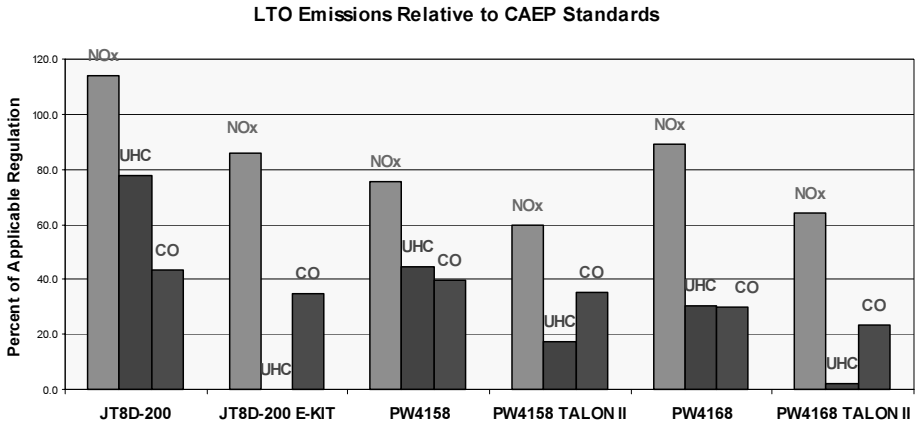


Figure 6: ICAO NOx Emissions Stringency Trends Source: ICAO

The introduction of ICAO Standards has contributed to the introduction of new technologies in the in-service fleet and to substantial reductions of NOx, HC and CO_2 and continued improvement is expected. Mandatory certification of new aircraft according to ICAO Standards has resulted in more efficient and cleaner aircraft.

Figure 7: Relative Reductions in Pollutants from Aviation by Engine Type Source: Pratt & Whitney

Figure 7 shows examples of relative reductions in emissions levels from landings and take-off (LTO) before and after implementation of ICAO's Standards. For example, in the first comparison from left to right for the Pratt & Whitney JT8D-200 engines, emissions levels for NOx, UHC, and CO are at their highest. However, after compliance with ICAO's Standards from P&W JT8D-200 E-Kit, the overall levels of emissions dropped significantly. In fact, unburned hydrocarbons have been virtually eliminated. Similar examples exist for aircraft engines from other manufacturers.

Establishing NOx Reduction Technology Goals

A six member IE panel met in 2005 to review industry capability to reduce emissions of NOx as defined in certification parameters. They looked at the past trends and considered medium and long terms technology projections. After the review and following a thorough consultation and evidence

based process, 10 and 20 year goals for NOx reduction technologies were established (The complete report has been published as ICAO Doc 9887). More specifically, the 2016 Medium Term Goal was set at 45% better than the 2004 Standard and the 2026 Long Term Goal was established at 60% better compared to the same baseline.

This was the first goal setting review of this kind for the whole aviation industry. A review of the NOx goals is planned to be held in early 2009, with a report available in mid 2009.

3.3. Reducing Environmental Impact through Improved Operational Measures

A significant way of achieving reduction in emissions is to shorten flight times and hence fuel consumption through improvements to the air traffic management (ATM) system. Such improvements have the potential to provide more direct routings for aircraft, as well as reducing the time spent in holding patterns waiting to land or queuing while waiting to depart.

According to the 1999 IPCC Special Report, improvements in ATM operational procedures could reduce aviation fuel burn by between 6 and 18%. A further 2 to 6% could come from improvements in other operational measures.

ICAO's main focus for operational measures is on the Global Air Navigation Plan. This plan requires environmental aspects to be taken into account right from the outset, when designing, developing and operating ATM systems. Emissions-related aspects of the plan include the flexible use of airspace; air traffic flow management; dynamic and flexible route management; terminal area design and management; aerodrome design and management; and performance based navigation.

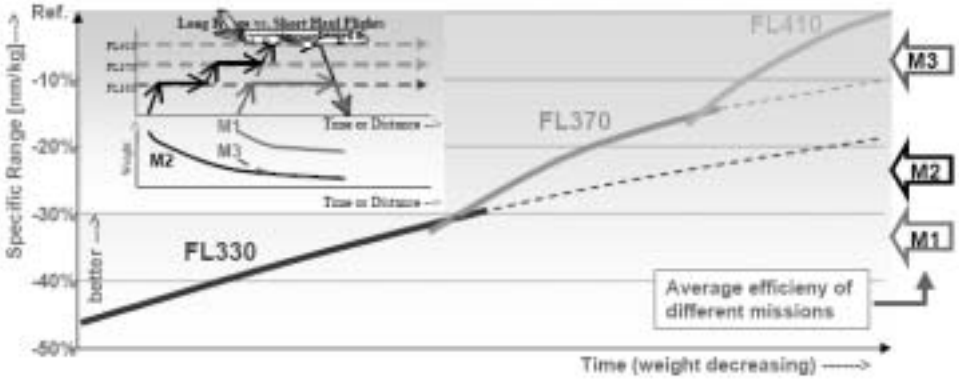


Figure 8: Typical Flight Profiles and Related Changes in Efficiency Source: ICCAIA.

The aviation community has been working on ATM operational improvements for decades. The work accelerated with the onset of Communication/Navigation/Surveillance and ATM systems (CNS/ATM). Technology development has been more rapid in recent years and improvements are now coming about even quicker. A major operational improvement was the implementation of Reduced Vertical Separation Minima (RVSM), which brought significant operational benefits to aircraft operators in terms of reduced fuel burn, availability of optimal flight levels, and increase in capacity, while also benefiting the environment. Figure 8 shows the relationship between efficiency and the cruise altitude as aircraft consumes fuel during its flight.

ICAO supported the development of RVSM, which was first implemented in 1997. RVSM has led to significant environmental benefits and will soon cover all airspace around the world. Studies in the European regions have shown that **RVSM leads to an average saving of 80 kg of fuel per flight in addition to significant reductions in NOx and sulphur oxide emissions** (EUROCONTROL January 2002).

Additional ICAO guidance to achieve fuel efficiency through operational measures is provided in ICAO Circular 303 - Operational Opportunities to Minimize Fuel Use and Reduce Emissions. That document identifies and reviews various operational opportunities and techniques for minimizing fuel consumption, and therefore emissions, in civil aviation operations. Operations covered in the guidance are: aircraft ground-level and in-flight operations, ground service equipment (GSE) and auxiliary power units (APUs), with potential actions to facilitate their broader application.

ICAO member States and regions have also launched initiatives to improve air transport systems in their areas of responsibility. Most notable among these are NextGen in the US and SESAR in Europe. ICAO is leading efforts to link these regional initiatives in broader globally harmonized networks and arranged a NextGen/SESAR Coordination Meeting in Montreal in September 2008. In addition, programs such as ASPIRE (Asia and South Pacific Initiative to Reduce Emissions) and AIRE (Atlantic Interoperability Initiative to Reduce Emissions) are helping reduce emissions by streamlining operations across wide areas of air traffic control. The potential for such initiatives was demonstrated on Nov 14, 2009 when a flight, using optimized procedures, between Sydney and San Francisco undertook 11 gate-to-gate operational procedures, from priority take-off clearance to a tailored arrival, that resulted in **savings of 1,564 gallons (5,920 litres) of fuel and 32,656 pounds (14.81 tonnes) of carbon emissions over normal conditions**. This was a collaborative effort between the airlines and regulatory authorities of several countries. Global cooperation through ICAO can help make such optimized flights routine.

ICAO has a central role to play in planning for the implementation of operational improvements. In addition to developing the necessary Standards and guidance material, ICAO has developed a global ATM Operational Concept that was widely endorsed and used as the basis for planning. ICAO also provides the planning framework through the Global Air Navigation Plan and several other documents and tools that support planning and implementation efforts.

Every ICAO region has identified performance objectives and has developed work programmes to bring near and medium term benefits, while integrating those programmes with the extensive work already accomplished. For example, ICAO is supporting a major technical cooperation project to implement an advanced air navigation system in the Caribbean region that is expected to substantially reduce aviation emissions in this region.

Establishing Environmental Improvement Goals for Operational Initiatives

Work is under way to define operational goals for fuel burn and to develop new guidance material on efficient operational procedures such as Continuous Descent Approach. An IE panel has been established to review the operational initiatives and to quantify environmental improvements expected from these initiatives in the mid and long term (10 and 20 years). ICAO's ATM (Air Traffic Management) experts' involvement in the process and coordination with relevant Panels is anticipated from the outset. The first meeting of this group is going to take place in early December, the review planned for January 2009 and a detailed report is expected in mid 2009.

The format of the results expected from this work are somewhat similar to those from the IPCC 1998 Special Report on Aviation and the Global Atmosphere that, in its chapter related to "air transport operations and relation to emissions", concluded that estimated improvements in ATM could improve overall fuel efficiency by 2 to 12 percent and that the potential for other operational measures was 2 to 6 percent. This data is now at least 10 years old. In view of current climate change concerns and in light of ICAO's leadership role, it is essential for ICAO to produce up-to-date data regarding potential reduction of fuel burn/CO_2 from improved operations.

3.4. Alternative Fuels Technology

A new and very promising area for research and development is aviation alternative fuels. This could be a win-win solution in that it will reduce aviation's dependence on climate changing fossil fuels while stabilizing the economic volatility associated with conventional fuels. The possibility of using alternative fuels is also being researched by fuel producers as well as the major aircraft manufacturers and it is foreseen that ICAO will play a crucial role by assisting with the development of the regulatory framework.

Currently, most civil aviation aircraft around the world use crude oil based kerosene. This fuel provides a good balance of properties required for aviation. The advantages of this fuel include high energy density and operation over a wide range of temperatures. However, concerns over volatility in fuel costs, energy supply security and the environment, have led to the need to investigate the development of alternative fuels. A viable alternative aviation fuel could offer important benefits by increasing the environmental performance of air transport, allowing it to substantially reduce CO_2

emissions. In addition to a potential reduction in CO_2, alternative fuels could have the added advantage of eliminating SOx in the exhaust (no sulphur in the fuel) and emitting 50% to 90% less particulate matter.

The alternative fuel technologies can be grouped broadly under three categories:

- XTL or Anything To Liquid (GTL, CTL, BTL)
- Biofuels (additive to conventional fuels)
- Exotic Fuels with a long-term horizon (e.g. Hydrogen)

Research organizations, manufactures, and users are currently investigating synthetic jet fuels (e.g. from coal, natural gas, or other hydrocarbon feedstock). Much progress has been achieved to date and there are high expectations for the certification of more environmentally friendly drop-in alternative fuels for aviation in the near term. The "drop-in" fuel is of immediate interest to aviation since it would be a direct substitute fuel that can be used without any substantial modification to engines or aircraft. The main challenge in XTL fuels is management of the CO_2 emitted during the fuel transformation process. The assessments on total life cycle impacts are continuing. Along with the work being carried out on carbon sequestration, these technologies may offer significant environmental benefits.

For the mid to long-term, research is underway on alternative fuels such as bio-fuel, available on a global basis, with a much higher environmental benefit. Bio-fuels present the challenge of chemical compatibility with traditional fuels since they are mainly foreseen as additives in the short to medium term. They also have generally lower efficiency and the affordability questions still has not been answered satisfactorily. However, feedstock such as algae, are being researched to answer some of these questions.

For exotic fuels, it can be argued that these are not fuels in the traditional sense since energy is needed to produce them. In addition, new infrastructure for storage and supply might be required. Also, since the energy density is low, a bigger volume is needed for on-board storage resulting in potential new aircraft configurations. Nevertheless, because of the potential for breakthrough technologies in this area, significant resources need to be dedicated for research and development.

There are several regional initiatives to advance alternative fuel technologies. In the US, a consortium CAAFI (Commercial Aviation Alternative Fuels Initiative) including all major stakeholders has been formed to coordinate alternative fuels research. Similarly in Europe, Omega is hosting a conference on alternative fuels in November 2008 to improve coordination in this area.

Whether for short term XTL, or medium term bio-fuels, or even long term exotic fuels, concerted international action is absolutely necessary to minimize duplication and share lessons learned across regional boundaries. Global coordination is the only way to translate today's possibilities into tomorrow's realities. ICAO is at the forefront of this international coordination and is leading the way to a internationally agreed road map that will identify the roles and responsibilities of the main stake-holders as well as provide a timeline of actions.

Establishing a Global Plan for Alternative Fuels

As a first formal step in international coordination, ICAO will hold a preparatory/ exploratory workshop on aviation alternative fuels from 10 to 12 February 2009. This event will provide a forum to explore challenges to development and deployment of alternative fuels for aviation, as well as initiatives to promote cooperation. The main purpose of the workshop is to encourage initiatives in global cooperation across national and regional boundaries. On the last day of the workshop, a meeting is planned to establish the organizing committee of a conference to be held in November 2009. This committee will include all major players, including fuel producers, consumers, designers, and regulators, with the aim of establishing a detailed programme for the November 2009 conference so that a internationally-agreed "road map" for alternative fuels can be issued at the end of the conference. This "road map" will identify the roles and responsibilities of the main stake-holders as well as provide a timeline of actions.

The workshop and the conference will outline of the importance of alternative fuels for aviation and discuss state of the art of different fuel alternatives in a panel format. It is expected that solid recommendations will come out of these events in terms of the short, medium and long term plans of action with timelines and benchmarks to measure progress. The issues covered for both synthetic and bio-fuels will be R&D efforts, production, commercial availability, fuel and engine certification, environmental assessment, and infrastructure Issues (transportation, storage, and interoperability). As described before, these events are being organized to examine production and delivery, certification and qualification, economic, business and environmental issues and research and development with the objective of establishing a "road map" for development and deployment of aviation alternative fuels.

ICAO realizes that aviation, because of its high acceptability threshold, faces a more serious challenge in alternative fuels. But the promise of environmental and economic benefit underscores the urgency of pursuing this option. Aviation stakeholders also represent the leading edge of technology in our society and therefore must lead the efforts to implement alternative fuels in our products. This is the only sustainable way to improve aviation's environmental footprint while allowing economic growth.

4. Next steps and concluding remarks

International aviation's contribution to the total CO_2 emissions generated by anthropogenic activities is relatively small compared to other energy and transport sectors, but it is growing. While domestic action to address aviation emissions can be treated similarly to other sectors under the Convention and the Kyoto Protocol, emissions from international aviation are, by definition, global in nature and cannot be circumscribed to national or recognized geographic boundaries. Assigning international emissions is an extremely complex task at best and difficult to implement or enforce.

ICAO has developed Standards, policies, and guidance on aircraft engine emissions for the use of parties in their national policies to reduce emissions. This has lead to 70% more fuel efficient aircraft today than the first generation of jet aircraft. General improvements accrued from a more efficient air navigation system are to be expected when the ICAO Global Air Traffic Management Plan is implemented worldwide. Furthermore several ICAO Contracting States, like Japan and Canada, have already initiated voluntary initiatives based on ICAO guidance.

ICAO provides an official, unbiased and effective international forum that has demonstrated its effectiveness in developing globally harmonized environmental Standards that have substantially increased the energy efficiency of air transport worldwide while increasing its level of safety at the same time.

It is essential that ICAO continue the collaborative effort with key aviation stakeholders including manufacturers, airlines, airports, air navigation providers, regulators, and governments to improve efficiencies in the overall air transport system. Manufacturers are keen to design aircraft that are optimized for the airlines and public use. In turn, airlines aim to optimise operations and maintenance (clean aircraft, performance monitoring, flight planning) in order to reduce the environmental impact of their operations while reducing costs and delivering better service to their customers. Airports are ready to implement innovative solutions (late engine run, reduce taxi time, innovative taxiing techniques, efficient power supply on ground) in doing their part in environmental improvement. There are key initiatives in air traffic management to improve operating procedures (more direct routes, better low-speed procedures, improved separation, CDA) that translate directly into less CO_2 emitted. Developments in alternative fuels offer the promise of environmental improvement and economic growth simultaneously. Governments and regulators need to work in an international, global framework, that can only be facilitated by ICAO, to set a long-term vision. This will promote internationally applicable Standards and goals resulting in coordinated robust research activities that will ultimately help achieve our shared long term vision.

ICAO is progressing well towards finalizing an ICAO Programme of Action on International Aviation and Climate Change. As mentioned in earlier paragraphs, several sub-groups in ICAO are in the process of establishing short, medium and long-term aspirational goals for fuel burn. The outcome of

the smaller groups will be consolidated in early to mid 2009 with a high-level review and finalization expected by the end of 2009.

ICAO realizes the urgency to implement solutions that reduce aviation's environmental footprint while allowing economic growth, especially in developing countries and islands that greatly depend on aviation for travel and trade. Research and development in aviation technologies, such as advanced materials, improved aerodynamics, and use of alternative fuels, offers great promise. These are win-win technologies and, once developed for aviation, will also trickle down to other sectors for an overall better environmental performance.

PAPER NO. 2: INTERNATIONAL LABOUR ORGANIZATION

Submission to be considered in the update of the Assembly Document (Bali Action Plan) to the AWG-LCA
Poznan, 6 December 2008

The ILO welcomes the opportunity to express additional views and make suggestions for the update of the Assembly Document.

II A shared vision for long-term cooperative action

A. Scope, nature and elements of a shared vision for long-term cooperative action

- **On the scientific basis**

Climate change is not only an environmental issue. It has far reaching consequences for economies and societies. Numerous parties as well as the IPCC has recognized the lack of relevant socio-economic analysis to inform decisions under the Convention. In particular, climate change and related policies directly affect workers and enterprises in developing as well as industrialized countries with major repercussions on livelihoods, incomes and poverty. The agreed outcome should recognize this information gap and include provisions that implementation measures should be guided by adequate socio-economic analysis and monitoring of impacts, notably on enterprises, communities, employment and incomes.

- **On the nature of a shared vision**

The agreed outcome of the comprehensive process which is taking place at present should be guided by the principle of equity. Sustainable development is contingent on economic viability, the preservation of the environment and social justice. Equitable outcomes from long-term cooperative action should therefore include the right to sustainable development, contribute to overcoming poverty and to more cohesive societies with broad access to decent jobs and income opportunities. The framework which will guide future measures and investments should promote the creation of decent work, opportunities for quality employment and income.

Equitable social outcomes from measures to address climate change will be crucial for the long-term political stability of the climate regime. An uneven distribution of costs and benefits from climate policies in societies could lead to political backlash, slowing down or even rendering the implementation of a new agreement impossible.

- **On the scope of a shared vision**

The shared vision should help to understand the practical implications of addressing climate change for sustainable development, including for economic and social outcomes.

Experiences in numerous countries and sectors demonstrate that inaction on climate change has massive negative impacts on employment, incomes and poverty. Initial

documentation of experiences with well-designed active climate policies suggests that these can have positive impacts on economic development and on employment generation. The shared vision should facilitate the coherence between climate and economic and social development policies.

- **On a shared vision for enhanced action on mitigation, future cooperative action on mitigation**

Future cooperative action can be significantly enhanced by realizing the synergies between mitigation measures, employment generation and poverty reduction. Active enterprise promotion, employment and labor market policies including skills development can significantly accelerate progress in mitigation measures such as energy efficiency, renewable energy deployment and sustainable land-use.

Likewise, policies for just transitions for enterprises and workers negatively affected by mitigation measures help to reduce the economic and social cost of a transition to low-emissions economies and enhance the political sustainability of ambitious climate policies.

- **Enhanced action on adaptation**

Investments in adaption should aim to address poverty as the root cause of vulnerability. This can be achieved by integrating measures into local economic development with active participation of local stakeholders, including enterprises, workers and local governments. The major investments in infrastructure can become a significant source of income for local communities.

- **Enhanced action on technology**

The transfer, adoption and deployment of technology will be greatly enhanced by measures which prepare governments, enterprises and workers. Capacity building needs include regulatory frameworks but also awareness, access to information and finance for small and medium-sized enterprises which account for over 90 per cent of all enterprises and an even higher share of employment in most countries. Skills shortages are a major impediment to the adoption and effective deployment of advanced technologies. The shared vision should explicitly address skills development and the engagement of small and medium-sized enterprises.

III Enhance action on mitigation of climate change

A. Measures, reportable and verifiable nationally appropriate mitigation commitments or actions, including quantified emission limitation and reduction objectives, by all developed countries Parties, while ensuring the comparability of efforts among them, taking into account difference in their national circumstances

- **On what needs to be measured, reported and verified**

In keeping with the goal of sustainable development, measurement, reporting and verification should include a set of social parameters, in particular changes in the

volume and quality of employment resulting from mitigation measures across the national economy.

- **How to measure, report and verify**

Measurement, reporting and verification should be carried out with the participation of representatives of industry, of workers and of local governments in the sectors and localities affected by mitigation policies.

B. Nationally appropriate mitigation actions by developing country Parties in the context of sustainable development, supported and enabled by technology, financing and capacity-building, in a measurable, reportable and verifiable manner

- **On the sustainable development context of NAMAs by developing country Parties**

Mitigation actions by developing country parties should be designed to generate significant benefits for poverty reduction and sustainable social development through the creation of employment and income opportunities.

- **On what needs to be measured, reported and verified in relation to actions**

In keeping with the goal of sustainable development, measurement, reporting and verification should include a set of social parameters, in particular changes in the volume and quality of employment resulting from mitigation measures across the national economy.

- **How to measure, report and verify**

Measurement, reporting and verification should be carried out with the participation of representatives of industry, of workers and of local governments in the sectors and localities affected by mitigation policies.

C. Policy approaches and positive incentives on issues relating to reducing emissions from deforestation and forest degradation in developing countries; and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries

- **On the context and objectives of policy approaches and positive incentives**

The success of measures to reduce deforestation and forest degradation in developing countries will depend in large measure on the access to sustainable forest and land-use generating sufficient employment and income opportunities for forest dwellers and communities on the agricultural frontier. Policies should include measures to generate such opportunities and to channel incentives to communities which preserve and rehabilitate forests.

Care should be taken to promote the role and respect the rights of indigenous and tribal peoples in the conservation of forests as carbon sinks in line with the provisions of ILO Convention C. 169.

- **On what should be measured, reported and verified**

REDD activities should measure, report and verify the impact on local communities, including indigenous peoples with respect to income, employment, migration and cultural identity.

- **On how measure, monitor and verify**

Measurement, monitoring and verification should include the participation of local communities and indigenous peoples.

- **On what should be supported in the areas of capacity-building, readiness and demonstrations**

Capacity building should include local communities and indigenous peoples as well as small and medium-sized enterprises to ensure broad access to incentives for avoided deforestation and for the rehabilitation of degraded forests. Capacity building should include the ability to meaningfully participate in decision making processes as well as an active role in implementation.

D. Cooperative sectoral approaches and sector-specific actions to enhance implementation of Article 4 paragraph 1 (c), of the Convention

- **On instruments and delivery/support mechanism**

Economic sectors have specialized organizations of industry/employers and workers with an in-depth understanding of the technical options, human resource requirements as well as of the economic and social implications of mitigation measures. These stakeholders should actively participate in the design, implementation and monitoring of policies to reduce the cost, enhance the effectiveness and maximize benefits in terms of employment. Sectoral organizations have an important role in facilitating just transitions for enterprises, workers and communities negatively affected by mitigation policies.

E. Various approaches, including opportunities for using markets, to enhance the cost-effectiveness of, and to promote, mitigation actions, bearing in mind different circumstances of developed and developing countries

- **On the extension, scaling up, review and improvement of the market-based mechanism**

A shift to programmatic approaches would allow major scaling-up of measures in developing countries. It should be designed to also give equal access to mitigation in small and medium-sized enterprises and local communities who are excluded from the current mechanisms by information barriers and high transaction cost. This would significantly enhance the benefits of market based mechanisms for sustainable development in addition to reducing emissions.

- **On the development of innovative approaches and mechanisms**

Assessing labor market impacts and adopting transition measures; promoting labor-management initiatives for ´greening workplaces´; and using labor policies for identifying opportunities for green jobs, greening existing jobs and phasing out unsustainable jobs through just transitions.

F. Economic and social consequences of response measures

Response measures can have significant positive as well as negative consequences enterprises, workers and communities. Adequate ex-ante analysis of impacts on employment, incomes and local development should be conducted to maximize benefits and to anticipate the need for just transitions.

Parties could benefit from sharing knowledge and experience on social impact assessment and developing a shared methodology based on best practices.

G. Ways to strengthen the catalytic role of the Convention in encouraging multilateral bodies, the public and private sectors and civil society, building on synergies among activities and processes, as a means to support mitigation in a coherent and integrated manner

For the cost and negative impacts to be minimized, and for the benefits to materialize, environmental, economic and social policies and programmes need to be well informed, coherent, broadly supported and able to engage stakeholders. Dialogue will be essential also for dealing with de downside of reducing emissions of GHGs. Workers and entrepreneurs should be assured that a green environment for society does not mean unemployment for them. Institutions for dialogue should be an integral part of the set-up for the implementation of the climate regime.

IV Enhanced action on adaptation

A. International cooperative to support urgent implementation of adaptation actions

- **On the vulnerability and adaptation assessments to support adaptation planning of the assessment process**

Climate related disasters and negative impacts often disrupt the functioning of local economies, the ability of enterprises to maintain or resume economic activity and for people to earn an income. Assessments should include socio-economic information

on the structure of local economies in exposed parts of countries, including the size and nature of enterprises, main sources of employment and income, critical factors such as survival strategies, debt, access to credit and social networks.

- **On incentivizing adaptation, and creating enabling environments**

Embedding adaptation into sectoral and local economic development leads to more integrated and effective adaptation. It provides opportunities to actively engage sectoral and local stakeholders in design and implementation.

Social dialogue involving national and local governments as well as representatives of enterprises, workers and local communities should be part of the enabling environment and of planning and implementation of adaptation strategies.

Investments in infrastructure are a major component of adaptation and represent a large share of the cost. Implementation of infrastructure projects with local communities through labor-based methods addresses the adaptation need as well as poverty as a major contributing factor to vulnerability. Where ever practicable such methods should be privileged as an implementation mechanism for infrastructure development in adaptation strategies.

- **Technological support**

Technical support should include capacity building for the integration of adaptation into broader local economic development, the establishment of representative organizations and dialogue mechanisms, identification of options to diversify local economies to make them more resilient and the use of labor-based technology for infrastructure works with local employment and income benefits.

D. Economic diversification to build resilience

A just transition for populations and regions depending on economic activities which are highly vulnerable to climate change like agriculture, tourism or infrastructure should include adaptive strategies in these sectors as well as diversification to less vulnerable sources of employment and income.

The impacts of adaptive and diversification strategies on the competitiveness of sectors and enterprises as well as on the volume, the quality and the distribution of employment and income should be analyzed ex-ante.

A number of proven economic and development policy tools can be used in adaptation and diversification, including Local Economic Development, public-private partnerships, producers´ organizations for economies of scale, needs-oriented technology transfer and skills development, credit and micro-finance.

E. Ways to strengthen the catalytic role of the Convention

Effective adaptation requires measures in a number of key economic sectors (agriculture, fisheries, tourism, and infrastructure a.o.). The Convention could play a

catalytic role by establishing a dialogue with these sectors globally to analyze adaptation needs and options and to share experiences and good practices. The specialized agencies of the UN-system have close contacts with the relevant sectors and can facilitate the work of the UNFCCC in this respect. Similarly, the Convention and the UN-agencies can promote an exchange between the climate and the economic and social development community to promote the mainstreaming of adaptation into broader development policies and strategies.

V. Enhanced action on technology development and transfer to support action on mitigation and adaptation

A. Effective mechanisms and enhanced means for the removal of obstacles to, and provision ...

The transfer, adoption and deployment of technology will be greatly enhanced by measures which prepare governments, enterprises and workers. Capacity building needs include regulatory frameworks but also awareness, access to information and finance for small and medium-sized enterprises which account for over 90 per cent of all enterprises and an even higher share of employment in most countries. Skills shortages are a major impediment to the adoption and effective deployment of advanced technologies. Technology transfer and development programmes should explicitly address skills development and the engagement of small and medium-sized enterprises.

B. Ways to accelerate the deployment, diffusion and transfer of affordable environmentally sound technology

- **On capacity building**

Capacity building should explicitly include the technology access for small- and medium sized enterprises, skills profiling and needs assessments and the upgrading or establishment of vocational and technical training institutions to deliver skills development.

PAPER NO. 3: INTERNATIONAL MARITIME ORGANIZATION

Note by the International Maritime Organization (IMO)

Input to the FCCC/AWGLCA/2008/16 – The Assembly document

This document contains three annexes:

Annex I:

GHG emissions from international maritime transport

A report on the latest GHG considerations within IMO, reporting on the outcome of the he fifty-eighth session of IMO's Marine Environment Protection Committee (MEPC 58) that was held in London, from 6 to 10 October 2008.

Annex II

GHG missions from international maritime transport.

Executive summary of Phase 1 of IMO's Study on Greenhouse Gas Emissions from Ships 2008/2009, presenting a CO_2 emission inventory from international shipping and future emission scenarios for 2020 and 2050.

Annex III

Ocean fertilization and CO_2 sequestration in sub-seabed geological formations

A report on the outcome of the thirtieth consultative meeting of Contracting Parties to the London Convention/third meeting of Contracting Parties to the London Protocol, that was held in London from 27 to 31 October 2008.

Annex I

GHG EMISSIONS FROM INTERNATIONAL MARITIME TRANSPORT

LATEST GHG CONSIDERATIONS WITHIN IMO

Note by the International Maritime Organization (IMO)

Background

1 Shipping is probably the most international of all the world's industries, carrying up to 90 per cent of global trade by weight in a cost and energy efficient way around the world. IMO, as the UN's specialized agency responsible for the global regulation of all facets pertaining to international shipping, plays a key role in ensuring that lives at sea are not put at risk and that the environment is not polluted by ships' operations - as summed up in IMO's mission statement: **Safe, Secure and Efficient Shipping on Clean Oceans.**

2 The issue of GHG emissions from ships has been considered by IMO's Marine Environment Protection Committee (MEPC) for many years and the outcome thereof brought to the attention of subsequent SBSTA sessions.

Latest GHG considerations within IMO - Outcome of MEPC 58

3 The fifty-eighth session of MEPC (MEPC 58) was held in London, from 6 to 10 October 2008. MEPC 58 continued to consider follow-up actions to resolution A.963(23) on "IMO Policies and Practices related to the Reduction of Greenhouse Gas Emissions from Ships". The resolution was adopted by the twenty-third session of the IMO Assembly in December 2003 and, recognizing CO_2 as the main greenhouse gas (GHG) emitted by ships, urges MEPC to identify and develop the technical, operational and market-based mechanisms needed to achieve limitation or reduction of GHG emissions from international shipping.

The first Intersessional meeting of the Working Group on GHG Emissions from Ships

4 MEPC 58 considered the outcome of the first Intersessional Meeting of the Working Group on Greenhouse Gas Emissions from Ships, held in Oslo, Norway, in June 2008. The week-long session had further developed the CO_2 Design Index for new ships; continued the review of the CO_2 operational index; and addressed best practices for fuel efficient operation of ships, as well as possible market-based measures to reduce GHG emissions from ships.

IMO GHG Study

5 During its deliberations, MEPC 58 noted with appreciation, the findings of Phase 1 of the updated 2000 IMO Study on GHG emissions from ships, which has been submitted to SBSTA 29 in a separate document.

Application of reduction measures

6 Throughout the debate at MEPC 58 on application of measures and matters of principle and policy, many delegations spoke in favour of the principle of common but differentiated responsibility (CBDR) under the UNFCCC. In their view, any mandatory regime aiming to reduce GHG emissions from ships engaged in international trade should be applicable exclusively to the countries listed in Annex I to the UNFCCC. Many other delegations expressed the opinion that, given the global mandate of IMO, as regards safety of ships and the protection of the marine and atmospheric environment from all sources of ship pollution, including emissions, the IMO regulatory framework on GHG emissions should be applicable to all ships, irrespective of the flags they fly.

Technical and operational GHG measures

7 MEPC 58 agreed to change the terms "Design CO_2 Index" to "Energy Efficiency Design Index"; and "Operational CO_2 Index" to "Energy Efficiency Operational Index".

8 During the session, MEPC 58 maintained its momentum and made substantive progress in further developing technical and operational measures to address GHG emissions from ships, including:

.1 development of the **Energy Efficiency Design Index** (EEDI) for new ships, together with Interim Guidelines on the method of calculation of the EEDI for trial purposes, with a view to further refinement and improvement. MEPC 58 invited delegations and industry observers to disseminate the Interim Guidelines on the EEDI to the maritime community at large, so that adequate experience could be gained on their adequacy as a tool to improve energy efficiency for new ships;

.2 continued review of the **Energy Efficiency Operational Index** (MEPC/Circ.471) and established an intersessional correspondence group co-ordinated by Japan to further advance the work with a view to finalization at MEPC 59 in July 2009; and

.3 further development of the basis for a fuel efficiency management tool, including finalization of **Guidance on best practices for fuel-efficient operation of ships** to be used in conjunction with the ship's **Energy Efficiency Management Plan** under consideration.

Market-based Measures

9 Considerable debate was undertaken by the Committee on a possible Emission Trading Scheme, a global levy on fuel and other hybrid market-based schemes for ships in international trade. The majority of delegations that spoke on the matter opposed the development of any market-based measures intended for the reduction of GHG emissions from ships as long as the issue of "Common but differentiated responsibility" was not resolved in full recognition of article 2.2 of the Kyoto Protocol. Other delegations were of the view that the issue on market-based measures was still at a preliminary stage and further information and studies were needed on such a highly complex matter.

10 The Committee agreed to dedicate sufficient time to hold an in-depth discussion at MEPC 59 and requested delegations to provide as much information as possible with a view to facilitating a focused debate.

The Second Intersessional GHG Meeting

11 In view of the tasks still outstanding, MEPC 58 agreed that the GHG Working Group should be re-convened intersessionally to carry out further work before MEPC 59. The Committee approved the following Terms of Reference for the meeting that will be held at IMO Headquarters from Monday, 9 March to Friday, 13 March 2009:

"Taking into account the outcome of MEPC 58:

.1 regarding the Energy Efficiency Design Index for new ships, consider, towards finalization:

.1 the Energy Efficiency Design Index formula, taking into account any trial application of the Index by calculation;

.2 the regulatory text using annex 6 to document MEPC 58/4 as a basis, including baseline (MEPC 58/4/8 and MEPC 58/4/34);

.3 the verification procedure; and

.4 any necessary associated guidelines;

.2 consider, towards finalization, the review of the interim guidelines on the Energy Efficiency Operational Index (MEPC/Circ.471);

.3 consider, towards finalization, the introduction of a management tool for all ships, taking into account the Ship Efficiency Management Plan considered during MEPC 58;

.4 consider, towards finalization, the guidance on best practices and other voluntary operational measures including reference text to be incorporated in the regulatory framework;

.5 consider possible impacts on the shipping sector from the measures envisaged; and

.6 present a written report to MEPC 59."

Correspondence Group on GHG Related Issues

12 MEPC 58 noted that the Intersessional Correspondence Group on Greenhouse Gas Emissions from Ships (co-ordinated by Australia and the Netherlands) would continue working with the following Terms of Reference:

> "Taking into consideration available relevant information, the Intersessional Correspondence Group on Greenhouse Gas Emissions from Ships is instructed to:
>
> .1 prepare detailed proposals on the measures identified in the Correspondence Group report (MEPC 57/4/5 and MEPC 57/4/5/Add.1), which have not been identified for further consideration by the GHG Working Group; and
>
> .2 present a final report to MEPC 59."

GHG Module in GISIS

13 The GHG module is now available in GISIS (Global Integrated Shipping Information System) to collect CO_2 indexing data and make it available to Member States and the industry to enable further research work (http://gisis.imo.org/Public).

Distribution by flag of the world merchant fleet

14 It may be noted that, in accordance with Lloyd's Register Fairplay's database, as at 1 March 2008, the distribution by flag of the world merchant fleet of registered ships above 400 GT was as follows:

	Number of ships	GT	DW
Annex I flag States	20,872 (33.42%)	209,015,681 (26.08%)	263,820,104 (22.82%)
Non-Annex I flag States	41,119 (66.58%)	593,330,359 (73.92%)	892,384,249 (77.18%)
Total	61,862	801,346,040	1,156,204,353

Shipping and sustainable development

15 Shipping is a crucial force in maintaining sustainable development, as it makes a massive contribution to global prosperity with only a marginal negative impact on the global environment. Both the poor and the rich benefit from seaborne trade. Moreover, due to the nature of shipping, developing countries can, and do, become major participants in the industry itself and, by so doing generate income and create national wealth.

The way ahead

16 The next session of the IMO's Marine Environment Protection Committee, MEPC 59 (July 2009), will continue work in accordance with its GHG work plan that culminates at that session. MEPC 59 is expected to agree to a package of measures aimed at increasing fuel efficiency of ship design and operation based on the outcome of the second intersessional meeting of the Working Group on Greenhouse Gas Emissions from Ships, as well as on submissions by member States and observer organizations. This first package will comprise technical and operational measures that most probably will include a finalized Energy Efficiency Design Index for new ships, a finalized Energy Efficiency Operational Index for all ships (new and existing) and guidance on best practices on fuel efficient ship operation for all stakeholders in the shipping industry.

17 Based on the report of the Intersessional Correspondence Group on Greenhouse Gas Emissions from Ships and other relevant submissions, the Committee will also continue considering possible market-based measures aimed at reducing GHG emissions from ships engaged in international trade.

18 The Committee will report the outcome of its considerations of follow-up actions to resolution A.963(23) on "IMO Policies and Practices related to the Reduction of Greenhouse Gas Emissions from Ships" to the twenty-sixth session of the IMO Assembly that will be held in November 2009.

19 The Secretary-General of IMO will submit a position paper to COP 15, informing the Conference of the outcome of IMO's work on limitation and reduction of greenhouse gas emissions from ships engaged in international trade.

20 IMO will continue its endeavours to reduce any environmental impacts from international shipping, a transport industry that is vital to world trade and sustainable development and shall keep UNFCCC and its subsidiary bodies updated on the progress.

Annex II

GHG EMISSIONS FROM INTERNATIONAL MARITIME TRANSPORT

IMO STUDY ON GREENHOUSE GAS EMISSIONS FROM SHIPS 2008/2009

Note by the International Maritime Organization (IMO)

Background

1 IMO's initial Study on Greenhouse Gas (GHG) Emissions from Ships was published in 2000 and is the most comprehensive assessment to date of the contribution made by international shipping to climate change. The Study estimated that ships in international trade in 1996 contributed about 1.8% of the world's total anthropogenic CO_2 emissions and clearly stated that there was no other mode of transport with a better CO_2 record on a tonne-mile basis.

2 The twenty-third session of the IMO Assembly adopted, in December 2003, resolution A.963(23) on "IMO Policies and Practices related to the Reduction of Greenhouse Gas Emissions from Ships". The resolution urges IMO's Marine Environment Protection Committee (MEPC) to, *inter alia,* identify and develop the mechanisms needed to achieve limitation or reduction of GHG emissions from international shipping and to consider the methodological aspects related to reporting, recognizing that CO_2 is the most prominent GHG emitted by ships.

3 MEPC 55, in October 2006, acknowledged that the threat from global warming was far too serious to be ignored and agreed that international shipping, although an already environmentally friendly and fuel efficient mode of transport, should take appropriate action. Subsequently, MEPC 55 decided to update the 2000 IMO GHG Study to provide a better foundation for future decisions and to assist in the follow-up to resolution A.963(23).

4 MEPC 56, in July 2007, approved Terms of Reference for the update of the 2000 IMO GHG Study that had been divided into two Phases:

.1 Phase 1, covering a CO_2 emission inventory from international shipping and future emission scenarios, was reported to MEPC 58 in July 2008; and

.2 Phase 2, covering greenhouse gases other than CO_2 and other relevant substances in accordance with the methodology adopted by UNFCCC, as well as the identification and consideration of future reduction potentials by technical, operational and market-based measures, will be submitted to IMO in April 2009 for consideration by MEPC 59 in July 2009.

5 Following a tendering process targeting selected institutes, the contract to update the IMO GHG Study was awarded to an international consortium of ten entities comprising six of the 12 invited institutes. The consortium is co-ordinated by MARINTEK of Norway and is made up of the following institutes and individual key experts: CE Delft,
The Netherlands; Dalian Maritime University, China (Peoples Republic of); David Lee, Manchester Metropolitan University, United Kingdom; Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Germany; DNV, Norway; Energy and Environmental Research Associates (EERA), United States of America; Lloyd's Register-Fairplay Research, Sweden; MARINTEK, Norway; Mokpo National Maritime University (MNMU), Republic of Korea; National Maritime Research Institute (NMRI), Japan; and Ocean Policy Research Foundation (OPRF), Japan.

Phase 1 report

6 MEPC 58, in October 2008, reviewed the Phase 1 report of the updated IMO Study on GHG emissions from ships and noted with interest, *inter alia*, the following findings:

.1 CO_2 emissions from international shipping have been estimated both from activity data and from international fuel statistics. It was concluded that the activity-based estimates with the use of detailed activity data (for different ship sizes and types) gave a better assessment of global fuel consumption and CO_2 emissions from international shipping than fuel statistics, due to apparent under-reporting of marine bunker sales;

.2 the consensus estimate for 2007 CO_2 emissions from international shipping (ships above 100GT) amounts to 843 million tonnes of CO_2 (2.7% of the world's total anthropogenic CO_2 emissions);

.3 by also including domestic shipping and fishing vessels (ships above 100GT but still excluding naval vessels), the amount would increase to 1,019 million tonnes of CO_2 (3.3% of the world's total anthropogenic CO_2 emissions); and

.4 future emissions from international shipping have been estimated based on global developments outlined by the Intergovernmental Panel on Climate Change (IPCC). **Assuming that there are no explicit regulations on CO_2 emissions from ships**, CO_2 emissions are predicted in the base scenarios to increase by a factor of 2.4 to 3.0 by 2050. For 2020, the base scenario predicts increases ranging from a factor of 1.1 to 1.3. These predictions take into account significant efficiency improvements resulting from expected long-term increases in energy prices.

7 The executive summary of the Phase 1 report is set out in the annex to this document. The full report may be found (in English only) at the IMO website:
http://www.imo.org/home.asp?topic_id=1737

Phase 2 report

8 MEPC 59 will be held at IMO's Headquarters in London from 13 to 17 July 2009 and is expected to review the Phase 2 report as well as the full final report covering both phases. IMO will submit the final report to the appropriate bodies of UNFCCC.

ANNEX

Updated Study on

Greenhouse Gas Emissions from Ships

Executive summary of Phase 1 Report
1st September 2008

Prepared for the International Maritime Organization (IMO) by:

- CE Delft, The Netherlands
- Dalian Maritime University, China
- David S. Lee, UK
- Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Germany
- DNV, Norway
- Energy and Environmental Research Associates (EERA) USA
- Lloyd's Register-Fairplay Research, Sweden
- MARINTEK, Norway
- Mokpo National Maritime University (MNMU), Korea
- National Maritime Research Institute (NMRI), Japan
- Ocean Policy Research Foundation (OPRF), Japan

Preface

This report constitutes Phase 1 of a study on greenhouse gas emissions from ships. This is an update of a study done for IMO in 2000. As in the 2000 report, a main objective of the update is to establish emission inventories and reduction potentials for greenhouse gas emissions from international shipping; however the scope of the updated study is broader and puts more emphasis on the trends and impacts of future emissions. As was also the case in the original study, the updated study is delivered to the International Maritime Organization by the consortium run by MARINTEK. This updated study benefits from a larger and more global team of expert contributors and the work is done in partnership with the following institutions:

CE Delft, Dalian Maritime University, Deutsches Zentrum für Luft- und Raumfahrt e.V., DNV, Energy and Environmental Research Associates (EERA), Lloyd's Register-Fairplay, Mokpo National Maritime University (MNMU), National Maritime Research Institute (Japan), Ocean Policy Research Foundation (OPRF).

The following individuals are the main contributors to the report:

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In the course of this work, the research team has gratefully received input and comments from the International Energy Agency (IEA), the Baltic and International Maritime Council (BIMCO) and the International Association of Independent Tanker Owners (INTERTANKO).

The objectives of Phase 1 of the study have been as follows: (1) to undertake an assessment of present day CO_2 emissions from international shipping; (2) to estimate future CO_2 emissions from international shipping emissions towards 2050; (3) to compare CO_2 emissions from shipping with other modes of transport; and (4) to assess the impact of CO_2 emissions from shipping on the climate. This report will be followed by a Phase 2 report which will address other greenhouse gases than CO_2 and the possibilities and mechanisms for reductions in GHG emissions.

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List of abbreviations

AIS	Automatic Identification System
CO_2	Carbon dioxide
EIA	United States Energy Information Administration
FAME	Fatty Acid Methyl Ester (a type of bio diesel)
FTD	Fischer Tropsh Diesel (a type of synthetic diesel)
GDP	Gross domestic product
GHG	Greenhouse gas
GT	Gross Tonnage
HFO	Heavy fuel oil
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organization for Standardization
LNG	Liquefied Natural Gas
MDO	Marine diesel oil
OECD	Organisation for Economic Co-operation and Development
OPRF	Ocean Policy Research Foundation
PM	Particulate Matter
RF	Radiative Forcing
SRES	IPCC Special report on emissions scenarios
UNCTAD	United Nations Conference on Trade and Development
UNFCCC	United Nations Framework Convention on Climate Change

Definitions

International shipping	Shipping between ports of different countries as opposed to *domestic shipping*. International shipping excludes military and fishing vessels. By this definition, the same ship may frequently be engaged in both international and domestic shipping. This is consistent with IPCC 2006 Guidelines.
Domestic shipping	Shipping between ports of the same country as opposed to *international shipping*. Domestic shipping excludes military and fishing vessels. By this definition, the same ship may frequently be engaged in both international and domestic shipping This definition is consistent with IPCC 2006 Guidelines
Coastwise shipping	Coastwise shipping is freight movements and other shipping activities that are predominantly along coast lines or regionally bound (e.g., passenger vessels, ferries, offshore vessels) as opposed to ocean-going shipping. The distinction between is made for the purpose of scenario modelling and is based on ship types, i.e. a ship is either Coastwise or an ocean-going ship
Ocean-going shipping	Ocean-going shipping is a term used for scenario modelling. It refers shipping refers to large cargo carrying ships engaged in ocean crossing trade.

1 Executive Summary

1.1 Introduction

This report has been prepared by an international consortium as set out in the preface to this report. The report covers Phase 1 of a study that will be conducted in two phases. Phase 1 concentrates on CO_2 emissions only. The report covers four main elements:

1. An inventory of current emissions of CO_2 from international shipping.
2. Estimates of future emissions of CO_2 from international shipping.
3. A comparison of CO_2 emissions from various types of ships with CO_2 emissions from other sources in the transport sector.
4. An analysis of the impact of CO_2 emissions from international shipping on climate change.

1.2 Main Conclusions

The Intergovernmental Panel on Climate Change (IPCC) developed guidelines for national greenhouse gas emissions inventories. These guidelines divide emissions from water borne navigation into two primary categories: domestic and international. International waterborne navigation is defined as navigation between ports of different countries. As set out in the terms of reference, this study provides estimates of present and future CO_2 emissions from international shipping. International shipping has been defined in accordance with the IPCC Guidelines. Total estimates that include domestic shipping emissions and emissions from fishing are also included in this report.

CO_2 emissions from international shipping have been estimated both from activity data and from international fuel statistics. Following discussion and analysis it is concluded that the activity-based estimates with use of detail activity data (for different ship sizes and types) give a better prediction of global fuel consumption and CO_2 emissions from international shipping than fuel statistics due to apparent under-reporting of marine bunker sales.

Previous activity-based estimates have relied on different sources of activity data resulting in differences in estimated emissions. The research team behind this study, whose members include lead authors and main contributors from all peer reviewed scientific studies on this topic and a participant from the IMO Informal Cross Government/Industry Scientific Group of Experts agreed to a consensus estimate for CO_2 emissions in 2007. This estimate is based both on analysis of new activity data that is unique to this study in addition to data from previous studies.
The activity based model developed cannot differentiate between international and domestic emissions. In order to provide an estimate for emissions from international shipping by use of on the activity based model, domestic emissions as reported in bunker statistics have been subtracted from the total shipping emissions.

Table 1. Consensus estimate 2007 CO_2 emissions [million tonnes CO_2]

	Low bound	Consensus estimate	High bound	Consensus estimate % Global CO_2 emissions
Total ship emissions[1]	854	**1019**	1224	3.3
International shipping[2]	685	**843**	1039	2.7

[1] Activity based estimate including domestic shipping and fishing, but excluding military vessels.
[2] Calculated by subtracting domestic emissions estimated from fuel statistics from the activity based total excluding fishing vessels.

IPCC has developed scenarios for future global development. Future emissions from international shipping have been estimated in this report based on global developments outlined by IPCC. Assuming that there are no explicit regulations on CO_2 emissions from ships, CO_2 emissions are predicted in the base scenarios to increase by a factor of 2.4 to 3.0 by 2050. For 2020, the base scenario predicts increases ranging from 1.1 – 1.3. These predictions take into account significant efficiency improvements resulting from expected long-term increases in energy prices.

Climate stabilization will require significant reductions of CO_2 emissions by 2050. To reduce CO_2 emissions from international shipping, it appears necessary to either modify the current path of continued growth in seaborne transport, since the efficiency gains expected cannot deliver net reductions in the face of such growth; and / or develop mechanisms that will result in the introduction of technologies with significantly lower emissions than what is anticipated in these scenarios.

1.3 Current CO2 emissions from international shipping

This study estimates international marine bunker fuel consumption and CO_2 emissions based on activity data and compares these with statistical data for global fuel sales to establish a consensus estimate for 2007 CO_2 emissions from international shipping.

1.4 CO2 estimate based on fuel statistics (top-down estimate)

A global inventory was established based on statistical data for fuel use, derived from IEA summaries of marine fuel sales. The methodology used for the fuel-based estimate conforms to the methodology used and reported in the 2000 IMO Study of Greenhouse Gases. This approach is limited by the quality of the statistical data, and the way in which fuel sales volumes are assigned as either international or domestic.

Annual fuel consumption data were obtained from the IEA database for all reporting years from 1971 to 2005, the most recent data available. CO_2 emissions were calculated using the emission factors for marine fuels established by the IMO Informal Cross Government/Industry Scientific Group of Experts. CO_2 emissions for 2005 and an estimate for 2007 are shown in Table 2.

Table 2. CO_2 Emissions from shipping based on IEA data [million tonnes CO_2]

Year	2005	2007 est.
International shipping	531	582
Domestic shipping	101	111
Fishing	18	20
Total	651	713

As discussed in the main section of the report, issues such as the classification of fuel sales and the availability of statistical data from various countries result in a risk of under-reporting global total fuel sales. This also applies to other global data sets of marine fuel consumption or emissions such as data from EIA which largely rely on the same data as IEA. Therefore, as called for in the terms of reference an activity-based estimate was also made for the purpose of comparison.

1.3.2 Activity-based estimate (bottom-up estimate)

A global inventory was established for all ships greater than 100 GT based on data from the Lloyds Register Fairplay database for the year 2007, and using the best available data on vessel activity, engine and fuel characteristics, and carbon dioxide emission rates. The methodology used for the activity-based estimate has been applied in a number of scientific studies of this topic. This approach was also used in the work of the Informal Cross Government/Industry Scientific Group of Experts established by the IMO Secretary General.

The input data must be estimated for each ship category based on available background data. Although there is uncertainty in all of these figures, some of them can be estimated with high accuracy (number of ships, average power of main and auxiliary engines, specific fuel oil consumption, and fuel carbon content), and emission rates based upon fuel and combustion conditions can be described within well-understood ranges that give a satisfactory level of confidence. Other activity inputs vary by vessel service and voyage conditions and these are more difficult to assess. Comparisons with estimates for different periods would result in expected differences (e.g., from year to year, among vessel types, among routes, and even voyage to voyage) as they depend on the transport demand and the fleet size. In this study, an extensive set of AIS data collected from a global network has been used to assist the assessment of ship activity; AIS information and information on engine operating hours, fleet operating practices, etc., provide us with the ability to produce a consensus estimate inventory for shipping that is bounded by the range of reasonable estimates largely driven by activity-based inputs.

Since the estimate is based on all ships greater than 100 GT, the inventory includes domestic shipping and fishing vessels. In order to explore the uncertainty in the estimate, low and high bounds estimates were made. These bounding estimates represent feasible results but are less likely than the consensus estimate.

Table 3. Activity-based 2007 estimate of CO_2 emissions [million tonnes CO_2]

	Low bound	Consensus estimate	High bound
Total ship emissions[1]	854	1019	1224
- Oceangoing	474	593	681
- Coastwise	240	275	357
- Other	140	150	186

[1] All non-military ships greater than 100 GT.

1.3.3 Comparison of fuel consumption estimates

Previous activity-based estimates have been reported for different years (2000, 2001, and 2007). In order to be able to compare them with the results from this study (2007), backcasts and forecasts for these point estimates are calculated from the time evolution of freight tonne-miles from Fearnleys (2007). The result is shown in Figure 1 which also presents international bunker sales statistics and the historical estimates from Eyring et al. (2005a) and Endresen et al. (2003) from 1950 to 2007. Since some of these studies included emissions from military vessels, auxiliary engines and boilers while others did not, corrections have been applied to allow comparison as detailed in the main report. Also, these studies typically estimate totals for the fleet of ships listed in national ship registries, as summarized in the Lloyds ship registry data; therefore, they represent what has been termed the World Fleet within which international shipping as defined by IPCC would be a subset.

The activity-based estimate from the present study is shown as a blue dot in Figure 1. Light blue whisker lines extend from this point to indicate the range of uncertainty given by the high and low bound estimates. The activity-based estimate from the present study is lower than the estimate from the IMO expert group and forecasts based on Eyring et al. (2005a); however it agrees well with the result of Corbett and Kohler (2003) when military vessels are removed
from their original figures. The 2007 estimate of this study is higher than that of Endresen et al. (2007), and higher than fuel statistics.

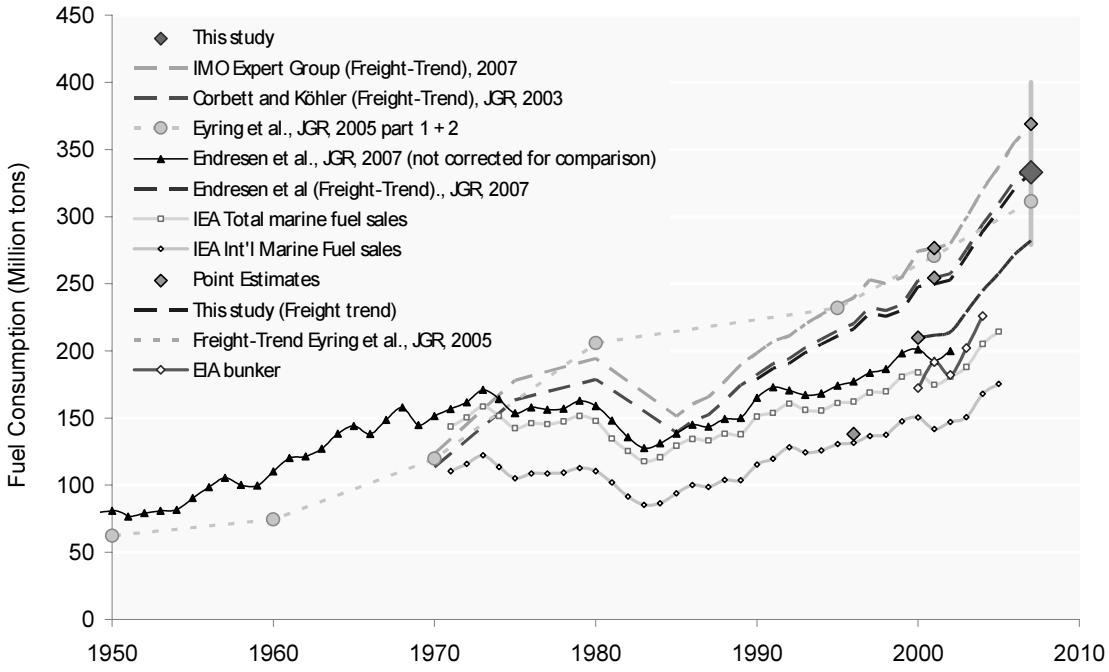

Figure 1. **World fleet fuel consumption (except military vessels) from different activity based estimates and fuel statistics. The blue square shows the consensus estimate from this study and the whiskers the high and low bound estimates**

1.3.4 Consensus estimate 2007 CO2 emissions from International Shipping

Activity-based estimates consistently predict fuel consumption values that are higher than what is indicated in fuel statistics. While these activity-based estimates share many common inputs and assumptions and as such are not fully independent, statistical data on the other hand show some inconsistencies and could be expected to under-report consumption. Vessels can be categorized by activity as shown in Table 3, although this grouping does not explicitly match IPCC delineation of international and national shipping; for example, the sum of coastwise and other vessel activity categories exceeds the IEA statistics for domestic and fishing by more than three times, which indicates that significant coastwise and other shipping activity would likely be international.

Following the discussions detailed in Section 1.3.3 of this report, the international team of scientists behind this study concluded that the activity-based estimate is a more correct representation of the total emissions from the world fleet including in national ship registries than what is obtained from fuel statistics. Our team agreed that the activity-based estimate
(Table 4) should be used as the consensus estimate from this study. Since the activity based model cannot separate domestic shipping from international shipping, domestic shipping emissions figures from bunker statistics have been used to calculate international shipping. Upper and lower bound estimates are about 20% higher and lower than the consensus figure.

Table 4. Consensus estimate 2007 CO_2 emission for international shipping [million tonnes CO_2]

	Low bound	Consensus	High bound
Total shipping emissions[1] (activity based)	854	1019	1224
Total less fishing (activity based)	796	954	1150
IEA domestic shipping (statistical data)	111	111	111
International shipping (hybrid estimate)	685	**843**	1039

[1] All non-military ships greater than 100 GT.

1.4 Future CO2 emissions from international shipping

Future CO_2 emissions from international shipping were estimated on basis of a relatively simple model developed in accordance with well-established scenario practice and methodology. The model incorporates a limited number of key driving parameters as shown in Table 5. These driving factors affect the various categories of ships in different ways. Therefore, the international shipping fleet was separated into three primary categories to allow differentiation of the overall effects of the above factors. These categories are:

- Coastwise shipping- Smaller ships used in coastal operations;
- Ocean-going shipping - Larger ships used long distance /intercontinental trade; and,
- Container ships (all sizes).

Table 5. Driving variables used for scenario analysis

Category	Variable	Related Elements
Economy	Shipping transport demand (tonne*miles/year)	Population, global and regional economic growth, modal shifts, sectoral demand shifts.
Transport efficiency	Transport efficiency (MJ/tonne*mile) – depends on fleet composition, ship technology and operation;	Ship design, propulsion advancements, vessel speed, regulation aimed at achieving other objectives but that have a GHG emissions consequence
Energy	Shipping fuel carbon fraction (gC/MJ fuel energy)	Cost and availability of fuels (e.g., use of residual fuel, distillates, biofuels, or other fuels)

Scenarios are based on the framework for global development and storylines developed by the Intergovernmental Panel on Climate Change (IPCC) in the special report on emission scenarios (SRES).

- Storyline A1: a future world of very rapid economic growth, global population that peaks in mid-century and declines thereafter, and rapid introduction of new and more efficient technologies. Major underlying themes are economic and cultural convergence and capacity building, with a substantial reduction in regional differences in per capita income. In this world, people pursue personal wealth rather than environmental quality.
    - A1 is modeled in three variations: A1FI – emphasis on fossil fuels, A1T emphasis on technology and A1B, balanced emphasis

- Storyline A2: a very heterogeneous world with continuously increasing global population and regionally oriented economic growth that is more fragmented and slower than in other storylines.

- Storyline B1: a convergent world with the same global population as in the A1 storyline but with rapid changes in economic structures toward a service and information economy, with reductions in material intensity, and the introduction of clean and resource-efficient technologies.

- Storyline B2: a world in which the emphasis is on local solutions to economic, social, and environmental sustainability, with continuously increasing population (lower than A2) and intermediate economic development.

1.4.1 Economy and future shipping transport demand

Transport demand governs the size and activity level of the world fleet and is the most important driver for emissions from ships. The number of tonnes to be transported will depend on developments in trade, locations of factories, consumption of raw materials and other factors, while the distance will be affected by issues such as changing trade patters or possible new sea routes.

When determining future tonne-mile projections, GDP projections in the SRES scenarios have been the primary consideration. A hybrid approach considering both historic correlations between economic growth and trade as well as detailed analysis considering regional shifts in trade, increased recycling, new transport corridors, inter alia has been employed to derive the projections for future trade.

1.4.2 Future transport efficiency

Changes in the fleet composition can feasibly improve efficiency since larger ships are potentially more energy efficient. The effect of using larger ships has been modelled by predicting a change in the world fleet based on current trends towards 2020 as estimated by Lloyds Register Fairplay Research. Due to the uncertainties in predicting a 2050 fleet composition, no structural change is explicitly modelled from 2020 to 2050.

Economical optimal speed may decrease since fuel costs are expected to increase relative to other costs; hence market-driven speed changes are modelled.

Improvements can be made to new and existing ships to increase their energy efficiency.
A detailed review of this topic will be made for Phase 2 of this study; however a preliminary assessment has been made to facilitate the scenario modelling. Since there are no regulations regarding fuel consumption, the change in the technology factor reflects improvements that are cost effective in the various scenarios rather than the technological potential. In addition to technological improvements, regulatory developments to improve other aspects of shipping may have impacts on the energy efficiency of ships. These factors are discussed and their impacts considered when determining scenario values for technological improvements.

1.4.3 Developments in marine fuels

The amount of CO_2 emitted from ships depends on the fuel type. For instance, certain fuels may contain more carbon per energy output than other fuels, and hence may produce more CO_2 emissions per unit work done. To capture this effect, future scenarios contain assumptions about future fuel use. When considering the market penetration of new fuels for the various scenarios it is noted that:

- Oil is a significant primary energy source in 2020 and 2050 in all scenario families (16-28% of world primary energy in 2050)
- In 2050, fossil fuels contribute from 57-82% of all primary energy in the SRES scenarios
- Previous estimates based on SRES scenarios range fuel consumption for shipping in 2050 from 400-810 million tonnes. This corresponds to 15-32 EJ or 10-15% of the global primary oil energy as specified for 2050 in the SRES scenarios.

It is thus considered that the SRES scenarios permit the continued use of oil-based fuels, although the cost would be expected to be higher. Therefore, in these non-GHG regulation scenarios, the move from oil-derived fuels would have to be motivated by economic factors. Since there are already binding emission targets for GHG reductions on land it is assumed that biofuels would fetch a better price there and would not be used by ships. The same situation would apply for the use of non-emitting or renewable energy from land.

1.4.4 Emission predictions

Key results from the scenario model are shown in Figure 2. Significant increases of CO_2 emissions are predicted. The emission increase is driven by the expected growth in seaborne transport. The scenarios with the lowest emissions deliver small reductions in 2050 compared to current emissions.

Our highest CO_2 emissions are essentially based on extrapolations of business as usual and minimum levels of efficiency improvements. Sustained low energy prices towards 2050 are a prerequisite for these scenarios. Therefore, the highest CO_2 emission scenarios do not appear likely. None of the scenarios show significant reductions in 2050 emissions. Such reductions would require radical changes compared to the assumptions in our model. Examples include:

- Abrupt decoupling between seaborne trade and global economic growth. In our model, the growth in transport demand is already lower than the correlation with GDP suggests, hence such decoupling must be rapid and very significant.
- Global economic growth rates significantly lower than the B2 scenario.
- Extreme fossil energy shortages compared to the SRES scenarios. According to SRES scenarios, by 2050, total primary energy consumption ranges from 160-284% of 2010 values and fossil fuels cover from 57-82% of global primary energy demand.
- Introduction of unexpected technologies.

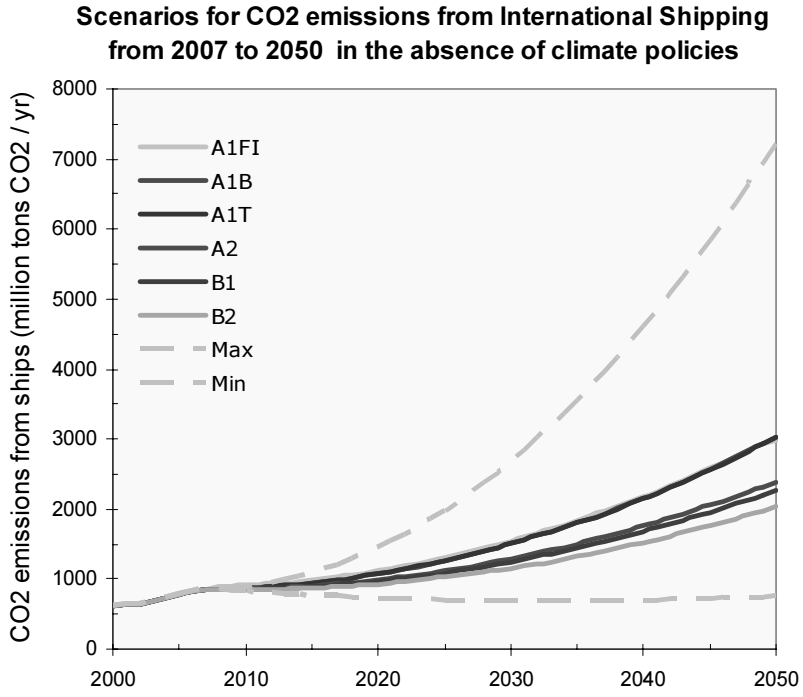

Figure 2. **Emission trajectories for different scenarios. Legend refers to IPCC SRES. The scenario terminology is explained in Section 0 of this summary**

1.5 Comparison of CO2 emissions from ships with emissions from other modes of transport

Efficiency ranges of various forms of transport was estimated using actual operating data, transport statistics and other information. The efficiency of ships is compared with that of other modes of transport in Figure 3. Efficiency is expressed as mass CO_2 / tonne-kilometre where the CO_2 expresses the total emissions from the activity and tonne-kilometre expresses the total transport work done. Total CO_2 emissions from ships have been compared to other transport modes based on fuel consumption data reported for other sectors in IEA statistics. This is shown in Figure 4. In this figure, the term 'Road diesel' refers to the total amount of diesel sold for road use, including cargo freight, passenger transport and diesel cars.

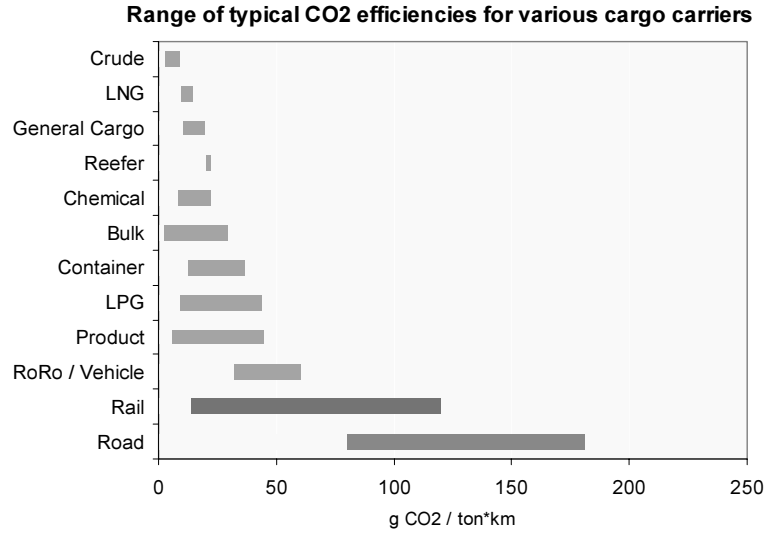

Figure 3. **Typical ranges of ship CO_2 efficiencies compared to rail and road**

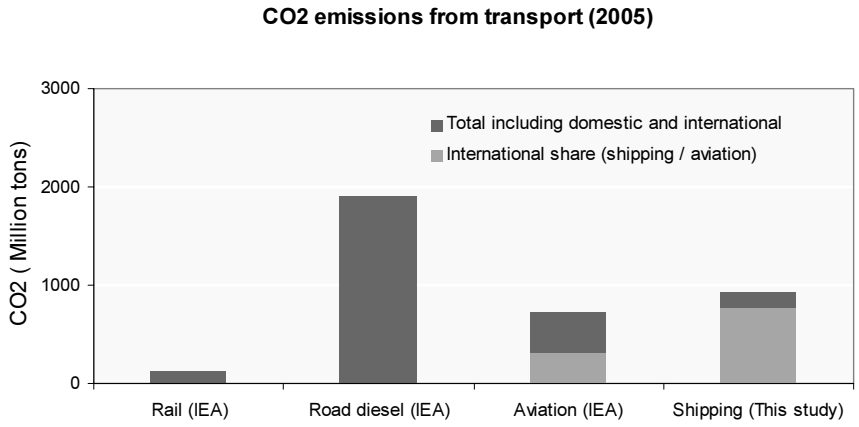

Figure 4. 2005 CO_2 emissions from shipping compared to other modes of transport

1.6 Radiative forcing impacts of CO2 emissions from shipping

Increases in well-mixed greenhouse-gases such as carbon dioxide lead to positive radiative forcing (RF) and to global warming. Other radiative effects from shipping emissions will be considered in Phase 2.

CO_2 remains in the atmosphere for a long time and will continue to have a warming effect long after its emission. Therefore, emissions data from ships starting as early as 1870 has been used when calculating the RF of shipping CO_2 emissions. Since the historic data does not distinguish between international and domestic shipping, RF calculations are based on total shipping emissions rather than international shipping only.

In order to calculate the RF from shipping we use a linear climate response model to calculate the contribution of CO_2 emissions to marginal CO_2 concentrations and the consequential radiative forcing. This model takes emission rates, calculates the resultant atmospheric concentrations of CO_2 and then the RF which arises from changes in CO_2 concentration.

The RF from shipping CO_2 for 2005 was calculated to be 46 mW m^{-2}, contributing approximately 2.8% to the total anthropogenic CO_2 RF. For comparison, aviation has a similar – if slightly smaller – present day annual emission rate (733 Tg CO_2, 2005) but the RF is only 28 mW m^{-2}. The somewhat larger forcing from shipping in this comparison may be easily explained by both the residence time of CO_2 in the atmosphere and the time period of the activity.

Stabilization of atmospheric CO_2 concentrations by the end of the 21st century will require significant reductions in future global CO_2 emissions. The resultant temperature from stabilizing CO_2 concentrations at various levels (450 ppm, 550 ppm etc.) depends on climate sensitivity. Climate sensitivity is common test of climate models to the global mean surface temperature arising from a doubling of the CO_2 concentration. This is usually estimated to be between 2 and 4.5°C. A recent assessment of climate stabilization concluded that at 550 ppm, a target of 2°C would be exceeded, and 450 ppm would result in a 50% likelihood of achieving this target. To achieve this goal, total global CO_2 emissions must be limited to the values shown in WRE 450 in Figure 5 below. For comparison, the WRE 550 emission trajectory is also shown.

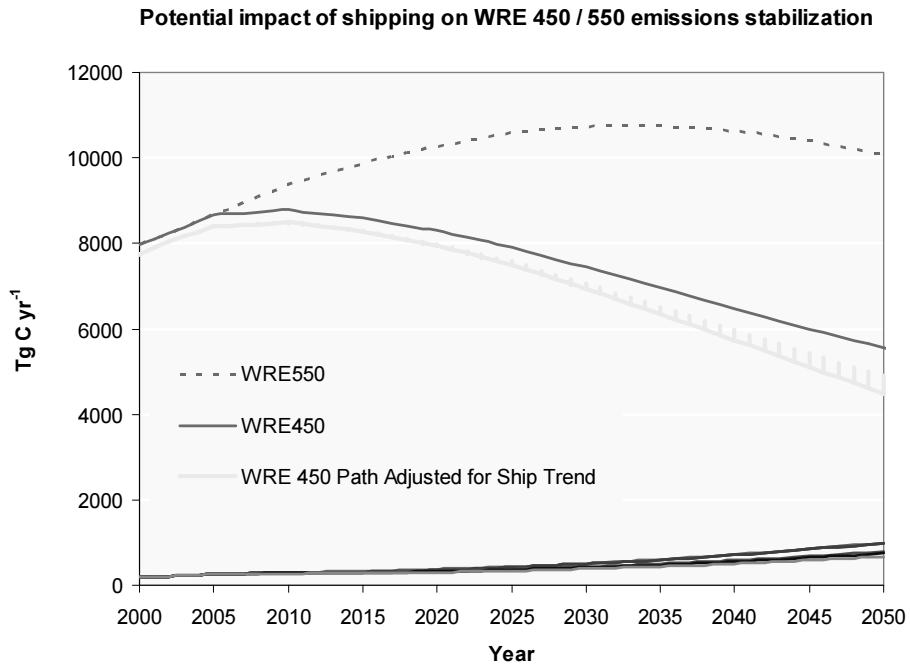

Figure 5. **Comparison of modelled shipping emissions, lines for WRE 450 and WRE 550, and WRE 450 adjusted for ship emissions (Global total less shipping emissions). To achieve stabilization of atmospheric CO_2 at 450 ppm, global CO_2 emissions must follow the WRE 450 line**

Annex III

OUTCOME OF THE 30TH CONSULTATIVE MEETING OF CONTRACTING PARTIES TO THE LONDON CONVENTION/3RD MEETING OF CONTRACTING PARTIES TO THE LONDON PROTOCOL (27 – 31 October 2008)

OCEAN FERTILIZATION AND CO_2 SEQUESTRATION IN SUB-SEABED GEOLOGICAL FORMATIONS

Note by the International Maritime Organization (IMO)

INTRODUCTION AND BACKGROUND

1 The 30th Consultative Meeting of Contracting Parties to the London Convention 1972 and the 3rd Meeting of Contracting Parties to the 1996 Protocol to the London Convention were concurrently held from 27 to 31 October 2008 at IMO Headquarters in London under the chairmanship of Mr. Victor Escobar Paredes (Spain). The sessions were attended by 38 Contracting Parties to the Convention and 24 Contracting Parties to the Protocol; nine States, which are neither Parties to the Convention nor the Protocol; one Associate Member of IMO; four United Nations organizations; one intergovernmental; and five non-governmental organizations. The full report of these Meetings will be issued in due course as document LC 30/16.

ACTIVITIES UNDERTAKEN TOWARDS REGULATION OF OCEAN FERTILIZATION

2 Fertilization of the oceans using micro-nutrients – for example, iron – is being discussed with the aim of sequestering carbon dioxide (CO_2).

3 In 2007, the governing bodies:

.1 endorsed the "Statement of Concern" of their Scientific Groups, taking the view that knowledge about the effectiveness and potential environmental impacts of ocean iron fertilization currently was insufficient to justify large-scale operations and that this could have a negative impact on the marine environment and human health;

.2 agreed that the scope of work of the London Convention and Protocol included ocean fertilization, as well as iron fertilization, and that these agreements were competent to address this issue in view of their general objective to protect and preserve the marine environment from all sources;

.3 agreed that they would further study the issue from the scientific and legal perspectives with a view to its regulation. To this end, they developed specific terms of reference for the Scientific Groups to discuss ocean fertilization in May 2008 and established the Legal Intersessional Correspondence Group (LICG), under the lead of the United Kingdom, to summarize the legal views by Contracting Parties as to whether, and how, the legal framework of the London Convention and Protocol applies to key scenarios on ocean fertilization (LC 29/17, paragraphs 4.14 to 4.29 and annex 6).

4 In October 2008, the governing bodies developed first general objectives relating to the management of ocean fertilization activities, based on the conclusions and recommendation in the LICG report (LC 30/4) and the comments thereto and the conclusions and recommendations in the report of the Working Group on Ocean Fertilization under the Scientific Groups (LC/SG 31/16, annex 2). After an intensive debate, the governing bodies developed and adopted resolution LC-LP.1 (2008) on the regulation of ocean fertilization, as shown in the annex hereto. In addition, it was agreed to further consider a potential legally binding resolution or an amendment to the London Protocol at their next session in 2009.

5 Furthermore, the governing bodies requested the Scientific Groups with the assistance of experts, as required, and in co-operation with relevant international organizations, as appropriate:

.1 to prepare a document, for the information of all Contracting Parties, summarizing the current state of knowledge on ocean fertilization, relevant to assessing impacts on the marine environment, taking into account the work done on this issue in other fora; and

.2 to provide updates to this document from time to time, as new information becomes available.

6 Recognizing also the benefits of early and regular exchanges of information on ocean fertilization, the governing bodies:

.1 invited Contracting Parties to keep the Secretariat informed of any research proposals they are assessing and to further advise it of their decisions on these proposals;

.2 requested the Secretariat to circulate this information to the Contracting Parties on a regular basis.

7 Finally, the governing bodies instructed the Secretariat that, over and beyond its routine distribution of the full report, the main outcomes of this session, including the ocean fertilization resolution should be distributed:

.1 in a circular letter to all London Convention and Protocol focal points in national administrations based on the short report to be prepared for the IMO Council;

.2 to all relevant institutions, including the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR); all regional fisheries management organizations; Antarctic Treaty bodies; UNESCO-IOC; the United Nations General Assembly (UNGA); UNFCCC; the Convention on Biological Diversity (UNEP/CBD; CPPS; the Scientific Committee on Oceanic Research (SCOR); GESAMP; the Inter-Governmental Panel on Climate Change (IPCC); and UN-Oceans; and

.3 in an IMO press release (distributed on 11 November 2008).

CO_2 SEQUESTRATION IN SUB-SEABED GEOLOGICAL FORMATIONS UNDER THE LONDON PROTOCOL

8 Further to the 2006 amendments to Annex 1 to the London Protocol to regulate CO_2 sequestration in sub-seabed geological formations under resolution LP.1(1) and the adoption, in 2007, of "Specific Guidelines for Assessment of Carbon Dioxide Streams for Disposal into Sub-seabed Geological Formations" to accompany these amendments, the Meeting of Contracting Parties adopted, at this session, a format for reporting on carbon dioxide streams into sub-seabed geological formations under the London Protocol. The electronic format in use for reporting on dumping activities under the London Convention and Protocol was amended accordingly.

9 Furthermore, the Meeting of Contracting Parties addressed the issue that if a CO_2 stream injected into a sub-seabed geological formation is expected to cross a jurisdictional boundary between two or more countries, regulators should take special care to notify and seek input from those countries before issuing the permit in order to ensure compliance with relevant regulations under the London Protocol.

10 The Legal and Technical Working Group on Transboundary CO_2 Sequestration Issues was established in 2007 and met from 25 to 27 February 2008 in Bonn, Germany. The Working Group took the view that Article 6 of the London Protocol prohibits the export of CO_2 streams from the jurisdiction of one Contracting Party to any other country, whether it is another Contracting Party or non-Contracting Party. It was also felt that "export" would include any movement from one Contracting Party to another country for disposal in that other country regardless of any commercial basis for that transfer. Consequently, it was felt that an amendment to Article 6 was required in order to permit such movements and the text for a possible amendment was developed, as shown in its report (LP/CO2 1/8, annex 3). The Working Group also developed explanatory texts for the 2007 CO_2 Sequestration Guidelines, in case amendments to Article 6 were adopted.

11 In discussing the report of the Working Group, it was reconfirmed that the aim to allow for the transboundary movement of CO_2 streams was justified as a climate change mitigation measure. Several Contracting Parties to the Protocol expressed the view that it was too early to aim at amending Article 6 of the Protocol and that other options, such as an interpretative resolution, should be explored further before a decision was taken. Other Contracting Parties supported the need for amending Article 6 and reasoned that the draft text proposed by the Working Group was balanced. As a result, the Meeting of Contracting Parties agreed to continue this discussion intersessionally by correspondence, focusing, *inter alia*, on the option of an amendment of Article 6 on the basis of the draft text developed by the Working Group in Bonn, or an interpretative resolution, or a combination of the two. The relevance of the Basel Convention and its relation to the London Protocol should also be explored further.

12 The Meeting of Contracting Parties agreed to give the political signal that, while this intersessional work was being planned to come to the best political and legal solution, the London Protocol should not constitute a barrier to the transboundary movement of CO_2 streams.

ANNEX

RESOLUTION LC-LP.1(2008)
ON THE REGULATION OF OCEAN FERTILIZATION
(Adopted on 31 October 2008)

THE THIRTIETH MEETING OF THE CONTRACTING PARTIES TO THE LONDON CONVENTION AND THE THIRD MEETING OF THE CONTRACTING PARTIES TO THE LONDON PROTOCOL,

RECALLING the objectives of the London Convention[1] and Protocol[2];

NOTING that the 'Statement of concern' on large-scale ocean fertilization by the Scientific Groups in June 2007 endorsed by the 29th Consultative Meeting and the 2nd Meeting of Contracting Parties in November 2007, and expanded on by the Scientific Groups in May 2008, remains valid;

NOTING decision IX/16 on 30 May 2008 of the 9th Meeting of the Conference of the Parties to the Convention on Biological Diversity which "requests Parties and urges other Governments, in accordance with the precautionary approach, to ensure that ocean fertilization activities do not take place until there is an adequate scientific basis on which to justify such activities, including assessing associated risks, and a global, transparent and effective control and regulatory mechanism is in place for these activities; with the exception of small scale scientific research studies within coastal waters";

NOTING United Nations General Assembly resolution 62/215, concerning "Oceans and the law of the sea", adopted on 22 December 2007, which in its paragraph 98 "encourages States to support the further study and enhance understanding of ocean iron fertilization";

NOTING that a number of other international organizations are considering the issue of ocean fertilization;

NOTING that knowledge on the effectiveness and potential environmental impacts of ocean fertilization is currently insufficient to justify activities other than legitimate scientific research;

1. **AGREE** that the scope of the London Convention and Protocol includes ocean fertilization activities;

2. **AGREE** that for the purposes of this resolution, ocean fertilization is any activity undertaken by humans with the principle intention of stimulating primary productivity in the oceans[3];

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[1] "Contracting Parties shall individually and collectively promote the effective control of all sources of pollution of the marine environment, and pledge themselves especially to take all practicable steps to prevent the pollution of the sea by the dumping of waste and other matter that is liable to create hazards to human health, to harm living resources and marine life, to damage amenities or to interfere with other legitimate uses of the sea." (Article II of the London Convention).

[2] "Contracting Parties shall individually and collectively protect and preserve the marine environment from all sources of pollution and take effective measures, according to their scientific, technical and economic capabilities, to prevent, reduce and where practicable eliminate pollution caused by dumping or incineration at sea of wastes or other matter. Where appropriate, they shall harmonize their policies in this regard." (Article 2 of the London Protocol).

[3] Ocean fertilization does not include conventional aquaculture, or mariculture, or the creation of artificial reefs.

3. **AGREE** that in order to provide for legitimate scientific research, such research should be regarded as placement of matter for a purpose other than the mere disposal thereof under Article III.1(b)(ii) of the London Convention and Article 1.4.2.2 of the London Protocol;

4. **AGREE** that scientific research proposals should be assessed on a case-by-case basis using an assessment framework to be developed by the Scientific Groups under the London Convention and Protocol;

5. **AGREE** that the aforementioned assessment framework should include, *inter alia*, tools for determining whether the proposed activity is contrary to the aims of the Convention and Protocol;

6. **AGREE** that until specific guidance is available, Contracting Parties should be urged to use utmost caution and the best available guidance[4] to evaluate the scientific research proposals to ensure protection of the marine environment consistent with the Convention and Protocol;

7. **AGREE** that for the purposes of this resolution, legitimate scientific research should be defined as those proposals that have been assessed and found acceptable under the assessment framework;

8. **AGREE** that, given the present state of knowledge, ocean fertilization activities other than legitimate scientific research should not be allowed. To this end, such other activities should be considered as contrary to the aims of the Convention and Protocol and not currently qualify for any exemption from the definition of dumping in Article III.1(b) of the Convention and Article 1.4.2 of the Protocol;

9. **AGREE** that this resolution should be reviewed at appropriate intervals in light of new and relevant scientific information and knowledge.

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[4] Such guidance includes, but is not limited to: previous agreements of the Consultative Meetings/Meetings of Contracting Parties; Annex III to the London Convention and Annex 2 to the London Protocol; the considerations for evaluating ocean fertilization proposals developed by the Scientific Groups (LC/SG 31/16, annex 2, appendix 3); and the Revised Generic Waste Assessment Guidance (LC 30/16).

PAPER NO. 4: INTERNATIONAL UNION FOR THE CONSERVATION OF NATURE ON BEHALF OF THE INTERNATIONAL UNION FOR THE CONSERVATION OF NATURE, THE NATURE CONSERVANCY, WWF, CONSERVATION INTERNATIONAL, BIRDLIFE INTERNATIONAL, INDIGENOUS PEOPLES OF AFRICA CO-ORDINATING COMMITTEE, PRACTICAL ACTION, WILD FOUNDATION, WILDLIFE CONSERVATION SOCIETY, FAUNA AND FLORA INTERNATIONAL AND WETLANDS INTERNATIONAL

Ecosystem-based adaptation:

An approach for building resilience and reducing risk for local communities and ecosystems.

A submission by IUCN to the Chair of the AWG-LCA with respect to the Shared Vision and Enhanced Action on Adaptation, on behalf of: IUCN, The Nature Conservancy, WWF, Conservation International, BirdLife International, Indigenous Peoples of Africa Co-ordinating Committee, Practical Action, WILD Foundation, Wildlife Conservation Society, Fauna and Flora International and Wetlands International

The listed observer organizations welcome the opportunity to submit views, ideas and proposals on enhanced action on adaptation (paragraph 1(c) of the Bali Action Plan). We view adaptation as an essential component of the 'shared vision' which aims to create a climate resilient society. In this submission, we wish to highlight the important contributions that ecosystem-based adaptation can provide to effective adaptation strategies. We recommend that ecosystem-based adaptation becomes one of the elements of the future adaptation framework under the UNFCCC.

Ecosystem-based adaptation includes a range of local and landscape scale strategies for managing ecosystems to increase resilience and maintain essential ecosystem services and reduce the vulnerability of people, their livelihoods and nature in the face of climate change [1].

[1] **See overleaf for further explanation of ecosystem-based adaptation**

Parties are invited to consider the following options for including ecosystem-based adaptation under the UNFCCC:

- Include ecosystem-based adaptation as a component of the Shared Vision of the AWG-LCA which aims to create a climate resilient society, and of the post-2012 adaptation framework;
- Increase incorporation of ecosystem-based adaptation into the implementation of the Nairobi Work Programme and the development of technical guidance and capacity;
- Incorporating ecosystem-based adaptation more fully into NAPAs and other national adaptation strategies and action plans;
- Aligning ecosystem-based adaptation strategies with ongoing efforts under the Convention on Biological Diversity, the UN Convention to Combat Desertification and other relevant international commitments.

Why "ecosystem-based" adaptation?

Global climate change is already adversely impacting the world's ecosystems and the people that depend on them. Impacts are escalating as temperature and precipitation patterns change and extreme weather events and related conditions increase in frequency and intensity. Climate change directly threatens the services ecosystems provide including food, clean water, coastal protection, fuel-wood, soil stability, and pollination. People who depend directly on natural resources are affected most severely. The draft findings of the Convention on Biological Diversity's Ad-Hoc Technical Expert Group on biodiversity and climate change are in full accord with these conclusions.

While global efforts to mitigate the causes of climate change are currently under way, adaptation is about "managing the unavoidable" – addressing the impacts that are already being experienced by people and ecosystems while mitigation measures take effect, and building resilience to future impacts. Ecosystem-based adaptation provides a cost-effective strategy that can be undertaken by Parties, and is especially effective at local levels with community involvement. Ecosystem-based adaptation may also contribute to climate change mitigation through the preservation or sequestration of carbon.

What is involved in ecosystem-based adaptation?

Ecosystem-based adaptation involves collective action among governments, communities, conservation and development organizations, and other stakeholders to plan and empower local action that will increase environmental and community resilience to the changing climate. Ecosystem-based adaptation and community-based adaptation are therefore mutually supportive. Examples of ecosystem-based adaptation that provide multiple benefits to local communities include:

- Maintaining and restoring "natural infrastructure" such as mangroves, coral reefs and watershed vegetation as a cost-effective means for reducing vulnerability to storm surge, rising sea levels and changing precipitation patterns;
- Protecting and restoring natural areas of cultural or religious significance, including areas critical for the cultural survival of indigenous groups;
- Enhancing the availability of natural resources as a source of food and other products important to livelihoods.
- Supporting indigenous peoples and local communities to adapt and enhance traditional knowledge systems and management practices to changing climatic conditions;
- Maintaining connectivity of ecosystems including protected areas and corridors in production landscapes involving a full range of stakeholders and governance arrangements that will ensure the continued supply of ecosystem services.

The development and implementation of ecosystem-based adaptation strategies championed by national governments will be supported in a variety of ways by the organisations listed above. This could include support for programmes designed to share knowledge and develop expertise at community and landscape scales. The development of the Ecosystems and Livelihoods Adaptation Network (ELAN) and other efforts will build capacity, share lessons learned, and link the science and practice of ecosystem-based adaptation to enhance the resilience of communities to climate change.

PAPER NO. 5: UNITED NATIONS CONVENTION ON BIOLOGICAL DIVERSITY SECRETARIAT

DRAFT FINDINGS OF THE FIRST MEETING OF THE SECOND AD HOC TECHNICAL EXPERT GROUP ON BIODIVERSITY AND CLIMATE CHANGE ON THE IMPACTS OF CLIMATE CHANGE ON BIODIVERSITY INCLUDING WAYS AND MEANS TO PROJECT IMPACTS[1]

1. The following is being submitted by the Secretariat of the Convention on Biological Diversity on behalf of the Ad hoc Technical Expert Group on Biodiversity and Climate Change in response to the call for submissions on paragraph 1 of the Bali Action Plan (decision 1/CP.13).

2. This submission is made with a view to making available, to Parties, work undertaken in other international processes, particularly the second Ad Hoc Technical Expert Group (AHTEG) on Biodiversity and Climate Change, which was convened in response to paragraph 12 (b) of decision IX/16 B of the Conference of the Parties to the Convention on Biological Diversity (CBD). The AHTEG was established to provide biodiversity related information to the United Nations Framework Convention on Climate Change (UNFCCC) though the provision of scientific and technical advice and assessment on the integration of the conservation and sustainable use of biodiversity into climate change mitigation and adaptation activities, which includes:

(a) Identifying relevant tools, methodologies and best practice examples for assessing the impacts on and vulnerabilities of biodiversity as a result of climate change;

(b) Proposing ways and means to improve the integration of biodiversity considerations and traditional and local knowledge related to biodiversity within impact and vulnerability assessments with particular reference to communities and sectors vulnerable to climate change;

(c) Identifying opportunities to deliver multiple benefits for carbon sequestration, and biodiversity conservation and sustainable use in a range of ecosystems including peatlands, tundra and grasslands;

(d) Identifying opportunities for, and possible negative impacts on, biodiversity and its conservation and sustainable use, as well as livelihoods of indigenous and local communities, that may arise from reducing emissions from deforestation and forest degradation;

(e) Identifying options to ensure that possible actions for reducing emissions from deforestation and forest degradation do not run counter to the objectives of the Convention on Biological Diversity but rather support the conservation and sustainable use of biodiversity.

[1] The following document has not been peer reviewed and, as such, presents an initial summary of the findings of the second ad hoc technical expert group on biodiversity and climate change.

BIODIVERSITY-RELATED IMPACTS OF ANTHROPOGENIC CLIMATE CHANGE

Anthropogenic changes in climate and atmospheric CO2 are already having observable impacts on ecosystems and species; some species and ecosystems are demonstrating apparent capacity for natural adaptation, but others are showing negative impacts. Impacts are widespread even with the modest level of change observed thus far in comparison to some future projections. Observed signs of natural adaptation and negative impacts include:

- **Geographic distributions:** Species' geographic ranges are shifting towards higher latitudes and elevations. While this can be interpreted as natural adaptation, caution is advised, as the ranges of some species are contracting from warm boundaries, but are not expanding elsewhere; there are also geographic limits to how far some species will be able to go. Range shifts have mostly been studied in temperate zones, due to the availability of long data records; changes at tropical and sub-tropical latitudes will be more difficult to detect and attribute due to a lack of time series data and variability of precipitation.
- **Timing of life cycles (phenology):** changes to the timing of natural events have now been documented in many hundreds of studies and may signal natural adaptation by individual species. Changes include advances in spring events (e.g. leaf unfolding, flowering, and reproduction) and delays in autumn events.
- **Interactions between species:** evidence of the disruption of biotic interactions is emerging. Changes in differential responses to timing are leading to mismatches between the peak of resource demands by reproducing animals and the peak of resource availability. This is causing population declines in many species and may indicate limits to natural adaptation.
- **Photosynthetic rates, carbon uptake and productivity in response to CO_2 "fertilization" and nitrogen deposition:** models and some observations suggest that global gross primary production (GPP) has increased. Regional modelling efforts project ongoing increases in GPP for some regions, but possible declines in others. Furthermore, in some areas CO_2 fertilization is favouring fast growing species over slower growing ones and changing the composition of natural communities while not appreciably changing the GPP.
- **Community and ecosystem changes:** observed structural and functional changes in ecosystems are resulting in substantial changes in species abundance and composition. These have impacts on livelihoods and traditional knowledge including, for example, changing the timing of hunting and fishing and traditional sustainable use activities, as well as impacting upon traditional migration routes for people.

The rate of climate change has already exceeded the capacity of some species and ecosystems to adapt naturally, and is close to exceeding that of others

Many of the mass extinctions that have occurred over geologic time were tied, at least in part, to climate changes that occurred at rates much slower than those projected for the next century. These results may be seen as potentially indicative but are not analogues to the current situation, as continents were in different positions, oceanic circulation patterns were different and the overall composition of biodiversity was significantly different. It should also be kept in mind that these extinctions occurred with the temperature change taking place over tens of thousands of years – a rate at which natural adaptation should have been able to take place. This is in contrast to the much more rapid rate of temperature change observed and projected today.

Given the rapid rate of projected change, some regions and ecosystems will be more vulnerable to extinction and degradation than others. The relative vulnerability of species and ecosystems is due to a combination of individual species traits that predispose them to risk, the degree of exposure of the environment to climate change, and their capacity to adapt, either genetically or behaviourally. For example, the very nature of small island developing States, as relatively isolated territories, low-lying and surrounded by an ocean or a sea, makes their biota extremely vulnerable to climate change

and related sea level rise, prolonged droughts and increases in hurricane and storm surges frequency and strength.

During the course of this century the resilience of many ecosystems (their ability to adapt naturally) is likely to be exceeded by an unprecedented combination of change in climate, associated disturbances (e.g., flooding, drought, wildfire, insects, ocean acidification) and in other global change drivers (especially land-use change, pollution and over-exploitation of resources), if greenhouse gas emissions and other changes continue at or above current rates (high confidence).[1]

Further climate change will have increasingly significant direct impacts on biodiversity. Increased rates of species extinctions are likely, with negative consequences for the provision of services these species and ecosystems provide. Poleward and elevational shifts, as well as range contractions and fragmentation, are expected to accelerate in the future. Contractions and fragmentation will be particularly severe for species with limited dispersal abilities, slower life history traits, and range restricted species such as polar and mountain top species and species restricted to freshwater habitats.

Increasing CO_2 concentrations are altering the basic physical and chemical environment underpinning all life, especially temperature, precipitation, and acidity. Atmospheric concentrations of CO_2 can themselves have important direct influences on biological systems, which can reinforce or act counter to responses to climate variables and complicate projection of future responses. The direct effects of elevated atmospheric CO_2 are especially important in marine ecosystems and in terrestrial systems that are not water-limited.

Climate change will also affect species indirectly, by affecting species interactions. Individualistic responses of species to climate and atmospheric change may result in novel species combinations and ecosystems that have no present day analogue (a finding supported by paleoecological studies). These impacts on communities may be more damaging in some regions than the direct effects of climatic changes on individual species, and may compromise sustainable development. The impacts of climate change on species will have cascading affects on community associations and ecosystems leading to non-linear responses, with thresholds or "tipping points" not yet well understood.

Climate change will interact with other pressures acting on natural systems, most notably land use and land-use change, invasive alien species and disturbance by fire. Land-use change and related habitat loss are currently major threats to biodiversity worldwide. Climate change is also very likely to facilitate the spread and establishment of invasive alien species. However, shifts in distributions of native species as an adaptive response to climate change will force a reassessment of how we define what is meant by "invasive". These pressures amplify climate change effects by causing fragmentation, degradation and drying of ecosystems, including increased incidence of fire, which is often exacerbated during climatic events like El Niño. Thus, it is vital to consider the effects of climate change in the context of interacting pressures and the influence they may exert directly on natural systems and on those systems' abilities to respond to climate change.

Extinction risks associated with climate change will increase, but projecting the rate of extinction is difficult due to lags in species' population responses, incomplete knowledge of natural adaptive capacity and the complex cascade of inter-species interactions in communities

Research shows that approximately 10% of species assessed so far are at an increasingly high risk of extinction for every 1°C rise in global mean temperature, within the range of future scenarios modeled in impacts assessments (typically <5^0C global temperature rise). Given the observed temperature rise, this now places approximately 6-8% of the species studied at an increasingly high risk of extinction. The current commitment to additional temperature increases (at least 0.5°C) also places an additional 5-7% of species at increasingly high risk of extinction (based on single species studies and not including losses of entire ecosystems). A recent study of global bird distributions estimated that each degree of warming will yield a nonlinear increase in bird extinctions

[1] This statement is extracted verbatim from IPCC WG2 Chapter 4 conclusions.

of about 100-500 species. Temperature increases of 2°C above pre-industrial begin to put entire ecosystems at risk and the extinction rate is expected to rise accordingly.

The understanding of the characteristics that contribute to species' risks of decline or extinction has improved. Species with small ranges and tropical montane species are at particular risk as are those with naturally fragmented or isolated populations or limited dispersal ability. Areas of most concern are the arctic and Antarctic regions, centres of endemism where many species have very narrow geographic and climatic ranges, low-lying regions, wetlands, coral reefs and freshwater systems where species have limited dispersal opportunities. Vulnerability is also affected by the degree and extent of other human pressures. Recent work suggests that for birds, amphibians and warm water corals as many as 35-70% of species have life-history traits that make them vulnerable to climate change. In the absence of strong mitigation in all sectors (fossil fuel and land-use), some ecosystems, such as cloud forests and coral reefs, may cease to function in their current form within a few decades.

The negative impacts of climate change on biodiversity have significant economic and ecological costs

A key property of ecosystems that may be affected by climate change is the values and services they provide. These include provisioning services such as fisheries and timber production, where the response depends on population characteristics as well as local conditions and may include large production losses. Climate change also affects the ability of ecosystems to regulate water flows, and cycle nutrients.

There is ample evidence that warming will alter the patterns of plant and animal diseases. Current research projects increases in economically important plant pathogens with warming. There has also been considerable recent concern over the role of climate change in the expansion of disease vectors. For example, short-term local experiments have demonstrated the impacts of predicted global change on plant health including rice. Furthermore, studies of the impacts of climate change on the range of the tick-borne disease Theileriosis (East Coast fever) show increases in areas of suitability in Africa.

The impacts of climate change on biodiversity will change human disease vectors and exposure. Climate change is predicted to result in the expansion of a number of human disease vectors and/or increase the areas of exposure. For example the increased inundation of coastal wetlands by tides may result in favourable conditions for saltwater mosquito breeding and associated increased in mosquito-borne diseases such as malaria and dengue fever.

Climate change affects the ability of ecosystems to regulate water flows. Higher temperatures, changing insolation and cloud cover, and the degradation of ecosystem structure, impedes the ability of ecosystems to regulate water flow. In Asia, for example, water supplies are at risk because climate change melts the glaciers that feed Asia's largest rivers in the dry season – precisely the period when water is needed most to irrigate the crops on which hundreds of millions of people depend.

Climate change will have important impacts on agricultural biodiversity. Even slight changes are expected to decrease agricultural productivity in tropical and subtropical areas. More frequent and more extreme droughts and floods will increase the likelihood of crop failure and may result in negative livelihood impacts including forced sale of assets, out-migration and dependency on food relief. The wild relatives of crop plants – an important source of genetic diversity for crop improvement – are also potentially threatened by climate change.

Changes and shifts in the distribution of marine biodiversity resulting from climate change could have serious implications for fisheries. The livelihoods of coastal communities are threatened by the projected impacts of climate change on coral reefs and other commercially important marine and freshwater species. Fisheries may improve in the short term in boreal regions but they may decline elsewhere with projected local extinctions of particular fish species important for aquaculture production. As a result of climate change and in the absence of stringent mitigation, up to 88% of the

coral reefs in Southeast Asia may be lost over the next 30 years. In addition, ocean acidification may cause pH to decrease by as much as 0.5 units by 2100 causing severe die-offs in shellfish.

Biodiversity loss and ecosystem service degradation resulting from climate change has a disproportionate impact on the poor and may increase human conflict. The areas of richest biodiversity and ecosystem services are in developing countries where billions of people directly rely on them to meet their basic needs. Competition for biodiversity resources and ecosystem services may lead to human conflict. Small Island Developing States and Least Developed Countries are particularly vulnerable to impacts such as projected sea level rise, ocean current oscillation changes and extreme weather events.

Indigenous peoples will be disproportionately impacted by climate change because their livelihoods and cultural ways of life are being undermined by changes to local ecosystems. Climate change is likely to affect the knowledge, innovations and practices of indigenous peoples and local communities and associated biodiversity-based livelihoods. However, it is difficult to give a precise projection of the scale of these impacts, as these will vary across different areas and different environments. For example, indigenous peoples and local communities in the Arctic depend heavily on cold-adapted ecosystems. While the number of species and net primary productivity may increase in the Arctic, these changes may cause conflicts between traditional livelihoods and agriculture and forestry. In the Amazon, changes to the water cycle may decrease access to native species and spread certain invasive fish species in rivers and lakes. Furthermore, climate change is having significant impacts on traditional knowledge, innovations and practices among dryland pastoral communities.

Shifts in phenology and geographic ranges of species could impact the cultural and religious lives of some indigenous peoples. Many indigenous peoples use wildlife as integral parts of their cultural and religious ceremonies. For example, birds are strongly integrated into Pueblo Indian communities where birds are viewed as messengers to the gods and a connection to the spirit realm. Among Zuni Indians, prayer sticks, using feathers from 72 different species of birds, are used as offerings to the spirit realm. Many ethnic groups in sub-Saharan Africa use animal skins and bird feathers to make dresses for cultural and religious ceremonies. For example, in Boran (Kenya) ceremonies, the selection of tribal leaders involves rituals requiring Ostrich feathers. Wildlife plays similar roles in cultures elsewhere in the world.

Novel environments and novel ecosystems are likely to emerge with potentially unexpected behaviour. Climate change is already resulting in novel climates in some microclimates within existing protected areas. This shift may render existing conservation efforts less effective.

Biodiversity can be important in ameliorating the negative impacts of some kinds of extreme climate events for human society; but certain types of extreme climate events which may be exacerbated by climate change will be damaging to biodiversity

Ecosystems play an important role in protecting infrastructure and enhancing human security. More than 1 billion people were affected by natural disasters between 1992 and 2002. During this period floods alone left more than 400 000 people homeless and caused many deaths. In response to these events many countries adopted plans and programmes recognizing the need to maintain natural ecosystems.

The value of biodiversity in ameliorating the negative impacts of some extreme events has been demonstrated. The value of mangroves for coastal protection has been estimated in some areas to be as much as US$ 300,000 per km of coast based on the cost of installing artificial coastal protection. A study of the overall value of wetlands for flood protection provided an estimated benefit of $464 per hectare. Furthermore, the conservation and sustainable use of biodiversity has a significant role to play in response to drought providing important genetic diversity in livestock and crops.

The impacts of climate change on biodiversity will reduce the ability of ecosystems to ameliorate the negative impacts of extreme events. Future predictions of the impacts of climate change on biodiversity have identified some of the ecosystems most critical for human security as being particularly vulnerable to the impacts of climate change. For example, climate change impacts

are expected to result in a loss of over half the area of mangroves in 16 Pacific island States by the end of the century.

Enhancing natural adaptation by biodiversity can reduce negative impacts from climate change and contribute to climate change mitigation by preserving key functions such as carbon sequestration

Climate change will continue to alter the composition, physical and trophic structure, successional processes and community dynamics of many ecosystems, with cascading effects to the services these ecosystems provide, including carbon storage. Examples include the invasion of temperate grasslands by woody plants possibly facilitated by increasing CO_2 concentrations, and changes in the structure of reef ecosystems due to bleaching and ocean acidification. Regional modelling also projects increases in GPP for some regions as a result of longer growing seasons and higher CO_2 concentrations. However, where water balance is more important GPP is projected to either decline or to increase only slightly relative to present day conditions. Changes in productivity will result in changes in litterfall and nutrient cycling. Where litterfall increases, it may contribute to increasing respiration and loss of soil carbon.

Ecosystems are currently acting as a carbon sink to sequester 30% of anthropogenic emissions, but if no action is taken on mitigation, these sinks would slowly convert to carbon sources as temperatures rise, largely due to the increased soil respiration and regional drought. Some studies suggest that this feedback could increase CO_2 concentrations by 20 to 200 ppm, and hence increase temperatures by 0.1 to 1.5ºC in 2100. The level of global warming which would be required to trigger such a feedback is uncertain, but could lie in the range of an increase in global mean surface temperature of between 2-4ºC above pre-industrial levels according to some models. In particular:

- Local conversion of forests from sinks to sources would be exacerbated by deforestation and degradation, which increases the vulnerability of forest to climate change and reduces local precipitation encouraging drying. Some models predict that the Amazon is particularly vulnerable to such processes. Between 25-50% of rainfall is recycled from the Amazon forest, forming one of the most important regional ecosystem services. Deforestation of 35-40% of the Amazon, especially in Eastern Amazonia, could shift the forest into a permanently drier climate, increasing the risk of fire and carbon release.
- Arctic ecosystems and tropical peatlands could also become strong sources of carbon emissions in the absence of mitigation. Recent studies estimate that unmitigated climate change could lead to thawing of Arctic permafrost releasing at least 100GtC by 2100, with at least 40Gt coming from Siberia alone by 2050. Such increases will not be offset by the projected advance of the boreal forest into the tundra.
- Experimental evidence suggests that the warming climate will alter the plant species present in ecosystems that are currently based on peat soils, reducing the capacity of the peat to sequester carbon.

ASSESSING THE RELIABILITY OF THE KNOWLEDGE ON THE IMPACTS OF CLIMATE CHANGE ON BIODIVERSITY AND IDENTIFYING KNOWLEDGE GAPS

There is considerable confidence that climate models provide credible quantitative estimates of future climate change, particularly at continental scales and above. However, at finer spatial scales projections have a high level of uncertainty, particularly in tropical and subtropical regions, and in relation to projections of rainfall change.

Confidence in climate change models comes from the foundation of the models in accepted physical principles and from their ability to reproduce observed features of current climate and past climate changes. Confidence in model estimates is higher for some climate variables (e.g., temperature) than for others (e.g., precipitation). There are, however, some limitations in the models. Significant uncertainties are, for example, associated with the representation of clouds leading to

uncertainties in the magnitude and timing, as well as regional details, of predicted climate change.

Despite uncertainties, models are unanimous in their prediction of substantial warming under greenhouse gas increases. This warming is of a magnitude consistent with independent estimates derived from other sources, such as from observed climate changes and past climate reconstructions. Furthermore, since confidence in the changes projected by global models decreases at smaller scales, other techniques, such as the use of regional climate models, or downscaling methods, have been specifically developed for the study of regional- and local-scale climate change.

Research needs and gaps remain. CBD Technical Series 10 outlined a number of research needs and gaps with regards to assessing the impacts of climate change and biodiversity. Some of these gaps have been filled, however many remain. For example, there is still a lack of extensive, readily available quantitative information on many species globally. While efforts to fill this need are underway (e.g., Global Biodiversity Information Facility), more work remains to be done, especially at understanding where species are not (a critical factor in performing many bioclimatic models). Human land and water use patterns are available for many parts of the world, but are not widely linked into the typical models used for looking at biodiversity impacts. This is also an impediment to using models to separate the impacts of climate change from other human activities.

Key uncertainties that limit our ability to project climate change impacts on ecosystems include projections for precipitation which carry a significantly higher uncertainty than temperature and uncertainties regarding ecological processes

Models currently contain inadequate representations of the interactive coupling between ecosystems and the climate system and of the multiple interacting drivers of global change. This prevents a fully integrated assessment of climate change impacts on ecosystem services; major biotic feedbacks to the climate system, especially through trace gases from soils in all ecosystems, and methane from labile carbon stocks such as wetlands, peatlands, permafrost and loess soils.

There is uncertainty with respect to the functional role of individual species and the functioning of complex systems. Further uncertainties are drawn from:

- the assumption of instantaneous (and often perfect) migration, which biases impact estimates;
- the net result of changing disturbance regimes (especially through fire, insects and land-use change) on biotic feedbacks to the atmosphere, ecosystem structure, function and biodiversity;
- the magnitude of the CO_2-fertilisation effect in the terrestrial biosphere and its components over time;
- the limitations of climate envelope models used to project responses of individual species to climate changes, and for deriving estimations of species extinction risks (see below);
- the synergistic role of invasive alien species in both biodiversity and ecosystem functioning;
- the effect of increasing surface ocean CO_2 and declining pH on marine productivity, biodiversity, biogeochemistry and ecosystem functioning; and
- the impacts of interactions between climate change and changes in human use and management of ecosystems as well as other drivers of global environmental change in ecosystems including more realistic estimates of lagged and threshold responses.

The complexity of ecosystems may often lead to non-linear responses that introduce uncertainty

Short-term responses within ecosystems and among species may considerably differ, and may even be the opposite of longer term responses. Ecological changes are likely to not be gradual, but stepwise, and changes may take place in the form of sudden shifts, whose timing and location is largely unpredictable. Non-linear responses include tipping points and thresholds beyond which

adaptation may no longer be possible. Sudden shifts may occur as a result of the outbreaks of pests or the decrease of recovery time between extreme events.

The difficulty in predicting thresholds makes the management of biodiversity and the diversity of ecosystems an important safeguard. Landscape-scale ecosystem heterogeneity may – to some extent – buffer against moderate changes in climate. In particular, the diversity of species and interactions amongst them, as well as landscape-scale habitat heterogeneity may provide a range of natural adaptive capacity in the face of a certain level of change.

Information on extreme event impacts is difficult to gather since these occur rarely and unpredictably. A further difficulty is that climate change scenarios are limited in ability to represent their changing frequency**.** Widespread and long-duration extreme events may induce a range of damaging impacts on ecosystems and biodiversity (e.g., as observed following the 2003 European heatwave).

Investment in key areas that require scientific development would reduce uncertainty in assessments of the impacts of climate change on biodiversity and related impacts on human society

More emphasis on deriving a credible range of precipitation projections and resulting water regime effects is needed. These should emphasise interactions between vegetation and atmosphere, including CO_2-fertilisation effects, in mature forests in the Northern Hemisphere, seasonal tropical forests, and arid or semi-arid grassland and savannas.

Improved understanding of the role of disturbance regimes is needed. This includes frequency and intensity of episodic events (drought, fire, insect outbreaks, diseases, floods and wind-storms) and that of species invasions, as they interact with ecosystem responses to climate change.

Improvements in the integration of feedback mechanisms are needed in order to address differences between modelled changes and observed impacts. Such an approach could include studies on impacts of rising atmospheric CO_2 on ocean acidification, and warming on coral reefs and other marine systems, and widening the range of terrestrial ecosystems for which CO_2-fertilisation responses have been quantified.

It is important to develop a much clearer understanding of the linkages between biodiversity impacts due to climate change and their implications for human society. Significant advances have been made recently in quantifying the value of ecosystems and their biodiversity, but these are not yet widely incorporated into climate change impact assessment approaches. One of the most effective approaches has been to integrate climate change impacts on ecosystems and biodiversity in terms of the related changes in various ecosystem services.

GUIDANCE ON THE APPLICATION OF ASSESSMENT TOOLS AND METHODOLOGIES RELATED TO THE IMPACTS OF CLIMATE CHANGE ON BIODIVERSITY AT A RANGE OF SCALES

Assessments of impacts of climate change on biodiversity using currently available tools is dependent on the integration of data on the distribution of species with spatially explicit climate data for a range of climate change scenarios

Despite their limitations, the use of bioclimatic modelling techniques allows a useful, and often accurate first cut assessment of spatial distribution of exposure and vulnerability in relation to conservation efforts. Where expert knowledge on species demography is available, techniques can be applied that include consideration of climate variability and require species abundance data, but this places a higher demand on the spatial and temporal resolution of future climate data. While the use of spatially downscaled future scenario data is ideal if achievable, for robust risk and impacts assessments it may be more useful to focus on a range of future climate scenarios even if they are not downscaled, and not only on a mean or median future scenario.

Good Practice Standards and Guidelines for bioclimatic models, associating observed changes with climate, and assessing vulnerability should be developed. This could include information on how to best use the climate data, report on the results and uncertainties and perform the associations and attributions of the event with climate change. Ideally, these guidelines should be developed through an international body such as IPCC.

Observed changes and climate variability can potentially be used to assess the sensitivity of bioclimatic models. There have been a number of reviews examining how species ranges and the timing of events (e.g., arrival dates, egg laying) have been observed to be consistent with regional climate changes. These changes have occurred with a relatively small amount of global temperature change. While the number of conjoined studies (examining observed changes linked to bioclimatic models) is still small, observed changes can be used to help assess the sensitivity of some bioclimatic models – are the changes observed in the direction projected by the bioclimatic models? Other ways of assessing whether species' ranges are associated with climate, and thus would potentially move with climate changes, is whether a species' range changes in association with climate variability.

Climate change impact assessments should optimally be integrated with assessments of other stresses on ecosystems such as current and future land-use change, and changes in disturbance where applicable. The direct effects of land use and land-use change may overwhelm climate change effects on biodiversity in the short to medium term. Alternative modelling approaches that simulate changes in ecosystem structure and biome type may be more mechanistically robust in simulating, for example disturbance regimes such as fire, and should be used where possible to provide alternative or complementary insights into species and ecosystem vulnerability.

Readily available, easy to use, multiple impact stressor tools are needed. There are many different tools available to project the potential impacts of climate change on biodiversity. However, these tools are hampered in many areas and for many species by the lack of availability of distribution data. Additionally, these efforts are often undertaken in isolation from other efforts and often only look at one, or a few, climate change scenarios for only one or a few different GCMs. Efforts are now underway to link emission scenarios, multiple GCMs, and multiple species bioclimatic tools to better enable the research community to not only look at impacts using a much broader range of emission scenarios using more GCMs, but to do so in a probabilistic fashion. This will provide better estimates of uncertainty and make it easier for researchers to reanalyze their results once new emission scenarios or new climate change models become available. These same modelling tools are also being used to link the same climate and emissions data with hydrological and sea-level rise models and it is possible that, in the near future, all could be examined simultaneously.

Tools for assessing the vulnerability of species and ecosystems to climate change are available. Models are not the only way of assessing the vulnerability of species and ecosystems to climate change. Expert based systems, coupled with data where available, can be used to assess the potential vulnerability of both species and ecosystems. Some of these techniques also examine other human impacts on species and ecosystems and allows a comparison of the relative contribution of climate change versus other drivers over time.

Currently, remote sensing provides the only viable way to monitor changes at a global scale, which has serious limitations on developing a globally integrated picture of species level responses. Field monitoring efforts could be productively strengthened, harmonised and organised into a global network, especially to include the coverage of areas not studied so far. In monitoring efforts, special attention should be paid to the impacts of extreme events because they may serve as an early warning of future vulnerability.

The establishment of multi-purpose monitoring programs which include the impacts of climate change on biodiversity would be beneficial in maximizing the use of limited resources. A monitoring programme that integrates biodiversity status, within a framework that includes threat status monitoring and the recording the effectiveness of adaptation measures is also recommended.

Experimental studies on multiple pressures in various ecosystems are needed to better define causal relationships

The experimental approach can be used to establish causality and define both the nature and magnitude of cause and effect relationships. This makes this approach very valuable despite its limitations arising mainly from the limited size of experimental plots. Experiments have already been used to assess the effects of increased temperature, altered precipitation regime and increased CO_2 level on population biology, species composition, phenology and biogeochemistry in various, mostly low-stature ecosystems. More studies are needed on the combined effects of multiple pressures including temperature, precipitation, CO_2, land-use, invasive species and nitrogen deposition. Finally, broader geographic coverage is necessary to draw globally relevant conclusions, as much of this work has been conducted in temperate, northern Hemisphere ecosystems.

Observations from indigenous and local communities form an important component of impact assessments as long as they are conducted with prior informed consent and with the full participation of indigenous and local communities

Indigenous peoples and local communities are holders of relevant traditional knowledge, innovations and practices, as their livelihoods depend on ecosystems that are directly affected by climate change. This knowledge is normally of a practical nature, and covers areas such as traditional livelihoods, health, medicine, plants, animals, weather conditions, environment and climate conditions, and environmental management as the basis of indigenous wellbeing. This knowledge is based on experience based on life-long observations, traditions and interactions with nature. However, further research is needed into impact assessments that involve indigenous peoples and local communities. This will substantially enhance the understanding of local and regional impacts of climate change.

The potential impacts of climate change on biodiversity and related livelihoods and cultures of indigenous peoples and local communities remains poorly known. Furthermore, such impacts are rarely considered in academic, policy and public discourse. In particular, climate models are not well suited to providing information about changes at the local level. Even when observations are included at the species level, there is little research on, for example, impacts on traditional management systems as an important strategy to cope with change. Accordingly it is suggested that further efforts are made to ensure that traditional knowledge, innovations and practices are respected, properly interpreted and used appropriately in impact assessments through contextually relevant practices in data collection and sharing, development of indicators, assessment validation and feedback, and applications.

Tools and methodologies for monitoring the impacts of climate change on biodiversity in partnership with indigenous and local communities can benefit from a range of practices. These include utilising the results of community-based monitoring linked to decision-making, especially because indigenous communities are able to provide data and monitoring information at a system rather than individual species level.

(a) Promote documentation and validation of traditional knowledge, innovations and practices are limited. Most knowledge is not documented and has not been comprehensively studied and assessed. Therefore there is need to enhance links between traditional knowledge and scientific practices.

(b) Revitalize traditional knowledge, innovations and practices on climate change impacts on traditional biodiversity based resources and ecosystem services through education and awareness raising, including in nomadic schools.

(c) Explore uses of and opportunities for community-based monitoring linked to decision-making, recognizing that indigenous peoples and local communities are able to provide data and monitoring on a whole system rather than single sectors based on the full and effective participation of indigenous and local communities.

PAPER NO. 6: UNITED NATIONS CONVENTION TO COMBAT DESERTIFICATION

Submission by the United Nations Convention to Combat Desertification
4th Session of the Ad Hoc Working Group on Long-term Cooperative Action under the Convention (AWG-LCA 4), Poznan, 1-10 December 2008

Information note: **Use of biochar (charcoal) to replenish soil carbon pools, restore soil fertility and sequester CO_2**

Abstract

The world's soils hold more organic carbon than that held by the atmosphere as CO2 and vegetation, yet the role of the soil in capturing and storing carbon dioxide is often one missing information layer in taking into consideration the importance of the land in mitigating climate change. Extraordinary demands are being placed on agricultural systems to produce food, fiber and energy and yet the inevitable changes in the flow of carbon into or out of soils have significant effect on a global scale. Biomass burning and the removal of crop residues reduce carbon in soil and vegetation, which has implications for soil fertility and the global carbon cycle.

The land has an unparalleled capacity to hold carbon and to act as a sink for green house gases making it imperative to focus on activities that enhances rehabilitation, protection and sustainable management of degraded lands. Conventional means to increase soil carbon stocks depend on climate, soil type and site specific management. Over the years, most efforts to manage greenhouse gases have involved planting trees, since the amount of carbon that can be sequestered in this way is substantial. However, the drawback of conventional carbon enrichment is that this carbon-sink option is of limited duration. The associated humus enrichment follows a saturation curve, approaching a new equilibrium level after some 50 to 100 years. The new carbon level drops rapidly again as soon as the required careful management is no longer sustained.

There exist opportunities to include sustainable land management processes and in particular the use of biochar into the CDM negotiation process through focused policy actions that include institutional synergy as well as better understanding of the sustainability cost-benefit of Biochar. This process could be undertaken starting in Poznan and towards the Copenhagen agreement.

Pyrolysis (of agricultural residues resulting in charcoal and energy production) with biochar carbon sequestration provides a tool to combine sustainable soil management (carbon sequestration) and renewable energy production. The process of pyrolysis or carbonization is known globally and can be implemented at both small scale (e.g. cooking stove) and large scale levels (e.g. biorefinery). About 50% of the carbon can be captured if biomass is converted to biochar. Charcoal enriched soils like Chernozems and in particular Terra Preta soils are among the world's most fertile soils and prove that soil organic carbon enrichment beyond the maximum capacity is possible if done with a recalcitrant form of carbon such as biochar.

The soil properties determine the different capacities of the land to act as a store for carbon that has direct implications for capturing greenhouse gases. Biochar offers unique options to address issues emerging from the conflicts and complementarities between cultivating crops for different purposes, such as for energy or for CO_2 sequestration or for food and the impacts on food security, land/soil degradation, water, and biodiversity. The fact that many of the drylands soils have been degraded means that they are currently far from saturated with carbon and their potential to sequester carbon may be very high (Farage et al 2003) making the consideration of Biochar, as a strategy for enhancing soils carbon sequestration, imperative.

Required policy actions

The global carbon trade market must be made accessible to land managers, especially in the tropics where sustaining SOC and soil fertility is most challenging and CO_2 emissions due to land use change are highest.

All stakeholders need to engage in the dialogue for the post 2012 climate regime. This approach of soil organic carbon restoration constitutes a significant adaptation tool to climate change, in addition to sequestering carbon. This could be a strong link between the three Rio conventions as it simultaneously addresses climate change, desertification and biodiversity issues.

There is the need to include into the negotiation agenda of UNFCCC practical approaches such as biochar-related mitigation (CDM) and other LCA adaptation initiatives, focusing on increased land productivity, which simultaneously takes into account the issue of climate change, desertification and biodiversity issues.

According to the IPCC biochar management would be a valid C sink in the current and post 2012 LULUCF guidelines. However, the following policy action is urgently required:

1. Raising awareness on the role of the land on mitigation and adaptation to climate change and in particular the importance of Biochar in enhancing the sequestration of carbon in the soils.
2. Inclusion of biochar in the CDM mechanism along with currently already included afforestation and reforestation (A/R).
3. Revision of the additionality rules in order to take into account the fact that biochar is a permanent means of carbon capture that has more value than the potentially reversible (A/R).
4. In view of item 3 above, increase the level of CERs that an annex I Party can use towards meeting the Kyoto Protocol targets from the current 1% to a higher percentage. This would result in large financial flows for both mitigation and adaptation to developing countries where use of this technique would result in the highest returns, due to the high losses of SOC.

The Values of Soil Organic Carbon (SOC)

According to Sombroek et al. (1993) it is important to separate effects due to organic matter per se (maintenance and improvement of water infiltration, water holding capacity, structure stability, retention of nutrients, healthy soil biological activity) from those due to decomposition (source of nutrients). The SOC pool is an important indicator of soil quality, and has numerous direct and indirect impacts on it such as, improved structure and tilth, reduced erosion, increased plant-available water capacity, water purification, increased soil biodiversity, improved yields, and climate moderation (Lal 2004). This is essential to sustain the quality and productivity of soils around the globe, particularly in the tropics where there is a greater proportion of nutrient poor soils with a greater susceptibility to carbon loss.

Greenhouse Gas (GHG) Emissions from Agriculture

The global SOC pool in the upper 1 m for the world's soils contains 1220 gigatons (Gt, 10^9 = billion tons) carbon, 1.5 times the total for the standing biomass (Sombroek et al. 1993). The total soil carbon (organic and inorganic) is 3.3 times the size of the atmospheric carbon pool (Lal 2004). As most agricultural soils have lost 50 to 70% of their original SOC pool (Lal 2003) they represent a considerable carbon sink if efforts are made to restore SOC, but also a huge source of GHG if soil management and deforestation rates are not changed. There is high agreement and much evidence that with current climate change mitigation policies and related sustainable development practices, global GHG emissions will continue to grow over the next few decades (25-90% between 2000 and 2030) (IPCC 2007).

Replenishing SOC Pools and the Global Potential of Biochar Carbon Sequestration

Increasing SOC with conventional means e.g. conservation tillage, use of manures, and compost, conversion of monoculture to complex diverse cropping systems, meadow-based rotations and winter cover crops, and establishing perennial vegetation on contours and steep slopes can sequester carbon. The sequestration potential depends on climate, soil type, and site specific management. SOC of cropland increases only if either SOC additions are enhanced or decomposition rates reduced (Sauerbeck 2001). Accumulating crop residues in the field can cause considerable crop management problems (increasing the susceptibility to wildfire, insect attach and disease, increasing N_2O and CH_4

emission). Therefore many farmers find it more expedient to burn crop residues than to incorporate them into the soil. Worldwide, the total carbon release from fire is of the order of 4-7 Gt of carbon per year. This flux is almost as large as the rate of fossil fuel consumption (about 6 Gt per year in 1990) (Goudriaan 1995).

Reduced decomposition is an advantage of charcoal (biochar). Biochar formation has important implications for the global carbon cycle. In natural and agroecosystems residual charcoal is produced by incomplete burning. As the SOC pool declines due to cultivation, the more resistant charcoal fraction increases as a portion of the total carbon pool (Zech and Guggenberger 1996, Skjemstad 2001, Skjemstad et al. 2002) and may constitute up to 35% of the total SOC pool in ecosystems (Skjemstad et al. 2002). Carbon dating of charcoal has shown some to be over 1500 years old, fairly stable, and a permanent form of carbon sequestration (Lal 2003).

An anthropogenically-enriched dark soil found throughout the lowland portion of the Amazon Basin and termed *Terra Preta de Índio* is one example how soil management can increase the productivity of soils for centuries (Woods 1995). These soils contain high concentrations of charcoal (Glaser et al. 2001); and significantly more plant available nutrients than in the surrounding soils (Lima et al. 2002). The existence of *Terra Preta* proves that infertile soils can be transformed into permanently fertile soils in spite of rates of weathering 100 times greater than those found in the mid-latitudes.

Systems (pyrolysis) converting biomass into energy (hydrogen-rich gas and bio-oil) and producing biochar as a by-product offer an opportunity to combine renewable energy production, carbon sequestration and soil restoration. Biochar can be produced by incomplete combustion from any biomass, and it is a by-product of the pyrolysis technology used for biofuel and bioenergy production. If the demand for renewable fuels by the year 2100 was met through pyrolysis, biochar sequestration could exceed current emissions from fossil fuels (Lehmann et al. 2006).

Biochar and Soil Fertility

The recalcitrant nature of charcoal makes biochar rather exceptional. Recent studies showed that soil biochar amendments are indeed capable of increasing soil fertility by improving chemical, biological, and physical properties. Biochar significantly increase plant growth and nutrition (Lehmann et al. 2003, Steiner et al. 2007). Lehmann et al. (2003) and Steiner et al. (2008) found improved efficiency of nitrogen fertilizers on biochar containing fields. The effects on soil biology seem to be essential as biochar has the potential to alter the microbial biomass (Steiner et al. 2004) and composition (Birk 2005) and the microbes are able to change the biochar's properties (Glaser et al. 2001). The majority of experiments conducted show that biochar soil amendments result in enhanced colonization rates my mycorrhizal fungi (Warnock et al. 2007). Rondon et al. (2007) found increased biological nitrogen fixation by common beans through biochar additions. Lehmann and Rondon (2006) reviewed 24 studies with soil biochar additions and found improved productivity in all of them ranging from 20 to 220% at application rates of 0.4 to 8 tons carbon ha^{-1}.

Advantages of Biochar Carbon Sequestration

- <u>No competition between SOC restoration, bio-fuels and food production</u>

Numerous researchers warn of deleterious effects on soil fertility if crop residues are removed for bio-energy production (Sauerbeck 2001, Lal 2004). Pyrolysis with biochar carbon sequestration provides a tool to combine sustainable SOC management (carbon sequestration), and renewable energy production. While producing renewable energy from biomass, SOC sequestration, agricultural productivity, and environmental quality can be sustained and improved if the biomass is transferred to an inactive carbon pool and redistributed to agricultural fields. The uses of crop residues as potential energy source or to sequester carbon and improve soil quality can be complementary, not competing uses.

- <u>Pyrolysis or gasification with biochar carbon sequestration</u>

Bioenergy with biochar carbon storage facilitates the generation of carbon-negative energy. Biochar producing gasifiers can have a broad range in size and in technological complexity. Biochar can be produced as a byproduct from cooking (biochar producing kitchen stoves). Decentralized small scale

projects are feasible and large capital investments are not necessary. As biochar is a byproduct of gasification, no carbon capture technology is necessary. There is no risk of harmful CO_2 leakage from biochar.

- Fast SOC buildup beyond the maximum sequestration capacity

From biomass to humus a considerable fraction of carbon is lost by respiratory processes, and also from humus to resistant soil carbon. Only 2-20% of the carbon added as above ground residues and root biomass enters the SOC pool by humification. The rest is converted to CO_2 due to oxidation, and furthermore the SOC pool is not inert to oxidation (Lal 2004). Soils can only sequester additional carbon until the maximum soil carbon capacity, or soil carbon saturation, is achieved, which requires a steady input of biomass and careful management practices. In contrast, about 50% of the carbon can be captured if biomass is converted to biochar (Lehmann et al. 2006).

The existence of Terra Preta proves that SOC enrichment beyond the maximum capacity is possible if done with a recalcitrant form of carbon such as biochar. These soils still contain large amounts of biochar derived SOC in a climate favorable for decomposition, hundreds and thousands of years after they were abandoned.

- Reduced deforestation

Only re-growing plant biomass can establish a carbon sink. The carbon trade could provide an incentive to cease further deforestation; instead reforestation and recuperation of degraded land for fuel and food crops would gain magnitude. As tropical forests account for between 20 and 25% of the world terrestrial carbon reservoir (Bernoux et al. 2001), this would reduce emissions from tropical forest conversion which is estimated to contribute globally as much as 25 % of net CO_2 emissions and up to 10 % of N_2O emissions to the atmosphere (Palm et al. 2004).

- Easy accountability and reduced risk

Current CDM projects dealing with charcoal aim either at reduction of methane emissions during charcoal production or substitution of fossil fuels by burning charcoal. In both cases the charcoal does not reduce GHG in the atmosphere.

Biochar as a soil amendment would provide a large permanent carbon sink. Potential drawbacks such as difficulty in estimating greenhouse gas removals and emissions resulting from land use, land use change and forestry (LULUCF), or destruction of sinks through forest fire or disease do not apply to biochar soil amendments. Furthermore, the biochar carbon sink is easily quantifiable. Biochar production transforms carbon from the active (crop residues or trees) to the inactive carbon pool. Biochar is a formally authorized soil amendment in Japan and is discussed to be part of Australia's emissions trading scheme. New Zealand invested in research development and commercialization of biofuel and **biochar**. The 2008 Farm Bill (H.R. 2419, the Food and Energy Security Act of 2008) was passed by the U. S. Congress and establishes the first federal-level policy in support of biochar production and utilization programs in the world, and is one of a handful of new, high-priority research and extension areas.
The avoided emissions of greenhouse gases are between 2 and 5 times greater when biochar is applied to agricultural land than used solely for fossil energy offsets. The potential revenues from carbon trading alone can justify optimizing pyrolysis to produce biochar for application to land (Gaunt and Lehmann 2008).

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PAPER NO. 7: UNITED NATIONS ENVIRONMENT PROGRAMME

Submission by UNEP under the Bali Action Plan – Technology

Thoughts Concerning Technical Assistance and Capacity Building to Support the Transfer of Climate Technologies: Possible activities and their potential impact

The *Special Report on Methodological and Technological Issues in Technology Transfer* by the Intergovernmental Panel on Climate Change helped consolidate the view that the 'transfer' of technologies is in fact a multi-faceted process that is more accurately described as development followed by 'diffusion' or 'dissemination'. This is because technology transfer requires the creation of an enabling policy environment, which entails stable macroeconomic conditions; broad stakeholder involvement; the development of human and institutional capacities for selecting and managing technologies, as well as to develop technology codes and standards; and the establishment of procedures that take equity issues into consideration while safeguarding property rights. **Efforts to promote technology transfer in the area of climate change mitigation may thus be usefully articulated in terms of strategies to foster the development of robust markets for cleaner energy technologies.**

A range of barriers hamper the development of such markets. Poor access to timely and unbiased information hinders both the setting of broad policy priorities and the drafting of sector-specific legislation and regulations by public authorities, prevents the finance industry from estimating more accurately the risks of cleaner energy technology investments, and stifles more widespread adoption of cleaner energy technologies by industry in developing countries. Reduced institutional and human capacities are a particularly important concern amongst governmental agencies, which face growing demands in the area of climate change, but lack of capacity also hampers the private sector's ability to organise itself in a more effective manner. Limited access to finance affects all actors in the market, from government, to suppliers, to end-users, and ultimately holds back private sector first-movers from entering the cleaner energy technology sector, thereby slowing down the large-scale private sector investment which typically follows: public sector funds are set to play a catalyser role, to support first-movers and pave the way for that large-scale private investment.

A 2007 report by the UN Framework Convention on Climate Change estimates the additional investment needed in developing countries in 2030 to mitigate climate change at just below USD 100 billion in current prices.[1] Since this investment directly supports the transfer of the cleaner energy technologies that can make climate change mitigation possible, the figure provides in effect a rough estimate of the implementation costs related to market development for cleaner energy technologies. The report argues that "carbon markets, the financial mechanism of the Convention, ODA, national policies and, in some cases, new and additional resources, will be needed to mobilize the necessary investment". It further recalls that Official Development Assistance (ODA) is of greatest importance to developing countries and, in particular, the least developed amongst those. Understandably, the report makes no attempt to estimate the share of ODA in the overall envelope required to mobilise the total sum noted above, as this could only be done on a case-by-case basis.

The table below outlines a range of activities aimed at fostering market development for cleaner energy technologies in developing countries that could be financed by governments *in order to create the conditions under which private sector, market oriented technology transfer occurs*. The selection includes actions with a potential to help overcome the various barriers mentioned above –

[1] *Investment and Financial Flows to Address Climate Change - Background paper on analysis of existing and planned investment and financial flows relevant to the development of effective and appropriate international response to climate change*. United Nations Framework Convention on Climate Change. Bonn, 2007.

poor access to timely and unbiased information, reduced institutional and human capacities, and limited access to finance. They thus aim to develop the 'soft' aspects of technology transfer and create conducive enabling environments.

The combined implementation cost is USD 1.9 billion over five years and would pave the way for much larger investments. This estimate does not include costs of large scale investments that would principally be addressed by other mechanisms. The various initiatives could be undertaken by bilateral or multilateral agencies. *Indicative costs and outputs are presented to indicate the magnitude of funding required, but are estimates only.*

Table 1: Summary of Identified Initiatives

	Initiative	**Scope**	**Funding (US$)**
Focus Area 1: Policy	1. Climate policy support	Help governments resolve specific issues related to the design and implementation of climate and sustainable energy policies and programmes	50 million One hundred policies supported
	2. National cleaner energy technology plans	Prepare comprehensive national technology plans that provide the basis for the systematic removal of barriers needed to develop markets for prioritised technologies	50 million National plans developed for 100 countries
	3. Improving energy subsidy frameworks	Provide institutional and financial support to governments willing to test out changes in energy subsidy regimes in favour of climate-mitigation technologies.	200 million Fifty perverse subsidies removed
	4. Financial innovation support facility	Help first-mover financial institutions develop new financial products, move up the learning curve and reduce the high transaction costs of initial climate sector commitments.	50 million One hundred financial products launched

NOTE: The implementation period for each initiative is five years

Table 1: Summary of Identified Initiatives (continued)

Initiative		Scope	Funding (US$)
Focus Area 2: Networking	5. Regional climate change networks	Operate regional networks of climate change officials that provide a means for sharing knowledge, exchanging information and experience, and accelerating technology transfer through cooperative regional efforts	40 million Ten networks established, covering 147 countries
	6. National cleaner energy technology centres	Establish national centres of excellence in clean energy technology, building off existing energy agencies or other suitable institutions	100 million Centres established in 100 countries
Focus Area 3: Finance	7. SME finance facility	Facilitate the scale-up of seed financing and later stage bank financing to climate entrepreneurs	100 million Two hundred SMEs launched
	8. Risk mitigation facility	Establish fund guarantee programmes to share market and technology risks, targeting the mobilisation through local commercial banks of domestic lending for climate projects	200 million Two billion of domestic lending across 15 new climate technology markets
	9. Least-developed country credit facility for climate infrastructure	Provide affordable long term financing on concessional terms for low carbon infrastructure projects	500 million Two billion financed in 10 countries
	10. End-user finance facility	Help the domestic banking community to begin financing the uptake of cleaner technology amongst households and small business	200 million Fifty lending sectors created, benefiting 20 million people
	11. Carbon finance facility	Facilitate first-of-a-kind carbon transactions based on new methodologies and approaches	50 million Two hundred projects served
	12. Incentive facility for first movers in industry	Provision of targeted support for first-movers investing in cleaner energy technologies through financial assistance and information which can help reduce transaction costs	200 million Twenty different technologies in 50 countries

NOTE: The implementation period for each initiative is five years

Table 1: Summary of Identified Initiatives (continued)

	Initiative	Scope	Funding (US$)
Focus Area 4: Technology	13. Regional technology market assessments	Creation of technology platforms to scale-up the uptake of cleaner energy technologies at the regional level in key areas such as energy-using devices, energy intensive industries or fossil-fuelled power generation	80 million Four platforms established, covering 10 sub-regions
	14. Energy efficiency standards and labels	Development of standards and norms for selected products and strengthening of national and regional capacities to adopt, implement and enforce a range of product standard programmes	75 million Five product standard programmes in 100 countries
		Total	**1.9 billion**

NOTE: The implementation period for each initiative is five years.

Annex 1: Description of Initiatives

Initiative 1: Climate policy support

Context: Policies that provide investment certainty help to reduce the risk premium for investors, lowering the cost of projects and the price that consumers have to pay for the low carbon technologies and services. Deciding which policy approach to take and how to implement it is challenging and poses a learning barrier to sector development. Many governments require support in determining, designing, and implementing policy instruments for the climate-mitigation sectors.

Proposed approach: Initiate a *Climate Policy Advisory Facility* to provide governments with small amounts of technical guidance, advice, and information in a fast, flexible and responsive manner to help resolve specific issues related to the policy formulation and implementation process. Targeted support interventions that can quickly respond to government requests have been shown to be an effective policy backstopping tool.

Impact: Help governments formulate 100 new policies to foster investment in climate mitigation.

Initiative 2: National cleaner energy technology plans

Context: Most national energy administrations in developed countries conduct quantitative studies of the potential for increased investment to reduce energy use and exploit domestic renewable energy resources within a specified time frame, which underpin their national policies and actions plans. Developing countries and economies in transition seldom conduct these analyses, which hinders their ability to frame sound long-term clean energy policies.

Proposed approach: Assessments of potential provide a comprehensive, systematic analysis of the energy efficiency and renewable energy 'project portfolios' and make it possible to prioritise opportunities based on cost-effectiveness considerations. They underpin consultations on clean energy programme development, which are most effectively conducted by a neutral third party with knowledge of the lessons learnt through comparable policy planning efforts in other countries.

Impact: Make the initial case or justification for undertaking the establishment of energy efficiency and renewable energy policies and programmes; characterise the current and future potential for energy efficiency and renewable energy, with a view to identifying the most cost-effective opportunities; obtain detailed information about specific measures and the broader clean energy market to aid in technology screening, and programme design and funding; and support priority setting and programme development.

Initiative 3: Improving energy subsidy frameworks

Context: Fossil fuel subsidies in many countries distort the market for low-carbon alternatives. Removing or transferring subsidies to cleaner technologies is not easy as they are usually controlled by parts of government that are distant from energy/climate decisions and are set in legislation, changes to which may be considered politically risky.

Proposed approach: Offer short-term institutional and financial support to governments willing to test out changes in energy subsidy regimes in favour of climate-mitigation technologies. Financial support could be used to temporarily level the subsidy regime, allowing cleaner technologies to compete on a level playing field.

Impact: Support 40 governments in improving/levelling subsidy frameworks at an average cost of US$5 million per intervention and less than US$1 per tCO_2. The governments receiving support would commit to changing subsidy legislation if/when the cleaner technology reached some market threshold.

Initiative 4: Financial innovation support facility

Context: Increased engagement of financial institutions is critical for mobilising climate investment. In the case of commercial finance, facilities that help share some of the preparatory and transitional costs can help mobilise initial investments into the sector. Banks face high front-end development costs and often a lack of internal management support for engaging in 'unproven' sectors and business activities. The more innovative the concept, the more the learning costs involved, both in terms of time commitments and the external costs of hiring external expertise. Resolving such potential blockages to investment can be a catalytic role for public-private cost-sharing facilities.

Proposed approach: Help first-mover financial institutions engage in and scale up their capital mobilisation to the climate mitigation sectors.

Impact: Support the development of 100 new climate finance products; assist 200 projects in raising financing; train thousands of bankers; help mobilise US$20 billion of new climate investment; and avoid 150 Mt of CO_2.

Initiative 5: Regional climate change networks

Context: Developing country governments seldom have sufficient institutional capacity and informed staff to effectively manage and report on their national programmes for greenhouse gas mitigation. Knowledge-sharing approaches that 'network' efforts in different countries and give officials the means of exchanging information and experience have proven to be an extremely efficient method of building institutional and individual capacity under other multilateral environmental agreements, notably the Montreal Protocol.

Proposed approach: Networking provides a platform for government focal points from developing countries to exchange experiences, develop their skills and tap the expertise of their peers in both developing and developed countries. In doing so, a networking platform builds the focal points' skills for implementing and managing their national programmes for climate change. Regional networks also provide a regular and common platform for international agencies, secretariats, and bilateral donors to communicate with and collect feedback from a large number of developing countries at one shot.

Impact: Strengthened access to information on climate change by, and improved institutional capacities of, climate change focal points in all developing countries through a networking effort which offers a coordinated and thus more effective response to what in essence are similar needs by countries within groupings according to similar levels of development.

Initiative 6: National cleaner energy technology centres

Context: The energy and fuel savings resulting from, respectively, improved energy efficiency and a shift to renewable energy represent a major incentive for developing country industries to adopt cleaner energy solutions throughout their operations. However, at present national energy agencies in these countries have limited capacities to provide tailored advice to local industries on cleaner energy

technology options, or to engage local financial institutions in cleaner energy technology financing. Similarly, access to lessons learnt from countries facing similar problems is poor.

Proposed approach: Provide tailored support for existing national energy agencies and help set up new ones where there are none – with a view to creating a centre of excellence at the national or, where relevant, sub-national levels. To this end a long-term business plan needs to be established around a self-funded centre relying on the price paid by potential customers to have access to the skills residing in the centre. Initial donor funds are required to build up those skills and cove core start-up centre costs.

Impact: Staff in developing country energy agencies trained; manuals on clean energy solutions for industry developed and adapted to local realities and sectoral specificities; energy audits conducted in key industries and industrial carbon dioxide emissions saved; economic efficiency improved.

Initiative 7: SME finance facility

Context: Mobilizing investment for SMEs involves working with a range of actors, from risk capital providers who finance innovation and new business development, to local banking institutions who provide SMEs working capital.
Entrepreneurs can transform markets, but the environment for entrepreneurship is poor in many developing countries, particularly in the new climate sectors. For new business ventures there is a lack of available enterprise development support services and seed financing is hard to secure, with most investors reluctant to engage too early.

Proposed Approach: Facilitate the scale-up of seed financing and later stage bank financing to climate entrepreneurs by capitalising specialist seed finance investors and providing incentives and technical support to commercial investors that allow them to shift their capital resources into the seed finance sector.

Impact: Seed and later stage financing to 200 new low-carbon enterprises in 50 developing countries. Increased availability of SME financing from a range of financial actors for entrepreneurs and clean energy SMEs.

Initiative 8: Risk mitigation facility

Context: In many countries where commercial banks have sufficient capital resources they may still be unwilling to provide financing to clean energy or other climate projects because of high perceived credit risks. In these situations guarantees can be used to mobilize available domestic liquidity by sharing in the credit risk of project loans. Typically guarantees are partial, that is they cover a portion of the outstanding loan principal with 50-80% being common. This ensures that the banks remain at risk for a certain portion of their portfolio to ensure prudent lending. When effectively structured, one dollar in guarantee funds can directly leverage US$12-15 of commercial investment into climate projects and indirectly catalyze long term growth of financial commitments to the sector.

Proposed approach: Set up a risk mitigation facility that would fund guarantee programmes targeting market and technology risks of new climate technologies. These programmes would be managed by existing national guarantee agencies and would target the mobilization through local commercial banks of domestic lending for climate projects.

Impact: Support local banking institutions to engage for the first time in the climate sectors, writing over US$2 billion of new loans across 15 new climate technology markets.

Initiative 9: Least-developed country credit facility for climate infrastructure

Context: Financial markets in many least developed countries lack the basic liquidity needed to meet medium to long term financing requirements of clean energy or other climate infrastructure projects. In these markets where high interest rates are seen as a large barrier, credit lines can be offered at concessional rates to induce borrowing and direct credit to target sectors and projects. The financing can either be in the form of senior debt or subordinated debt. Subordinated debt can substitute for and reduce the amount of senior debt in a project's source of funds thus improving the debt-to-equity ratio and reducing risk from the senior lender's point of view. Subordinated debt can also substitute for and reduce project sponsor equity requirements by providing the needed capital to a project finance structure.

Proposed approach: Operate a credit line facility for providing long term financing to climate infrastructure projects through commercial financial institutions in least-developed countries. Lending would be on concessional terms to provide affordable long term financing for climate projects.

Impact: US$2 billion of low carbon infrastructure financed across 10 countries.

Initiative 10: End-user finance facility

Context: Banks are typically reluctant to finance unfamiliar technologies, and most climate technology applications fall in that category. Furthermore, the development of new lending products imposes significant additional transaction costs on banks, especially at the retail level. Therefore, financial sector awareness of climate, and the ability of banks to manage the additional costs and risks of providing financing to these new markets are crucial for the dissemination of low-carbon technologies. New efforts are needed to initiate and scale up local bank financing of small-scale climate technologies.

Proposed approach: Launch a programme to mobilize local bank lending for users of small scale climate technologies. Each intervention would combine banker training with a financial incentive (interest subsidy or risk-sharing option) to help first-mover banks write their first 10,000 – 20,000 loans for a specific climate technology, the number at which lending to these sectors begins to make commercial sense.

Impact: Successful interventions lead to self sustaining financial markets that can finance hundreds of thousands and eventually millions of systems. Help launch 200 new credit markets in thirty developing countries, each aimed at surpassing the 10,000 to 20,000 loan threshold, and in total providing 20 million people with access to a range of low-carbon technologies.

Initiative 11: Carbon asset development facility

Context: Least Developed Countries have thus far failed to substantially benefit from the carbon market. With industrial mitigation potential being small and the majority of opportunities lying in rural areas, the transaction cost of initial LDC carbon projects has been particularly high. However, once the first projects have been completed others will develop more easily and the market will grow.

Proposed Approach: Stimulate growth and commercial investment in LDC Carbon Markets by facilitating first-of-a-kind CDM and voluntary market transactions based on new methodologies and innovative approaches with high potential for replication.

Impact: Capitalized at US$ 50 million, the facility could support the completion of about 200 projects in 40 countries over 5 years. Those reference projects will mitigate (or sequester) a minimum of 200 million tons of CO2 over a 20-year period.

Initiative 12: Incentive facility for first movers in industry

Context: Limited donor assistance cannot directly decrease the cost competitiveness of new technologies. However it can play a role in assisting the transfer of proven technologies to new markets, particularly those in smaller countries where technology providers have difficultly overcoming initial market development costs. While large emerging economies usually present enough of a market opportunity for technology transfer to occur on a purely commercial basis, without the prospect of large commercial volumes, small- to medium-sized least developed countries lack the market potential required for companies to invest in transferring a technology.

Proposed approach: Offer an incentive programme, whereby a fixed cost-sharing subsidy is paid to each company that successfully transfers a priority technology to a target country. The programme would aim to cost-share technology transfer and market deployment costs, not capital costs – the reasoning being that if the technologies are not financially viable once transferred, then uptake will drop off once programme support is removed. The support should target the one-off soft costs that a company will need to invest in commercialising a technology in a given country. These costs typically are in the US$50,000 to US$1 million range.

Impact: Technology providers willing to invest the capital needed to adapt a technology in least-developed country markets, to fulfil local certification requirements, to train local staff and dealers, and to generally develop a market presence in the country.

Initiative 13: Regional technology market assessments

Context: There is an urgent need to move beyond narrowly defined national technology needs assessments to in-depth analyses of the actual market and trade barriers that prevent technology transfer and uptake from taking place, and to follow this up by an analysis of the policy, institutional and financial measures that will overcome these barriers.

Proposed approach: Take a holistic view to market and trade barriers to technology diffusion by considering the uses of a technology both across sectors and countries – to capitalise on the potential market opportunities that exist within different applications of the technology in neighbouring countries with similar needs and levels of development. To this end technology performance benchmarks need to be conducted and local networks of intermediaries (notably equipment suppliers and distributors, installers, service companies, and energy auditors) need to be strengthened.

Impact: Generally applicable approaches for conducting technology market assessments established, tested, and refined for wider application; four technology platforms created (in the areas of minimum performance standards for energy-using devices, renewable energy supply, energy efficiency of energy-intensive industries, and energy efficiency of fossil-fuelled electricity generation); and experiences coordinated among sub-regions through ‘knowledge platforms’.

Initiative 14: Energy efficiency standards and labels

Context: Energy performance standards have proven to be an effective tool to break down the barriers hindering a more widespread diffusion of energy efficient technologies. Standard development requires consultation with concerned industry stakeholders, coordination of certification bodies and testing laboratories, and policy and institutional support to implement and enforce the standard.

Proposed approach: A range of mutually complementary activities are needed to implement energy efficiency standards and labels: identify key technologies in terms of their mitigation potential, facilitate the development of appropriate efficiency standards, support national authorities enact regulation underpinning the implementation of the standards, help establish certification procedures and bodies, and support national authorities with implementation arrangements and enforcement procedures.

Impact: Improved energy performance standards for key technologies developed through an inclusive, consultative process; strengthened national and regional technical capabilities to manage the implementation of a policy that mandates energy efficiency norms for certain technologies; strengthened national policy and institutional capacities to adopt, implement and enforce a programme of energy efficiency norms and standards for priority technologies.

PAPER NO. 8: UNITED NATIONS OFFICE FOR THE COORDINATION OF HUMANITARIAN AFFAIRS ON BEHALF OF THE INTER-AGENCY STANDING COMMITTEE

Climate Change, Migration and Displacement: Who will be affected?

Working paper submitted by the informal group on Migration/ Displacement and Climate Change of the IASC - 31 October 2008

In its Fourth Assessment Report, the Intergovernmental Panel on Climate Change (IPCC) notes migration and displacement as being likely key impacts of climate change due to changing patterns of extreme weather and climate events, which may be gradual or sudden. Fully recognizing the importance of this assertion for our current and future operations, an informal group, mandated by the Inter-Agency Standing Committee (IASC)[1] Working Group has made progress in defining a shared understanding about the main areas of concern and proposing appropriate typology and terminology on migration and displacement induced by climate change.[2]

This working paper provides a preliminary overview of this progress. It describes how existing international legal frameworks may apply to populations increasingly affected by the effects of climate change events and environmental degradation, and suggests appropriate terminology. It also outlines a number of potential operational and legal gaps, and calls for further research and cooperation on this issue.

There are complex linkages between climate change and human mobility. Current estimates of the number of people who will be obliged to move as a result of climate change and environmental degradation by the year 2050 range from 25 million to one billion. This raises important questions surrounding statistics and available data in this field, the methodologies used to collect data and estimate current and future flows, and the underlying assumptions behind them.

Neither the UN Framework Convention on Climate Change, nor its Kyoto Protocol includes any provisions concerning specific assistance or protection for those who will be directly affected by the effects of climate change.

It is foreseeable that the majority of movements prompted by climate change and environmental degradation will occur within countries although increased cross-border movement of people is also likely.
The chart on the following page outlines a preliminary analysis of the nature of movement, the types of persons affected and applicable legal framework. This is followed by short summary of existing terminology that may be applicable to affected populations. IASC organizations are committed to continue to work on these issues, and encourage Member States to:

1. Take account of, and manage, the humanitarian consequences of climate change, including protecting those who may move as a result.
2. Launch a dialogue among Member States on how to fill existing and foreseeable legal, operational and capacity gaps associated with climate change and human mobility, and to allocate sufficient additional funding to this issue from both climate change specific funding mechanisms and ODA.
3. Recognize that significant further research and analysis is needed regarding the scale, nature and patterns of climate related population mobility, and regarding those who do not and cannot move, and draw on the IASC's considerable existing mechanisms, tools and capacities to support such efforts.

[1] The Inter-Agency Standing Committee (IASC) is a unique inter-agency forum for humanitarian coordination and for its members a policy development and decision making forum involving key UN and non-UN humanitarian actors. The IASC was established in June 1992 in response to UN General Assembly Resolution 46/182 on the strengthening of humanitarian assistance. More information can be found at www.humanitarianinfo.org/iasc. This paper was drafted by an informal task force, mandated by the IASC Working Group and convened by IOM in collaboration with UNHCR, the RSG on Human Rights of IDPs, OCHA and other interested IASC organizations.

2 This paper should be read in conjunction with 'Reducing the Humanitarian Consequences of Climate Change', produced by the IASC and the International Strategy for Disaster Reduction (ISDR).

Nature of movement, affected persons and applicable framework

Cause of movement	Nature of movement	Existing legal framework
1. Hydro-meteorological extreme hazard events	Temporary forced displacement as a result of a specific hazard event within national borders. Temporary forced displacement across international borders as a result of a specific hazard event. Temporary voluntary movement across international borders as a result of a specific hazard event. Forced displacement as a result of areas being designated as prohibited for habitation by authorities potentially resulting in internal displacement, forced cross-border movements and/or voluntary cross-border movements	Those moving within existing borders are currently protected by: • International human rights law if they move voluntarily • International human rights law and the Guiding Principles on internal displacement if they are forcibly displaced Those moving across international borders: **Potential gap 1: Those moving across international borders as a result of hazard events (and subsequent designation of prohibited areas) are protected by international human rights law, which, however, does not entitle them to admission and stay in another country. They are not automatically protected by the 1951 refugee convention, unless they meet established criteria. In some cases, they might be in need of protection and assistance temporarily pending return. More analysis is necessary to determine if some may be covered by existing regional conventions regardless of their formal status.**
2. Environmental degradation and/or slow onset extreme hazard events	Such processes will likely be gradual, beginning with voluntary movements (in- and outside the country) and potentially ending in forced displacement (in- and outside the country). Environmental degradation whether at early or advanced stages and/or slow onset disasters may also result in areas being prohibited for habitation by authorities leading to internal displacement, forced cross-border movements and/or voluntary cross-border movements (see above).	Those moving within existing borders are currently protected by: • International human rights law if they move voluntarily • International human rights law and the Guiding Principles on Internal Displacement if they are forcibly displaced Potential gap 1: Those moving across international borders (see above). **Potential gap 2: There is a lack of criteria to distinguish between voluntary and forced movements in hazard related disaster settings.**
3. Significant permanent losses in	Such processes if not prevented by sufficient mitigation, could be gradual, beginning with voluntary movements (in- and outside the	Those moving within existing borders are currently protected by: • International human rights law if they move voluntarily

state territory as a result of sea level rise etc.	country) and potentially ending in forced displacement (in- and outside the country). These could include: • Voluntary movements inside the country (to safe parts of country) and across internationally recognized borders. • Displacement within the national territory Forced cross-border movements, including in extreme cases the entire loss of state territory.	• International human rights law and the Guiding Principles on internal displacement if they are forcibly displaced Potential gaps 1 & 2: (see above) **Potential gap 3: Should a state lose its entire territory, one of the constituent elements of statehood, it is not clear whether its statehood would continue to be recognized by the international community. There is a risk that its population would be rendered stateless. While UNHCR has a mandate for the prevention of statelessness and the protection of stateless persons, specific arrangements will need to be forged which permit for their movement elsewhere and prevent statelessness.**
4. Armed conflict/violence over shrinking natural resources	Forced displacement in the case of such armed conflict or violence could result internal displacement or in people crossing international borders as refugees or persons under temporary or subsidiary forms of protection	Those moving within existing borders are currently protected by: • International humanitarian law (IHL) • International human rights law • The Guiding Principles on Internal Displacement Those moving across international borders could be protected by • International humanitarian law (IHL) • International human rights law • International refugee law Subsidiary and temporary protection regimes for persons fleeing from or displaced by armed conflicts

Existing terminology on displacement and migration

Internally displaced persons (IDPs)
The currently accepted definition of IDPs are *"persons or groups of persons who have been forced or obliged to flee or to leave their homes or places of habitual residence, in particular as a result of or in order to avoid the effects of armed conflict, situations of generalized violence, violations of human rights or natural or human-made disasters, and who have not crossed an internationally recognized State border."* (*Guiding Principles on Internal Displacement, E/CN.4/1998/53/Add.2*.). This definition includes all those forcibly displaced within their country due to the effects of climate change.

The Guiding Principles are recognized by the international community as important international framework for the protection of IDPs (2005 World Summit Outcome). They reflect existing international human rights law and international humanitarian law. An increasing number of States have made use of them in the development of national laws or policies and in Africa, States that have ratified the Great Lakes Protocol on internal displacement are obliged to incorporate them into their domestic law.

Refugees:
In international or regional refugee law a refugee is a person, who meets the criteria under the applicable refugee definition provided for in international or regional refugee instruments, UNHCR's mandate, and/or in national legislation.

Environmental factors that cause movements across international borders are not grounds, *in and of themselves*, for the grant of refugee status under the 1951 Refugee Convention. The terms "environmental refugee" and "climate refugee" therefore have no legal basis in international refugee law, and it is recommended that they not be used in official or unofficial documentation. Their use could potentially undermine the international legal regime for the protection of refugees, misdescribe what are projected to be essentially *internal* movements, and create confusion regarding the link between climate change, environmental degradation and migration.

The refugee definition has evolved over the past six decades. Under international law, a refugee is a person who "owing to well-founded fear of persecution for reasons of race, religion, nationality, membership of a particular social group or political opinions, is outside the country of his nationality and is unable or, owing to such fear, is unwilling to avail himself of the protection of that country, or who, not having a nationality and being outside of the country of his former habitual residence as a result of such events, is unable or, owing to such fear, is unwilling to return to it" (1951 Convention relating to the Status of Refugees, Art. 1A(2), 1951, as modified by the 1967 Protocol).

UNHCR has been mandated to protect as refugees, persons who fear serious and indiscriminate threats to life, physical integrity or freedom resulting from generalized violence or events seriously disturbing public order, in addition to persons falling within the 1951 Convention definition.

In Africa, the refugee definition has been broadened to encompass persons compelled to leave their country not only as a result of persecution, but also "owing to external aggression, occupation, foreign domination or events seriously disturbing public order in either part or the whole of his country of origin or nationality." (*Art. 1(2) Organization of African Unity (OAU) Convention Governing the Specific Aspects of Refugee Problems in Africa, 1969*)

In Latin America, the 1984 Cartagena Declaration on Refugees adds the criterion "massive violation of human rights." (Section III(3) *Cartagena Declaration on Refugees, adopted by the Colloquium on the International Protection of Refugees in Central America, Mexico and Panama)*

Stateless persons
A stateless person is defined as a "*a person who is not considered as a national by any state under the operation of its law*". (1954 Convention Relating to the Status of Stateless Persons, Article 1) Persons who possess a nationality in formal terms but whose nationality is ineffective are generally referred to as de facto stateless persons. Additionally, stateless refugees are defined in the 1951 Refugee Convention as persons "who, not having a

nationality and being outside the country of his former habitual residence as a result of such events, is unable or, owing to such fear, is unwilling to return to it". Stateless refugees are protected under the 1951 Refugee Convention.

IASC organizations have committed to further analysis and collaboration regarding these typologies and terminologies.

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