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Scoping Paper for a proposed Technical Paper: Levels of Greenhouse Gases Preventing Dangerous Anthropogenic Interference with the Climate System

(Submitted by Vice-Chairman Prof. Yuri Izrael)

The Panel may recall its request to Prof. Izrael for the Scoping Paper. An earlier draft was circulated to the Bureau and selected experts for comments. The attached document is a revision based on the comments received. The comments received, collated, are in IPCC-XIX/Doc. 8b.

The document is submitted for discussion and decision.

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To the XIX Session of the IPCC

SCOPING PAPER FOR

THE TECHNICAL PAPER

LEVELS OF GREENHOUSE GASES IN THE ATMOSPHERE PREVENTING DANGEROUS ANTHROPOGENIC INTERFERENCE WITH CLIMATE SYSTEM

A draft prepared by Vice-Chairman of the IPCC Yuri Izrael

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and various governments.

0 Executive Summary

1 Background

Article 2 of the UN Framework Convention on Climate Change (UN FCCC) states that:
"The ultimate objective of this Convention and any related legal instruments that the Conference of the Parties may adopt is to achieve, in accordance with the relevant provisions of the Convention, stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system".

Although an approach to the problem as well as to the mechanisms for stabilization of the carbon dioxide (CO_2) level in the atmosphere is currently being intensively discussed by the world research community and within the IPCC, an issue of **non-hazardous levels of CO_2 and other greenhouse gases is still open**. A certain lack of knowledge on this subject has been recently noted by the IPCC XVIII Session (Wembley, UK, 24-29 September, 2001). The IPCC Synthesis Report, adopted by the session, had noted that there is essentially a lack of knowledge on what is a "dangerous anthropogenic interference with the climate system", and that this question requires comprehensive and integrated investigations (see Question 9 of the IPCC Synthesis Report). The IPCC considers this question as one of the priorities of its future work (see Document IPCC-XVIII/INF. 6 of the IPCC XVIII Session).

As a practical step toward answering this question a proposal to prepare an IPCC Technical Paper (TP) preliminary entitled as **LEVELS OF GREENHOUSE GASES IN THE ATMOSPHERE PREVENTING DANGEROUS ANTHROPOGENIC INTERFERENCE WITH CLIMATE SYSTEM** was submitted to the Session by Vice-Chairman of the IPCC Professor Yu. A. Izrael after consultations with the delegations of Argentina, Kenya, Russian Federation, Senegal, and Ukraine (see Document IPCC-XVIII/INF.8). The IPCC Session has requested a Scoping paper outlining the proposed TP. This document was prepared in accordance with this request.

The first version of this document was prepared in November 2001. It was distributed among the IPCC Bureau members and selected IPCC experts. Many of them provided valuable comments on and substantive input to the Scoping paper. The Twenty-fourth Session of the IPCC Bureau (Geneva, Switzerland, 17–18 of December, 2001) has considered the document. After discussion, during which many serious comments and suggestions on the document were made, the IPCC Bureau decided to distribute a revised version of the Scoping paper among governments for review. The revised draft was circulated to the governments in early January, 2002.

Responses of 28 governments were received in January and February, 2002. Majority of them (25) were largely supportive and did not contain any objections against the idea of the proposed TP. However, their views were very different with regard to some aspects. In particular, the following issues were frequently discussed in the comments: a title of the TP, general approach to the problem (scientific criteria vs. socio-economic ones and/or political procedures), necessity to use existing IPCC reports, possibility to develop needed methodology on the basis of existing IPCC publications and terminology. It was also recommended to limit analysis to methodological approaches and abstain from calculations of critical GHG levels in the atmosphere at this stage. Many of these suggestions were adopted and used in revision of the TP. Majority of **governmental experts** provided detailed general and specific comments and constructive suggestions on improving the text that comprised a **valuable input** to the Scoping paper. The

author of and the contributors to the Scoping paper are highly thankful to all governments for their comments and suggestions.

It may be recalled that the Intergovernmental Panel on Climate Change (IPCC) has been established jointly by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP), in particular, to make periodic **assessments of the science**, the **impacts**, and the socio-economic aspects of climate change, and of adaptation and mitigation options to address climate change, and **to assess, and develop as necessary, methodologies**. The proposed TP is aimed at:

- analysing information on hazardous (dangerous) levels of greenhouse gases and/or approaches to quantifying them already presented in reports and other documents of the IPCC;
- assessing the scientific literature on the subject published after 1999 and, therefore, not considered in the IPCC Third Assessment Report (TAR);
- developing methodological approach to constructing critical and tolerable levels of GHG content in the atmosphere using existing IPCC concepts and approaches;
- identifying deficiencies of information on the subject including a lack of basic knowledge, monitoring data, and model means.

Thus, the proposed TP does not exceed the IPCC mandate, and meet requirements existing in relation to such IPCC documents, see Procedures for the Preparation, Review, Acceptance, Adoption, Approval and Publication of the IPCC Reports (available on the website www.ipcc.ch) for the procedures applicable to an IPCC Technical Paper.

The Synthesis Report of the IPCC Third Assessment Report (TAR) states that “Natural, technical, and social sciences can provide essential information and evidence needed for decisions on what constitutes “dangerous anthropogenic interference with the climate system”. At the same time, such decisions are value judgements determined through socio-political processes, taking into account considerations such as development, equity, and sustainability, as well as uncertainties and risk”.

Thus, an issue of "levels of greenhouse gases in the atmosphere preventing dangerous anthropogenic interference with the climate system" has scientific and political components. Both are important for ultimate decision whether given level is hazardous (dangerous) or tolerable. The proposed paper concentrates mainly on the **scientific side** of the problem according to mandate of the IPCC.

Namely, the proposed TP will consider **levels** of the greenhouse gases (GHG) in the atmosphere which may be hazardous (dangerous) for the CLIMATE SYSTEM **from the perspective of its climate-forming, biospheric, or socio-economic functions.** Direct effects on social or economic systems as well as political implications will not be analysed and taken into account in this TP, however, criteria based upon them might be also very efficient in future IPCC assessments.

An important concept of tolerable **rate of changes** of GHG content in the atmosphere will be partly considered. However, its detailed analysis is beyond the proposed TP because it comprises a separate well defined set of issues. "Genre" of TP, in particular, page limitations do not allow us considering both principal complementary concepts together. However, some bridges between these two concepts will be established.

The proposed Technical Paper will mainly be based on the analysis of information available from previous reports approved/adopted by the IPCC.

2 Introduction

This section presents a brief introduction to the issues which are to be considered in the Technical Paper. The prime objective is to determine the perspective from which the concepts of non-hazardous levels of content of greenhouse gases in the atmosphere and dangerous interference with the climate system will be considered. The basic definitions will be given.

2.1 Greenhouse gases in the atmosphere, anthropogenic rise of their concentrations, and global climate change

2.2 Article 2 of the UN FCCC and the roles of science in support of defining "dangerous" anthropogenic interference with the climate system

2.3 What may constitute a non-hazardous level of GHG: a critical level concept

Some working notions and definitions

An "**element**" of the Earth system means an object or a process within the Earth system.

"**Climate-forming**" means "climate-generating", "causing/defining" climatic patterns.

The climate-forming elements of the geosphere (= lithosphere + hydrosphere + atmosphere) and biosphere[1] and their interactions comprise the "**climate system**". This understanding of the climate system emanated from the UN FCCC.

Examples of **elements of the climate system**: objects - atmosphere, ocean, terrestrial waters, forests, permafrost, mountain glaciers; processes - insolation, precipitation, evaporation, melting of ice, freezing of water, photosynthesis.

A "**state**" of the climate system: internal conditions within the climate system, e. g., concentrations of GHG in the atmosphere, temperature and amount of precipitation, ground-level flux of solar radiation, albedo of the Earth's surface, ice sheets area, a rate of carbon uptake/release by forests. The conditions can be anthropogenically changed, in particular, due to anthropogenic emission of substances to the atmosphere and its consequences.

The climate system and its elements have important **climate-forming function** (generates climate patterns), **biospheric function** (maintains biodiversity and biogeochemical cycles) and **socio-economic function** (maintains life supporting systems of humans).

Classification of different states of the climate system

Tolerable state: internal conditions under which the climate system CAN work in a mode

[1] Hereinafter "biosphere" means biota and its interactions with the environment.

allowing its climate-forming, biospheric and socio-economic functions with certain level of confidence. Such state is considered "non-dangerous", "non-hazardous" .

Intolerable state: internal conditions under which the climate system (or its major components[2]) CANNOT work in a mode allowing its climate-forming or biospheric or socio-economic functions.

Indeterminate state: the rest ones (exist because of uncertainty, incompleteness and/or inaccuracy of information about actual state of the climate system, Earth's system response, etc.).

Tolerable states, indeterminate states and intolerable states of the climate system comprise "**tolerable zone**", "**indeterminate zone**" and "**critical zone**", respectively.

Tolerable limit for a state of the climate system (TL-Climate): a boundary between the tolerable zone and the indeterminate zone of internal conditions of the climate system.

Critical limit for a state of the climate system (CL-Climate): a boundary between the indeterminate zone and the critical zone of internal conditions of the climate system.

Corresponding (upper) levels of greenhouse gases (GHG) content in the atmosphere (i.e. tolerable and critical ones) referring to TL-Climate and CL-Climate, respectively.

Tolerable (non-dangerous) **Level for GHG content** (TL-GHG): a level below which respective conditions of the climate system are within the tolerable zone.

Critical Level for GHG content (CL-GHG): a level beyond which respective conditions of the climate system are within the critical zone.

Key elements of the climate system: elements that predominantly determine working of the climate system in a mode allowing its climate-forming, biospheric and/or socio-economic functions. Such elements can be of different spatial scale (e. g., global, regional, local) and temporal scale (e. g., long-range, medium-range, short-range).

Scope

Scientists:
- justify a list of key elements and propose to policy-makers particular confidence levels for calculation of the TL-Climate;
- give a scientific basis and develop methodologies for calculating TL-Climate and CL-Climate corresponding to proposed elements and confidence levels;
- give scientific basis and develop methodologies for calculating TL-GHG and CL-GHG from TL-Climate and CL-Climate.

Requests to policy-makers:
- make decisions upon confidence levels proposed by scientists for calculation of the TL-Climate;
- elaborate the mechanisms that prevent exceeding the tolerable levels of GHG in the

[2] This addition will be further implied, but not displayed.

atmosphere calculated by scientists using key elements and confidence levels adopted through political procedures;
- make judgements and decisions on preferable location of a state of the climate system WITHIN the tolerable zone.

Usage

In the long run a state of the climate system **MUST** be kept beyond the critical zone. This will prevent a breakdown of the climate system, while exceeding the critical limit will lead to this inevitably due to the laws of Nature with no regard to political or socio-economic considerations.

(This "MUST" is NOT policy prescriptive, because notions "policy", "economy" as well as "public opinion" are not applicable at all within the critical zone corresponding to breakdown of the climate system or its major components. It is determined by laws of Nature only and, therefore, is completely within the scope of science. - Yuri Izrael)

It is **EXPEDIENT** to keep a state of climate system within the tolerable zone. This is to prevent a risk of imperceptible approaching and crossing the critical limit arising from uncertainty, incompleteness and/or inaccuracy of information about actual state of the climate system, Earth's system response, etc.

Note 1: Criteria for selection of key elements and confidence levels (i. e., risk thresholds in fact) for calculations TL-Climate and CL-Climate should be mainly of scientific nature (e. g., sensitivity, adaptive capacity, vulnerability), but also with respect to TL may have socio-economic and humanitarian components reflecting ideas of equity and sustainable development.

Note 2: **Non-hazardous (non-dangerous) level of GHG**: a level that does not exceed the tolerable one, i. e. TL-GHG.

Note 3: Once calculated, CL- and TL-GHG will be further clarified/modified along with a progress in understanding of what are the key elements, their sensitivity and adaptive capacity, as well as on cause-effect relationships and tolerable risks.

Note 4: A concept of critical and tolerable levels are presented above for one greenhouse constituent for simplicity and clarity of working notions and definitions. Its multidimensional version will also be developed.

Note 5: Critical and tolerable levels of GHG can be modulated by other factors of non-climatic nature. In this connection, the combined effects, synergism, and weakening also should be investigated.

Note 6: Keeping a state of the climate system within the tolerable zone, might be rather far from the critical limit, can occur costly. A size of indeterminate zone depends on deficiencies of knowledge about the Earth's processes and systems, available model means as well as on quality of environment and climate monitoring systems. The size of indeterminate zone can be reduced through obtaining new scientific information that requires respective additional funding of basic and applied science, and monitoring programmes.

2.4 Major issues to be considered in the Technical Paper:

- What is the Earth's climate associated with a given long-term level of GHG content in the

atmosphere?

- Which elements of various scales (objects and processes in the climate system, their interactions, biosphere or a component of the geosphere, processes within them) are predominantly affected by an increase in GHG content in the atmosphere and associated global climate change with respect to their climate-forming, biospheric or socio-economic functions?

- What is the sensitivity of these elements and their adaptive capacity?

- Which elements are the most vulnerable under increases in GHG content in the atmosphere and associated global climate change with respect to their climate-forming, biospheric, or socio-economic functions?

- How to determine a level of confidence for defining the tolerable limit for a state of the climate system, i. e., in fact, tolerable risk thresholds?

- What are the critical and tolerable GHG levels in the atmosphere?

- How does the proposed critical level concept relate to the concept of hazardous rate of increase of GHG content in the atmosphere?

- What existing IPCC assessment products are needed for quantifying GHG critical and tolerable levels, and tolerable risk thresholds?

- What additional fundamental studies of this problem and efforts in the field of modelling and monitoring are or will be needed in the near future?

- How might decision making strategies be applied in addition to scientific analysis to decide what are the tolerable risk thresholds?

3 Earth's climate associated with a given long-term level of GHG content in the atmosphere

The main purpose of this section is to briefly **summarise** the major findings of WG I of the IPCC and other IPCC groups regarding cause-response relationships GHG content-climate. Such relationships are needed for estimating critical and tolerable levels of GHG in the atmosphere.

3.1 Climate-forming factors including description of natural greenhouse effect and its anthropogenic enhancement

3.2 What are the predominant changes in global climate in response to a given change of GHG content in the atmosphere?

- Temperature;
- Precipitation;
- Cloudiness;
- Ground-level flux of solar radiation (including photosynthetically active radiation and hazardous ultraviolet radiation);
- Climatic extremes.

3.3 Regional aspects

3.4 Cause-response relationships describing dependence of change in global climate on a change in GHG content in the atmosphere

3.5 Uncertainties

3.6 Conclusion

4 Effects of an anthropogenic increase in GHG content in the atmosphere and associated climate change on the climate-forming function of the climate system

The elements of the climate system predominantly affected by an increase in GHG content in the atmosphere and associated change in global climate will be analysed in this section from the perspective of climate-forming function of the climate system. Sensitivity and adaptive capacity of these elements will be considered. The most vulnerable ones from the perspective of their climate-forming function will constitute a group of "key elements-1"

4.1 The elements predominantly affected by an increase in GHG content in the atmosphere and associated change in global climate

- Atmospheric elements;
- Terrestrial elements (pedosphere, cryosphere, hydrosphere, biosphere);
- Marine elements (cryosphere, hydrosphere, biosphere);
- Interactions between objects and processes within the climate system (including carbon emissions from the permafrost due to warming, carbon distribution over components of geosphere and the biosphere, carbon deposition to the bottom of the ocean);
- Others.

4.2 Sensitivity of the elements and their adaptive capacity

4.3 Modulation of sensitivity and/or adaptive capacity by non-climatic factors

4.4 The most vulnerable elements from the perspective of their climate-forming function: candidate key elements-1

4.5 An approach to construction of TL-Climate and CL-Climate as determined by the properties of key elements-1.

4.6 Conclusion

5 Effects of an anthropogenic increase in GHG content in the atmosphere and associated climate change on biospheric function of the climate system

Besides their climate-forming function, the majority of elements of the climate system play an important biospheric role. Such elements and the major effects on them of an increase in GHG content in the atmosphere and associated change in global climate will be considered in this section from the perspective of biospheric function of the climate system. Sensitivity and adaptive capacity of these elements will be considered. The most vulnerable ones from the perspective of their biospheric function will constitute a group of "key elements-2".

5.1 Biodiversity of terrestrial, soil and marine ecosystems (including invasions of alien species)

5.2 Photosynthetic utilisation of solar energy within terrestrial ecosystems and oceanic surface layer

5.3 Global biogeochemical cycles, including hydrological cycle

5.4 Chemical composition of the atmosphere, atmospheric deposition, and their impact on the biosphere

5.5 Sensitivity of the elements and their adaptive capacity

5.6 Modulation of sensitivity and/or adaptive capacity by non-climatic factors

5.7 The most vulnerable elements from the perspective of their biospheric function: candidate key elements-2

5.8 An approach to construction of TL-Climate and CL-Climate as determined by the properties of key elements-2.

5.9 Conclusion

6 Effects of an anthropogenic increase in GHG content in the atmosphere and associated climate change on socio-economic function of the climate system

An increase in GHG content in the atmosphere may heavily affect socio-economic function of the climate system. Such effects will be considered in this section. Sensitivity and adaptive capacity of the elements of the climate system from the perspective of their socio-economic function, and their vulnerability will be the focus of this section. The most vulnerable ones from the perspective of their socio-economic function will constitute a group of "key elements-3".

6.1 Water resources

6.2 Climatic resources of agriculture and food production

6.3 Forest resources

6.4 Quality of the environment from the perspective of human health

A degree to which the IPCC findings allow calculating the critical and tolerable levels of GHG content in the atmosphere is analysed in this section on the basis of existing IPCC documents. In this context, the necessity for further development of relevant fundamental studies, as well as in modelling and monitoring activities, is also discussed.

The purpose here is to discuss the prospects for the IPCC work on the problem in framework of priorities stated by the XVIII Session of the IPCC (Wembley, UK, 24-29 September 2001) and reflected in the IPCC Synthesis Report.

9 List of publications on the problem published in 1999-2001 and not analysed in the TAR