Greenhouse gas indicators: a helpful tool for policy making in the greenhouse effect era

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ABSTRACT

Environmental quality indicators increasingly appear a fundamental tool for environmental policy. Among these indicators, greenhouse gas indicators seem particularly suitable to help the negotiating process on the climate change. In fact, the recent developments of the International Convention on the protection of the global climate, one of the focus points of the UNCED '92 conference of Rio, have led the international debate towards the needs of limiting the greenhouse gas emissions, which are considered the most important agents of potential climatic changes. In particular, the introduction of greenhouse gas indicators may help both the definition of the reduction targets of emissions to allocate to the different countries and the distribution of the financial and technological resources necessary for the achievement of the Convention objective. Starting from a review of the greenhouse gas indicators proposed in the international debate and in the framework of the Italian proposal to the negotiating, we suggest some indicators which seem to us the more suitable and acceptable from all the Parties. Furthermore, we present a preliminary proposal to utilize these indicators for the definition of national strategies for the reduction of greenhouse gas emissions. For this purpose, we consider the indicators as a helpful tool both to individuate the economic sectors more responsible of emissions and to individuate the sectors that are more sensitive with respect to policies suitable to limit emissions.

INTRODUCTION

Starting from the United Nations Conference on the Human Environment, held in Stockholm in 1972, the environment issue appears more and more among the priorities of the international agenda. With the ever-increasing deterioration of the environmental situation, the possibility that man could modify the climate of the Earth has begun to make its way in the world. At first as an alarm thrown by the scientists, then as a possible threat which was recognized by the governments of all the World. The international debate gave rise to a framework convention on climate change which was one of the focus points of the United Nations Conference on Environment and Development of

Rio in 1992. Even though the text signed in Rio doesn't contain any specific commitments for the Parties, the convention recognizes that the human activities are enhancing the natural greenhouse effect and establishes the principle that all the Parties should protect the climate system for the benefit of present and future generations of humankind. It fixes the objective to stabilize the «..greenhouse gases concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system..», and underline that the developed countries should begin to modify their longer-term trends in the greenhouse gas emissions.

During the two years of the negotiation necessary to draft the convention, the debate often dwelt upon the use of greenhouse gas indicators. These indicators are members of a large set of support tools for environmental policy well-known as "environmental indicators". The environmental indicators were born in the scientific community as objects having a cognitive and leading function for the research, but were soon given other important tasks: communication tasks, because of their capability to communicate and their possibility to represent synthetically high quantity of information; tasks of "international solidarity", as tools able to facilitate the international cooperation, and, last but not least, policy tasks, as tools to support the decision making.

As greenhouse gases indicator we mean a parameter which is able to give an indication on the emissions of a specific country or of a specific political or economic unit, for instance an economic sector.

The use of greenhouse gas indicators could be helpful to the different countries to define policies and measures relating to the climatic change, both at national and international level. For instance, they could be helpful to:

1) show the present levels of emissions and their trends, aiding to understand the reasons that justify different emissions by different countries;
2) define objectives for policies and measures, as global or national reduction targets of greenhouse gas emissions;
3) allocate to the different countries the efforts for reaching the final objective of the Convention, in a context of equity.

GREENHOUSE GAS INDICATORS

The necessity both to understand the specific situation and the reasons of every country and to utilize a tool easy to understand and to communicate with, suggests the use of a set of indicators. Each indicator has advantages and disadvantages that we must consider, and the best solution is most probably an integrated use of them.

Their calculation needs the correct knowledge of emission data. Presently, this task is not possible because we have not any official emission data for many countries, and the collection of the national inventories is in progress under the leadership of the IPCC. However, to facilitate the comprehension of the text, we calculated them using, as emission data, only the estimates of the CO_2 emissions from fossil fuel burning and cement production [1], because they represent the estimates less disputable and based on methodologies generally accepted. The calculation has been done for four countries which are representative of homogeneous groups. They are Canada, a developed country of OECD, Romania, a country that is undergoing the process of transition to a market economy, India and Mexico, two developing countries that were very active during the international debate, and the first a leader country of the Third

World, and the second a developing country with availability of fossil fuels. For the statistic information we used ENEA [2]. The data are referred to 1986.

As absolute indicators, we consider the total and the sectorial greenhouse gas emissions, both at global and national level. These indicators, easy to estimate and monitor, have the advantage to provide precise indications of the principal sources of emissions, but they cannot be used in a context of international equity. In fact, they do not consider the specificity introduced by the local conditions (productive and social situation, usages and customs, climatic conditions, geographic distribution of the population, etc.), and do not take into account the necessity for all the countries to promote development.

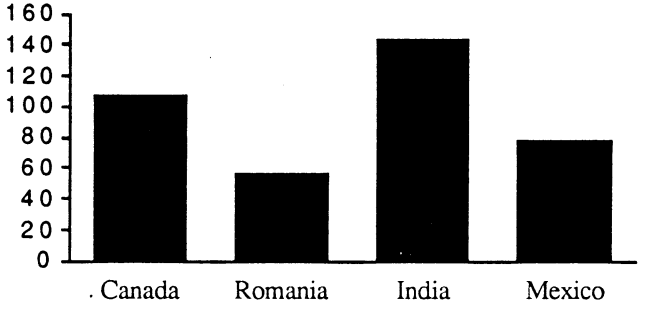

Fig.1 - CO2 emissions from fossil fuel burning and cement production in 1986 (in million tons of carbon)

Among relative indicators there is one easy to estimate, to monitor and to communicate to the public which regards the emissions per capita by country. It respects the issue of equity, according to the condition that each person in any country could emit as much as any person in another country, regardless of location, economic standard of living etc. However, it has the same disadvantages of the absolute indicators; moreover, it is possible an increase of the total emissions even if the value of this indicator decreases.

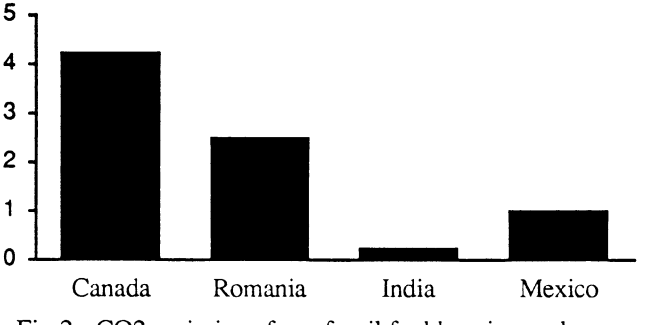

Fig.2 - CO2 emissions from fossil fuel burning and cement production per capita in 1986 (in tons of carbon per capita)

An indicator that considers the level of economic activity and standard of living regards the emissions per Gross Domestic Product. This indicator is related to parameters that traditional economic considerations suggest as a measurement of welfare and economic growth. It does not take into account the present debate on the sustainability and on economic growth which is compatible with the environment. Moreover, it is difficult to determine for the non-OECD countries.

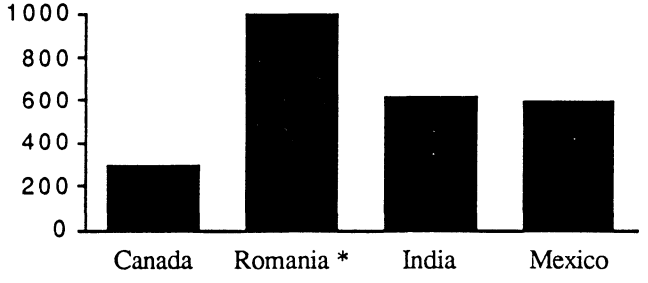

Fig.3 - CO2 emissions from fossil fuel burning and cement production per gdp at current price and exchange rates in 1986 (in tons of carbon per 1000 US$). * = per gnp

The geographic position, the conformation of the ground, the dimension, the mountainousness etc. suggest the introduction of indicators that we can call "geographic indicators". Their introduction is justified by the necessity to take into account the specific conditions of a country. However, their definition is not easy as well as their communication. That is, it is very difficult to define the parameters to use for these indicators because the choice of the parameters is influenced by social, cultural, environmental conditions. The only one proposed regards the emissions per total surface. Easy to estimate, it has the same disadvantages of the other relative indicators proposed.

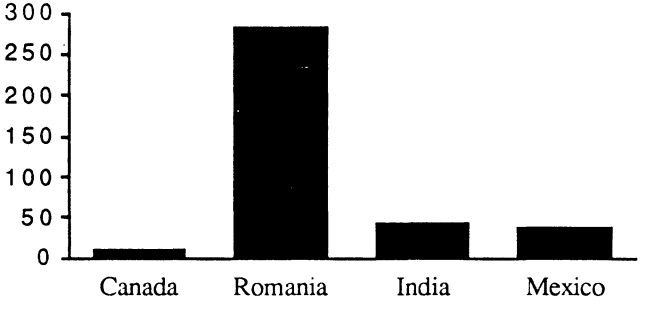

Fig.4 - CO2 emissions from fossil fuel burning and cement production per surface unit (in tons of carbon per sq. km)

Emissions by sector per unit of "product" represent a set of relative indicators that could be helpful to define national sectorial strategies to reduce

the greenhouse gas emissions (e.g., the emissions from transport sector per vehicle per km, or per passenger per km, etc).These indicators could help for planning national strategies that include specific environmmental goals. In the international context, they could give some indications of the reasons why the emissions vary among countries, and where it is possible and convenient to reduce them. The principal disadvantage is the complexity of these indicators.

In international negotiating it is particularly helpful to utilize stratified indicators. These indicators imply the use of one indicator, but the target would be different for different groups of countries, and each group is characterized by comparable values for a reference parameter. In this way it is possible to consider the differences between countries regarding reduction potential costs, ability to pay, past actions, or some other criteria may be taken into account.

The last group of indicators to consider are the dynamic indicators. They focus on rates of growth or reduction, rather than on absolute quantities, with reference both to absolute value (such as the average annual growth rate of the total emissions, or of the sectorial emissions) and to relative value (such as the average annual growth rate of the emissions per capita, etc). They provide indications about the expected path of the future emissions and trends. Again, the principal disadvantage is the difficulty to estimate and to monitor.

During the preliminary works of the Convention on Climate Change, it appeared the possibility of using greenhouse gas indicators to quantify the possible committments for the Parties. The authors of this paper collaborated to the drafting of the Italian proposal to the negotiation. One conclusion of the discussion was that the choice of the indicators had to follow a distributional equity criterium. In the context of the Convention, this indication lead to the choice of two different indicators: one for the reduction targets and one for the transfer of financial and technological resources required to reach the objective, that is the focal points of the Convention. Of course, these two aspects have to be negotiated jointly.

The experience of international negotiations (Protocols UN-ECE on SO_2, NO_x etc) suggests it is more practical to use absolute indicators also referring to "anthropogenic" emissions, that is the emissions caused only by human activities or coming from modification to natural sources or sinks caused by man. But these simple indicators are not usable in an international context covering economic situations very different among them. Moreover, as far as reduction targets are concerned, an elementary criterium of equability leads to the conclusion, largely supported by the developing countries, that no person in any country has the right to emit more greenhouse gases than a person in another country. The application of this principle, however, would lead to emission increases of incalculable proportions if the population growth is not taken into account. For these reasons, and taking into account the overall picture of international relations, it is necessary for the developing countries to cooperate in reaching the international objective. The hypothesis of mediation that takes these considerations into account consists in the allocation of the emission reductions according to per capita emissions. Each country will therefore assume its own responsibilities, but the size of such contributions will be greater for all those countries for which this value is higher. An appropriate adjustment of this criterium is to consider population values at a certain date, e.g. 1990, in order not to privilege population growth in developing countries.

In order to define the indicators for assigning financial and technological resources identified as being transferable at an international level, reference

must be made to the ratio of total emissions to gdp, adjusted according to purchasing power parity. This criterium allows resources to be directed on a preferential basis to countries characterized by intense greenhouse gas emissions and economically in development.

As we have just said, the Convention signed in Rio does not contain any specific committments for the Parties. Nevertheless the Italian proposal, presently put aside in the text approved, remains a good basis for discussion for the future developments of the negotiating process.

AN APPLICATION TO THE ITALIAN SITUATION

The greenhouse gas indicators could be used also to define national strategies for the reduction of emissions of these gases. In fact, with the use of sectorial indicators and especially with the use of relative indicators referred to the sectorial emissions per unit of "product", we can identify the economic sectors more responsible of emissions and the sectors that are more sensitive with respect to policies suitable to limit emissions. The results can be referred both to the contribution of each gas to the global warming and to the contribution of all gases considered as a whole. In the last case, we can calculate a kind of "weighted addition" by means of an index used as weight factor. The index that we used is the index suggested by IPCC [3], that is the Global Warming Potential. It represents the time integrated commitment to climate forcing from the instantaneous release of 1 kg of greenhouse gas expressed relative to that from 1 kg of carbon dioxide. Because this work has only an illustrative purpose, as example of application we utilize only absolute indicators, both total and sectorial. The emissions are referred to the GWP following the methodology mentioned above. Although the GWP represents only a preliminary proposal for an index that includes the contribution of all greenhouse gases to the climate forcing, and the supplement of the IPCC scientific assessment [4] suggests not to utilize the indirect GWPs reported in the first report because of our incomplete understanding of the processes below, we think that this exercise is helpful still. In fact, *as first approximation*, this index gives some preliminary considerations, that can be integrated with other analysis tools to obtain helpful and interesting indications. From this point of view, and keeping in mind the limits of applicability of the index, an analysis such as the analysis which we have proposed, could be helpful for a better understanding of the influence of human activities on the climate. It could contribute setting up a new approach which considers all the gases emitted by anthropic activities that affect the climate.

Starting from a first inventory of the annual emissions on provincial basis of the principal air pollutants [5], realized in the framework of the CORINAIR project of the European Community, some preliminary national esimates of greenhouse gas emissions have been realized[6], [7], [8], [9]. For our calculation, we use the estimates realized by ENEA for the Report on the State of the Environment of 1991, published by the Ministry of the Environment. Currently, these estimates represent the best estimates available. The numeric values utilized for GWPs are the values proposed by IPCC for a time integration period of 20 years [3]. Such choice of time integration period has been done to evaluate the short term effects. A graphic representation of the contribution of greenhouse gases and of the principal sectors to the total emissions is shown in fig. 5 and 6.

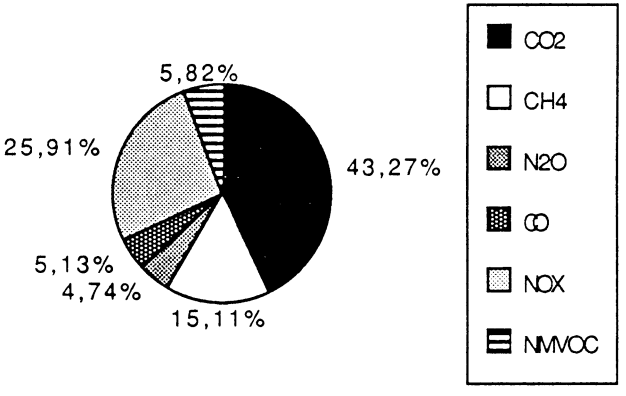

Fig.5 - Contribution in percentage to the total emissions of greenhouse gases, except CFC and halocarbons, in Italy, expressed as CO_2 following the method described in the text.

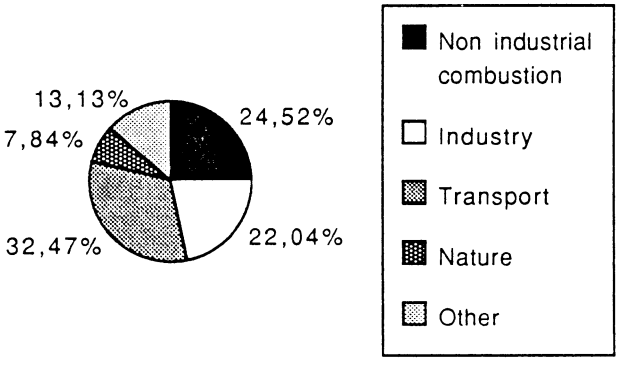

Fig.6 - Contribution in percentage of the principal macrosectors to the greenhouse gas emissions (exept CFC and halocarbons) in Italy. The nomenclature is referred to the original CORINAIR nomenclature [5]. With Nature we mean the emissions caused by natural sources only; consequently we exclude from this item the emissions caused by modification attribuitable to the human activities (e.g. the emissions of CO_2 caused by land-use changes).

A first consideration coming from the analysis of the figures is the relative importance of the carbon dioxide as one of the principal agents of possible climate change also in the short term. However, it is significative the role of other greenhouse gases like nitrous oxides and methane.

The sectorial analysis confirms the characteristic of industrialized country of our country, that is a country characterized by emissions mainly coming from

energetic and industrial processes. In fact the contribution of the natural sources is only the 7% of the total. Moreover, this approach underlines the "global dangerousness" of the sector characterized by the emission of many greenhouse gases, in particular the transport sector. The identification of sectors with these characteristics could help to identify the sectors that are globally more responsible of climate change caused by human activities, but, at the same time, that are particularly sensitive to policies of reduction of emissions.

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