

STATEMENT
ON THE FUTURE OF OUR CLIMATE
November 1991

Summary

Climate, one of the components of our natural environment, faces with great probability changes unprecedented in the history of mankind as the consequence of human activity. It is a proven fact that the concentration of atmospheric gases intensifying the greenhouse effect of the atmosphere has been increasing at an accelerating rate for quite a time. Assuming the increase of the emissions of these gases at an unchanged rate, the risk of climate change accompanied a continuous increase of the mean surface temperature becomes greater and greater. Rise of sea-level in the warmer climate, alteration of the extension of polar ice covers, displacement of the climate zones, as well as more adverse precipitation supply that may occur in many regions of the earth are warning that already the present-day generation should take steps to avoid the risk of climate change and its consequences, or to mitigate it at least.

Danger of climate change has come into the limelight of experts' and governmental authorities' interests all over the world. Under the aegis of the United Nations Organization, a process of international negotiations has been commenced which, relying on the common interest of the whole world – and solving the conflicting interests between countries at various levels of economic development – can lead, hopefully in the near future, to a rate of progress that can be sustained and that emphasizes also preservation of the state of the environment.

On the basis of scientific investigations it seems probable that climate change is going to result in significant environmental and economic consequences in Hungary, too. In the light of all these, national possibilities of reducing the greenhouse gas emissions should be considered, and greater attention should be paid to observations and studies of atmospheric environment and climate in order to achieve more exact estimations of climate change rate and its consequences.

Introduction

Climate change is one of the most serious global environmental risks of our age. Because of reasons of nature, climate has been always changing on various time-scales, to different extent and with alternating sign, at this time, however, as a consequence of human activity, a warming trend with extreme rate can be added to these changes. This process, according to the international and national scientific predictions, could cause serious ecological and economic problems, at first in areas specifically sensitive to the changes, then, in case of continued warming tendency, the measures of the problems and also their spatial extension can be significantly increased. Therefore, the Meteorological Scientific Committee of the Hungarian Academy of Sciences emphasizes that it is necessary to draw the general public's attention to the global climate change and its scientific, economic and environmental-political aspects in a statement described below.

Climatic variations of the past

Most of the living world characteristics, as well as many features of the social and economic life - including agricultural production or utilization of energy - have been developed basically in alignment with the specific meteorological conditions, with climate of the environment. Climate of the earth has never and nowhere been steady, its changes can be always traced during the earth's history. Typical examples for these changes are the processes of repeated glaciations in the Quaternary, the period of the so called "Climatic

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Optimum", 5-6 thousands years ago that was warmer and more humid than the climate of present days, or the "Little Ice Age" that lasted for a few hundred years and ended about 1850.

Historical changes have two common features: they were relatively slow, and the processes were of natural origin in every case.

For our days the situation has been changed: beside the natural forces human activity has been added to the climate determining factors and – for lack of proper control and intervention - within a few decades it can bring about changes of the present climate of such extent and rate that has never been experienced in the past one hundred thousand years.

Effects of human activity on the earth's climate

The only activity with which man can intervene in the atmospheric processes is changing the global energy balance between the atmosphere and the surface as well as that which is typical of the atmosphere of the earth. Modification of this balance can take place, first of all, in consequence of the increase of certain gas concentrations that strengthens the greenhouse effect of the atmosphere. While these gases let the shortwave solar radiation through without almost any loss, they absorb effectively the outgoing longwave radiation from the surface, which associates with excess energy at the surface and in the lower layers of the atmosphere, and consequently results in warming. The greenhouse gases of natural origin constitute determining factors of the earth's climate: in the absence of water vapour, carbon-dioxide and methane a climate of 33 C degrees colder would dominate on our planet.

Significant anthropogenic alteration of the atmosphere composition began around the middle of the 19th century, with the development of the Industrial Revolution, and since then more and more carbon-dioxide has been emitted into the atmosphere by combustion of fossil fuels (coal, oil and natural gas). It has been proven that for today the carbon-dioxide concentration in the atmosphere already exceeds by 25% the level that occurred about one hundred years ago. Unsparing deforestation in the tropics also contributes considerably to the increase of carbon-dioxide in the atmosphere.

Carbon-dioxide, is however, not the only one of the greenhouse gases whose amount increases owing to human activity. Just to mention the most important ones, they are methane deriving from rice paddies, live-stock breeding, biomass burning and the hydrocarbon industry; nitrous oxide that originates mainly from fertilization and various fossil fuel combustion, as well as the halocarbons (species of freon and halon) widely used in the industry. The latter artificial gases have come into focus mainly because of their capability to dissolve stratospheric ozone.

Although the stratospheric concentration of the enlisted greenhouse gases is just a fraction of that of carbon dioxide, their importance is explained by the fact that their longwave radiation absorption bands coincide with those in which water vapour and carbon-dioxide absorption are insignificant. Increasing the methane content of the atmosphere just by one single molecule makes the greenhouse effect 21 times, while one freon-11 molecule makes it 12000 times more intense than one carbon molecule does. Therefore, today's intensification of the greenhouse effect due to human activity can be explained only partly by the accumulation of atmospheric carbon-dioxide; for the other half of intensification all the other gases are responsible.

Anthropogenic increase of the greenhouse effect in about the lower ten-kilometre layer of our atmosphere has already resulted in an energy surplus of 2.2 joule per second and square metres. Comparing this with the energy that heats the surface and the atmosphere together by 240 joule per second and square metres on average, it is clear that the effect of the greenhouse gas released by human activities cannot be disregarded. Parallel to the warming, the amount of the most important greenhouse gas, the atmospheric water vapour, also increases, that may bring about further acceleration of the warming rate in the future.

Danger of the climate modification effect of human activity is enhanced by the fact that most of the greenhouse gases have very long residence time. Methane leaves the atmosphere already after 10 years, however, the most important types of freons, on the other hand, dissolve in 100-200 years only, and the nitrous oxides in about 150 years in the upper layers of the atmosphere. The carbon-dioxide molecules of anthropogenic origin might reside 200 years in the atmosphere before the oceans or the biosphere absorb them. Therefore, even if mankind decides to stop immediately all the activities that enhance the atmospheric greenhouse effect, posterity would experience the consequence of previous releases even over centuries.

Expected climate change and its consequences

If human activity follows the actual trends in the future, too, that is the energy production is mostly based on combustion of fossil fuels, the energy efficiency improves only at modest rate, the release of methane and nitrous oxide of agricultural origin remains uncontrolled, and only those countries keep to the Montreal Protocol on retaining the halocarbons production and release, that have undersigned it so far, then the measure of the atmospheric greenhouse effect around 2030 will be equal to a level that would be caused by a carbon-dioxide concentration twice as much as that before the Industrial Revolution. Considering this circumstance, the basic question is: what sort of temperature change and other consequences are expected owing to modification of the atmospheric energy balance in conjunction with the enhancement of the greenhouse effect?

The atmosphere and those parts of the natural environment directly connected with the atmosphere (i.e., oceans, soil of the continents, vegetation, as well as snow- and ice-covers) constitute the climatic system. The consequences of the increase of greenhouse gases amounts (in other words, the climate sensitivity) can be estimated with approximate accuracy only, because of the complicated nature of the feedback mechanisms in system, which strengthen or weaken the initial interferences. In accordance with model calculations applied to the climatic system, a doubled level of carbon-dioxide would cause a few degrees increase of the global mean surface temperature. However, this warming could be moderated and delayed for decades by the large heat capacity of the oceans water mass.

Based on recent trends of the development of human activity and a consequent growth of the atmospheric greenhouse effect, the following most probable picture of the future climate emerges. The global mean temperature will increase by an amount of 0.2-0.5 degrees/decade, by 2025 it will be one degree higher, and by the end of the next century it will be 2-5 C degrees higher than that of today. Warming will be more intense in the high latitudes than in the tropics. Therefore, temperature difference between the polar regions and the Equator will decrease, the intensity of the extratropical cyclones will decline, the regular cyclonic paths will alter. The already started rise of sea-levels will continue; by 2025 an increase of 20 cm, by the end of the next century that of 40-100 cm is expected on average.

Compared to the macro-scale changes, the regional consequences can be assessed with a much greater uncertainty. On the basis of international and national research, in the area of Hungary a warming of a few tenths of a degree resulting in the initial phase of changes of the earth's climate will be accompanied by further deterioration of water supply in the vegetation season. This situation will be worsened yet by the enhanced potential of evaporation due to the temperature increase and cloud amount decrease, and, in addition by the probable decrease of precipitation amount. At a later of the global climate change process, this tendency might proceed, the character of the regional consequences, however, could be basically changed when the warming reaches a few degrees.

The environmental and economic consequences of the climate modifications outlined above can become apparent, first of all, through the changes in the natural water supply, in changes of the water outputs of rivers, in alterations of average crop yields of certain agricultural products, and in changes of the tree growth. From the point of view of expectable consequences in alteration of plants it is essential that the enhanced evaporation capacity can be partially counterbalanced by irrigation only, since - at least in the initial period of the climate change - the precipitation amount also decreases. Alterations in certain climatic constituents, such as, first of all, the changes in the mean temperature and its annual course, can cause substantial effects of energy utilization. Alterations of the atmospheric motion influence then the air quality as well. Beside the gradual alterations of mean values, significance should be assigned to the probable changes in the frequency of extreme climatic events (for example, droughty periods) that can be assessed by less accuracy only, for the time being.

Uncertainty factors

The broad outlines of the most probable climate in the future are given above, however, have many uncertainties. The main uncertainty factors are as follows:

- The future intensity of sources and efficiency of sinks of some greenhouse gases, as well as some chemical reactions in the atmosphere cannot be given numerically with the required accuracy; thus, the growth rate of the amount of these gases in the atmosphere cannot be exactly predicted.

- The rate of evaporation will increase with warming. It is not known, however, by which amount will the water vapour amount in the atmosphere increase and how will the cloud amount and the radiation characteristics of the clouds change, which are important as the radiation effect of the cloudiness considerably exceeds (with an opposite sign) the overall radiation effect of the greenhouse gases. Therefore, an occasional increase of the cloud amount can effectively counterbalance the rate of warming.

- Measures of the energy exchange between the oceans and the atmosphere, as well as between the upper and lower layers of the oceans are not known exactly. These factors also regulate the change rate of the earth's climate and its spatial distribution.

- It is difficult to describe quantitatively the response of the polar ice-covers to climate change, which has a basic influence, in addition to the thermal expansion of water on the rate of sea-level rise.

The uncertainty in connection with the future of climate is well characterized by that it is still argued whether a change of the earth's climate induced by growing greenhouse effect due to human activity has commenced at all? It is a fact that the earth's climate in the 20th century has been warmed by 0.4-0.6 degrees and the decade of 1980 was the warmest one during the last 150 years. The climate models attest that this warming corresponds to the observed growth of the greenhouse gas concentration in the atmosphere. At the same time, we cannot exclude the possibility that we face natural variations only governed by internal random processes of the climate system: in accordance with the theoretical calculations, all the features of the observed temperature variations during the past one hundred years could have been developed by themselves, i.e. free from any external effects on the climate system.

Conclusions

To date mankind - not intentionally, but gradually becoming aware of the risk - has become capable of influencing the earth's climate through its activity. Climatological observations, calculations by means of numerical models and experiences of early impact studies indicate that there is still considerable uncertainty concerning the measures, the spatial distribution of the changes as well as their social, economic and natural consequences. Consideration of this problem, however, on its merits, cannot be further postponed. Realising that the risk is too great for the process to become irreversible or, at least, faster than flexibility of the ecological systems or the adaptability of man.

Risk of climate change is a global problem, which concerns mankind as a whole, although to different extent in the various regions. The human activities contributing in all probability climate change also differ in their character and measure from country to country, consequently responsibility of the individual countries is not the same. The above mentioned natural processes, the environmental and economic effects do not "know", however, about boundaries between countries. In these days, all over the world, scientists, lawyers and politicians dealing with this problem work on a draft of an international convention to set limits to the effects of human activities on climate, the acceptance and respect of which could keep the climate change under control at least. For promoting the international arbitrations, the United Nations Organization set up an intergovernmental panel. The convention under consideration on climate change aims, first of all, at the limitation of the greenhouse gas emissions and their reduction later on.

We should deal with the problem of climate change at national level, all the more so since in the area of Hungary this process would deteriorate the state of the environment probably in many ways. We can contribute by more effective energy utilization, wide-ranging substitution of the greenhouse gases and reduction of the emissions in other ways, as well as appropriate silviculture to the worldwide efforts. Additionally, we should promote the exploration of the risk of climate change and the associated uncertainties in more details, the better understanding of the regional effects, the adaptation to the climatic conditions by the aid of the comprehensive observation of the climatic constituents, regular analysis of their state variations, increasing the efforts to study the climate related fields and by strengthening the careful management of the natural resources, the environment friendly attitude of the producers and customers, as well as by means of utilizing the relevant international scientific and technological results.