

At its 5<sup>th</sup> (259<sup>th</sup>) regular session, held on 27 May 2020, Presidency of the Croatian Academy of Sciences and Arts, prompted by the high intensity of recent climate changes and their impact on man and nature, adopted the following

## Statement on Climate Changes

### How is the climate changing?

Average temperature at the earth surface has risen by about 1°C over the past hundred or so years. The last decade has been the warmest in the history of modern civilization. Associated with global warming are other changes in the climate system: increase of frequency of heat waves, intensification of rainy episodes and prolongation of droughts, reduction of snow-covered area in the northern hemisphere, decrease of sea ice area (especially in the Arctic), reduction of ice cover in Greenland and West Antarctica and of numerous glaciers around the world, increase of ocean acidity, and rise of global sea level.

Present climate changes succeed the changes that have taken place in the recent past, and even in the distant, geological past. Thus, on time scales of tens of thousands to several hundreds of thousands of years, ice ages alternated with warmer periods, the last of which is currently underway. In the recent history, a medieval climatic optimum has been observed, followed by the so-called little ice age. Finally, global warming has been going on since the 19<sup>th</sup> century, with the rate of temperature rise being extremely high.

### What are the causes of climate changes?

When investigating the climate changes and their causes, geophysicists and other scientists have two methods at their disposal. On the one hand, various parameters describing the climate system are observed and the data collected are processed and analysed in some detail. On the other hand, computer models are developed in order to investigate how various external factors affect processes in the atmosphere, oceans, ice cover, and other parts of the climate system. When it comes to external factors, first and foremost the natural ones are taken into account, namely the intensity of solar radiation reaching the earth and the concentration of water vapour and other atmospheric constituents, such as volcanic aerosol, which influence the absorption of the solar and earth radiation. Additionally, there are anthropogenic external factors, which include changes in the concentration of greenhouse gases and anthropogenic aerosols in the atmosphere, and they are primarily associated with the combustion of fossil fuels. Computer modelling also takes into account internal processes in the earth system, thus allowing for a number of feedbacks – both positive (which lead to strengthening of a particular process) and negative (which result in dampening of an initial disturbance).

By analysing data collected over the last hundred or so years and by comparing them with the results of computer modelling while taking into account various external factors, scientists have concluded that present global warming is partly related to

natural processes, but also that anthropogenic processes have recently taken over the leading role. Namely, due to the human activity, and especially due to the combustion of fossil fuels, there is an increase in the concentration of greenhouse gases in the atmosphere. Thus, for example, the concentration of carbon dioxide in the atmosphere is today higher than it has ever been in the last 800,000 years. Because greenhouse gases let the solar radiation to reach the earth surface, but absorb the longwave radiation emitted by the earth, temperature increases at the earth surface. This is a process that dominantly influences the present global warming and thus also other changes in the climate system.

### **What is expected in the future?**

Computer models, which have been verified by using historical data, are utilised to create climate projections. While preparing the projections, assumptions have to be made on the future greenhouse gas emissions, and therefore a number of scenarios are considered – ranging from the optimistic ones (which imply that greenhouse gas emissions will be significantly reduced in the future) to the pessimistic ones (which assume that greenhouse gas emissions will continue following the current practice).

According to the state-of-the-art climate projections, it could be expected that by the end of this century the average temperature will further increase by 0.3–1.7°C in the case of optimistic scenario or by 2.6–4.8°C in the case of pessimistic scenario. This will lead to a change of many other climatic parameters, and thus, for example, it is expected that by the end of the century the mean sea level will further rise by 26–55 cm (optimistic scenario) or by 45–82 cm (pessimistic scenario). In addition to the changes of average values also expected are the changes of extreme values, and this is what affects man and nature the most.

### **What are the consequences of climate changes?**

Human activity has intensified climate changes. They are developing at high rates today and therefore have a significant impact on people and ecosystems that are adapted to earlier, relatively stable climate. It is expected that climate changes will result in an increase of mortality due to heat waves as well as in the emergence of various diseases and the spreading of infections. Also expected is a greater risk of floods, droughts and fires around the world and of eutrophication and anoxia events in the oceans. Climate changes will continue to adversely affect ecosystems by threatening the permafrost area and the soil in general, by dramatically changing the Arctic, and by affecting the loss of biodiversity. All this can lead to the changes in agriculture and fisheries, to the destruction of infrastructure and to a reduction of productivity, which will jeopardize economic conditions. Economic and social disruptions stimulate migrations and often lead to war conflicts and reduced level of security in the world.

Climate changes manifest themselves in different ways and have an adverse effect on many areas of the world and on various economic sectors. However, some communities, areas and ecosystems are particularly vulnerable. As it is expected that the climate changes will affect the developing countries more heavily than the developed countries, and that the developing countries will experience more difficulties

while adapting to the changes than the developed countries, it is likely that inequality in the world will increase in the future.

### **What can be done?**

The way the people should react to recent climate changes can be summed up in three words: research, mitigation and adaptation.

The purpose of further research of climate changes is to improve the database, on the one hand, and to improve computer models, on the other. As can be seen also from this text, climate projections result in a range of numbers, thus allowing for their limited reliability primarily due to different parameterizations used while developing the computer models. Future research should increase the reliability of climate projections and make it possible to reduce the ranges of projected temperatures and other related quantities.

When it comes to mitigation of climate changes, it is widely accepted that the net greenhouse gas emissions should be reduced to zero by the middle of this century – if the future climate changes are going to develop according to the optimistic scenario. Such a goal presupposes not only the reduction of greenhouse gas emissions but also their removal from the atmosphere. Greenhouse gas emissions can be reduced by decreasing the use of fossil fuels in energy production, transport and other activities, and by increasing the use of renewable energy sources. In order to remove greenhouse gases from the atmosphere, a combined ecological and technological approach should be used. If implemented wisely, such changes could result not only in social but also in economic benefits, due to the development of new technologies and the creation of new jobs.

Finally, since climate changes cannot be avoided, no matter how much we manage to mitigate them, it is necessary to prepare for adaptation. While doing so, it should be taken into account that the developed countries have been the major contributors to climate changes whereas the developing countries will be more heavily impacted by the changes. This raises a number of moral and ethical issues, which cannot be resolved without an international cooperation.

Intensive international cooperation in the scientific approach to climate changes has been organized over many years by the Intergovernmental Panel on Climate Change. Its regular reports are the best source of information on climate changes. When it comes to international cooperation in the political approach to climate changes, the most influential are the United Nations. They have included the fight against climate changes and their consequences among the Sustainable Development Goals and, in addition, have supported the acceptance of a series of climate agreements the most important of which is the 2015 Paris Climate Agreement. This agreement represents the best basis for tackling the climate change issue that the international community has reached so far and it envisages further improvements and addition of new mechanisms – especially when it comes to the allowed contributions of individual countries to greenhouse gas emissions and to the ways of verifying the commitments. It is to be hoped that the agreement will be fully implemented and that all countries around the world will participate in its implementation.

## How can Croatia react?

Croatia is increasingly involved in these international efforts, by drafting a law on climate changes and ozone-layer protection, by developing a low-carbon development strategy and climate change adaptation strategy, and by preparing an integrated energy and climate plan and a number of other documents.

Also, the first projects have been launched, for example those dealing with the energy efficiency of buildings. It is expected that the number and scope of such projects will increase, implying that a list of priorities should be compiled by taking into account two criteria. The first is the usefulness of the project not only under the present but also under the future conditions, i.e., when the climate will be different. The second criterion stems from the fact that large projects could help revive the Croatian economy – that is, that they could fit into a kind of Croatian *new deal*. Let us mention a few possible projects. Building the retention and irrigation systems would allow excess rainwater to be delivered to arid areas when needed. Establishing the high-speed rail connections throughout Croatia would reduce the need for short-haul air connections (up to some 500 km) and thus contribute to reducing the greenhouse gas emissions. Climate changes should also be taken into account when planning the reconstruction of Zagreb after the great earthquake of 22 March 2020, so as to improve not only the earthquake resilience of buildings but also their energy efficiency (by using cold materials and by improving insulation), to upgrade the district heating network (by its extension to the central part of the city), etc.

The Croatian Academy of Sciences and Arts is ready to assist in drafting the necessary documents and in implementing projects that will be dedicated to climate changes – regardless of whether they address research, mitigation or adaptation.

President  
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