ADAPTATION TO CLIMATE CHANGE - SERBIAN SCENARIO

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Abstract: Anthropogenic factors joined the astronomical and geophysical generators of climate change at the beginning of industrialization in the second half of the 18th century. Human action has resulted in accelerated climate change which, due to its huge negative impact on civilization and the human community, deserves a serious approach. It is a global problem that, however, manifests itself at the regional, national and local levels. During strategic planning and practical action in the field of agriculture, water management, forestry, energy, ecology, protection of human health, etc. climate change is crucial. The aim of the authors is to, following a review and a detailed analysis of climate change in Serbia, point out possible directions of action in order to increase the adaptive potential of our society, and reduce the negative impacts.

Keywords: climate change, environment, anthropogenic factors, Serbia, adaptation, environmental policy.

GLOBAL CLIMATE CHANGE AND THE INTERNATIONAL RESPONSE

Climate change in a broader sense is a consequence of complex abiotic and biotic processes and is reflected in statistically significant changes in climatic parameters over long periods. For millions of years, these changes were primarily determined by the action of two groups of factors: astronomical (relating to the activities of the Sun and other astronomical objects, as well as the relations of these

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objects and the Earth distance, trajectories, relative position, inclination, etc.) and geophysical ones (e.g. volcanic eruptions, tectonic plate movement and inclination changes) (Sekulić, Dimović, Kalmar Krnajski Jović & Todorović, 2012: 13). Under their influence, climate changes took place gradually, which enabled the flora and fauna, but also the human species to adapt to them without major difficulties. With the beginning of industrialization, in the second half of the 18th century, astronomical and geophysical factors were joined by anthropogenic factors (created by human activity) and in the next two centuries the latter took precedence, leading to accelerated climate change. Namely, industrialization involves the combustion of large amounts of fossil fuels (for the purpose of obtaining electricity) and the transfer of natural habitats (for example deforestation) to urban and agricultural areas, which resulted in disruption of the existing balance in the presence of certain gases in the atmosphere. Due to the increased concentration of carbon dioxide, water vapor, methane, nitrogen sub oxide, Freon and ozone, the Earth is unable to absorb the short-wave radiation of the Sun, which usually returns to space, so infrared rays remain under the gas layer and our planet absorbs them. Under the influence of this process, the greenhouse effect occurs along with global warming as its consequence.

The most significant driver of global warming is atmospheric carbon dioxide, whose concentration has increased significantly in the last few decades. During the 1990s, the combustion of fossil fuels emitted about 6 Gt of carbon per year, and at the beginning of the 21st century, that amount increased by 30% and amounted to 7.8 Gt. Emissions resulting from deforestation due to the expansion of areas intended for housing and agricultural activities account for about 12% of total anthropogenic carbon dioxide emissions. Given that the emissions of other greenhouse gases (GHG) are caused by human activity; it is obvious that we live in an age of anthropogenically induced climate change. Thus, climate change in a narrower sense represents those climate changes that occur as a result of human activities in the biosphere. Accordingly, the climate change defined in Art. 1, Para. 1, Item 2, of the United Nations Framework Convention on Climate Change (Law on Ratification of the United Nations Framework Convention on Climate Change, with annexes, Official Gazette of the FRY International Agreements, no. 2/97, UN Convention/UNFCCC) is directly or indirectly conditioned by human action.

Global warming and climate change have a negative impact on ecosystems and biodiversity, land, agriculture, forestry, hydrology, water resources, energy, human health, availability of drinking water and food, transport, etc. It is a summary and certainly incomplete presentation of the worrying consequences of climate change for civilization and the entire human community, so it is quite understandable that the UN General Assembly in the late 1980s and early 1990s defined the issue of climate as a global problem and common concern of humanity. The already mentioned UN Convention, which was adopted at the 1992 Conference on Development and the Environment in Rio de Janeiro, is of special importance. Accordingly, there has been a consensus for many years on the need to reduce greenhouse gas emissions in order to prevent the causes of climate change (mitigation measures). Given that this is an extremely complex and long process that requires huge financial resources, as well as well-designed and synergistic action at the global, regional, national and local levels, the positive effects of mitigation measures cannot be expected for many years to come. Due to that, more and more attention is paid to adaptation measures, i.e. climate change adaptation measures. Adaptation is essentially a measure aimed at reducing the vulnerability of natural and anthropogenic systems to the observed or expected effects of climate change. In any case, a meticulous consideration of climate change, its causes and consequences, as well as planning an adequate response (regardless of whether it is a mitigation or adaptive measure), is one of the greatest challenges to humanity in the 21st century.

SERBIAN POLICY IN THE FIELD OF CLIMATE CHANGE

In proportion to its area, population and economic potential, Serbia significantly contributes to global warming and climate change. According to the data of the International Energy Agency (IEA) from 2009 (which have not changed significantly in the meantime), the intensity of greenhouse gas emissions in relation to the national product in Serbia is five times above the world average. In relation to the national product calculated at purchasing power parity, the observed carbon dioxide emission ranks our country among the top ten most important emitters in the world. In addition, Serbia has an extremely small national product per unit of energy consumed four times less than the world average and six times less than the average of the member countries of the Organization for Economic Cooperation and Development (OECD). Therefore, the energy consumed in Serbia contains an above-average amount of greenhouse gases and produces an economic result below the average, which makes it one of the poorest countries in Europe. In the region of Western Balkans, Serbia stands out with its relatively significant contribution to global warming: namely, its share in carbon dioxide emissions is higher than its share in national product (GDP), primary energy consumption (TPES) or population (Kovačević, 2010: 147-149). An additional concern is the fact that 70% of electricity is of fossil origin, i.e. produced in thermal power plants by burning lignite of poor quality. Equally unfavorable news is that the development of renewable energy sources is still in its infancy, although Serbia has significant sources of energy from the sun, wind, water, biomass and geothermal energy, and that the environmental awareness of citizens is extremely low. Accordingly, it is not surprising that, if these unfavorable trends continue and intensify, Serbia will be severely affected by global warming and climate change. According to the relevant climate scenarios, an increase in temperature of 1°C by 2040, or 2°C by 2070 and 4°C by the end of the century are to be expected in our country (Climate change and health, 2016). This could result in a number of frightening consequences, including: increased frequency of climatic extremes (droughts, storms, "acid rains", floods, landslides, erosion processes); accelerated melting of snow cover and glaciers on high mountains and poles; threatening the survival of small island states and states with low coastal zones due to rising sea and ocean levels; salinization and shortage of drinking water; reduction of areas under agricultural crops; desertification; migrations of population in search of food and water; armed conflicts over limited resources; danger of spreading infectious diseases and increased degree of morbidity and mortality, etc.

In the Second Report of the Republic of Serbia to the UNFCCC from August 2017 (Report), our country presented a number of alarming data on observed and expected climate change (climate scenarios) and their negative impact in the following sectors:

1) Hydrology and water resources: 99 significant flood areas have been identified, located along the banks of large rivers the Danube, Tisza, Sava, Drina, Velika Morava, South Morava and West Morava. The floods of May 2014 affected 1.6 million people, and the damage and losses were estimated at around €1.5 billion. Starting from climate scenarios, further intensification of erosion processes can be expected in the future, with moderate to high reliability; torrents and floods on small rivers and increased flooding by the rivers of medium size (with moderate reliability). Measures of adaptation to changed climatic conditions in the sector of hydrology and water resources are, according to the period required for their implementation, divided into short-term, medium-term, long-term and continuously long-term. There is also a division into risk-free measures (NR no regret), low risk regret (LR low regret) and those that require additional technical and economic analysis (TEAR techno economic analyzes required) (Report, 2017: 85-90);

2) Forestry in the period between 2003 and 2012, damage from forest fires occurred on an area of 36,095 ha, which is about 1.6% of forests in our country. In 80% of cases, forest fires occurred during March, April, July and August. The expected increase in temperature, as well as more frequent and longer dry periods, will contribute to faster expansion and increase of forest areas that will be affected by fires. Pedunculate oak (*Quercus robur L.*) and beech (*Fagus sylvatica L.*) are most exposed to the negative impact of climate change. The most common negative factors in forest ecosystems during the observed period were pests, primarily moths (*Lymantria dispar*) and diseases. Given that there is a real danger that gubernatorial attacks in the future will contribute to significant economic losses in this sector and reduce the number and quantity of ecosystem services provided by forests, a number of short, medium and long-term adaptation measures have been proposed (ibidem: 90-95);

3) Agriculture expected reduction of corn yield for the 2071-2100 period. It ranges from -22% to -52% for the entire country, while the reduction of winter wheat yields in the south of Serbia will be -10% (regional vulnerability). Water and aeolian erosion affect approximately 80% of agricultural land, primarily in hilly and mountainous areas, but also in lowland areas, primarily in Vojvodina. In the long run, the effects of extreme weather conditions can reduce soil fertility and significantly impair its functions, so the selection and introduction into production of drought and high temperature resistant varieties, crop rotation, rational and efficient use of fertilizers, increasing organic content in the soil, irrigation, afforestation to protect the land from erosion processes, as well as other adaptation measures should be given priority (ibidem: 95-101);

4) Human health - intense heat waves (tropical nights and summer days), increase in average temperatures, increasingly present climatic extremes (droughts, storms, floods, etc.), poor air quality, high concentration of carbon dioxide and other greenhouse gases, along with other climate changes affect the increased incidence of vector-borne infectious diseases (malaria - *Malaria tropica*, Lyme disease - *Lyme borreliosis*, West Nile fever - *Encephalitis Nili occidentalis*, Dengue fever), spread of water-borne infectious diseases (cholera - *Cholera* and diarrhea - *Diarrhea*) and an increase in the mortality of the vulnerable part of the population (persons with cardiovascular and respiratory diseases, diabetics, elderly people of lower socio-economic status, children, etc.) (ibidem: 101-103).

In addition, the Report lists the measures and activities that our country is taking or, according to the established dynamics, intends to take in order to adapt vulnerable sectors and systems through capacity building, strengthening resilience and reducing vulnerability to observed and expected climate change. Regarding its contribution to achieving the goals of the UN Convention, the following activities stand out: a) in June 2015, the Government of the Republic of Serbia submitted the Intended Nationally Determined Contributions to Reducing Greenhouse Gas Emissions, predicting a 9.8% reduction in GHG emissions by 2030, as compared to the levels released in 1990; b) a Department for Climate Change was established in the Ministry of Environmental Protection in 2008, with the aim of providing the necessary institutional structure for fulfilling the obligations towards the UNFCCC, but also in the process of accession to the European Union (EU); c) numerous and significant researches and systematic observations of climate change have been realized, primarily thanks to the participation of scientific, state and other institutions and individuals in scientific and technical programs of the World Meteorological Organization, EU, as well as projects financed and realized on the principle of bilateral and multilateral cooperation; d) contents on the environment that directly or indirectly deal with climate change have become an integral part of curricula, programs and textbooks for primary and secondary school students, but also for university students (which affirms the view that the development of environmental awareness is an imperative of modern times); e) in previous years, continuous efforts have been made to improve cooperation with Member States and UNFCCC bodies; f) through the process of drafting the Report to the UNFCCC, the establishment of a system

for continuous monitoring, reporting and verification (MRV) of data and information relevant to the fight against climate change has begun (ibidem: 107-114).

Based on the data from the Report, it can be unequivocally concluded that as a party to the UNFCCC, the Kyoto Protocol (Law on Ratification of the Kyoto Protocol to the United Nations Framework Convention on Climate Change, Official Gazette of RS - International Agreements, no. 88/07 and 38/09 - other law), The Doha Amendment (Law on Ratification of the Doha Amendment to the Kyoto Protocol to the United Nations Framework Convention on Climate Change, Official Gazette of the RS - International Agreements, no. 2/17) and the Paris Agreement (Law on the Ratification of the Paris Agreement, Official Gazette of the RS - International Agreements, no. 4/17), Serbia contributes to the global fight against climate change in accordance with its capacities, national specifics and established development goals. At the same time, our country aspires to EU membership (accession negotiations opened on January 21, 2014), so the relations between the EU and Serbia in the field of climate change should be viewed as part of the overall relations between this organization and the candidate country in light of the possibility of harmonizing the policy and regulations of the candidate country with the policies and regulations of the EU. Hence, Serbia's efforts in the field of climate change are primarily determined by the activities carried out within the process of Serbia's approach to the EU, i.e. the process of harmonization of national legislation with the acquis communautaire. Climate change policy and law form an important part of Chapter 27 - Environment and climate change, which is not yet open. The experience of most countries that have completed accession negotiations indicates that this is an extremely demanding, complex and expensive chapter, both because of its scope and because of the marked lag in terms of environmental protection standards and the fight against climate change in relation to the EU. According to estimates by the European Environment Agency (EEA), almost 85% of national regulations in the field of environment and climate change derive from about 500 EU regulations and directives (Halpern, 2014: 215). The successful conclusion of the negotiations and the closure of Chapter 27 will only be possible if Serbia provides adequate guarantees regarding the timing and manner in which the full transposition, implementation and effective application of the acquis in this area will be ensured. The exceptional importance of this issue is confirmed by the fact that about 20% of all proceedings for non-compliance with EU regulations, which the European Commission initiates against member states, relate to the environment (Delivet, 2013: 227). Accordingly, it is necessary to raise the level of implementation of the National Program for the Adoption of the Acquis (NPAA) from 60%, as it was from 2013 to 2015, to over 90% in the coming period. Harmonization of national legislation with EU regulations is of key importance for our country (Vukasović & Todić, 2012), but it is also important to strengthen the existing administrative and judicial capacities, form new institutional resources and continuously improve the knowledge and practical experience of employees (Medjak, 2017). Last but not least, Serbia must successfully respond to the financial challenge. Communal and energy infrastructure lags drastically behind the level of environmental services in the EU (Belgrade, Novi Sad, Nis and other large cities do not have municipal wastewater treatment systems; the rate of solid municipal waste recycling is only 4%, while in the EU it is over 40%; exposure of population to emissions of sulfur dioxide is 5.5 times higher *per capita* than in the EU member states, etc.). Having in mind the stated data, the total costs of Serbia (capital, operational and administrative) for the fulfillment of the acquis communautaire from Chapter 27 for the period 2011 - 2030 are estimated at €10.6 billion. Operating costs (amounting to €4.6 billion) will not be financed from international sources, but in accordance with the application of the "polluter pays" principle and the principle of full cost recovery, from private sources, resource use fees, and the budget (National Strategy for approximation in the field of environment for the Republic of Serbia, Official Gazette of RS, no. 80/2011). Yet despite limited financial resources, there are still positive changes in the fight against climate change, as evidenced by the fact that the production of electricity from renewable sources has

grown significantly in recent years - 2019 from the total of 1,361 GWh of electricity obtained in this way, wind farms (Čibuk 1 - installed capacity 158 MW, Kovačica - 104.5 MW and Košava - 69 MW) produced 892 GWh, or 65.6%. Čibuk 1 is the largest wind farm in Serbia, in the construction of which required an investment of €300,000,000. It will supply electricity to about 113,000 households and will contribute to the reduction of carbon dioxide emissions by 370,000 tons per year. In the same year, mini hydropower plants (16.9%) and biomass processing plants (10%) significantly participated in the production of electricity from renewable sources (Spasić, 2020). Undoubtedly, this is an exceptional achievement of our country and an initial step towards an ambitious strategy formulated by the European Council in 2007, relating to the energy sector and climate change in the EU Member States until 2020. As a central part of the strategy, the 20-20-20 concept includes: a) reducing greenhouse gas emissions by 20% compared to 1990; b) increasing of the share of renewable energy sources in energy consumption by 20%; c) increasing energy efficiency in order to reduce energy consumption by 20% (Kronja et. al., 2015: 37-38).

CONCLUSION

As a party to the UNFCCC and supporting documents, Serbia contributes to the global fight against climate change in accordance with its capacities, national specifics and established development goals. Also, the process of joining the EU requires our country to fully comply with EU climate policy and take on an appropriate share in climate action. Therefore, the accession negotiations and the beginning of the implementation of the Paris Agreement (after December 31, 2020) impose significantly greater responsibility and more complex obligations on Serbia in the field of climate change. These obligations are closely linked and complementary.

According to the forecasts of the Intergovernmental Panel on Climate Change (IPCC), greenhouse gas emissions will increase in the next few decades, so that the positive effects of mitigation measures cannot be expected in the long run. Although mitigation is not being abandoned, in recent times, both globally and in Serbia, increased attention has been paid to adaptation measures, the implementation of which contributes to increasing tolerance to climate change. The choice of possible adaptation measures is hampered by Serbia's modest adaptive potential, the use of different, often inconsistent forecasting methods, and the unreliability of data. In order to overcome these shortcomings and select adequate adaptation measures, it is necessary to take into account the following recommendations: adaptation to climate change must be set as one of the priorities; adaptations not only reduce the damage, but also use the positive effects; it is necessary to achieve intensive cross-sectoral cooperation and regional approach, develop a National Strategy and form a National Council for Adaptations; balanced regional development, improving climate change monitoring, strengthening educational capacities and raising public awareness of this problem are prerequisites for effective adaptation; special attention must be paid to the development of resources and capacities for disaster risk reduction, application of 'soft', i.e. non-structural adaptation measures and the participation of the civil sector in the decision-making process and strategic documents (Sekulić et al., 2012: 59-60).

Based on the above, as well as the fact that there is a high degree of vulnerability of Serbia in an alarming climate situation, we can conclude that climate change due to its extreme complexity and potentially huge negative impact on the functioning and survival of human society deserves a very serious approach. This is a fundamental input and a crucial factor in planning and making strategic decisions, as well as in the implementation of mitigation and adaptive measures in the fields of hydrology and water resources, forestry, agriculture, human health, energy, transport, environmental protection, etc.

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