14th IQC International Quality Conference

14. International Quality Conference

CONFERENCE MANUAL

May 24th - May 27th 2023, Kragujevac
Faculty of Engineering, University of Kragujevac

14th IQC QUALITY RESEARCH International Quality Conference

14. International Quality Conference
Conference manual

ISBN: 978 - 86 - 6335 - 104 - 2

Editors: ***Dr Miladin Stefanović,*** full professor
Faculty of Engineering, Kragujevac
Dr Aleksandar Đorđević, assistant professor
Faculty of Engineering, Kragujevac

Technical Editors: ***Dr Hrvoje Puškarić***, higher lecturer
Academy of Professional Studies Sumadija, Kragujevac
Dr Marija Zahar Đorđević, research assistant
Faculty of Engineering, Kragujevac

Publisher: **FACULTY OF ENGINEERING**
34000 KRAGUJEVAC
Sestre Janjić 6

CENTER FOR QUALITY
34000 KRAGUJEVAC
Sestre Janjić 6

For publisher: ***Prof. dr Slobodan Savić***

No. of copies: 200

Printing: ***Interprint***, Kragujevac

Publication of Conference manual and organization of
14. International Quality Conference is supported by:
Ministry of Science, Technological Development and Innovation of the Republic of Serbia

Izdavanje Zbornika radova, organizovanje i održavanje
14. International Quality Conference podržalo je:
Ministarstvo nauke, tehnološkog razvoja i inovacija Republike Srbije

14th International Quality conference

Scientific Advisory Board

1. Slavko Arsovski, Faculty of Engineering, University of Kragujevac, Kragujevac, Serbia, president
2. Zdravko Krivokapić, Faculty of Mechanical Engineering, University of Montenegro, Podgorica, Montenegro, vice president
3. Zoran Punoševac, AQS, Kruševac, Serbia, vice president
4. Yury Klockov - Клочков Юрий Сергеевич, Peter the Great St.Petersburg Polytechnic University, Russian Federation

Programme Committee

1. Miladin Stefanovic, Faculty of Engineering, University of Kragujevac, Serbia Peter the Great St. Petersburg Polytechnic University, president,
2. Aleksandar Đorđević, Faculty of Engineering, University of Kragujevac, vice-president
3. Aleksandar Vujović, Faculty of Mechanical Engineering, University of Montenegro, Podgorica, Montenegro, co-president, Montenegro
4. Abd-Elrahman, Ain Shams University Faculty of Commerce, Cairo, Egypt
5. Aleksei V. Bogoviz - Independent researcher, Moscow, Russia
6. Ali Ahmadi Awwad Rawabdeh, Faculty of Economics and Administrative Sciences, Yarmouk University, Irbid, Jordan
7. Alina-Andreea Dragoescu Urlica, U.S.A.M.V.B. Timişoara, România
8. Ayşegül Akdogan Eker, Yıldız Technical, University Mechanical Faculty, Beşiktaş/İstanbul, Turkey
9. Bojan Lalic, Faculty of Technical Sciences, University of Novi Sad, Serbia
10. Bruno S. Sergi - Harvard University, USA and University of Messina, Italy
11. Bülent Eker, Namık Kemal University, Tekirdağ, Turkey
12. Changiz Valmohammadi, Taylor's University, Malaysia
13. Cristiano Fragassa, Alma Mater Studiorum Universita di Bologna, Italy
14. Elena G. Popkova - Leading researcher of the Center for applied research of the chair "Economic policy and public-private partnership" of Moscow State Institute of International Relations (MGIMO University), Russia

15. Evandro Eduardo Broday, Federal University of Technology Paraná, Paraná, Brasil
16. Ezendu Ariwa, London Metropolitan Business School, London Metropolitan University, UK
17. George F. Fragulis, Western Macedonia University of Applied Sciences, Kila, Greece
18. Goran Putnik, University of Minho, Braga, Portugal
19. Ibrahim Badi, Department Mechanical Engineering, Misurata University, Misurata, Libya
20. Iñaki Heras, Universidad del País Vasco, San Sebastian, Spain
21. Jelena Sakovic Jovanovic, Faculty of Mechanical Engineering, University of Montenegro, Podgorica, Montenegro
22. Jovan Filipovic, Faculty of Organizational Sciences, University of Belgrade, Serbia
23. Krešimir Buntak, University North, Koprivnica-Varaždin, Croatia, Croatia
24. Lula Paweł, Cracow University of Economics, Poland
25. Martí Casadesús, AQU Catalunya, Barcelona, Spain
26. Michael Olarewaju Ogundele, Department of Education Foundations, Faculty of Education, University of Jos, Jos, Nigeria
27. Milan Erić, Faculty of Engineering, University of Kragujevac, Serbia
28. Miodrag Lazić, Faculty of Engineering, University of Kragujevac, Kragujevac, Serbia
29. Muafi, Universitas Islam Indonesia Yogyakarta, Indonesia
30. Nenad Simeunovic, , Faculty of Technical Sciences, University of Novi Sad , Serbia
31. Nikola Stefanovic, Singidunum University, Beograd, Serbia
32. Norizan Kassim, University of Nizwa, Oman
33. Pablo Cabanelas, University of Vigo, Spain
34. Paul M. Andre, AQE Group, Chicago, Illinois, USA
35. Prasun Das, SQC & OR Division of the Indian Statistical Institute (ISI), Kolkata, India
36. Samuel Fosso Wamba, Toulouse Business School, Federal University of Toulouse Midi-Pyrénées, Toulouse, France
37. Stanislav Karapetrović, University of Alberta, Edmonton, Canada
38. Tadeja Jere Jakulin, University of Primorska, Koper, Slovenia
39. Tadeusz Sikora, The Department of Quality Management, Cracow University of Economics, Kraków, Poland
40. Ugljesa Marjanovic, Faculty of Technical Sciences, University of Novi Sad, Serbia
41. Vesna Spasojevic Brkic, Faculty of Mechanical Engineering, University of Belgrad, Serbia
42. Vladimir Senic, Faculty of Hotel Management and Tourism, University of Kragujevac, Serbia

43. Zora Arsovski, Faculty Of Economics, University of Kragujevac, Kragujevac, Serbia
44. Roman Tsarev, International Academy of Science and Technologies, Moscow, Russian Federation
45. Ionel Bostan, Cuza University, Romania
46. Danijela Ćirić Lalić, Universty of Novi Sad, Serbia
47. Anurag Hazarika, Tezpur Central University, India
48. Dinh Tran Ngoc Huy, International University of Japan, Japan
49. Samrad Jafarian-Namin, Yazd University, Iran
50. Yakuthan K. Karrieva, Tashkent State University of Economics, Tashkent, Uzbekistan
51. Shakhlo T. Ergasheva, Tashkent State University of Economics, Tashkent, Uzbekistan
52. Zorana Tanasić, University of Banja Luka Faculty of Mechanical Engineering, Banja Luka, Bosnia and Herzegovina

Dear friends,

By providing international platform, 14. International Quality Conference 2023 will gather experts from industry and academia in order to exchange ideas and present results of ongoing research in a range of topics.

This Conference has a motto "Quality, education, and innovation, the path to sustainable success".

We invite you to participate in this important event.

Sincerely yours,
President of Organization Committee

Prof. dr Miladin Stefanovic

14th IQC QUALITY RESEARCH

CONTENT BOOK 1:

Quality Festival 2023
ISBN 978-86-6335-104-2

Saša Jovanović [1]
Jelena Petrović
Danijela Nikolić
Zorica Djordjević
Vanja Šušteršič

CLIMATE CHANGES - TRENDS AND PERSPECTIVES IN THE REPUBLIC OF SERBIA

Abstract: *Climate change definitely has a global character and is clearly happening and has an impact in every part of the planet Earth. In the last few decades, the climate on the territory of the Republic of Serbia has seen significant changes in most climate parameters. These changes have an unequivocal impact on the quality of life of the population of the Republic, as well as on the development of the economy. The paper analyzed the degree of change in certain climatic parameters, especially the increase in average temperature. A comparison with corresponding global trends was also made. As a comparison, two time periods were analyzed, the first from 1961-1990 and the second from 1991-2020 (in accordance with the periodicals of the World Meteorological Organization - WMO). The parameter values were observed at 26 main meteorological stations, i.e. the entire network in the Republic of Serbia, except for the stations on the territory of Kosovo and Metohija due to the unavailability of complete data for the period 1991-2020. Especially for the city of Kragujevac, the trend of changes in average temperature and precipitation was observed. In accordance with the results of the analysis, appropriate conclusions and assumptions of future trends in changes in climate parameters were drawn. As part of the final considerations, the possible impacts of climate change on the quality of life of the citizens of the Republic of Serbia, as well as on the living world in general, are listed.*
(Times New Roman, 10pt, Italic, align Justify).

Keywords: *Climate change, Republic of Serbia, Global warming, changes in climate parameters*

1. Introduction

Climate, in fact, represents a kind of product of the climate system. The Earth's climate system is a complex dynamic system that consists of the five most important components: atmosphere, hydrosphere, cryosphere, lithosphere and biosphere, as well as their mutual reactions.

Climate changes, in a broader sense, are the consequences of complex abiotic and biotic processes and are reflected in statistically significant changes in climate parameters over longer or shorter periods.

The phenomenon of global warming caused the first scientific polemics during the seventies and eighties of the last century. Today, just a few decades later, major changes in the entire climate system of planet Earth are an almost undeniable fact that is

Corresponding author: Saša Jovanović
Email: dviks@kg.ac.rs

contested by relatively few researchers. A somewhat more intense controversy is being waged over the real causes of this potentially catastrophic consequence for life on Earth. Nevertheless, the great coincidence with the extreme increase in the number of inhabitants on the planet and accelerated technological development as well as the enormous increase in energy needs indicates that the anthropogenic factor is dominant in terms of influencing dramatic changes in climate parameters [Jovanovic et.all].

Life on planet Earth is, among other things, possible due to the existence of the natural greenhouse effect. However, the greenhouse effect, which was a blessing for the planet Earth for millions of years, is gradually turning into a serious threat due to certain human activities. With accelerated industrialization and rapid human population growth, greenhouse gas emissions—caused by the burning of fossil fuels, deforestation and land clearing for agriculture, and many other activities—are constantly increasing. In the last 100 years, greenhouse gases were emitted into the atmosphere significantly more intensively and faster than natural processes could remove them. The diagram shown in Figure 1 shows changes in the mean global temperature, changes in the concentration of carbon dioxide in the atmosphere, as well as variations in solar activity [www.co2.earth]. The coincidence between the increase in CO2 concentration and the increase in global temperature is more than obvious. Also, it can be concluded that solar activity did not significantly change its intensity.

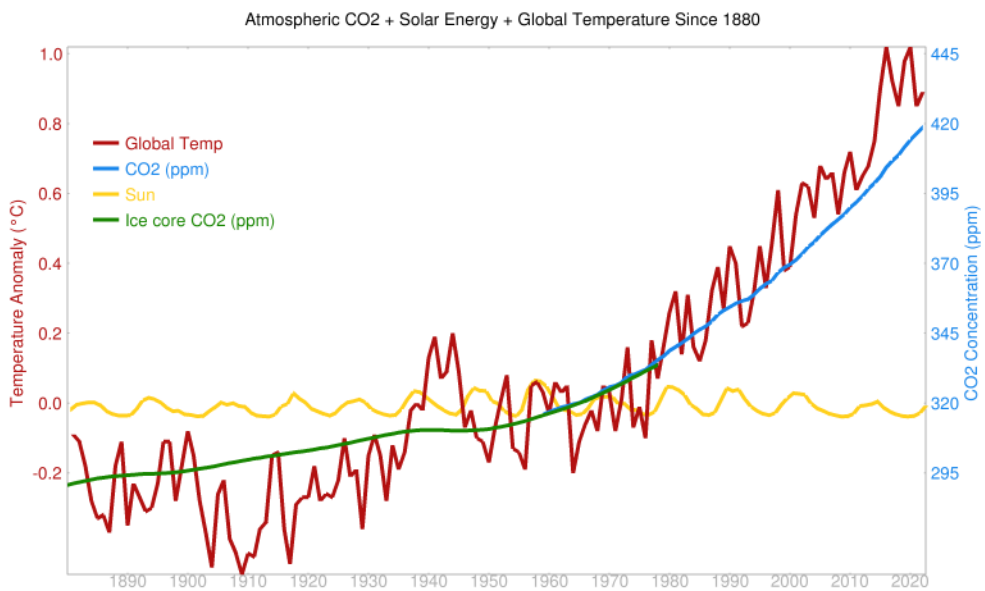

Figure 1. The connection between the change in mean global temperature and the increase in CO2 concentration in the atmosphere [www.co2.earth]

It goes without saying that the climate of any climate on the planet is one of the most influential factors on the quality of life of people, as well as on all economic activities. In addition, climate change is one of the five most significant factors that lead to the loss of

biodiversity, endangering many plant and animal species, whose survival depends mostly on their speed of adaptation to new conditions. And in this sense, these processes lead to the disruption of many segments that make up the quality of life of every inhabitant of this planet.

2. Changes in climatic parameters on the territory of the Republic of Serbia

The climate of Serbia, as a country located in the southeastern part of Europe, can be described as moderate-continental with more or less pronounced local characteristics. Spatial distribution of climate parameters is determined by geographical location, relief and local influence, as a result of a combination of relief, air pressure distribution on a larger scale, terrain exposure, presence of river systems, vegetation, urbanization, etc. Among the geographic features that characterize important synoptic situations important for the weather and climate of Serbia, we should mention the Alps, the Mediterranean Sea and the Gulf of Genoa, the Pannonian Plain and the Morava Valley, the Carpathians and the Rhodope Mountains, as well as the hilly mountainous area with valleys and plateaus. The predominant meridional position of the river basins and the plains in the north of the country enable the deep penetration of polar air masses to the south[www.hidmet.gov.rs/klimatologija_srbije.php].

The characteristics of the climate in the territory of the Republic of Serbia have also undergone significant changes, especially in the last few decades. The size and trend of these changes depend on the observed climate parameter, but certainly the most pronounced change was observed in the increase in air temperature in all periods of the year (with different intensities), as well as in the entire territory of the Republic of Serbia. In this part, an analysis of the change in certain climate parameters was performed, as well as the relationship with certain global climate changes.

Data from 26 synoptic stations throughout Serbia were analyzed, excluding the stations located in Kosovo and Metohija due to incomplete data. The structure of the observed stations is dominated by stations with a relatively low altitude (< 300 masl) - there are 19 of them. Three stations belong to the altitude zone between 300 and 500 masl, and the remaining four stations are at positions with an altitude higher than 1000 masl. Values for two thirty-year time periods (according to WMO periodicals), namely: 1961-1990 and 1991-2020, were observed and compared. As a result of the analysis, Figure 2 shows the change in mean annual temperature for each of the observed stations. It can be clearly seen that there has been an important change at all stations - an increase in the average annual temperature. The average increase in mean annual temperature for all stations is +1.06 °C. Only a few stations recorded an increase of less than one degree Celsius. It can also be seen that the biggest change, in terms of temperature, took place at Kopaonik (+1.4 °C), the station with by far the highest altitude (1710 masl). Of the remaining three mountain stations, two more (Zlatibor and Sjenica) also record above-average warming on an annual basis. Only the mountain station Crni Vrh has a below-average increase in mean annual temperature (+ 0.8 °C). Among the other trends, it can be pointed out that the largest number of stations in Vojvodina, as well as Belgrade, which is located on the border of this northern autonomous province, have an above-average growth in Tsr. The south of Serbia, on the other hand, generally has a below-average increase in temperature. In the cities of central Serbia, warming around average values (1.0 - 1.1 °C) was recorded in most cases. The region where the Negotin station is located showed a certain specificity of changes in

climate parameters. Until now, this region has shown certain specificities of the climate and important differences and characteristics compared to relatively close localities.

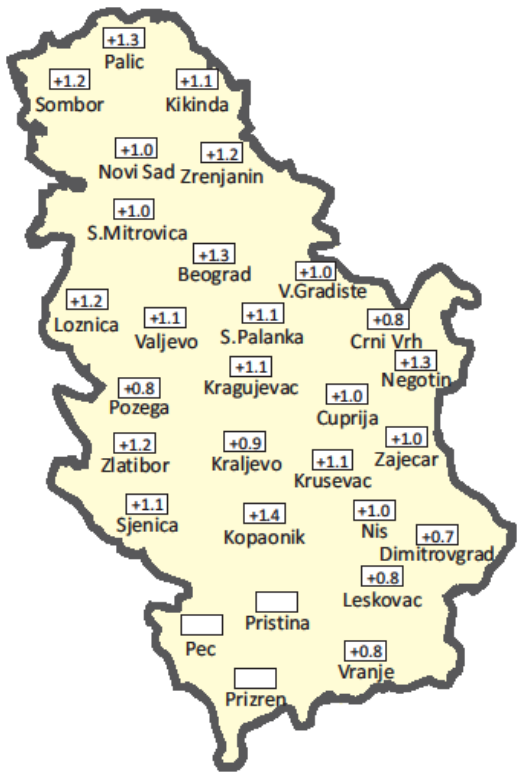

Figure 2. Changes in mean temperatures at the observed stations for the two analyzed periods

The change in temperature for the observed two periods at the annual level is not evenly distributed across all seasons. Figure 3 shows the observed change in temperature for four seasons: winter (January, February, December), spring (March, April, May), summer (June, July, August) and autumn (September, October, November). It should be noted that only in the case of the winter period, the months from the calendar year, which are not in a three-month sequence, were taken. What is unequivocally observed is a markedly higher increase in summer temperatures compared to the remaining three seasons. This increase corresponds to a significant increase in the number of days with temperatures higher than 30 °C or 35 °C at all observed stations [www.hidmet.gov.rs/klimatologija_srednjaci.php], which unambiguously affects the health of the majority of the population, the working abilities of employees, as well as the living world in general.

In comparison with the global increase in temperature[www.ncei.noaa.gov/access/monitoring/monthly-report/global/202213],it can be noticed, at first glance, that the air temperature over the territory of Serbia has changed more than the planetary average. However, when calculating global deviations, air temperatures above water surfaces (seas

and oceans) have a significant share and in those locations, due to the temperature inertness of the water mass, as a rule, the effect of global warming is smaller (example of the month of March 2023 for the Northern Hemisphere: warming over the seas and oceans it was +0.84 °C, and over land surfaces as much as +2.66 °C, while in the forest it would be, due to the dominance of water surfaces, +1.62 °C). In this sense, it is relatively difficult to compare the increase in temperature on the territory of the Republic of Serbia with the global average, but it can be said unequivocally that the warming is significant and has an accelerating trend.

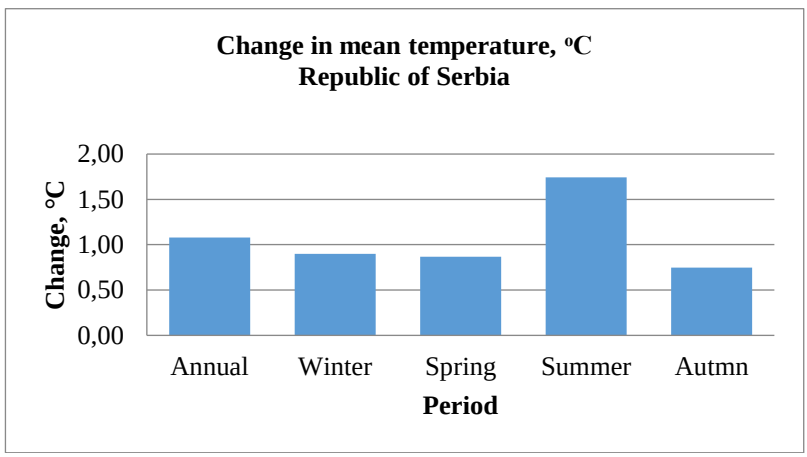

Figure 3. Temperature rise by season

When we talk about the change in the precipitation regime, there was not such a degree of change as in the average temperature, but it can be said with a high degree of certainty that there was a noticeable increase in the amount of precipitation. That average increase during the year, at the level of the Republic of Serbia, amounts to 30.44 mm, that is, almost 5% compared to the previous reference period (1961-1990). This increase indicates the fact that the increase in temperature, at least for the time being, caused a corresponding increase in the amount of precipitation and that this is one of the possible natural defense mechanisms. This fact is somewhat contrary to the majority of predictions that a warmer and drier climate awaits these areas in the future. However, due to increased evaporation due to higher temperatures, the question is whether the increase in precipitation is sufficient compensation for that process, so that the possible effects of precipitation deficit can certainly be discussed. The largest absolute deviation, i.e. increase, was again recorded at the station on Kopaonik (+119.3 mm), and in percentage terms in Novi Sad (17.2%). Figure 4 shows the distribution of changes in the amount of precipitation at the observed stations.

At the stations in the north of Serbia, in Vojvodina, an above-average increase in precipitation was recorded in relation to the entire republic, and below-average in the east. In addition, the amount of maximum daily precipitation increased at a larger number of stations (on 21 of the observed 26), as well as the frequency of days with precipitation of over 10 mm (20 of the observed 26).

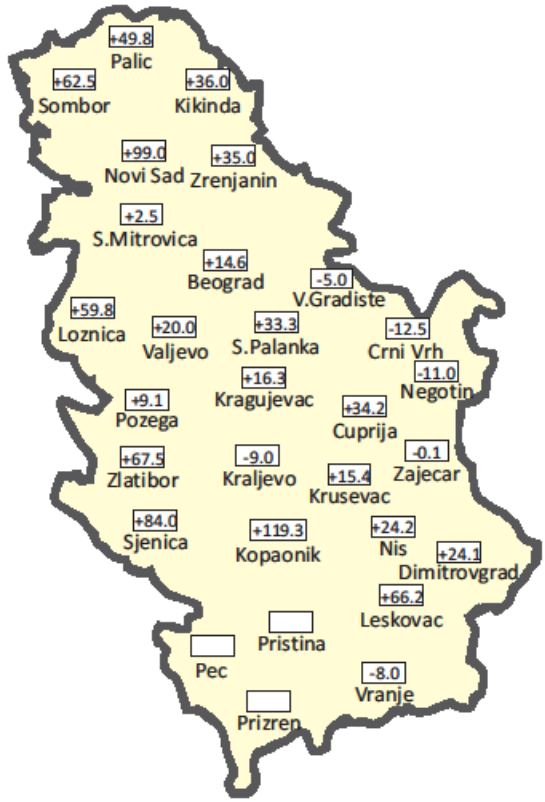

Figure 4. Changes in the annual amount of precipitation at the observed stations for the two analyzed periods (mm)

With the aim of a more detailed overview of the trends in average temperature changes for the city (station) of Kragujevac, a comparative analysis was performed for the two mentioned periods (Table 1), but on a monthly basis.

Table 1. Mean monthly temperatures and amounts of precipitation for the two observed periods for the Kragujevac station

	Tsr, [°C]												
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year
61-90	-0.1	2.2	6.3	11.3	16.1	19	20.6	20.2	16.7	11.4	6.4	1.8	11.0
91-20	1.3	3	7.1	12.1	16.7	20.7	22.6	22.3	17.3	12.2	7.4	2.4	12.1
Change	1.4	0.8	0.8	0.8	0.6	1.7	2	2.1	0.6	0.8	1	0.6	1.1
	Amount of precipitation, mm												
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year
61-90	41.1	38.7	44.4	49.4	73.8	84.7	68	53.3	48.1	38.2	48.2	47.6	635.5
91-20	42.1	40.1	46.6	54.3	70.3	77.2	65.8	56	53.6	54.2	44.6	47	651.8
Change	1	1.4	2.2	4.9	-3.5	-7.5	-2.2	2.7	5.5	16	-3.6	-0.6	16.3

The diagram in Figure 5 shows the distribution of changes in average monthly temperatures for each of the 12 months during the year, and the diagram in Figure 6 shows the change in monthly precipitation.

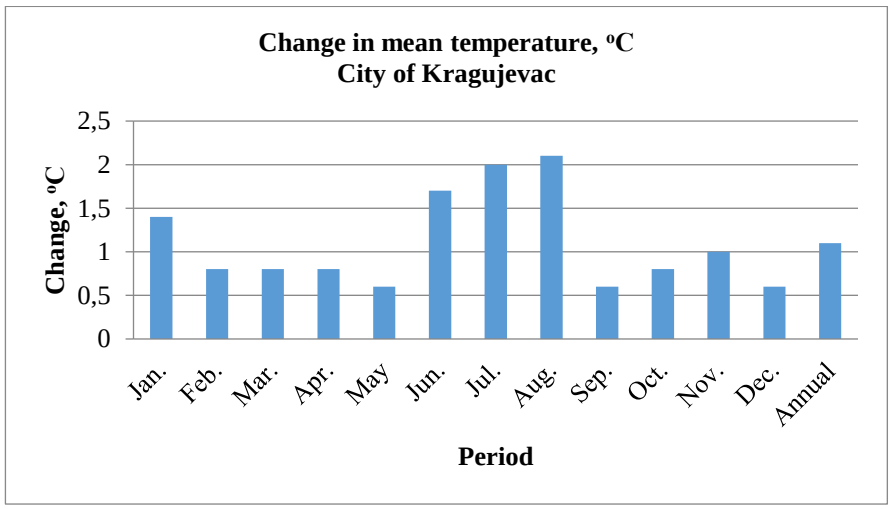

Figure 5. Temperature change by month for Kragujevac station

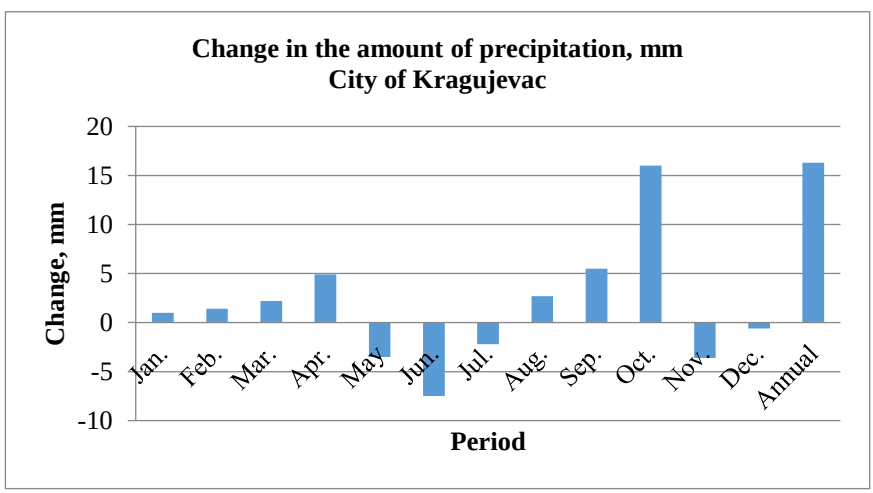

Figure 6. Change in the amount of precipitation by month for the Kragujevac station

The distribution of the increase by month (Figure 5) shows that several months, primarily the summer months - June, July and August, as well as the winter month of January - show a more significant increase in temperature than the average annual increase. This applies especially to July and August. On the other hand, several months (May, September and December) have a relatively small change in mean temperatures. When it comes to precipitation, on a monthly level, for the city of Kragujevac, the biggest change is observed in the months of October (precipitation surplus of 16 mm) and June

(deficit of 7.5 mm). If we look at the change at the annual level, it can be seen that it is practically equal to the October increase, while the other months, in summary, are in balance for both observed periods (1961-1990 and 1991-2020).

3. Conclusion

Climate change, and above all global warming, represent a big and difficult problem for today's civilization. These changes are mostly caused by human activities, and especially as a result of the excessive emission of greenhouse gases. An increase in average temperatures has been recorded practically in every place on planet Earth, but this change is certainly uneven. The aim of this paper was to indicate the scope and trends of climate change in the territory of the Republic of Serbia, as the central part of the Balkan Peninsula. In the paper, according to the presented data, the trend of a serious and accelerated increase in average temperatures, as well as a moderate increase in the amount of precipitation, is clearly indicated. There is also a clear trend of a marked increase in temperatures in the summer months and a more moderate one in the other seasons. This type of change, among others, has a special impact on the health, quality of life and work abilities of people in that time period. At the end, a shorter, more detailed analysis was given, by month for the city of Kragujevac regarding the change in mean temperature and amount of precipitation during the year.

References:

Jovanovic, S., Savic, S., Despotovic, M. (2009). Changes of Climate parameters in urban areas of the Republic of Serbia, National Conference on Quality of Life, Kragujevac**,** 39-43.

https://www.co2.earth/

https://www.hidmet.gov.rs/ciril/meteorologija/klimatologija_srbije.php

https://www.hidmet.gov.rs/ciril/meteorologija/klimatologija_srednjaci.php

https://www.ncei.noaa.gov/access/monitoring/monthly-report/global/202213

IPCC - Fifth Assessment Report, 2014.

IPCC - Sixth Assessment Report, Working group I, II and III, 2022.

Saša Jovanović
Faculty of Engineering
University of Kragujevac,
Kragujevac,
Serbia
dviks@kg.ac.rs

Jelena Petrović
RHMZ Serbia,
Kragujevac,
Serbia
jelena.mast.met@gmail.com

Danijela Nikolić
Faculty of Engineering
University of Kragujevac,
Kragujevac,
Serbia
danijelan@kg.ac.rs

Zorica Djordjević
Faculty of Engineering
University of Kragujevac,
Kragujevac,
Serbia
zoricadj@kg.ac.rs

Vanja Šušteršič
Faculty of Engineering
University of Kragujevac,
Kragujevac,
Serbia
vanjas@kg.ac.rs

CIP - Каталогизација у публикацији

Народна библиотека Србије, Београд

005.6(082)

INTERNATIONAL Quality Conference (14 ; 2023 ; Kragujevac)
Conference Manual / 14. International Quality Conference, May 24th - May 27th 2023, Kragujevac ; [editors Miladin Stefanović, Aleksandar Đorđević]. - Kragujevac : Faculty of Engineering, Center for Quality, 2023 (Kragujevac : Interprint). - XXI, 2094 str. : ilustr. ; 25 cm

Tekst štampan dvostubačno. - Tiraž 200. - Napomene i bibliografske reference uz radove. - Bibliografija uz svaki rad.

ISBN 978-86-6335-104-2

a) Менаџмент тоталним квалитетом – Зборници

COBISS.SR-ID 115653385
