

Ministry of Education and Science of Ukraine

ODESA NATIONAL UNIVERSITY OF TECHNOLOGY

International Competition of
Student Scientific Works

BLACK SEA SCIENCE 2023

PROCEEDINGS



ODESA, ONUT 2023

Ministry of Education and Science of Ukraine

Odesa National University of Technology

International Competition of Student Scientific Works

BLACK SEA SCIENCE 2023

Proceedings

Odesa, ONUT
2023

ILTO RIVER CLIMATE CHANGE SCENARIO

Author: Ninaka Berdzenishvili

Advisor: Nana Berdzenishvili

Iakob Gogebashvili Telavi State University (Georgia)

Abstract. *The research paper refers to the climate change scenario of the Ilto river catchment from 2041 to 2100. The aim of the study is to analyze the extent to which climate change will affect the Ilto river basin from 2041 to 2070 and from 2071 to 2100 based on parameters such as average temperature and average maximum and minimum temperatures, annual precipitation and maximum daily precipitation, average wind speed and relative humidity. The study is based on quantitative data provided by CENN. The analysis showed that from 2041 to 2100, the warming trend will continue in all seasons and annually, the average maximum and minimum temperatures will increase, the annual amount of precipitation will decrease throughout the simulation period, the maximum amount of precipitation during the day and night will also decrease during the period of the study, the annual value of relative air humidity will increase slightly in the period 2041-2070, while a decrease will be observed in the period 2071-2100 indicating that climate change will affect the Ilto catchment.*

Keywords: *Climate Change, Ilto River, Temperature, precipitation, wind speed, humidity.*

I. INTRODUCTION

Climate change and issues related to it have become relevant for Georgian reality after climate-related changes have been observed in Georgia since the 70s of the last century (გოგოს, 2019). Studies on the climate in Georgia show changes in the basic parameters such as air temperature, average annual precipitation, relative humidity, humidity regime, etc., which clearly indicate all trends of climate change in the country (Environment and Security Initiative, 2011).

The impact of climate change on the water catchment basins of the rivers in Georgia has aroused interest. Accordingly, the aim of the study is to analyze the scenario of climate change in the catchment basin of the Ilto¹ River. Therefore, the main research question seeks to investigate the extent to which climate change will affect the Ilto River catchment in 2041-2100. Furthermore, there are sub-research questions which aim to particularly study the extent to which: (1) climate change will affect average temperatures and average maximum and minimum temperatures for the years 2041-2070 and 2071-2100; (2) climate change will affect annual precipitation and maximum daily precipitation during 2041-2070 and 2071-2100; (3) climate change will affect average wind speed and relative humidity for the years 2041-2070 and 2071-2100.

The study is divided into five main parts. After the introduction, the discussion is about the theoretical framework of the research which provides a solid basis for the

¹ Ilto River flows in Kakheti region, Georgia and it is the right tributary of Alazni. The length of the river is 45 kilometers (გოგოს, 2019).

interest in the mentioned issue. The third part describes the methods by which the research questions will be answered. The fourth chapter discusses the climate change scenario of the Ilto River from 2041 to 2100, and the last chapter summarizes the results of the study.

II. LITERATURE ANALYSIS

Climate variability, natural evolution, and human activity combine to drive global change at different scales (Liu, Y., Yu, K., Zhao, Y., & Bao, J, 2022). In particular, climate change may affect water cycle processes, runoff and regional water balance (Liu, Y., Yu, K., Zhao, Y., & Bao, J, 2022).

A paper on the effects of climate change and human activity on runoff in western China showed that temperature has a significant increasing trend, while precipitation, evaporation, runoff, relative humidity, sunshine duration, and wind speed have a decreasing trend (Liu, Y., Yu, K., Zhao, Y., & Bao, J, 2022). Effects of climate change and human activities on runoff showed that until 1985, climate change had a greater impact on runoff reduction than human activity. After 1985, the impact of climate change has decreased and the impact of human activity on runoff has increased (Liu, Y., Yu, K., Zhao, Y., & Bao, J, 2022). Climate change has driven the cycle of precipitation and evaporation, affected the regional water balance and distribution of water, and human activities have altered the hydrological process (Liu, Y., Yu, K., Zhao, Y., & Bao, J, 2022).

Kalugin, in a scientific article about the Lena and Selenga Rivers, emphasizes that the analysis of air temperature anomalies in the period from 1861 to 2005 using a 30-year moving average of the Lena and Selenga basins showed that the average annual air temperature decreased by 0.10C and 0.20C (Kalugin, 2022). The results of the spatial analysis of the attribution of anthropogenic climate change to changes in mean annual air temperature and precipitation showed that the increase in warming from the south to the north, due to the increase in greenhouse gas emissions, was noted in both river basins (Kalugin, 2022). Differential integral curves of Lena and Selenga annual runoff from 1861 to 2005 showed that Lena runoff increased under climate change conditions and anthropogenic greenhouse gas emissions (Kalugin, 2022). Since the 1970s, Selenga runoff has clearly increased under climate change conditions (Kalugin, 2022).

It should be noted that the effects of climate change and anthropogenic activities on flow indicators in a tropical river basin in southern China have been investigated (Xu, F., Zhao, L., Niu, C., & Qiu, Y, 2022). Climate change and anthropogenic activities are the two main driving factors that affect changes in river flow (Xu, F., Zhao, L., Niu, C., & Qiu, Y, 2022). The response of different stream flow indicators to climate change and anthropogenic activities was investigated. Precipitation increased slightly by 24.8 mm, while temperatures increased significantly by 0.230C and sunshine hours decreased by 0.03 hours over the decade (Xu, F., Zhao, L., Niu, C., & Qiu, Y, 2022).

These studies create a concrete scientific framework that emphasizes the fact that climate change affects river basins. Therefore, within the framework of the mentioned literature review, which created the ground for further research, it is interesting to analyze extent to which the climate changes will affect the Ilto River catchment.

III. METHODS OF RESEARCH

In order to give an appropriate answer to the research questions, I have to rely on a project carried out by CENN, which was implemented within the framework of the EU-supported project², where quantitative data related to air temperature, precipitation, wind speed and relative air humidity from 2041 to 2100 will be analyzed.. It should be noted that the data obtained as a result of the research carried out by CENN is based on the data recorded in the period 1961-2020 in the catchment basin of the Ilto River. It should be noted that the methodology for the assessment of future changes includes the forecast calculated with the MPI-ESM-MR A1B scenario of the global model, which was reduced to a 20 km grid using the RegCM_v.4.0 regional model for the territory of the South Caucasus region on the basis of which the climate scenarios were built for 33 meteorological stations and the climate forecast was made based on the SRES scenario.

IV. RESULTS OF ILTO RIVER CLIMATE CHANGE SCENARIO

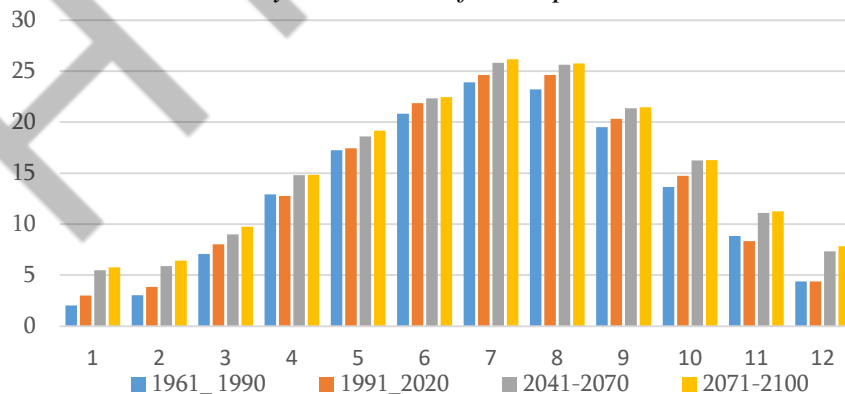
According to the research questions, the changes in temperature, amount of precipitation, wind speed and relative air humidity need to be analyzed. First, temperature variation will be discussed.

According to Figure 1, the warming trend in all seasons and annually continues throughout the simulation period from 2041 to 2100. More specifically, warming up to 2-2.8 degrees is expected from November to March from 2041 to 2070. The smallest increase is expected in the month of June by 0.6 degrees, and the rate of warming for the rest of the months is 1-1.5 degrees. It should be noted that the warming from 2071 to 2100 continues at relatively low rates. The annual warming rate is 0.3 degrees, but depending on the seasons, the warming rate in winter and spring is higher by 0.4-0.5 degrees.

As for the average maximum and minimum temperatures, according to Figure 2, the temperature parameters will increase by 1.2-1.4 degrees annually in the period of 2041-2070. Maximum warming is expected in winter by 2⁰C. By the year 2100, both the average maximum and minimum temperatures will increase by 0.9 degrees in winter.

Fig. 1

Average seasonal and annual actual values of temperature for the periods 1961-90, 1991-2020, and values obtained by the scenario for the periods 2041-2070 and 2071-2100. (Akhmeta, ⁰C)

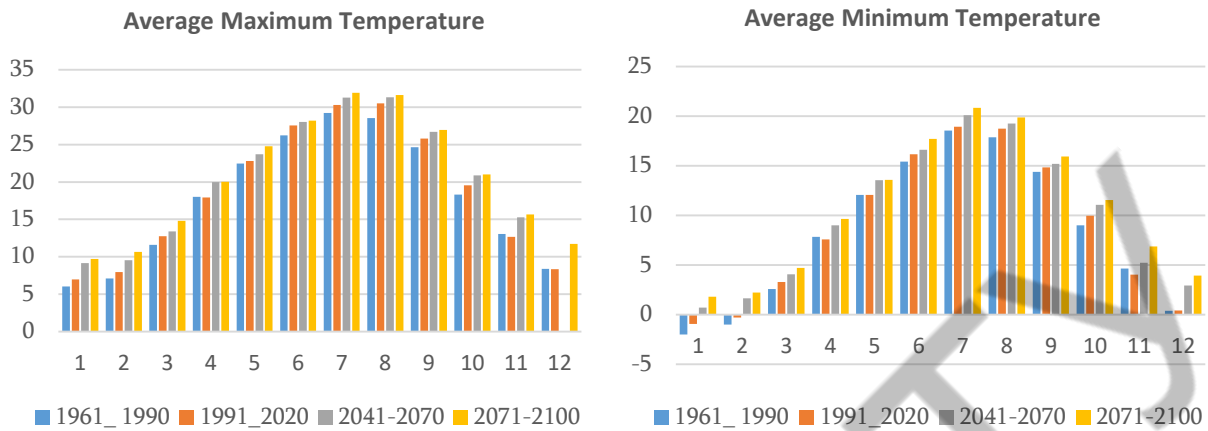


Source: CENN

² Georgia Climate Program (GEO-CAP): Promoting Civil Society Engagement in Climate Change Policy Development and Implementation

Fig. 2

Seasonal and annual actual values of the average maximum and minimum temperatures for the periods 1961-90, 1991-2020 and the values obtained by the scenario for the periods 2041-2070 and 2071-2100. (Akhmeta, °C)

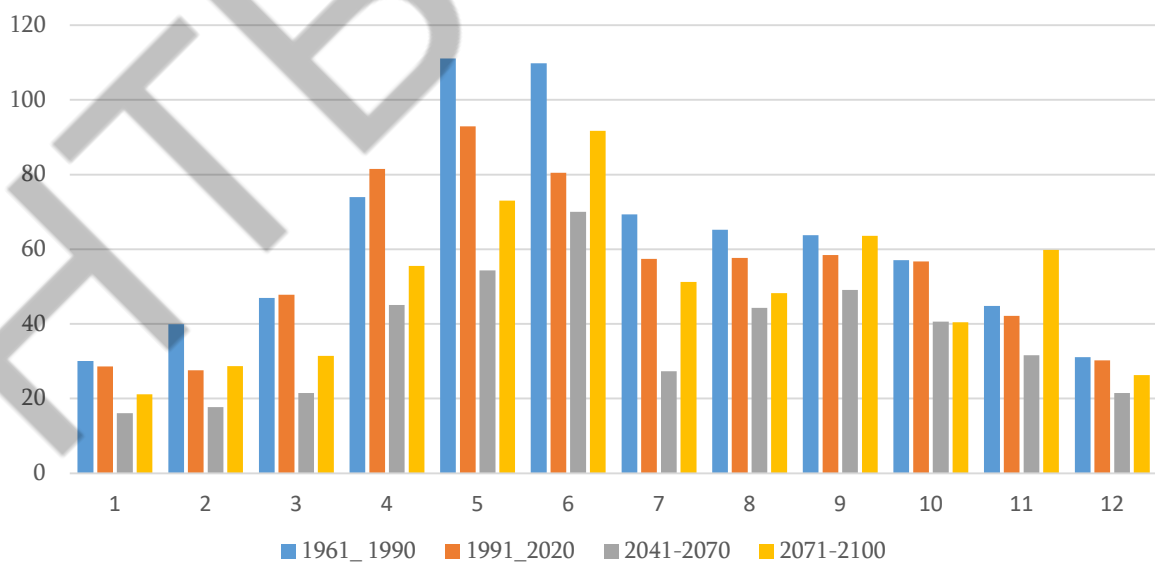


Source: CENN

As shown in Figure 3, the annual amount of precipitation has decreased, especially in the months of May and June. More specifically, the decline from 2041 to 2070 is quite large, as the annual total will decrease by 1/3. The annual amount of precipitation will decrease especially in winter and spring. In the period from 2071 to 2100, the rate will increase compared to the previous period, but the rate will still remain low. It should be noted that the maximum decrease in the amount of precipitation is recorded in the spring season.

Fig. 3

Actual values of seasonal and annual precipitation totals for the periods 1961-90, 1991-2020, and scenario values for 2041-2070 and 2071-2100 (Akhmeta, mm)



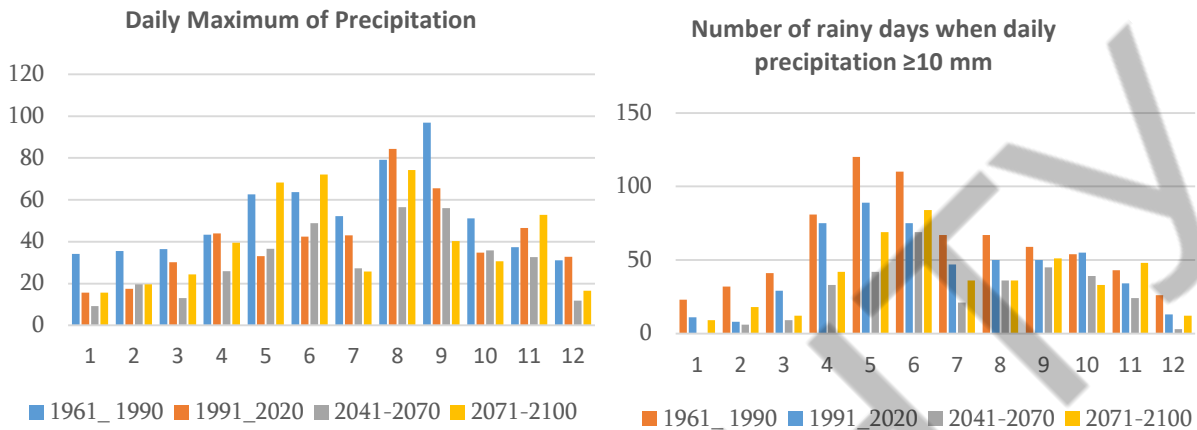
Source: CENN

As for the amount of maximum precipitation during the day and night, it will decrease during the research period and as shown in Figure 4, the maximum will be observed from September to August. For the period from 2041 to 2070, the annual maximum is expected in August. By 2100, the total and daily maximum precipitation

will increase compared to the previous period, but will still remain low compared to the observation period (1961-2020).

Fig. 4

Seasonal and annual actual values of the maximum precipitation during the day and night and the number of days with more than 10 mm of precipitation for the periods 1961-90, 1991-2020, and the values obtained by the scenario for the periods 2041-2070 and 2071-2100. (Akhmeta, mm)

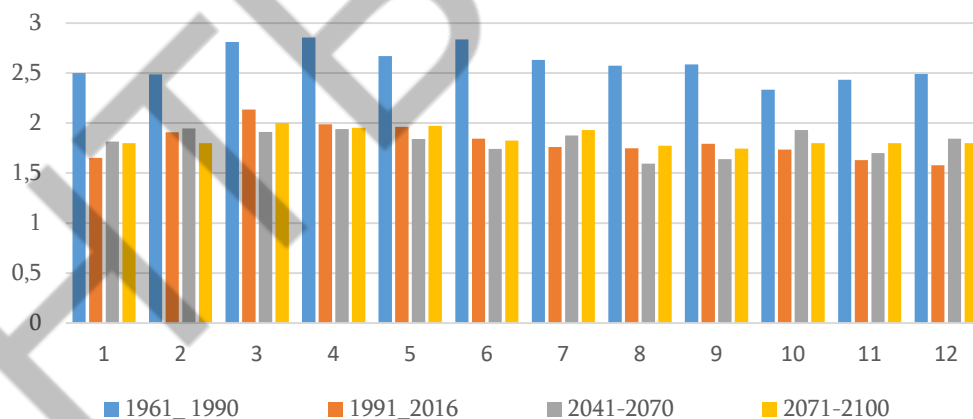


Source: CENN

As shown in Figure 5, the wind speed decreases from 2041 to 2070. Although the rate increases slightly by 2100 in some months, overall variability is small and wind speeds remain low.

Fig. 5

Seasonal and annual actual values of wind for the periods 1961-90, 1991-2020 and values obtained by the scenario for the periods 2041-2070 and 2071-2100 (Akhmeta, m/s).

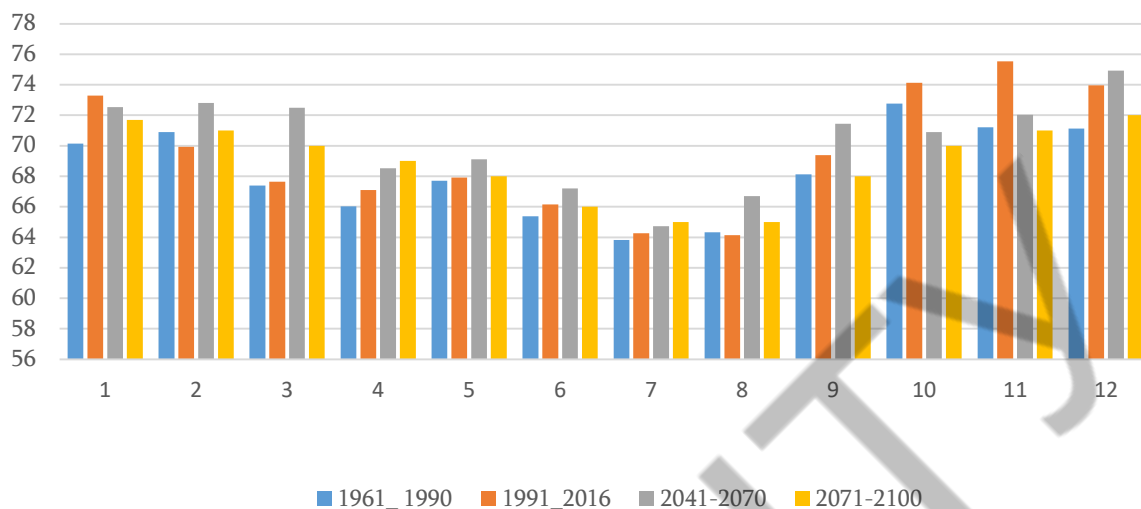


Source: CENN

As for the relative air humidity (Figure 6), the annual value slightly increases within 1% in the period 2041-2070, and a slight increase is followed by a decrease in the period 2071-2100. In the period from 2041 to 2070, an increase of about 2.5% is recorded in spring, in summer and winter the rate increases by 1.5%, and in autumn the relative humidity of the air as a whole decreases. As for the period from 2071 to 2100 compared to the period of previous years, there will be a decrease in each season, more precisely by about 1% in spring and summer, and by about 2% in autumn and winter.

Fig. 6

Average seasonal and annual actual values of relative humidity for the periods 1961-90, 1991-2020 and values obtained by the scenario for the periods 2041-2070 and 2071-2100 (Akhmeta, %)



Source: CENN

V. CONCLUSION

Climate change in Georgia causes changes in air temperature, relative humidity, humidity regime and average annual precipitation. The climate change scenario of the Ilto river basin for the period from 2041 to 2100 was of interest, research aim was to investigate changes regarding average temperature and average maximum and minimum temperatures, annual precipitation and maximum daily precipitation, average wind speed, and relative humidity, and the specific information based on the data recorded in the period 1961-2020 in the catchment basin of the Ilto River was analyzed.

As a result, a scenario was obtained, according to which the warming trend in all seasons and annually continues throughout the simulation period, and the average maximum and minimum temperatures will also increase. Furthermore, the annual amount of precipitation as a whole will decrease in the period of 2041-2100. The maximum amount of precipitation during the day and night will also decrease during the study period. As for the annual value of the relative air humidity, it will increase slightly in the period of 2041-2070, and the slight increase will be followed by a decrease in the period of 2071-2100. Therefore, to conclude, climate change affects the mentioned parameters, which causes the variation of the mentioned indicators in the Ilto catchment basin.

VI. REFERENCES

- Bast, L. J. (2010). *Seven Theories of Climate Change*. The Heartland Institute.
 Environment and Security Initiative. (2011). *Climate Change in the South Caucasus*. Zoï Environment Network.
 Kalugin, A. (2022). Climate change attribution in the Lena and Selenga river runoff: An evaluation based on the earth system and regional hydrological models. *Water*, 14(1), 118. doi:<https://doi.org/10.3390/w14010118>.

- Liu, Y., Yu, K., Zhao, Y., & Bao, J. (2022). Impacts of climatic variation and human activity on runoff in western china. *Sustainability*, 14(2), 942. doi:<https://doi.org/10.3390/su14020942>.
- Xu, F., Zhao, L., Niu, C., & Qiu, Y. (2022). Effect of climate change and anthropogenic activities on streamflow indicators in a tropical river basin in southern china. *Water*, 14(3), 304. doi:<https://doi.org/10.3390/w14030304>.
- სიმონიძე, რ., ქირია, ქ., გელაძე, ა., მეესენი, ჰ., სააკაძე, ლ., ყაჭეიშვილი, ლ., გულედანი, ი. (2011). მდინარე ალაზნის აუზის წყლის რესურსების დაბინძურების შემცირების ღონისძიებები სოფ. ჰერეთისკარის მაგალითზე. თბილისი: საქართველოს მწვანეთა მოძრაობა/დედამიწის მეგობრები საქართველო.
- ფიფია, ბ. (2019). საქართველოს ძირითადი მდინარეების ენერგეტიკული პოტენციალის შეფასება არსებული ჰიდროლოგიური მონაცემების გათვალისწინებით. თბილისი.
- ჯიქია, გ. (2017). მდინარე ალაზანზე მიკრობიოლოგიური და ანთროპოგენური სტრესფაქტორების გავლენის შესწავლა თევზ მურწას მაგალითზე და მისი ეკოტოქსიკოლოგიური შეფასება. თბილისი: სოხუმის სახელმწიფო უნივერსიტეტი.

ANALYSIS AND ASSESSMENT OF ECOLOGICAL SAFETY OF EMISSIONS FROM PRODUCTION OF CARBON PRODUCTS Authors: Koval Vasy ¹ , Olieniuchenko Volodymyr ² Advisor: Belokon Karina ¹ ¹ Zaporizhzhia National University (Ukraine) ² University of Occupational Safety Management in Katowice (Poland).....	856
THE USE OF BY-PRODUCTS OF CROP PRODUCTION TO STABILIZE THE BALANCE OF NUTRIENTS IN THE SOIL Author: Vitaly Kryzhanivskyi Advisor: Oleksandr Tkachuk Vinnytsia National Agrarian University (Ukraine).....	863
PLASTIC WASTE AS A SOURCE OF FINANCIAL AID TO THE ARMED FORCES OF UKRAINE Author: Dmytro Shelinhovskiy Advisor: Vladyslav Mykhailenko ¹ , Svitlana Kuznichenko ² ¹ Odesa State Environmental University (Ukraine) ² University of Greifswald (Germany).....	872
ASSESSMENT OF THE ECOLOGICAL STATE OF GREEN SPACES IN THE CITY OF ALMATY Authors: Yusefovych Sophia ¹ , Utegenova Aruzhan ² , Nugmanov Daniyar ² Advisors: Elena Kharlamova ¹ , Saule Nurmakova ² ¹ Kremenchuk Mykhailo Ostrohradskiy National University (Ukraine) ² K.I. Satpayev Kazakh National Research Technical University (Kazakhstan).....	879
OPTIMIZATION OF ANAEROBIC FERTILIZATION PARAMETERS OF CATTLE MANURE WITH WINE-MAKING WASTE TO OBTAIN MORE BIOGAS YIELD ON TYPICAL BIOGAS PLANTS. Author: Umarashvili Bekkhan Advisor: Magda Davitashvili Iakob Gogebashvili Telavi State University (Georgia).....	891
ILTO RIVER CLIMATE CHANGE SCENARIO Author: Ninaka Berdzenishvili Advisor: Nana Berdzenishvili Iakob Gogebashvili Telavi State University (Georgia).....	903
THE IMPACT OF URBAN PARK RECONSTRUCTION ON THE AGGREGATE STRUCTURE OF SOIL Author: Filip Zots Advisor: Olga Kunakh Oles Honchar Dnipro National University (Ukraine).....	910
ENVIRONMENTAL SAFETY OF THE OIL AND GAS COMPLEX Authors: Artem Tristan ¹ , Chaudchar Akhansha ² Advisors: Olena Stepova ¹ , Khan Nadeem Ahmad ² ¹ National University "Yury Kondratyuk Poltava Polytechnic" (Ukraine) ² Mewat Engineering College, Nuh (India).....	925