ICYS
MHEM

NOVEMBER 15-16

2023

INTERNATIONAL CONFERENCE OF YOUNG SCIENTISTS ON METEOROLOGY HYDROLOGY AND ENVIRONMENTAL MONITORING (ICYS-MHEM)

Ukrainian
Hydrometeorological Institute
https://uhmi.org.ua/conf/
conference.uhmi@gmail.com
Prospekt Nauky, 37, Kyiv, Ukraine, 03028

STATE EMERGENCY SERVICE OF UKRAINE
NATIONAL ACADEMY OF SCIENCES OF UKRAINE
UKRAINIAN HYDROMETEOROLOGICAL INSTITUTE

INTERNATIONAL CONFERENCE OF YOUNG SCIENTISTS ON METEOROLOGY, HYDROLOGY AND ENVIRONMENTAL MONITORING (ICYS-MHEM)

Kyiv, Ukraine, November 15-16, 2023

Book of Abstracts

Kyiv – 2023

Organized by the Young Scientists Council of Ukrainian Hydrometeorological Institute (UHMI) of the State Emergency Service of Ukraine and the National Academy of Sciences of Ukraine

This Book of Abstracts presents the theses of the International Conference of Young Scientists on Meteorology, Hydrology and Environmental Monitoring (ICYS-MHEM) that took place at the Ukrainian Hydrometeorological Institute (UHMI) of the State Emergency Service of Ukraine and the National Academy of Sciences of Ukraine on November 15-16, 2023. Overall, 29 scientific presentations were delivered by young scientists in three sections: Terrestrial Hydrology and Hydrochemistry; Meteorology, Climatology, Agricultural Meteorology; Environmental Monitoring.

У збірнику вміщено тези доповідей Міжнародної конференції молодих учених з питань метеорології, гідрології та моніторингу довкілля – International Conference of Young Scientists on Meteorology, Hydrology and Environmental Monitoring (ICYS-MHEM), що проходила 15-16 листопада 2023 року в Українському гідрометеорологічному інституті ДСНС України та НАН України. Дослідження молодих учених представлено в 29 доповідях на трьох наукових секціях: гідрологія і гідрохімія суходолу; метеорологія, кліматологія, агрометеорологія; моніторинг довкілля.

https://doi.org/10.15407/icys-mhem.2023

CONTENT

Terrestrial Hydrology and Hydrochemistry

Meteorology, Climatology, Agricultural Meteorology

Environmental Monitoring

TERRESTRIAL HYDROLOGY AND HYDROCHEMISTRY

PROBABILISTIC CHARACTERISTICS OF RIVER ICE REGIMES IN THE PRYPIAT BASIN WITHIN UKRAINE

Oleksandr Afteniuk, Liudmyla Gorbachova
Ukrainian Hydrometeorological Institute, Kyiv, Ukraine, afteniuk@ukr.net

Hydrometeorological support of different branches economics is closely related to the involvement of various hydrological information, in particular, the ice regime characteristics of rivers and reservoirs. The most complete and thorough generalization of observation materials of the ice regime characteristics of the water bodies of Ukraine was carried out in the 60s and 70s of the 20th century. In the future, such studies were carried out for individual river basins and for different observation periods. In addition, in most of these studies, the probabilistic characteristics of the river ice regimes were not determined. At the same time, the probabilistic characteristics significantly expand knowledge about the variability, magnitudes and timing of ice phenomena on water bodies. Such knowledge is important for the design and operation of hydraulic structures.

The main objective of this research is the determine the probabilistic characteristics of the appearance dates of the main phases of the ice regime, as well as the duration of ice phenomena and continuous freeze-up on the rivers of the Prypiat basin. The investigation was carried out for the following indicators of the ice regime: appearance date of ice, date of freeze-up, break-up date (i.e., melt onset), date of ice disappearance, duration of continuous freeze-up, overall duration of ice. In the Prypiat River basin the data from 29 water gauges from the observations beginning to 2020 inclusive are using for research.

The methodological approaches that developed by B.M. Ginzburg in 1969 were used to determine the probabilistic characteristics of the river ice regimes of the Pripyat basin. Thus, the analytical probability distribution of the appearance dates of the main phases of the ice regime were determined according to the Pearson curve of type III, and as its parameters were used the multi-annual mean ($\overline{D}$), the standard deviation (σ_D), and the asymmetry coefficient (C_s). The standard deviation was used instead of the variation coefficient, since the variation coefficient changes depending on the initial date when numerically expressing the multi-annual mean date of the ice indicator. When calculating the probabilistic distribution of the appearance dates of the main phases of the river ice regimes, their statistical series were arranged from early to late dates, i.e., low probability values were assigned to early dates, and large probability values were assigned to later dates. The calculated appearance date of ice indicator of certain probability was determined by the formula $D_{P\%} = \overline{D} - \sigma_D F (P\%, C_s)$, where F – the Foster number. The probabilistic characteristics of the duration of continuous freeze-up and overall duration of ice were also determined according to the Pearson curve of type III, but according to traditional parameters: the multi-annual mean, coefficients of variation and asymmetry. The empirical probability distribution for both the appearance dates of the main phases of the ice regime and duration of continuous freeze-up and overall duration of ice were determined by the Weibull formula. The parameters of the analytical curves by the method of moments are determined.

The analytical curves of the dates of appearance dates of ice and freeze-up on the rivers of the Prypiat basin have a negative asymmetry, i.e., there is an asymmetry of the series relatively to the mean dates aside the later dates. At the same time, the analytical curves of the dates of break-up and of ice disappearance have the opposite trend, i.e., there is an asymmetry of the series aside the early dates. Most series of the duration of continuous freeze-up and overall duration of ice are also asymmetric aside decreasing their values. The asymmetry coefficients are little values. The values of the standard deviation of the appearance dates of main phases of the ice regime vary from ±14.4 to ±27.1 days.

Keywords: ice regime, probability characteristics, Pripyat basin, statistical parameters, Pearson type III

https://doi.org/10.15407/icys-mhem.2023.006

TERRITORIAL FORECASTING OF THE DRY WEATHER FLOW OF THE RIVERS OF THE SOUTHERN BUG RIVER BASIN

Anastasia Blaha, Zhannetta Shakirzanova
Odessa State Environmental University, Ukraine, Blagaya2302@gmail.com

Dry weather flow is forms due to the depletion of both groundwater reserves and channel reserves, which still remain in the river network, lakes and swamps after the termination of the supply of surface thaw-rainwater from spring irrigation. Forecasts of the river boundary flow in the summer, autumn and winter period are used in the development of monthly and decadal plans for the operation of large reservoirs, in the planning of navigation, energy production of hydroelectric power plants on rivers, which should ensure reliable, uninterrupted operation of economic facilities, as well as in forecasts of low water in rivers.

The object of the research is the rivers of the Southern Bug river basin. The summer and winter dry weather flow on the rivers of the Southern Bug river basin is characterized by stability, low water and considerable duration; autumn rises are observed after torrential rains. Sometimes the dry weather flow is broken by small rain floods.

The purpose of this work is to develop a methodology for territorial forecasting of the dry weather flow of rivers in the Southern Bug river basin and to evaluate its effectiveness, a cartographic presentation of the predicted values of the dry weather flow and to determine the probability of their occurrence in a multi-year period.

The basis of the forecast of low water flows in the dry weather flow period of rivers in the basin of the Southern Bug River is the solution of the water balance equation in the form of dependencies generalized for a number of the water gauge station.

According to the data on water flow (runoff modules) on the date of the forecast release and averages for the decade, regional dependencies were constructed for each month of the season of low water flow of rivers separately.

The methodology of territorial short-term forecasts of the average decadal flow of water of the dry weather flow summer, autumn and winter runoff of rivers in the basin of the Southern Bug River is evaluated as satisfactory - the interval of the criteria of quality and efficiency of the methodology is 0.68-0.84, and the short-term forecasts evaluation is quite high - P% varies from 70% to 94%, with the number of members of the series exceeding 500 points.

In the prognostic method of territorial short-term forecasts of the dry weather flow of rivers in the basin of the Southern Bug River, it is proposed to establish the certainty or probability of exceeding (probability of occurrence of) forecast values (P%), which is especially important for rivers that have not been studied in terms of hydrology. In order to determine the reliability of forecast values of average decadal water flows of the summer, autumn and winter dry weather flow, the empirical distribution of the average monthly runoff modules in the specified boundary seasons in river basins in the basin of the Southern Bug River was established.

Map-schemes of distribution on the territory of forecast values of average decadal water consumption and their probable values were constructed using the program Surface Mapping System Surfer Version 11.6.1159. The map schemes are built on the date of the release of the forecast make it possible to carry out spatial monitoring of the dry weather flow of rivers and to issue forecasts of water runoff during this period in a specific point of the territory, even for those rivers for which there is no monitoring of the runoff.

Keywords: short term forecast, dry weather flow, cartographic form.

https://doi.org/10.15407/icys-mhem.2023.007

RESEARCH OF THE PIVDENNY BUH RIVER BASIN HYDROMETEOROLOGICAL CHARACTERISTICS TIME TRENDS IN THE CONDITIONS OF MODERN CLIMATE CHANGE

Anhelina Dokus[1,2], Hanna Bolbot[3], Dmitry Skorokhod[1]
[1]Odessa State Environmental University, Odesa, Ukraine, angel.dokus@gmail.com
[2]State Organization «Institute of Market and Economic & Ecological Researches of the National Academy of Sciences of Ukraine», Odesa, Ukraine
[3]Ukrainian Hydrometeorological Institute, Kyiv, Ukraine

The climate change observed in recent decades affects all phases of river water availability, so it is an actual task to study the time series trends of the Pivdenny Buh River basin average annual hydrometeorological characteristics in the context of modern climate change.

Each year, research on climate change in Ukraine becomes increasingly relevant and in demand. This is due to the long-term trend in air temperature throughout the country, which indicates an increase in air temperature. There is an increase in the frequency of meteorological hazards in different regions of Ukraine. Climatologists detect climate records accompanied by abnormally warm winters and a shift in seasons. There is a redistribution of precipitation in time and space.

In recent decades, due to an increase in air temperature, there has been a tendency to increase absolute air humidity and, consequently, decrease relative air humidity, which affects the amount of evaporation from the surface of catchment areas and water bodies.

In order to research the influence of climate change on the annual distribution of the Pivdenny Buh River basin water balance components, a retrospective (as of 2020) analysis of time series of hydrometeorological factors and characteristics of the annual runoff of the rivers of the Pivdenny Buh River basin was conducted.

The constructed time series graphs of the Pivdenny Buh River basin air temperature in indicate the presence of a pronounced general trend towards an increase in air temperature, which certainly affects the amount of evaporation in the basin, which is included in the water balance equation as an indicator of losses in river catchments.

The time series graphs of the Pivdenny Buh River basin absolute air humidity according to the data of separate meteorological stations of the Pivdenny Buh River basin indicate a general tendency to increase values over a multi-year period. The difference integral curves of average annual values of absolute air humidity of the Pivdenny Buh River basin are cyclical in nature with a tendency to decrease from the beginning of the study period until 1998. Since 1998, there has been an upward trend in absolute air humidity.

The total annual precipitation, which is the incoming part of the water balance of rivers, tends to decrease. Total annual precipitation has been cyclical, with a downward trend since 1980, an upward trend since 1995, and a downward trend again until 2020.

The time series graphs of annual water layers (averaged over the period from 1980 to 2020) of the rivers of the Pivdenny Buh River basin show that there is a tendency to decrease values over a multi-year period, and the difference integral curves indicate the presence of cyclical variability in the annual runoff of the study area rivers – an increase in runoff until the late 90s of the last century, a decrease until 1995, then an increase until the early 2000s and then a decrease again (except separate gauging stations).

The time series graphs and difference integral curves of the annual water layers of the Pivdenny Buh River basin rivers are mostly synchronous, i.e., the same course of water content is observed throughout the entire time interval.

Keywords: water balance, climate change, the Pivdenny Buh River, hydrometeorological characteristics.

https://doi.org/10.15407/icys-mhem.2023.008

MODERN NATURAL CONDITIONS OF RUNOFF FORMATION IN THE KUYALNIK LIMAN BASIN

Anhelina Dokus[1,2], Oleg Rubel[2]
[1]Odessa State Environmental University, Odesa, Ukraine
[2]State Organization «Institute of Market and Economic & Ecological Researches of the National Academy of Sciences of Ukraine», Odesa, Ukraine, angel.dokus@gmail.com

The climate change observed in in the last decade is characterized by increasing air temperatures against a background of low precipitation, which can significantly reduce river flow and increase evaporation, resulting in the shallowing of the Kuyalnik Liman. In recent decades, evaporation has far exceeded the amount of atmospheric precipitation inflow.

The current critical condition of the Kuyalnyk Liman, which has deteriorated significantly, is due to insufficient water supply from river runoff and increased evaporation.

Over the past 10 years, intense drying of the Sukha Zhurivka, Koshkivka, and other rivers in the Kuyalnyk Liman watershed has been observed. The Velykyi Kuyalnyk River in the Berezivskyi region has been recorded to be completely dry for 61.5 km, which is 80 % of the total length of the river in the district. In Berezovsky region, 34 ponds were also recorded as completely dry. In Podilsky region, 11 ponds have completely dried up. Surface water does not meet the needs of the economy and population in terms of both quantity and quality [1].

Water levels at the post liman Kuyalnyk – Odesa, averaged for each month for the period from 2001-2022, fluctuate widely throughout the year: average long-term water levels (norms) range from 75 cm in September and October to 106 cm in April; minimum water levels (low-water years) range from 32 cm in August to 55 cm in March; maximum water levels (high-water years) range from 173 cm in December-February to 231 cm in April.

At the same time, the average monthly water levels for 2022 are below their long-term average values and range from 55 cm in October and September to 89 cm in March.

Calculated and averaged over two calculation periods (1980-1999 and 2000-2020), the average monthly precipitation values indicate a predominant decrease in the second twenty years, especially in April, during the formation of the spring flood, and in the warmest month of the year, August. In January, February, and March, there was an increase in the amount of liquid precipitation and a lack of snow cover. A significant increase in air temperature in winter contributes to an increase in evaporation.

Reduced precipitation and increased evaporation losses due to climate warming and anthropogenic activities have negatively affected the flow of the Velykyi Kuyalnyk River and other rivers and beams in the liman basin, and, accordingly, the filling of the liman itself.

The identified trends in water levels in the Kuyalnik Liman from 2001 to 2020 indicate the prospects for further decline, shallowing and increased mineralization, which will worsen the conditions for the functioning of the liman as a balneological facility.

Climate change forecasts [1] expected in the liman catchment in the future (by 2050, RCP4.5 climate scenario) indicate that average annual air temperatures will increase, while annual precipitation will not change. Statistically significant trends in fluctuations of air temperatures during warm and cold periods will also be positive. Such a distribution of climatic factors of runoff formation will lead to a decrease in the water resources of the Kuyalnik Liman catchment by 25.5 % compared to their state before 1989.

Keywords: Kuyalnik Liman, river runoff, climate change.

1. Water regime and hydroecological characteristics of Kuyalnitskyi Liman: Monograph / N.S. Loboda, E.D. Gopchenko, Eds. Odessa State Environmental University. Odessa: TES, 2016. 332 p.

https://doi.org/10.15407/icys-mhem.2023.009

EFFECT OF TELECONNECTION PATTERNS ON THE RUNOFF FORMATION OF LITHUANIAN RIVERS DURING THE WARM PERIOD

Karolina Gurjazkaitė, Vytautas Akstinas
Lithuanian Energy Institute, Kaunas, Lithuania, karolina.gurjazkaite@lei.lt

River discharge and flow dynamics are influenced by numerous natural and anthropogenic factors, which implies the need for comprehensive studies to reach sustainable water resource management and enhance predictions and preparedness for extreme events, especially droughts. Talking about warm season risks, anthropogenic activities in rivers create additional challenges in water management. In human-regulated rivers, maintaining ecological flow downstream of technical structures is essential to balance anthropogenic and ecosystem needs and reach EU WFD goals. Therefore, it is important to understand the conditions of runoff formation and its natural causality. Previous research in Lithuania has established that the multi-annual average of low-flow discharge ($Q_{30\_average}$) could be assumed as the potential value of ecological flow. However, the causality of this parameter was not sufficiently investigated because this measure can be influenced by multiple large-to-local scale driving forces that govern discharge volume and flow patterns. This study focuses on investigating teleconnections, which represent long-distance effects between large-scale atmospheric oscillations and regional climatic anomalies, as significant drivers of the hydrological cycle. Teleconnections are well-known to impact temperature and precipitation, thereby affecting discharge volumes and flow regimes. However, their influence may vary significantly on spatial and temporal scales. Specifically, this study examines five Northern Hemisphere teleconnection patterns (North Atlantic Oscillation (NAO), East Atlantic (EA), East Atlantic/Western Russian (EATL/WRUS) Scandinavian (SCAND), Polar/Eurasian (POL)), which manifest themselves through a variety of influences on the climate of Europe. Lithuanian rivers from three hydrological regions exhibiting diverse feeding patterns were studied to assess the relationship between teleconnections and the formation of low-flow parameters. Non-parametric Wilcoxon sum rank test was applied to assess the connections between the selected teleconnections and the low-flow of the warm period. The findings of this study indicated that some of the indices showed only an occasional effect, however, the SCAND index was revealed to be closely related to the runoff variability in the warm period. Consequently, the results of this study contribute to a better understanding of the impact of teleconnections on the formation of low-flow parameters that one day might be assumed as ecological flow, as well as providing valuable insights for sustainable water resource management.

Keywords: teleconnection patterns, flow formation, low-flow, ecological flow

https://doi.org/10.15407/icys-mhem.2023.010

METHODOLOGICAL BASICS OF FORECASTING FLOODS ON THE RIVERS OF TRANSCARPATTIA

Andrii Kolesnik, Zhannetta Shakirzanova
Odessa State Environmental University, Ukraine, lovelybull2016@gmail.com

The formation of floods of mixed origin in the cold and warm periods of the year is characteristic of the rivers of Transcarpathia. They are often accompanied by significant and prolonged flooding of territories, sometimes with catastrophic consequences. For the purpose of warning about dangerous hydrological phenomena, an urgent task is hydrological forecasting of maximum levels and water flows during periods of floods on rivers.

The object of the research is the Tysa River and its tributaries, which are characterized by the formation of maximum runoff from melting snow and rainfall in the winter-spring period. The Carpathians, which occupy the southwestern part of Ukraine, play a major role in shaping the climate of the territory under consideration, where a mountain climate associated with heavy precipitation is created. It should be noted that heavy precipitation in the Tysa river basin is characterized by a long duration and intensity of precipitation. Such rains are accompanied by the rapid formation of catastrophic river floods, mudslides and floods.

The purpose of this work is the analysis of modern mathematical models for forecasting the maximum water levels and discharges of floods and the creation of a methodology for short-term forecasting of the flood flow of Transcarpathian rivers.

Mathematical models of rain and snow-rain runoff of mountain rivers were developed as structural components of basin prognostic systems (in the Tysa basin - "Tysa", in the Latorica river basin - "LATORICA", 2011). Such models were created at the Ukrainian Research Hydrometeorological Institute of the State Emergency Service of Ukraine and the National Academy of Sciences of Ukraine (UkrHMI) https://uhmi.org.ua/dep/hydro/ and are implemented in the operational activities of the Transcarpathian Regional Center for Hydrometeorology http://gmc.uzhgorod.ua/vgpro.php. These models are conceptual with concentrated parameters and serve for short-term forecasting of runoff (discharges /levels) during rain and snow-rain floods and long-term forecasting of spring flood characteristics.

In foreign practice, a new generation MIKE 11 modeling complex has been developed and is used in the operational practice of European countries. In UkrHMI, the adaptation of the NAM RR MIKE 11 hydrological model to calculation and forecast modeling of both average daily and maximum discharges of the mountain rivers of Transcarpathia (the rivers Tysa, Rika, Borzhava). The quality of NAM module calibration is related to the quality and availability of hydrometeorological data and the impact of anthropogenic activities on river flow. In addition, as part of the adaptation of the MIKE 11 model, predictive hydrological modeling was carried out based on the data of the WRF NMM mesoscale short-term weather forecast model and satisfactory results were obtained.

The basis of the development of the method of forecasting the maximum flood water levels by the authors is the method of appropriate levels for the Tysa River, taking into account the data of automatic posts under different conditions of the formation and superimposition of flood waves along the river and its tributaries. The physical basis of the method of forecasting discharges and water levels in river sections is the Saint-Venant equation, which reflects the basic patterns of movement of river waves in a one-dimensional approximation. The essence of the method is to establish an empirical relationship between the appropriate levels (discharges) of water observed in the upper and lower reaches. The prematurity of the forecast is equal to the difference in the timing of the occurrence of such levels (discharges) in the specified creations.

Thus, in order to warn about the negative consequences of passing the maximum water levels of floods of mountain rivers of Transcarpathia, which are caused by heavy precipitation or melting snow, it is carried out both when using modern prognostic mathematical models and when using the method of appropriate discharges or water levels.

Keywords: floods, rain and snow-rain runoff, mathematical models, forecast

https://doi.org/10.15407/icys-mhem.2023.011

WATER QUALITY ASSESSMENT OF KATLABUKH LAKE AND INFLOWING RIVERS

Dmytro Lutai, Natalia Kichuk
Odessa State Environmental University, Odessa, dmitriylutay@gmail.com

The estuary zone of the Danube forms a large bog delta with a total area of about 5640 km^2 of Danube lakes (Kahul, Katlabukh, Yalpuh, Kytay, Sasyk), which in recent years are subject to intensive anthropogenic pollution. After their damming and transformation into water reservoirs, water exchange is carried out with the help of a system of locks and channels, without forced water supply, which has significantly affected deterioration, both the regime of lakes and their hydrochemical condition. This is especially true for the Katlabukh and Kytay lakes, which have much worse conditions of water exchange because of their geographical location and the anthropogenic impact on the catchement area of the rivers falling into the lakes, there is a need for thorough analysis of their hydrologic and hydrochemical regimes in order to provide appropriate recommendations.

The object of the study is the surface waters of the lake Katlabukh and the rivers that fall into it.

The aim of the work is to assess the water quality of the lake Katlabukh and the studied rivers according to modern methods and the possibility of using their water resources.

For the characteristics of hydrochemical regime of the rivers Yenika, Tashbunar, Velykyy Katlabukh, Katlabukh lake, the data of the monitoring laboratory of waters of Danube regional office of water resources for the period of 2000-2018 years were used.

The water pollution index (WPI) and the water pollution coefficient (WPC) were used to assess the water quality of the investigated objects. For carrying out the relevant calculations the maximum permissible concentrations for the fishing purpose were applied as the strictest.

Summing up the results of the water quality assessment of the investigated objects it is possible to note that the worst WPI can be attributed to the river Tashbunar, where 95% of surface waters are estimated as moderately polluted, influencing significant anthropogenic impact, the level of which is close to the limit of ecosystem stability. River Velykyy Katlabukh has 79% of surface waters of this class, river Yenika has 63%, and Lake Katlabukh has 28%.

But according to the estimation of the water pollution coefficient (WPC), the surface waters of the rivers Yenika and Velykyy Katlabukh are the most polluted. Such high pollution rates are provided by heavy metals, chlorides, nitreous nitrogen, which are not included in the methodology of WPI. According to the provided calculations, the highest indicators of water pollution coefficient were obtained for the Yenika River in 2002 -2.88, in 2014 - 2.45, in 2015 -2.54. These waters are classified as moderately polluted.

Conclusion. The conducted studies show that currently the sources of water supply in Lake Katlabukh are in an unsatisfactory condition, and according to a lot of indicators of microbiological, biogenic, chemical pollution, as well as the level of mineralization, they exceed regulatory requirements, which makes them unsuitable (without deep cleaning) for water supply to almost all groups of water users.

The main reason for the unsatisfactory quality of water in the lake can be considered the low water levels during the last two years and the inability to fill the lake before the lower limited level and the anthropogenic impact of the rivers that flow into the lake and, having very high levels of pollution, worsen the situation even more.

In order to improve the state of surface waters in Lake Katlabukh, it is necessary to increase water exchange, preferably with the use of additional forced water supply, taking into account its geographical position, to develop a program of specific measures, to ensure compliance with environmental legislation by all water users

Keywords: anthropogenic impact, quality, mineralization, water exchange.

https://doi.org/10.15407/icys-mhem.2023.012

HYDROLOGICAL MODEL OF UKRAINE: SETUP, CALIBRATION, AND WEB INTERFACE

Valeriy Osypov[1], Nataliia Osadcha, Andrii Bonchkovskyi, Oleksandr Kostetskyi, Viktor Nikoriak, Yurii Ahafonov, Yevhenii Matviienko, Herman Mossur, Volodymyr Osadchyi

[1] Ukrainian Hydrometeorological Institute, Kyiv, Ukraine, valery.osypov@gmail.com

The planning of river basin management should utilize a high-resolution, process-based hydrological model to tackle issues such as diffuse pollution, drought, flood forecasting, and the impact of climate change. The studies available to date only encompass five meso-scale and one large-scale river basins in Ukraine.

The objective of this study is to calibrate the Soil and Water Assessment Tool (SWAT) for all Ukrainian river basins, including upstream transboundary parts. The model could potentially assist in land management and assessing the impact of agriculture on water resources; hence, considerable attention is paid to agricultural practices and crop rotations.

The Soil and Water Assessment Tool (SWAT) is a process-based semi-distributed hydrological model developed by the United States Department of Agriculture's Agricultural Research Service (USDA-ARS) in collaboration with numerous institutions. SWAT is widely used for simulating the impact of land management practices on water resources, including water quantity and quality, as well as assessing the overall environmental impact of land use and climate changes.

The watershed, encompassing transboundary areas, covers an area of 873,600 km^2, with Ukraine accounting for 68.7% of it. The inputs for the model consist of topography, river network, merged national soil maps with the properties for each soil polygon and underlying horizons, land cover, and agricultural practices such as crop rotations, fertilization, and operation schedules. In calibrating the model, we arranged daily discharge data from 56 gauges, snow cover from 61 locations, and crop yields of primary crops. The modeling period spans 41 years from 1980 to 2020. The modeling results are evaluated based on three criteria: the Nash-Sutcliffe coefficient (NS), the coefficient of determination (R2), and the percent bias (PBIAS).

The model is available via a user-friendly web platform that features an interactive map of Ukrainian subbasins. Users can inspect the model inputs for each subbasin and monitor the daily dynamics of key outputs: river discharge, water flow components, evapotranspiration, soil water, and snow cover. The results can be downloaded as an image or a CSV file for further research.

The hydrological model of Ukraine has the potential to address a wide range of issues related to water and agriculture: water supply, flood forecasting, soil water availability, water quality, the impact of climate change, and so on. The model will be expanded in the future to include sediment and nutrient transport.

Keywords: Hydrological model, Soil and Water Assessment Tool (SWAT), Ukraine river basins, river discharge, water flow.

https://doi.org/10.15407/icys-mhem.2023.013

AIR TEMPERATURE AS A BASIS FOR LONG-TERM FORECASTING OF BREAK-UP ICE AT THE DNIPRO CASCADE RESERVOIRS

Viktoriia Prykhodkina, Borys Khrystiuk
Ukrainian Hydrometeorological Institute, Kyiv, Ukraine, nil.admirari14@gmail.com

The ice regime on water bodies depends on large-scale atmospheric processes that develop over large areas and over a long period of time. The basis of long-term forecasts of the ice regime on water bodies are assumptions about the uniformity of atmospheric processes during the synoptic season and the regularity of their trends from season to season. The most widespread approach to long-term forecasting is based on finding relationships between the quantitative indicators of atmospheric circulation over the forecasting object or over separate adjacent (large in the area) synoptic areas or zones and the terms (dates) of ice phenomena appearance (more often their deviation from the norm).

Long-term forecasting of ice regime of the Dnipro Cascade reservoirs is very important, first, for the operation of hydroelectric power stations. In addition, such forecasts also ensure the work of other sectors of the economy, namely shipping, fisheries, utilities, etc. Forecasting the terms of break-up ice at the reservoirs is necessary to determine the terms, depth of spring triggering of the reservoirs, and safe transit regime of spring ice run through the Dnipro Cascade. At the same time, there are no methods of the long-term forecasting of break-up ice terms at the Dnipro Cascade reservoirs. Note that the break-up ice at the rivers of Ukraine is largely determined by the air temperature in February (Huseva A.A., 1947). Therefore, the main objective of this research is the determine of the relationship between the mean air temperature for the first decade of February and the break-up ice dates at the Dnipro Cascade reservoirs, as well as to using possibilities assessment of obtained results for the long-term forecasting.

The research the used the break-up ice dates at 38 water gauges which are located at the banks of 6 reservoirs of the Dnipro Cascade, as well as the mean air temperature for the first decade of February. This information was obtained from published reference materials prepared by the Central Geophysical Observatory named after Borys Sreznevsky (Kyiv). The research period at each water gauge was taken depending on the water filling year of each reservoir and to 2020, inclusive. Response evaluation of freeze-up at the Dnipro Cascade reservoirs to changes in the air temperature of February were determined by the calculated correlation coefficients between the break-up ice dates and the mean air temperature for the first decade of February.

The analysis of observation series for the break-up ice dates at the Dnipro Cascade reservoirs showed that the data of 3 water gauges, namely the Kaniv reservoir - Vyshhorod town, Kamianske reservoir - Svitlovodsk town and Dnipro reservoir - Kamianske town have a significant anthropogenic influence. So, the information about these water gauges was excluded from further research. The break-up ice dates at the reservoirs are characterized by considerable variability. Correlations between the break-up ice dates and mean air temperature for the first decade of February are classified as the medium relationships. As a result, the forecasting dependencies have the rather low quality criteria. Hence, to obtain more acceptable results is necessary to expand the search other predictors of atmospheric processes both in space and time.

Keywords: break-up ice, Dnipro reservoirs, correlation, air temperature, long-term forecasting

https://doi.org/10.15407/icys-mhem.2023.014

POSSIBILITIES OF THE LONG_TERM FORECASTING OF THE APPEARANCE DATES OF ICE PHENOMENA AT THE DNIPRO CASCADE RESERVOIRS BY HEAT FLOW COEFFICIENTS

Veronika Rozlach
Ukrainian Hydrometeorological Institute, Kyiv, Ukraine

The development of reliable and accurate long-term ice regime forecasts is one of the most difficult tasks in hydrological practice, which has not yet been satisfactorily solved. Reliable and lead time forecasts of ice phenomena appearance and the freeze-up appearance on reservoirs are essential for the rational use of water resources and for establishing reservoir operation regimes that take into account the requirements and interests of various economic sectors: hydropower, navigation, fisheries, communal services, etc. Currently, the Ukrainian Hydrometeorological Service has no methods for long-term forecasting of ice phenomena on the Dnipro River reservoirs, and those that are officially adopted and used were developed for long-term forecasts of phenomena only on rivers. Therefore, it is extremely relevant to develop methods for long-term forecasting of ice phenomena on the Dnipro reservoirs.

The purpose of research is to find correlation links between quantitative indicators of atmospheric processes, which expressed in terms of heat flux coefficient, and the dates of ice phenomena in the reservoirs of the Dnipro cascade and to analyze the results.

The paper also analyzes current climate change in the study region, since the ice regime is directly dependent on temperature. Changes in air temperature over the past decades have led to a reduction in the total number of days with ice phenomena on rivers, an increase in water temperature in the autumn and winter, a later of ice phenomena appearance, unstable ice cover, and difficulties in determining the appearance of ice regime phases.

Taking into account the change in the climate normal in recent years, the data from 2000 to 2020 were used for the study, since it is from this period intensification of the climate warming process is observed. A representative hydrological gauging station was selected for each of the 6 reservoirs of the Dnipro River and dependencies of ice phenomena on the thermal coefficient, which is defined as the ratio of the number of periods with cold air flows to the number of periods with warm air flows during natural synoptic periods (September 01 - October 10), were obtained. This takes into account the direction of movement of air masses and their intensity.

The results show that the correlation coefficients of the forecast dependencies range from 0.0005 to 0.449, and forecast error tolerance was 40-57%. This result indicates that forecasting dependencies cannot provide reliable forecasts. Therefore, the methodological approach used in the study, which was developed in the second half of the twentieth century under conditions of a more stable air temperature regime, cannot be used in modern climatic conditions. To obtain more reliable prognostic dependencies for long-term forecasting of the ice-appearance date, it is necessary to expand the search for predictors that characterize atmospheric processes both in space and time.

Keywords: Dnipro reservoirs; ice phenomena appearance; methods of long-term forecasting; prognostic dependencies.

https://doi.org/10.15407/icys-mhem.2023.015

USE OF WATER RESOURCES OF THE LEFT TRIBUTARIES OF THE MIDDLE DNIPRO: HYDROPOWER AND MELIORATION

Serhii Sarnavskii
Taras Shevchenko National University of Kyiv, e-mail: serhijpetrovich@gmail.com

The left tributaries of the Middle Dnipro - Psel, Vorskla, Sula, Trubyzh, Supii, Zolotonoshka, Kryva Ruda, Kobelyachok, Kagamlyk, Irkliy, Kovray and Kovalivka belong to the category of medium and small rivers. These rivers are important for the left-bank forest-steppe of Ukraine, where they flow. They are used for irrigation of agricultural land and for hydropower. Global climate change in the region and the introduction of green electricity in Ukraine, these two aspects are currently very important for two reasons. The total flow volume of the rivers of the left bank of the Middle Dnipro subbasin is similar to the flow volume of the Southern Bug, and the catchment area is even larger. The three largest rivers of the region, Psel, Vorskla and Sula, are particularly promising in this aspect.

Today, small hydroelectric power plants only operate on the Psel and Vorskla rivers. All hydroelectric power plants are located in the middle course of the river: on the Psel - within the boundaries of Sumy and Poltava regions, and on Vorskla - within the boundaries of the Poltava region. The left bank of the Middle Dnipro has 15 small hydros operating today, with 10 of them on the Psel and 5 on the Vorskla. River Psel, from the village of Nyzy in the Sumy region to the village Sukhorabivka fish of Poltava region, fully regulated. The following small hydropower plants operate on Psel: Nyizivska, Vorozhblyanska, Mykhailivska, Bobrivska, Knyshivska, Veliko-Sorochynska, Shishatska, Velika Bagachka, Ostapievska and Sukhorabivska. The total annual electricity generated is 4.78 MW. Upon the completion of its planned operation by 2025 as planned in the plan for the development of hydroelectric power plants, the Malobudyshchanska hydroelectric power plant is scheduled to be functional. 5 small hydroelectric power stations operate within the Vorskla riverbed and its left tributary – the Vilshanka – Opishnyanska, Vakulynska mini hydro, Poltava Hydro mini hydro, Nizhnyomlinska and Kuntsivska. The Vorskla river from the village of Kuzemin in southern Sumy Oblast to the village of Kunzevo in Poltava Oblast is regulated by regulating locks and small hydrographic locks. These locks are located in the villages of Kuzemin (Sumy Region) and Derevky (Poltava Region). Both systems are included in the development plans of their regions until 2025, within which 2 small hydroelectric power plants will operate. A total of 1.72 MW of small hydropower is generated within the Vorskla Basin. The power of hydroelectric power stations on both rivers ranges from 0.19 MW to 1.04 MW - Shyshatska small hydroelectric power station.

Global climate changes also affected the Left Bank-Dnipro hydrological region. Over the past 30 years, the average annual air temperature has increased by 1.5-2 ^{0}C and the annual precipitation has decreased by 20-30 mm. The most significant changes are seen in the southern, southwestern, and eastern parts of the left bank of the Middle Dnipro, especially in the small river basins of the Dnipro Lowlands and the lower reaches of the Sula, Psel and Vorskla rivers. Therefore, these regions need irrigation systems functioning within their river basins. The left bank of the middle Dnipro River basin has a total of 26 irrigation systems covering a total area of 65,000 hectares. The largest number of irrigation systems is in the Dnipro Lowland river basin:13 irrigation systems (12,000 ha) on the left bankin Cherkasy Oblast,11 irrigation systems (50,000 ha) in Poltava Oblast, and 2 irrigation systems (up to 3,000 ha) in Kharkov Oblast.

Thus, the left bank of the middle Dnipro river has great potential for hydropower and water quality improvement. The total capacity of small hydropower plants in the Psel and Vorskla river basins is 6.5 MW, which is about 6.37% of the total capacity of small hydropower plants in Ukraine (in 2019: 102 MW for Ukraine). The use of small hydroelectric power stations on Vorskla and Psel is quite promising for Poltava and Sumy regions for local consumption and the growth of the share of green energy in these regions. As for irrigation systems, in general, 32% of the total irrigated area in the Dnipro basin (196,000 ha) is concentrated on the left bank of the middle Dnipro river.

Keywords: Middle Dnipro, hydropower, irrigation systems, Psel, Vorskla.

https://doi.org/10.15407/icys-mhem.2023.016

LONG-TERM SPATIAL FORECASTING OF MAXIMUM MELT-RAINFALL RUNOFF OF RIVERS OF UKRAINIAN POLISSYA

Denys Sivaiev, Zhannetta Shakirzanova
Odessa State Environmental University, Ukraine, sivaevxxx1d@gmail.com

Climate change induces water resource redistribution and increases the risk of flooding in Ukraine. The application of the EU Flood Directive and the adaptation of Ukraine's legislation to EU standards are crucial for effectively managing hydrological risks and ensuring environmental protection concerning water resource utilization. Furthermore, predictive monitoring of water bodies during periods of maximum river discharge is of paramount importance for planning protective measures against territorial inundation and safeguarding critical infrastructure.

The research focuses on the rivers of Ukrainian Polissya, which are characterized by the formation of maximum runoff from snowmelt and rainfall during the winter-spring period.

The purpose of this study is to utilize a mathematical model for spatial long-term forecasting of characteristics related to maximum melt-rainfall runoff in lowland rivers and to apply automated methods for annual hydrological monitoring of the sizes of maximum runoff through prediction and cartographic representation using computer tools.

Analyzing the beginning dates of spring floods over a long period (from the beginning of flow observations on rivers up to 2023), it can be observed that there is a tendency towards earlier development of spring processes in rivers of the Ukrainian Polissya region. Hence, in recent years, the notable features, under the conditions of an unstable winter temperature regime, low snow accumulation, and uneven snow accumulation, have been the occurrence of floods from snowmelt and rainfall in earlier, almost winter periods (in 2019, 2020, 2021, 2022, 2023, etc.).

The basis for long-term forecasting of characteristics related to maximum melt-rainfall runoff in lowland rivers is regional dependencies of modular coefficients of flow layers or maximum water discharge on cumulative water reserves in the snow cover and spring precipitation. These characteristics are expressed relative to their average values over a long period. The preliminary assessment of the water content of maximum melt-rainfall runoff is carried out using the discriminant analysis method by combining hydrometeorological factors. The values of flow layers or maximum water discharge are forecasted based on regional dependencies while determining the average long-term values of flow layers or maximum water discharge (modules).

For the automation of the forecasting process, a computer system named "Pripyat" is proposed, which allows for a preliminary prognostic evaluation of flood hazards. For this purpose, a cartographic representation of characteristics related to maximum melt-rainfall runoff in the form of modular coefficients of flow layers or maximum water discharge is utilized. Alongside the maps of predicted values of modular coefficients, a schematic map depicting the probability of exceeding forecasted values over a multi-year period (in percentages) is provided for any part of the territory, regardless of the degree of its hydrometeorological study.

Conclusions: The proposed methodology can be effectively used to prevent negative consequences associated with the formation of maximum melt-rainfall runoff in the rivers of the Ukrainian Polissya region. The prognostic cartographic monitoring of maximum runoff values has confirmed its potential for successful management of hydrological risks and environmental threats, particularly during extraordinary situations.

Keywords: floods, melt-rainfall runoff, modeling, forecast.

https://doi.org/10.15407/icys-mhem.2023.017

SOME GREEN INFRASTRUCTURE DEVELOPMENT SCENARIOS AND THEIR INFLUENCE ON CERTAIN CONDITIONS OF URBAN FLOW FORMATION. CASE STUDY OF REVUCA CITY, SLOVAKIA

Kostiantyn Sokolchuk
Institute of Hydrology, Slovak Academy of Sciences, Bratislava, Slovak Republic
Faculty of Horticulture and Landscape Engineering, Slovak University of Agriculture, Nitra, Slovak Republic,
kostia.socholchuk@gmail.com

With the development of cities, modeling the flow of water in urban conditions becomes an increasingly necessary task. A preliminary assessment of the prospects of different scenarios of green infrastructure development is the goal of this work. To fulfill the task, the current land cover of the city and its changes under various scenarios were analyzed from a hydrological point of view. Such an assessment is necessary both in the context of the development of specific cities, and as a data preparation for further detailed modelling.

The object of this study is the inner city of Revuca, south-eastern part of the Banská Bystrica Region, Slovakia. The city lies mostly on a flat alluvial cone; the topography includes moderately cutted highlands in the central part, and mountains on its edge. Soils are deeply antropogenically transformed, represented mainly by fluvial cultisems on the floodplains and by various subtypes of cambisoles, with medium and high water permeability. Their hydrological type was predefined as intermediate between C and D.

The type of land cover and its imperviousness are among the key factors that determine the course of water flow formation processes. As an integral, digital indicator was used Curve number number (CN). It is a function of hydrologic soil group (HSG), cover type, treatment, hydrologic condition, antecedent runoff condition and impervious area in the catchment. CN vary from 0 to 100, where a CN equal to 100 means that all the precipitation turned to surface runoff and no infiltration occurred, CN of 0 means that all precipitation infiltrated, so there was no runoff. Curve numbers were determined using official tables, data from other similar cities, maps of land use categories, using photos and satellite images. The percentage of impermeable areas was calculated also separately. For detailed analysis, the city was divided into 447 subcatchments according to how water enters the stormwater network. Averaging across catchments is done using QGIS.

Current conditions and possible changes under three development scenarios were assessed. Sequential scenarios include: replacing the roofs of the largest buildings with green roofs (scenario 1), plus replacing of the paved areas (not the roads) with permeable pavements (scenario 2) and plus the significant improvement of the vegetation condition in areas with bare soil (scenario 3). These scenarios describe changes in approximately 21% of the studied area. Each subsequent stage changes about a third of this number, while bare soil accounts for the largest area. At the same time, the same percentage of the city is occupied by green zones and grass plots, and almost 23 percent are occupied by households.
It was determined that in the inner city of Revuca, the average CN in current conditions is 88.8, more than 38.7% of the territory is impervious. Considered changes allow reducing average CN to 85.8, while the percentage of water impervious surface decreased by almost a third, to 27.8%. The changes are much more significant in central and industrial districts, which can contribute to reducing the load on the drainage network.

The next steps are to refine the data on land cover and the corresponding CN, add other scenarios and model the change in the flood passage scenarios according to each of them.

Keywords: Green infrastructure, land cover, Curve Number method, GIS

https://doi.org/10.15407/icys-mhem.2023.018

METEOROLOGY, CLIMATOLOGY, AGRICULTURAL METEOROLOGY

INNOVATIVE METHODS FOR AIR MICROPOLLUTION RESEARCH

Nikola Djubina[1], Kristiāna Jansone, Olga Sozinova
[1]University of Latvia, Faculty of Geography and Earth Sciences, Riga, Latvia, olga.sozinova@lu.lv

Microscopic biological pollution, such as pollen, can have detrimental effects on human health, serving as a primary cause of respiratory allergies and pollinosis. Furthermore, pollen, as a prominent constituent of biological microscopic pollution, may contribute to the dispersion of industrial pollutants due to the accumulation of chemical elements on its surface. This study aims to evaluate the capacity of pollen to adhere to and transport particulate matter, including potential microplastics.

The study encompasses a comprehensive approach, involving multiple aspects of pollen collection. Firstly, pollen samples were obtained directly from plants. Additionally, pollen was collected from various surfaces, representing different environmental contexts. Furthermore, specialized techniques were employed to capture pollen from airflow. Lastly, controlled laboratory conditions were established to simulate pollution of pollen samples. The collected pollen samples were then subjected to analysis using a scanning electron microscope to examine the composition of the pollen wall, detect different chemical elements, and identify the presence of nanometer-sized particles on the pollen surface. Through this investigation, two distinct types of pollen samples were differentiated: clean and polluted. The analysis of clean pollen samples revealed the presence of chemical elements, including oxygen (O), carbon (C), potassium (K), phosphorus (P), and calcium (Ca), on the surfaces of hazel (Corylus) and alder (Alnus) pollen. It should be noted that the concentration of these elements may vary depending on factors such as plant species and growth conditions. Moreover, hazel pollen (Corylus) exhibited the presence of chemical elements like lead (Pb), zinc (Zn), and tin (Sn), which can be attributed to environmental pollution.

This abstract presents a preliminary overview of the study, with future research planned to expand upon these initial findings. Subsequent investigations will involve the inclusion of additional plant species and rigorous laboratory experiments to further elucidate the variations in pollen wall composition across different plants, while also considering the influence of diverse growth conditions and environmental factors.

Keywords: pollen, pollen surface, microplastics, air pollution, innovation

https://doi.org/10.15407/icys-mhem.2023.020

ANALYSIS OF SOLAR RADIATION CHANGES IN LARGE CITIES OF UKRAINE IN THE SUMMER PERIOD

Vazira Martazinova, Vitalii Shpyg, Yaroslav Kykhtenko
[1]krainian Hydrometeorological Institute, Kyiv, Ukraine, ykihtenko@gmail.com

Solar energy is the cleanest and most common renewable energy source. The solar energy market today is almost 103 gigawatts (GW). According to the International Energy Agency (IEA), about 125 GW of solar energy is produced in the world. In Ukraine, the average annual amount of total energy of solar radiation ranges from 1,070 kWh/m² in the northern part of Ukraine to 1,400 kWh/m² and above in the Autonomous Republic of Crimea. Along with a fairly large number of works devoted to the components of the radiation balance, research is mainly conducted to study their spatio-temporal distribution over the territory, and in Ukraine, the main source of data remains the few weather stations at which relevant observations are made.

This exploration uses data from surface observations and reanalysis data. In particular, the surface observation data were taken from the Borys Sreznevsky Central Geophysical Observatory. Reanalysis data - from the European Center for Medium-Range Weather Forecasts, ECMWF [http://www.ecmwf.int/en/research/climate-reanalysis/era-interim].

For the exploration, 5 large cities of Ukraine were chosen, which highlight different parts of the country - Kyiv, Kharkiv, Lviv, Dnipro and Odesa.

Validation was carried out on surface observation data using data covering the period 2008-2020. An exploration of the temporal distribution of direct, diffuse and total solar radiation was carried out on reanalysis data covering the period 1991-2020.

For each city as a whole, for the summer and for a single month of the season, the values of direct, diffuse and total solar radiation were obtained according to the reanalysis data. The minimum and maximum values that occurred are determined. For each city, a general trend for the summer as a whole and separately for June, July and August was obtained.

It was found that the reanalysis tends to underestimate diffuse and overestimate direct solar radiation. According to the reanalysis data, the changes in diffuse solar radiation are insignificant in terms of values for all cities, in terms of the actual direction of changes - for Kyiv, Kharkiv and Lviv, in Dnipro and Odesa at the end of the studied period there is a tendency for it to decrease. In general, these conclusions are confirmed by the data of surface observations, with the exception of Kyiv (for all summer months), as well as for June in Odesa and Lviv, where an increase in its values is observed at the end of the studied period. The largest fluctuations (both according to surface observations and reanalysis) occur for direct solar radiation and, as a result, appear in the amount of total solar radiation. In general, for the summer period in all five cities, there is a tendency to a slight increase in the amount of total solar radiation.

Keywords: solar radiation, surface observation, reanalysis, summertime, climate change

https://doi.org/10.15407/icys-mhem.2023.021

REGRESSION MODEL FOR POTENTIAL EVAPORATION PREDICTION

Dmytro Oshurok, Vladyslav Sidenko
Ukrainian Hydrometeorological Institute, Kyiv, Ukraine, oshurok@uhmi.org.ua

Potential evaporation is one of the key variables in numerous studies, such as water balance calculations or assessment of hydrological impacts on different crops. This parameter represents the maximum evaporation over a certain area under available atmospheric conditions. Thus, potential evaporation/evapotranspiration depends on a number of meteorological variables: solar radiation, air temperature and humidity, wind speed etc. Among all of the factors, thermal and solar radiation characteristics play the most important role. Some methods based only on these parameters can be found in literature as alternatives to simplify estimation of potential evaporation [1, 2].

The aim of this study is to derive a method for calculation of yearly sum of potential evaporation in complex terrain conditions based on regression relationship at points located at different elevation above sea level. For this reason, ERA5 reanalysis data at fifty grid points in Transcarpathia in the domain from 22.25°E to 24.5°E of longitude and from 48°N to 49°N of latitude were used. Three predictors were applied: mean air temperature of the warmest month of the year, mean temperature in June-August and yearly sum of total solar radiation that reaches a horizontal plane at the Earth's surface. The last one consists of net short-wave radiation and downward long-wave radiation fluxes.

The results of the analysis for the period 1961–2020 show the highest Pearson correlation coefficients for the third predictor in range 0.82–0.93 with mean r = 0.88. The first and the second variables have lower relationship with potential evaporation, mean r values equal to 0.64 and 0.78, respectively. The procedure for approximation of obtained relationships revealed strong dependencies of linear regression coefficients on terrain height for all predictors. This allows applying a regression model to approximate coefficients a and b likewise, however quadratic function fits better in this case. Overall, six experiments were conducted in order to calculate yearly sums of potential evaporation using approximated and non-approximated coefficients of regression. Obtained values have been compared to ERA5 actual evaporation. As a measure for results verification, we selected a sum of errors that are negative deviations from potential evaporation. The most accurate estimates were achieved based on total solar radiation without approximation of regression parameters. Approximation leads to larger errors, nevertheless both methods outperform "original" reanalysis estimates on 41% and 11%, respectively. Thermal parameters seem less acceptable to predict potential evaporation. Comparative analysis shows that the usage of mean temperature of summer season is more reasonable if radiation data is unavailable. It is worth noting that the largest errors detected at points located inside the main ridges and in the northeastern part of the Carpathians.

We conclude that total solar radiation is the most suitable parameter for potential evaporation prediction. Moreover, it provides some improvement in precision compared to ERA5 potential evaporation. Derived regression relationships are particularly important for hydrological impacts estimations in the near future using climate projections data.

Keywords: Transcarpathia, ERA5 reanalysis, predictor, regression coefficients

1. Anwar S.A., Salah Z., Khald W., Zakey A.S. 2022. Projecting the Potential Evapotranspiration of Egypt Using a High-Resolution Regional Climate Model (RegCM4). Environmental Sciences Proceedings, 19, 43. https://doi.org/10.3390/ecas2022-12841
2. Shvidenko A., Buksha I., Krakovska S., Lakyda P. 2017. Vulnerability of Ukrainian Forests to Climate Change. Sustainability, 9, 1152. https://doi.org/10.3390/su9071152

https://doi.org/10.15407/icys-mhem.2023.022

MODELING AEROSOL EFFECTS ON THE ATMOSPHERE DURING THE APRIL 2020 WILDFIRE EPISODE

Mykhailo Savenets
Ukrainian Hydrometeorological Institute, Kyiv, Ukraine, savenets@uhmi.org.ua

Wildfires are among the biggest sources of aerosol emissions, in particular black and organic carbon. These aerosols modify meteorological processes through direct and indirect aerosol effects. Despite our knowledge of the main aerosol-meteorology interactions, their role in the atmosphere often remains uncertain depending on weather conditions. This study presents the analysis of the main aerosol effects observed during the severe wildfire event that occurred in the Chornobyl Exclusion Zone (CEZ) in the north of Ukraine in April 2020.

The study is based on seamless modeling using the Environment-High Resolution Limited Area Model (Enviro-HIRLAM). Simulations were performed at 15 km horizontal resolution with downscaling to 5 and 2 km resolution. The model covered 40 vertical levels with a 3-hour data output. Based on the emissions derived from the IS4FIRES and IASA ECLIPSE, it was simulated the three-dimential distribution, transportation, and deposition of black carbon (BC) and organic carbon (OC), including other main aerosol types (dust, sea salt, and sulfates) for considering real aerosol content. Aerosol components were divided into groups by their size (Aitken, accumulation, and coarse modes) and solubility (soluble or insoluble). Enviro-HIRLAM simulations included runs with aerosol effects (direct (DAE), indirect (IDAE), and both (DAE+IDAE) aerosol effects included) and a reference (REF) run without aerosol effects.

Elevated BC and OC content significantly modified meteorological conditions, mainly because of DAE. During the period of clear-sky conditions, aerosols caused local 2-m air temperature decrease up to -3^{o}C. At the same time, cloudy conditions caused the opposite effect, and the 2-m air temperature increased up to 5^{o}C, especially on the edge of the stationary front, which was observed on April 14, 2020. Emitted aerosols affected the moisture regime and resulted in drier conditions with a lower amount of precipitation. These effects were prevailing despite elevated BC and OC content, which influenced cloud formation in different ways depending on weather conditions. The changes were also observed for wind. However, the suggestion is that the observed wind changes because of DAE and IDAE might happen due to the spatial shifts in wind patterns as a result of the overall impact, not because of a direct influence on air pressure at the local scale.

The presented results were obtained within individual grant INFRAIA-2016-1-730897 “High Performance Computing Europa-3 (HPC-Europa3) Transnational Access programme” while conducting the project “Integrated modeling for assessment of potential pollution regional atmospheric transport as result of accidental wildfires” (2020–2022).

Keywords: Enviro-HIRLAM, seamless modeling, direct and indirect aerosol effects

https://doi.org/10.15407/icys-mhem.2023.023

ROOFTOP RAINWATER HARVESTING EFFICIENCY MODELING BASED ON PRECIPITATION CLIMATOLOGY OF THE SOUTHERN REGION OF UKRAINE

Oleksandr Shchehlov
Ukrainian Hydrometeorological Institute, Kyiv, Ukraine, alexsh@uhmi.org.ua

The southern part of Ukraine is one of the most vulnerable regions of the country to climate change due to the increasing precipitation deficit. The region is highly dependent on a system of canals fed with water from the Kakhovka reservoir. The Kakhovka Dam destruction on June 6, 2023 and the consequent disappearance of the reservoir led to water supply problems to many settlements and agricultural lands. Rainwater harvesting in a precipitation-deficient region is an important measure for climate change adaptation. One of the solutions to mitigate the consequences of technical water deficit at the individual household level is an installation of rooftop rainwater harvesting systems (RRWHS). To evaluate the feasibility of using such systems and estimate the amount of water potentially collected, simulations are performed based on both climatological and climate projections data. Various indicators can be used to evaluate the RRWHS efficiency, e.g. volume of water that can be collected (precipitation inflow PI index) or the amount of time with a shortage of water in the water storage (demand exceeds supply, DES index) for a given roof area, the roof and the water storage geometry and average water consumption. The essence of the DES index is the time in days when water demand exceeds the actual water supply to the RRWHS water storage. The DES calculation involves solving the water balance equation as described in [1]. The water level change component of the equation takes into account runoff coefficient (depends on the roof geometry), the roof area, actual precipitation during a day, water outflow (daily water demand), daily evaporation rate and an area of the water storage [1]. When solving the water balance equation, the condition of not exceeding the actual water storage volume must be met. The E-OBSv27.0e dataset [2] was used as input data on precipitation over the period 1991-2020. The results of DES and PI simulations were obtained for the roof area of 50, 75, 100 m^2 under the condition of the runoff coefficient equal to 0.75. The results were obtained for a fixed daily water demand of 0.3 m^3 and the water storage volume of 2.0 m^3. For climatological assessment, the daily DES data in the southern region of Ukraine were averaged over months, seasons and the whole climatological period. Since the efficiency of RRWHS depends on the roof area, for practical purposes PI index per 1 m^2 of the collection area was calculated as well. The simulation code has been adapted to use both GFS and WRF forecast data as an input. Thus, it can be used for operational forecasting of the water level in the water storage of preset parameters in different sites of the Southern region of Ukraine.

Keywords: precipitation, adaptation to climate change, rooftop rainwater harvesting, modeling

1. Liaw, C.H., Tsai, Y.L. Optimum storage volume of rooftop rain water harvesting systemsfor domestic use. Journal of the American Water Resources Association. 2004. 40. 901-912. https://doi.org/10.1111/j.1752-1688.2004.tb01054.x
2. Cornes, R., van der Schrier, G., van den Besselaar, E.J.M., Jones, P. An Ensemble Version of the E-OBS Temperature and Precipitation Datasets. J. Geophys. Res. Atmos. 2018.Vol. 123 (17). 9391-9409. https://doi.org/10.1029/2017JD028200

https://doi.org/10.15407/icys-mhem.2023.024

FUTURE TEMPERATURE AND PRECIPITATION CLIMATE INDICES CHANGES OVER THE TRANSCARPATHIA REGION ON EURO-CORDEX MULTIMODEL ENSEMBLE

Vladyslav Sidenko, Dmytro Oshurok
Ukrainian Hydrometeorological Institute, Kyiv, Ukraine, vladyslavsidenko@gmail.com

This study aims to assess potential climate changes in the Transcarpathia Region in the period 2021-2050 relative to the 1991-2020 base period based on the calculation of temperature and precipitation climate indices: annual average air temperature, number of frost days (FD), number of summer days (SU), number of tropical days (TD), amount of winter precipitation, amount of summer precipitation, annual count of days with more than 20 mm precipitation (R20mm) and maximum amount of precipitation for two consecutive days (AMP2). The domain under study includes the Transcarpathia Region of Ukraine and its neighbouring territories and has extremely complicated topography, with an altitude range between 101 m and 2061 m ASL. Such complexity significantly influences an interpolation/downscaling procedure applied to climatological variables (e.g., air temperature, atmospheric precipitation, etc.). In this study, daily data collected at 11 meteorological stations located in the domain was used. Data of four essential climate variables, namely minimum air temperature (tn), mean air temperature (tm), maximum air temperature (tx), and atmospheric precipitation (rr), were used in the calculations. The period covered by the data time series is 1961-2020. Data of climate model simulations (historical and future projections) were obtained from the Coordinated Regional Climate Downscaling Experiment project for the European domain (Euro-CORDEX). In our calculations, the Euro-CORDEX daily data of tn, tm, tx, and rr (converted previously from precipitation flux) was used. We only selected Euro-CORDEX simulations which (1) were performed based on RPC4.5, (2) provide output data in the Gregorian (or similar) calendar, and (3) provide output for all four variables. Thus, a multimodel ensemble of climate simulations utilised in our calculations consists of eleven members (combinations of 5 GCMs and 8 RCMs). Quality control of the station time series was performed by means of the INQC software (https://CRAN.R-project.org/package=INQC). Homogenization was performed using the Climatol package (https://CRAN.R-project.org/package=climatol) (Guijarro, 2018). We used the MISH software (Szentimrey and Bihari, 2014) to perform gridding/downscaling of the station data on the grid with the spatial resolution of 0.05° in both horizontal directions (~5 km). Bias-correction of the climate model data was performed by means of linear/variance scaling (for the air temperature data) and quantile matching (for the atmospheric precipitation data) methods. After bias correction of the climate projection data, they were statistically downscaled by means of the MISH software to the 0.05° grid, the same as for the observation data. The downscaling was performed for the period of 2006-2050 for each climate variable and each climate model (GCM-RCM combination). Spatial fields of air temperature (minimum, average and maximum) and amounts of precipitation for each day of the historical period (1961-2020) and the period of climate projections (2006-2050) were obtained. Based on the MISH downscaled climate model data, 8 climate indices were calculated for each year of the projection period (2021-2050) and each grid point of the interpolation grid (with the 0.05° spatial resolution). Finally, differences (anomalies) in the climate indices averaged over 1991-2020 and 2021-2050, i.e. calculated base observations and projections, respectively, were computed. Our calculations showed a moderate increase in air temperature (and other related indices, such as SU and TD) in 2021-2050 compared to 1991-2020. The increase is more intensive on valleys of the domain, while mountain tops and ridges will experience less intensive changes. Atmospheric precipitation will not change significantly.

Keywords: daily air temperature, daily atmospheric precipitation, climate indices changes, EURO-CORDEX, Transcarpathia Region

https://doi.org/10.15407/icys-mhem.2023.025

INTERANNUAL VARIABILITY OF TOTAL AND LOW CLOUDINESS OVER LARGE CITIES OF UKRAINE: AN INTERCOMPARISON OF OBSERVATIONS AND REANALYSIS

Anna Tsila, Vitalii Shpyg
Ukrainian Hydrometeorological Institute, Kyiv, Ukraine, tsila.anna@gmail.com

Cloud cover is one of the important climate indicators. The characteristics of the cloud cover regime can be used to determine the peculiarities of atmospheric circulation, the planetary albedo of the climate system, the effective radiation of the underlying surface and the possible distribution of precipitation, so quantifying changes in cloud cover in modern conditions is relevant. Changes in circulation indices should affect changes in both the quantitative indicators of cloud cover and the repeatability of the main cloud types.

An analysis of climatic studies of cloud cover and its actual changes over the territory of Ukraine, which were carried out by Ukrainian scientists, showed that they are based only on ground-based observations. The features of the spatial distribution of individual characteristics were obtained using long-term observations of the same length at all weather stations of the Ukrainian hydrometeorological network. Ukrainian studies of cloud cover fluctuations due to climate change are based on ground observations. Moreover, the length of the rows depends on the goal of the study and the time of its completion.

This paper is devoted to the analysis of total and low cloudiness for each month between different decades in relation to the climate norm (1981-2010).

The input data for this study was total cloud cover and low cloud cover from ERA5 [https://cds.climate.copernicus.eu/cdsapp#!/dataset/reanalysis-era5-single-levels-monthly-means?tab=overview] for each month of the year for the period 1981-2020 years. The horizontal grid resolution was 0.25 degrees. The data of total and low cloud cover measured in points (from 0 to 10) were also used, which were obtained from the archive of Ukrainian hydrometeorological observation network, which is situated in the Borys Sreznevsky Central Geophysical Observatory. The average monthly data from 15 meteorological stations for the period from 1981 to 2020 were collected: Kyiv, Kharkiv, Odesa, Dnipro, Zaporizhzhia, Kryvyi Rih, Lviv, as well as Kropyvnytskyi, Lutsk, Mykolaiv, Sumy, Uzhhorod, Kherson, Chernivtsi, and Chernihiv.

An analysis of cloud cover changes over the past four decades (1981-1990, 1991-2000, 2001-2010, 2011-2020) compared to the climate norm of 1981-2010 showed that they were oscillating over the territory of Ukraine. In some decades both a decrease and an increase of total and low cloudiness were observed in different parts of the country. However, for certain months, there are tendencies toward a decrease in cloud cover over time. These tendencies are most typical for spring and summer. Partially similar changes can be noted for the autumn-winter period. The decrease of low cloud cover prevails over the total cloud cover.

Keywords: climate change, total cloudiness, low cloudiness, reanalysis, observation

https://doi.org/10.15407/icys-mhem.2023.026

VALIDATION OF PRECIPITATION DATA OF GPM SATELLITE PRODUCTS OVER UKRAINE

Olena Zabolotna, Oleksandr Kryvoshein, Oleksiy Kryvobok
Ukrainian Hydrometeorological Institute, Kyiv, Ukraine, zabolotnaolena@ukr.net

This study provides a description and results of the validation methodology of GPM satellite precipitation data for the territory of Ukraine. Validation was carried out by comparing satellite data with ground weather stations data and included the following stages: data collection and processing, bringing the data to the same spatial and temporal resolution, calculating correlation coefficients and estimation of confusion matrices.

Correlation analysis was carried out for two studied periods (the first period - April-September 2020, the second - April-September 2021). Satellite data were provided by the GPM project of NASA and ground data were provided by 155 meteorological stations of the Ukrainian National Hydrometeorological Network.

Satellite and ground data were calculated to have the comparable values, that is 12 hours precipitation sums, from 6:00 a.m. to 6:00 p.m. For this, weather stations data were obtained as the sum of the amount of precipitation for this period of the day, and the satellite data that were downloaded for every half an hour as intensity mm/h, were converted into mm/day, thus obtaining the precipitation amount for the specified period of the day.

For obtaining reliable results of validation, correlation coefficients were calculated and confusion matrices were built. Confusion matrices are based on the division of precipitation into classes of different intensity. Confusion matrices were calculated for four classes of precipitation (mm): “0-2”, “2-5”, “5-10”, “>10”. Calculations were performed using the software environment for statistical calculations R.

The comparison analysis showed that a larger number of stations (117) has a correlation coefficient 0.5 - 0.8. The coefficients of the confusion matrices showed that low-intensity precipitation or “no precipitation”, as well as high-intensity precipitation, are estimated by the satellite with high accuracy in comparison with the ground-based weather station measurements. So, according to the "specificity" indicator, the highest level of correspondence of satellite data (GPM Late, GPM Early) to ground data has precipitation class >”10 mm”. The low value of the "specificity" for the range of 0-2 mm is explained by the fact that satellite methods are able to detect very low values of precipitation intensity, while the station shows their absence - 0 mm. Thus, according to the values of the confusion matrices, we see that a large part of the values of surface observations of precipitation in the range of 0-2 mm are shown by the satellite method as “2-5 mm” class. We can also see that the “2-5 mm” class by satellite has the most confusion with the 0-2 mm class by station (GPM Late, GPM Early). However, based on the high values of the "recall" for the range of 0-2 mm (GPM Late, GPM Early), we can conclude that when the station does not show this amount of precipitation (0-2 mm), then the satellite also shows another class of values. The high values of the coefficient of "precision" show that the satellite measurements are really reliable, that is, the presence or absence of precipitation will be determined precisely, since the highest value of "precision" is typical for low and high amounts of precipitation (on average 0.76 and 0.66, respectively). Heavy precipitation or no precipitation detected by satellites is confirmed by ground stations in most cases.

Keywords: precipitation, satellite data, ground data, comparison

https://doi.org/10.15407/icys-mhem.2023.027

ENVIRONMENTAL MONITORING

ASSESSMENT OF ANTHROPOGENIC PRESSURE BY NUTRIENTS AND ORGANIC SUBSTANCES IN THE SULA RIVER BASIN

Andrii Bonchkovskyi
Ukrainian Hydrometeorological Institute, Kyiv, Ukraine, andriybonch19@gmail.com

The paper focuses on a man caused pressure in the Sula River with organic substances and nutrients which are the main factors affecting the water status. The Sula River is a left tributary of the Dnipro River flows into the Sulynska Bay of the Kremenchuk Reservoir. The water resources of the Sula River are used for drinking water supply, melioration, fish farming, etc. The Sulynska Bay is a spawning area for fish and the place of their largest commercial concentration. For a long time, the bay has been experiencing frequent cases of a critical decrease in dissolved O_2, resulting in fish kills.

Materials and methods of the study. The Electronic Services Portal of the State Agency of Water Resources of Ukraine (e-services.davr.gov.ua) as of 2021 was used to assess the contribution of studied compounds from point sources. The population was calculated based on the Atlas of the Administrative and Territorial Arrangement of Ukraine (2021). The pressure of nutrients and organic substances is calculated based on the person's excretion coefficients, their removal by treatment facilities (Behrendt, Huber, Kornmilch et al., 2000; Osadcha, Luzovitska, Ukhan et al., 2022).

Results and discussion. The total pressure from point sources is the sum of the urban population's contributions and industrial enterprises. Pollution with organic substances and nutrients from point sources is mainly associated with the wastewater discharge from settlements. There are 1141 settlements in the Sula basin, including 7 ones with a population ≥ 10 ths. people (36%), and 17 settlements with 2-10 ths. people (12%). The pressure of organic substances from the population connected to sewer systems was 512.9 $t \cdot year^{-1}$ for biochemical oxygen demand (BOD_5) and 726.7 $t \cdot year^{-1}$ for chemical oxygen demand (COD). In terms of nutrients, the flow to surface waters was 162.3 $t \cdot year^{-1}$ for N and 56.1 $t \cdot year^{-1}$ for P. The largest organic pollution is caused by wastewater from the Ichnia municipal facility, while the nutrient pressure was caused by the corresponding enterprise in Pryluky. Annually, 111.2 $t \cdot year^{-1}$ of organic substances in terms of BOD_5 and 133.1 $t \cdot year^{-1}$ in terms of COD is discharged into the Sula River basin with industrial wastewater. The pressure of nutrients supplied by industrial wastewater was 18.4 $t \cdot year^{-1}$ of Total nitrogen (TN) and 1.8 $t \cdot year^{-1}$ of Total Phosphorus (TP). The largest polluter in the Sula basin is Linovytskyi Sugar Plant "Krasnyi", whose wastewater discharged ~ 67% of nutrients and up to 96% of organic substances from the total amount.

Diffuse sources are dominated by pollution from the population without access to sewerage networks. To a greater extent, this applies to small settlements of ≤ 2000 people. This pressure is 2304 $t \cdot year^{-1}$ for BOD_5 and 3917 $t \cdot year^{-1}$ for COD. Additionally, 224.3 tons of nitrogen and 31.5 tons of phosphorus are discharged annually into the Sula basin. The role of other diffuse sources, such as agriculture, land use patterns, etc., has a much smaller impact on the formation of surface water quality in the Sula River basin.

Conclusions. The ecological status of surface waters in the Sula River basin depends on the quantitative parameters of anthropogenic pressure, which, according to BOD_5, is 2928 $t \cdot year^{-1}$, COD – 4777 $t \cdot year^{-1}$. For nitrogen and phosphorus compounds, the obtained indicators in the context of the year reach 405 $t \cdot year^{-1}$ and 89 $t \cdot year^{-1}$. The peculiarity of the Sula River basin is that the dominant share of organic substances and nitrogen comes from diffuse sources. The relative contribution of distributed sources for BOD_5, COD, and TN is 79%, 82%, and 55%, respectively. At the same time, for TP, the main pressure is formed by point sources. A similar pattern is characteristic of other river basins in Ukraine and around the world and is related to the peculiarities of the P geochemical cycle. The contribution of diffuse sources is due to the total natural background and the population without access to sewerage networks. Among the point sources, 82 - 89% of the pressure is associated with wastewater discharge from municipal enterprises. The results obtained should serve as a basis for developing measures to overcome the impact of anthropogenic pressure.

Keywords: the Sula River basin; nutrients; organic substances; anthropogenic pressure.

https://doi.org/10.15407/icys-mhem.2023.029

PERSPECTIVE FOR THE APPLICATION OF RENEWABLE ENERGY SOURCES AT ROCK DUMPS

Zariana Halchenko, Olga Medvedieva
M.S. Poliakov Institute of Geotechnical Mechanics of the National Academy of Scienses of Ukraine, Dnipro, Ukraine,
zhalchenko85@gmail.com

Introduction. The use of renewable energy sources (RES) on open pit rock dumps has the potential to become an important solution for ensuring sustainable development and reducing the negative impact on the environment within mining regions.

Methods. Solar and wind energy are among the main RES that can be applied to open pit rock dumps.

Solar energy. Open dumps can be an excellent location for solar panels. They can use open space to collect solar energy and generate electricity. With the development of solar cell and solar panel technologies, it becomes possible to increase the efficiency of generating electricity from solar energy sources, making this alternative more and more attractive.

Wind energy. Landfills can be an ideal place to install wind energy installations, which will allow wind energy to be used to generate electricity. Wind energy installations should be effectively placed on the top of the dumps. Our Institute is considering the possibility of installing wind energy installations with a vertical axis of rotation, which work efficiently at low wind speeds and produce electricity already at a wind speed of 3-5 m/s. Also, similar wind energy installations are more ecological, they do not create a noise load and are easier to maintain.

The results. The use of renewable energy sources on open rock dumps has a number of promising aspects:

1. Energy efficiency is the main advantage of using RES. Excavation rock dumps often have significant dimensions and a high concentration of natural resources. The use of renewable energy sources such as solar and wind energy can provide constant and stable energy capacity for certain processes in mining enterprises.

2. Environmental efficiency. Traditional sources of energy, such as coal or gas, cause significant emissions of pollutants. The use of RES will help to reduce the impact on the environment significantly and to improve the ecological situation in the areas of mining regions.

3. Economic benefits. The use of RES can help reduce the costs of enterprises on traditional energy sources, thereby ensuring economic sustainability.

4. Innovation and development. The introduction of RES can stimulate innovation and the development of new technologies, which ensures the creation of new jobs and supports the economy of the region.

Conclusions. The implementation of RES on open rock dumps may require large investments, technical equipment and research. However, this is a profitable solution for providing additional sources of energy, balancing the environmental impact of mining regions, and in the long run, economic benefits. All this will lead to sustainable development of mining regions.

Keywords: mining region, renewable energy sources, energy efficiency, ecological efficiency, environment.

https://doi.org/10.15407/icys-mhem.2023.030

HYDROGEOLOGICAL AND METEOROLOGICAL ASPECTS OF THE GEODYNAMIC STATE OF THE SEISMOGENERATING REGION

Vasyl Ignatyshyn[1,2], Monika Ignatyshyn[1], Adalbert Ignatyshyn[1], Bohdan Kuplovsky[1], Vasyl Prokopyshyn[1], Oleschuk Olena[1], Tibor Izhak[2]

[1] Institute of Geophysics by S.I. Subbotin Department of Seismicity of Carpathian Region, Lviv, Ukraine, rgstrs1962@i.ua

[2] Ferenc Rakoczi II Transcarpathian Hungarian College Higher Education, Department of Geography and Tourism Beregszász, Transcarpathia, Ukraine

Transcarpathia is the territory of Ukraine, where local earthquakes of various magnitudes and energy classes occur, which are characterized by a certain periodicity in their manifestations. The most dangerous in terms of deterioration of the ecological condition of the region are perceptible local earthquakes, which occur on the territory of the Transcarpathian internal depression with a frequency of one to six events per year. A feature of felt earthquakes is their higher energy and, accordingly, magnitude, such earthquakes are also felt by the population of the region. Perceptible earthquakes are indicators of seismic activity in the region. The seismic background on the territory of Transcarpathia is represented by dozens of weak underground shocks in terms of energy, which are registered by seismic stations of the region. Seismic monitoring on the territory of the Transcarpathian internal depression is carried out by seismic stations and regime geophysical stations of the Carpathian research-methodical geophysical and seismological party of the Seismicity Department of the Carpathian region of the Institute of Geophysics by S.I. Subbotin of the National Academy of Sciences of Ukraine. Seismic digital DAS seismometers, instruments for observing meteorological parameters are mounted at all observation points: meteorological stations; devices for observing geophysical fields. Deformometric observations in the region, which have been carried out on the territory of the Transcarpathian internal depression since the 1980s, are important. The beginning of deformation observations was laid by the installation of two deformation graphs in the tunnel near the village. Muzhieve, Berehiv district, Transcarpathia region, with bases of 11.5 m and 20 m. According to the results of deformographic observations, compression in the near-latitudinal direction and expansion in the near-meridional direction were noted at this point. To confirm the obtained results, in 1989, a strain measuring station was installed at the regime geophysical station "Berehove" in the city of Berehove, Transcarpathia region, which consisted of two mutually perpendicular strain gauges with bases of 6.m and 24.5 m. In the zone of the Oash deep fault in 1999, a a quartz horizontal deformograph with a base of 24.5 m, which revealed the expansion of rocks in the near-latitudinal direction with values typical for modern horizontal movements in the Carpatho-Balkan region. Based on the results of geophysical observations in the region, it was noted that earthquakes occur in the interval of dynamic movements of the crust, registered at the point of deformographic observations. These seismotectonic processes occur and are accompanied by abnormal changes in the parameters of the meteorological state of the region, in particular air temperature and atmospheric pressure. Hydrogeological parameters have a significant influence on seismotectonic processes: atmospheric precipitation, water levels in the rivers of the region. Intense precipitation causes intense movements of the crust, the values of which were equal to the monthly values of rock displacements and which after some time were accompanied by the manifestation of local seismicity in the period 2006-2015.

Keywords: hydrogeological parameters, meteorological conditions, earthquakes, modern horizontal movements of the crust, air temperature, atmospheric precipitation, strain graph

https://doi.org/10.15407/icys-mhem.2023.031

SOME ASPECTS OF THE WATER SALINITY DYNAMICS IN THE FLOODPLAIN ECOSYSTEMS

Natalia Ivanova
Institute of Hydrobiology of National Academy of Sciences of Ukraine, Kyiv, Ukraine, natiwinao@gmail.com

Global climate change, often low water content of rivers, as well as changes in the hydrological regime of water bodies as a result of various anthropogenic activities are displayed in the change in the hydrochemical regime of water bodies, namely in the increase in the total dissolved solids and salinity of water. The processes of salinization of freshwater water bodies, their reasons and possible consequences for the environment and humans have being actively researched in recent years.
Fluctuations in the water surface level and temporary drying of water bodies can be one of the factors affecting the change in salinity of water in a water body. Significant level fluctuations are characteristic of floodplain ecosystems, for example, for the Stentsivsko-Zhebriyansky Plavni (floodplains) (SZhP), which are the object of research in this work.

The purpose of the work is to conduct monitoring studies and analyze the dynamics of water salinity in the floodplain ecosystem of the SZHP. The methods used are expedition research, measurement of salinity and the total dissolved solids using the AZ-8603 multifunctional conductometer, as well as analysis of previous research.

Stentsivsko-Zhebriyansky Plavni are especially valuable wetlands of the lower Danube River in terms of biodiversity. Their modern total area is about 78.11 km^2, of which 72,34 km^2 have been part of the Danube Biosphere Reserve (Ukraine) since 1998. This is a complex of water bodies, watercourses and wetlands, formed approximately 2 000 years ago. These wetlands are floodplains of the lower Danube River, as well as its tributaries - the small steppe rivers Murza, Laptysh, Chatal, Dunaets. Among the reservoirs of the SZhP, it is worth noting the Velykiy and Maly Soloni, Pozhezhny, Grabovsky and Zhebriyansky estuaries.

Since 1978, due to the construction of the Danube-Sasyk canal, the SZhP was divided into two parts - Stentsivsky (43 km^2) and Zhebriyansky(28 km^2). Today, the only combination of parts is a siphon-type duiker with a cross section of 8 m^2 under the channel, which is often clogged with reed rhizomes, plant residues, garbage and does not perform its functions.
Today, the flow from the floodplains into the sea is regulated, and the inflow of seawater into the wetlands is almost impossible. But at the same time, the total dissolved solids and salinity of water in different parts of the floodplains are higher than the indicators of fresh water – in the winter of 2023, the water salinity ranged from 2.93 g/dm^3 near the duiker on the side of the Zhebriyansky plavni to 6.02 g/dm^3 near lock № 5 (near the Primorske-Vylkove freeway). In the winter and spring of 2023, the complete drying of reservoirs was observed in some areas. In May 2023, the flow of Danube water into the flood plain was restored. As a result, the water level rose by an average of 0.3 m. At the same time, the salinity of the water near the duiker decreased to 0.81-0.83 g/dm^3 (June 2023), and near lock № 5 to 2.12-2.15 g/dm^3.

At the same time, in different parts of the Zhebriyansky estuary, the indicator fluctuated within the range of 0.82-1.69 g/dm^3, while in the bottom layer the indicator increased by 10-110 mg/dm^3. In the part of Zhebriyansky floodplains separated by an earth dam, which dried up in winter, the water salinity was 5.77 g/dm^3, and in the coastal zone of the Velykiy Soloni Estuary, which was also waterless as early as April 2023, it was 9.99-17.8 g/dm^3. Such significant water salinity affects both the hydroecosystem and coastal vegetation, and should be taken into account when choosing to maximize certain ecosystem services during the economic use of these water bodies.

Keywords: Stentsivsko-Zhebriyansky Plavni, floodplain, the lower Danube River, water salinity

https://doi.org/10.15407/icys-mhem.2023.032

THE SIGNIFICANCE OF THE ECONOMY OF NATURAL USE IN THE CONDITIONS OF THE INTERACTION OF PRODUCTION AND THE NATURAL ENVIRONMENT

Zoya Kalinichenko, Roman Zhuchkov
Zaporizhia National University, Zaporizhia, Ukraine kalina.donntu @gmail.com

The field of nature management is an important component of the national economic complex. The state controls the use of natural resources and the preservation of the environment. Existing environmental problems related to the use of resources are secondary to the priorities of state economic policy. The most disincentive influence on the dynamics of natural resource attraction and environmental protection is exerted by the institutional irregularity of resource use monitoring processes. This is related to the lack of an effective system of natural resource inventories, the inequality of different forms of ownership of natural resources, and the dualistic nature of the system of management and regulation of natural resources. It should also be pointed out the asymmetry of the system of fiscal regulation and inter-budgetary relations regarding the distribution of resource payments and environmental fees.

The influence of environmental factors on the economy is obvious: the economy as a sphere of material production directly depends on the resource base, territorial features and natural raw materials. The quality and quantity of resources and raw materials determine the possibilities and limits of economic growth.

Global and local ecological systems are characterized by appropriate resistance to external and internal influences. Possible manifestations of survival under adverse conditions, cyclical and rhythmic processes, balance of natural processes. But these manifestations have certain limits.

Certain types of activities can quickly cause changes in the state of natural components and affect the effectiveness of activities. Thus, industrial pollution of the atmosphere in a number of cases leads to crop losses of agricultural products. Discharges of pollutants into water sources reduce fish productivity, etc. Such consequences have the character of external effects in relation to activities that are a source of negative changes in the state of the environment. External effects are not taken into account first, but they significantly affect economic results.

Quite often, external costs are difficult to estimate. As a rule, they are costs for society, and in some cases for future generations. Environmental problems cause situations when the economic value of ecological resources is not reflected in the price. This is the main thing for the economy of nature use.

The state should play a significant role in the regulation of nature management processes. One of the possibilities of ensuring the resource potential of further development was proposed as a model of the interaction of five main factors: population, natural resources, food, capital, environment. The method of economic-mathematical modeling was used, which was called "intersectoral balance" and took into account the requirements of environmental protection. The results of economic activity - generation of production waste and costs associated with their disposal - were introduced to the existing "costs - output" model.

Keywords: nature management, monitoring, resources, ecology, economic result

https://doi.org/10.15407/icys-mhem.2023.033

DRAINING OF THE KAHOVKA WATER RESERVOIR CAUSED BY THE RUSSIAN BLOWING OF THE HYDROELECTRIC PLANT DAM

Andrii Oreshchenko
Ukrainian Hydrometeorological Institute, Kyiv, Ukraine, andrey_o@uhmi.org.ua

Abstract. On June 6, 2023, the Russian military blew up the Kakhovska HPP dam. During the day, large areas of the Kherson region and the nearest cities (Kherson and Oleshki) were flooded. In addition to flooding, this case led to the gradual draining of the Kakhovske reservoir, pollution of the Black Sea, restoration of the Dnipro riverbed, and the formation of a complex hydrological structure of medium and large reservoirs and watercourses.

Methods. Multispectral satellite images were provided by the European Space Agency (Sentinel-2A). They used to separate areas flooded with water with a high degree of accuracy. Lower quality images from NASA's Terra, Aqua and NOAA-20 satellites were also used.

Results. The surface area of the Kakhovske reservoir was 2,061 km^2 before the destruction of the dam. 3 days after the breakthrough, approximately a quarter of the reservoir area (553 km^2, 27.3%) was drained, mainly in the northeast. This is explained by shallower depths and the outflow of water downstream. The water intakes of large cities (Nikopol, Zaporizhzhia, Energodar), which are located within relatively shallow parts, have dried up. The water receded relatively evenly, the most on the left bank.

On June 13th there were formed the separate reservoirs with an area of 200-400 km^2 at the reservoir. The old bed of the Dnipro began to be restored. Water moved for 300 m from the city of Nikopol to the old channel. 15.06 observations were impossible due to cloud cover.

On 18.06 the riverbed of the Dnipro River was restored. They began to form secondary watercourses that connected the Dnipro with the reservoirs from which the remaining water left. The reservoir stopped providing its economic and ecosystem services — water could not be obtained for drinking water supply, electricity generation, and irrigation. The water intake of the North Crimean Canal was exposed. This date can be considered the day of the termination of the Kakhovske reservoir. Its remaining area was 655 km^2.

As of June 20, the area of reservoirs was 509.3 km^2, decreasing by 24%. The old channel of the Dnipro River is clearly distinguished. Numerous channels of small and medium watercourses were formed. The water level decreased by 10 m. On 21.06, the reservoir area decreased to 460.39 km^2, after another 3 days it decreased by 165.25 km^2 to 295.14 km^2 (14.3%), i.e. by 50 km^2 every day. The channel area was 123.73 km^2, i.e. 6% of the reservoir area. June 25 area was 289.24 km^2.

On June 28, precipitation led to an increase in the area to 318.27 km^2 (15.44%).

Conclusion. We witnessed perhaps the world's only unplanned draining of a large reservoir caused by a terrorist attack. The consequences are there: the drainage of the water intake of the North Crimean Canal will lead to the loss of productivity of part of agricultural land. Most of the remaining water basins will dry up, except of the lakes formed as a result of draining Kakhovske reservoir. Water from them is drained by a system of small watercourses that will follow each other until vegetation appears. After they dry up, the area of the reservoir will decrease by about 6% compared to the initial area.

It is not yet known what scenario will be chosen to restore the Kakhovske reservoir. One of the initiatives involves the transfer of plots to agricultural production. Their area on the right bank is 72,701.1 hectares, and on the left — 116,192.3 hectares, respectively — the latter are not yet available for use due to invasion.

Keywords: Kakhovske reservoir, dam, drainage.

https://doi.org/10.15407/icys-mhem.2023.034

GROUNDWATER MONITORING FOR DRINKING WATER SUPPLY IN TERNOPIL CITY

Tetyana Pokshevnytska
National Transport University, Kyiv, Ukraine

The problem of contamination of underground sources of water supply in Ukraine is currently serious and requires immediate resolution. It is necessary to conduct systematic monitoring of water quality, develop and implement strategies to reduce emissions of hazardous substances and ensure proper storage of toxic waste. It is also important to increase public awareness of the need to protect the environment and use environmentally friendly technologies.

In order to study the complex system of "groundwater quality - environmental impact - population health" and identify relationships between its various components, systematic monitoring of groundwater pollution in Ukraine is necessary. This monitoring may include various research methods, such as geochemical, hydrochemical, hydrogeological, and others, which will contribute to the study of the complex system of groundwater pollution in Ukraine and identify priority areas for their purification and preservation.

The research utilized theoretical and empirical methods, with the main ones being a systemic approach, methods of analysis and synthesis (comparison, analogy, abstraction, formalization, classification). Standard laboratory methods for chemical analysis of groundwater quality were used in the chemical-bacteriological control laboratory serving the "Ternopilsky" water intake for drinking water.

The "Ternopilsky" water intake is an object of the Municipal Enterprise "Ternopilvodokanal". The operation of facilities for the production of drinking water is carried out in accordance with technological regulations and in compliance with regulatory documentation.

The main parameters that determine the quality of groundwater include chemical composition, physical properties, bacteriological composition, and radioactivity. According to regulations, drinking water must meet the requirements for drinking water quality, which includes the maximum allowable concentration of substances and the absence of pathogenic microorganisms.

Due to the potential consequences for the environment and human health in case of inadequate control over water quality, we have assessed some possible consequences of such an impact. Possible consequences include: a decrease in the level of groundwater, water pollution, a change in water composition, and an impact on local flora and fauna. By the nature of the impact, excessive use of groundwater can lead to a decrease in the level of groundwater, which can lead to a decrease in soil quality and affect ecosystems that depend on groundwater; careless handling of waste and chemicals can lead to groundwater pollution, which can pose a threat to human health and ecosystems; groundwater has its own composition and level of mineralization, so improper use can lead to a change in water composition, which can affect its use for drinking and industrial water supply; groundwater is an important element for local ecosystems, so the consumption and pollution of groundwater can affect local flora and fauna.

Requirements for the quality of groundwater in Ukraine are aimed at ensuring safety for drinking water supply and other needs. In order to reduce possible consequences of groundwater use, it is necessary to conduct constant monitoring of water quality, regulate water use, regulate groundwater consumption, and take measures to purify and protect it from pollution.

Keywords: water sources, water use, groundwater, water quality monitoring

https://doi.org/10.15407/icys-mhem.2023.035

THE METHODOLOGY FOR BURNING EFFICIENCY ESTIMATION IN UKRAINE USING NO_2/CO RATIO

Valeriia Rybchynska[1, 2], Mykhailo Savenets[2]
[1] Taras Shevchenko National University of Kyiv, Kyiv, Ukraine, valerie.rybchynska@gmail.com
[2] Ukrainian Hydrometeorological Institute, Kyiv, Ukraine

Atmospheric chemistry transport modeling and air quality decision-making rely on the input emissions data. Due to the existing uncertainties in emission inventories that come from the biases in assessment methodologies, huge efforts are made towards combining various approaches based on different data sources. Information about ratios of chemical compounds provides us with valuable knowledge about changes in fuel consumption by anthropogenic emission sources and natural air pollution releases. NO_2/CO ratio is among the most popular parameters for estimating burning efficiency that can be applied for remote sensing data. In this study we present the methodology for burning efficiency estimation relevant for Ukrainian territory.

We used seven pre-war case studies including three days for Kyiv (representing the variety of emission sources), two days for Mariupol (representing prevailing coal-fired industries), and two days for wildfires as reference cases for comparison. The methodology was developed using NO_2 and CO total columns (remote sensing by TROPOMI – Sentinel-5P), supported by the boundary layer height and wind parameters from the ERA-5 reanalysis.

The methodology consists of four main steps: (1) NO_2 and CO filtering using cloudiness and a quality assurance index; (2) meteorological data processing for obtaining the prevailing wind field at the top of the boundary layer; (3) NO_2 and CO content processing over emission sources and in the background; and (4) computation of NO_2/CO ratio.

The methodology testing reveals applicability for NO_2/CO ratio usage over Ukraine as for assessing the changes in fuel consumption, so also for further correction of emission factors. For selected case studies, NO_2/CO ratio equals 2.6 to 6.5 for wildfires, 3.1 to 4.6 for Mariupol, and 10.8 to 31.7 for Kyiv.

Keywords: nitrogen dioxide, carbon monoxide, TROPOMI, wildfire emissions, urban emissions

https://doi.org/10.15407/icys-mhem.2023.036