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ENVIRONMENTAL ISSUES OF ZAKARPATTIA

Manual

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Project HUSKROUA/1901/6.1/0075
“Environment for the Future by Scientific Education”

Uzhhorod – 2023

UDC 502+504(477.87)
E45

Reviewers:

Dmytro Dubyna – Doctor of Biological Sciences, professor, chief researcher of the Department of Geobotany and Ecology, M.G. Kholodny Institute of Botany, National Academy of Sciences of Ukraine

Svitlana Hapon – Doctor of Biological Sciences, Professor of the Department of Botany, Ecology and Teaching Methods of Biology, Poltava V.G. Korolenko National Pedagogical University

Yuriy Tyukh – Candidate of Biological Sciences, Deputy Director for Scientific Research, Synevyr National Nature Park

Mykhailo Haydur – Candidate of Pedagogical Sciences, Deputy Director of the Department of Ecology and Natural Resources, Transcarpathian Regional State Administration

Recommended for publishing by the Academic Council of STATE UNIVERSITY «Uzhhorod National University», protocol No. 11 of December 18, 2023

Environmental Issues of Zakarpattia. Manual / N. Kablak, Ya. Hasynets, L. Felbaba-Klushyna, V. Mirutenko and others ; Gen. Ed. prof. N. Kablak and prof. L Felbaba-Klushyna. – Uzhhorod : RIK-U, 2023. – 324+356 p.

ISBN 978-617-8276-79-9

The manual contains scientific materials devoted to the coverage of contemporary environmental issues of Zakarpattia. Considerable attention is paid to the peculiarities of its natural conditions. Emphasis is placed on the preservation of biodiversity in the face of climate change. While devising this textbook, the authors resorted to the analysis of literary sources as well as the findings of their own research. It will benefit school teachers, students and postgraduates of higher educational institutions majoring in natural sciences, employees of the nature reserve fund, and representatives of the authorities.

This manual was produced with the financial support of the European Union within the project HUSKROUA/1901/6.1/0075 “Environment for the Future by Scientific Education” (EFFUSE) of ENI CBC Programme Hungary-Slovakia-Romania-Ukraine 2014-2020. Its contents are the sole responsibility of NGO “Institute of Development of Carpathian Region” and do not necessarily reflect the views of the European Union.

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https://idcr.info/current-project.php?id=11&lang=en
https://effuse.science.upjs.sk/index.php/en/

ISBN 978-617-8276-79-9

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heolohichnykh protsesiv na terytorii mistechka Solotvyno (Zakarpattia, Ukraina) [Patterns of Development of Natural and Technogenic Dangerous Geological Processes on the Territory of the Town of Solotvyno (Zakarpattia, Ukraine)]. *Zbirnyk naukovykh prats IHN NAN Ukrainy*. Tom 12. 2019 S.70-83 DOI:10.30836/igs.2522-9753.2019.185745 [in Ukrainian]

10.2. DANGEROUS AND SPONTANEOUS METEOROLOGICAL PHENOMENA *(R. Ozymko, M. Karabiniuk)*

Over time, the interaction between man and the forces of nature has not lost its significance, and to some extent, on the contrary, it has gained even greater scope. One frequently comes across information about terrible destruction of buildings, hydraulic structures, flooding of territories, damage to property and even human casualties. Dangerous and spontaneous meteorological phenomena belong to such destructive forces of nature. They are atmospheric phenomena by their nature that rapidly develop in space and time, which complicates their predictability. These phenomena cause great damage to various sectors of the economy of any country, disrupting its development. Total losses from them can reach tens or even hundreds of millions of hryvnias per year. Very often, such phenomena are observed in combination with other dangerous or natural phenomena, which increases their negative impact. For example, heavy rains are accompanied by thunderstorms, hail, and gusty winds; heavy snowfalls – by blizzards, sleet snow, strong wind, etc.

In the history of the hydrometeorological service of Ukraine, the criteria for dangerous and spontaneous phenomena have changed many times. New criteria for dangerous and spontaneous meteorological phenomena, adopted by the Ukrainian Hydrometeorological Center in 2019, are in effect today. Therefore, according to the new standards, the following definitions and concepts are applied (Regulations..., 2019):

1. *Dangerous meteorological phenomena of the 1st level of danger (DMP I)* – «weather phenomena that, based on quantitative indicators, duration and territory of distribution, create certain inconveniences for the population and the functioning of the economic complex of the country».

2. *Spontaneous meteorological phenomena of the 2nd level of danger (SMP II)* – «these are natural phenomena that, based on quantitative indicators, duration and territory of distribution, pose a threat to the population and disrupt the functioning of the country's economic complex».

3. *Spontaneous meteorological phenomena of the 2nd level of danger (SMP III)* – «these are natural phenomena that, based on quantitative indicators, duration and territory of distribution, pose a threat to people's

lives in large areas, lead to large-scale damage to the country's economic complex, and harm the environment».

The territory of Zakarpattia Region is characterised, in general, by a relatively favorable climate for the life and activities of the population. However, the natural-geographic features of the territory and the specifics of atmospheric circulation cause, compared to the flat part of Ukraine, a significant development of various modern dangerous and spontaneous meteorological phenomena and processes. The most dangerous and most common processes include significant, heavy and extreme precipitations (Spontaneous Meteorological..., 2006; Report on..., 2013; Semerhei-Chumachenko, Ozymko, 2019; Ozymko, 2020; Karabiniuk, Markanych, 2020), the criteria of which are given in Table 10.2.1.

We will focus our attention on atmospheric precipitations that meet the criteria of SMP II and SMP III, as those that have the most negative impact on the surrounding natural environment and human activities. Further, the characteristics of the spatio-temporal distribution of heavy and extreme precipitations in Zakarpattia Region during a typical climatological period (1990-2019) are presented.

Table 10.2.1.

Types of atmospheric precipitation according to the criteria DMP I, SMP II and SMP III (Regulations..., 2019)

Name of a phenomena	Criteria for DMP I (colour marking – yellow)		Criteria for SMP II (colour marking – orange)		Criteria for SMP III (colour marking – red)	
	quantitative indicator	duration	quantitative indicator	duration	quantitative	duration
Snow	significant snowfall 7-19 mm	≤ 12 hours	heavy snow 20-29 mm	≤ 12 hours	extreme snowfall ≥ 30 mm	≤ 12 hours
Wet snow	significant wet snowfall 15-49 mm	≤ 12 hours	heavy wet snowfall 50-79 mm	≤ 12 hours	extreme wet snowfall ≥ 80 mm	≤ 12 hours
Rain	significant rainfall 15-49 mm	≤ 12 hours	heavy rainfall 50-79 mm	≤ 12 hours	extreme rainfall ≥ 80 mm	≤ 12 hours
Rain in mudflow-prone areas	significant snow 15-29 mm	≤ 12 hours	heavy rainfall 30-49 mm	≤ 12 hours	extreme rainfall ≥ 50 mm	≤ 12 hours

Downpour	-	-	heavy downpours 30-49 mm	≤ 1 hour	extreme downpours ≥ 50 mm	≤ 1 hour
Prolonged rains	-	-	heavy prolonged rainfall 100-149 mm	> 12 hours ≤ 48 hours	extremely prolonged rainfall ≥ 150 mm	> 12 hours ≤ 48 hours

From January 1, 1990 to December 31, 2019, 33 stationary hydrometeorological observation points in Zakarpattia Region recorded a total of 3,104 individual cases of rainfall, wet snowfall, and snowfall of the SMP II and SMP III criteria, the long-term dynamics of which are presented in Fig. 10.2.1 (Ozymko, 2020). The figure shows considerable variation in the number of SMP between different and even consecutive years. The biggest difference is noted between 2000 and 2001 (157 individual cases), and the largest amplitudes of fluctuations are observed between the first (1990-1999) and second (2000-2009) decades. During the studied period, the maximum recurrence rate of SMP occurred in 1998 (222 individual cases), and the minimum – in 1990 (36 individual cases). In this way, the absolute amplitude of the multiannual course of the recurrence of SMP was 186 individual cases within 30 years.

On average, there are observed 103 individual cases of rainfall according to the criteria of the SMP, which is a high indicator and can be tentatively considered the average annual climatological norm in the territory of Zakarpattia Region. In Fig. 10.2.1 the trend of an increase in the recurrence of spontaneous precipitation for 1990-2019 was identified. If this trend continues, in the future, we should expect an increase in the number of SMP cases. Sharp interannual fluctuations in the recurrence of spontaneous meteorological phenomena can negatively affect their timely forecasting and adaptation to the consequences (Semerhei-Chumachenko, Ozymko, 2019).

Analysis of the distribution curve of multiannual variability of heavy and extreme precipitations (refer to Figure 10.2.1) reveals certain rhythms in recurrence, and given the multiannual period of the research – certain cycles. Rhythms are repetitions of certain atmospheric (or natural) processes or fluctuations in their intensity, as well as the associated fluctuations in the values of meteorological elements that are not strictly periodic in nature: the amplitude of fluctuations during rhythms is not constant, and the intervals between the occurrence of the phenomenon or between extreme values are not rigidly equal. Rhythms with large (multiannual) time intervals between repetitions of the process or extreme values of its intensity

or between extreme values of the element are called cycles (International Meteorological..., 1992). The rhythmicity is traced regarding the recurrence maxima in 1992, 1995, 1998, 2001, 2004 (2005), 2007 (2008), 2010 and 2016 (2017). Thus, 3-year cycles of recurrence of heavy and extreme precipitations are quite clearly distinguished. The only exception is the period from 2011 to 2015. Of course, in quantitative terms, peaks of recurrence did not always coincide, but were above the average annual value.

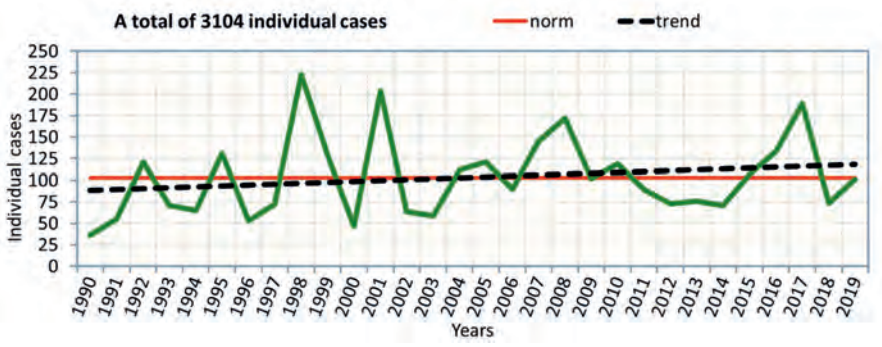

Fig. 10.2.1. Multiannual dynamics of individual cases of heavy and extreme precipitations in Zakarpattia Region (Ozymko, 2020)

In Fig. 10.2.2 the dynamics of heavy and extreme precipitation in view of the seasons is presented, which makes it possible to highlight interseasonal fluctuations and changes in the recurrence of precipitations that have met the criteria of SMP. Over the last three decades (1990-2019), there has been a sharp increase in individual cases of heavy and extreme precipitations in winter, as evidenced by the clear trend and rising amplitude of fluctuations. Admittedly, in the winter of 1991 and 1997, there was no individual case of heavy or extreme precipitation, and the maximum recurrence occurred in 2017 – 83 individual cases. It is obvious that it is at this time of the year that we should expect an intensive increase in the frequency of precipitations according to the criteria of the SMP and, respectively, a complication of weather conditions (Ozymko, 2020).

In the spring, the trend is almost steady, so the interannual amplitude of variation in the number of individual cases is more or less smoothed out relative to the average value (19 individual cases), although significant differences were recorded in some years with a maximum in 2001 – 92 individual cases and a minimum in 2012 – 1 individual case. In the summer, there is a slight positive trend in the frequency of individual cases. Two maxima stand out: 1998 (93 individual cases) and 2008 (112 individual cases). A third (997 individual cases) of all heavy and extreme precipitation was observed in the summer, which is associated with a significant number of heavy rains. The

average annual recurrence of heavy and extreme precipitation is 33 individual cases. A slight negative trend in the recurrence of cases was observed only in autumn. Just as in summer, two peaks stand out: in 1992 (89) and in 1998 (109 individual cases). On average, 29 individual cases of heavy and extreme precipitation were recorded in autumn (Ozymko, 2020).

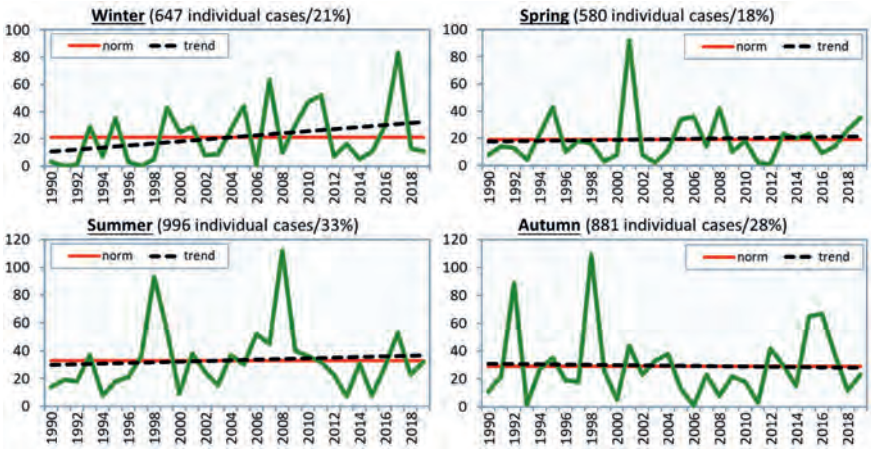

Fig. 10.2.2. Seasonal recurrence of individual cases of heavy and extreme precipitation in Zakarpattia Region (abscissa axis – years, ordinate axis – number of individual cases) (Ozymko, 2020)

Of all the seasons, only in winter there were years when heavy or extraordinary precipitation was not recorded. A sharp increase in the recurrence of individual cases of precipitation of the SMP criteria in winter is explained by an increase in air temperature in the cold period of the year, which led to a change in the structure of precipitation In Zakarpattia Region, there is a tendency of increasing the recurrence of days with rain and decreasing the number of days with snow, especially in winter, which has significantly intensified since the early 21st century (Balabukh, 2008; Balabukh, Lukianets, 2015). It can also be explained by more rapid climatic changes in this season of the year, among which there may be mentioned the restructuring of circulation mechanisms in the atmosphere. Significant interannual fluctuations in recurrence of heavy and extreme precipitation with a maximum difference of 80-90 individual cases prove the difficulty of making long-term weather forecasts and climate forecasts for the territory of Zakarpattia Region.

Recurrence cycles are also distinguished in terms of seasons (refer to Fig. 10.2.2). In winter, a 6-year cycle of recurrence maxima is clearly observed 1993 (29), 1999 p. (43), 2005 (44), 2011 (52) and 2017 (83 individual cases), which increases gradually. In spring, less clear 6-year cycles of recurrence maxima are observed in 1995 (43), 2001 (92), 2008 (42), 2013

(23) and 2019 (35 single cases). In summer, 10-year cycles of recurrence of maxima are distinguished in 1998 (93), 2008 (112) and 2017 (54 individual cases). In the autumn, unclear 6-year cycles of recurrence of maxima of fixed individual cases of SMP are observed in 1992 (89), 1998 (109), 2004 (38), 2012 (42) and 2016 (67 individual cases).

Hence, in Zakarpattia Region, in all seasons of the year, there is significant interannual variability in the recurrence of individual cases of heavy and extreme precipitation. The most noticeable changes in recurrence were recorded in winter and summer.

As can immediately be seen from Fig. 10.2.3, the major part accounts for heavy and extreme rainfalls (81%/2526 individual cases), much less – for snowfalls (11%/333 individual cases) and wet snowfalls – (8%/245 individual cases). The differentiation of the phase state of heavy precipitation (SMP II) practically corresponds to the general picture of the ratio. However, when comparing extreme precipitation (SMP III), twice as much volume accounts for wet snowfalls (16%/74 individual cases), a little less for snowfall (12%/58 individual cases) and, certainly, the major part of it – on rains (72%/333 individual cases). Such a considerable unequal distribution of precipitation phases is due to the climatic features of Zakarpattia oblast and the predominance of synoptic processes characteristic of the warm half-year, during which even in the cold period of the year it rains quite often (Ozymko, 2020).

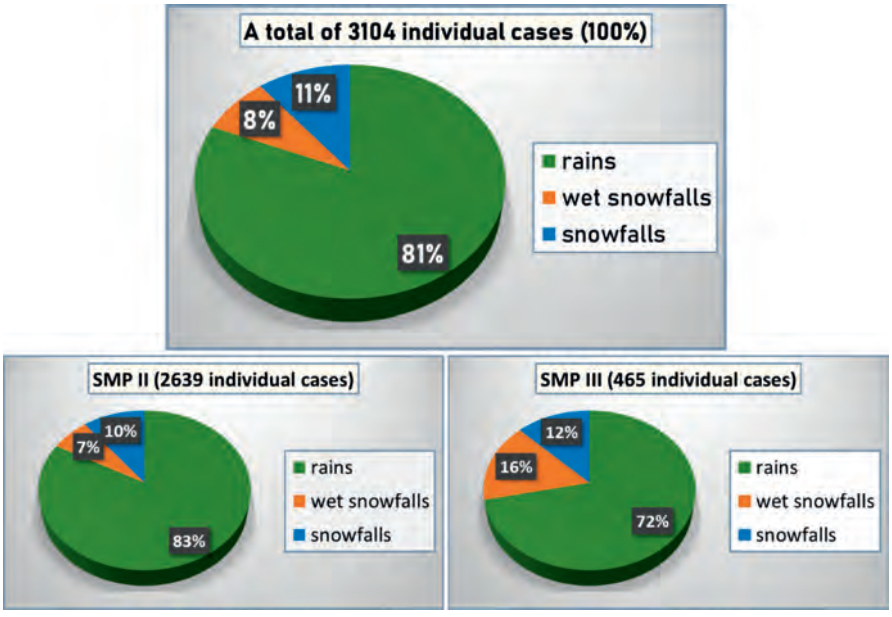

Fig. 10.2.3. The ratio of heavy and extreme precipitations in Zakarpattia Region by different phases during the period of 1990-2019 (Ozymko, 2020)

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Environmental Issues of Zakarpattia. Manual / N. Kablak, Ya. Hasynets,
E 45 L. Felbaba-Klushyna, V. Mirutenko and others; Gen. Ed. prof. N. Kablak and prof. L Felbaba-Klushyna. – Uzhhorod : RIK-U, 2023. – 324+356 p.
ISBN 978-617-8276-79-9

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Team of authors:

N. Kablak, Ya. Hasynets, L. Felbaba-Klushyna, V. Mirutenko, M. Vakerych, M. Balazh, I. Besehanych, A. Hiurtler, V. Leta, I. Kalynych, M. Karabiniuk, R. Kish, V. Klushyn, N. Kryvtsova, F. Kurtiak, O. Mateleshko, L. Miklovsh, M. Nychvyd, R. Ozymko, H. Popovych, V. Sabadosh, M. Savenko, Yu. Shpontak, O. Stankevych-Volosianchuk, Ya. Syvokhop, D. Tomenchuk

Author's correction

Font: Noto Serif. Offset paper. Offset printing. Format: 70x100/16.
Conditional printed sheets: 55,3. Order: No 156K. Circulation: 1000 copies.

The original layout was made and printed
by RIK-U LLC, 88006, Uzhhorod, 36 Karpatskoyi Ukrainy st.
Certificate of the subject of the publishing business:
DK No. 5040 dated January 21, 2016.