IMPACT OF CLIMATE CHANGES ON THE FLOW REGIME IN THE MUREŞ HYDROGRAPHIC BASIN, SĂVÎRŞIN SECTOR

Maria Roana JURCOANE[1], Laura ŞMULEAC [2], Cristina TULBURE [2]
[1] Technological High School "King Mihai I" Savarsin, Romania
[2]University of Life Sciences "King Mihai I" from Timisoara, Romania
Corresponding author: laurasmuleac@usvt.ro

Abstract. *In the conditions of global climate change, when the distribution of precipitation is constantly changing, and the intensity with which it occurs, increasingly affects the flow of water into rivers. Watercourses, if not arranged and left to nature, affect human settlements through the destructive effect of water. Floods can lead to human and animal losses, make people sick and leave residents homeless. They can also affect the environment, infrastructure and property. Under these conditions, it is necessary to carry out flood defence works and they will be done only after an analysis of the risk of occurrence and the importance of the defended objectives. In this paper, the Mures hydrographic basin, Săvîrşin sector is analyzed, the evolution of precipitation, flow and water level in 2021-2022 is monitored. It was noted that the highest amounts of precipitation fell in 2022, of 173 mm, and the lowest of 22.1 mm in October 2021. The maximum flow rate was in May 2021, of 576 m^3/s, and the minimum of 36 m^3/s in October of the same year. The maximum water level was recorded was in May (277) and the minimum was recorded in October -22, both values in 2021. However, there were no flood problems in the Săvîrşin sector during the analyzed period.*

Keywords*: floods, Mures river basin, water flow, water level, precipitation, dammings*

INTRODUCTION

Rapid changes in the environment are caused by the growth of the world's population, by the increasing rate of resource consumption by human society, and by changes in technologies and political-social organization. The most important component of global change is climate change due to the greenhouse effect, which will have an important impact on the environment and economic and social activities. Global warming has led to an increase in the frequency of extreme events, with the rapid alternation between severe heat/drought and heavy rainfall/floods becoming increasingly evident (CHEN et all., 2020).

Climate change affects all regions of the world. The ice caps are melting and sea levels are rising. In some regions, extreme weather and precipitation are becoming more frequent, while others are experiencing extreme heat waves and drought (APEL et all., 2021).

According to the Report on the State of the Environment in Romania, climate variability will have direct effects on sectors such as agriculture, forestry, water resources management, which can lead to changing vegetation periods and moving demarcation lines between forests and meadows and can increase the frequency and intensity of extreme weather phenomena (storms, floods, droughts). The changes in the climate regime in Romania fit into the global context, taking into account regional conditions: the temperature increase will be more pronounced in summer, while in northwestern Europe the most pronounced increase is expected in winter (NEVO et all., 2022).

In this context, sustainable water management will play an important role in adapting humanity to its altered environment and help avoid increasing global temperature by more than 1.5° Celsius. The management of this vital resource requires a truly integrated approach at river basin level, taking into account environmental, social, economic and health dimensions (ŞMULEAC et all., 2022).

Climate change is expected to have a major impact on water resources and their sustainable management. Among the countries in the Danube basin, Romania is expected to be

more affected by climate change, mainly through the frequency and magnitude of floods, including flash floods, as well as the intensity and duration of droughts with negative repercussions on aquatic quality and biodiversity. The challenges posed by the impacts of climate change offer a unique opportunity to strengthen and develop the management and risks of water resources (NEGRU et all, 2013).

Currently, in order to forecast the availability of water resources by river basins, it is necessary to take into account the effect of climate change on water resources. The estimation of the impact of climate change and variability on the hydrological regime in a river basin shall be based on long-term simulations carried out using a hydrological model, using as input the rainfall and temperature series resulting from simulations of climate evolution carried out using a regional meteorological model (YANG Q et all, 2021).

MATERIAL AND METHODS

The Mures hydrographic basin is located in the central and western part of Romania, having for its extremities the following coordinates: longitude: 20º 11' western limit; 25° 44'- eastern limit and latitude: 45° 14'south limit and 47° 08' northern boundary. The Mureş hydrographic basin borders to the north with the Crişuri and Someş hydrographic areas, to the south with the Banat hydrographic area, the Jiu and Olt hydrographic basins, to the west the Şiret hydrographic basin, and to the east the border with Hungary. The basin is located in the area bounded by the Eastern, Southern and Apuseni Carpathians, and its lower sector is located in the center of the Tisa plain.

The Mures hydrographic basin has a total area (including the Ier channel) of 28,418 km^2 and according to the Cadastral Atlas of Romanian Waters, the surface is 28,310 km^2), representing a share of 11.97% of the country's surface (GYŐRI et all., 2010).

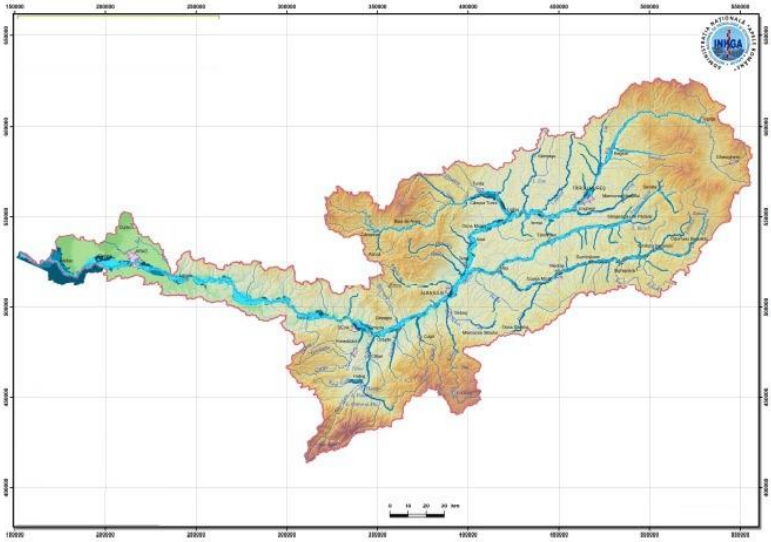

Figure 1. Mureş River Basin

The hydrographic network comprises a number of 798 watercourses, which have a total length of over 10,000 km, namely 10861 km.

Of the cadastral watercourses, 711 meet the analysis criteria within the Mures River Basin Management Plan.

The total population of the localities within this river basin is 1,877,642 inhabitants. The distribution of the population, at the level of the Mures hydrographic basin, depending on the residence environment is as follows: in the urban area 1,052,037 inhabitants and in the rural area 825,605 inhabitants.

On the territory of the Mures hydrographic basin, a number of 210 damming works are carried out, totaling a length of about 825 km.

For flood protection in the Mures river basin, several types of works were carried out, such as:

- dams for permanent accumulations
- dams for non-permanent accumulations
- Dams
- water derivatives
- hydrotechnical nodes
- polders

RESULTS AND DISCUSSIONS

The damming works carried out in the Mures hydrographic basin (figure 2) have a defense role for a number of 240 localities, of which 55 are urban centers, a number of 8,827 houses in urban areas and 60,240 in rural areas, The total area defended by these damming works is approximately 190,000 ha.

Important damming works are found in Reghin, Targu-Mures, Ludus, Niraj and Comlod, damming works of the Tarnava Mică River from Târnăveni, damming of the Piriului de Cimpie, defense of the municipalities of Sighisoara, Blaj, Mediaş, Dumbrăveni, Copsa Mică, Alba Iulia and Deva. Other important impoundments are in localities in Alba (Mihalț) counties, in Hunedoara county at Ilia, in Arad county, at Lipova, in the Arad-Pecica area, in the area of Sâmbăteni – Paulis localities, at the intersection of Arad and Timiș counties in the Felnac - Periam area, but also in Timiș county in Periam - Cenad localities.

Reported by counties, the situation of dams is as follows: in Mures County - 8 dammings, in Arad County - 7 dammings, in Alba County - 3 dammings, in Sibiu County - 3 dammings and in Hunedoara County - 2 dammings.

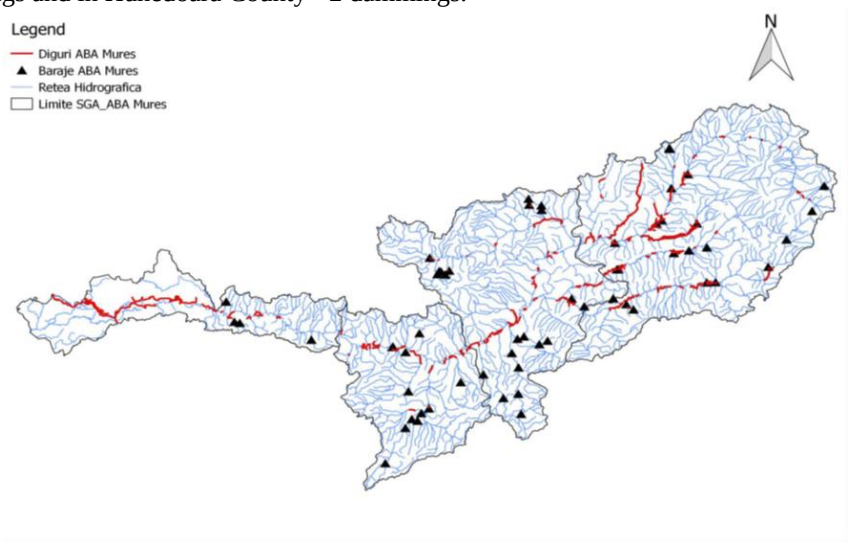

Figure 2. Water management scheme existing in Mures river basin

In order to determine the flood risk on the Săvîrșin sector, the amount of rainfall and the water level in the Mures River were analyzed. From the analyzed data on the water level in the Săvîrșin sector (figure 3), it can be seen that the maximum water level was recorded in May (277) and the minimum was recorded in October -22.

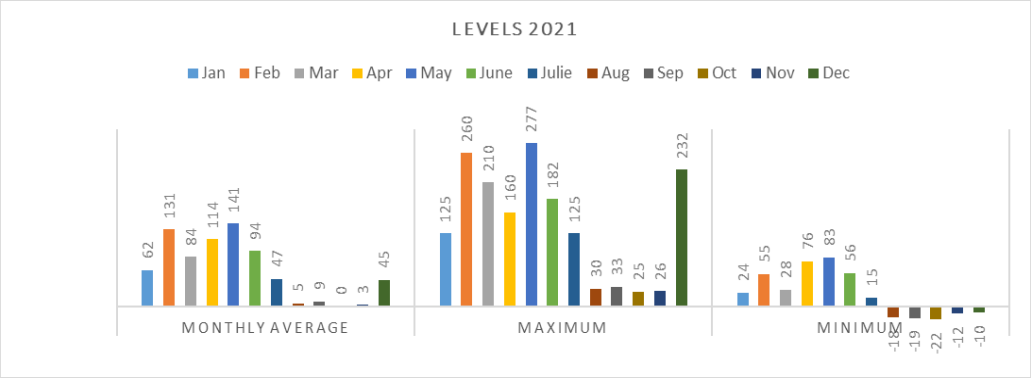

Figure 3. The level of Mures River at Vârşin Sector in 2021

In terms of measured flows, the maximum value recorded in 2021 was 576 m^3/s in May and the minimum value in October was 36 m^3/s (Figure 4).

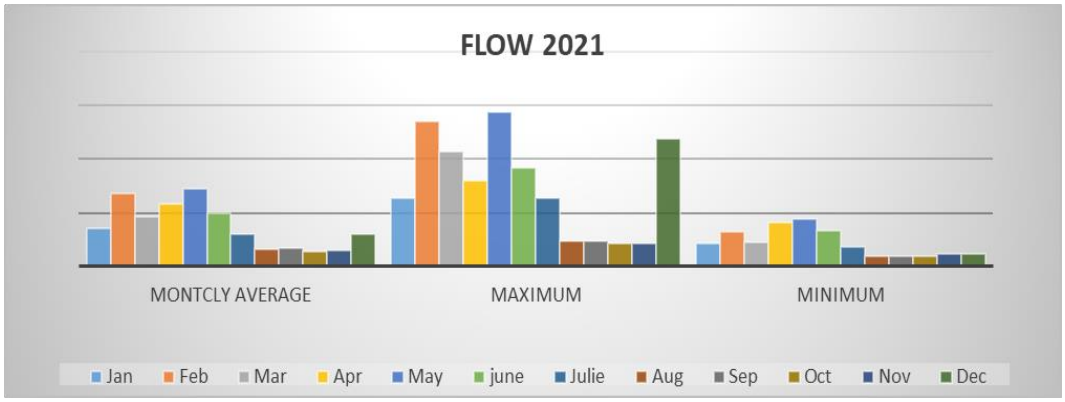

Figure 4. The Flow of Mures River at Săvîrșin Sector in 2021

The amount of precipitation is very important, being the decisive factor in determining the level and flow of water. Figure 5 shows that the highest amount of rainfall was in December at 151.7 mm and the lowest at 22.1 mm in October, the month with the lowest water flow on the river.

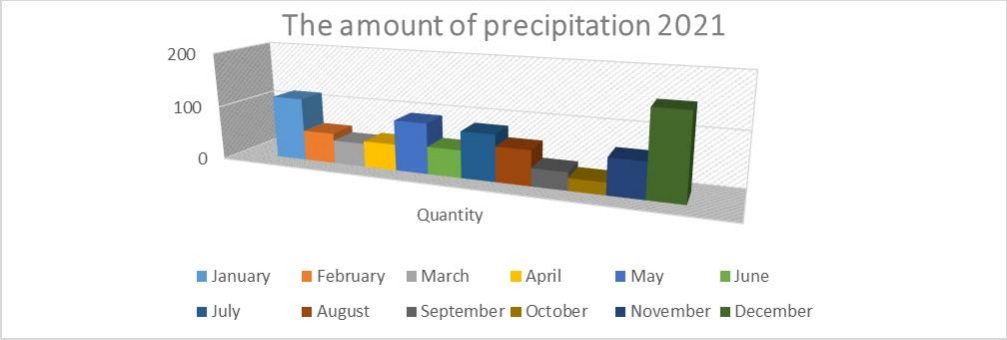

Figure 5. The amount of precipitations in 2021

From the analysis of water levels in the Săvîrșin sector in 2022, it can be seen that the maximum value was recorded in December, by 190 m, and the heart in August by -19 (figure 6).

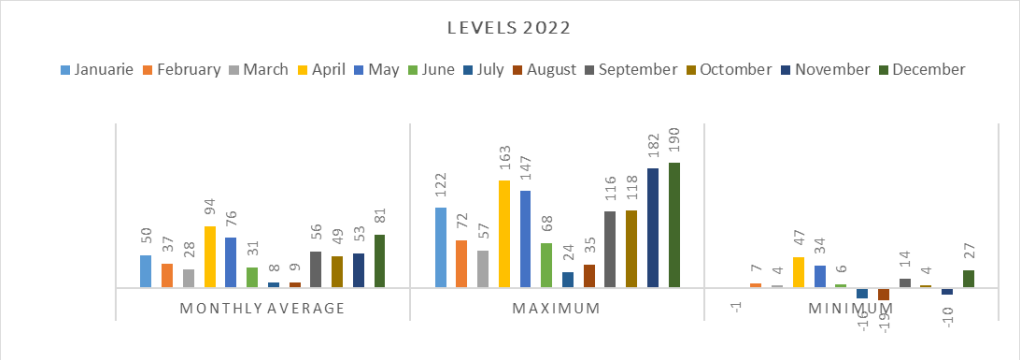

Figure 6. The Level of Mures River at Săvîrșin Sector in 2022

The maximum flow recorded on the Mureș River was 384 m^3/s in December, and the minimum in August, of only 38.9 m^3/s, being correlated with the water level (figure 7).

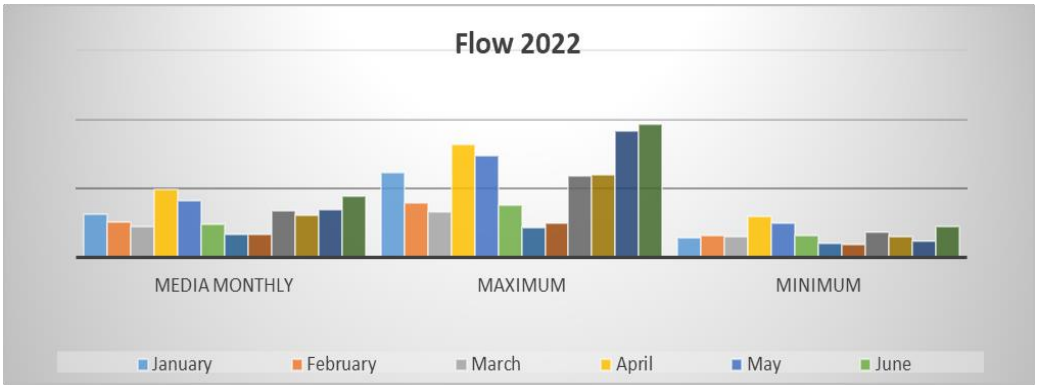

Figure 7. The Flow of Mures River at Săvîrșin Sector in 2022

Figure 8 shows that the highest amount of precipitation fell in September, at 173 mm, and the lowest was 23.7 mm in October 2022.

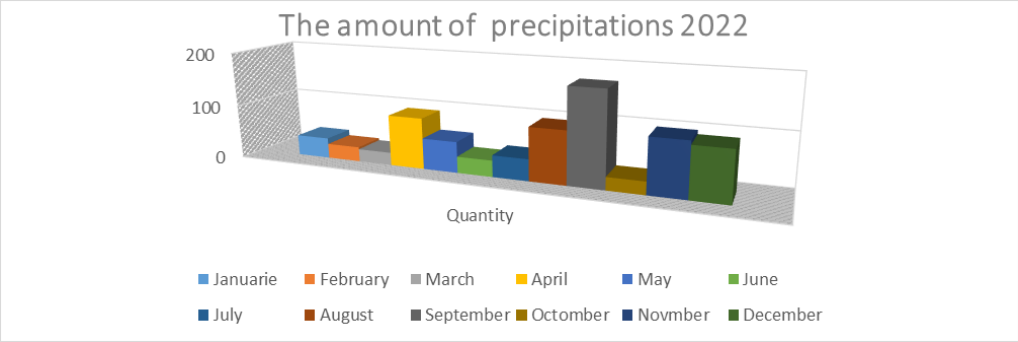

Figure 8. The amount of precipitations in 2022

CONCLUSIONS

This paper analyzed the risk of flooding on the Mures River, one of the longest rivers in Romania. The river basin has a large area of 28,418 km^2, which represents 11.2% of the country's surface, and the population of this river basin is 1,877,642 inhabitants. In these circumstances, the protection of localities against floods is a priority. In this approach, a number of 210 damming works were carried out, totaling a length of about 825 km. The damming works carried out have a defense role for a number of 240 localities, of which 55 are urban centers, a number of 8,827 houses in urban areas and 60,240 in rural areas, The total area defended by these damming works is approximately 190,000 ha.

The rainfall in 2021 and 2022, water levels and flows over the two years were analyzed. It was noted that the highest amounts of precipitation fell in 2022, of 173 mm, and the lowest of 22.1 mm in October 2021. The maximum flow rate was in May 2021, of 576 m^3/s, and the minimum of 36 m^3/s in October of the same year. The maximum water level was recorded was in May (277) and the minimum was recorded in October -22, both values in 2021. However, there were no flood problems in the Săvîrșin sector during the analyzed period.

BIBLIOGRAPHY

APEL H., VOROGUSHYN S, MERZ B., 2021 - Brief communication: Impact forecasting could substantially improve the emergency management of deadly floods: case study July 2021 floods in Germany, Nat. Hazards Earth Syst. Sci., 22 (2022), pp. 3005-3014

BRAGOI U., 2016 - Floods - causes, forms of manifestation, effects, ways to combat them (Thesis). Technical University of Moldova

CHEN F, CHEN Y, CHEN F, CHEN Y., 2020 - Urban climate research and planning applications in China: A scientometric and long-term review (1963–2018) based on CiteSpace. Clim. Res., 81, 91–112

CHIRICA L., 2016 - General Hydrology - Practical Landmarks, Moldova State Faculty , Faculty Of Biology And Pedology. Chișinău.

COPPOLA, DAMON P, 2007 - Introduction to International Disaster Management. Elsevier, Oxford

GYŐRI MARIA-MIHAELA., 2010 - Maximum Runoff On The Mureș River In The Petriș-Păuliș Section. Geographia Napocensis 2.

HÂNCU, C., DAN, 2008 - River Regulations And Flood Control

MOHANTY M.P, MUDGIL S, KARMAKAR S, MOHANTY M.P, MUDGIL, S, KARMAKAR, S. 2020 - Flood management in India: A focussed review on the current status and future challenges. Int. J. Disaster Risk Reduct., 49

NECULAU, G., STAN, F.I., 2016 - Evaporation and evapotranspiration in Romania. Geographical Forum XV, 39-48. https://doi.org/10.5775/fg.2016.058.s

NEGRU, O., PĂTRUȚ, S., ȚONE, A.-M., 2013 - Management of Flood Emergency Situations In Romania, Conference Proceedings Water resources from Romania. Vulnerability to the pressure of man's activities, Targoviste - Romania

NEVO SELLA, EFRAT MORIN, ADI GERZI ROSENTHAL, ASHER METZGER, CHEN BARSHAI, DANA WEITZNER, DAFI VOLOSHIN, FREDERIK KRATZERT, GAL ELIDAN, GIDEON DROR, GREGORY BEGELMAN, GREY NEARING, GUY SHALEV, HILA NOGA, IRA SHAVITT, LIORA YUKLEA, MORIAH ROYZ, NIV GILADI, NOFAR PELED LEVI, OFIR REICH, OREN GILON, RONNIE MAOR, SHAHAR TIMNAT, TAL SHECHTER, VLADIMIR ANISIMOV, YOTAM GIGI, YUVAL LEVIN, ZACH MOSHE, ZVIKA BEN-HAIM, AVINATAN HASSIDIM, AND YOSSI MATIAS, 2022 - Flood forecasting with machine learning models in an operational framework. Hydrology and Earth Systems Science (HESS)

QOMARIYATUS SHOLIHAH, WAHYUDI KUNCORO, SRI WAHYUNI, SISILIA PUNI SUWANDI, ELISA DWI FEDITASARI 2020 - The analysis of the causes of flood disasters and their impacts in the perspective of environmental law, IOP Conf. Series: Earth and Environmental Science 437

SĂGEATĂ, R., DUMITRESCU, B., GRIGORESCU, I., PERSU, M., 2015 - Typologies on the vulnerability to flooding of Romanian cities. Institute of Geography, Romanian Academy.

ȘMULEAC ADRIAN, LAURA ȘMULEAC, COSMIN ALIN POPESCU, SORIN HERBAN, TEODOR EUGEN MAN, FLORIN IMBREA, ADINA HORABLAGA, SIMON MIHAI, RAUL PAȘCALĂU, TAMAS SAFAR, 2022 - Geospatial Technologies Used in the Management of Water Resources in West of Romania, Water, Vol 14, No 2

ȘMULEAC LAURA, RĂDULESCU HORTENSIA, IMBREA FLORIN, ȘMULEAC ADRIAN, PAȘCALĂU RAUL, 2022 - Water management to reduce floods in the hydrographic Basin Bega-Timiș, International Multidisciplinary Scientific GeoConference: SGEM, Vol 22, pg. 247-254

ȘMULEAC, L., IENCIU, I.A., 2020 - Hydrology and Hydrogeology, Ed. Agroprint, Timișoara.

Stanley A. Changnon, Jr., Richard J. Schicht, and Richard G. Semonin, 1983 - A plan for research on floods and their mitigation in the United States, Illinois State Water Survey Division, Department of Energy and-Natural Resources

TIȘCOVSCHI, A.A., DIACONU, D.C., 2004. Meteorology and hydrology - practical works. University Publishing House, Bucharest

YANG Q, ZHENG X, JIN L, LEI X, SHAO B, CHEN Y. 2021 - Research Progress of Urban Floods under Climate Change and Urbanization: A Scientometric Analysis. Buildings.; 11(12):628. https://doi.org/10.3390/buildings11120628