

Using GIS tools in the study of paleovalley in the Verchny Prut basin

Liudmyla KOSTENIUK^{1*}

¹ *Yuriy Fedkovych Chernivtsi National University, Chernivtsi, Ukraine*

* Corresponding author: Liudmyla Kosteniuk. E-mail: lkosteniyk@chnu.edu.ua

KEYWORDS: GIS, SRTM, paleogeomorphological analysis, paleovalleys, Chorny Cheremosh, Chorna Tysa, Lyuchka, Oslava

1 Introduction

The use of new, modern methods of digital mapping and geoinformation tools in research allows us to take a fresh look at the seemingly already known and defined problematic issues of clarity of the stages of origin and formation of the basins of the river systems of the Ukrainian Carpathians and their gradual stabilization within the current boundaries. The long-standing and clearly defined position of leading specialists, Ukrainian geomorphologists (Andreychuk, 2012; Bayrak, 2008; Klapchuk, 1994) and hydrologists (Kostenyuk and Smyrnova, 2010), thanks to the use of new geographic information technologies and access to modern software, opens up new opportunities for its revision and clarification. An important aspect of studying basin systems in mountainous regions, such as the Ukrainian Carpathians, is the use of not just a cartographic research method with the corresponding results of visualization, zoning, or creation of appropriate mapping schemes, but also the use of system analysis. That is, thanks to GIS applications (TIN interpolation qgis), when creating appropriate models, we can reveal in more detail the complex issues of the reformation of ancient drainage valleys and their modern reflection in the relief of this territory. The complex and not fully disclosed issue of the reformation of ancient drainage valleys in the Pliocene-Pleistocene period is extremely important for understanding modern channel processes in the rivers of the Upper Prut basin, as it still significantly affects the perception of the current pattern of the hydrosystem of the study basin and the inherited nature of channel macroforms in some of its sections.

2 Methods

It is the ambiguous conclusions and results of previous researchers that prompt the use of new, more advanced methods that will better substantiate and determine the course of the processes of restructuring the river network of the southeastern macro-slope of the Ukrainian Carpathians, as well as identify the factors that caused these changes. First of all, it is important to take into account and rely on the changes in the configuration of the Upper Prut hydrosystem at different stages of its functioning and development. One of the methods for studying the peculiarities of river basin hydrosystem formation is geomorphological analysis (Karabinyuk, Hnatyak, Buryanyk, Hostyuk and Karabinyuk, 2021). The pattern of the hydrographic network is a reliable indicator of the morphology and genesis of the modern relief, tectonics and neotectonics, and the type and intensity of surface runoff (Bayrak, 2008).

3 Results

The Upper Prut basin is quite interesting in this regard, as it is known to have several "special" sections of the valley and channel network, which indicate significant reformation, so-called

interceptions, and changes in flow at different stages of orogeny of the Carpathian mountain-fold structure. From the hydrological and channel studies point of view, the study of the hydrographic network of the Upper Prut is quite important, since changes in the number and length of tributaries cause changes in the magnitude of the main factors of channel formation: water and sediment flow, and the availability of data on ancient flow valleys will determine the nature and boundary conditions of river channel formation (Kostenyuk and Smyrnova, 2010). Let's take a closer look at the study area. As can be seen from Figure 1, the orographic connection between the Black Tisza-Prut-Black Cheremosh river valleys is clearly traced, with only the direction of flow through this ancient valley remaining open. It should be noted that many researchers attributed to this ancient form a southeastern direction through the Suceava River basin to the upper reaches of the Moldova River (a right tributary of the Siret River, which flows within Romania), while others (Klapchuk, 1994) consider the direction of flow through this valley to be radically opposite: from the upper reaches of the White Cheremosh from the Marmarosh massif, through Verkhovyna-Vorokhta to the village of Delyatyn.

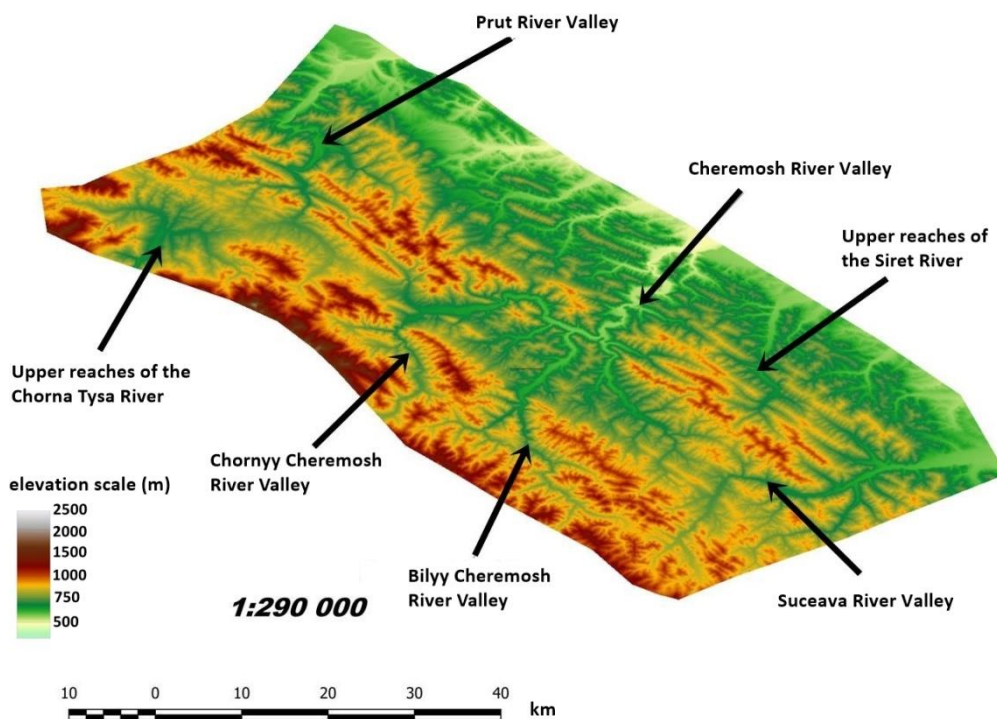


Figure 1 Hypsometric map based on the digital relief model (DRM) of the mountainous part of the Verchny Prut basin and the adjacent territory.

As we can see, the question of the Vorokhta-Putyla lowlands and depressions in the Suceava River valley remains open, since V. M. Klapchuk's theory does not provide a clear answer to the question of the formation of this area under the northwestern direction of flow. The correct answer to this dilemma will be found only during thorough research of alluvial deposits of terraced levels, which are preserved in fragments, and a comprehensive analysis of the results obtained by paleogeomorphologists and hydrologists in joint work in the future. Today, the issue of re-shaping the hydrological network of the Ukrainian Carpathians and Upper Prut rivers (in particular, intercepting their main tributaries and changing the direction of flow) remains insufficiently studied and substantiated, despite the enormous work of well-known specialists, geomorphologists and hydrologists who have devoted a lot of time and effort to

solving it (Burshtyns'ka, Babushka and Halochkin, 2020). However, there are still many nuances that require more detailed study and clarification, as well as a possible rethinking of digital modeling using the latest GIS technologies. After all, these complex problematic issues, supplemented by field research, may be able to be looked at from a new, more practical perspective.

4 Conclusions

The formation of the modern hydrosystem of the Upper Prut basin was a complex process. At different stages of the study of this basin system, various theories of possible reformation of both the main channel streams and minor tributaries were proposed. At the same time, we are talking not only about their configuration but also about the periodic increase or decrease in the area of the entire catchment basin, which is known to significantly affect the total flow module. The reasons for these transformations are currently considered to be periodic upward movements and subsidence in various local areas, which is reflected in the change in the erosion base and, accordingly, the reconfiguration of the river system to new conditions.

References

- Andreychuk Y. (2012) 'Heoinformatsiyne modelyuvannya stanu baseynovykh system (na prykladi prytochy Dnistra – richky Koropets)': *avtoref. dys. kand. heohr. nauk. Liviv.* (In Ukrainian)
- Bayrak H.R. (2008) 'Vysvitlennya morfometrychnykh pokaznykiv rel'yefu metodamy ArcGIS', *Problemy heomorfolohiyi i paleoheohrafiyi Ukrayins'kykh Karpat i prylehlykh terytoriy.* Materialy mizhn. seminaru. L'viv. pp. 135 – 140. (In Ukrainian)
- Bayrak H.R. (2014) 'Mozhlyvosti HIS dlya vidobrazhennya kharakterystyk rel'yefu i proyaviv suchasnoyi ekzodynamiky', *Problemy bezpererвної heohrafichnoyi osvity i kartohrafiyi.* Vyp. 19. Kharkiv. pp. 3 – 6. (In Ukrainian)
- Burshtyns'ka Kh., Babushka A. and Halochkin M. (2020) 'Modelyuvannya hidrolohichnykh protsesiv z vykorystannyam HIS ARCGIS ta modulya HEC-RAS', *Heodeziya, kartohrafiya i aerofotoznimannya.* Vyp. 91. pp. 28 – 40. (In Ukrainian)
- Karabinyuk M. M., Hnatyak I. S., Buryanyk O. O., Hostyuk Z. V., Karabinyuk Ya. V. (2021) 'Suchasna dynamika rivniv vod ta yikh pavodkovykh pidyomiv u verkhiv"yi richky Prut u mezhakh landshaftu Chornohora (Ukrayins'ki Karpaty) ', *Fizychna heohrafiya ta heomorfolohiya.* 1-3 (105-107) pp. 7 – 17. (In Ukrainian)
- Klaphuk V.M. (1994) 'Etapy rozvytku richkovykh dolyn baseynu verkh'n'oho Prutu', *Dysertatsiya na zdobuttya nauk. stupenya kand. heohr. nauk; Instytut heohrafiyi NAN Ukrayiny; spets. 11.00.04 "heomorfolohiya i evolyutsiyana heohrafiya".* Kyiv. (In Ukrainian)
- Kostenyuk L.V. and Smyrnova V.H. (2010) 'Formuvannya hidrohrafichnoyi merezhi hirs'koyi chastyny baseynu Verkh'n'oho Prutu', *Hidrolohiya, hidrokimiya i hidoekolohiya.* Kyiv : Obriy. Tom 2(19). pp. 105 – 113. (In Ukrainian)
- Kostenyuk L.V. and Popiuk Y.A. (2019) 'Osoblyvosti formuvannya hidrohrafichnoyi merezhi richkovoyi systemy Pistyn'ky-Lyuchky-Lyuchky Sopivky', *Naukovi zapysky Ternopil's'koho pedahohichnoho universytetu imeni Volodymyra Hnatyuka.* (vypusk 47). pp. 33 – 40. (In Ukrainian)
- Kostenyuk L.V., Zablots'ka N.V. (2022) 'Osoblyvosti ruslovykh protsesiv na hirs'kykh richkakh v mezhakh Vorokhto-Putyl's'koho nyz'kohir'ya (baseyn Cheremoshu) ', *Naukovi zapysky Ternopil's'koho pedahohichnoho universytetu imeni Volodymyra Hnatyuka.* (vypusk 52). pp. 51 – 59. (In Ukrainian)
- Kostenyuk L. (2022) 'Zastosuvannya prohramnoho zabezpechennya HIS dlya doslidzhen' ruslovykh protsesiv (na prykladi baseynu r. Richka) ', *Naukovyy visnyk Chernivets'koho universytetu.* Vyp. 839. pp. 91 – 99. (In Ukrainian)