ФІЗИЧНА ГЕОГРАФІЯ

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FEATURES OF RIVER CONFLUENCE NODE FUNCTIONING IN THE SUKIL RIVER BASIN

The article studies three largest confluences of rivers in the Sukil basin for 1880-2021 period. The morphodynamic types of confluences have been determined, and the analysis of their displacements has been conducted; influence of the geological and geomorphological structure on the patterns of their functioning has been determined.

Key words: *river confluence, functioning, morphodynamics, the Sukil river, river channel.*

Introduction. Significant morphodynamics of rivers' confluence is mainly caused by horizontal deformations of a larger river. The morphodynamics of nodes is also determined by peculiar features of the confluence: water dischatge and structure of water flows, accumulation of alluvium within the channel and low floodplain directly at the point where a tributary flows into the main river, morphodynamics of channels of these rivers upstream and downstream, and the relief of the floodplain. The confluence of rivers is the basis of erosion for a smaller river, which is also a key to the functioning of river systems in general. Therefore, the ***aim*** of the study is to determine characteristic features of river confluence functioning of the largest watercourses of the Sukil River basin.

Despite numerous foreign publications, in Ukraine there are almost no studies of the morphodynamics of river confluence, including those located in the Ukrainian Carpathians. Studying the functioning of river confluence of small streams in the Skybovi Carpathians and within the area of the Pre-Carpathian depression may be the key for understanding the mechanism of the formation and passage of floods, characteristic features in the development of horizontal channel deformations and transport-accumulative activity of two merging streams and one merged flow.

Analysis of previous studies. River confluence in fluvial geomorphology have been studied only since the second half of the 20th century. One of the first areas of study was the hydrodynamics of two merging streams and the laterality of the merged water flow [15]. The basics of the confluence nodes' functioning are described in the study [16], where the dependence of the increase in depth and cross-sectional area of the river channel on the increase in flow turbulence in the confluence nodes of multi-flow channels is determined. It was also found that channel depth increases with a decrease in the difference in flow rates of the two merging streams. Channel depth decreases with increasing of sediment discharge. The influence of the flow dynamics on the transport and accumulation of material in the area of the confluence, as well as the morphology of the tributaries and the merged channel, are described in studies [8, 9]. According to these features, the author defines six zones in the confluence node: stagnation zone, flow deviation, flow separation, zone of maximum speed, flow restoration, and flow displacement zones. The defining parameters for functioning of a confluence node are the angle of confluence of two streams and the discharge ratio of water and sediment flows between two streams. The mechanism of sediment accumulation with different morphometric parameters of merging streams is determined. Among these fundamental studies, the most referred are works on changes in channel forms caused by tributaries (Richards, 1980; Roy & Woldenberg, 1986; Rhoads & Kenworthy, 1995); on sedimentation features in merging channels (Church & Kellerhals, 1978; Knighton, 1980); on ecosystems in non-regulated (Bruns et al. 1984) and regulated (Petts, 1984; Petts & Greenwood, 1985) tributary channels; tributary network structure features (Abrahams & Campbell, 1976; Flint, 1980; Abrahams & Updegraph, 1987). In Ukraine, confluence nodes are only becoming a separate object of studies. In general terms, functioning characteristics of confluence nodes, including the example of the Carpathian rivers, are presented in the works of O. Obodovsky (1998, 2017).

Presentation of the main study material. There are 407 permanent watercourses in the Sukil River network, which form 482 confluence nodes. The first-order streams form the largest number of confluence nodes. These are mainly short and low-water streams, the average length of which is 500-600 m. They form 310 confluence nodes of the first order, by the analogy with the order of watercourses, and 56 confluences of the second order. They are located mostly in the mountainous part of the basin. Streams of the second order form 14 confluence nodes of the third order, and one is a confluence node of fourth order. Accordingly, merging of the Sukil River with the Svicha River is the confluence node of the fifth order.

To determine characteristic features of the functioning, morphology and morphodynamics of confluence nodes, three largest confluences in different parts of the basin were selected. They are the confluence of the rivers Bryaza-Shchavyna in the mid-mountain area, Sukil-Besarabka rivers in the inter-mountain basin and Sukil-Svicha rivers in the Pre-Carpathians area (Fig. 1).

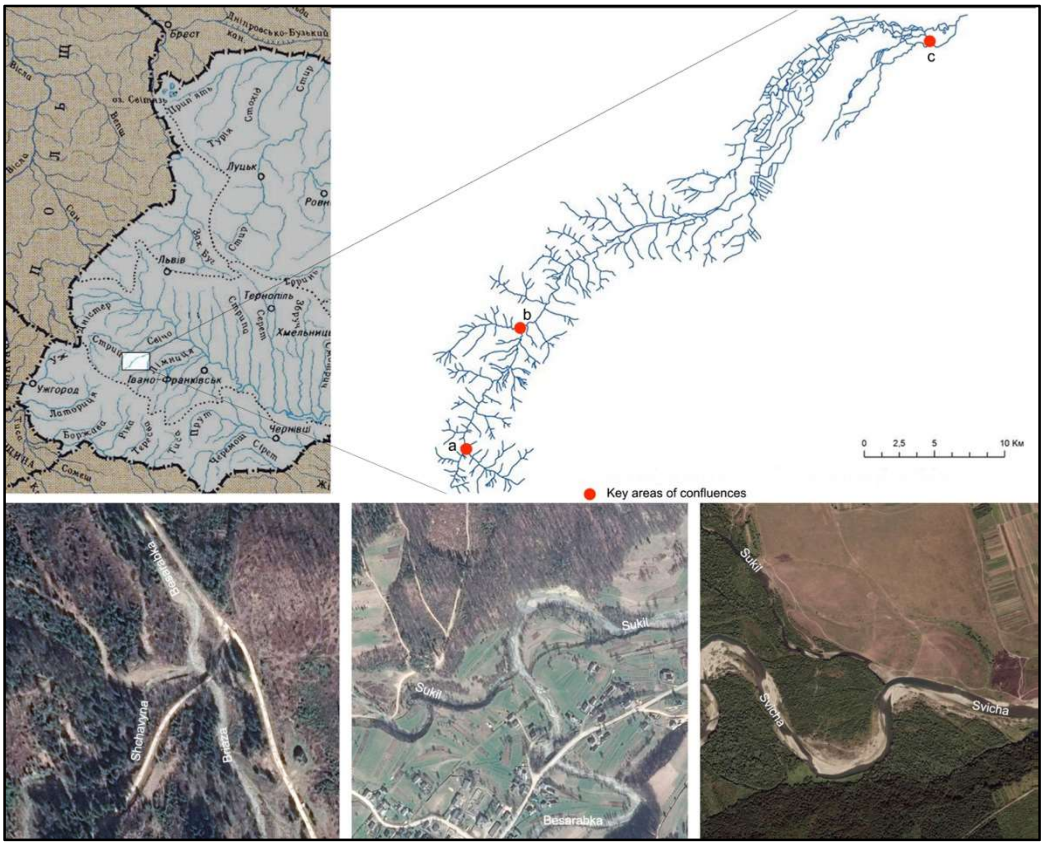

Fig. 1. Location of confluence nodes: a) Bryaza-Shchavyna; b) Sukil-Besarabka; c) Sukil-Svicha [23]

The first confluence node of *Bryaza-Shchavyna* is located in the mountainous part of the Sukil basin, at altitude of 748 m above sea level, on the edge of the advance of the Zelemyanka Skyba tectonic zone on the Parashka Skyba [3]. This is an asymmetric merging of streams of the 3rd order from which the Besarabka River of the 4th order is formed (Fig. 1). The Bryaza River is relatively straight before the confluence, with availability of slightly and moderately rolled boulders and pebbles. The channel has a number of minor accumulative forms that rise slightly above the water level. The floodplain is two-sided and wide for a mountain river, up to 105 m; during floods, additional river arms may be formed (Fig. 2). The Shchavyna River, before confluence with the Bryaza River, has a gentle winding channel made up of slightely rolled boulders and pebbles. The bending of the river is caused by a slight expansion of the valley, decrease in the angle of the river, and Menilite sediments, which are relatively easy subject to lateral erosion. The floodplain is one-sided and it changes sequentially with the bends of the channel; the maximum width is 60 m (Fig.2).

The upper angle of confluence of the Bryaza and Shchavyna rivers is 116°; after the confluence, the merged flow deviates by 45°. This configuration is due to the presence of an accumulative form at the confluence arrow (Fig. 3), formed as a result of a sharp decrease in the transporting capacity of the Shchavyna River when it flows into the Bryaza River, and the erosion caused by waters of the Bryaza River. Considering a significant 2-3% slope of the riverbeds, backwater on the tributary, which contributes to the accumulation of sediments, is unlikely, as two sub-basins of the rivers are in the same physical and geographical conditions; accordingly, the height and duration of floods will also be the same.

According to the morphological classification [5], the Bryaza-Shchavyna confluence is a delta-type, with a river delta at the Shchavyna River (Fig. 3). The delta is composed of boulder-pebble material, accumulated there during floods period. It is worth mentioning that the lower part of the delta is eroded by the waters of the Bryaza River, which indicates the key role of the Bryaza River in the Bryaza-Shchavyna confluence node.

According to Dixon's morphodynamic classification [12], a confluence node is fixed. Available satellite images from years 2009-2020 indicate that there was a change only in the configuration of accumulative forms in the Shchavyna River delta and a slight deviation of the flow at the river mouth (Fig. 2).

a) b)

Fig. 2. Google Earth Pro Satellite images of the Bryaza-Shchavyna confluence node for the years: a) 2009; b) 2020

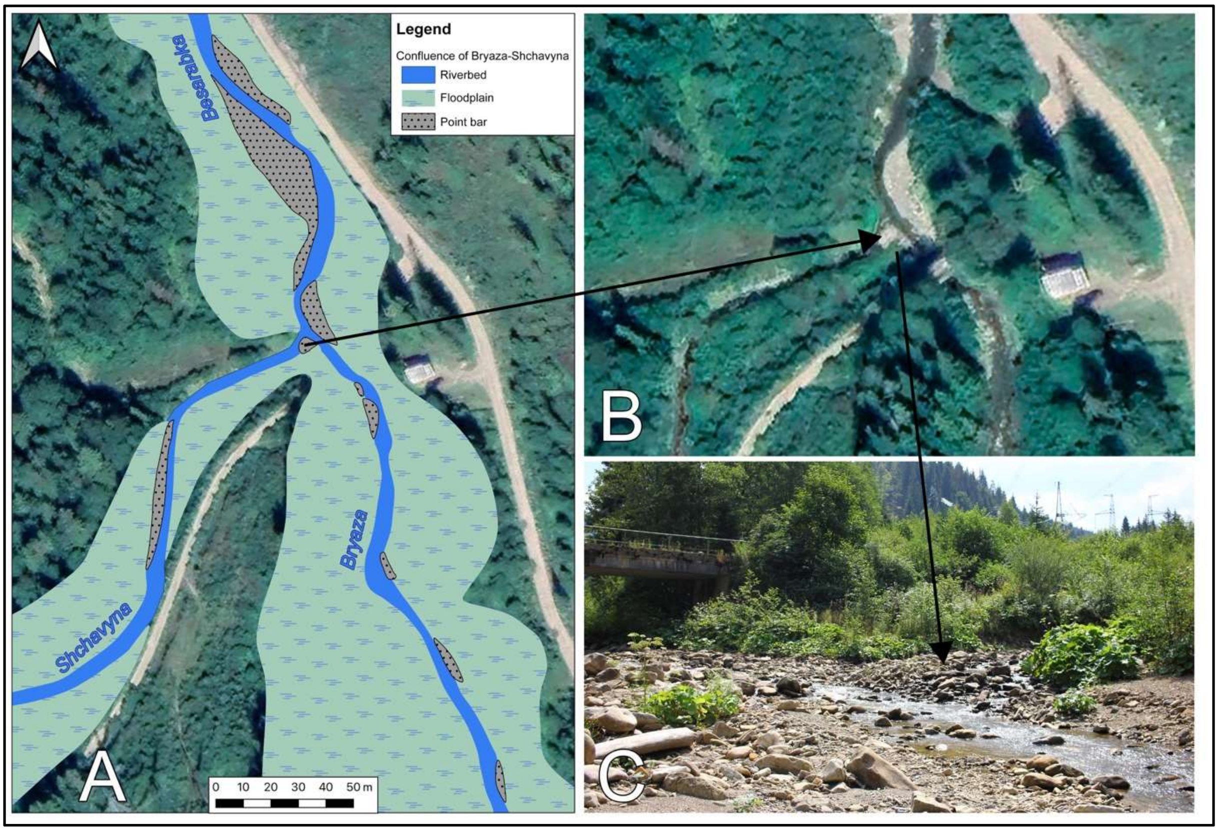

Fig. 3. Bryaza-Shchavyna confluence node in the mountainous part of the Sukil basin (A) flood-plain channel area; (B) satellite image of delta from year 2020; (C) delta in the mouth of the Shchavyna River

After merging, the channel of the newly created river Besarabka is slightly winding, and composed of slightly and moderately rolled boulders and pebbles with well-developed accumulative forms in the form of pointbar up to 60 m long and 16 m wide. This is due to the decrease in the slope of the river to 1.77% after merging and increase of water discharge of the merged channel.

The Sukil-Besarabka confluence node is located in the neighborhood of Kozakivka village, within Skolivska Skyba at altitude of 541.4 meters above sea level, and is an asymmetric confluence of the 3rd-order Sukil stream with the 4th-order Besarabka stream (Fig. 4). The channel of the river Sukil, before the confluence, is straight up to 100 m, and cut into bedrock. At a distance of 100 m or more from the mouth, there are 2 steep meanders, also cuted in bedrock. The channel of the Besarabka River in the neighborhood of Kozakivka village is meandering, cut into bedrock, and composed of medium and well-rolled pebbles. However, at a stretch of 120 m above the confluence, the channel is straight and cut into bedrock as well. Sandstones form cross the channel at an angle of 120-135°. In this section, the river has a slope. Alluvium accumulation is present in the part where rapids are adjacent to the river bank (Fig. 4). After the confluence, the merged channel is meandering; there are 3 fixed bends that then turn into a straight channel. The first meander cuts the left bank of the folded flysch. Despite directed lateral erosion, in 2011-2020 period, the curvature of the meander decreased. The reason for this became the collapse of the 20-meter-high erosive bank that shifted the channel closer to the center of the meandering axis.

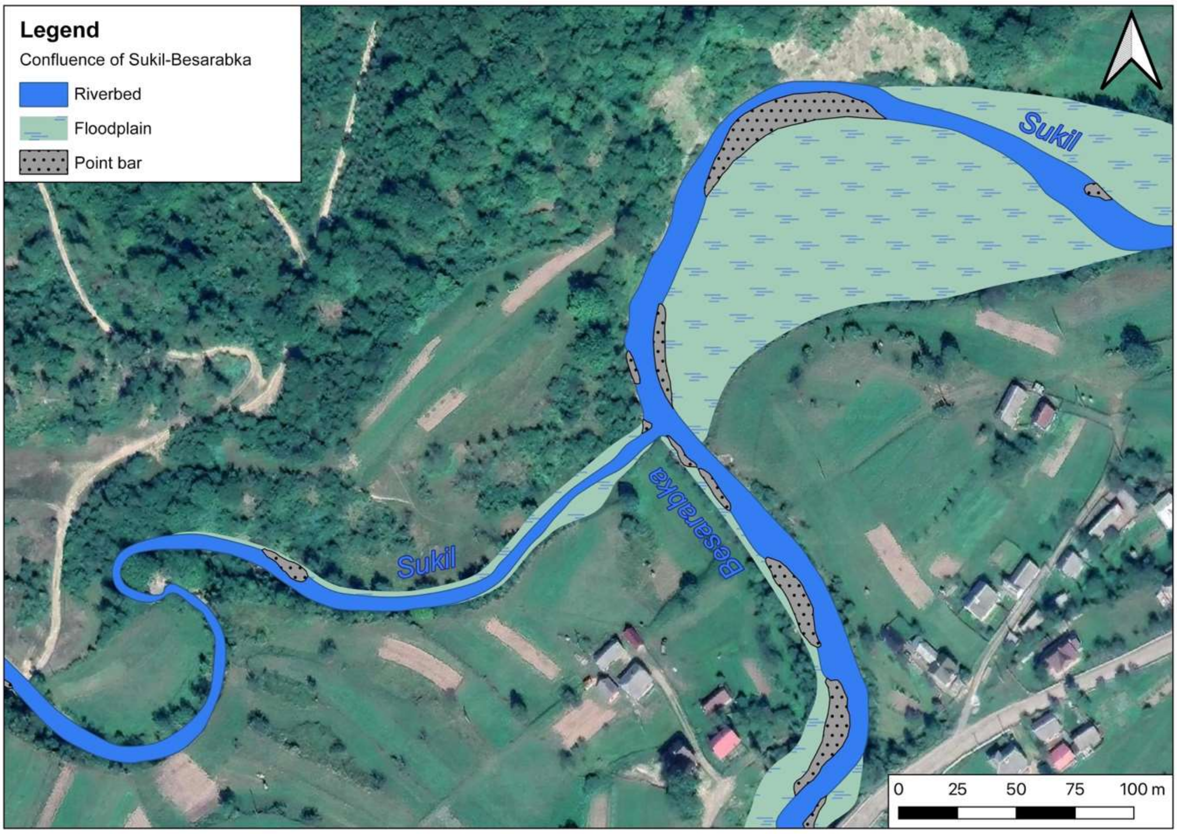

Fig. 4. Sukil-Besarabka confluence node in the vicinity of Kozakivka village

The morphological type of the confluence node is non-delta, simple (Fig. 5). Although a slight accumulation of alluvium was recorded at the confluence of the river Sukil into the river Besarabka, which form a slighty appearance pointbar at the center of merged riverbed. The river Sukil flows into the river Besarabka at the angle of 90°, diverting the merged flow by 30° in the northern direction. This factor and the presence of bedrocks in this part of the river channel led to development of meander and an erosive bank. A backwater on the tributary or main river is unlikely, as both channels have a significant slope before the confluence, and their basins are in the same climatic conditions, which practically makes it impossible for different timing and levels of floods.

The morphodynamic type of the Sukil-Besarabka confluence node is fixed. According to the data from satellite images of various timing and topographic maps of scale 1:25,000 from year 1929 and year 1959, the confluence node did not change its position.

The *Sukil-Svicha* confluence node is located within the Pre-Carpathian depression, in particular Sambir geological structure, which in terrain corresponds to the Peredkarpatska upland. The dynamics of the Svicha riverbed is greater and plays a major role in the dynamics and formation of the confluence node, as the Svicha River has a higher water discharge. According to the data from Lviv Regional Center for Hydrometeorology, average annual water discharge of the Svicha River in Zarichne village (22 m^3/c) is 8 times bigger from the Sukil River in the village of Tysiv (2.7 m^3/c).

The degree of functioning of the confluence node can be analyzed using long-term data. The analysis of topographic maps from different time, Google Earth Pro satellite images and multispectral Landsat 4-7 and Sentinel satellite images made it possible to establish significant different time migrations of the confluence node (Fig. 6) and to single out three main dynamics periods of the Sukil-Svicha confluence node.

Fig. 5. Sukil-Besarabka confluence node in the near of Kozakivka village

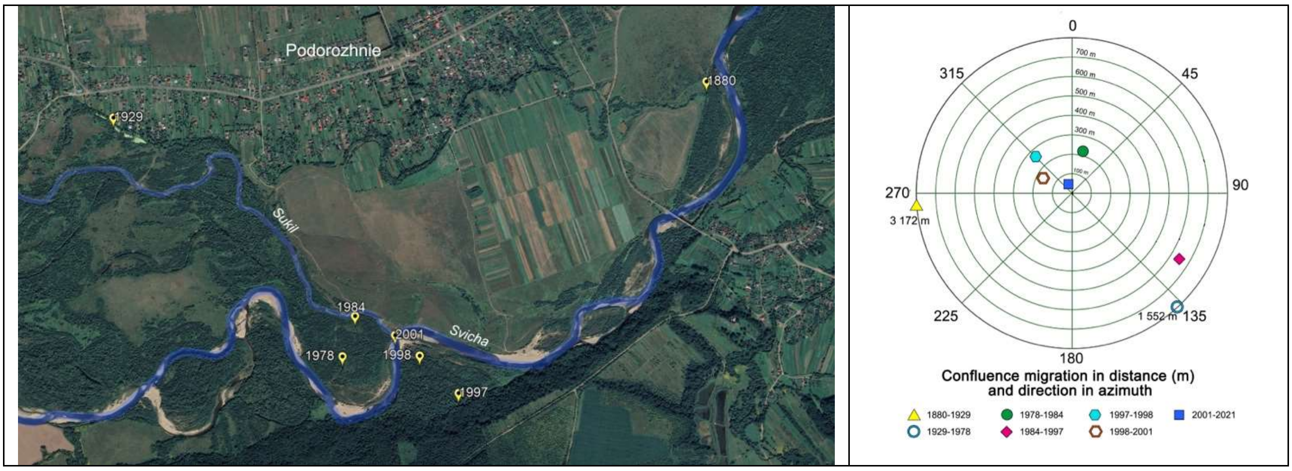

Fig. 6. Location of the Sukil River mouth for the 1880-2021 period on the Google Earth image from 2019 [24]

The first period covers time from 1880 to 1984, and is characterized by maximum displacements of the confluence node. In 1880, the Sukil-Svicha confluence node was located at a distance of 2.8 km to the northeast in comparison with the current location (Fig. 7a). On the map from 1929, the confluence node is significantly shifted and located at the distance of 3172 мeters to the east from its location in 1880. (Fig. 7b). The main reason for this change is a significant horizontal deformation of the Svicha river channel. In the period of 1880-1929, the river channel shifted to the north by 250 meters, which led to the interception of waters of the Sukil River by the Svicha River and formation of a new confluence (Fig. 7a, 7b). A part of the cut-off channel of the Sukil River, 4-km long, turned into a low-active channel that exists today (Fig. 7; Fig. 7b) [24].

In the 1929-1978 period, the river Svicha formed a new channel within a high floodplain (Fig. 7c), which led to the displacement of the Sukil river mouth to southeast by 1,552 meters from the location of the confluence node in 1929 and increase of the Sukil River by 1,700 meters in length. The main Svicha channel turned into a secondary one, connecting the Sukil and Svicha rivers (Fig. 7 b).

The second period (1984-2001) is also marked by displacements of the Sukil-Svicha confluence, although they are much smaller in comparison to the first period. The biggest change in the morphology of the confluence node was recorded in the period of 1991-2001 (Fig. 8). Its maximum displacement was 750 meters, and it occurred in 1993-1994 and was linked with the breakthrough of the neck of the Svicha meander. It is worth noting that during 1989-1990, no displacements of the confluence node were detected, although during these years the maximum water discharge at the hydro measure station in Zarichne village was 515 m^3/s. in 1989. The similar situation was observed in 1997-1998, when maximum water discharge of 834 m^3 was recorded, but the displacement of the confluence node was only 280 meters [24].

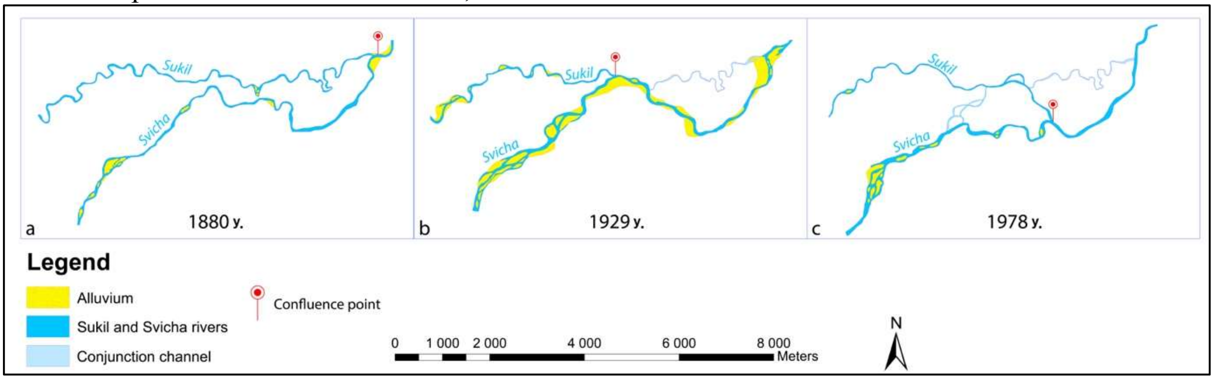

Fig. 7. Merging of rivers Sukil and Svicha in 1880 (a); 1929 (b); 1978 (c) [24]

The third period (2001-2021) is character-rized by stabilization of the Svicha-Sukil confluen-ce node (Fig. 8) when maximal displacements are 25-50 meters. During that period, a number of catastrophic floods occurred, in particular in 2007, 2008, 2010, and 2020. For example, water discharge during the flood in July 2008, according to the data from the hydrological station on the Svicha River in Zarichne village, exceeded the annual average by 57 times, which is the largest indicator for the entire period of observations at this hydrological station. It is important to note that the images from 2008, taken before and after the flood, showed virtually no changes in the morphology of the Svicha and Sukil riverbeds, both within the confluence and in the upstream channels of these rivers (Fig. 9).

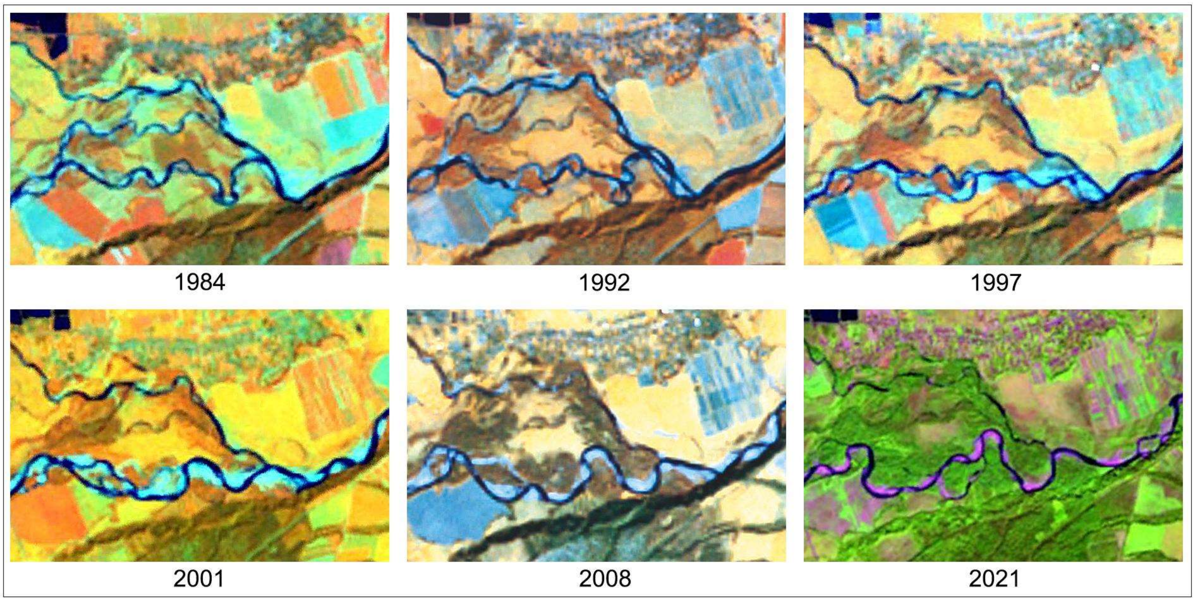

Fig. 8. Landsat multispectral satellite images for the period of active displacements (1978-2001) and the period of stabilization (2001-2021) of the Sukil-Svicha confluence

There are two main possible reasons for the stabilization of the channels and the confluence node. The first is related to changes in the hydrological parameters of the flow during catastrophic floods and the deviation of the main flow axis at the top area of the meanders to the center of the channel and, as a result, minor lateral erosion [21]. The second reason is the localized manifestation of deep erosion in the channel. The latter is evidenced by data from the hydrological station in village Zarichne. Thus, during the 1982-2008 period, the Svicha riverbed deepened by 3.4 m, including 1.6 m in 2008 [2]. Deepening of the channel at the hydrological station in Zarichne village, located about 2 km downstream from the Sukil confluence point, probably contributed to the development of regressive deep erosion, which, accordingly, stabilized the development of horizontal channel deformations within the confluence. The increase in deep erosion of the Svicha River channel is also indicated by the increase in deep erosion in the Sukil channel (area from the confluence to 120 m upstream), which was established by UAV images and field studies.

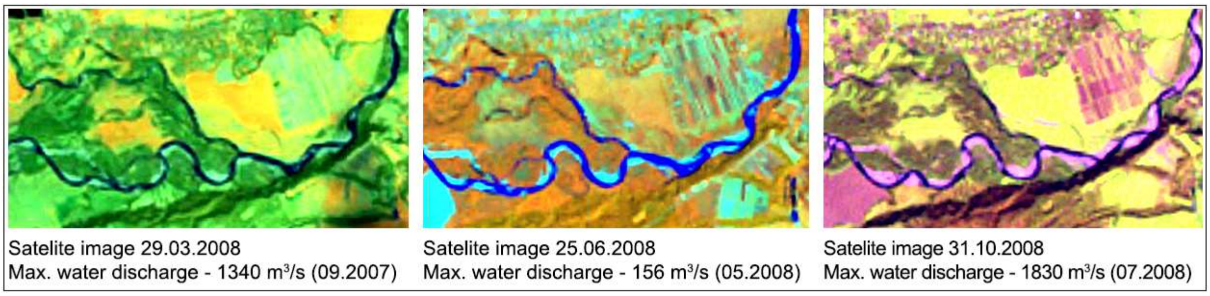

Fig. 9. Landsat multispectral satellite images that show no displacement of the Sukil-Svicha confluence node during the catastrophic flood of 2008 [24]

Fig. 10. Satellite and aerial photographs of the Sukil-Svicha confluence in 2006-2021

A comparative analysis of the 2008 and 2021 images revealed significant horizontal displacements of the Svicha riverbed upstream from the Sukil confluence (Fig. 8). During this period, the maximum horizontal deformations in this section are up to 220 m, the meanders become more omega-shaped and the meandering belt of the Svicha channel increases (Fig. 8). A different trend is observed downstream of the Svicha channel from the mouth of the Sukil River. Here the Svicha River channel straightens and bending decreases (Fig. 8). A significant difference in the manifes-tation of horizontal deformations of the Svicha channel before and after the Sukil's confluence is also indirect evidence of localized deep erosion in the Svicha channel in the section from the mouth of the Sukil River and downstream of the Svicha River.

The backwater from the river Svicha during the catastrophic flood in July 2008 is likely the cause of the formation of the river delta at the mouth of the Sukil River. As the deep eroxion of Svicha River was larger, the basis of erosion of the river Sukil was lowered, which resulting deep erosion from the mouth to 120 m upstream. During high water levels, different water discharge levels are recorded on the rivers Svicha and Sukil, alongside with different periods of flood passage (the water level drop on the Svicha River lasts 2-3 days longer than on the Sukil River); there is backwater from the Svicha River against the Sukil River. This leads to decrease in the flow velocity in the Sukil's mouth part and the accumulation of sediments there during high floods, an increase in the slope of the Sukil's mouth part during the low water period [5]. The formation of the river delta can be seen on Landsat images taken before and after the 2008 flood (Fig. 9) and on Google Earth satellite images (Fig. 10).

River delta, formed at the mouth of the Sukil River, led to decrease in width from 25 meters in 2006 to 6-7 meters in 2013. The size of the delta is growing: in 2013 it was 3,865 m^2, and in 2019 it was 4,355 m^2. The accumulative form size incrised is caused by sediments accumulation in the area near the top. Figure 11 shows a 21-meter shift of the confluence to the northwest between 2006 and 2013, as well as the features of erosion and accumulation processes.

In the 2013-2021 period, vegetation growth was observed on the accumulative form in the Sukil River mouth (Fig. 10). There are two reasons for this. The first is the absence of floods during this period (data from Lviv Regional Center for

Hydrometeorology), and the second reason is a deep erosion of the Sukil channel in the mouth area caused by the deepening of the Svicha channel by 3.4 m in the period of 1982-2008, in particular by 1.6 m in 2008 [2], which reduced the frequency of times for backwater from the river Svicha against the Sukil River.

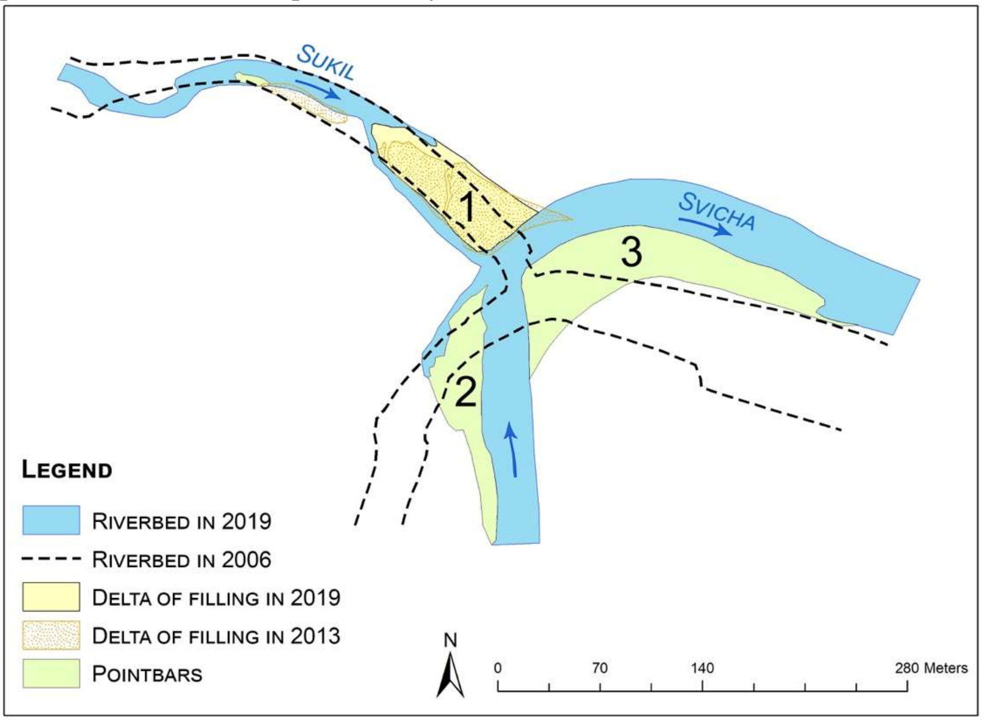

Fig. 11. Configuration of the Sukil-Svicha confluence node in the 2006-2019 period

The analysis of the long-term migration of the Sukil-Svicha river confluence, analysis of its morphodynamics and horizontal deformations of the riverbeds of the two rivers allowed us to identify two probable scenarios for the displacement of the confluence node in the coming years.

First scenario: the confluence node will keep its location. From 2013 to 2021, the displacement of the confluence node is minimal (up to 3 meters). Such a trend will continue in the coming years, as the river Sukil flows into the river Svicha at the top of a meander that shifts downstream at an average rate of 2-5 m/year. Despite the fact that the confluence of the rivers is located on the accumulative section of the Svicha River channel, no changes in these forms are foreseen. The river delta in the Sukil River increases only in the upper part of the accumulative form. The lower part of the form is influenced by lateral erosion of the Svicha flow, which erodes the river delta. The accumulative forms in the Svicha channel are also influenced by the Sukil flow (Fig. 11). Accumulative form No. 2 (Fig. 11) was formed by a riffle in the river that was recorded until 2019. Its growth is due to the formation of a shadow zone at the confluence of two rivers [8]. Accumulative form No. 3 (Fig. 11) has been unstable since 2005 and is constantly changing its configuration. It is influenced by high water conditions, especially by different timing of floods on the merging rivers [8, 9]. Flooding on the river Sukil and low waters at the river Svicha leads to the erosion of accumulative form No. 3 (Fig. 11) in its upper stream due to the high kinetic energy of the flow, and accumulation of sediments in the lower part due to a sharp decrease in energy and transport capacity as a result of the channel widening.

The second scenario is associated with a possible displacement of the confluence node due to a breakthrough of the interfluve by the Svicha River. Potential breakthrough zones have been identified (Fig. 12).

The interfluve in zone A (Fig. 12) decreased from 120 m to 115 m between 2015 and 2019, and in the period of 2019-2023 it decreased further to 62 m. This sudden and rapid bank erosion is due to the meandering of the Svicha River and the flood in 2020, which caused the main channel-forming river discharge [1]. In the flood-free period from 2015 to 2019, the bank retreated at an average rate of 2 m/year. In the period of severe flooding in 2020, it was 12 m/year. Under a normal hydrological regime of two years, with a frequency of severe flooding every 8-12 years, the Svicha River will connect with the Sukil River by 2030. This will result in a 460-meter shift of the confluence to the northwest and a 485-meter reduction in the length of the river Sukil.

A potential breakthrough is also located in Zone B (Figure 12). The active development of the meander in this part has led to a decrease in the interfluve from 240 m in 2015 to 180 m in 2019, and to 80 m in 2023. The bend of the Svicha meander in this part of the channel has reached the most favorable value of *l*=1,40*L*, according to which the increase in the flow's kinetic energy at the bend is 50-80% [5], which led to the intensive development of lateral erosion. Under this scenario, the Sukil confluence will shift to the northwest by 560 meters and its length will decrease by 640 meters. If the erosion rate trend of 20-25 m/year is maintained, the breakthrough of the interfluve in Zone B could be in 2026-2027. However, an alternative scenario is also possible, when during a flood the Svicha River cuts a new channel at the neck of the meander, and formation of a new confluence node, as a result of the interfluve breakthrough, would not occur.

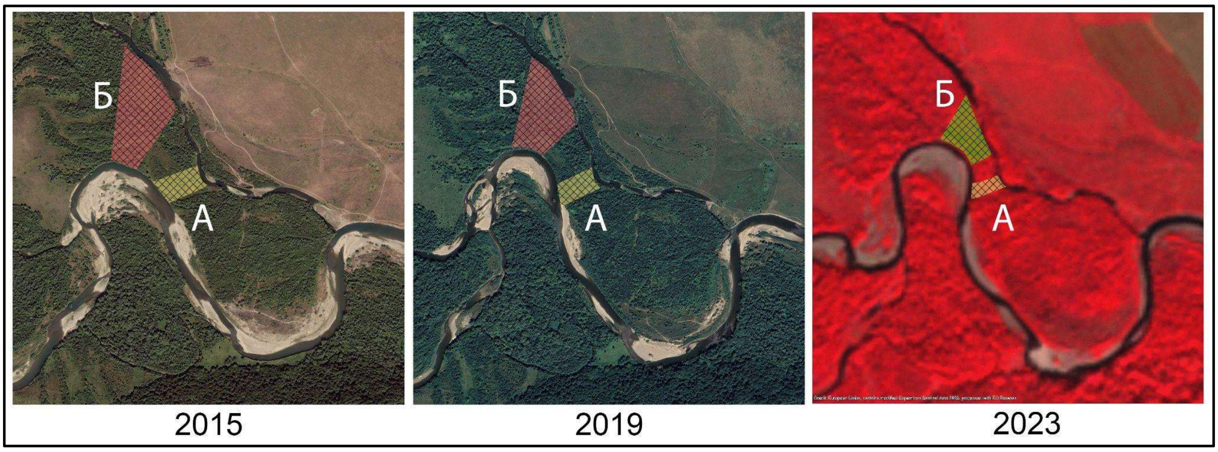

Fig. 12. Potential breakthrough zones between the Sukil and Svicha rivers with the formation of a new confluence node (Source: Google Earth Pro; Sentinel-hub)

Conclusions. The analysis of the three largest confluences in the Sukil basin revealed that: the Bryaza-Shchavyna confluence is located in the mountainous part and is asymmetrical, of delta type, and fixed; the Sukil-Besarabka confluence is located in the intermountain basin, and is asymmetrical, of delta type, and fixed; the Sukil-Svicha confluence is located in the Peredkarpatska upland and is a Y-shaped confluence with a river delta on the Sukil River. The displacement of the confluence is due to the meandering of the main river. Three probable scenarios for the displacement of the Sukil-Svicha confluence in the coming years have also been identified.

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Анотація:

Назар РИБАК, Лідія ДУБІС. ОСОБЛИВОСТІ ФУНКЦІОНУВАННЯ ВУЗЛІВ ЗЛИТТЯ РІК В БАСЕЙНІ РІЧКИ СУКІЛЬ

У статті проаналізовано морфодинаміку вузлів злиття річок різного порядку в басейні річки Сукіль, верхня частина якого знаходиться у межах Скибових Карпат, а нижня – у межах Передкарпатського прогину. Її вивчення ґрунтувалося на польових та картографічних методах досліджень, у тім числі на аналізі різночасових топографічних карт та супутникових знімків Google Earth Pro із використанням програмного середовища QGIS. Аналізовані супутникові знімки охоплюють період 2006–2022 рр., з максимальними паводками у 2008 та 2010 рр., під час яких відбулися найбільші горизонтальні деформації русел, максимально проявилася ерозійно-акумулятивна діяльність водних потоків, що є ключовим у морфодинаміці вузлів злиття.

Згідно з проведеними дослідження у структурній організації річкової мережі Сукелю налічується 407 водотоків різного порядку за класифікацією Хортона–Страллера. Вони формують 382 вузли злиття. Домінуючими є вузли, утворені злиттям водотоків першого і другого порядку у гірській частині басейну, які є стійкими через домінування глибинної ерозії у межах їхнього злиттях. Найбільшу морфодинаміку мають вузли злиття річок вищих порядків. Їхній аналіз дав змогу виокремити три ключові вузли злиття у басейні Сукелю – Бряза–Щавина, Сукіль–Бесарабка та Сукіль–Свіча. Річки, що їх утворюють, значно відрізняться геолого-геоморфологічними умовами, водністю, проявом та інтенсивністю розвитку руслових процесів, що й зумовило суттєві відмінності у функціонуванні, морфології та морфодинаміці досліджуваних вузлів злиття.

Перший вузол злиття Бряза–Щавина розташований у Скибових Карпатах, на висоті 748 м н. р. м., є асиметричним злиттям потоків 3-го порядку, з яких утворюється річка 4-го порядку – Бесарабка. За морфологічною класифікацією він зачислений до дельтового типу з дельтою виповнення у руслі Щавини, а за морфодинамічною класифікацією – до фіксованого (стабільного). Дельта виповнення складена з валунно-галечникового матеріалу, акумульованого головно у період повеней і паводків. Нижня частина дельти виповнення розмивається водами Брязи, що свідчить про ключову її роль у функціонуванні вузла злиття Бряза–Щавина.

Вузол злиття Сукіль–Бесарабка розташований на висоті 541,4 м н. р. м. у міжгірській улоговині в околицях с. Козаківка. Характеризується асиметричним злиття двох потоків 3-го і 4-го порядку. Сукіль впадає у Бесарабку під прямим кутом, відхиляючи об'єднаний потік на 30° у північному напрямку, що головно зумовило розвиток бокової ерозії та утворення меандри. Аналіз різночасових супутникових знімків і топографічних карт масштабу 1:25 000 засвідчив, що вузол злиття не змінив свого положення у плані. Отож за морфодинамічним типом вузол злиття зачислений до фіксованого, а за морфологічним типом – до бездельтового простого.

Вузол злиття Сукіль–Свіча знаходиться на Передкарпатській височині у межах Передкарпатського прогину. З 1880 до 2021 року виокремлено 3 періоди динаміки вузла злиття Сукіль–Свіча у плані. Перший період – 1880–1984 рр. характеризується максимальними зміщеннями вузла злиття у плані. Максимальне зміщення становить 2,8 км і спричинене перехопленням Свічею русла Сукелю, що призвело до утворення нового вузла злиття. Другий період – 1984–2001 рр. характеризується багаторазовими, але меншими зміщеннями до 750 м. Третій період – 2001–2021 рр. характеризується стабілізацією вузла злиття Свіча–Сукіль, максимальні зміщення становлять 25–50 м. З 2008 р. в гирлі Сукелю утворюється дельта виповнення. Головною умовою її формування є підпір вод Сукелю водами Свічі під час паводків. Виокремлено два ймовірні сценарії зміщення вузла злиття в плані у найближчі роки. Перший – вузол збереже своє сучасне розташування. Другий – сформується новий вузол злиття внаслідок розвитку горизонтальних деформацій русла Свічі, прориву межиріччя та перехоплення русла Сукелю. За морфологічним типом вузол злиття Сукіль–Свіча є дельтового типу з дельтою виповнення у руслі Сукелю. Головним механізмом багаторічної морфодинаміки цього вузла злиття є горизонтальні деформації, що відбуваються шляхом розвитку бічної ерозії русла Свічі.

Вивчення функціонування вузлів злиття річок Карпатського регіону є важливим з позиції розуміння механізмів функціонування басейнових систем, у тім числі формування та проходження повеней і паводків, особливостей розвитку горизонтальних деформацій русла, а отже розробки пропозицій протипаводкових заходів.

Ключові слова: вузли злиття рік, функціонування, морфодинаміка, Сукіль, русло.

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