ACTA GEOBALCANICA
8-4, 2022, pp. 123-128

CHANGES OF THE HYDROGRAPHIC CONFLUENCE IN SIELPIA FROM THE BEGINNING OF THE 19TH CENTURY (OLD-POLISH INDUSTRIAL DISTRICT)

DOI: *https://doi.org/10.18509/AGB218-4123k*
UDC: *903.8:911.374.4]:551.435.1(438)"18"*

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submitted: *10.03.2021*
accepted: *08.05.2021*
published: *10.09.2021*

Abstract
The case study of the hydrographic confluence in the Sielpia based on the cartographic method allowed to capture changes in the hydrographic network related to the development and decline of the Old-Polish Industrial District (OPID), which was based on the use of hydropower in iron metallurgy. The formation and disappearance of artificial industrial reservoirs and canals, and also changes of the rivers course, were reflected in cartographic materials.

Keywords: river network changes, hydrographic confluence, Old-Polish Industrial District.

INTRODUCTION

The study area is located in the Polish Uplands [1], in the Holy Cross Mts. region, in the Vistula river basin [2]. The hydrographic confluence in Sielpia is located within the Old-Polish Industrial District (OPID) where iron ores were extracted and processed on a large scale in the last centuries [3]. The hydropower of rivers was then used for metallurgy. The anthropogenic small-scale water retention system (ASWRS) was created, consisting of numerous canals and ponds, which supplied water to ironworks [4]. The hydrographic confluence in Sielpia is located at the junction of two riverbeds (Czarna Konecka and Czarna Taraska rivers), draining the NW margin of the Holy Cross Mts. (Fig. 1).

The analysis of changes in a river network based on cartographic materials was frequently published. This analytic method, especially when verified by geomorphological field research, provides a good tool for tracing changes in fluvial environments during last centuries [5] [6] [7] [8] [9] [10] [11] [12] [13] [14] [15].

AIM AND METHODS

The aim of this study is to determine the impact of the development and decline of OPID on the transformation of the hydrographic confluence at Sielpia in recent centuries. Historical and cartographic materials from XIX, XX and XXI century were used:

1.West Gallizien, topicality:1801-1804
2.Topographic Map of the Polish Kingdom, sheet: Końskie, topicality: 1822-1831, the year of publishment: 1843
3.Map of the General Staff the Red Army of Workers and Peasants, sheet: Końskie, topicality: 1893-1898, the year of publishment: 1940
4.West Osteuropa, sheet: Gruppe Warschau XXVII-7-F, topicality: 1914-195, the year of publishment: 1915
5.Tactical Map of Poland, sheet: Końskie, topicality: 1937-1938, the year of publishment: 1938
6.Detailed Geological Map of Poland, sheet: Radoszyce, topicality: 1945-1953, the year of publishment: 1968
7.Topographic Map, sheet: Końskie, topicality: 1974, the year of publishment: 2000
8.Topographic Map, sheet: Nowy Dziebałtów, topicality: 1985
9.Orthophotomap, topicality: 2003/2004
10.Orthophotomap, topicality: 2010
11.Orthophotomap, topicality: 2018
12.Orthophotomap, topicality: 2019/2020.

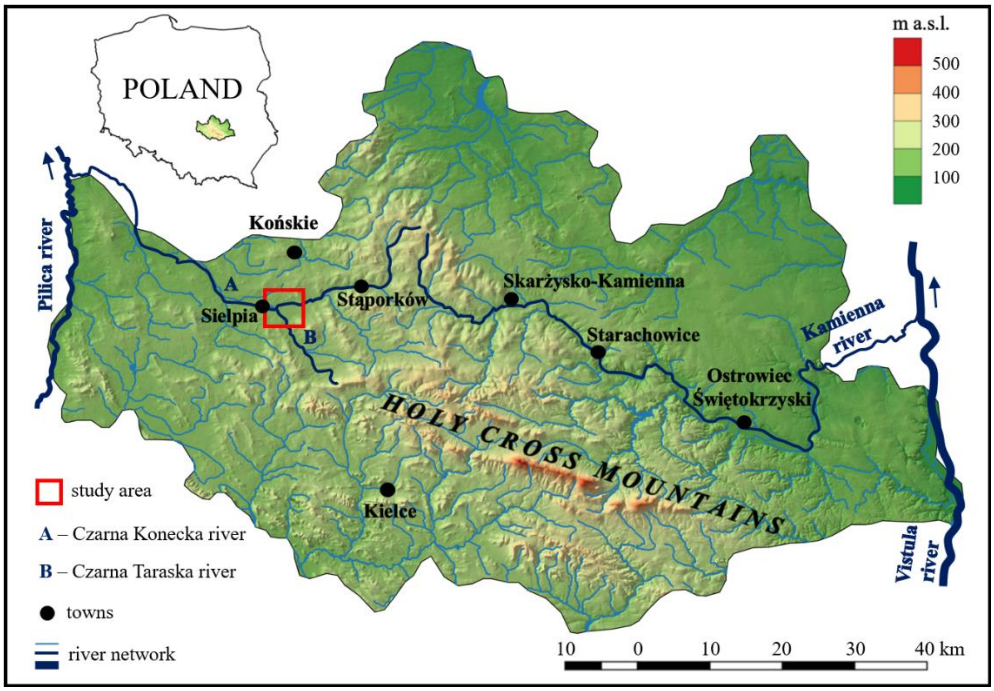


Figure 1. Location of the study area on the Digital Elevaton Model (DEM) of Old-Polish Industrial District (boundaries of the OPID according to A. Borkiewicz) Results are presented graphically using INKSCAPE and QGIS software.

RESULTS

Cartographic materials show changes of the river network from the beginning of the 19th c. to the present time (Fig. 2). Around 1800, there was no reservoir in Sielpia and the Czarna Konecka river had an anastomosing pattern on its 1.5 km long section upstream of connection with Czarna Taraska river. At that time, by the scythe factory [3] in Czarna Taraska river, there was a reservoir from which three channels were diverging, joining each other about 0.5 km downstream of the dam. Czarna Taraska river connected with one of the side riverbed branches (the most southern one) of Czarna Konecka river in Sielpia, and after another 200 m it flowed into the main, northern riverbed of this river (Fig. 2A). The decline of the scythe factory contributed to the disappearance of the pond on Czarna Taraska river already in the second decade of the 19th c. At that time, in the area of the dried-up pond, a double-channel system developed along a 1 km section of the watercourse (Fig. 2B). The estuary section of the Czarna Taraska river also changed, as it flowed N along a straight channel.

Its natural meandering channel (Fig. 2A) is not marked on the map of the Kingdom of Poland (Fig. 2B), as it was probably dry at that time, and all the flow was directed to the anthropogenic canal diverting water to the N. Changing the course of the Czarna Taraska river may have been connected with the construction of the reservoir in Sielpia in 1821 (hydrotechnical works). The reservoir in Sielpia was constructed in the third decade of the 19th c. In 1837, it was expanded to include the southern water body [16], which was separated by a causeway from the pre-existing lake. At the end of the 19th c., there was an island in the center of this southern water body and an elongate peninsula in the eastern part. Czarna Konecka river and Czarna Taraska river flowed into a small bay north of it, whereas the southern bay was reached by a natural, water-filled meandering abandoned channel of the Czarna Taraska river starting at the causeway of a drained pond in Świnków (Fig. 2C). Re-filling with water of this oxbow lake was probably connected with the existence of a system of water regulation and distribution on this dyke.

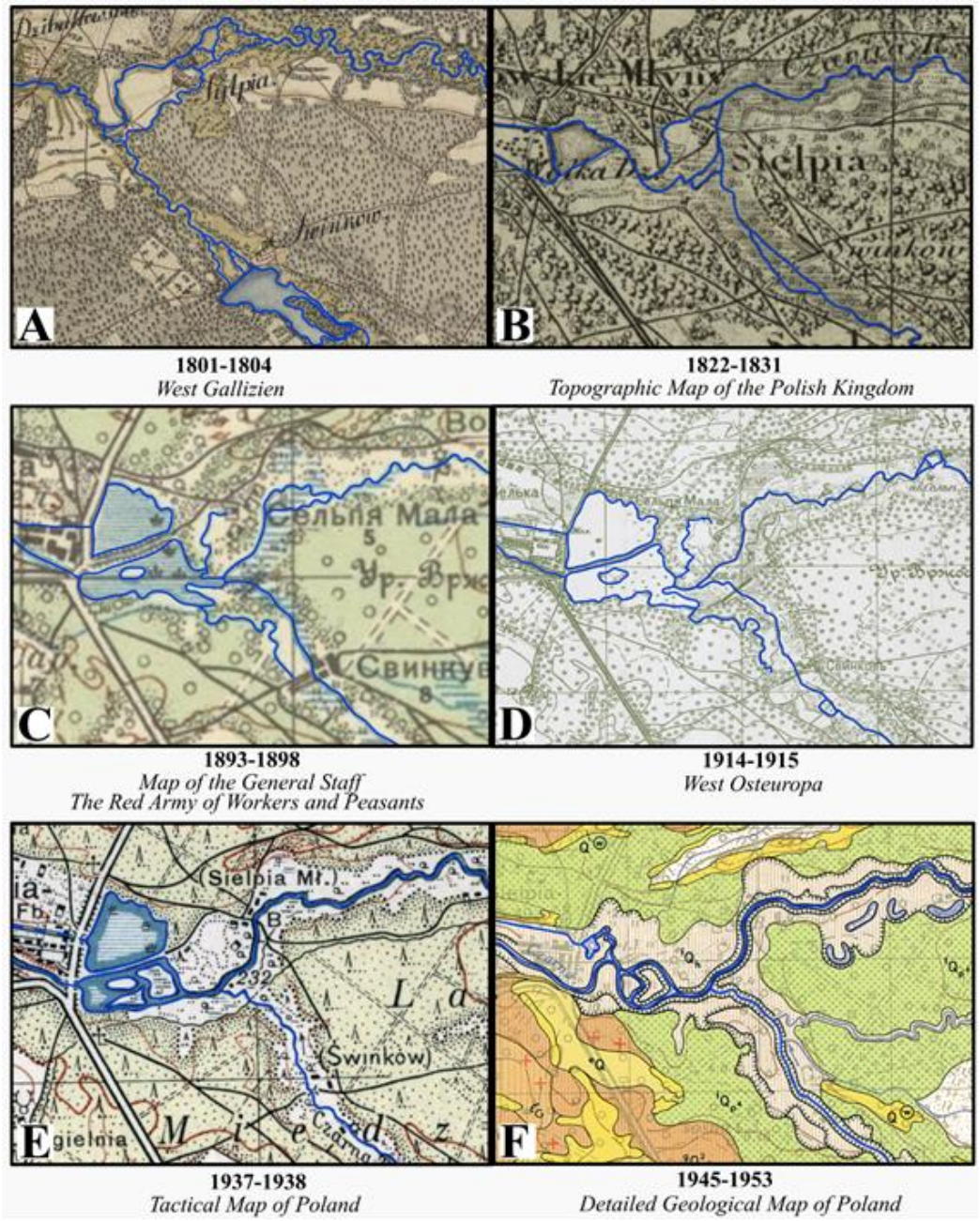
In the 19th c., the anastomosing section of the Czarna Konecka river upstream of the reservoir in Sielpia was regulated. The northern channel became an oxbow lake, the southern one was straightened. Hydrotechnical works led also to the disappearance of the anastomosis of Czarna Taraska river near Świnków. The floors of both valleys became swampy (Fig. 2A-C).

Until the outbreak of World War I, the northern bay in Sielpia reservoir was completely terrestrialzed and both rivers flowed into it, accumulating an inland delta. The southern bay remained unchanged (Fig. 2C-D), which indicates that the meandering abandoned channel of the Czarna Taraska river was filled with water, but flows therein must have been small and regulated by human. In the early 20th c., a mill and a small pond were constructed on the Czarna Konecka river (Fig. 2D). However, it was a short-lived situation, as already in the interwar

period the pond disappeared and the river upstream of the reservoir in Sielpia flowed along a single channel, whose sinuosity decreased until the mid-20th c. (Fig. 2D-F).

In the interwar period, probably after the decline of the ironworks in Sielpia (1921) and the neglect of hydrotechnical infrastructure, the southern water body of the Sielpia reservoir became very silted and three islands were formed (Fig. 2E). This was probably also the reason for the final drying of the abandoned channel of the Czarna Taraska river. There was also a significant reduction of wetland areas (Fig. 2D-E). Even before the outbreak of World War II, the Sielpia reservoir ceased to exist, as the flood of 11-15 May 1939 [17] destroyed both water bodies, and the retreating Polish army in September of that year tore down the bridge with the hydrotechnical infrastructure [18]. In the drained reservoir depression, a multi-channel system was functioning. The course of individual riverbed branches referred to the morphology of the lake depression (islands, delta) and was determined by the location of the destroyed two weirs (southern and northern) towards which the water was directed. The main branch of the Czarna Konecka river used the southern weir, and near the northern weir existed a small pond (Fig. 2F).

A new reservoir in Sielpia was constructed in 1962 [18]. It was a single water body with two small islands (Fig. 2G). Cartographic materials from Polish People's Republic times (Fig. 2F-H) show the gradual and slow development of the Czarna Konecka delta in the SE part of this reservoir, as well as the development and cut off of the meander, located about 0.5 km downstream of the former short-lived mill pond (comp. Fig. 2D).



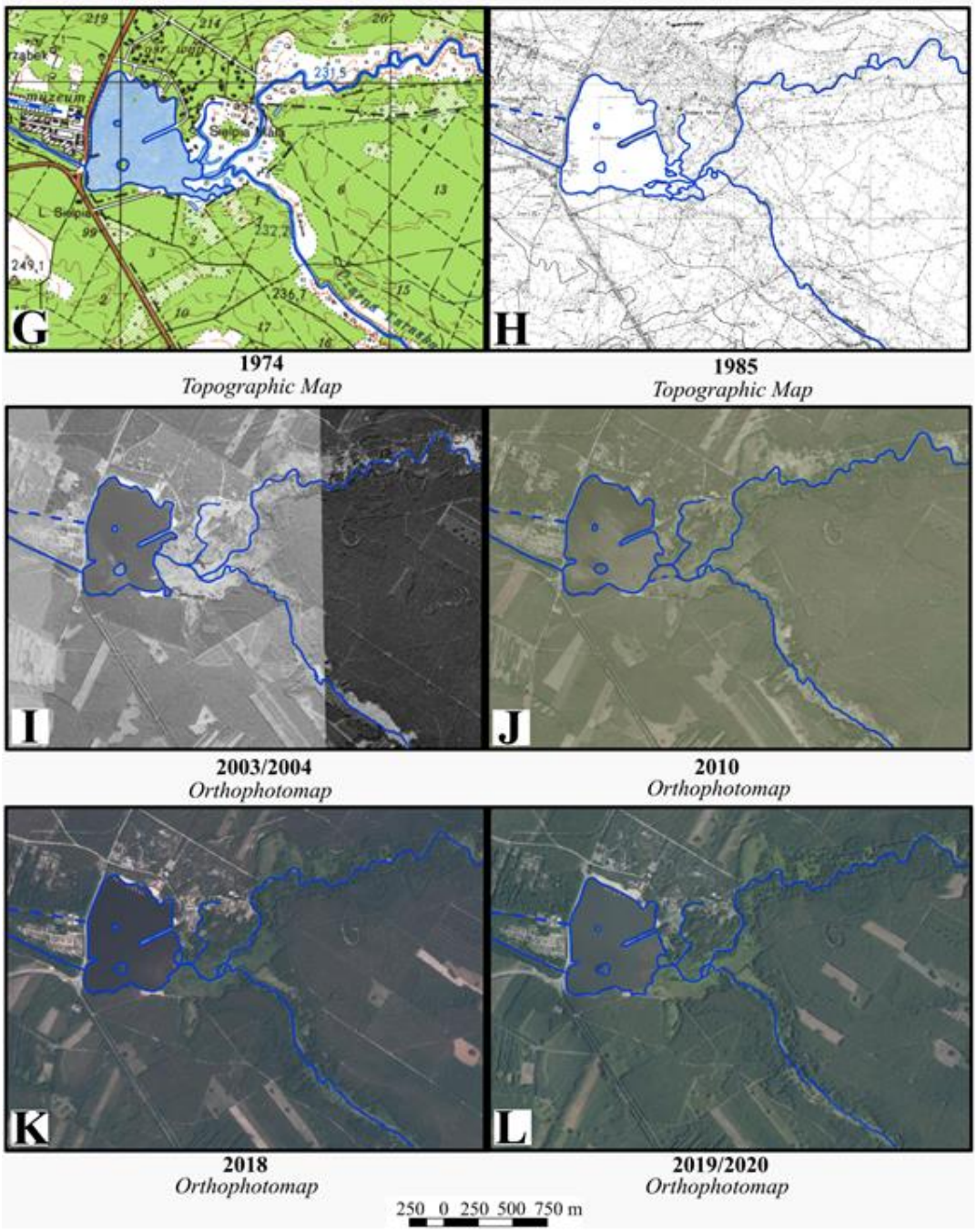


Figure 2. Hydrographic confluence in Sielpia on cartographic materials from the last centuries [15 modified]

The silting rate of the Sielpia reservoir probably increased in the 1990s. In 2003 its entire eastern part was filled with an extensive inland delta. In the following years, this delta must have been dredged out, because in 2010 it occupies an incomparably smaller area (Fig. 2I-J). In the last decade the reservoir has been silted once again, although the size of the delta (Fig. 3) is much smaller than in 2003. As of 2018, sediment dredging and reservoir revitalization efforts have resumed (Fig. 2K-L). In the present-day, both rivers have a single-channel system. The meanders of the Czarna Konecka river do not show significant changes in the last thirty years, while the estuary section of the Czarna Taraska river has become more sinusoidal (Fig. 2H-L) due to natural fluvial processes leading to the transformation of a straight artificial canal into a natural meandering channel [15].

Figure 3. Inland delta in the Sielpia reservoir in 2018 (photo by K. Ociepa)

CONCLUSIONS

In the last two centuries, a transformation of the hydrographic confluence in Sielpia took place, which was associated with the development and decline of OPID and later milling (appearance and disappearance ASWRS). This transformation rested on regulation and channelization of watercourse sections, construction and disappearance of water bodies, or also changes in river patterns. Similar environmental changes have been reported also in other areas of the OPID [4] [13] [14] [19].

Some changes in the river network noted in the study area (e.g. channels straightening) are typical for highly human-transformed valleys, located in various parts of the World, especially in Europe [8] [12]. The anthropogenic impact on hydrographic confluences in such valleys can be very large [5] [20] [21].

Acknowledgments

The authors thank Mr Krzysztof Ociepa for making available the aerial photographs from 2018, illustrating the inland delta in the Sielpia reservoir.

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