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THE DYNAMICS OF THE MINOR RIVERBED OF TESLUI RIVER IN RELATION TO THE HUMAN FACTOR (1910-2008) - CASE STUDY: REŞCA - FĂRCAŞELE DE JOS SECTOR

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Abstract: Teslui River has suffered during the last century (1910-2008) important changes that have been reflected both in the morphology of the drainage canal (the minor riverbed) and in the natural hydrological regime. These changes concern mostly the relation between the anthropic factor and the minor riverbed, which is often subjected to an increasingly intense human pressure. The present study analyses the riverbed section situated between Reşca and Fărcaşele de Jos, by presenting a general image of the spatial dynamics of the minor riverbed of Teslui, based on recent cartographic materials (topographical maps, aerial images and Landsat images).

Key words: dynamics, minor riverbed, morphometrics, anthropization

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INTRODUCTION

The present study aims to achieve a detailed analysis of the vertical and horizontal dynamics of a river sector, on the basis of cartographic materials and direct observations obtained from the field research.

Over time, changes in the minor riverbed can have a negative impact on human activities, especially when the adjacent flood plain is densely populated (Rapp et al., 2003).

Thus, changes in the geometry of the minor riverbed have generated negative effects on human society and the environment, destruction of hydro-technical works (bridges, dykes, consolidation of river banks) and have caused losses of agricultural land (Radoane & al., 2005).

In this respect, studies on the historical dynamics of water courses have enjoyed greater attention in recent years, in order to recreate, on the one hand, the natural behavior of the river (by using historical data), and to determine the present conditions of evolution, on the other (Feier & Radoane, 2007).

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STUDY AREA

The riverbed sector between Reşca and Fărcaşele de Jos, analyzed in this study, is located in the eastern part of the Oltenia Plain (The Plain of Caracal) and represents the last part of the lower course of Teslui, more precisely the confluence between Teslui and Olt.

From a mathematical perspective, the area is located at the meeting point of the 44º10' northern latitude parallel and the 24º22'30" eastern longitude meridian (figure 1).

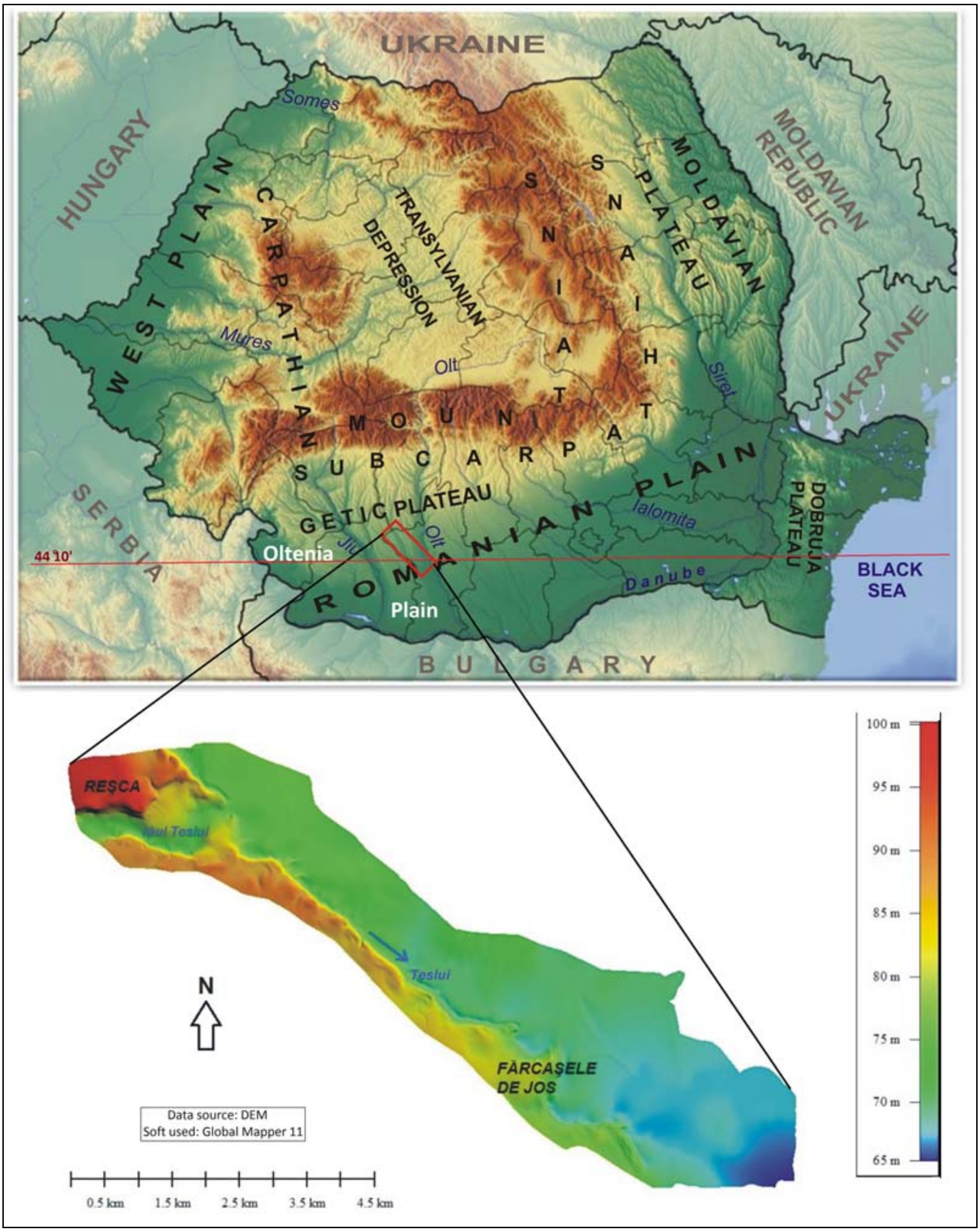

Figure 1. The geographic position of the riverbed sector Reşca - Fărcaşele de Jos (Teslui) in Romania
(Source: SRTM)

The riverbed sector that forms the object of this study has a length of 13 Km, (around 12% of Teslui’s total length), an average slope of 0.7 m/km, a liquid multiannual flow of 1.6 m³/s and a solid (alluvium) multiannual flow of 0.99 kg/km (the data was provided by the Reșca hydrometric station, which is included in the studied area). Generally, changes occurring in minor riverbeds are determined by a series of factors such as lithology, geological structure, solid flow, liquid flow, vegetation, tributaries and, above all, human activities (Popa & Condurache, 1997).

Natural factors play an indirect role in influencing the dynamics of Teslui’s riverbed. Thus, the lithology of this area is made up of lowland quaternary deposits composed of fine or medium gravel, alternating with clay sands, situated above the Pliocene deposits of the Getic Depression (Savin, 2008). These deposits are easily swept by an accelerated flow of water. In addition, the liquid flow of the river is an important factor in the evolution of the minor riverbed, because it generates flash floods that cause changes in the course, self-capturing meanders and alluvial deposits. The minor riverbed of Teslui, downstream of Reșca, exhibits numerous meanders due to a reduced water flow. In recent times, the highest flows have been recorded at Reșca hydrometric station in 2005 (4,41m³/s) and 2006 (2,18m³/s), when major flash floods occurred, severely impacting the lateral dynamics of the river’s course. When there is an excessive solid flow and the slope remains constant, the river loses its ability to carry the entire amount of alluviums, and the amount that cannot be carried away is deposited, forming isles and banks. Between Reșca and Fărcașele de Jos, Teslui river receives its last left-side tributary, Potopinu, and a series of small, undeveloped torrential organisms on its right side, which is more developed. Torrential precipitations significantly increase the amount of sediments. The present study emphasizes the anthropic factor, which is very important for the lateral dynamics of Teslui’s minor riverbed downstream from Reșca. The anthropic impact is an important problem in the entire river basin, but much more in the minor riverbed, where it takes the form of damming, changes in the water course, bridge building.

METHODOLOGY

In order to describe the dynamics of Teslui’s minor river bed in the studied sector (Reșca-Fărcașele de Jos), two research methods, frequently employed in geographical studies, were used: the qualitative method and the quantitative method.

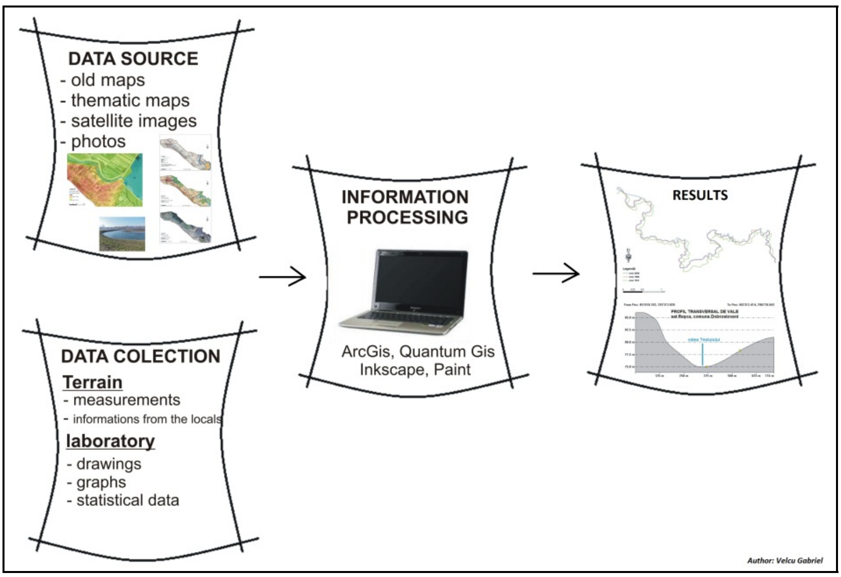

Figure 2. Simplified methodological diagram (Olt – Teslui confluence sector)

The first method is exemplified by the mapping of Teslui’s minor riverbed in three distinct cartographic materials, by means of GIS techniques.

The starting point was the cartographical document so called *„Drawing Master Plan”*, with a scale of 1:20.000, in a Lambert-Cholesky projection, made in 1910, more specifically the Caracal and Dăneasa (Olt County) sheets.

The second cartographic material used for creating the digital terrain model (DEM) by extracting the contour lines and the altitudes is the topographic map (1980), with a scale of 1:25.000, drafted by the Military Topography Department.

The most recent materials that confirm the dynamics of Teslui’s riverbed are the aerial mappings, with a scale of 1:5.000, from 2008. The vector information resulting from digitizing the cartographic materials was then overlaid, in order to create a map of Teslui’s riverbed dynamics that can be used for various measurements. The quantitative method aimed to extract specific morphometric parameters for the horizontal behaviour of the riverbed, such as the length and width of the minor riverbed and the degree of meandering, elements that allow for a thorough analysis of the river’s configuration and dynamics over time and space.

The entire methodology of the study can be summarised by a simple diagram (figure 2).

RESULTS AND DISCUSSIONS

General aspects of the riverbed’s dynamics, as determined on the basis of cartographic materials**.** Drawing Master Plans (scale of 1:20.000, from 1910) are the instruments that explain the evolution of Teslui River in the first half of the 20th century. The river’s course was completely different from its present state. It was possible to distinguish three sectors of braiding: the first one, at the exit point of Teslui from the village of Reșca, the second one, more evolved, next to the village of Hotărani, and the third, the most evolved of the three, on the north-eastern limits of Fărcașa de Sus (figure 3).

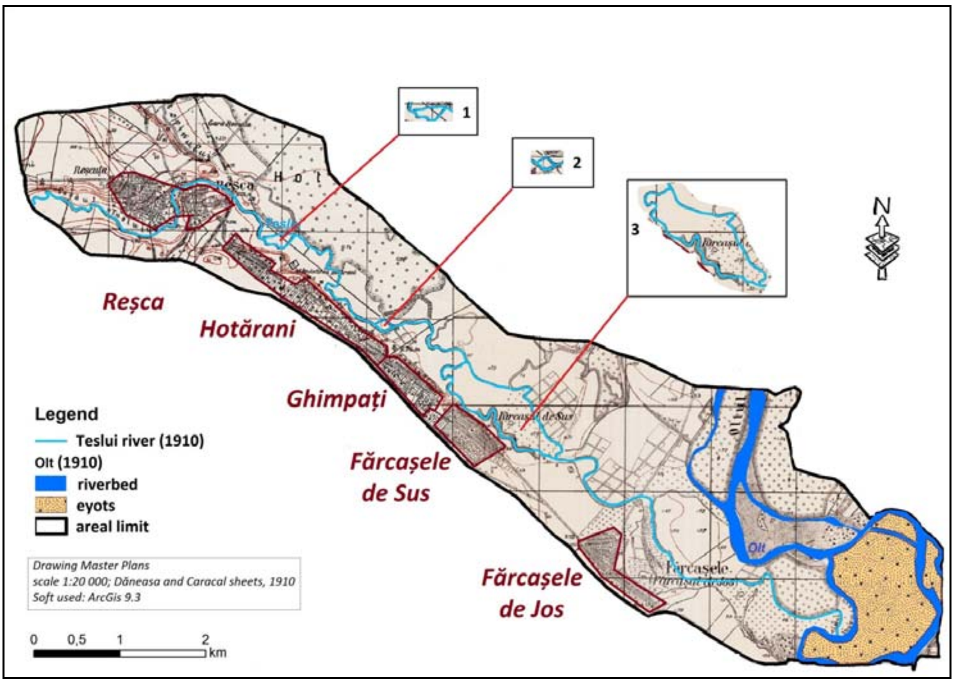

Figure 3. The dynamics of Teslui’s riverbed and the position of the braiding areas in the Resca - Farcasele de Jos sector
(Source: Drawing Master Plans, 1910)

The minor riverbeds of Teslui and Olt rivers are very dynamic during this period. Particularly at the confluence of these rivers, there is a strong development of accumulation forms, such as scroll bars and eyots. Insignificant human interventions are limited to a couple of drainage canals built in the flood plain of Teslui river. Olt River is presented on maps as not being channelled and very unbraided. Also, the point where Teslui spills into the Olt is the southernmost point (figure 4).

The topographic map (with a scale of 1:25.000, from 1980) is different from the map previously presented, both in terms of the evolution of river bends and because of the construction of irrigation systems. The system of dykes is presented in a fragmentary manner on the left bank of Teslui (in the final sector) and is completely absent in the case of Olt's riverbed. Scroll bars are gradually replacing eyots. Whereas the previous material presented Teslui's riverbed in its natural state, with a wide area of divagation during *„high waters"* or flash floods, the situation in 1980 is different, with a flood plain modified by human activity through irrigation systems and partial damming of areas, which slowly cancel the river's freedom (figure 5).

The purpose of these drainage – damming – irrigation interventions was to turn this area, which suffered from frequent flooding, into agricultural lands. Also, the expansion of farms right up to the level of the minor riverbed in some sectors (the village of Reșca) put pressure on the river's course, which nowadays frequently crosses the villagers' gardens. The last cartographic materials consulted were the aerial mappings (scale of 1:5.000, 2008), and they explain in detail the present dynamic of Teslui's riverbed. After the regulation of Olt's lower course, the problem of channelling the confluence sectors of its tributaries emerged, and this could limit to a certain extent the shifting of the junction point. Therefore, in 1997, Teslui's left bank was reinforced with a 2 metre high dyke, which ran for 4 km, from the junction point upstream. In this manner, the minor riverbed of Teslui oscillates in this sector between the right bank, left in its natural state, and the left bank, which is dammed (figure 6).

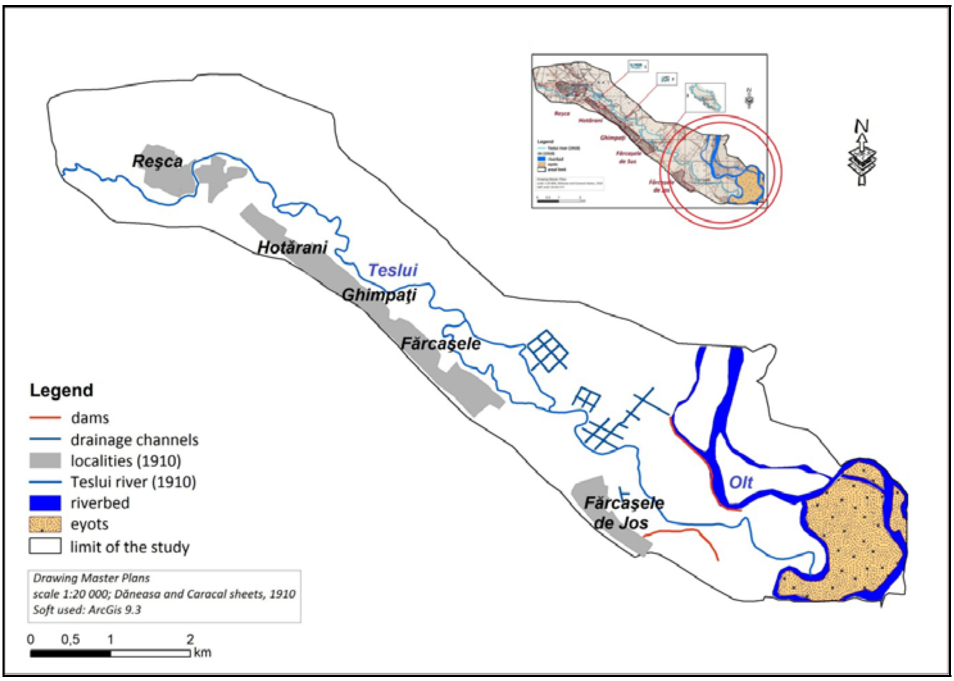

Figure 4. Map of human interventions in the Teslui – Olt confluence area
(Source: 1:20.000, Drawing Master Plans, 1910)

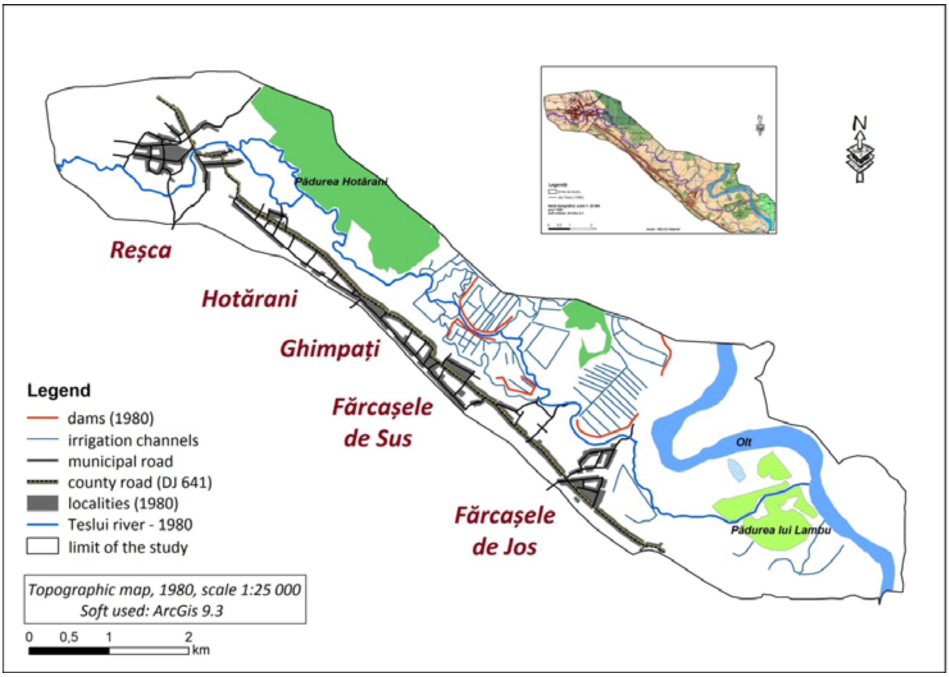

Figure 5. Map of human interventions in the Reșca – Fărcașele de Jos sector of Teslui's riverbed
(Source: topographic maps, 1980)

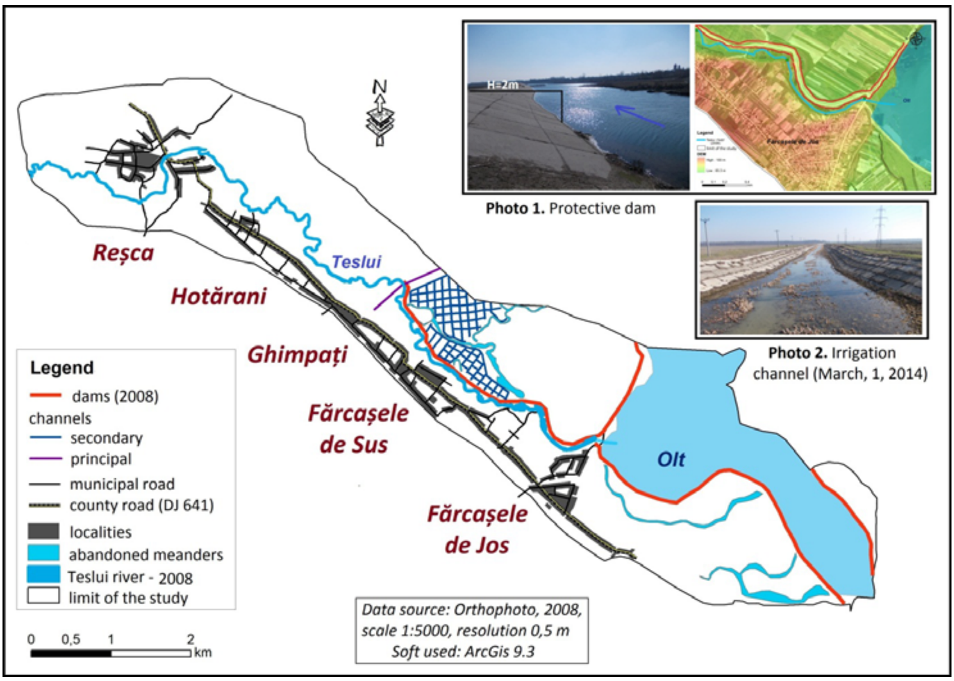

Figure 6. Map of human interventions in the Resca – Farcasele de Jos riverbed sector, Teslui
(Source: aerial maps from 2008)

In the research field, even today it is possible to see traces of the river course's changes, signalled by abandoned river arms, oxbows and ponds, left near the dammed areas that have a high level of phreatic waters.

The morphometrics characterisation of the minor riverbed between 1910 and 2008

The research carried out on the ground and using cartographic methods strengthens the idea of Teslui's minor riverbed dynamics (figure 7a).

Thus, 13 cross sections have been established (profiles taken at intervals of 1 kilometre), where several measurements were made: width of the minor riverbed (l), sinuosity index (Is), length of the minor riverbed (L) between the extreme profile points (1 – 13) (figure 7b).

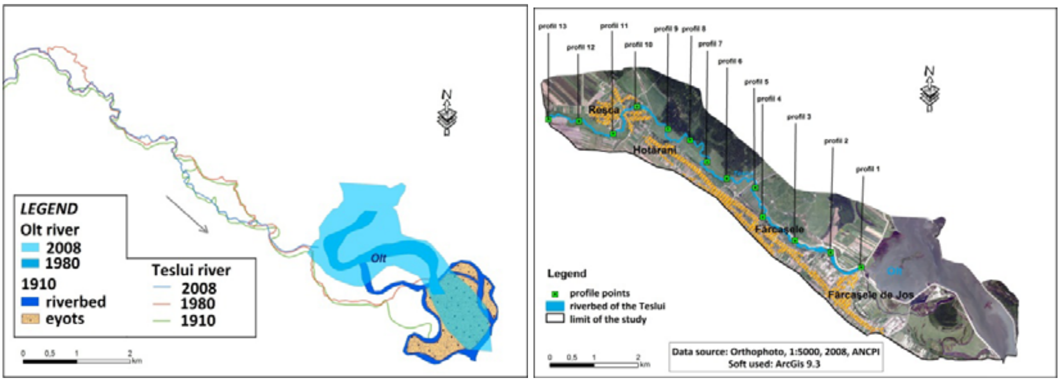

Figure 7. The dynamics of Teslui's minor riverbed (a) and the location of the profile positions (b)
(Source: ortophotoplans, 2008)

The width of the minor riverbed is the first morphometric parameter measured for each cross section, with significant variations between 1910 and 2008 (figure 8).

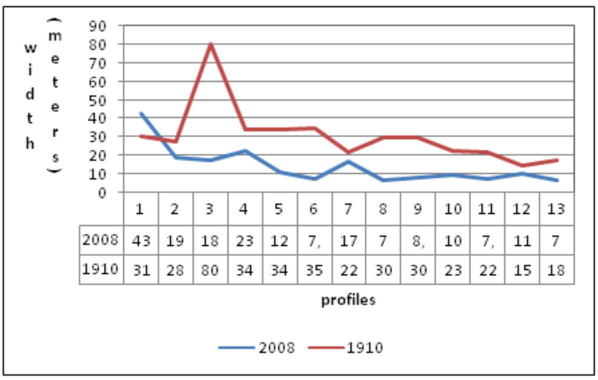

Figure 8. Variation of Teslui riverbed's width in the Reșca-Fărcașele de Jos sector, 1910-2008

It is to note a slight increase in the width of the minor riverbed along the river, with variations ranging between 7 and 80 metres, the average value being 43.5 metres (measured at full banks). In the riverbed sectors that experienced anastomosis, the measurements taken were those of the main flow canal. A comparison of the river bed's width in 1910 and 2008 shows a clear tendency of narrowing of the river over time, and this parameter tends to increase from upstream towards downstream. If in 1910 there are noticeable differences in the distribution of values, in 2008, these differences are much lower. This situation is explained by the fact that the riverbed was affected by human intervention, and nowadays, the course of the river is determined by human interventions. The partial canalization of the river on its final 4 kilometres led to the concentration of the entire water flow on a single canal, thus generating a wider by 12 metres compared to the past, when Teslui River could divagate freely at the slightest fluctuation in flow. Therefore, the average width of the minor riverbed calculated for 1910 was of 30.9 metres, compared to a maximum of 14.6 metres in 2008.

The length of the minor river bed and sinuosity index

Data from 1910, 1980 and 2008 show that the length of the riverbed has changed between these moments by several hundreds of meters, based on the analysed cartographic material. The river's length decreased continuously form 15.4 kilometres in 1910 to 15.2 kilometres in 1980 and 12.7 kilometres in 2008. This decrease can be explained by the shifting of the confluence point towards the North, which is visible on the ground because of the abandoned river arms and oxbows of the old course. The local presence of stretches of dykes on the topographic map (1980) shows us that Teslui's freedom of movement has been somewhat limited. The river's course is 200 metres shorter. The massive difference of 2.5 kilometres between 1980 and 2008 is the result of the embanking of the right bank and the complex works that altered the confluence between Olt and Teslui Rivers. The once flooded terrain became arable land and the inhabited area expanded (Olt's flood plain). The sinuosity index was determined for the main flowing canal by calculating the ratio between the sinuous length of the minor river bed and the straight line length of the same river bed. In cases of meanders, their length is calculated as a ratio between the length of the minor river bed and the chord. Values lower than 1.5 characterise a sector of a river as having a sinuous riverbed and values equal to or above 1.5 are associated with river sectors which have a river bed with many meanders (Leopold & Volman, 1957).

The average value for the sinuosity index calculated for the three reference moments (1910, 1980 and 2008) is 1.39, a value that characterises the riverbed as sinuous. The moment with the greatest evolution is that of 1980, and afterwards the index's value decreased to 1.23 in 2008 (figure 9). Therefore, the river has transformed itself from a sinuous riverbed to a river bed with meanders and then back to a sinuous river bed.

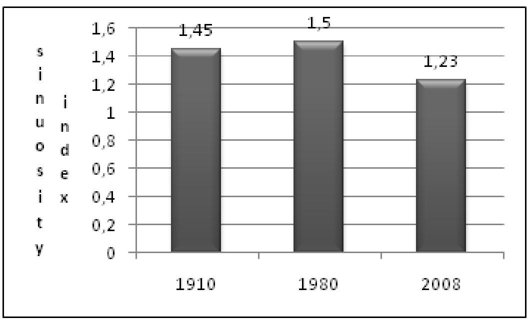

Figure 9. The variation of the sinuosity index – Teslui River (Reșca-Fărcașele de Jos)

CONCLUSIONS

Systematic observations of the morphometric parameters specific for the horizontal configuration of Teslui's riverbed (measured at 13 cross sections) allow for the identification of Teslui's evolutionary tendencies in the 1910-2008 interval, seen as representative for its behaviour under the influence of human actions.

Therefore, it is possible to observe that the river maintains its basic morphometric characteristics over the entire time span, with the exception of the minor riverbed's width, which suffers from significant narrowing due to the development of the course. In addition, an increase in the dynamic character was noted until 1980 (the evolution of meanders towards complex forms), followed by a decrease in the riverbed's dynamic nature (straightening and shortening of the minor riverbed because of self-capturing meanders).

The human factor played an extremely important role in the dynamics of Teslui and Olt riverbeds through the regulation of the entire confluence sector. The expansion of households in the alluvial plain and the cultivation of lands close to the minor river bed determined the river to react at the slightest human impulse by changing its course.

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